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Luiza de Melo Carvalho

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

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Orientador: Profa. Dra. Mailce Borges Mota
Co-orientador: Pietra Cassol Rigatti

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Profa. Dra. Maria Rita Drumond Viana
Coordenadora do Curso

Banca Examinadora:

Profa. Dra. Mailce Borges Mota
Orientadora
UFSC

Ma. Pietra Cassol Rigatti
Co-Orientadora
UFSC

Prof. Dr. Alison Roberto Gonçalves
Avaliador
UFPR

Profa. Dra. Pamela Freitas Pereira Toassi
Avaliadora
UFC

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ABSTRACT

A lot is still discussed about the organization of the mental lexicon, and how lexical access takes place in word selection during the comprehension and production of language. Studies in the area of second language learning seek to investigate lexical access in bilingual individuals and how words are chosen, in a context in which more than one language can be selected. Through an experiment of phonological priming with Korean-English bilinguals, Lee et al. (2005) revealed facilitation in word reading comprehension, which indicates non-selectivity in lexical access for homophone words that do not share orthographic information. Thus, the authors concluded that the L2 shares phonological information with the L1, and the spelling-sound knowledge is activated automatically, regardless of the linguistic form presented. However, concerning multilingual individuals, even less is known about the organization of their mental lexicon, only that the more the languages that interact in their lexicon, more complex is its organization (Toassi, 2016). Therefore, considering the need of more studies in the area, the present study partially replicates the study by Lee et al. (2005), in the context of multilingualism, seeking to comprehend whether or not the same results apply to native speakers of Brazilian Portuguese, speakers of English as an L2, learners of Korean as an L3.

Keywords: writing systems, lexical access, multilingualism, phonological priming

RESUMO

Muito ainda se discute a respeito da organização do léxico mental e de como ocorre o acesso à seleção das palavras durante a compreensão e produção da linguagem. Dessa forma, estudos na área de aprendizado de segunda língua buscam investigar o acesso lexical em indivíduos bilíngues e como se dá a seletividade das palavras em um contexto em que mais de uma língua pode ser selecionada para utilização. Através de um experimento de priming fonológico do par linguístico coreano-inglês, Lee et al. (2005) revelaram a facilitação na leitura das palavras alvo, indicando não-seletividade no acesso lexical de palavras homófonas que não compartilham informações ortográficas. Dessa forma concluiu-se que a L2 compartilha informações fonológicas com a L1 e o conhecimento da relação grafema-fonema é ativado automaticamente, independente da forma linguística apresentada. No entanto, no que diz respeito a indivíduos multilingues, pouco se sabe a respeito da organização de seu léxico mental, apenas que quanto mais línguas interagem no léxico, mais complexa é sua organização (Toassi, 2016). Portanto, considerando a necessidade de mais estudos na área, o presente estudo busca replicar parcialmente o estudo de Lee et al. (2005), no contexto do multilinguismo, visando compreender se os mesmos resultados se aplicam a indivíduos falantes nativos de português brasileiro, falantes de inglês como L2 e aprendizes de coreano como L3.

Palavras-chave: sistemas de escrita, acesso lexical, multilinguismo, priming fonológico

Table of Contents

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

Reading is an essential task in everyday life. When learning 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. Thus, the present study has the purpose of better understanding this issue and was initially motivated by my experience learning Korean. The present study was conducted at the Language and Cognitive Processes Laboratory (LabLing/UFSC), directed by Prof. Dr. Mailce Borges Mota at UFSC. The study is part of a family of studies aimed at investigating lexical access and the multilingual mental lexicon (Toassi, 2012, 2016; Toassi & Mota, 2015, 2018, 2020, 2021) By means of a study where phonological priming was measured in two different conditions through an online word naming task, I investigate language selectivity in lexical access of word recognition and production, focused on native speakers of Brazilian Portuguese, who have English as a second language (L2), and are learning Korean as a third language (L3).

The mental lexicon can be defined as a flexible and extendable mental word-store capable of incorporating new knowledge, and it is responsible for storing a great quantity of information for each word in all language aspects, such as syntax, semantics, and phonology (Toassi, 2016). In addition, “lexical items can be linked and organized in the mental lexicon according to their relation of meaning (synonym, antonym) and according to their morphological similarity” (Szubko-Sitarek as cited in Toassi, 2016, p. 30). Nevertheless, these assumptions concern the monolingual mental lexicon and, according to Toassi (2016), the

complexity of the arrangement and processing of the lexicon is increased by the number of languages and aspects that interfere in its organization.

With this in mind, it is necessary to understand that a lot has been discussed in the area of second language learning and multilingualism regarding whether or not there should be a distinction between bilingual and multilingual individuals. From this angle, scholars of the area of multilingualism are in favor of this differentiation due to the effects of prior linguistic knowledge in subsequent language acquisition (De Angelis, 2007). Therefore, according to Hammarberg (2001), a bilingual is a person with knowledge of two languages, while a multilingual is a person with knowledge of three or more languages. Thus, in order to study the interaction of first and second language in the bilingual mental lexicon, researchers use a "process of activating a word's meaning so it can be used in further linguistic processing" (Reichle, 2011, p.774). This process is called lexical access, and can take place at the level of comprehension of a word (in a sentence, for example), or in order to communicate (selection of words for speech production). Studies conducted in the area aim to understand "how the meaning of the word is activated and how is it possible to find an intended word for production or to identify a word for comprehension" (Toassi, 2016, p. 35). However, regarding the multilingual mental lexicon there is the need for further exploration of how more than two languages interact and influence each other in word production and comprehension.

When addressing lexical access in comprehension, it is important to also think about the reading abilities in more than two languages. Reading is an essential part of communication in all languages which have a writing system, and it is commonly known that each language is represented in one or more distinctive graphic forms. The expressions of the mapping of these graphic forms onto language are called writing systems (Perfetti & Dunlap, 2008), which can be primarily distinguished across languages by the type of linguistic units represented by its

graphemes (Cook & Bassetti, 2005). For instance, a consonantal writing system, such as in Hebrew or Arabic, represents language using consonants; syllabic writing systems, like in Thai and Tibetan, as based on syllables; morphemic writing systems, which is the case of Chinese and Japanese, represent language adopting morphemes. In the same way, a phonemic (or alphabetic) writing system—such as the one used in English, Portuguese, and Korean—segments language into phonemes, which are represented by graphemes. However, despite having the same type of writing system, these languages differ in scripts (English and Portuguese are represented by the Roman alphabet, while Korean is represented by the Hangul alphabet). Bearing this in mind, according to the proposal by Perfetti and Zhang (as cited in Perfetti & Dunlap, 2008), "learning to read is learning how one's writing system encodes one's language". Thus, when learning a new language, apart from learning oral skills, a person also needs to learn a new writing system, and how this system maps graphic units into language units.

Concerning the features of lexical access and the difference between writing systems, Lee et al. (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 asynchrony (SOAs) of 140ms and 250ms for Korean-English bilinguals. 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 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" (Lee et al., 2005). Therefore, 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 et al., 2005). Moreover, the authors 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. Even though in Lee et al. (2005) the authors use the term lexical access to identify the process being described in the study, there is the discussion about lexical selection - which would involve word production, one step further from mere comprehension. This discussion will be approached and explained in the review of literature.

Therefore, the present study aims to investigate lexical access in word naming task by replicating Experiment 2 from Lee et al. (2005), in which participants will partake in an online phonological priming experiment. However, the issue under investigation is if the results will be similar to the original study when assessed in the context of multilingualism. Thus, the subjects are native speakers of Brazilian Portuguese (BP) that have English as a second language and are currently learning Korean as a third language (L3).

Objectives, research question and hypothesis

The present study aims to investigate language selectivity in lexical access of word recognition and production, focused on native speakers of Brazilian Portuguese, who have English as an L2, and are learning Korean as an L3, by means of a study where phonological priming will be measured in two different conditions (140ms and 250ms stimulus onset asynchrony). Differently from the original study—Lee et al., 2005—which investigated lexical access by the paradigm of phonological priming from L2 to L1 as well as from L1 to L2 for Korean-English bilinguals, the present study aims to investigate from L2 to L3 for Brazilian Portuguese-English-Korean multilinguals. The study will pursue the following question:

RQ1: Does the L3 share phonological information with the L2, and will its spelling-sound knowledge be activated at an 140ms SOA in relation to a 250ms SOA?

Significance of the study

As previously said, what is known from the arrangement of the mental lexicon concerns mostly, monolingual and bilingual mental lexicons. The organization and processing of the multilingual mental lexicon still holds some mysteries that need to be further explored (Toassi, 2016). Therefore, with the goal of providing more scientific data, and in order to help clarify some of the questions related to lexical selectivity in word naming, the present study posits itself as a significant piece of research.

Organization of the project

This project is divided into four sections. Firstly, in section 2 there is the Review of Literature, in which I approach relevant topics, such as, the mental lexicon in subsection 2.1.; lexical access in subsection 2.2.; writing systems in subsection 2.3.; and the study from Lee et al. (2005), in subsection 2.4.—which is the source of materials for the experiment I will conduct. Moreover, after the Review of Literature, in section 3 I present the Method, in which I explain the experimental design. Afterwards, in section 4, I present the Results and Discussion, followed by the Final Remarks. In the last part of the study there are the appendix and references.

Review of Literature

The present literature review will be divided into four subsections. The first 2 topics to be discussed will be the mental lexicon—both monolingual and multilingual—and its

organization. The second subsection will present a definition of lexical access and the models of lexical access in word comprehension. Moreover, the third subsection will concern the writing systems, scripts, and orthographies of Portuguese, English, and Korean—the three languages involved in the present study. Finally, the fourth subsection will present a detailed summary of Lee et al. (2005), with the purpose of familiarizing the reader to the experiment that will be replicated.

The Mental Lexicon and Multilingualism

In 1987, Aitchinson defined the mental lexicon as the human word-storage or mental dictionary. However, this definition is rather shallow, considering that in 1987 dictionaries were not as evolved as nowadays, since changes in them were not frequently made (Toassi, 2016). Due to the flexibility and ability of incorporating new words, a more accurate and modern definition of the mental lexicon is the one provided by Szubko-Sitarek (2015), who states that the mental lexicon contains a considerable number of lexical entries including all the information on individual words. Furthermore, the author also acknowledges that the organization of the mental lexicon occurs according to the relations between meanings (e.g. important and essential are synonyms; important and unimportant are antonyms) and according to the morphological similarity of the lexical items. However, according to Toassi (2016) these assumptions were made based on research on the monolingual mental lexicon. Even though they may be present in the bilingual mental lexicon, there is the need of further exploration of its organization in bilingual individuals. The more different languages are added to the mental lexicon, the more its complexity increases and the greater the aspects that may interfere in its organization become.

Regarding the non-monolingual lexicon, it is important to acknowledge the possible differences between the bilingual and multilingual lexicons. In other words, is learning a third or fourth language qualitatively different than learning a second language? If so, are there characteristics exclusive to the multilingual lexicon? From the perspective of scholars who study multilingualism, a differentiation between bilingualism and multilingualism is needed due to the effects of prior linguistic knowledge in subsequent language acquisition (De Angelis, 2007). According to De Angelis (2007), a general theory of non-native language acquisition cannot be based only on the L2 learner behavior. Therefore, it needs to be able to explain how the mind performs when two, or more than two languages, are involved. It also must be based on the knowledge and comprehension of how the mind obtains, treats, saves, arranges, and uses all the linguistic information available to the learner, not just the information that belongs to the first or the second language.

Furthermore, if researchers were to apply the term second language to the processes of learning any language after the first one such assumption would have some important repercussions. For instance, it would be assumed that learning a third or fourth language is not in any way different than learning a second language. Differently, scholars who investigated third language acquisition found that the acquisition of an L3, L4 or any additional languages is different from the acquisition of a second language mainly due to the influence from one language system onto another, which is a recurrent process in multilinguals (Toassi, 2012). Thus, according to Hammarberg (2001), in his study on the role of L1 and L2 in the acquisition and production of an L3, a bilingual is a person with knowledge of two languages, whereas a multilingual is a person with knowledge of three or more languages. Such distinction between monolinguals, bilinguals, and multilinguals has led to questions regarding how lexical items are stored—if there are separate or integrated lexicons for the multiple languages—and if

lexical access is nonselective, in which candidate words from all of the speakers' languages will be activated for competition, or restricted to the target language.

Thus, concerning lexical storage, Szubko-Sitarek (2015) proposed two hypotheses: the two-store hypothesis—which states that words from different languages are represented separately; and the one-store hypothesis—which claims that there is one integrated memory system for both languages. However, researchers posited a new question concerning the integration/separation of the lexical and conceptual levels of words. Since the focus of the debate had changed from the perspective of language as a whole to the levels of representation of each word. Therefore, the lexical level would be composed by the word form, whereas the conceptual level would be related to the word meaning (Toassi, 2016). With the purpose of discussing these levels of representation, it is significant to mention the first definition regarding the bilingual lexicon, proposed by Weinreich (1953). According to the author, three types of bilinguals should be considered: coordinate, compound and subordinative. For the coordinate bilinguals, there are two conceptual representations, one for each word in the L1 and L2. In contrast, the compound bilinguals bear only one conceptual representation for two words (L1 and the equivalent translation in the L2). Concerning the subordinative bilinguals, there is a reliance from the L2 into the L1. Therefore, access to the conceptual representation of the L2 word is only possible through the L1 word. According to De Groot (1993), the level of proficiency will determine the way in which the L2 lexicon will be accessed by subordinative bilinguals.

In the interest of solving the debate, another hypothesis was proposed, which stated that lexical forms were separated in the two languages, but the meaning was shared. However, according to Kroll and Sunderman (2003, as cited in Toassi, 2016), this simplistic view cannot be accepted, since research on word recognition has shown that, despite the fact that the

representation of lexical forms might be integrated, there could be some restrictions regarding the shared representation of semantics. Therefore, the question regarding the integration/separation of the two lexicons of bilingual individuals has been reformulated as "to what extent are words from the multilingual's different languages interconnected at both the lexical and the conceptual levels?" (Szubko-Sitarek, 2015, p. 68). Furthermore, it has also been proposed that the variables that could influence the answer to this question are related to the learner/language user and to the particular characteristics of the languages involved (Toassi, 2016).

In order to answer the question regarding lexical access and selectivity, Szubko-Sitarek (2015) explains that the nonselective approach to lexical access does not mean that the multilingual cannot distinguish the words from the three or more languages. In fact, it means that language specific information is only available after the word activation. Consequently, words from the non-target language may be initially activated.

Lexical Access

According to Reichle (2011, p. 774), lexical access can be defined as the "process of activating a word's meaning so it can be used in further linguistic processing". Such further linguistic processing can involve the comprehension of a word (in a sentence, for example), or its production (as selecting words during speech production). Therefore, studies conducted in the area aim to understand how the definition of the word is activated and how is it possible to find a deliberate word for production or to identify it for comprehension (Toassi, 2016).

Given this, research conducted regarding how the monolingual mental lexicon is accessed 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 multilingual. This issue relates to the selective/nonselective view of lexical access, considering that, according to the selective view, only words or lexical entries of the targeted 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.

In this context, in order to better understand the process of lexical access in bilingual individuals, and the experiment conducted in the present study, it is important to understand the dual route model of reading, the models of lexical access known in the area, and the tasks used in each of them, which will be explored in the next subsections.

The Dual-Route model

Based on the dual-route theory of reading, Cook and Bassetti (2005) mention that there are two possible routes for the recognition of a written word. The dual-route theory proposes the existence of two routes for word reading comprehension: a phonological route, which occurs through the mapping of graphemes into phonemes, that are assembled into larger units; and the lexical route, which recognizes the written word as a whole. The former depends on reliable mappings for shallow orthographies, the latter is needed for irregular or exceptional words, that is, words whose assembled grapheme-phoneme mappings fail to match the target pronunciation (Perfetti & Dunlap, 2008).

The computational implementation of the dual-route theory of reading is commonly known as the Dual Route Cascaded (DRC) model, originally proposed by Coltheart, Rastle, Perry, Langdon, and Ziegler (2001). The DCR model can perform the 2 tasks most commonly

used to study reading: lexical decision and reading out loud. Its goal is to explain how skilled readers perform certain basic reading tasks. The model consists of three routes: (1) the lexical semantic route, (2) the lexical non semantic route, and (3) the grapheme-to-phoneme correspondence (GPC) route. All routes are composed of interacting layers of units. These units represent letters in the letter layer and words in the lexicon layer, which are the most elementary parts in each layer. The implementation of this model has shown that the range of variables that influence human latencies have also influenced the DCR model's latencies in the same way, making this model one of the most successful of the existing computational models of reading. This model was based on monolinguals and, later on, inspired bilingual models.

Moreover, Harm and Seidenberg (2004) also addressed this debate of whether words are read visually (a direct mapping from orthography to semantics) or phonologically (a direct mapping from orthography to phonology to meaning), by creating a large-scale computational model based on connectionist principles. The main goal was to examine how this model would solve the problem, comparing the model's performance to people's performance. At first, the model relied more on the orthography-phonology-semantics component; later on, with additional training, the contribution of orthography-semantics increased. Therefore, the authors concluded that skilled reading involves both visual and phonological pathways working together, and the contribution of each pathway will depend on what the other pathway does. In proficient readers, both pathways make contributions in reading to most words. Likewise, it is possible to notice the effects of orthography on phonological processing, and the orthography can be accessed simultaneously with phonology for lexical processing (Gonçalves, 2017). The division of labor depends on the writing systems, and how they represent sound and meaning. Even so, according to the authors, the computational principles are the same (Harm & Seidenberg, 2004). One example of this theory in practice can be when Chinese learners of

English read English words, they seem to rely more on sight-word knowledge (lexical route), whereas native users of alphabetic writing systems rely more on the phonological route (Perfetti & Dunlap, 2008).

Besides the Dual-Route Cascaded model, for the purpose of the present study, it is important to better understand the models of lexical access, and the types of tasks involved in word recognition.

Models of lexical access

Concerning lexical access in bilingual individuals, there are two models widely known in the field, the Revised Hierarchical Model (RHM) and the Bilingual Interactive Activation Model (BIA). The first one proposes that the words from the two languages are stored in separate lexicons. This model is called hierarchical due to the dominance of the L1 over the L2 (Toassi, 2016). Some common tasks used in this model of lexical access are: naming task, translation task, ERP measures, translation recognition paradigm, semantic word detection task, ERP measures and reaction times, and picture naming task.

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, as cited in Toassi, 2016). Since the BIA model is essential in bilingual word recognition research, and it is also the model employed in Lee et al. (2005), it will receive particular focus in this section.

Dijkstra and Van Heuven (2002) point out that the BIA used to be a word recognition model involved with the identification of orthographic representations. However, due to limitations in its lexical and language representations, its handling of context effects, and its lack of an implemented task structure, Dijkstra and Van Heuven (2002) proposed solutions that entail significant changes in the BIA. Therefore, in order to solve the aforementioned issues in

the model, the authors propose the BIA+ (Dijkstra & Van Heuven, 2002), which incorporates some changes in relation to the BIA (1998, as cited in Dijkstra & Van Heuven, 2002), as it refers to the language nodes, as well as to the addition of representations and a task decision component. Furthermore, they state that the BIA+ model makes a distinction 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).

In relation to language selectivity, the BIA+ model defends nonselective lexical access and an integrated mental lexicon across languages due to the model's three levels of representation, where both languages can compete for selection. Moreover, target word recognition is influenced by orthographic neighbors from both languages. When sublexical and lexical orthographic representations are activated, they also activate associated phonological and semantic representations (Dijkstra & Van Heuven, 2002). Therefore, in orthographically related languages, the number of items activated will be larger than for more distinct languages (this activation is the same for both BIA and BIA+). Types of tasks related to test the BIA+ model can be reading low and high constraint sentences with cognates and interlingual homographs; visual word paradigm with eye-tracker; naming task; reading sentences with interlingual homographs and cognates while monitored by the eye-tracker (Toassi, 2016). Even though in Lee et al. (2005) the authors use the term lexical access to identify the process being described in the study, there is the discussion about lexical selection—which is a process that involves word production, which is one step further from just accessing the lexicon. When participants are required to do a word naming task, they are not only being asked to comprehend the word being read, but also to produce an oral outcome when reading the word out loud. Therefore, such process would be considered lexical selection, bearing in mind that when

participants are reading the word out loud, it implies word production. For the purpose of the present study—which aims to replicate the study by Lee et al. (2005)—the same terms and keywords will be used.

Considering the aforementioned affirmation that in orthographic related languages the quantity of activated items will be larger than in distinct languages, a question posited by Lee et al. (2005), is whether or not words that share phonological information, but no orthographic similarity would also activate a larger quantity of items for selection in the bilingual mental lexicon. Thus, in order to further explore this issue, it is relevant to define how languages can differ in writing systems, scripts, and orthographies—which is the focus of the next section.

Writing Systems, scripts, and orthographies

In order to better understand Experiment 1 from Lee et al. (2005) it is also important to understand characteristics of writing systems, scripts and orthographies, as well as how they differ across languages.

Writing systems

A writing system is defined as the overall term for the ways in which written symbols connect to the language (e.g., alphabetic, syllabic writing system) or the specific rules for writing used in a particular language (e.g., the English writing system, the Chinese writing system) (Cook & Bassetti, 2005). The writing systems differ across languages according to what linguistic units are represented by the graphemes. For instance, a phonemic (or alphabetic) writing system - such as English, Portuguese, and Korean—segments language into phonemes, which are represented by letters. In the same way, a consonantal writing system, such as Hebrew or Arabic, represents consonants. Moreover, syllabic writing systems, like Thai and Tibetan, represent syllables; morphemic writing systems, like Chinese and Japanese, represent

morphemes. Additionally, according to Bassetti (2005), a second language writing system (L2WS) may differ from a first language writing system by representing different linguistic units. When this happens, it is more difficult to learn the new writing system. Moreover, research in L2WS shows that when the L1 and L2 writing systems encode the same linguistic units, the reading experience previously developed in the L1 facilitates L2 reading (Cook & Bassetti, 2005). Finally, different writing systems are read differently, and consequently, "learners are affected by the processes and strategies developed to use in their L1 writing system" (Bassetti, 2005, p. 2)

Scripts and orthographies

Besides the differences among writing systems, languages can also diverge in their scripts, which is the systematic expression of visual forms for writing (Perfetti & Dunlap, 2008), and the physical implementation of the writing system (Cook & Bassetti, 2005). For example, English uses an alphabetic (or phonemic) writing system represented by the Roman alphabet, while Korean—also an alphabetic writing system—is written in Hangul. According to Cook and Bassetti (2005), the same script can be used to represent different languages and what will determine the way the script is used to represent a specific language will be the orthography.

Cook and Bassetti (2005) define orthography as the rules for using a script in a particular language. Similarly, Perfetti and Dunlap (2008) define orthography as the implementation of a writing system to a specific language (e.g., English and Italian have the same writing system and the same script, but one is different from the other because of their orthography and punctuation). In alphabetic writing systems, orthographies vary in the transparency of mappings between graphemes and phonemes. In other words, the spelling-sound correspondence can be more transparent or opaque. For instance, Italian and Finnish are

very transparent (or shallow), English is relatively nontransparent (deep or opaque), and Danish falls in between (Perfetti & Dunlap, 2008). Therefore, in more transparent orthographies, the learner can confidently connect a letter to a sound. The more shallow or transparent the orthography—that is, the more reliable the correspondence between graphemes and speech segments—the more the reader uses a print-to-sound decoding strategy. The deeper or less transparent the orthography, the more the reader uses a direct look-up of the word, without grapheme-speech decoding (Frost et al., 1987; Katz & Feldman, 1983; Katz & Frost, 1992; as cited in Perfetti and Dunlap, 2008).

Metalinguistic awareness

According to Koda and Zehler (2008), metalinguistic awareness is the ability to identify, analyze, and manipulate language forms. In the same way, Jessner (2006, p. 42) defines metalinguistic awareness as "the ability to focus attention on language as an object in itself or to think abstractly about language and, consequently, to play with or manipulate language". In light of this, when learning to read, children must first understand which language elements are encoded into the writing system, and then recognize how these elements are encoded (Koda & Zehler, 2008). The same applies for second language learners learning a L2WS. However, some differences can be noted, as these learners already know how to read their first language writing system, so they are not learning from scratch.

Within the ability to make metalinguistic inferences, an important ability that influences second language literacy is phonological awareness, which according to Kuo and Anderson (2008) is the capability to reflect upon and manipulate phonological units in a language. Also, it may entail sensitivity to the phonological structure of the language. Moreover, research has shown that phonological awareness plays a crucial role during the process of learning how to read an alphabetic script (Kuo & Anderson, 2008). The authors also state that when there is an

explicit representation of phonological units the learning of phonology-orthography relations in an alphabetic script is facilitated. Thus, it accelerates early literacy development. L2 phonological awareness can be defined as awareness of the phonological structure of spoken words and the ability to access and manipulate phonological structure (Saiegh-Haddad, 2019). For second language learners, having the awareness of a phonological structure of a language means understanding what are the possible sound combinations in a new language, which may help learners assimilate and retain phonological strings in the language. According to Saiegh-Haddad (2019), L2 phonological awareness is affected by L2 language-specific factors—L2 language ability and L1-L2 linguistic distance. The author also highlights the importance of viewing phonological awareness in L2 as a two-dimensional construct including a (1) metalinguistic component, which may be metalinguistic in nature and language-independent, and (2) a linguistic component which is language-specific and reflects phonological representations in L2.

Considering the aforementioned information about writing systems, scripts and orthographies, in the following subsection I describe the similarities and differences between Brazilian Portuguese, English and Korean in terms of their representation of written language.

Brazilian Portuguese, English, and Korean writing systems

Taking into account how languages differ in writing systems, scripts, and orthographies, it is important to define the types of writing systems, scripts and orthographies involved in the study. Firstly, Brazilian Portuguese and English are languages that have alphabetical writing systems, both employing the same script—the Roman alphabet. Considering this, even though these languages seem similar to one another, they diverge in terms of orthography. Therefore, according to Perfetti and Dunlap (2008) in their grapheme-

to-phoneme correspondence (GPC)[1] ordering (based on orthographic depth of various languages), Portuguese is considered to have a relatively transparent orthography. Consequently, when reading Portuguese, a learner can connect a letter to a sound with more reliability than other languages. On the other hand, due to its orthographic depth—one grapheme can correspond to multiple phonemes, as well as there are many grapheme-to-phoneme correspondence exceptions—English is considered to have a very opaque orthography, which increases the difficulty when readers need to connect a letter to a sound.

At the same time, the Korean language is also represented by an alphabetical writing system. However, it diverges in script and orthography from the previously presented languages. The Korean alphabet is called Hangul, a non-Roman alphabet. As in the Roman alphabet, each symbol represents a single consonant or a vowel. In contrast to the linear horizontal sequences used in English and Portuguese orthography, Hangul symbols are combined into syllable blocks, in order to resemble the form of its predecessor: the Chinese characters. The grapheme-phoneme correspondence is considered to be highly consistent and reliable at the individual symbol level; however, syllable blocks do not always correspond with spoken syllable boundaries. Some restrictions concern consonant sounds that are not allowed in syllable-final position, and consonant clusters (Park, 2008). Therefore, some syllable blocks may have a less transparent pronunciation, which can be a challenge for non-native speakers when reading in Korean.

Nonselective access of spelling-sound knowledge for Korean-English bilinguals

Significant inquiry has been directed to the issue of how readers use information from a printed word to access the suitable entry in the mental lexicon where word knowledge is

[1] Previously mentioned here as spelling-sound knowledge

stored. According to Jorm and Share (1983), in spoken language the listener must use an internal representation of speech to access the lexicon, referred by the authors as a phonological code. However, in written language the "lexical entries may be accessed either via a phonological code or by a code based on the visual features of a word" (Jorm & Share, 1983, p. 103), as it was later verified by Harm and Seidenberg (2004), who concluded that skilled reading involves both visual and phonological pathways working together. When a phonological code is used to access a lexical entry for a printed word, this process is referred to as pre-lexical phonological recoding (Jorm & Share, 1983). This process is generally believed to be carried out by the implementation of the grapheme-to-phoneme correspondence rules.

Going beyond the dual-route model (Coltheart et al., 2001), the presence of phonological recoding in word recognition ignited a myriad of discussions within the field of monolingual research. According to Lee et at. (2005), studies supporting this hypothesis suggest the possibility of phonological recoding even in L2 recognition. Moreover, research has shown the presence of phonological priming between L1 and L2 for alphabetic (French-Dutch) bilinguals (Van Dyck, and Van de Poel, 1999 as cited in Lee et al., 2005).

Given the differences between English and Korean writing systems, and the representation of phonological information at different hierarchical levels in their information processing, Lee et al. (2005) investigated phonological priming from L2 English to L1 Korean as well as from L1 to L2 for Korean-English bilinguals. Furthermore, the study also assessed the question of whether activating the orthographic cues of very different writing systems would fail to activate bilingual information automatically.

In the study, two experiments were conducted using primed word naming tasks. Experiment 1 was divided in parts 1a and 1b, and addressed the question of phonological

priming from an L1 prime (Korean nonword) to an L2 target (English word). Experiment 1a had SOAs (stimulus onset asynchrony[2]) of 140ms for the primes. Experiment 1b had longer SOAs, of 250ms. In contrast, Experiment 2 (also divided into 2a and 2b) investigated phonological priming from L2 (English nonword) to L1 (Korean word). Parts 2a and 2b also differed in SOAs of 140ms and 250ms, respectively (Lee et al., 2005). The authors' motivation for varying the SOAs was to manipulate for how long participants would be primed. The duration of the prime for Experiments 1a and 2a was 140ms, which, according to Lee et al. (2005), is considered too brief to involve awareness. In contrast, the duration of the prime in Experiment 1b and 2b was 250ms, considered long enough to allow conscious processing (Lee et al., 2005).

Participants for both experiments were forty-three college students who were Korean-English bilinguals. Out of the forty-three students, twenty-nine were female, with an average age of 19, and 14 students were male, with an average age of 20. All of them were enrolled in the Introductory Psychology class at Pusan National University in South Korea and participated in the experiment as a course requirement. Additionally, participants had normal or corrected-to-normal vision, and were taught English as a second language in middle and high school, giving them 6 years of English study. All students were raised in the southeastern part of Korea, which includes the city of Pusan.

Regarding the materials for Experiment 1, twenty-eight English target words were selected from the CELEX database (Baayen, Piepenbrock, & Van Rijn, 1993 as cited in Lee et al., 2005), with an average frequency of 10658; CELEX is based on over 17 million words. Two types of Korean nonword primes were made, a phonological prime and a control prime. It is interesting to notice that, even though Korean and English do not overlap orthographically

[2]The time period from priming to the target onset

at all, the phonological primes were made by an appropriate combination of consonants and vowels, in such way that the Korean nonword resembled the pronunciation of the English target (e.g., English prime "SAAT", Korean target "셋" /sɛt/). On the other hand, the control prime was made to be phonologically different from the English target in that there were no phonemes in common between the prime and the target.

The subjects sat 60cm away from the computer screen and had to read the target out loud as quickly as possible but to do it accurately. The prime and the target were presented by Superlab experimental software with three-field priming technique (mask-prime-target sequence). Each trial consisted of: (1) a row of four hash marks for 500ms; (2) the Korean nonword prime for 140ms in Experiment 1a, and 250ms for Experiment 1b; (3) the English word target for 1800ms. Intertrial interval was 1000ms. Stimuli order was randomized, and all letters were presented as white on a dark background.

Results of the first experiment show that phonological priming from an L1 prime to an L2 target was significant across both SOAs. Target reaction time (RT) and error rates in both SOAs followed the same pattern, with faster time and fewer errors in the phonological condition. Thus, according to the authors, this suggests that the spelling-sound information in L1 is automatically invoked in the early stage of processing and is still available in the later stage. Since the phonological effect is not greater for the longer SOA, it appears that no additional use is made of the prime's phonological information in the 250ms SOA beyond the effects that occur in the first 140ms (Lee et al., 2005).

For Experiment 2 (2a and 2b), forty-eight target words were selected from the Korean Word Frequency database (Lee, Lee, Nam, Chung, Lee, & Choi, 1991, as cited in Lee et al., 2005). Their average frequency was 573; the Korean Word Frequency is based on over 1 million words. Similarly to Experiment 1, two types of non-word primes were constructed to

be used as the phonological prime and the control prime, except that for Experiment 2 these primes were in English. The phonological prime was made by the combination of consonants and vowels to resemble the pronunciation of the Korean target. The control prime was made to be phonologically different from the English target (Lee et al., 2005).

As for the interpretations of results, the authors concluded that they were similar to Experiment 1. Therefore, results for Experiment 2 demonstrated that phonological priming from an L2 prime to an L1 target was substantial at both SOAs, suggesting that the spelling-sound knowledge of L1 is automatically activated in early stages, and L2 processing takes advantage of this available phonological information.

In conclusion, the study reports that phonological information activated by either an L1 or L2 prime can interact with phonological information from the other language. Thus, L2 shares phonological information with L1, and the spelling-sound knowledge is activated, apparently automatically, at an SOA of 140ms. The constant pattern of phonological priming of L1 and L2 targets at the 140ms SOA indicates that the spelling-sound knowledge of bilingual lexicons is triggered when any linguistic form is presented. Moreover, it is important to point out that this indiscriminate activation of spelling-sound knowledge in the Korean-English bilingual system takes place in the absence of any common orthographic cues because the two languages have totally different writing systems (Lee et al., 2005). As for future contributions, the authors leave to be asked the question of whether there is a relationship between the degrees of experience with L2 and its corresponding degrees of phonological processing. Furthermore, they point out limitations such as the making of stimulus materials and the participants' level of L2 proficiency.

Further testing

Other studies sought to analyze similar questions to Lee et al.'s (2005). For instance, Jouravlev, Lupker, and Jared (2014) investigated cross-language phonological activation in the sub-lexical level Russian-English bilinguals. Through the experimental paradigm of masked onset priming, with L2 (English) primes and L1 (Russian) targets, the results have shown that phonological overlap between primes and targets led to faster naming latencies. Moreover, the time-course of phonological and orthographic processing for our bilinguals reflected the time-course reported for monolinguals in the ERP data.

Under the same scope, considering that phonological activation created by reading a word in one language facilitates word identification in the other language, Nakayama, Sears, Hino and Lupker (2012) examined the integration of phonological representations for Japanese-English bilinguals—languages that are represented by different scripts. Similarly to experiment 2 from Lee et al. (2005), in this study participants made lexical decisions to English targets (e.g., GUIDE) that were primed by Japanese primes. However, one main difference is that there were three types of masked primes: cognate translation equivalents (e.g., ガイド, /gaido/, guide), phonologically similar but conceptually unrelated words (e.g., サイド /saido/, side), and phonologically and conceptually unrelated words (e.g., コール, /koRru/, call). The results suggest that phonological representations for different languages are integrated even if the languages use different scripts.

In Choi, Nam, and Lee (2010), the same authors who participated in Lee et al.'s study (2005) further explored the topic in question. The experiment was similar to Lee et al. (2005): two sets of 34 prime-target pairs served as stimuli, being Korean to English (Korean-English) pairs and English to Korean (English-Korean) pairs. In both cases, the targets only shared phonological information with the primes. However, the authors stated that the 140ms prime

is too long to be within a prelexical stage, therefore, the objective of the study was to test phonological activation at 50ms primes. The results showed significant bilingual priming - even in the second-then-first language direction (Choi, Nam, & Lee, 2010). Moreover, according to the authors, these results go against the argument that only the first language can be processed phonologically, and that second language can also be processed phonologically.

Considering the studies mentioned above, it is possible to suggest that this topic has need of further testing in different contexts, such as approaching a different group of participants (e.g., non-native speakers), and exploring the multilingual mental lexicon.

Method

As previously stated, lexical access is the process of activating a word definition so it can be used in further linguistic processing (Reichle, 2011). In order to assess word recognition, experiments in the area are theoretically based on the BIA model, which is specially involved with the identification of orthographic representations (Dijkstra & Van Heuven, 2002). Therefore, the present study uses the experimental paradigm of phonological priming to investigate the selectivity of lexical access from L3 to L2 by Brazilian Portuguese native speakers, who have English as an L2 and study Korean as an L3. The experimental design consisted of the replication of Experiment 2 (2a and 2b) from Lee et al. (2005). Moreover, alongside with the phonological priming experiment, the participants also answered an info biographical questionnaire, and two language proficiency exams, for both English and Korean languages. Considering the current scenario of the pandemics, the data collection was conducted remotely, and the experiment was hosted in Cognition - a website that could be accessed in any web browser. Moreover, the researcher monitored the experiment through

video call. The study was pre-registered previous to the data collection in the Open Science Framework[3].

Participants

The experimental group was composed of nine Brazilian Portuguese native speakers, who have English as a second language in B2 or superior level, following the Common European Framework (CEFR) classification, and are currently learning Korean as a third language in 2B or superior level, according to King Sejong Institute[4] leveling. Eight participants were female, and one participant was male. Their age ranged from 18 to 26 years old (*M= 21.7, SD = 2.63)*. All of them completed the experiment. They were recruited via email, messages in social networks or private communication. After having read and signed the *Termo de Consentimento Livre e Esclarecido* (TCLE) (Appendix A), the participants answered a biographical questionnaire [5](Appendix B)—both available online and held in the Google forms platform. Additionally, they took an English proficiency test, which can be found on the website Exam English[6], and a Korean proficiency test, which can be found on King Sejong Institute website[7]. Finally, participants were asked to complete an online word naming task. In the biographical questionnaire, all 9 participants reported having basic knowledge of Spanish, but none of them stated being fluent in this language.

[3] https://osf.io/btjsp/
[4] The institute is a Korean governmental agency responsible for teaching the Korean language in 76 countries, including Brazil.
[5]https://docs.google.com/forms/d/e/1FAIpQLSfEg1itR9b54nz4brUn7h1BmGEcSZcflNYpsMcGSDBzLoDvg/viewform

[6] http://www.examenglish.com/leveltest/grammar_level_test.htm
[7] https://nuri.iksi.or.kr/front/page/participation/onlineLevelTest/main.do

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. In this section I will detail the presented instruments.

Info biographical questionnaire

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

English proficiency test

The participants performed online English proficiency test, held in the platform Exam English. The test, that has the objective of leveling participants according to their abilities in the language, 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—and are based on participants' knowledge of grammar and vocabulary, as well as their listening comprehension. Moreover, the results are provided immediately after the end of the test. Once finished, the participants sent their results to the researcher via email.

Korean proficiency test

Alongside with the English proficiency test, the participants also partook in an online Korean proficiency test, held in the online platform for King Sejong Institute. The tests are

designed to assess eight levels from King Sejong Institute Beginner level (1A) to Intermediate Level (4B)—according to the Institute's curriculum. 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 of free access for all, the results are immediately available, and can be saved in PDF format. As well as for the English proficiency test, the participants also sent the results to the researcher via email.

Word naming task

In the word naming task, participants were required to read aloud, as quickly and as accurately as possible, 48 target Korean words divided in two blocks—consisting of ninety-six trials each. 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, primes were presented at an SOA of 140ms. In the second block, primes were presented at a 250ms SOA. 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 for 140ms in part 1, and 250ms for 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 for 140ms in part 1, and 250ms for 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 for 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 within-subject variable of SOA (140ms and 250ms). The dependent variable was

reaction time. All the 48 target words, phonological, and control primes were those used by Lee et al. (2005). The experimental design contemplated the following conditions:

CONDITION 1: Phonological prime

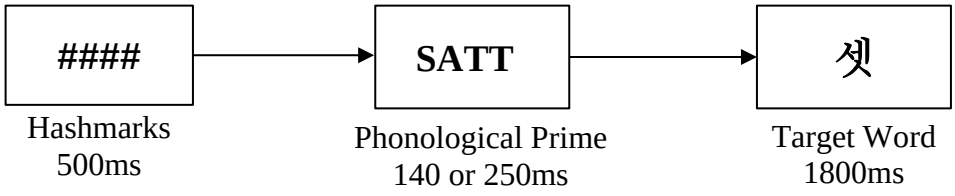

Figure 1: Experimental design of condition 1: a trial containing a phonological prime

CONDITION 2: Control prime

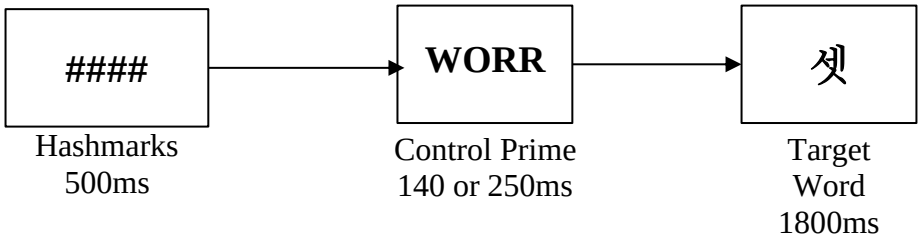

Figure 2: Experimental design of condition 2: a trial containing a control prime

As a phonological priming experiment, participants were presented with both phonological and control primes to each of the target words, with the purpose of investigating the effects of the English primes in the reaction time (RT). Therefore, participants had to read the same target word two times in each part of the experiment, once preceded by the phonological prime (e.g., Figure 1), and once preceded by the control prime (e.g., Figure 2). 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 (Appendix C) presented phonological

primes (condition 1) first, followed by control primes (condition 2). List 2 (Appendix D), had condition 2 first, followed by condition 1. Considering a possible order effect, it is important to highlight that it was also made sure that the same word would not be presented two times in a row.

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

Figure 3: Design of the 2x2 Latin square.

The task was programmed in was programmed in JavaScript, which allowed it to be ran on Google Chrome or Mozilla Firefox, in any computer available. The hosting and online programming of the experiment was made through Cognition[8]. At the same time, the softwares Vim and Git were used in the programming. The former is a highly configurable text editor, and the latter, a version control system tool. Moreover, the JsPsych (de Leeuw, 2015) library was used in order to simplify the development of the task and assure the quality of the reaction time (RT) measurements. Participants' response was automatically recorded for 1800ms, from the moment the target words appeared until the moment they left the screen.

[8] https://www.cognition.run

The word naming task was hosted in Cognition. 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, it is not possible to detail the monitor type, considering each participant did the experiment on their own computer. 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. After the first block had ended, participants were able to take a short break before moving on to the next block, in which the words would also automatically appear on the screen.

Procedures

The word naming task reported in the present study was conducted online. More specifically, the behavioral data was collected remotely. Thus, each participant chose the best environment for taking the task, in their own computer. After confirming their intention to participate in the study, they received an email with the guidelines for the step-by-step of the data collection. First, participants were asked to (1) read and agree to the consent form (namely, the TCLE) which was made 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 stage of the data collection and send the results to the researcher. After these procedures were completed, participants did the word reading task. The researcher accompanied this stage of the data collection through video call, in order to assist in case there were any problems. When taking the word naming task, participants were asked to test their microphones, in order to make sure the data collection would be precise. Then, a practice session was conducted so they could be familiarized with the procedure. After

such session, the word naming task began, and lasted for approximately 10 minutes. The present study was approved by UFSC's Ethics Review Board.[9] In the following subsection, the pilot study will be addressed.

Pilot Study

The pilot study was conducted in the third week of March 2021. Its main objective was to test instruments and procedures. One PB native speaker (1 female) participated in the pilot study. She signed the consent form, answered the info biographic questionnaire, and took the proficiency tests before performing in the word naming task.

The researchers followed the data collection through video call. Based on our own observations as well as on participant's feedback, typos and formatting errors were fixed. No further adaptations on the instruments were necessary. In the following section, I will present and discuss the results of the experimental task.

Results and discussion

The present section will report the results of the behavioral phonological priming experimental task from 9 participants. First, I will address the pre-processing procedures that the raw data went through before the statistical analysis could take place. Then, I will present the results of the behavioral phonological priming experiment. Finally, I will discuss the results in light of the literature presented above and compare them to Lee et al.'s (2005).

[9] CAAE: 40474920.9.0000.0121

Data pre-processing

Two dependent variables were looked into during the data pre-processing procedures. First, participants' pronunciation accuracy in L3 Korean was assessed. Participants who mispronounced more than 50% of the words would be considered to be guessing the answers and their data would be discarded; there was no such case. Additionally, when answers were not recorded, these trials would be considered as missing data and would not enter the analyses Second, participants' reaction times were analyzed. RTs were measured in Chronset (Roux, Armstrong & Carreiras, 2016). When RTs were smaller than 500ms, the recordings were verified manually in the software Ocenaudio[10] and corrected to their actual number. Then, latencies over 1800ms were discarded. After the data pre-processing procedures, the data from 9 participants remained for further analysis. The data of one particular participant was only stored up to 80%, possibly due to connection problems. Considering that the majority of the data was stored, this participant's data was included in the analysis. Therefore, data of all nine participants were analyzed.

Data analyses

All data analyses were carried out in the R environment (R Core Team, 2014). In order to follow the same steps as the original research from Lee et al. (2005), first the RT were analyzed using ANOVA. The ANOVA was a 2 x 2 repeated measures design, with a within-subject variable of prime type (i.e., phonological, control), and a within-subject variable of SOA (i.e., 140ms, 250ms). The results showed that the main effects of condition [$F(1554.7) = 31.96$, $p < 0.001$] and SOA [$F(1553.9) = 35.42$, $p < 0.001$] were significant. However, the

[10] OcenAudio (2015). Audio editor. Available from https://www.ocenaudio.com/

interaction of condition and SOA was not significant [$F(1554.2) = 0.85$, $p = 0.36$]. The ANOVA results here presented are partially similar to the results from Lee et al. (2005), in which for RT, there was a significant main effect for prime type, and the interaction of prime type and SOA was not statistically significant. However, the studies diverge when it comes to the significance of the SOA: in the present study SOAs are statistically significant, while in Lee et al. (2005) they are not (*Fs < 1)*.

We also ran a linear mixed-effects model using the *lme4* package (Bates et al., 2015) with target words and participants as random effects (Table 1) and condition and SOA as fixed effects. The results (Table 2) showed that participants' average RT was 865ms. There was a significant facilitation when participants read the target words that were preceded by Condition 1 (Table 3), the phonological primes ($\boldsymbol{\beta} = -34{,}80$, $p = 0.001$). Moreover, a numeric facilitation was also observed when participants faced the interaction between Condition 1 with a 140ms SOA ($\boldsymbol{\beta} = -13{,}52$, $p = 0.36$), however, it was not significant (*C.I.* = -42.33, 15.30), just like in Lee et al. (2005). Additionally, as it is possible to see in Table 4 and Figure 5, the descriptive statistics for SOA and plot of RTs show that participants' longer exposure (250ms) to the English prime resulted in a significant effect of SOA on their responses ($M = 880.34$, $SD = 199.43$), contrary to the 140ms trials, in which participants took longer to produce the outcome ($M = 913.23$, $SD = 207.58$).

Random Effects		
Group	**Parameter**	**SD**
Target	(Intercept)	44.518
Participant	(Intercept)	150.547
Residual		147.374

Table 1: Random effects

	Est.	**2.5%**	**97.5%**	**p-value**
(Intercept)	896.941	796.702	997.181	0.000
Condition (English)	-34.795	-55.501	-14.090	0.001
SOA (140ms)	50.701	30.271	71.131	0.000
Interaction (English:140ms)	-13.519	-42.334	15.295	0.358

Table 2: Results of the analysis by Linear Mixed Models

SOA	*Mean RT (ms)*	*SD*
140ms	913.23	207.58
250ms	880.34	199.43

Table 3: RT descriptive statistics for SOA

Condition	*Mean RT (ms)*	*SD*
C1 - English	877.43	196.14
C2 - Control	917.26	210.36

Table 4: RT descriptive statistics for condition

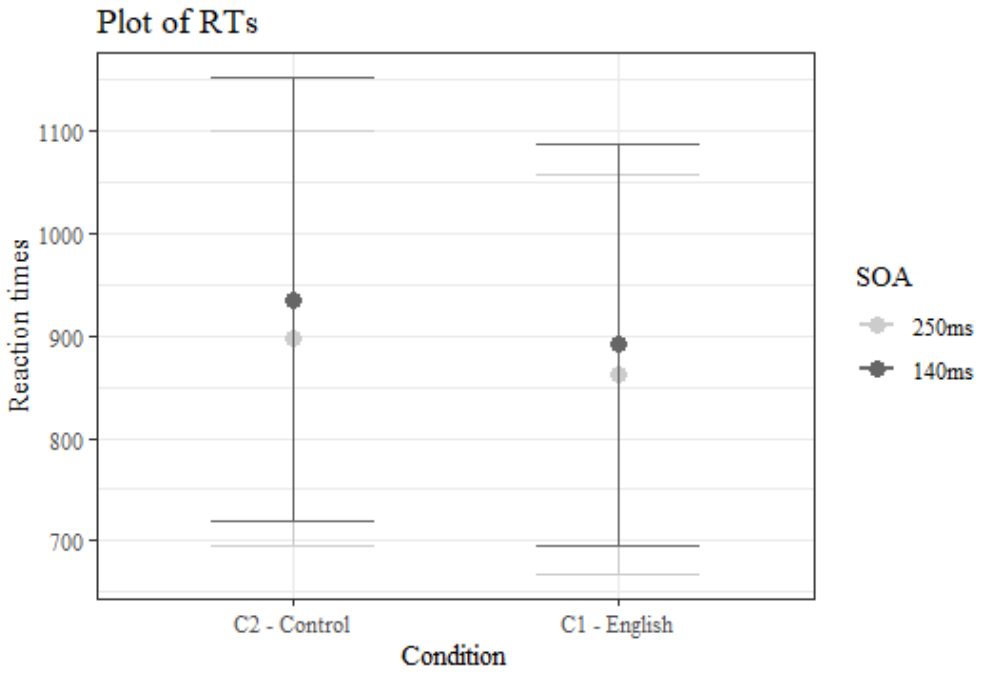

Figure 4: Plot of RTs

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 inspired by Lee et al.'s (2005) findings, and aimed at understanding if the spelling-sound knowledge of L2 and L3 would be activated when reading target L3 words, by means of a study

where phonological priming in the L2 was measured in two different conditions (140ms and 250ms SOAs). Despite the studies in the area of bilingualism (Van Heuven, Dijkstra, & Grainger, 1998; Dijkstra, Grainger, & Van Heuven, 1999; Lee, Nam, & Katz, 2005; Nakayama, Sears, Hino, & Lupker, 2012; Jouravlev, Lupker, & Jared 2014), little is known about the multilingual lexicon. Therefore, the present study represents a meaningful 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—considering that the languages involved in the study differ in scripts.

The results reported here were in line with the findings of Lee et al. (2005), in some particular points. It is possible to state that participants' spelling-sound knowledge of L2 English was activated during the reading aloud of words in L3 Korean. However, the present study did not find a facilitation in the 140ms SOA in relation to the 250ms SOA. These results can be interpreted as evidence that, for nonnative speakers of 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 et al. 2010).

The results of the ANOVA show that there was a significant effect of condition and SOA, but not a statistically significant effect of the interaction of both condition and SOA. These findings are similar to Lee et al. (2005) in two points: (1) the significant effect of condition, and (2) the absence of an effect in the interaction of condition and SOA. Differently from Lee et al. (2005) with bilinguals, the significant effects presented here imply that during the reading and production task, there was an influence of the 250ms SOA in participants' response times, considering they were longer exposed to the primes, which facilitated their

response when naming the target word in L3 Korean. Additionally, the condition of English prime also presented a significant facilitation, which can indicate the sharing of phonological information between L2 English and L3 Korean.

Besides the ANOVA, we also ran a linear mixed-effects model, considering that this model is more robust than the ANOVA (Baayen, Davidson, & Bates, 2008). The results of the linear mixed-effects model, similarly to the ANOVA, presented a numeric facilitation in the interaction of condition and SOA, even though the interaction was not 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 140ms SOA were presented together. However, we did not see a significant effect, possibly due to our sample size. Moreover, the results of the linear mixed-effects models presented a significant effect of SOAs, differently from Lee et al. (2005), but similar to our ANOVA results. This significant effect can be due to the different sample assessed in the study, which was not composed of native speakers of Korean, but native speakers of Brazilian Portuguese learning Korean as an L3. Thus, it is possible to hypothesize that due to their not so frequent usage of Korean, longer primes were more helpful when performing the task.

Concerning the significant effect of the prime type, the results from both the ANOVA and the linear mixed-effects models show that L2 phonological primes, in comparison with control primes, facilitated L3 word naming, consequently reducing their reaction times 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, which 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).

Moreover, considering orthographic processing, it is important to recall the aforementioned literature. 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, the results from Lee et al. (2005) and from the present study show that phonological information is activated and shared, despite the orthographic representation, considering that English and Korean have both alphabetical writing systems, but use different scripts to represent language.

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, aimed at contributing to the literature regarding multilingual lexical access and phonological processing, with data from adult native speakers of Brazilian Portuguese who also speak English as an L2 and Korean as an L3.

However, it is important to highlight our limitations, so they can be overcome in further studies. The first limitation we must address is the sample size, which might have affected - as mentioned above—the significance of the interaction between condition and SOA.

Additionally, our sample was composed of Brazilian Portuguese-English unbalanced bilinguals, therefore, considering the languages involved in the study, the instructions of the experiment were written in English, which might have preactivated the phonological information of the L2 before the task itself. 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. the results indicated that there is a sharing of phonological information between participants' L2 and L3, and that their spelling-sound knowledge of the L2 is activated with the presence of phonologically similar words between L2 and L3, despite the writing systems involved in the process. This phonological similarity can be a facilitator to learners' pronunciation development and vocabulary acquisition (Pollastek, 2015). Considering the parallel activation of languages when selecting words for further linguistic processing, exploring these phonological similarities across languages can ease the learning of a new language, especially the ones with different writing systems—which can be more complex to master.

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Appendices

Appendix A

Participação em Experimento de Priming Fonológico

Termo de Consentimento Livre e Esclarecido (TCLE) baseado na resolução 510/2016 de acordo com o CNS (Conselho Nacional de Saúde)

UNIVERSIDADE FEDERAL DE SANTA CATARINA

CENTRO DE COMUNICAÇÃO E EXPRESSÃO

DEPARTAMENTO DE LÍNGUAS E LITERATURAS ESTRANGEIRAS—DLLE

LABLING—LABORATÓRIO DA LINGUAGEM E PROCESSOS COGNITIVOS

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

Caro (a) Participante,

Eu, Luiza de Melo Carvalho, CPF: 345.190.118-84, RG: 49.278.183-7, aluna de graduação do curso de Letras - Inglês da Universidade Federal de Santa Catarina, orientada pela Professora Dra. Mailce Borges Mota, tenho como objetivo desenvolver um estudo sobre o processamento de leitura em coreano.

Gostaria de convidá-lo(a) a participar desta pesquisa, que busca investigar como processamos a leitura de um novo alfabeto. Os estudos nessa área visam não só compreender o processamento de uma língua, mas também desenvolver meios de aperfeiçoar o seu ensino e aprendizagem. Peço que você leia este formulário de consentimento e tire todas as dúvidas que possam surgir antes de concordar em participar do estudo.

Os experimentos aplicados serão realizados remotamente, de forma online. Se você concordar em participar deste estudo, você será solicitado(a) a preencher um questionário biográfico, realizar um teste de proficiência em coreano e realizar um experimento de *priming* fonológico. Você preencherá o questionário biográfico com alguns dados pessoais (por exemplo, idade, sexo, etc.). O teste de proficiência será realizado em uma plataforma online. O experimento de *priming* é uma tarefa de leitura de palavras. Você lerá as palavras em um computador. Seu tempo de resposta será gravado automaticamente. Esta tarefa terá duração de 30 minutos.

Em decorrência da participação nesta pesquisa, você pode estar exposto(a) a eventuais riscos, mesmo que baixos, tais como nervosismo, constrangimento, cansaço ou aborrecimento inerentes a qualquer situação de avaliação, assim como a quebra de sigilo mesmo que de maneira involuntária e não intencional. Para minimizar a possibilidade de desconforto, sessões de prática serão feitas antes da aplicação do experimento para que você possa se familiarizar com os procedimentos. Como o experimento será realizado remotamente, orientamos que busque um local em sua residência que seja confortável e propício para a realização da coleta de dados. Recomendamos cadeiras confortáveis, iluminação e temperatura adequadas e posicionamento adequado do monitor do computador, de acordo com a sua altura.

De acordo com a legislação brasileira, sua participação é voluntária e não remunerada. Os pesquisadores estarão à disposição para esclarecimentos, antes, durante e depois da pesquisa. Você tem assegurada a liberdade de desistir de participar a qualquer momento do estudo, sem nenhuma penalização.

Ao clicar no campo “Aceito participar da pesquisa” e informar seu nome e RG, esse TCLE será enviado automaticamente para o seu email e para o email da pesquisadora assistente. A data e horário do envio ficam registrados automaticamente. Guarde cuidadosamente a sua via, pois é um documento que traz importantes informações de contato e garante os seus direitos como participante da pesquisa. Caso a sua participação nessa pesquisa lhe traga alguma despesa, você tem direito a ressarcimento. Caso venha sofrer qualquer prejuízo, material ou imaterial, comprovadamente decorrente de sua participação nesta pesquisa, você será indenizado de acordo com a legislação vigente.

Os dados obtidos neste estudo serão mantidos em sigilo e serão armazenados no LabLing. Os dados serão acessados apenas pelos pesquisadores responsáveis. Os resultados desta pesquisa serão divulgados em eventos ou publicações científicas sem qualquer identificação dos participantes. Você pode ter acesso aos resultados da pesquisa a qualquer momento entrando em contato com os pesquisadores.

Os procedimentos metodológicos adotados obedecem aos preceitos éticos implicados em pesquisas envolvendo seres humanos, conforme normatizado pela Resolução do Conselho Nacional de Saúde nº 510 de 07 de abril de 2016, que dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais. As pesquisadoras também aderem a esse documento e comprometem-se a conduzir a pesquisa de acordo com o que preconiza a referida Resolução.

Contatos. Tendo qualquer dúvida sobre a pesquisa, você pode entrar em contato com Luiza de Melo Carvalho, pelo e-mail lumelocarvalho@hotmail.com ou pelo telefone (16) 98143-2549, ou com a professora Dra. Mailce Borges Mota através do e-mail mailce.mota@ufsc.br, telefone (48) 3721-3792, ou no prédio do Centro de Comunicação e Expressão—CCE, bloco B, sala 513, Universidade Federal de Santa Catarina, UFSC.

Comitê de Ética em Pesquisa (CEP). A pesquisa, da qual faz parte esse questionário, foi avaliada e aprovada pelo Comitê de Ética em Pesquisa com Seres Humanos (CEPSH) da UFSC. O CEPSH é um órgão colegiado interdisciplinar, deliberativo, consultivo e educativo, vinculado à Universidade Federal de Santa Catarina, mas independente na tomada de decisões, criado para defender os interesses dos participantes da pesquisa em sua integridade e dignidade e para contribuir no desenvolvimento da pesquisa dentro de padrões éticos. Caso você tenha alguma dúvida ou reclamação quanto à condução ética dessa pesquisa, você pode entrar em contato com o CEPSH—UFSC. Endereço: Prédio da Reitoria II, 4º andar, sala 401, Rua Desembargador Vitor Lima, nº222, Trindade, CEP 88040-400, Florianópolis-SC. Telefone: (48) 3721-6094. E-mail: cep.propesq@contato.ufsc.br.

☐ Aceito participar da pesquisa (link para o registro do consentimento)

☐ Não aceito participar da pesquisa (link para mensagem de agradecimento)

Termo de consentimento livre e esclarecido

Eu, _____, email _____, declaro que li e compreendi as informações do **Termo de Consentimento Livre e Esclarecido**. Eu compreendo meus direitos como voluntário(a) da pesquisa, concordo em participar deste estudo e em ceder meus dados para a pesquisa. Compreendo o objetivo do estudo bem como os procedimentos que serão realizados. Receberei uma via assinada deste formulário de consentimento.

Apendix B

Questionário demográfico e de experiência linguística

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

Orientadora: Profa. Dra. Mailce Borges Mota (PPGI/ PPGLg/CNPq/ UFSC)

Pesquisadoras: Luiza de Melo Carvalho (DLLE)

*Obrigatório

1. Endereço de e-mail *

2. Idade *

3. Data de nascimento *

Exemplo: 7 de janeiro de 2019

4. Nacionalidade *

5. Sexo *

Marcar apenas uma oval.

- ◯ Feminino
- ◯ Masculino

6. Telefones (celular e residencial)

7. Além do português, quais outros idiomas você tem conhecimento?

8. Você é falante de inglês?

Marcar apenas uma oval.

- ◯ Sim
- ◯ Não

9. Em caso de resposta positiva para a pergunta anterior, selecione as opções que melhor definem sua relação com o idioma: *

Marcar apenas uma oval por linha.

	Sim	Não	Não falo inglês
Já fiz curso de inglês	◯	◯	◯
Faço curso de inglês atualmente	◯	◯	◯
Falo inglês mas nunca fiz curso de inglês	◯	◯	◯
Após o português, inglês foi o segundo idioma que aprendi	◯	◯	◯

10. Sobre seu estudo de coreano, selecione as respostas que melhor representam sua relação com o idioma: *

Marcar apenas uma oval por linha.

	Sim	Não
Já fiz aulas de coreano	◯	◯
Faço aulas de coreano atualmente	◯	◯
Estudo coreano por conta própria/online	◯	◯
Coreano é o terceiro idioma que aprendi	◯	◯

11. Caso coreano não seja o terceiro idioma que você aprendeu, explique.

12. Outras informações

Appendix C

Stimuli - List 1

condition	code	prime word	target
C1 - English	english25	SUC	석
C2 - Control	control48	DEA	플
C1 - English	english24	SAB	삽
C2 - Control	control47	SAV	포
C1 - English	english23	BII	비
C2 - Control	control46	COH	턱
C1 - English	english22	BOOL	불
C2 - Control	control45	WAHN	택
C1 - English	english21	BUK	북
C2 - Control	control44	RUTE	탑
C1 - English	english20	BOL	볼
C2 - Control	control43	SEH	키
C1 - English	english19	BOHI	보
C2 - Control	control42	OLEE	칠
C1 - English	english18	BUH	벗
C2 - Control	control41	OATE	추
C1 - English	english17	BAC	백
C2 - Control	control40	DOUN	천
C1 - English	english16	BAMM	밤
C2 - Control	control39	QUIL	척
C1 - English	english15	MIT	밑
C2 - Control	control38	MORC	책
C1 - English	english14	MILV	밀

C2 - Control	control37	FO	조
C1 - English	english13	MUN	문
C2 - Control	control36	DU	자
C1 - English	english12	MORR	모
C2 - Control	control35	WATEE	영
C1 - English	englosh11	MUGG	먹
C2 - Control	control34	DUL	암
C1 - English	english10	MAR	막
C2 - Control	control33	DI	악
C1 - English	english9	DOMH	돔
C2 - Control	control32	GYI	씨
C1 - English	english8	DOL	돌
C2 - Control	control31	STE	실
C1 - English	english7	DOGG	독
C2 - Control	control30	PEAC	신
C1 - English	english6	DUMH	덤
C2 - Control	control29	RUL	식
C1 - English	english5	DUC	덕
C2 - Control	control28	ARS	시
C1 - English	english4	THAM	댐
C2 - Control	control27	FUH	소
C1 - English	english3	KNOF	노
C2 - Control	control26	WORR	셋
C1 - English	english2	NOTT	낯
C2 - Control	control25	FOD	석
C1 - English	english1	KNOC	낙
C2 - Control	control24	ZAB	삽

C1 - English	english26	SATT	셋
C2 - Control	control23	NUP	비
C1 - English	english27	SOH	소
C2 - Control	control22	COOE	불
C1 - English	english28	SIH	시
C2 - Control	control21	GUK	북
C1 - English	english29	SIK	식
C2 - Control	control20	HOI	볼
C1 - English	english30	SIIN	신
C2 - Control	control19	LU	보
C1 - English	english31	SIL	실
C2 - Control	control18	NAX	벗
C1 - English	english32	SIE	씨
C2 - Control	control17	WEM	백
C1 - English	english33	AK	악
C2 - Control	control16	CIPP	밤
C1 - English	english34	ARN	암
C2 - Control	control15	REN	밑
C1 - English	english35	YEONG	영
C2 - Control	control14	BOHI	밀
C1 - English	english36	JA	자
C2 - Control	control13	STA	문
C1 - English	english37	JO	조
C2 - Control	control12	MORR	모
C1 - English	english38	CHAC	책
C2 - Control	control11	SKEH	먹
C1 - English	english39	CHUC	척

C2 - Control	control10	DES	막
C1 - English	english40	CHUR	천
C2 - Control	control9	PEEM	돔
C1 - English	english41	CHOO	추
C2 - Control	control8	FOL	돌
C1 - English	english42	CHIL	칠
C2 - Control	control7	GASS	독
C1 - English	english43	KEE	키
C2 - Control	control6	DEEH	덤
C1 - English	english44	TABB	탑
C2 - Control	control5	EXI	덕
C1 - English	english45	TAEG	택
C2 - Control	control4	WOLL	램
C1 - English	english46	TUK	턱
C2 - Control	control3	JUFF	노
C1 - English	english47	POR	포
C2 - Control	control2	SPUK	낯
C1 - English	english48	PUL	풀
C2 - Control	control1	FLAS	낙

Appendix D

Stimuli - List 2

condition	code	prime word	target
C2 - Control	control27	FUH	소
C1 - English	english48	PUL	플
C2 - Control	control26	WORR	셋
C1 - English	english47	POR	포
C2 - Control	control25	FOD	석
C1 - English	english46	TUK	턱
C2 - Control	control24	ZAB	삽
C1 - English	english45	TAEG	택
C2 - Control	control1	FLAS	낙
C1 - English	english44	TABB	탑
C2 - Control	control23	NUP	비
C1 - English	english43	KEE	키
C2 - Control	control22	COOE	불
C1 - English	english42	CHIL	칠
C2 - Control	control21	GUK	북
C1 - English	english41	CHOO	추
C2 - Control	control20	HOI	볼
C1 - English	english40	CHUR	천
C2 - Control	control19	LU	보
C1 - English	english39	CHUC	척
C2 - Control	control17	WEM	백
C1 - English	english38	CHAC	책
C2 - Control	control16	CIPP	밤

C1 - English	english37	JO	조
C2 - Control	control15	REN	밀
C1 - English	english36	JA	자
C2 - Control	control14	BOHI	밀
C1 - English	english35	YEONG	영
C2 - Control	control13	STA	문
C1 - English	english34	ARN	암
C2 - Control	control12	WHEA	모
C1 - English	english33	AK	악
C2 - Control	control11	SKEH	먹
C1 - English	english32	SIE	씨
C2 - Control	control10	DES	막
C1 - English	english31	SIL	실
C2 - Control	control9	PEEM	돔
C1 - English	english30	SIIN	신
C2 - Control	control8	FOL	돌
C1 - English	english29	SIK	식
C2 - Control	control7	GASS	독
C1 - English	english28	SIH	시
C2 - Control	control6	DEEH	덤
C1 - English	english27	SOH	소
C2 - Control	control5	EXI	덕
C1 - English	english26	SATT	셋
C2 - Control	control4	WOLL	램
C1 - English	english25	SUC	석
C2 - Control	control3	JUFF	노
C1 - English	english24	SAB	삽

C2 - Control	control2	SPUK	낯
C1 - English	english23	BII	비
C2 - Control	control28	ARS	시
C1 - English	english22	BOOL	불
C2 - Control	control29	RUL	식
C1 - English	english21	BUK	북
C2 - Control	control30	PEAC	신
C1 - English	english20	BOL	볼
C2 - Control	control31	STE	실
C1 - English	english19	BOHI	보
C2 - Control	control32	GYI	씨
C1 - English	english18	BUH	벗
C2 - Control	control33	DI	악
C1 - English	english17	BAC	백
C2 - Control	control34	DUL	암
C1 - English	english16	BAMM	밤
C2 - Control	control35	WATEE	영
C1 - English	english15	MIT	밑
C2 - Control	control36	DU	자
C1 - English	english14	MILV	밀
C2 - Control	control37	FO	조
C1 - English	english13	MUN	문
C2 - Control	control38	MORC	책
C1 - English	english12	MORR	모
C2 - Control	control39	QUIL	척
C1 - English	english11	MUGG	먹
C2 - Control	control45	WAHN	택

C1 - English	english10	MAR	막
C2 - Control	control41	OATE	추
C1 - English	english9	DOMH	돔
C2 - Control	control42	OLEE	칠
C1 - English	english8	DOL	돌
C2 - Control	control40	DOUN	천
C1 - English	english7	DOGG	독
C2 - Control	control44	RUTE	탑
C1 - English	english6	DUMH	덤
C2 - Control	control43	SEH	키
C1 - English	english5	DUC	덕
C2 - Control	control18	NAX	벗
C1 - English	english4	THAM	댐
C2 - Control	control47	SAV	포
C1 - English	english3	KNOF	노
C2 - Control	control48	DEA	플
C1 - English	english2	NOTT	낯
C2 - Control	control46	COH	턱
C1 - English	english1	KNOC	낙