DOI: http://dx.doi.org/10.5007/2175-8026.2023.e94613

EFFECT OF INTERLINGUAL HOMOGRAPHS AND WORD FREQUENCY ON BILINGUAL LEXICAL ACCESS

Pâmela Freitas Pereira Toassi[1*]
[1]Universidade Federal do Ceará, Fortaleza, CE, Brasil

Justin Lauro[2**]
[2]Barry University, Miami, FL, United States of America

Liana Maria da Silva Gadelha[1***]
[1]Universidade Federal do Ceará, Fortaleza, CE, Brasil

Maria Teresa Carthery-Goulart[3****]
[3]The University of Hong Kong, Hong Kong, China

Abstract

In two experiments, a language decision task, and a multiple-choice English-Portuguese translation task, we examined the effect of interlingual homographs and word frequency on lexical access of Brazilian-Portuguese - English bilinguals. Language choice, accuracy, and response times were registered by the PsyToolkit software, and linear mixed-effects models were used in the analysis of the data. The results of this study align with the non-selective lexical access hypothesis. Bilinguals had facilitated access, particularly for words in the L2. There was also an interference effect of word frequency observed in both the L1 and L2 for interlingual homographs.
Keywords: Bilingualism; lexical access; interlingual homographs; word frequency

[*] Assistant Professor at the Department of English Studies, its Literature and Translation, and permanent professor of the Post-Graduate Programs of Translation Studies (POET) and of Linguistics (PPGLin) of the Federal University of Ceara. She was a Fulbright Visiting Scholar in the Department of Psychology at Barry University in 2023. Holds a PhD in Linguistics (Letras-Inglês) through the Federal University of Santa Catarina and post-doctoral studies at the Post-Graduate Program in Neuroscience and Cognition from the Federal University of ABC. She is the cofounder and leader of LabFoM - Laboratory of Phonetics and Multilingualism (labfom.ufc.br). Her research interests are: lexical access, vocabulary acquisition, teaching and learning of English as a foreign language, teacher formation, multilingualism, crosslinguistic influence, reading and translation. Email: pamelatoassi@ufc.gmail.com. ORCID: https://orcid.org/0000-0003-3273-639X.

[**] Assistant Professor of Psychology at Barry University, where he is the head of the cognitive psychology laboratory. He received a PhD in Psychology from the University of Texas at El Paso and post-doctoral studies at Florida Atlantic University. His main research interest is in the bilingual acquisition of novel words. He may be contacted at jlauro@barry.edu. ORCID: 0000-0003-0936-4794.

[***] Holds a Master in Translation Studies from the Postgraduate Program in Translation Studies (POET), from the Federal University of Ceará (UFC). Specialist in Applied Linguistics, from 7 de Setembro University (Uni7). Graduated in Portuguese from Vale do Acaraú State University (UVA). Graduated in English, from the Federal

University of Ceará (UFC). Effective professor at the State Education department, in a technical public high school, in the state of Ceará. Email: lianagadelha1313@gmail.com. ORCID: https://orcid.org/0000-0001-8561-9600.

[****] Associate Professor at the Center for Mathematics, Cognition and Computing, Federal University of ABC and a researcher at the Cognitive and Behavioral Neurology Unit, School of Medicine, University of São Paulo. She is a speech and language therapist, graduated from the Faculty of Medicine, University of São Paulo. She obtained her M.Sc. in Psychology in the area of Neurosciences and Behavior from the Institute of Psychology, University of São Paulo and her Ph.D. in Sciences (Neurology) from the Faculty of Medicine, University of São Paulo. She has been a Visiting Scientist at the Medical Research Council - Cognition and Brain Sciences Unit, Cambridge (2007-2008) and is currently a Visiting Researcher and a Lecturer in the Unit of Human Communication, Development, and Information Sciences, Faculty of Education, The University of Hong Kong. She has studies in Cognitive Neuroscience of Language, Neuropsychology, Psycholinguistics, and Neurolinguistics. Email: teresa.carthery@gmail.com. ORCID: 0000-0002-2751-4541.

Introduction

One of the main questions concerning the bilingual lexicon is if the words of a bilingual's two languages are activated even when only one language is intended to be used, which is commonly referred to as the nonselective access hypothesis. The opposite view, the selective access hypothesis, is that bilinguals can select only one of their languages to use, without the interference of the non-target one. One way to investigate the issue of selectivity has been to measure the performance of bilinguals on lexical decision, word or picture naming tasks, with stimuli consisting of words that share phonological (interlingual homophones), semantic (cognates) and orthographic features (interlingual homographs, cognates and false friends) between their two languages.

The rationale driving these studies is that if lexical access is nonselective in nature, the shared features between words across two languages would facilitate lexical access. This would be reflected in faster reaction times (RTs) and higher accuracy compared to words that do not share those properties. On the other hand, words which share some features but not others (e.g., interlingual homophones), would lead to an interference effect due to possible ambiguity resolution. This would result in slower reaction times and lower accuracy. However, if lexical access were selective, none of these word similarity features would interfere in the process.

In order to further investigate the bilingual lexicon selectivity issue, we investigated lexical access in Brazilian Portuguese- English bilinguals by having them perform a language decision and a multiple-choice translation task, both containing interlingual homographs (HG) between their two languages. In the following we explore the effect of the interlingual homographs on bilingual lexical access.

Interlingual homographs

Interlingual homographs are words that share the same orthography across two languages but have different meanings in each language. If lexical access is non-selective, both words would be automatically activated until the speaker selects the correct word, resulting in a lexical interference effect. The effect of interlingual homographs in bilingual lexical access has been investigated in a variety of experimental tasks. For example, one study examined language production in a picture naming task using interlingual homographs with English-French and French- English bilinguals (Jared & Szucs, 2002). The pictures to be named had different pronunciations in each language, were low-frequency in English and high-frequency in French. Word production was divided into three blocks: in the first block participants only named words in English, in the second block they named words in French, and in the third block they named words in English again. The results showed that the English-dominant bilinguals named control words similarly to the homographs in the first block. However, after having named the French words, an interference effect from the interlingual homographs appeared in the third block, in which naming was significantly faster for the control words as compared to the homographs after having read French words prior to reading English. For the French-dominant bilinguals, interlingual homographs were named significantly slower than the control words both in the first and third block. This might indicate that, for the English-dominant bilinguals, the activation of the L2 phonological representations was not as strong when participants performed a monolingual task (block 1). However, after naming words in their L2, activation of the L2 increased and interfered with the homographs in block 3. On the other hand, for the French-dominant bilinguals, naming in the L2 showed an effect of the L1 phonological activations even for the monolingual experiment (block 1).

We might interpret the results of Jared and Szucs (2002) as favoring a greater influence of the L1 on the L2 as compared to the influence of the L2 on the L1. These results would be aligned with a possible asymmetry on the influence of the bilinguals' two languages in the direction L1 -> L2 (Poort & Rodd, 2022)

Another study with English-French bilinguals applied a visual-image matching task containing interlingual homographs and cognates (Vingron et al., 2022). The experimental task was divided into an English block and a French block, in the order of participants' language acquisition. Interlingual homographs interfered with lexical access. Participants demonstrated lower accuracy and longer reaction times for interlingual homographs than control words. Additionally, word frequency did not have an effect on accuracy for the control words but influenced reaction time. High-frequency control words had a shorter reaction time than low-frequency words. Finally, language use also influenced participants' accuracy and reaction time. Higher L2 usage led to lower accuracy in the task in the L1 and higher accuracy in the task in the L2. For cognate words, accuracy was not different across controls, but reaction time was slower in the L2 block as compared to the L1 block.

Interlingual homographs, cognates and translation equivalents were used in an experimental paradigm involving sentence reading and priming effects of the L2 into the L1 for Dutch- English bilinguals (Poort & Rodd, 2022). Participants read sentences in English containing cognate, interlingual homographs and translation equivalents (controls), and after 15 minutes were asked to make a semantic relatedness task with those same target words in their L1, Dutch. The results provided evidence that cross-lingual priming is bidirectional since the interlingual homographs suffered an inhibition effect. However, there was no effect of facilitation for the cognate words.

An interference effect of interlingual homographs has also been observed in semantic relatedness judgment task(s) (Durlik et al., 2016). Polish-English bilinguals made semantic relatedness judgements in their L2. Experimental conditions were divided into 4: two in which word pairs were related and 2 in which they were unrelated in meaning. For the unrelated condition, there could be a pair containing a homograph or a control word. In the homograph condition, the unrelated word in English was related to the Polish meaning of that homograph. On the other hand, for the related condition, there could be a pair of a translation of the homograph word with the meaning of the L1 – Polish or a control word. The results demonstrated that participants took longer to judge the pairs of words, when the words were unrelated, and when the word-pairs contained a homograph compared to a control. When the words in the word-pair were related, RTs were longer when preceded by a homograph compared to a non-homograph control. However, there was no interaction between proficiency and the critical conditions of the experiment.

Several studies have also investigated the effect of interlingual homographs in bilingual lexical access using a lexical decision task (Lemhöfer & Dijkstra, 2004; Dijkstra, Van Jaarsveld & Ten Brinke, 1998; Dijkstra, Grainger & Van Heuven, 1999; Poort, Warren & Rodd, 2016; Dijkstra, De Bruijn, Schriefers & Ten Brinke, 2000; Vanlangendonck, Peeters, Rueschemeyer & Dijkstra, 2020; Kerkhofs, Dijkstra, Chwilla & De Bruijn, 2006; Dijkstra, Moscoso del Prado Martín, Schulpen, Schreuder & Harald Baayen, 2005; Elston-Güttler, Gunter & Kotz, 2005; Poort & Rodd, 2017; Barcelos & da Luz Fontes, 2021). Nevertheless, in the study presented here, a language decision task has been applied. Instead of deciding if the word presented is a real word or not, in a language decision task, participants must choose to which language the presented word belongs. It is argued that the frequency-dependent inhibitory effects across languages might be larger in a language decision than in a lexical decision task (Dijkstra, Timmermans & Schriefers,2000).

In one language decision task examining the effect of interlingual homographs, Dutch-English bilinguals made language decisions on interlingual homographs which were divided into three word frequency conditions: high-frequency in the L1 and low-frequency in the L2, low-frequency in the L1 and high-frequency in the L2, and low-frequency in both languages (Dijkstra et al., 2000). The results clearly showed a cross-language frequency effect, in which, the language choices for English (L2) in the low-frequency in the L1 and high-frequency in the L2 condition were greater than the Dutch (L1) ones. This is also consistent with the RT data, showing shorter RTs for the English (L2) choices than the Dutch (L1) ones in this condition. This matter of word frequency in bilingual lexical access is the focus of the data analysis presented in this paper. However, before going into the details of the analysis carried out, we explore in the following section the role of word frequency on bilingual lexical access.

Word frequency

It is well known in the lexical access literature that high-frequency words have facilitated processing compared to low-frequency ones. For bilinguals, it has been proposed that word frequency seems to affect the L2 more than the L1. This has been termed as the "weaker links" hypothesis (Gollan et al., 2008) or the frequency-lag hypothesis (Gollan et al., 2011).

The weaker-links hypothesis was first demonstrated in a study in which bilinguals showed larger frequency effects in a picture naming task than monolinguals, as well as larger frequency effects in their non-dominant language than in the dominant one (Gollan et al., 2008). According to this hypothesis, low-frequency words have a greater effect on bilinguals in their non-dominant language. The follow up to the weaker links hypothesis replicated the findings from the original study. Frequency effects were larger for the non-dominant language (Gollan et al., 2011). In that study, a picture naming task, a lexical decision task and a reading task with eye movement recording compared English monolinguals, Spanish-English bilinguals and Dutch- English bilinguals. Experiment 1 consisted of a picture naming task and experiment 2, an eye-tracking reading task. The comparison of experiments 1 and 2 showed that in reading, lexical access is frequency driven, however, in production, semantic constraint effects drive lexical access. Similarly, in a reading task, with eye movement recording, a greater word frequency effect for older French-English bilingual adults than younger ones was found during reading paragraphs while having their eye movements monitored (Whitford & Titone, 2017). However, a separate study (Ivanova & Costa, 2008) failed to find any differences in word frequency effects between the dominant and non-dominant language comparing Spanish-Catalan and Catalan-Spanish bilinguals.

It has been argued that the interference effect of interlingual homographs is commonly seen when they are low-frequency words in the target language and high-frequency in the non-target one (Dijkstra, Timmermans & Schriefers, 2000). In order to further investigate the effects of word frequency in bilingual lexical access, data from different corpus must be compared. Frequency is normally measured in fpm, that is, frequency per million words. However, this measure makes it difficult to compare data from large corpus, in which there are too many words with less than 1 fpm. In addition, in these large corpora, the difference between frequency 1 and 2 fpm and 10 and 20 fpm is the same, which also does not facilitate comparisons. In order to take frequency into account when investigating the bilingual lexicon, comparisons between different corpora are required. A Zipf scale, which is logarithmic and ranges from 1 to 7 has been proposed (Van Heuven, Mandera, Keuleers & Brysbaert, 2014), and this scale was used in the present study, which is further detailed in the next sections.

The present study

In this paper, we present a more in-depth analysis of the data from Gadelha and Toassi (2022), which investigated lexical access processes of Brazilian Portuguese – English bilinguals, by means of a language decision task and a multiple-choice translation task, containing interlingual homographs. The results of Gadelha and Toassi (2022) showed that, in the language decision task, control words in English had better accuracy and faster reaction times than control words in Portuguese and interlingual homographs. In addition, repetitive priming effects were investigated, and results evidenced that control words had facilitated processing but interlingual homographs had not. While the original study was designed to test the hypotheses of non-selective vs selective bilingual lexical access in tasks that explicitly demanded the activation of both languages, the results suggested that factors other than the word-type (i.e., presence of interlingual homographs) might have influenced lexical access, as evidenced by differences in accuracy, reaction times and priming effects in specific word-types. To study these factors, in the current study we employ LMM in order to obtain a more comprehensive view of the phenomenon investigated. Our hypotheses for the reanalysis of the data are the following:

1. Word types (interlingual homographs or control words) predict the degree of cross-language lexical access in bilinguals.

2. Language specific word-frequency is a predictor of bilingual lexical access.

Method

Participants

The present study included 26 Portuguese-English bilingual participants. However, data of 3 participants had to be excluded, resulting in a final sample of 23 participants. All participants signed a consent form and the present study was approved by the Ethics Review Board of the Federal University of Ceara (CAAE 33969320.8.0000.5054). All participants were Brazilians and spoke English as a second language[1]. Further information regarding their characteristics is presented in Table 1.

Table 1: *Participant characteristics*

Sample Size	23
Mean age (SD), Range	36.4 (7.6), 25-57
Sex	18 Female, 5 Male
Education	21 (91.3%) graduate students 2 (8.75%) undergraduate students
Profession	23 (100%) English teachers
Age that started having contact with English	1 (4.3%): from 1 to 7 years old 14 (60.9%): from 7 to 14 years old 6 (26.1%): from 14 to 21 years old 2 (8.7%): after 21 years old.
Age that started formal learning of English	1 (4.3%): from 3 to 7 years old 11 (47.9%): from 7 to 14 years old 7 (30.4%): from 14 to 21 years old 4 (17.4%): after 21 years old.

Way(s) in which they had contact with English before starting formal learning	20 (87%): through movies, TV shows, music, video game, internet, TV or radio 1 (4.3%): through school 2 (8.7%): no contact.
If they are still studying English	22 (95.7%): yes 1 (4,3%): no.
Subjective L2 rating - Reading	17 (73.9%): Advanced 6 (26.1%) Intermediate.
Subjective L2 rating - Listening	10 (43.5%): Advanced 12 (52.2%): Intermediate 1 (4.3%): Basic.
Subjective L2 rating - Speaking	9 (39.1%): Advanced 14 (60.9%): Intermediate.
Subjective L2 rating - Writing	10 (43.5%): Advanced 11 (47.8%): Intermediate 2 (8.7%): Basic.

Materials

Stimuli

The first step in stimuli preparation was to build a corpus of Brazilian Portuguese- English homograph words. Having as the main criteria that the words should have the exact same spelling in the two languages and different meanings, we were able to select 34 words. Each one of these 34 homograph words was paired with a control word in English and another in Portuguese. Controls and homographs should be matched in number of letters, grammatical class and frequency. In order to be able to analyze frequency effects among Portuguese-English words Zipf-scale (van Heuven, Mandera, Keuleers, & Brysbaert, 2014) was used for frequency. The values were obtained from the SUBTLEX corpus American English using the SUBTLEXUS database (Brysbaert & New, 2009) for the English words and from the Léxico do Português Brasileiro (Estivalet & Meunier, 2017) for the Portuguese words (Table 2).

Table 2: *Descriptive statistics for the frequency of the stimuli on Zipf scale*

	Homograph English version	Homograph Portuguese version	Control in English	Control in Portuguese
Median	4.18	3.46	4.3	3.51
Mean (SD)	4.05 (1.16)	3.45 (0.94)	4.02 (1.18)	3.34 (0.96)
Minimum	1.59	1.81	1.59	1.51
Maximum	6.5	5.62	6.29	5.66

In Experiment 1, 17 homographs and 34 control words (17 in English and 17 in Portuguese) were used. Therefore, Experiment 1 had 51 target words. In Experiment 2, 34 homographs and 34 controls in English were used. Target words were divided into two lists, each with 17 homographs and 17 controls words in English. Therefore, each participant viewed 34 total target words in Experiment 2. The stimuli are available at https://osf.io/qds3b/?view_only=9fa166365652407c80f30fe9249b4bcb.

Apparatus

Data were collected online using the PsyToolKit software (Stoet, 2010, 2017).

Procedure

Experiment 1 - language decision task

Of the 34 homograph corpus constituted for the present study, 17 were randomly selected to be part of Experiment 1. The matched control words for these homographs, 17 in English and 17 in Portuguese also formed the list of words of this task. These 51 words were randomly presented to participants, one at a time. They had to decide as fast and accurately whether the word presented on the center of the screen was a word in Portuguese or in English. They had up to 3000 ms to answer. Before starting the actual task, participants saw a welcome screen, an instructions screen and had a training session with 15 words. The trials proceeded as follows:

- a fixation cross was shown on the center of the screen for 500ms;
- after that, there was a 500ms blank screen interval;
- the target word (either a HG or a control in Portuguese or English) was presented in lower case, font arial 40, on the center of the screen;
- participants had up to 3000 ms to decide whether the word was from Portuguese or English;
- their answer was given by pressing the keys A or L from the computer keyboard.
- after pressing the keys, A or L to answer, or after 3000 ms had passed, the word disappeared from the screen and there was a blank screen interval of 500ms before the next trial began.

For this task, two lists were built, in one of them, the key A referred to Portuguese and in the other to English, to avoid the effect of the participant's dominant hand.

Experiment 2 – Multiple choice translation task

For this task, all the 34 homograph words were used, the same 17 interlingual homographs from experiment 1 plus another pool of 17 homographs which were not present in the first task. The 34 matched control words in English of these homographs were also present in Experiment 2. These 68 words were divided into two lists containing 34 words, each with 17 homographs and 17 control words in English. From now on, the homograph and control words which were present in Experiment 1 will be referred to as "studied HGs" and "studied controls" and the homographs and control words which were only present in Experiment 2 will be referred to as "non-studied HGs" and "non-studied controls".

Experiment 2 was designed as a multiple-choice translation task from English to Portuguese. Participants had to choose, using the keys "a", "g" and "l", the best translation for the word presented. Before the actual task, participants saw a welcome screen, an instructions screen and had a training session with 10 words. The trials proceeded as follows:

- a fixation cross was shown on the center of the screen for 500ms;
- after that, there was a 500ms blank screen interval;
- the word in English was presented in lower case, font arial 60, on the center of the screen;
- the three options of translations in Portuguese were presented in lower case, font arial 30, at the bottom left, right and middle of the screen, corresponding to the keys a, g and l of the computer keyboard;
- participants had up to 3000 ms to choose the best translation;
- their answer was given by pressing the keys A, G or L of the computer keyboard;
- after pressing the keys, A, G or L to answer, or after 3000 ms had passed, the words disappeared from the screen and there was a blank screen interval of 500 ms before the next trial began.

For this experiment two lists were built. Both the studied and non-studied HGs were divided into two lists. The homographs and controls were counterbalanced across the two lists, in a way that each part of the pair HG-CT was placed in one of the lists.

Data Analysis Plan

Experiment 1 - language decision task

The independent variables of Experiment 1 were word type (Control words and homographs), and language (Portuguese and English). This resulted in the following conditions: Control words in English, Control words in Portuguese, and English/Portuguese homographs. Additionally, word frequencies In Portuguese and English were transformed to Zipf and scaled from 1 to 7(e.g. Van Heuven et al., 2014). These transformed frequencies were treated as continuous independent variables. The dependent variables were response accuracy for control words in Portuguese and English, and language choice (Portuguese or English) for the homographs. Because homographs had the same spelling in English and Portuguese, there was no correct response in the homograph condition. Additionally, reaction time (RT) in milliseconds (ms) for correct trials of participants' language decisions for control words and all trials for the homograph condition were analyzed as a dependent variable.

Accuracy and language choice were analyzed with a generalized linear mixed effects model. Reaction time was analyzed with a linear mixed effects model. These models were analyzed using linear mixed-effects regression models within the lme4 package (Bates et al., 2015) of R (version 4.2.3; Baayen, 2008; Baayen et al., 2008; Core Team, 2017). A model comparison approach was taken in which the simplest model, including the design variables and their interactions as fixed effects and random intercepts for participants and items, was calculated first. Random slopes across participants and items were added for one variable at a time to determine whether model fit improved, indicated by a significant difference in the log-likelihood ratio. If model fit improved, the random slope was retained. Therefore, the final model represents the maximal random effects structure in which the model converged.

Experiment 2 – Multiple choice translation task

The independent variables of Experiment 2 were the conditions: SHG (studied homographs), SCT (studied controls), NHG (non-studied homographs) and NCT (non-studied controls). The dependent variables were Accuracy and Reaction time. The analysis proceeded the same way as in experiment 1, where Accuracy was analyzed with a generalized linear mixed-effects model and Reaction time was analyzed with a linear mixed-effects model. These models were analyzed using linear mixed-effects regression models within the lme4 package (Bates et al., 2015) of R (version 4.2.3; Baayen, 2008; Baayen et al., 2008; Core Team, 2017) and the analysis started with the simplest model and ended with the most complex one.

Results

Experiment 1 – Language Decision Task

First, 7 trials (0.59% of total trials) were removed from the analysis because they did not have a computed response within the 3000 ms determined for the test. Separate analyses were then carried out for control words and homograph words. For all the analyses, linear and logistic mixed-effects regression models were analyzed using linear mixed-effects regression models within the lme4 package (Bates et al., 2015) of R (version 4.2.3). A model comparison approach was taken such that random slopes across participants and items were incrementally added to determine if model fit improved, indicated by a significant difference in the log-likelihood ratio. If the model fit improved, the random slope was retained. As such, the final model represents the maximal random effects structure for each model.

Analysis of Control words

In order to assess the effect of English and Portuguese frequency, separate analyses had to be completed on control words only. Accuracy was higher for English than Portuguese controls. Also, RTs were shorter for English than Portuguese controls (Table 3). These results might indicate some facilitation for English words as compared to Portuguese ones. In order to analyze if these observed differences were significant and if they interacted with word frequency, the following steps were carried out.

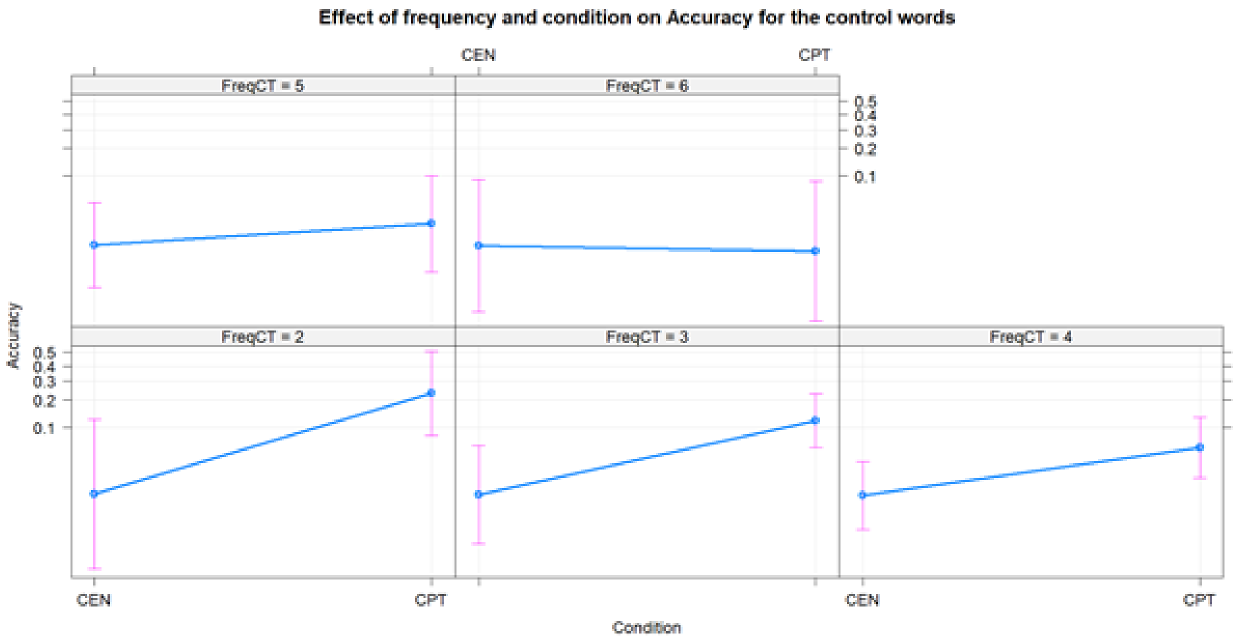
Table 3: *Descriptive statistics for the control words*

	Accuracy Rates	RTs for correct Trials (SD)
Control English	97%	829 (291)
Control Portuguese	85%	990 (331)

A preliminary model treating accuracy as the dependent variable and language condition (English control vs Portuguese control) as a predictor, with random intercepts by participant and by word was calculated. Adding random slopes by condition for participants and for words did not converge. Therefore, in the model comparing language condition, there was a significant difference in accuracy rates by condition, Z = 3.14, $p < .001$. While accuracy rates across both conditions was high, participants were more likely to correctly identify English words than Portuguese words. Adding random slopes by participant and by word in the model did not converge.

Next, Zipf transformed word frequency was included in the model. Adding random slopes by participants and by words did not converge. Therefore, the final model included condition (English vs. Portuguese) and word frequency as predictors, and random intercepts for participants and words. The difference in accuracy between English and Portuguese control words was not quite significant, Z = 1.91, $p = .057$. The interaction between frequency and control condition in English was not significant, Z = -0.46, $p = .96$, nor was the interaction between control condition in Portuguese and frequency, Z = -1.32, $p = .19$. The model can be better visualized in Figure 1.

Figure 1: *Effect of frequency and condition on accuracy for the control words*



Although the interaction of frequency was not significant, we can clearly observe the pattern displayed in Figure 1, in which accuracy of English words seems to increase as frequency increases. For low-frequency words (FreqCT = 2) we can see a greater accuracy for PT than EN. This difference seems to be maintained towards more intermediate frequency values (FreqCT = 3 and 4). However, the difference seems to be slightly smaller. For higher frequencies (FreqCT = 5 and 6) there seems to be practically no difference between conditions.

To analyze the RTs of correct trials, the simplest model was calculated first. Language condition was treated as the predictor, with random intercepts by participants. RTs for correct trials were treated as the dependent variable.

Treating RTs as the dependent variable and control condition (English or Portuguese) as a predictor, and random intercept by participants. Adding random intercepts by words significantly improved model fit, $Chi^2(1) = 60.74$, $p < .001$. Adding random slopes by condition for participants also improved model fit, $Chi^2(2) = 10.70$, $p = .004$. Adding random slopes by condition for words did not improve model fit, $Chi^2(2) = 2.19$, $p = .34$. Therefore, the preliminary model assessing language condition on RTs for correct trials included language (English or Portuguese) as a predictor, random intercepts by participants and words, and random slopes for condition by participants. RTs were significantly faster for Control words in English compared to control words in Portuguese, t = 3.78, $p < .001$ (see Table 3).

To examine the role of word frequency, frequency (transformed to Zipf and centered) was added to the linear mixed effects model. Model fit improved significantly, Chi2(2) = 16.22, $p < .001$. In this model, RTs were not significantly different between conditions, t = 1.71, $p = .097$. The word frequency was a significant predictor of RTs for correct trials for the English controls, t = -2.495, *p* = .018. As the word frequencies increased, RTs on correct trials for the English controls decreased. There was no significant interaction between Portuguese controls and word frequency, t < 1.

Figure 2: *Effect of frequency and condition on RT for the control words*

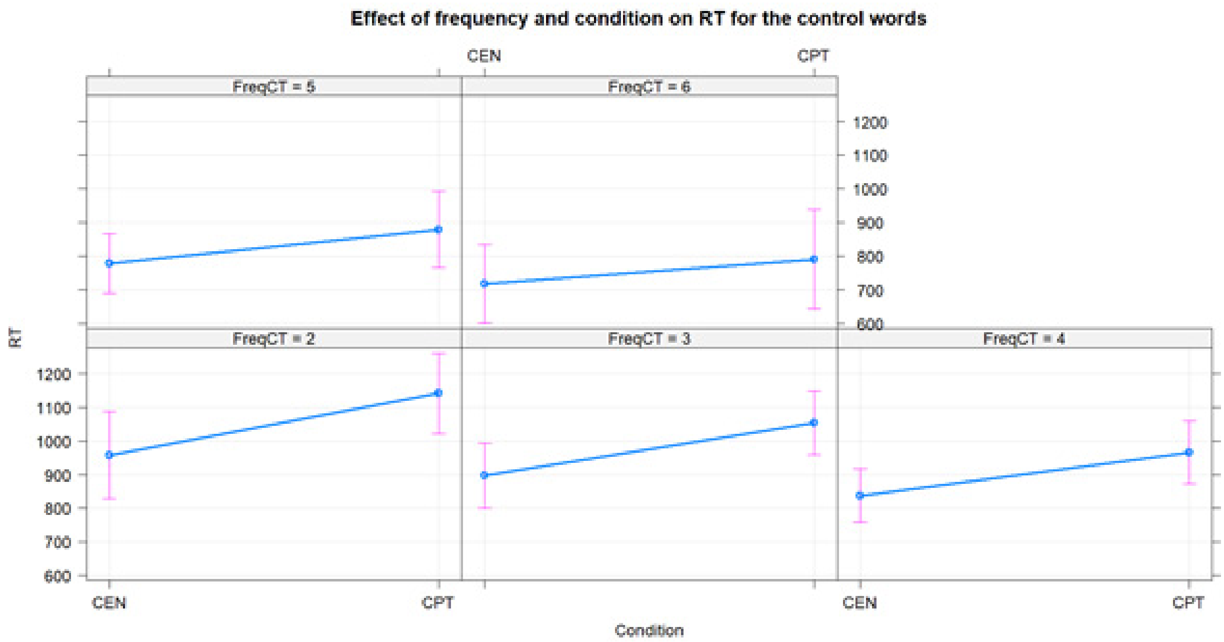


Figure 2 shows that RT for the control words in English was shorter than for the control words in Portuguese for all the frequency ranges. The difference between the RT of the two conditions seems to decrease as word frequency increases, possibly due to the interaction between condition in English and frequency. The results of RTs are aligned with accuracy, in which we see that facilitation for English words is greater with the increase of frequency, which is demonstrated in higher accuracy and shorter RTs.

Analysis of homographs

Since the homograph words did not have a correct answer, they were analyzed separately from the control words (Table 4).

Table 4: *Descriptive statistics for the homographs*

	Language choice	RTs (SD)
English	57,6%	1020 (439)
Portuguese	42,4%	1028 (442)

Response times did not seem to differ for the language choices. However, English appears to have been preferred over Portuguese for the homograph words (Table 4). A chi square test demonstrated that the choices for English were significantly greater than for Portuguese ($Chi^2(1) = 8.99$, p=0.0027). In order to verify if those differences interacted with word frequency linear mixed-effects models were calculated.

First, we analyzed language choice. The simplest model was calculated with language choice (English or Portuguese) as the dependent variable, and English and Portuguese frequencies (1 to 7 scale) as predictors and random intercepts by participants. Adding random intercepts by words significantly improved model fit, $Chi^2(1) = 12.46$, $p < .001$. Adding random slopes by English and Portuguese word frequencies by participants and by words did not converge. Therefore, the final model included English and Portuguese frequencies as predictors of language choice, with random intercepts for participants and items. However, neither English frequency nor Portuguese frequency significantly predicted language choice, z's < 1.

To analyze the RTs, the simplest model included language choice (English or Portuguese) as a predictor and random intercept by participants. Adding random intercepts by words significantly improved model fit, $Chi^2(1) = 12.96$, $p = .001$. Adding random slopes for language choice by participants did not improve model fit, $Chi^2(2) = 3.45$, $p = .18$, nor did random slopes by language choice for words, $Chi^2(2) = 2.15$, $p = .34$. Therefore, the preliminary model included language choice, and random intercepts by participants and by words. There were no significant differences in RTs for English or Portuguese language decisions, t < 1.

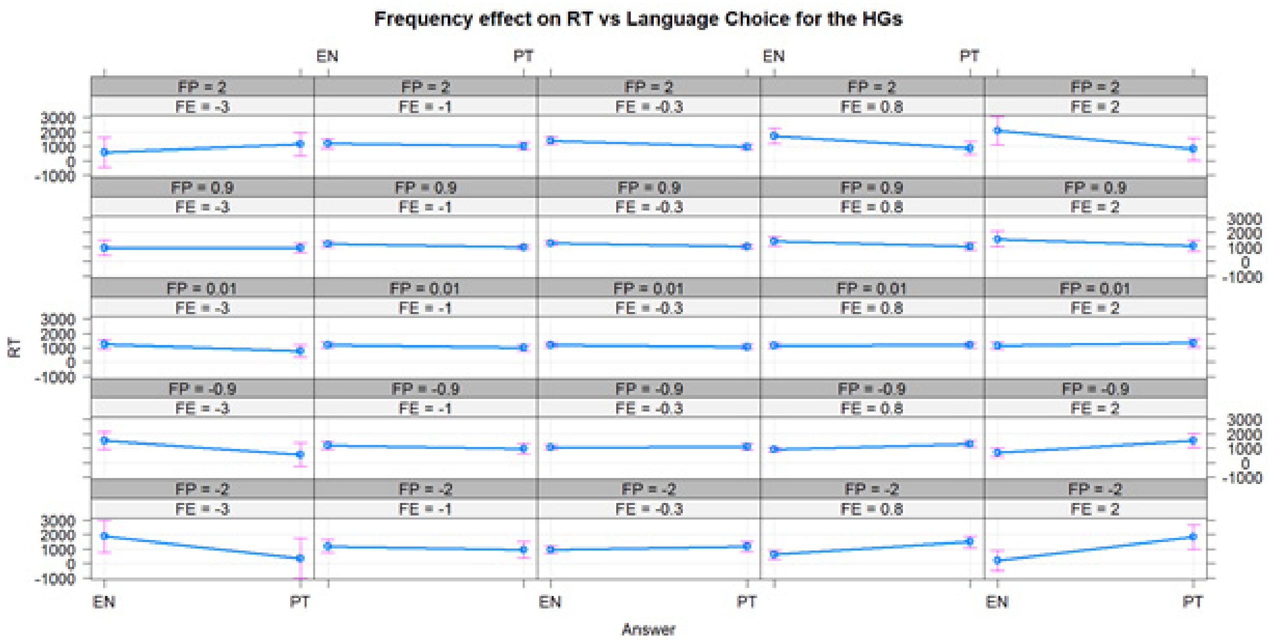
In order to assess the role of word frequency, English and Portuguese frequencies (transformed to Zipf) were centered and added to the LMM. That is, word frequencies centered around zero, which resulted in English frequencies ranging from -3 to 2, having their average at -0.3 and Portuguese frequencies ranging from -2 to 2, having their average at 0.01. Model fit significantly improved, $Chi^2\ (6) = 27.46$, $p < .001$.

Language choice was a significant predictor of RTs, t = 15.76, $p < .001$. Participants responded faster when categorizing words as Portuguese. English frequency was not a significant predictor, t = -0.37, p = .71. Portuguese frequency was a significant predictor of RTs, t = 2.94, p = .007. There was also a significant interaction between language choice and word frequency in Portuguese, t = -3.51, $p < .001$. As frequencies in Portuguese increased, RTs were faster for Portuguese language decisions. The interaction between Portuguese language choice and English word frequencies was not significant, $t = 1.83$, $p = .07$, nor was the interaction between English and Portuguese word frequencies, $t = 1.72$, $p = .10$. However, there was a significant three-way interaction between language choice, frequencies in English and frequencies in Portuguese, $t = -2.345$, $p = .02$. When English frequencies increase, RTs for English decisions decrease and when frequencies in Portuguese increase, RTs in Portuguese decrease.

Table 5: *HGs, RTs, Language Choice and Frequency*

	Effect of frequency and Language Choice for the HG		
Predictors	*Estimates*	*CI*	*p*
English	1172.64	1026.32 – 1318.96	**<0.001**
Portuguese	-80.85	-220.20 – 58.49	0.255
FrequencyEnglish	-18.84	-118.03 – 80.34	0.709
FrequencyPortuguese	156.28	51.77 – 260.80	**0.003**
Portuguese:FrequencyEnglish	131.79	-9.63 – 273.21	0.068
Portuguese:FrequencyPortuguese	-231.53	-361.21 – -101.86	**0.001**
English:FrequencyPortuguese	156.42	-22.92 – 335.76	0.087
Portuguese:FrequencyEnglish:FrequencyPortuguese	-247.83	-455.61 – -40.04	**0.020**
Random Effects			
σ^2	134063.00		
$\tau_{00\ Participant}$	44254.42		
$\tau_{00\ Word}$	11930.55		
ICC	0.30		
$N_{Participant}$	23		
N_{Word}	17		
Observations	387		
Marginal R^2 / Conditional R^2	0.065 / 0.341		

Figure 3: *Effect of frequency on RT vs Language Choice for the Homographs*



For the average frequency of Portuguese and English words (FP = 0.01 and FE = -0.3), RTs are very similar in Portuguese and English. The greatest differences can be observed when word frequency is high in both languages (Zipf in Portuguese and English = 2), and when frequencies are low in both languages (Zipf Portuguese = -2 and Zipf English=-3). In these cases, RTs are shorter for PT than EN. However, when word frequency is low in Portuguese (-2) and high in English (2), RTs are shorter in English.

As a follow up analysis, we compared RTs across the three conditions in LMMs with participants and items as random intercepts. Considering all trials for the model, RTs for controls in English were significantly shorter than controls in Portuguese (t=4,19, p<.001) and HGs (t=4,78, p<.001). For correct trials for the controls and all trials for the HGs, the differences remained significant between the same conditions, RTs for controls in English were significantly shorter than controls in Portuguese (t=3,69, p<.001) and HGs (t=4,62, p<.001), For these analyses we could not include frequency since controls words have only one frequency and HGs have two, one for Portuguese and two for English.

Discussion of Experiment 1

The analysis of the control words in Experiment 1 showed that accuracy was higher in English than in Portuguese. However, when this variable was analyzed in a generalized linear mixed-effects model, having both participants and words as random intercepts and word frequency together with condition as predictors, the difference between accuracies in English and Portuguese decreased, not quite reaching statistical significance. This might be due to sample size. Nevertheless, when we plot the model, we can see that the difference of accuracy between English and Portuguese controls is affected by the increase of frequency. For low-frequency, accuracy was higher for Portuguese than English, whereas for high-frequency, there is practically no difference between English and Portuguese accuracy.

On the other hand, the interaction of frequency was significant for the RTs for the control words in English. We clearly see that as frequency increased, RTs decreased. However, RTs were not statistically significant between conditions. For the control words, we can see the effect of frequency for the L2. This is consistent with the frequency-lag hypothesis (Gollan et al., 2011) which states that there are larger frequency effects for the non-dominant language, which is the L2 in the present study.

For interlingual homographs there was a preference for choosing English over Portuguese. However, RTs were quite similar for the two language choices. The statistical analysis did not reveal any interaction between frequency and language choice.

When RTs were analyzed, participants were faster when choosing Portuguese than English. In addition, there was an interaction of frequency and Portuguese choice. This interaction between word frequency and language was not observed when participants chose English. However, there was a three-way interaction, in which RTs decreased as frequency increased, for the two conditions.

The results of the interlingual homographs align with the study of Dijkstra, Timmermans, and Schriefers (2000) in which Dutch-English bilinguals also preferred the L2 over the L1 and had a shorter RT in a language decision task, when the HGs had a low-frequency in the L1 and a high-frequency in the L2. In the present study, RTs were shorter for EN in this scenario, low-frequency in the L1 and high-frequency in the L2.

Therefore, the analysis of both control words and interlingual homographs demonstrate that frequency influenced accuracy and RTs, but not language choice. It influenced the RT for the language choice. For the control words, frequency interacted with RTs for the answers in English, whereas for homographs it interacted with RTs when participants chose Portuguese.

A possible interpretation for these results is that when there was no cross-language competition (i.e., control words), frequency only interacted with the L2, considered the less dominant language. When there was cross-language competition during lexical access (i.e., interlingual homographs) frequency decreased RT for Portuguese (L1) language choice. In other words, when two different words are spelled the same in each language (but have different meanings), if the word is frequently used in the L1, access to the L1 word in the lexicon is faster.

In short, participants were faster and more accurate for English than Portuguese controls and chose more English than Portuguese for the homographs, however, when they chose Portuguese for the homographs it was due to a higher frequency in that language, which also led to faster RTs.

Experiment 2 – Translation Task

First, 140 trials (17.9% of trials) were removed from the analysis because they did not have an answer computed within the 3000ms determined for the test. Accuracy was higher and RT was shorter for the studied controls (SCT) than for the other three conditions (SHG, NCT and NHG) (Table 6). This might indicate a priming effect of this condition.

Table 6: *Descriptive statistics for studied and non-studied HGs and CTs*

	SCT	SHG	NCT	NHG
Accuracy Rates (%)	89.44	73.55	82.93	77.64
Response Time for correct trials (ms)	1852	2032	1943	2043

In order to further investigate this priming effect, linear and logistic mixed-effects regression models were analyzed using linear mixed-effects regression models within the lme4 package (Bates et al., 2015) of R (version 4.2.3). A model comparison approach was taken such that random slopes across participants and items were incrementally added to determine if model fit improved, indicated by a significant difference in the log-likelihood ratio. If the model fit improved, the random slope was retained. As such, the final model represents the maximal random effects structure for each model.

The simplest model had Accuracy as the DV, Condition as the IV, and random intercepts by participants for the simplest model. Adding random intercepts by item significantly improved model fit, $Chi^2(1) = 35.61$, $p < .001$. Adding random slopes by condition for participants, and for words, failed to converge. Therefore, the preliminary model included Condition as the predictor, and random intercepts by participants and by words.

There was no significant difference in accuracy between SCT and NCT, z = 1.112, $p = .27$. There was a significant difference in accuracy between SCT and SHG, z = 2.63, $p = .009$. There was also a significant difference in accuracy rates between SCT and NHG, z = 2.03, $p = .04$. Accuracy rates were highest for SCT (89.44%), and significantly lower for SHG (73.55%) and NHG (77.64%).

In order to assess the impact of word frequency, frequency was added to the model as a continuous independent variable. There was significant improvement of model fit, $Chi^2(4) = 38.95$, $p < .001$. In this model, there was a significant interaction between accuracy of the SCT and English word frequency, z = -3.420, $p < .001$.

Response Time

Response Time as the dependent variable, and condition as the independent variable, and random intercepts by participants as the simplest model. Adding random intercepts by item improved model fit, $Chi^2(1) = 124.7$, $p < .001$. Adding random slopes by condition for participants and for words did not converge. There were no significant differences amongst the conditions in this model.

Adding frequency (Zipf, measured from 1 – 7) as a continuous predictor improved model fit, $Chi^2(4) = 39.736$, $p < .001$. Therefore, the final model included condition, English frequency (measured continuously) as predictors, and random intercepts by participants and by items.

There was no significant difference between SCT and SHG, t = -0.832, $p = .41$. There was no significant difference between SCT and NCT, t = -0.697, $p = .49$, nor between SCT and NHG, t = -0.248, $p = .80$. There was a significant effect of English frequency such that response time for SCT condition decreased as frequency increased, t = -3.884, $p < .001$. Table 7 presents the results of the model in detail.

Table 7: *RT and frequency across conditions*

	RT vs conditions		
Predictors	*Estimates*	*CI*	*p*
SCT	3136.58	2512.54 – 3760.62	**<0.001**
SHG	-397.56	-1335.93 – 540.81	0.406
NCT	-272.50	-1040.24 – 495.24	0.486
NHG	-99.72	-889.38 – 689.94	0.804
Frequency	-280.15	-421.86 – -138.44	**<0.001**
SHG:Frequency	132.75	-80.95 – 346.46	0.223
NCT:Frequency	88.97	-84.61 – 262.55	0.314
NHG:Frequency	73.65	-103.84 – 251.14	0.415
Random Effects			
σ^2	138722.78		
τ_{00} Word	58489.23		
τ_{00} Participant	31770.90		
ICC	0.39		
N Participant	23		
N Word	68		
Observations	519		
Marginal R^2 / Conditional R^2	0.201 / 0.516		

The effect of word frequency on RT across conditions can be better visualized when the model is plotted (Figure 4).

Figure 4 *Effect of frequency on RT across conditions*

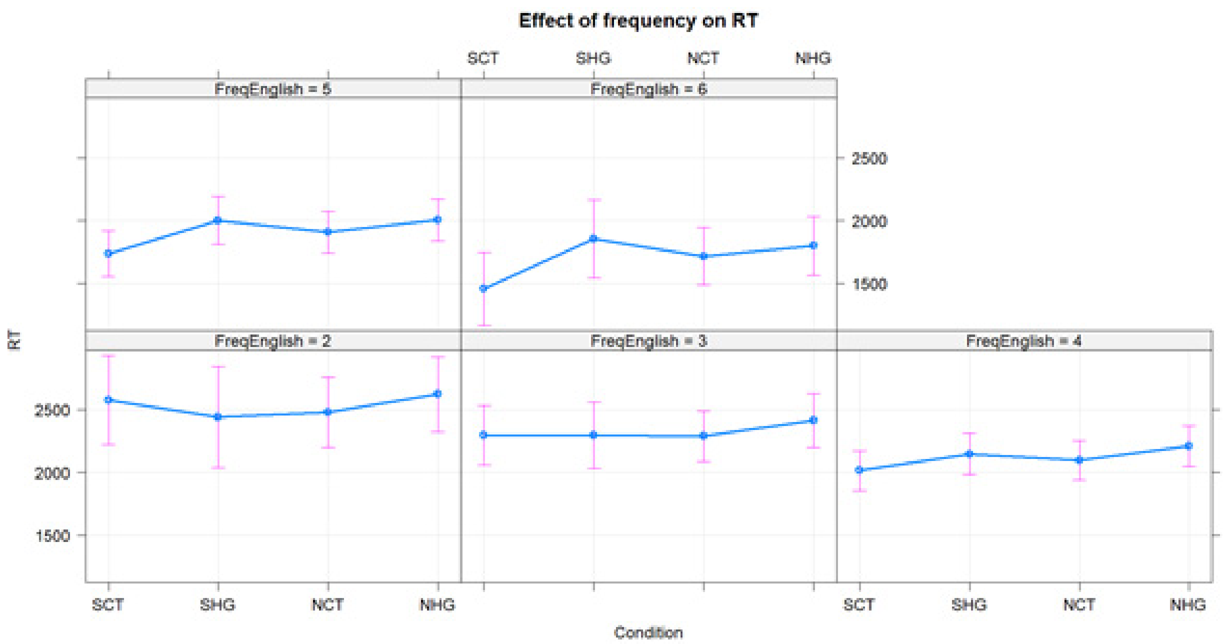


Figure 4 shows that RTs for the SCT were clearly affected by word frequency. For the word frequency range 2 to 4, we can see that RT is similar across conditions. For high-frequency (5 and 6), there was a large decrease for RT in SCT conditions as compared to the other three conditions.

Discussion of Experiment 2

The translation of the control words was faster and more accurate than that of the homographs. Specifically, studied control words were significantly faster and more accurate than homographs. These results suggest a possible priming effect of the studied control words interacting with word frequency in English compared to the studied homograph words, demonstrated by shorter RTs when frequency was high, 5 or 6. For the studied homographs, no priming effect nor word frequency effects were observed in English.

These results are consistent with experiment 1, in which there was a clear facilitation of processing of the control words in English as compared to control words in Portuguese and English-Portuguese homographs. The results are also consistent with the inhibition effect of the interlingual homographs commonly reported in the literature (e.g., Jared & Szucs, 2002; Vingron et al., 2022; Poort & Rodd, 2022; Durlik et al., 2016; Dijkstra, Van Jaarsveld & Ten Brinke, 1998; Poort, Warren & Rodd, 2016; Dijkstra, De Bruijn, Schriefers & Ten Brinke, 2000; Dijkstra, Moscoso del Prado Martín, Schulpen, Schreuder & Harald Baayen, 2005).

General Discussion

In two experiments, a language decision task and a multiple-choice translation task, evidence for the bilingual non-selective lexical access was observed. Participants favored the L2 in the language decision task, frequency effects were observed in the L1 and L2, and interference effects were observed in interlingual homographs.

In a language decision task, English controls were responded to faster and more accurately than Portuguese controls. In the same task, when presented with interlingual homographs, participants chose English more often than Portuguese. RTs for homographs were shorter for Portuguese choices only when both frequencies (in Portuguese and in English) were at their highest or lowest. When word frequency was average, there was practically no difference. When frequencies were unbalanced, high-frequency English and low-frequency in Portuguese, RT was shorter for choices in English than in Portuguese.

In a multiple-choice translation task, studied controls in English also had greater accuracy and shorter RTs than the other conditions. This effect also interacted with word frequency. These results together point to a facilitation towards the L2, in the experimental conditions applied to the two tasks. One possible explanation could be the nature of the tasks themselves. Because it was a bilingual task, participants were trying to inhibit their dominant language, which led to a greater activation of the L2. Regarding the hypotheses of the present study, both word types and language specific word-frequency can be considered as predictors of bilingual lexical access.

Word frequency interacted with RTs for the control words (even with accuracy, even though it was not significant), with Portuguese choice for the HGs and with RTs for the SCT in experiment 2. In relation to word type, the HGs had their processing delayed in relation to control words in English in both experiments, indicating an interference effect. There was no observed interference effect between the HGs and the controls in PT, the L1 for experiment 1. An additional explanation would be that the L2 had a more facilitated processing since there was greater accuracy, shorter RT and more language choices for the L2 in experiment 1 and greater accuracy and shorter RT for studied control words in experiment 2.

Our findings support the non-selective lexical access hypothesis and corroborate previous findings on the inhibitory effects of interlinguistic homographs (Poort et al. 2016; Port & Rood, 2019), especially when accessed in tasks demanding high code-switching, as the situation proposed in our first experiment. According to the non-selective access hypothesis, interlingual homographs induce the activation of two semantic representations in bilinguals, impacting accuracy and reaction times. The present study extends these findings by demonstrating that the frequency of the homograph in each language can modulate the interactive lexical access, making one of the representations more or less accessible. On the other hand, in the second experiment, we verified that the facilitation induced by repetition priming was evidenced only for the control stimuli, and not for the interlingual homographs. This finding suggests that both linguistic representations of the homographs were activated in the first experiment. As the task of the second experiment demanded access to only one linguistic representation (meaning in Portuguese), we could argue that the priming effects of the non-target meaning of the homograph lead to interference and consequently reduction of the repetition priming effect.

Based on these results we can argue that the bilingual lexicon is interactive in nature, with L1 and L2 influencing each other in both directions. We can suggest that word frequency plays a role on lexical access of the two languages and that the relations established in this interactive lexicon cannot be explained by simple contrasts such as symmetry and asymmetry. The understanding of the bilingual lexicon seems to be more complex than has been stated and offers more room for further investigation.

Conclusion

In the present study, a language decision task and a multiple-choice translation task containing interlingual homographs was performed by Brazilian-Portuguese - English bilinguals. Participants' L2 was the preferred language in a language decision task. English words were led to more accuracy and shorter RTs in both experiments. There was evidence that word frequency both in L1 and L2 might influence bilingual lexical access, indicating the interactive nature of the bilingual lexicon. The results of the two experiments provided further evidence for the nonselective view of bilingual lexicon access, based on the interference effects of the interlingual homographs.

Note

1. In order to have an objective estimate of participants' L2 proficiency, they performed a receptive vocabulary test (Institute for Test Results and Test Development, University of Leipzig, available at: https://www.itt-leipzig.de/static/vltenglish_01r/index.html)at the end of the experimental session. In this test participants had to match 150 words to their definitions in up to 30 minutes (time was controlled by the website). The test is available online and it is free. It is based on high frequency words and its results indicate reading levels of the Common European Framework of Reference (CEFR). When the participant finished the test, the result was automatically displayed on the screen. Participants' score on the vocabulary test were included as a continuous variable in the data.

References

Baayen, R. H. (2008). *Analyzing linguistic data: A practical introduction to statistics.* Cambridge: Cambridge University Press.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language, 59*, 390-412.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67*, 1-48.

Barcelos, L., & da Luz Fontes, A. B. A. (2021). O processamento de cognatos e falsos cognatos por brasileiros falantes de português, inglês e francês. *Revista Linguagem em Foco*, *13*(4), 37-55.

Brysbaert, M., & New, B. (2009). Moving beyond Kucera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. Behavior Research Methods, 41, 977–990. http://dx.doi.org/10.3758/ BRM.41.4.977

Core Team, R. (2017). *A language environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Dijkstra, T., De Bruijn, E., Schriefers, H., & Ten Brinke, S. (2000). More on interlingual homograph recognition: Language intermixing versus explicitness of instruction. Bilingualism: Language and cognition, 3(1), 69-78.

Dijkstra, T., Grainger, J., & Van Heuven, W. J. (1999). Recognition of cognates and interlingual homographs: The neglected role of phonology. Journal of Memory and language, 41(4), 496-518.

Dijkstra, T., Moscoso del Prado Martín, F., Schulpen, B., Schreuder, R., & Harald Baayen, R. (2005). A roommate in cream: Morphological family size effects on interlingual homograph recognition. Language and Cognitive Processes, 20(1-2), 7-41.

Dijkstra, T., Van Jaarsveld, H., & Ten Brinke, S. (1998). Interlingual homograph recognition: Effects of task demands and language intermixing. Bilingualism: Language and cognition, 1(1), 51-66.

Durlik, J., Szewczyk, J., Muszyński, M., & Wodniecka, Z. (2016). Interference and inhibition in bilingual language comprehension: Evidence from Polish-English interlingual homographs. *PloS one*, *11*(3), e0151430.

Elston-Güttler, K. E., Gunter, T. C., & Kotz, S. A. (2005). Zooming into L2: Global language context and adjustment affect processing of interlingual homographs in sentences. Cognitive Brain Research, 25(1), 57-70.

Estivalet, G. L., & Meunier, F. (2017). Corpus psicolinguístico Léxico do Português Brasileiro. Soletras, (33), 212-229.

Gadelha, L. M. da S., & Toassi, P. F. P. (2022). Acesso lexical de palavras homógrafas interlinguísticas português brasileiro: Inglês em uma tarefa de decisão linguística e de tradução. Revista Linguagem Em Foco, 13(4), 56–77. https://doi.org/10.46230/2674-8266-13-7368

Gollan, T. H., Montoya, R. I., Cera, C., & Sandoval, T. C. (2008). More use almost always means a smaller frequency effect: Aging, bilingualism, and the weaker links hypothesis. Journal of Memory and Language, 58(3), 787–814.

Gollan, T. H., Slattery, T. J., Goldenberg, D., Van Assche, E., Duyck, W., & Rayner, K. (2011). Frequency drives lexical access in reading but not in speaking: the frequency-lag hypothesis. Journal of Experimental Psychology: General, 140(2), 186.

Ivanova, I., & Costa, A. (2008). Does bilingualism hamper lexical access in speech production?. Acta psychologica, 127(2), 277-288.

Jared, Debra, & Szucs, Carrie. (2002). Phonological activation in bilinguals: Evidence from interlingual homograph naming. Bilingualism: Language and Cognition, 5 (3), 225-239. https://doi.org/10.1017/S1366728902003024.

Kerkhofs, R., Dijkstra, T., Chwilla, D. J., & De Bruijn, E. R. (2006). Testing a model for bilingual semantic priming with interlingual homographs: RT and N400 effects. Brain research, 1068(1), 170-183.

Lemhöfer, K., Dijkstra, T. (2004). Recognizing cognates and interlingual homographs: Effects of code similarity in language-specific and generalized lexical decision. Memory & Cognition 32, 533–550. https://doi.org/10.3758/BF03195845

Poort, Eva. D., & Rodd, Jennifer. M. (2022). Cross-lingual priming of cognates and interlingual homographs from L2 to L1. Glossa Psycholinguistics 1(1): 11, pp. 1–33. DOI: https://doi.org/10.5070/G601147

Poort, E. D., & Rodd, J. M. (2017). The cognate facilitation effect in bilingual lexical decision is influenced by stimulus list composition. Acta Psychologica, 180, 52-63.

Poort, E. D., Warren, J. E., & Rodd, J. M. (2016). Recent experience with cognates and interlingual homographs in one language affects subsequent processing in another language. Bilingualism: Language and Cognition, 19(1), 206-212.

Stoet, G. (2010). PsyToolkit - A software package for programming psychological experiments using Linux. Behavior Research Methods, 42(4), 1096-1104.

Stoet, G. (2017). PsyToolkit: A novel web-based method for running online questionnaires and reaction-time experiments. Teaching of Psychology, 44(1), 24-31.

Vanlangendonck, F., Peeters, D., Rueschemeyer, S. A., & Dijkstra, T. (2020). Mixing the stimulus list in bilingual lexical decision turns cognate facilitation effects into mirrored inhibition effects. Bilingualism: Language and Cognition, 23(4), 836-844.

van Heuven, W. J. B., Mandera, P., Keuleers, E., & Brysbaert, M. (2014). SUBTLEX-UK: A new and improved word frequency database for British English. Quarterly Journal of Experimental Psychology, 67, 1176–1190.

Vingron, N., Furlani, N., Mendelson, O., & Titone, D. (2022). I see what you mean: Semantic but not lexical factors modulate image processing in bilingual adults. Memory & Cognition, 50(2), 245-260.

Whitford, V., & Titone, D. (2017). The effects of word frequency and word predictability during first-and second-language paragraph reading in bilingual older and younger adults. Psychology and aging, 32(2), 158.

Recebido em: 29/06/2023
Aceito em: 01/09/2023