

Spelling-sound knowledge in the context of multilingualism: is lexical access selective or nonselective?

Conhecimento da relação grafema-fonema no contexto do multilinguismo: o acesso lexical é seletivo ou não-seletivo?

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Abstract

The present study investigates shared phonological information and selectivity during lexical access in Brazilian Portuguese-English unbalanced bilinguals, learners of Korean as an L3. Participants took part in a word naming task which used L2 primes with targets from the L3 at stimulus onset asynchronies (SOA) of 140ms and 250ms. The results show a significant facilitation effect in word naming when an English prime was presented in comparison with control primes. Additionally, a significant facilitation effect was also seen in trials in which the primes were presented at a 250ms SOA in relation to a 140ms SOA. Taken together, the results indicate that participants' spelling-sound knowledge of L2 English was activated during the reading aloud of words in L3 Korean, which indicates nonselectivity in lexical access and a shared mental lexicon across languages.

Keywords

Writing systems. Lexical access. Multilingualism. Phonological priming.

Resumo


O presente estudo investiga o compartilhamento de informações fonológicas e a seletividade no acesso lexical em indivíduos bilíngues português brasileiro-inglês não balanceados, falantes de coreano como L3. Participantes realizaram uma tarefa de nomeação de palavras que utilizou primas da L2 com palavras-alvo da L3 em assincronias de início de estímulo (SOA) de 140ms e 250ms. Os resultados mostram um efeito de facilitação significativo na nomeação de palavras-alvo precedidas por um prime em inglês, em comparação aos primas controle. Além disso, um efeito de facilitação significativo também foi observado em tentativas em que os primas foram apresentados em SOAs de 250ms em relação a SOAs de 140ms. Em conjunto, os resultados indi-

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cam que o conhecimento da relação grafema-fonema em inglês (L2) dos participantes estava ativo durante a leitura em voz alta de palavras em coreano (L3), o que indica uma não seletividade no acesso lexical e um léxico mental compartilhado entre as línguas.

Palavras-chave

Sistemas de escrita. Acesso lexical. Multilinguismo. Priming fonológico.

1 Introduction

Reading is an essential task in everyday life. When learning to read in a new language, students need to be able to understand how the written language encodes the spoken one. A lot of differences can be found across the written representation of languages, which can become a challenge for the learner, especially if such languages differ in writing systems and scripts.

However, despite these differences, the languages learned by an individual can share information since they are always active to some extent (DIJKSTRA; VAN HEUVEN, 2002). Here we address this issue in the case of multilingualism. Based on Lee, Nam, and Katz (2005), we assessed phonological priming in two different conditions through an online word naming task to investigate language selectivity during lexical access in word production in native speakers of Brazilian Portuguese who have English as a second language (L2) and are learning Korean as a third language (L3).

2 Bilingual lexical access and language nonselectivity across different scripts

In 1987, Aitchinson defined the mental lexicon as the human word-storage or mental dictionary. However, this definition is not adequate to describe a system that, due to its flexibility and ability to incorporate new words, contains a vast number of lexical entries and all the information on individual words. Szubko-Sitarek (2015) states that the organization of the mental lexicon is based on the relations between meanings (e.g., “important” and “essential” are synonyms; “important” and “unimportant” are antonyms) and the morphological similarity of the lexical items (e.g., “govern,” “government,” “governmental,” “governor”). However, according to Toassi (2016), these assumptions are based on research on the monolingual mental lexicon. Even though they may be true for the bilingual mental lexicon, there is a need for further exploration of its organization, given that the larger the number of different languages in the mental lexicon, the greater is its complexity.

An important process in the study of the mental lexicon of bilinguals (here

defined as those with knowledge of two languages) and multilinguals (here defined as those with knowledge of three or more languages) is lexical access. Reichle (2011, p. 744) defines lexical access as “a process of activating a word’s meaning so it can be used in further linguistic processing.” This process can take place at the level of comprehension of a word (e.g., in a sentence) or in order to communicate (e.g., selection of words for speech production). Studies on lexical access aim to understand how individuals activate the definition of a word and how is it possible to find a word for production or to recognize a word for comprehension (TOASSI, 2016).

Research on monolingual lexical access has shown that there are many possibilities of interference from within the language (TOASSI, 2016). For example, when one word is activated, other words of similar form, meaning, syntax, orthography, or even emotional content may also be activated and compete for selection (SZUBKO-SITAREK, 2015). Extending these assumptions to the bilingual/multilingual lexicon, the question that remains to be answered is whether or not similar words will be activated only in the target language or in all of the languages of a bilinguals/multilingual speaker. This question relates to the selective/nonselective view of lexical access. According to the selective view, only words or lexical entries of the target language will be available for competition. On the other hand, the nonselective view proposes that words/lexical entries from the bilinguals’ two languages will be activated for competition (DIJKSTRA; VAN HEUVEN, 2002).

In relation to lexical access in bilingual individuals, two models are widely known in the field: the Revised Hierarchical Model – the RHM (KROLL; STEWART, 1994) – and the Bilingual Interactive Activation Model, the BIA (DIJKSTRA; VAN HEUVEN; GRAINGER, 1998). The RHM proposes that the words from the two languages are stored in separate lexicons. As Toassi (2016) explains, the model is hierarchical because of the dominance of the L1 over the L2. Given that the L1 lexicon and conceptual memory are already established in the case of late L2 acquisition, the RHM proposes that L2 words are added to the system through lexical links with the L1 (TOASSI; MOTA, 2015). However, as the learner becomes more proficient, conceptual links are established directly with the L2.

The second model of lexical access, the Bilingual Interactive Activation model (BIA), consists of three levels of representation: letter, word, and language (GRAINGER; DIJKSTRA, 1992). Dijkstra and Van Heuven (2002) point out that the BIA was first presented as a word recognition model to identify orthographic representations. However, due to limitations in its lexical and language representa-

tions, Dijkstra and Van Heuven (2002) proposed the BIA+ model, which incorporates some changes in relation to the BIA. The BIA+ model distinguishes between a word identification system and a task decision system. In addition, the model “assumes interactivity within the word identification system and between this system and higher-order systems such as the parser” (DIJKSTRA; VAN HEUVEN, 2002, p. 176).

The BIA+ model proposes nonselective lexical access and an integrated mental lexicon across languages. The model has three levels of representation, where both languages can compete for selection. Moreover, target word recognition is influenced by orthographic neighbors from both languages. When sub-lexical and lexical orthographic representations are activated, they also activate associated phonological and semantic representations (DIJKSTRA; VAN HEUVEN, 2002). Therefore, the number of items activated in orthographically related languages will be larger than for more orthographically distinct languages. Considering the word naming task, the model predicts parallel activation of languages in the mental lexicon. More specifically, all the languages of the multilingual would be activated when performing the word naming task.

Lee, Nam, and Katz (2005) investigated the presence of phonological recoding in word recognition through naming tasks that used either first (L1) or second language (L2) primes with targets from the other language at stimulus onset asynchronies (SOAs) of 140ms and 250ms for Korean-English bilinguals. Considering that in orthographically related languages, the quantity of activated items will be larger than in distinct languages, a question posited by Lee, Nam, and Katz (2005) was whether or not words which share phonological information, but no orthographic similarity, would also activate a larger quantity of items for selection in the bilingual mental lexicon.

The study consisted of two experiments: experiment 1 (1a and 1b) addressed the question of phonological priming from an L1 prime (Korean nonword) to an L2 target (English word) across short and long stimulus onset asynchronies (SOAs). Experiment 2 (2a and 2b) investigated phonological priming from L2 (English nonword) to L1 (Korean word) across short and long SOAs. The results showed that phonological information activated by either an L1 or L2 prime can interact with phonological information in the other language. Therefore, according to Lee et al. (2005), the uniform pattern of phonological priming of both L1 and L2 targets at the 140ms SOA implies that the spelling-sound knowledge of bilingual lexicons is activated when any linguistic form is presented. Lee, Nam, and Katz (2005) emphasize that the nonselective activation of spelling-sound knowledge

in the Korean-English bilingual system occurs in the absence of any common orthographic cues because the two languages have two completely different writing systems.

Here we investigate language selectivity in lexical access in native speakers of Brazilian Portuguese who have English as an L2 and are learning Korean as an L3. Partly based on Lee et al. (2005, Experiment 2), we measured phonological priming from L2 to L3 in two different conditions – 140ms and 250ms SOAs. We pursued the following question: Does the L3 share phonological information with the L2?

Alongside the phonological priming experiment, the participants answered a biographical questionnaire and performed two language proficiency exams for both English and Korean languages. Considering the scenario of the COVID-19 pandemic, the data collection was conducted remotely, and the experiment was hosted in Cognition – a website which hosts online experiments for free. The study was pre-registered in the Open Science Framework¹ prior to starting the data collection and was approved by the university's Ethics Review Board.²

3 Method

3.1 Participants

Eighteen native speakers of Brazilian Portuguese (14 female) participated in the study. All participants have English as a second language at CEFR B2 or superior level and are currently learning Korean as a third language at 2B or superior level, according to King Sejong Institute³ leveling. Participants' age ranged from 19 to 30 years old ($M = 20$, $SD = 1.41$). They were recruited via e-mail, messages in social networks or private communication. After having read and signed the consent form, the participants completed a biographical questionnaire. Both the consent form and the questionnaire were available online and held on the Google forms platform. Additionally, participants took an English proficiency test, which can be found on the website Exam English⁴, and a Korean proficiency test⁵, which can be found on King Sejong Institute's website. Finally, participants were asked

1 <https://osf.io/btjisp/>

2 CAAE: 40474920.9.0000.0121

3 The institute is a Korean governmental agency responsible for teaching the Korean language in 76 countries, including Brazil.

4 http://www.examenglish.com/leveltest/grammar_level_test.htm

5 <https://nuri.iksi.or.kr/front/page/participation/onlineLevelTest/main.do>

to complete an online word naming task, which will be described below. In the biographical questionnaire, five participants reported having basic knowledge of Spanish, but none of them stated being fluent in this language. Two participants reported having some knowledge of Japanese, two reported having studied French, other two participants reported having basic knowledge of Chinese, and one participant reported having studied some basic aspects of Norwegian and Italian in the past.

3.2 Instruments

Four distinct instruments were used in the study: a biographical questionnaire, an English proficiency test, a Korean proficiency test, and an online word naming task.

3.2.1 Biographical questionnaire

The participants answered a biographical questionnaire held on the Google forms platform. The questionnaire aimed at collecting basic information, such as age, country of origin, sex, and linguistic information that may help understand the participants' familiarity with the foreign languages involved in the study.

3.2.2 English proficiency test

The participants performed an online English proficiency test, held in the platform Exam English. The test is available online and is free access for all. There are two tests available – the grammar and vocabulary test and the listening test. The score is based on the Common European Framework levels of proficiency (CEFR) – varying from A1 to C2. The results are provided immediately after the test-taker completes the exam. In the present study, participants were asked to send their results to the researchers via e-mail.

3.2.3 Korean proficiency test

Besides the English proficiency test, the participants also took an online Korean proficiency test, held in the online platform for King Sejong Institute. According to the Institute's curriculum, the tests are designed to assess eight levels, from Beginner Level (1A) to Intermediate Level (4B). The results are based on participants' listening and reading performance in multiple choice tests. The former

evaluates the comprehension of colloquial language, while the latter evaluates participants' ability to use vocabulary and grammar. Moreover, the test is free access for all, the results are immediately available and can be saved in PDF format. As in the English proficiency test, the participants were also asked to send the results to the researchers via e-mail.

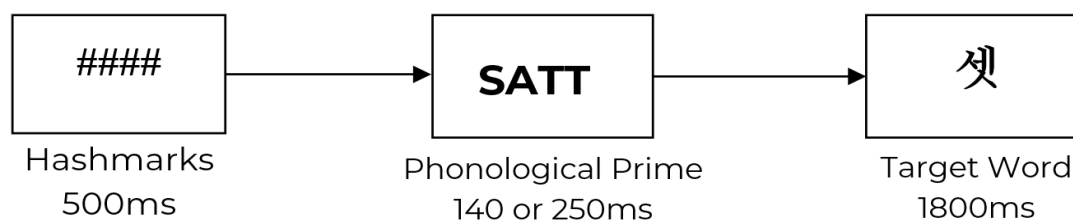
3.2.4 Word naming task

In the word naming task, participants were required to read aloud, as quickly and accurately as possible, 48 target Korean words divided into two blocks, each consisting of ninety-six trials. Each target Korean word was preceded by either a phonological or a control prime. Both prime types were English non-words. In the first block, the prime-target SOA was 140ms. In the second block, the prime-target SOA was 250ms. There were two conditions for the experimental design. For condition 1, each trial consisted of: (1) a row of four hash marks for 500ms; (2) the phonological prime, 140ms SOA in part 1, and 250ms SOA in part 2; (3) the Korean word target for 1800ms. The intertrial interval was 1000ms. Similarly, for condition 2, each trial consisted of: (1) a row of four hash marks for 500ms; (2) the control prime, 140ms SOA in part 1, and 250ms SOA in part 2; (3) the Korean word target for 1800ms. The 48 target words were repeated four times throughout the task, once for each condition and each SOA. Therefore, participants had to read a total of 192 target words (48 target words, each repeated 4 times).

The independent variables of interest were prime type (phonological and control primes) and SOA (140ms and 250ms), both within-subjects. The dependent variable was reaction time (RT). All 48 target words, as well as all phonological and control primes, were those used by Lee et al. (2005). The experimental design included the following conditions:

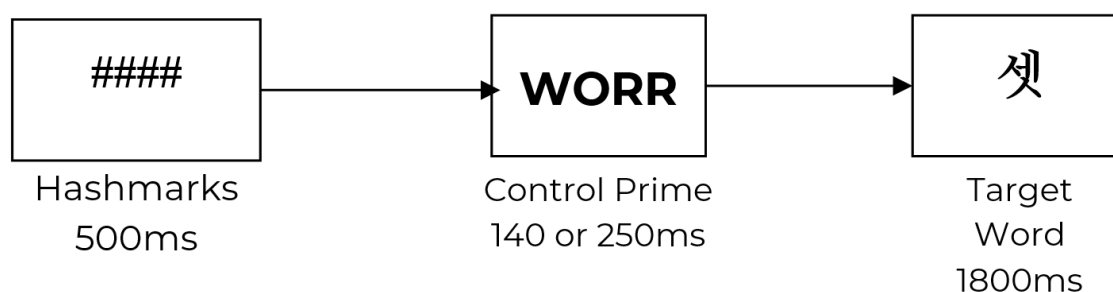
CONDITION 1: Phonological prime

Figure 1 – Experimental design of condition 1: a trial containing a phonological prime



Source: Elaborated by the authors.

CONDITION 2: Control prime

Figure 2 – Experimental design of condition 2: a trial containing a control prime

Source: Elaborated by the authors.

As a phonological priming experiment, participants were presented with both phonological and control primes to each of the target words to investigate the effects of the English primes in RTs. Therefore, participants had to read the same target word two times, once preceded by the phonological prime (e.g., Figure 1) and once preceded by the control prime (e.g., Figure 2), in each part of the experiment. In order to counterbalance the types of primes and the target words, we produced two lists of stimuli according to a 2x2 Latin square (Figure 3). List 1 presented phonological primes (condition 1) first, followed by control primes (condition 2). List 2 had condition 2 first, followed by condition 1. It is important to highlight that the same word would not be presented twice in a row to avoid a possible order effect.

Figure 3 – Design of the 2x2 Latin square.

List 1	List 2
CONDITION 1 Phonological prime	CONDITION 2 Control prime
CONDITION 2 Control prime	CONDITION 1 Phonological prime

Source: Elaborated by the authors.

The task was programmed in JavaScript, which allowed it to be run on Google Chrome or Mozilla Firefox on any computer available. The code for the task was created in the software Vim, a highly configurable text editor. Modifications to this code were registered in Git, a version control system tool. Moreover, the JsPsych (DE LEEUW, 2015) library was used in order to simplify the development of the code for the task and assure the quality of the RT measurements. Separately, the task was hosted on Cognition⁶ for free. Participants' responses were automatically recorded by Cognition for 1800ms, from the moment the target words appeared until the moment they left the screen.

The words appeared in the middle of the computer screen, in a black Open Sans Extra Bold font of size 271 on a white background. Since the experiment was conducted remotely and each participant performed the task on their own computer, it is not possible to describe the type of monitor used. Participants were instructed to read the Korean words out loud as fast and accurately as possible. Once they started one block of the experiment, the words appeared automatically on the screen, and their production would be recorded automatically, with no need to press any buttons. At the end of the first block, participants could take a short break before moving on to the next block, in which the words would also automatically appear on the screen.

3.3 Procedures

All data reported in the present study was collected remotely. Thus, each participant chose the best environment for taking the task, on their own computer. After confirming their intention to participate in the study, they received an e-mail with the guidelines for step-by-step data collection. First, participants were asked to (1) read and, if interested in participating in the study, sign the consent form available through a Google Form, (2) answer an online biographic questionnaire, and (3) take two proficiency tests – for both English and Korean languages. Participants had one week to complete this first data collection stage and send the results to us. The second stage of data collection consisted of the performance of the word naming task. During this task performance, participants were accompanied through a video call for assistance in case of problems. Before starting the word naming task, participants were asked to test their microphones. Then, a practice session was conducted, followed by the word naming task, which lasted for approximately 10 minutes.

⁶ <https://www.cognition.run>

4 Results and discussion

4.1 Data pre-processing

Two dependent variables were looked into during the pre-processing data procedures. First, participants' pronunciation accuracy in L3 Korean was assessed. Participants who mispronounced more than 50% of the words would be considered guessing the answers, and their data would be discarded; there was no such case. Additionally, when answers were not recorded, these trials were considered as missing data and were not included in the analyses. Then, participants' RTs were analyzed. Reaction times were measured in Chronset (ROUX; ARMSTRONG; CARREIRAS, 2017). When RTs were smaller than 500ms, the recordings were verified manually in the software Ocenaudio (OCENAUDIO DEVELOPMENT TEAM, 2015) and corrected to their actual length. After the data pre-processing procedures, the data from 18 participants remained for further analysis. The data of one particular participant was only stored up to 80%, possibly due to connection problems during the performance of the naming task. Considering that most of the data was stored, this participant's data was included in the analysis. Therefore, the data of all 18 participants was analyzed.

4.2 Data analysis

The data analysis was carried out in the R environment (R CORE TEAM, 2014). The data was analyzed with linear mixed-effects model using the lme4 package (BATES *et al.*, 2015) with participants as random effects (Table 1) and condition and SOA as fixed effects. The model did not converge when random slopes for participants were added, so only intercepts were included. The results (Table 2) showed that participants' average RT was 942.82ms. There was a significant facilitation effect when participants read the target words that were preceded by Condition 1 (C1 – English), the phonological primes ($\beta = -29.93$, $p = 0.00003$).

Additionally, in Table 3 and Figure 4, it is possible to see the descriptive statistics of RTs by SOA and a plot of RTs. They show that longer exposure to the English prime resulted in a significant effect of SOA on responses ($M = 851.87$, $SD = 178.27$), contrary to the 140ms trials, in which participants took longer to respond ($M = 908.73$, $SD = 194.51$). Considering that the interaction was nonsignificant, no further analyses were carried out. Thus, the effects of condition and SOA seem to be independent.

Table 1 – Random Effects

Group	Parameter	SD
Participant	(Intercept)	130.4
Residual		146.0

Source: Elaborated by the authors.

Table 2 – Results of the analysis by Linear Mixed Effects Model

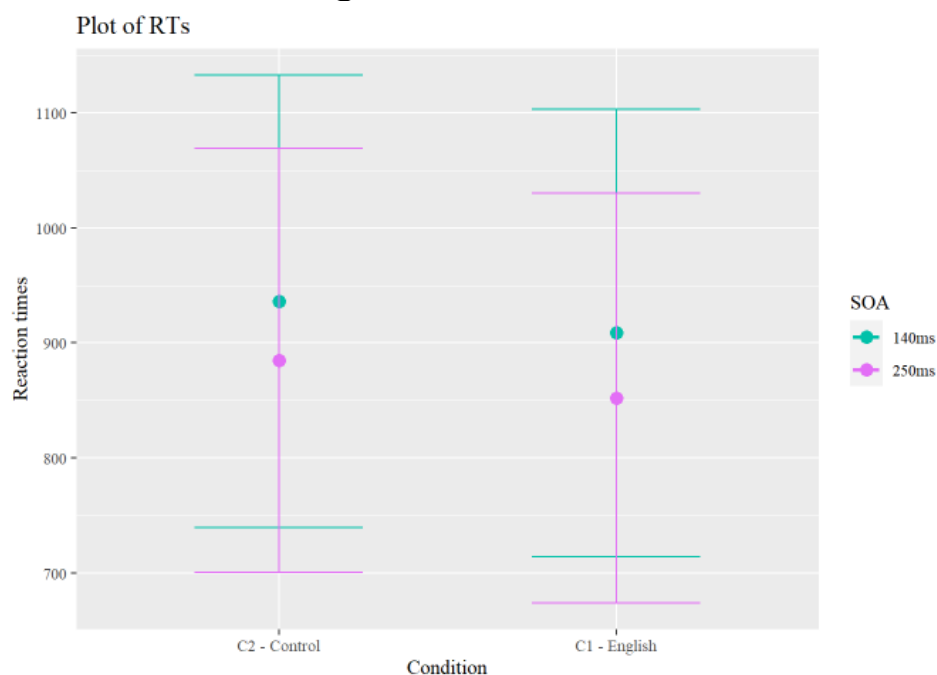
	Estimate	<i>p</i>
Intercept	942.82	0.000*
Condition (English)	-29.93	0.00003*
SOA (250ms)	-58.59	0.000*
Interaction (English:250ms)	-1.80	0.859

Source: Elaborated by the authors.

Table 3 – Means and SDs for RTs by SOA

Condition	SOA	Mean RT (ms)	SD
C2 – Control	140ms	936.20	196.75
C1 - English	140ms	908.73	194.51
C2 – Control	250ms	884.70	184.31
C1 - English	250ms	851.87	178.27

Source: Elaborated by the authors.

Figure 4 – Plot of RTs

Source: Elaborated by the authors

4.3 Discussion

The main objective of the present study was to investigate whether Brazilian Portuguese-English unbalanced bilinguals learning Korean as an L3 activate L2 phonological information during an L3 word naming task. The question pursued in the present study was motivated by Lee, Nam, and Katz's (2005) findings that the spelling-sound knowledge of bilingual lexicons is activated even when no orthographic information is shared across languages, considering English and Korean have two completely different writing systems. Employing a study where phonological priming in the L2 was measured in two different conditions (140ms and 250ms SOAs), we aimed at understanding if the spelling-sound knowledge of L2 and L3 would be activated when reading target L3 words. Despite the studies in the area of bilingualism (DIJKSTRA; GRAINGER; VAN HEUVEN, 1999; JOURAVLEV; LUPKER; JARED, 2014; LEE; NAM; KATZ, 2005; NAKAYAMA *et al.*, 2012; VAN HEUVEN; DIJKSTRA; GRAINGER, 1998), little is known about the multilingual lexicon. Therefore, the present study is a step towards understanding the organization and interaction of languages in Brazilian Portuguese-English bilinguals learning Korean, as well as the phonological and orthographic processing of second and third languages that differ in scripts.

The results reported here are in line with Lee, Nam, and Katz's findings (2005) in some particular points. First, the trials with English primes presented shorter RTs than trials with control primes. We interpret these results as evidence of activation of participants' spelling-sound knowledge of L2 English during the reading aloud of words in L3 Korean. In other words, these results provide evidence for the coactivation of L2 and L3 during the word naming process. Second, unlike Lee et al (2005), the present study did not find a facilitation effect in the 140ms SOA in relation to the 250ms SOA. These results can be interpreted as evidence that, for non-native speakers of the study, English (L2) or Korean (L3) – longer SOAs are more effective in producing phonological priming effects in the L3. Even though both 140ms and 250ms priming can be considered too long to be within the prelexical stage (CHOI; NAM; LEE, 2010), participants' performance could have been influenced by their proficiency level in the target language.

Moreover, the present study has shown a significant effect of SOAs, differently from Lee, Nam, and Katz (2005). This effect can be due to the sample assessed in the study, which did not include native speakers of Korean, but native speakers of Brazilian Portuguese learning Korean as an L3. Our participants were intermediate learners of Korean. Although they are expected to be fluent read-

ers of Korean, they might still experience some difficulty when reading in a different writing system. In addition, due to their not-so-frequent usage of Korean compared to the other languages they master, participants profited more from longer primes. The results also show facilitation in the interaction of condition and SOA, although it was not statistically significant. This implies that there was a trend for a facilitation effect on participants' word recognition and production in Korean as L3, in the trials in which the English prime and the 250ms SOA were presented together.

Concerning the significant effect of the prime type, the results show that L2 phonological primes, compared to control primes, facilitated L3 word naming, consequently reducing their RTs in trials where an English prime was presented before the target word, at both SOAs. This facilitation suggests that phonological information from the L2 was active during a task, which required the L3. It could indicate nonselective lexical access and an integrated mental lexicon across languages, with both languages concurrently activated and competing for selection (DIJKSTRA; VAN HEUVEN, 2002).

According to the BIA+ model of lexical access, the recognition of the target word is influenced by orthographic features from both languages. Thus, when orthographic representations are active, they also activate associated phonological representations (DIJKSTRA; VAN HEUVEN, 2002). In orthographically related languages, the number of items activated will be larger than for languages with distinct writing systems. However, Lee, Nam, and Katz's (2005) study and the present one show that phonological information is activated and shared, despite their different orthographic representation. Both English and Korean use alphabetical writing systems but are represented by different scripts.

Final Remarks

The investigation of the process of lexical access is made possible through a variety of experimental paradigms that are able to provide empirical data regarding the organization and interaction of the languages in the brain. On that note, the present study, through the experimental paradigm of phonological priming, contributed to the literature regarding multilingual lexical access and phonological processing, with data from adult native Brazilian Portuguese speakers who also speak English as an L2 and are learning Korean as an L3.

However, it is important to highlight our limitations to be overcome in further studies. The first limitation we must address is the sample size, which should

be larger in future studies. Additionally, our sample was composed of Brazilian Portuguese-English unbalanced bilinguals. The instructions of the experiment were written in English, which might have preactivated the phonological information of the L2 before the onset of the task itself, considering the languages involved in the study. Further testing could include the instructions in Brazilian Portuguese, or even in Korean, in order to assess the phonological activation of the L2 during the task only.

Finally, our results may be helpful for language students. Phonological information was shared between participants' L2 and L3, and the spelling-sound knowledge of the L2 was activated with the presence of phonologically similar words between L2 and L3, despite the distinct writing systems involved in the process. This phonological similarity can be a facilitator to learners' pronunciation development and vocabulary acquisition (POLLATSEK, 2015). Considering the parallel activation of languages when selecting words for further linguistic processing, exploring these phonological similarities across languages can ease learning a new language, especially of those with different writing systems – which can be more complex to master.

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