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LEXICAL ACCESS AND ITS RELATIONSHIP WITH SECOND LANGUAGE PROFICIENCY

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Resumen

Cuando escuchamos palabras en nuestra lengua materna (L1), la integración de la información como la fonológica, la semántica y las propiedades visuales de las palabras se activan y este proceso se conoce como acceso al léxico. Se podría hipotetizar que en una segunda lengua (L2) existe una activación similar del léxico. El objetivo de esta investigación fue explorar si el acceso al léxico era similar en español (L1) y en inglés (L2) en participantes universitarios aprendices del inglés (n = 63). El diseño de la investigación incluyó cuatro condiciones que mostraron de manera simultánea estímulos visuales (imágenes o palabras escritas) y estímulos auditivos (una palabra hablada) donde se registraron los movimientos oculares de los participantes hacia los estímulos presentados. Se evaluó la proficiencia de la L2 de los participantes y se les aplicó un cuestionario para explorar las prácticas de lengua en la L2 que realizaban fuera del salón de clases. Los resultados indicaron que en la presentación de imágenes, los participantes mostraron una mayor preferencia por el estímulo visual que correspondía de manera más cercana a la información fonológica de la palabra hablada en la L2 y la proficiencia en la L2 modulaba esta preferencia, sin embargo, no sucedió el mismo proceso en la L1. En cambio, cuando se presentaron palabras escritas, los participantes mostraron mayor preferencia hacia las características de la forma visual similares a la representación de la palabra hablada tanto en la L1 como en la L2, a su vez, la proficiencia no tuvo relación con esta preferencia. Por su parte, las dos actividades principales relacionadas con la práctica de la L2 fuera del aula fueron lectura de textos y ver películas, donde la proficiencia en la L2 aumentaba dependiendo de la edad de los participantes y la frecuencia de realizar las actividades fuera del salón de clases. En conclusión, esta investigación sugiere que el acceso al léxico se activa de manera diferente en la L1 y en la L2 cuando se presentan imágenes o palabras escritas. Además, la proficiencia de la L2 aumenta dependiendo de las actividades realizadas fuera del salón de clases, por ejemplo, ver películas en inglés.

Palabras clave: acceso al léxico, preferencia visual, práctica de la L2, proficiencia

Abstract

When we hear words in our first language (L1), the integration of information, such as the phonological, semantic, and visual properties embedded in words, become active; this process is known as lexical access. It could then be hypothesized that a similar activation of words occurs when we hear words in a second language (L2). The objective of this research was to describe if lexical access was similar in the L1 and in the L2 in undergraduate English (L2) learners (n = 63). The stimuli were manipulated under four experiments that concurrently presented visual stimuli (images or written words) and a spoken word while participants' eye movements toward the displayed stimuli were recorded. Participants' proficiency in the L2 was assessed and a questionnaire to explore the language practices that participants performed outside the English language classroom was applied. The main results showed that when images were displayed, participants showed a larger visual preference toward the phonological information of the spoken words in the L2, a preference which was modulated by a higher proficiency in the L2 and which was not observed in the L1. Conversely, when written words were displayed, a visual preference for the visual properties related to the shape of the spoken words in the L1 and in the L2 was observed, and proficiency in the L2 was not related to this preference. In addition, reading specialized texts in English and watching movies in English were the two main language practice activities performed by students outside the language classroom. Moreover, proficiency in the L2 increased depending on the participants' chronological age and the frequency of performing activities outside the language classroom. In conclusion, the evidence of this research suggests that lexical access is activated differently in the L1 and in the L2 when images or written words are displayed. Furthermore, proficiency in the L2 is positively influenced by language practice performed outside the language classroom, such as watching movies in the L2.

Keywords: lexical access, visual preference, L2 practice, proficiency

Introduction

The mastery (or proficiency) of English as a second language has become an academic requirement for college students in Mexico, such is the case for students at the National Autonomous University of Mexico (UNAM, for its abbreviation in Spanish henceforth), as reported in the webpage of this institution (https://www.rector.unam.mx/). Since UNAM college students are in the process of developing lexical access in the L2, it is relevant to explore how lexical access is processed in this population, as a way to describe their lexical access as learners of a second language (L2), specifically of English.

One of the main interests of Psycholinguistics is to understand the way word representations activate language information. For instance, when we hear the word *table,* different types of information may become active, such as the activation of phonological information (i.e., the pronunciation of the phoneme /t/ from ***t****able*), semantic information (i.e., the meaning of the word), and even visual representations that resemble a table (i.e., an image of a board and four legs) (Huettig & Altmann, 2007).

One of the techniques that allows us to explore these different types of language activation is the tracking of eye movements. These movements are recorded by an eye-tracker, which is a device that captures the trajectory of the pupil when visual stimuli, such as words or images, are displayed on a screen. Furthermore, it has been demonstrated through eye-tracking studies that when there is a simultaneous presentation of visual representations of objects (i.e., images) and an auditory stimulus (i.e., spoken names of objects), eye gaze will fixate on the visual representation of the object that corresponds to the auditory input heard previously. That is, when the first syllable of the word ***ta****ble* is heard and multiple images are presented simultaneously, among them a table, eye gaze will be directed preferentially toward the image of the table. Therefore, visual preference will move away from images unrelated to the word *table* (Huettig & Altmann, 2005).

Additionally, Huettig and Altmann’s (2005) study showed that an image which is semantically related to a spoken word receives longer eye fixations; that is, longer attention to the image of a sailboat is expected when the spoken word *lake* is presented when no other images are semantically related to the spoken word. In other words, the participants of this study activated the information related to the spoken word *lake* since this word was not pictured, and therefore, longer eye fixations were observed toward *sailboat* which was the object related semantically to *lake*. This activation of related information to objects in a target-absent Experiment is an example of lexical access processing.

In another study, Huettig and McQueen (2007) demonstrated that the pronunciation of a spoken word, that is the phonology of the words, is an important element in lexical access processing to activate words. These authors performed four experiments with Dutch native speakers who heard a spoken word (e.g., *beker* [*beaker*]) and simultaneously saw the visual representations of objects (i.e., images and written words) related to the spoken word. The main results revealed that when the information related to an object that it is heard becomes active, native speakers of Dutch showed a visual preference toward the phonological information.

Then, the lexical access processing described by Huettig and McQueen (2007) shows that in native speakers of Dutch other words are activated when they have a relation with a spoken word. However, is lexical access processing similar in second language learners? That is, is lexical access processing similar when a spoken word in a second language is heard?

In this research, an L2 learner is defined as a person who learns an additional language from the first language in a formal setting (i.e., in school). In addition, a proficiency level in the L2 might be observed in situations where the comprehension of oral and written modalities of the language takes place (Council of Europe, 2001).

Additionally, exploring the relationship between lexical access and proficiency in the L2 could provide an insight on the information that becomes active when a spoken word in the L2 is heard by L2 learners of English. If proficiency of English as an L2 is an important factor that reveals a visual preference for the phonology of the words in the L2, this could lead to improvements in the teaching materials created for UNAM college students who are native speakers of Spanish. That is, the evidence provided by this research could contribute toward a better understanding of the information that L2 learners find relevant when a spoken word is heard and visual stimuli concur simultaneously. Moreover, the results of this research could have an impact on the language teaching materials or techniques used to learn vocabulary in the L2 (i.e., object naming), which could help raise students' awareness of the phonology and orthography of words and strengthen vocabulary in the L2.

Thus, the main objective of this research was to describe lexical access and its possible relationship with L2 proficiency in L2 learners of English, specifically in college-native speakers of Spanish. However, it was also relevant to describe lexical access in the first language (L1) to contrast if there were similarities between lexical access in the L1 and the L2. Lexical access in the L1 (Spanish) would be expected to be similar to the evidence found by Huettig and McQueen (2007) with native speakers of Dutch, where a visual preference for the phonology of words was observed. Therefore, for this study if lexical access in L2 learners of English is similar to their L1 lexical access, it will mean that proficiency in the L2 will modulate the lexical access in the L2. We might be able to observe a visual preference for the phonology of the words in the L2, as other studies have suggested (Mishra & Singh, 2016; Canseco-Gonzalez et al., 2010; Shook & Marian, 2013). Then, the scope of this research is the cognitive processing of lexical access to words in the L1 and the L2 of college students learning English as an L2.

To accomplish the objectives of this research, a visual preference task, similar to the Huettig and McQueen (2007) research described above, was used, where visual and auditory input concurred, and eye movements were tracked to observe the preference for the visual stimuli that was presented in the task. That is, a spoken word was heard (auditory input) by college students learning English as an L2, and objects or the labels of the objects (written words) were exhibited as the visual stimuli. These objects and labels were related to the auditory input at the phonological and semantic levels; also, an object or a label that shared physical features with the spoken word and a distractor—an object or label with no relation to the spoken word nor the other stimuli—were presented. Spoken words and stimuli were presented in the L1 and the L2 in different experiments to explore differences or similarities in lexical access in each language. Additionally, a proficiency language test was applied to explore participants' lexical knowledge of words in English. Lastly, to know more about participants' language practices in the L2, a questionnaire to obtain sociodemographic and qualitative information was also applied.

The following section describes the information related to second language learners to explain the perspective considered in this research regarding this concept and other related terms. Afterward, some of the theoretical proposals between cognition, visual preference, and language, particularly within lexical access are presented. Finally, the methodology and the results of this research are described.

Second language learners and language proficiency

Learning English as a second language has become an important academic requirement for college students at UNAM as it provides access to international postgraduate programs and employment opportunities. Commonly, an L2 learner enrolled in this university has learned Spanish as the first language (L1) at home and has learned English as the L2 at school.

For this research the terms *L2 learner* and *bilingual* imply a distinction, which will be detailed below. An *L2 learner* is a person who has acquired two languages, such as Spanish as an L1 and English as an L2, but whose L1 has been used as a primary way to interact or socialize with family since birth, while the L2 has been learned in formal settings (i.e., in school), or informally, at a certain point in life (Mitchell et al., 2019, p. 18; The Douglas Fir Group, 2019). In contrast, there is a lack of agreement on the definition of what a *bilingual* is because these speakers are often classified into different types based on individual and context characteristics. For instance, Grosjean (2010) defines a bilingual as a person that knows at least two languages. Marian et al. (2018) assume that bilinguals have a larger linguistic experience than monolinguals due to the acquisition of the L1 plus the L2, where linguistic experience is understood as the exposure that one person has toward one language. Another distinction made within bilinguals is that they can be simultaneous or successive (Costa & Sebastián-Gallés, 2014) where the first ones are those who learned two languages at the same time from birth; and the latter are those who learned an L2 later in life due to formal learning, immersion in a country or migration, to name a few. Other classifications of bilinguals specify the life period when L2 acquisition started. That is, early bilinguals are those who started L2 acquisition during childhood (prior to 7-years-old), while late bilinguals are those who started L2 acquisition after 7-years-old (Marian et al., 2018); some researchers consider late bilinguals those who learned an L2 after 4-years-old (Gervain et al., 2013).

As can be observed, a bilingual can be defined from different perspectives, making the distinction between a bilingual and an L2 learner unclear. The distinction proposed by The Douglas Fir Group (2016) has shed light on the difference between L2 learners and bilinguals by delimiting the situations for the learning and use of additional languages. For instance, a college student from Mexico, whose L1 is Spanish and has learned English as an L2 in school for a few hours (i.e., more than 360 hours of formal instruction of English), is considered an L2 learner; so socialization and schooling has been achieved mainly in the L1. In contrast, bilinguals are immersed in the context of the L2 (i.e., formal education and socialization). This research is interested in L2 learners since most college students at UNAM have only had formal instruction in English as an L2 in school and have not had an immersion experience in English as an L2. Then, the term **L2 learner** will be used in this dissertation since it reflects the context of the participants considered in this study, where the dominant language for education and socialization is Spanish. Nevertheless, the term *bilingual* might appear depending on the theories and studies reviewed for this research.

The term L2 learner is closely related to the *proficiency* and *dominance* concepts. Proficiency usually refers to a specific component of a language skill, such as the vocabulary or the grammatical knowledge in a language. Thus, proficiency can be estimated through tests designed for this purpose (Montrul, 2016) as the *Test of English as a Foreign Language* (TOEFL; Educational Testing Service, 2018). In contrast, dominance frequently refers to the main language used on a daily basis or to the predominant language a person is exposed to, and it is generally measured by self-reported questionnaires (Montrul, 2016). Consequently, proficiency and dominance are not interchangeable since higher levels of proficiency in one language do not determine language dominance (Vicente et al., 2019). That is, proficiency can be operationalized as a cognitive or as a linguistic component, while dominance can be measured as a multidimensional construct when learning a second language (Montrul, 2016).

For this dissertation, the concept of proficiency was delimited to the vocabulary (lexical) knowledge in an L2, leaving behind other language skills that could expose L2 proficiency, such as oral and written expressions, since the main objective of this research is to explore lexical access in an L2. In addition, it is important to highlight that despite the existence of language proficiency exams such as the TOEFL test, which provide information regarding L2 proficiency, simplified tests on lexical decision have been developed to assess language proficiency. For instance, the LexTALE (Lemhöfer & Broersma, 2012) is a test in which participants decide if a word displayed on a screen exists in English. The results of this test provide a parameter on English proficiency that can indicate a beginner, an intermediate or an advanced level of acquisition. According to Lemhöfer and Broersma (2012), the LexTALE has demonstrated high coefficients of reliability and validity when contrasted with language proficiency exams such as the Quick Placement Test (QPT, Oxford University Press, 2001). Then, for this research it should be noted that L2 lexical knowledge and L2 proficiency was measured through the LexTALE.

Additionally, to know the language use and practices of the L2, sociodemographic information was collected. Some of the questions used for this research were adapted from the Bilingual Language Profile (BLP; Birdsong et al., 2012) and from the Language History

Questionnaire (LHQ3; Li et al., 2019). These questionnaires collect information related to the age of acquisition of the L2, exposure time and use of the L2, which is complementary information about dominance in terms of the L2 learner notion seen previously. In the Instruments and Materials section there is more information about this adapted language experience questionnaire.

In conclusion, for this research L2 learners have had formal instruction of English in school but have not had an immersion experience in an English-speaking country. In addition, language *proficiency* in the L2 will be considered as the dependent variable as a means to explore lexical access, the independent variable, in L2 learners of English. It is important to mention that this research will not cover the formal or informal instruction received by L2 learners since the main scope is to observe the way college students at UNAM perform lexical access in the L2. The results of this research could provide evidence for future research on the development of language teaching materials or techniques to learn vocabulary in the L2 that could strengthen the vocabulary of English as an L2 in college students. In other words, the scope of this dissertation is oriented toward the cognitive processing of lexical access in learners of English as an L2.

In the following section, a general perspective of the models that have been proposed on lexical access in second language learners will be provided.

Theoretical proposals on lexical access

Several theories within the psycholinguistic perspective have tried to explain how lexical access processing accounts for the comprehension of words. As a result, diverse theoretical models have been proposed to describe this processing through the visual and auditory perception of words.

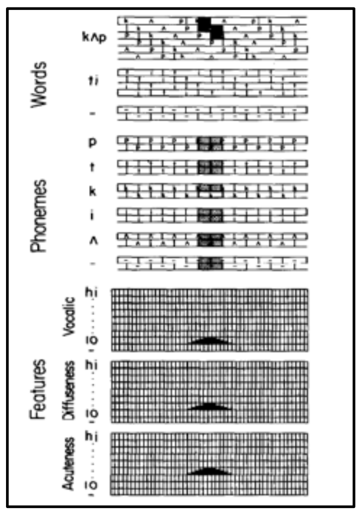
One of the most accepted models on lexical access processing in the L1 is the TRACE model (McClelland & Elman, 1986). This connectionist model attempts to characterize, through a neural network of interactive activation, the means through which linguistic information is connected and analyzed by different units at different layers. Additionally, these units activate and inhibit distinct connections that exist in order to recognize the information that is perceived. The name of this model, according to McClelland and Elman (1986), refers to a trace in the information that is processed and analyzed simultaneously in each phase or layer. This processing resembles a working memory mechanism within this network. Thus, the TRACE model sustains feedback processing in different directions combined with activation and inhibition in each unit inside the network.

Principally, the TRACE model is divided into three levels that perform as a cascade; that is, each level has units that receive external information (an input) and send internal information (an output) when activations from other units are perceived (McClelland, 1979). Therefore, the units in each level identify words by auditory or visual perception. The three levels that make up this model are: a) Features, b) Phonemes and c) Words (see Figure 1). At the Features level, the dimensions of sounds are analyzed (e.g., a stop consonant as /b/; for further details see McClelland, 1979). At the Phonemes level, the input is analyzed by each phoneme embedded in a word (e.g., */b/+ /æ/ + /g/ = bag*) and, at the Words level, lexical access is processed through the activation of words that were previously analyzed in cascaded processing by the former levels (e.g., the activation of the consonant /b/ and the vowel /æ/ activates the word *bag /bæg/* and the inhibition of the word *big /bIg/* occurs). Therefore, lexical access in this model is the activation of the correct word when an input is perceived and the concurrent inhibition of lexical candidates that do not match with the perceived input. This inhibitory process of word candidates is assumed to occur at each level of the TRACE model. Also, this model considers the *context-sensibility of cues* when analyzing the input information. In other words, we might perceive how the consonant /b/ activates the candidates: *bag, bad* and *big*. However, as cues unfold, as in the phrase *She forgot her b**ag***, the words *big* and *bad*, are inhibited (McClelland, 1979). Furthermore, the activation of specific units that analyze the input, such as in a phrase as *teacup /tik^p/,* are visualized in black cells, as in Figure 1, whereas cells in white show input inhibition.

Moreover, one advantage of the TRACE model is that both visual (i.e., written words) and auditory (i.e., spoken words) input are considered. Therefore, lexical access can be activated through two modalities.

Figure 1

Representation of the three processing levels proposed in the TRACE model to analyze lexical information



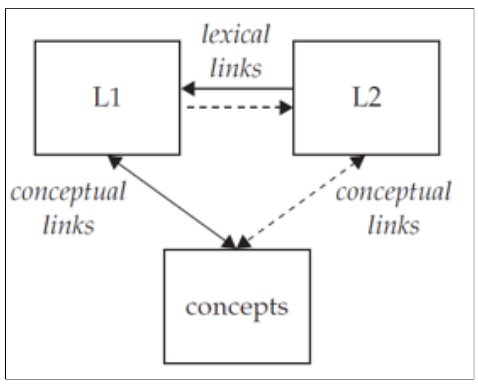
Note. In this neural network each level is specialized in order to analyze input: the sounds (Features), the representation of sounds (Phonemes), strings of words (Words), and stored information related to each word. Taken from McClelland and Elman (1986, p.9).

Accordingly, authors such as Kroll and Stewart (1994) have proposed that lexical processing is different between monolinguals and L2 learners. To describe this supposition, they proposed the Revised Hierarchical Model (RHM) (Kroll & Stewart, 1994), which assumes that words and concepts are stored by labels that are different in the L1 and the L2. As a result, words and concepts are connected directly and influenced by language proficiency in the L2.

The RHM suggests that an L2 learner, at the beginning, translates words from the L1 to the L2 to access the meaning of L2 words. As a learner progresses in the acquisition of the L2, the RHM assumes that access to L2 words' meaning is processed directly without the mediation of the L1. In Figure 2, solid lines indicate a direct connection between each element and the dotted lines demonstrate weak connections that may appear between the L1 and the L2, which rely on L2 proficiency. In addition, the RHM predicts that translations from the L1 to the L2 will be mediated conceptually due to the robust relation between words and concepts in the L1. Also, words accessed from the L2 to the L1 will be mediated through the lexicon so that when the L2 learner tries to access the L2 word's storage, this L2 learner may be able to find word associations and equivalents from the L1. Consequently, direct processing in these words' associations in the L2 is expected since the concepts were established previously by the L1 (Kroll & Bogulski, 2012).

Figure 2

The RHM by Kroll & Stewart (1994)



Note. Taken from Kroll and Bogulski (2012, p.2).

Apart from the RHM, other models of bilingual lexical access and processing with different factors have been proposed, as is the case of the Bilingual Interactive Model (BIA) and its updated version BIA+ (Dijkstra & van Heuven, 2002). These models suggest that L1 activation is available momentarily when L2 words are processed. In other words, bilinguals' lexical access is likely to be similar to that of monolinguals, that is, only one language is activated. If the opposite is true, bilinguals should be able to activate both languages simultaneously, which has actually been evidenced using lexical recognition tasks (Kroll & Bogulski, 2012).

Another model that integrates lexical access and its processing in two languages is the BLINCS model (*Bilingual Language Interaction Network for Comprehension of Speech*) created by Shook and Marian (2013). This computerized and connectionist model simulates an architectural organization of the bilingual lexicon, and the way different elements interact in order to process information perceived either by visual or auditory input or both. One of the advantages of considering this model for the research that is being described here is that it has been tested experimentally within an English and Spanish interaction. Furthermore, the BLINCS model is based on the interactive proposals described previously in the TRACE model, the BIA+ and the RHM.

The general architecture of the BLINCS model includes different levels: the Phonological, the Phono-lexical, the Ortho-lexical and the Semantic level (see Figure 3). At the Phonological, level it is assumed that a shared system between the two languages exists. The correct activation of phonemes will depend on the language or input. For instance, the Spanish phoneme /x/ (as in **j**ícama) will activate the words in Spanish that share that phoneme, then, a total inhibition of the words in English will be expected since that phoneme has a different pronunciation in English (/ˈhikəmə/; Macmillan Education, 2002). Meanwhile, the phono-lexical and the ortho-lexical levels have started their analysis since orthography involves phonological activation when reading words (Shook & Marian, 2013; Huettig & McQueen, 2007; Mishra & Singh, 2016). The difference between the phono-lexical and the ortho-lexical levels consists in the syllabic structure analyzed by the first one (i.e., consonant-vowel-consonant or CVC) whereas the second one analyzes the characteristics of each orthographic system (e.g., *photo* in English *vs. foto* in Spanish, these words are similar in pronunciation but orthographically different). Likewise, the BLINCS model proposes a single semantic level, where concept representations of words are shared between both languages, as predicted by the RHM. Then, associations between words and objects are strengthened, that is, the meaning of words will be equivalent in both languages.

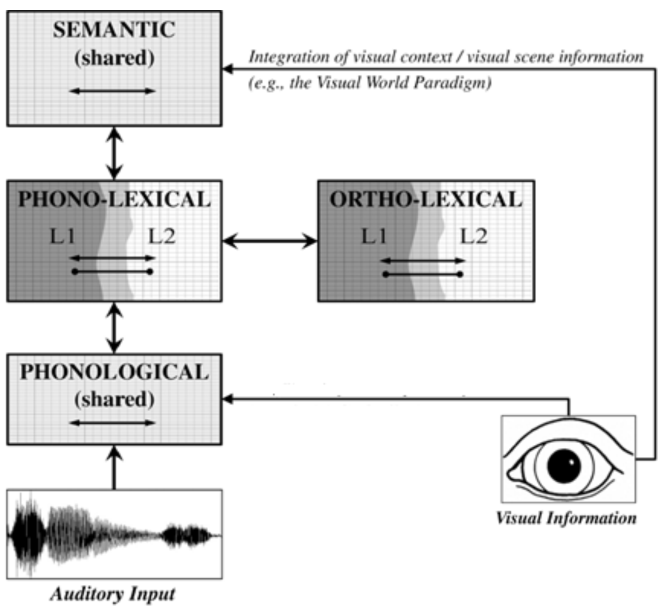
Another advantage of the BLINCS model is the integration of visual input, such as images and written words of the objects that activate linguistic information. Hence, in this model, a direct activation through visual and auditory input in two languages is processed by complementary nodes that allow the interchange of information between its levels (the phonological, the phono-lexical, the ortho-lexical and the semantic). An example provided by the authors of the BLINCS model about the activation between these levels is through the auditory input of the word *pear* in English, which would activate the word "*perro" /'perro/* [*dog*] in Spanish, which is close at the phonological and orthographic levels to *pear*. This input would activate the first three levels (the phonological, the phono-lexical, and the ortho-lexical) but demonstrate a lower activation at the semantic level since these two words, *pear* and *perro,* do not share any semantic features. To illustrate language activation, authors of the BLINCS model presented simultaneously the images of a *pear*, a *dog* [*perro*] and a *volcano* (which is a distractor since it is phonologically, orthographically, and semantically unrelated to *pear* or *perro*). As a result, this model displayed a higher activation toward the images of *pear* and *perro* in the phonological, the phono-lexical and ortho-lexical levels that concurrently transmitted information to the semantic level, which sends the semantic analysis of the perceived input to the three previous levels. Therefore, inhibition of the word *volcano* was observed at these levels.

The previous information suggests that visual input (such as the visual representations of an object as images) promotes lexical access and the activation of words in the L1 and in the L2. Shook and Marian (2013) indicate that this activation is possible in both languages since the semantic level, shared by both, is active. Consequently, the representation of an object at the semantic level provides feedback to the phono-lexical candidates that exist in English and in Spanish (e.g., *pear* and *perro*).

Moreover, the integration and activation of the information processed at each level of the BLINCS model is controlled through *self-organizing maps* (SOM). These maps represent an interconnected network that features an unsupervised learning algorithm inside the levels of the BLINCS network; that is, each SOM integrates the previous information learned and adapts the new information perceived into similar inputs or matches (e.g., words) in order to generate a mapped integration of the lexical information, such as in the ortho-lexical level (see Figure 4).

Figure 3

The BLINCS model (*The Bilingual Language Interaction Network for Comprehension of Speech model*)



Note. This model simulates the perception of the auditory input which may concur with the visual information. Taken from Shook and Marian (2013).

Figure 4

Illustration of a SOM at the ortho-lexical level in the BLINCS model

Note. Gray areas represent mapped words in Spanish and white areas represent words in English. Each area is grouped by the ortho-lexical information in each language. Taken from Shook and Marian (2013).

To sum up, this section included some representative models that provide a perspective on lexical access processing. The need to illustrate lexical processing in learners of more than one language promoted the creation of cognitive models such as the BIA, BIA+ and the RHM, which describe language processing in one person. Additionally, the BLINCS model simulates different processing levels (i.e., phonological, ortho-lexical, semantical, to name a few) during lexical access in two acquired languages and the means through which words are analyzed when perceived through visual or auditory input (Shook & Marian, 2013). Although this model was conceived for bilinguals, the main assumptions immersed in the BLINCS model could be applied to the mechanisms that are active in the lexical processing of L2 learners when input in the L2 is perceived. Therefore, this model will be an important reference for this dissertation regarding lexical access.

The following section will describe how lexical access can be explored through the visual preference technique. As mentioned before, this technique provides evidence on the cognitive representations that a person activates when the presentation of auditory input concurs with visual input (Huettig et al., 2006; Huettig et al., 2011b; Huettig & McQueen, 2007; Cortés-Monter et al., 2017).

Lexical access studied through the visual preference technique

The visual preference technique attempts to relate the cognitive processing of language comprehension through eye movements (Feng, 2011) and allows the collection of lexical access data in real time. Recently, two paradigms within the framework of visual preference have been proposed: the *visual world paradigm* and the *visual search paradigm* (Huettig et al., 2011). The former is characterized by the movements of the eyes when visual stimuli, such as images or words, are displayed on a screen; participants are simply instructed to keep their eyes on the screen. Within this paradigm, eye movements can be tracked in order to identify the first place the gaze is attracted to, the duration of that gaze, and the trajectory of the eyes while an experiment is carried out. In the visual search paradigm, the instructions are intended to guide the movement of the eyes toward an object when other objects are displayed simultaneously on a screen. An example of the instructions given in this paradigm is "*Find the yellow circle as fast as possible*." This circle is displayed on a screen among other stimuli as distractors. The objective of this paradigm is to identify behavioral responses through reaction times and responses in order to infer efficiency when searching for specific objects.

These paradigms have been used in different studies that explore the lexical access phenomenon. Specifically, the visual world paradigm has provided evidence in adults on lexical access when visual and auditory stimuli are presented simultaneously (Huettig & Altmann, 2007; Huettig & McQueen, 2007; Huettig et al., 2011a; Mishra & Singh, 2016; Smith, 2017). The results of these studies suggest that phonological activation precedes semantic processing since the pronunciation of a word must be analyzed before the semantic level, which is subsequent as illustrated above in the TRACE and BLINCS models.

Bearing this in mind, this dissertation will make use of the visual world paradigm since it is aimed at exploring participants' visual trajectory while an experiment is carried out. In addition, this paradigm allows the differential analysis on the fixation of looks when visual stimuli are displayed concurrently with other stimuli of no interest. The duration of the fixation toward the target stimuli through different intervals in milliseconds can also be analyzed (Huettig & McQueen, 2007; Huettig & Altmann, 2005). To illustrate the studies in this area, the following paragraphs describe some visual preference and lexical access studies done with adults in one or more languages.

Huettig and McQueen (2007) explored whether there was a visual preference toward the phonological, semantical or shape information of a target word when auditory input was presented. Adult speakers of Dutch heard spoken sentences with a target word such as *beker* [*beaker*] while four visual stimuli were displayed on a screen; the target word was not displayed. The screen was divided into four quadrants: one had a cohort (a word that shares the first syllables with another word), that is, a phonological competitor such as *bever* [*beaver*] in Dutch; another a shape competitor or an object that shared visual features with the target object like *klos* [*bobbin*]; another a semantic competitor or an object related semantically with the target word as *vork* [*fork*]; and another an object unrelated to the previous categories or a distractor such as *paraplu* [*umbrella*]. In addition to images, written words of the objects in Dutch were presented as a supplementary manipulation of the study. Besides the former manipulation, another controlled variation in the experiment was the moment when the auditory and visual stimuli were presented; that is, in Experiment 1, the presentation of the visual stimuli concurred with the auditory stimuli (a spoken sentence with a target word such as: *Yesterday she saw the beaker*, where *beaker* was the target word that was not displayed among the visual stimuli). In Experiment 2, the visual stimuli appeared 200 ms before the onset of the target word. Experiment 3 was similar to Experiment 1, however, instead of objects as visual stimuli, written words, such as the name of the objects in Dutch were displayed. Experiment 4 was similar to experiment two, but the written names of the objects in Dutch were displayed. Each trial lasted 1,300 ms. Results showed that in Experiment 1, the gaze trajectory started on the phonological competitor, then moved to the shape competitor, and lastly onto the semantic competitor. In Experiment 2, results exhibited a visual preference for the shape competitor since participants observed the display of images before the onset (200 ms; a preview window) of the target word embedded in the spoken sentence. According to Huettig and McQueen (2007), image processing could imply earlier activation when a preview window is displayed. Shape competitors revealed a main visual preference, while phonological activation had a secondary preference, and the semantic competitor was of least interest for participants.

When written words were displayed (Experiments 3 and 4), instead of objects, participants revealed a visual trajectory where the phonological competitor preceded the shape competitor and the semantic competitor came last. According to Huettig and McQueen (2007), these visual preferences demonstrated lexical processing in cascade through the visual and auditory stimuli presented within the different manipulations. In other words, this visual preference exposed a sequence in which first phonological information was decoded, followed by the shape information, and lastly, the semantic information when the target word embedded in the spoken sentence was provided. The results of Huettig and McQueen's (2007) study show that visual preference is triggered by visual stimuli (words and images) that concur with an auditory input that activates the phonological information, followed by the shape information, and finally the semantic information of words. Thus, this study demonstrated lexical access processing in speakers of one language.

Huettig et al. (2011b) later suggested that literacy influenced visual preference. Thus, they conducted an experiment in which participants were assigned into either of two groups according to the years of schooling: participants with 13 to 17 years of literacy formed the high literacy group and participants between 0 and 9 years of literacy were assigned to the low literacy group. Participants' mean age was M = 24.3 for the high literacy group and M = 27.2 for the low literacy group. All participants were native speakers of Hindi as an L1. The visual task consisted of an array of four competitor images: a phonological competitor, a semantic competitor and two unrelated distractors. All of these images were competitors to the target word, which was not displayed. Along with the visual stimuli, a spoken sentence with the target word was presented, such as: *Today he saw a crocodile*, where *crocodile* was the target word. The experiments were carried out in Hindi, and therefore the stimuli and the competitors were presented in this language. In the first experiment, the spoken sentence with the target word *mangar* [*crocodile*] was presented simultaneously with the images of the following objects: the phonological competitor to the target word *matar* [*peas*], the semantic competitor *kachuwa* [*turtle*] and two unrelated distractors. In the second experiment, the semantic competitor was replaced with another unrelated distractor. Each trial lasted 4,200 ms and participants saw the images first for 1,000 ms and then listened to the spoken sentence with the target word. Additionally, images were displayed on the screen for 2,000 ms after the spoken word was presented. This manipulation meant that all participants had enough time to see the images before and after the presentation of the spoken sentence. The main results of this study showed that both groups preferred the semantic competitor. However, the high literacy group had a visual preference for the phonological competitor when the phonological information of the target word was available; that is, their visual preference was related to the onset of the acoustic information, which led to a faster discrimination in milliseconds toward the other competitors. In contrast, the low literacy group revealed a larger visual preference for the semantic competitor, in other words, they showed a minimal visual preference for the phonological competitor compared to the high literacy group. Thus, this study by Huettig et al. (2011b) suggests that despite both groups showing lexical cascade processing, participants in the low literacy group showed a visual preference for the semantic information over the phonological. According to these authors, this cascade processing between both groups reveals a processing related to a word-object preference. Hence, this cascade processing in the low literacy group had minimal activation of the phonological level associated with lexical access; that is, their visual preference for the phonological competitor also was minimal. Similarly, these participants, despite the absence of the semantic competitor showed activation of the phonological information. Nevertheless, their performance was different from the high literacy participants, who were faster at discriminating the competitors and at identifying the phonological information earlier. Therefore, literacy can be considered as an important factor that contributes to phonological activation related to lexical processing in cascade.

A different study by Mishra and Singh (2016) explored if Hindi and English bilingual speakers in India simultaneously activated words that shared phonological elements when auditory input was perceived in those languages. This research inquired into whether words in the L1 (Hindi) were activated when words in the L2 (English) were perceived and in reverse. Participants were divided into two groups depending on their L2 proficiency (high *vs.* low), which was measured using a sociodemographic questionnaire and a self-report about L1 and L2 proficiency. The purpose of assessing language proficiency was to identify if participants with low L2 proficiency revealed a different processing than participants with a higher L2 proficiency, mainly in the decoding and translation of the perceived L2 words toward the L1. For instance, in the experiment with L1-L2 direction, the target word in Hindi *haddi* [*bone*] was similar to the translation of the L2 cohort *boat*, and the image of a boat was displayed with three other unrelated images on a screen. In the experiment with L2-L1 direction, participants heard the target word in English *thumb* [*angootha,* in Hindi] that was similar with the cohort in Hindi *angoor* [*grapes*], thus *angoor* was displayed with three other unrelated images on a screen, as in the previous experiment. The main results of the Mishra and Singh (2016) study suggest that participants with high and low proficiency activated the counterparts of the target words presented in the other language and this promoted phonological activation related to the stored words in both languages. Phonological activation in each experiment was revealed independently if the input was from the L1 or the L2, additionally, this activation was predominant in both groups in the L2 to L1 direction. However, the authors argue that L2 proficiency was an important factor that influenced these results since participants with high L2 proficiency identified the cross-linguistic cohorts earlier (140 ms after the onset of the target word) whereas low L2 proficiency participants identified those cohorts later (200 ms after the onset of the target word). In other words, the fixation of looks demonstrated that participants with high L2 proficiency showed an earlier activation to the cohort stimuli, as opposed to participants with low L2 proficiency in both directions (from the L1 to the L2 and from the L2 to the L1). Mishra and Singh (2016) also indicate that this phonological activation was revealed through the presentation of images that concurred with an auditory input, which is another way to explore these activations. Therefore, this study demonstrated that phonological activation from the L1 to the L2 is automatic and independent of the language perceived by these participants. Additionally, this phonological activation occurs when images are displayed concurrently with auditory input, and L2 proficiency determines the rapidness of lexical access in the L2.

Canseco-Gonzalez et al. (2010) explored the activation of cohorts in bilinguals, that is, they explored if an auditory input in the L1 (Spanish) or in the L2 (English) influenced lexical access in each language. Age of L2 acquisition and L2 proficiency were considered as aspects that could have an impact on lexical access, specifically between language cohorts. The experiments of this study were divided into three modalities. In the first one, only participants' L2 (English) was used. Therefore, the instructions of the experiment and dialogues between participants and the researcher were in English. In the second experiment, L1 (Spanish) and L2 (English) were alternately used; that is, the instructions of the experiment were given in English, while dialogues between participants and the researcher were in Spanish. In the third experiment, the instructions of the experiment and dialogues between participants and the researcher were in Spanish. The quantitative use of each language in the experimental session is not mentioned in this study, the authors only emphasize the way instructions were delivered before the trials of each experiment. Stimuli presentation on a screen was manipulated by two kinds of lexical competition. The first one was a *within-language* lexical competition, where the name of the target object in English overlapped phonologically with the onset of an object that was a cohort in English, images of both objects were simultaneously presented with an unrelated competitor. The second type of lexical competition was *between-language* where the name of the target object in English overlapped phonologically with the onset of another object in Spanish. Both objects were presented with an unrelated competitor. For instance, one within-language competition trial included words in the same language that shared the first syllable, such as the target word ***be**ans* against the cohort ***bee**tle*. In contrast, one between-language competition trial included words in different languages but that shared the first syllable, such as the target word ***bee**tle* in English against the Spanish cohort ***bi**gote* [*mustache*]. In both manipulations, the third object was unrelated to the target words. These objects concurred with the presentation of an auditory input, such as *Click on the beans*, and participants had to respond using a mouse to click on the correct object displayed alongside the other two competitors (cohort and unrelated object). The main results of the Canseco-Gonzalez et al. (2010) study showed a visual preference for the cohorts, within and between languages. However, this preference was influenced by the age of L2 acquisition and the language use to deliver instructions and dialogues between participants and researchers. Furthermore, Canseco-Gonzalez et al. (2010) suggest that the extent of lexical activation is influenced by participants' language proficiency. Additionally, the age of L2 acquisition influenced lexical activation. In other words, participants that acquired the L2 before 7 years of age revealed a visual preference for the target in the within-language manipulation (***be**ans*-***bee**tle*), however, Canseco-Gonzalez et al., (2010) highlight that these participants were unable to entirely inhibit the activation of the L1 (Spanish) since eye movements showed a prevalence toward the Spanish cohort (***be**ans*-***bi**gote*).

The studies described above demonstrate diverse means in which lexical access can be explored in one or more languages. Huettig and McQueen's (2007) study revealed a process favoring phonological information embedded in words in speakers of Dutch. Correspondingly, Huettig et al. (2011a) study suggested that high literacy influences the course of lexical access.

That is, low literacy reveals a slower activation of the orthographic and phonological representation embedded in words in contrast to high literacy. Then, this evidence allows us to assume that literacy involves an analysis at different levels when lexical access occurs. In addition, high literacy might influence the establishment of broader phonological representations as opposed to low literacy where the cascaded analysis is narrowed (Huettig et al., 2011b). Moreover, language proficiency is an important factor since the evidence suggests that the higher L2 proficiency is, the faster phonological processing in the L2 is (Mishra & Sigh, 2016). The importance of L2 proficiency on the visual preference for the phonology of words in the L2 over words in the L1 is depicted in Canseco-González et al.'s (2010) study in which participants with a higher L2 proficiency showed a greater visual preference for the word in the L2 than in the L1. This suggests that the activation of words in the L2 could be influenced by L2 proficiency.

Another factor that these studies have shown is the manipulation of the modalities in which the activation of words might occur with the presentation of written words, but images could trigger this activation as well (Huettig & McQueen, 2007). Then, if the presentation of the modalities of written words and images activate words in the L1, this might suggest that lexical access in the L2 could be activated by these modalities as well. Nevertheless, the evidence on the activation of words through the written words' modality in the L2 is still limited. Therefore, this research aims to explore if proficiency in L2 learners of English reveals lexical access through images and written words, not only in the L1 but in the L2 as well, where, according to the evidence presented so far, the phonological activation of a word will precede the semantic or the shape information in the L1 and in the L2. In the following section the rationale and the methodology for the current research are described.

Rationale

Lexical access may activate different levels of information of words when an auditory input concurs with the presentation of visual stimuli (Huettig, et al. 2011a; Huettig & McQueen, 2007). The activation of this information could be related to the theoretical proposals of the connectionist models which postulate how lexical access is processed when we perceive auditory or visual input as in the TRACE model (McClelland & Elman, 1986). That is, when visual or auditory input is perceived, the phonology of words is primarily activated and the semantic information of words could then be activated as the phonology of words is analyzed.

Consequently, the proposals of models that integrate lexical access in speakers of more than one language were developed to illustrate if the activation of words is achieved as in the TRACE model and some examples were presented previously: the RHM (Kroll & Stewart, 1994), the BIA+ (Dijkstra & van Heuven, 2002), and the BLINCS model (Shook & Marian, 2013). These models suggest the relation between the words stored in each language and the modalities that activate lexical access in the L2, such as the auditory input (when we hear a word in the L2) and the visual input (the written presentation of words, and the images that represent labeled objects in the L2). One of these models is the BLINCS model which explains lexical access processing in speakers of two languages and the way words are analyzed when they are perceived by visual and auditory input (Shook & Marian, 2013). The BLINCS model simulates different processing levels regarding lexical access (i.e., phonological, orthography, semantic) in speakers of two languages where phonology is the first phase that analyzes words that are activated through a given input (written or spoken words and images). Then, the orthography of the words is analyzed and lastly the semantic information of words along with the visual representations of objects (i.e., images). So, for the current dissertation, the BLINCS model is an important reference to understand the lexical access processing of L2 learners.

Additionally, the presentation of written words is a manipulation that has shown how lexical access might occur in the L1 (Huettig & McQueen, 2007), but images could also trigger lexical access processing in the L2 (Huettig, et al., 2011b; Mishra & Singh, 2016; Canseco-González et al., 2010; Rodríguez-Lázaro et al., 2019: Shook & Marian, 2013). Then, if the presentation of written words and images activates words in the L1, this might suggest that lexical access in the L2 could be activated by written words and images as well. Nevertheless, the evidence on the activation of words through the written words modality in the L2 is still limited. Moreover, since L2 learners are in the process of developing lexical access in an L2, it is relevant to explore lexical access processing when a spoken word in the L2 and visual input (images and written words) related to a word in the L2 are presented simultaneously.

Also, the current study will explore if the visual preference is similar in the L1 and the L2 when a spoken word and a visual input related to that word concur. The results might provide evidence that phonological information precedes semantic information when auditory and visual input are perceived in an L2, as has been found in the L1 (Huettig & McQueen, 2007).

Moreover, according to Mishra and Singh (2016) and Canseco-González (2010), L2 proficiency contributes to a faster visual preference for phonological information. Likewise, Veivo et al. (2016) suggest that depending on the level of L2 proficiency, orthography is activated through phonology when auditory and visual stimuli concur, such as in the presentation of cohorts in an L2. Then, for the current dissertation L2 proficiency will be measured to find its possible relationship with lexical access processing. That is, proficiency has been observed to influence the activation of phonological information of perceived words in the L2, then it is expected that L2 learners would demonstrate a similar visual preference for the phonological information (Huettig & McQueen, 2007).

In addition, this dissertation attempts to provide evidence about lexical access processing in L2 learners through visual preference, which is a technique accepted by diverse authors to explore lexical access and its processing (Weber & Cutler 2004; Yee & Sedivy, 2006; Huettig & McQueen, 2007; Mishra & Singh, 2016; Huettig et al., 2011b; Canseco-González et al., 2010).

Finally, the evidence provided by this research could contribute to a better understanding of lexical access in L2 learners when auditory and visual input in the L2 are presented simultaneously and to contrast this information with lexical access processing in an L1. Then, this research will not cover the formal or informal instruction received by L2 learners since the main scope is to observe the way college students at UNAM perform lexical access in the L2 and if their proficiency influences lexical access processing. In other words, the scope of this dissertation is oriented toward the cognitive processing of lexical access in second language learners.

Problem statement

Research on lexical access and visual preference in speakers of one language has demonstrated a visual preference for the phonological information embedded in words over the semantic information (Huettig & McQueen, 2007; Mishra & Singh, 2016; Huettig et al., 2011b). Furthermore, different theoretical models have proposed how lexical access in the L2 is achieved (e.g., the BLINCS model by Shook & Marian, 2013) and research with bilinguals has evidenced a visual preference for the phonological information of words in the L2, nevertheless, L2 proficiency has been suggested as an important factor, which determines visual preference (Mishra & Singh, 2016; Canseco-González et al., 2010). Therefore, it could be argued that lexical access in the L2 is influenced by the development of L2 learning because L2 learners are developing lexical access in another language different from the L1. So, the main question of the current research is **will L2 lexical access have a relationship with L2 proficiency?** L2 proficiency could be considered an important factor in lexical access that promotes a visual preference for the phonological information embedded in words over the semantic information in the L2 (Mishra & Singh, 2016; Canseco-González et al., 2010). But, if L2 proficiency does not determine lexical access processing with a visual preference for the phonological information of words in the L2, then, a different visual preference for other information related to words could be observed, for instance, a visual preference for the semantic information of words in the L2 (Mishra & Sigh, 2016; Rodríguez-Lázaro et al., 2019). However, in previous studies (Mishra & Singh, 2016; Canseco-González et al., 2010) bilingual participants have been implied to have a different proficiency, exposure, and use of the L2 when contrasted with L2 learners (The Douglas Fir Group, 2016; Kroll et al., 2002). Since a visual preference for the phonological information of L2 words through the presentation of auditory and visual input in bilinguals has been found, but not in L2 learners, then, **will lexical access in L2 learners reveal a visual preference for the phonological information over the semantic information of words in the L2?**

Moreover, in Huettig and McQueen's (2007) study, the presentation of two modalities of the visual input (images *vs*. written words) was contrasted in speakers of one language and the main results showed a visual preference for the phonology of words in both modalities. Then, if the presentation of written words and images activates words in the L1, this suggests that lexical access in the L2 could be activated by these modalities as well, as shown with images (Mishra & Singh, 2016; Canseco-González et al., 2010). Nevertheless, the evidence on the activation of words through the written words' modality in the L2 is still limited. Then, a secondary question for the current dissertation is **will L2 learners have a similar lexical access for the phonological information when written words and images are presented in the L2?** That is, L2 learners might show a similar visual preference for the phonological information of the words in the L2 over the semantic information in both modalities as observed in speakers of one language (Huettig & McQueen, 2007). If this is not the case, then lexical access in the L2 in each modality (images *vs*. written words) will show a different visual preference by L2 learners where other information rather than phonology, such as the semantic information of words, might be observed.

Lastly, it is worth investigating if lexical access is similar in the L1 and in the L2 in L2 learners, that is, **is lexical access for the phonological information of words similar in the L1 and L2?** If so, this could imply that lexical access is similar in both the L1 and L2. But if not, then, this would reveal that lexical access occurs differently in each language, and this could indicate that each language follows a different lexical access route to process the input that is being perceived either in the L1 or the L2.

General objective

1. To describe lexical access in the L2 to the phonological, semantic and shape information of words through images and written words in L2 learners.

Specific objectives

1. To describe if lexical access to the phonological, semantic and shape information of words is modulated by L2 proficiency when images are presented in the L2.

2. To describe if lexical access to the phonological, semantic and shape information of words is modulated by L2 proficiency when written words are presented in the L2.

Variables

- *L2 proficiency (dependent variable)*

Conceptual definition: L2 proficiency was defined as the lexical knowledge that a participant has in a second language such as English.

Operational definition: L2 proficiency was measured through the LexTALE test which identifies lexical knowledge in English (see Materials and Instruments section).

- Lexical access (independent variable)

Conceptual definition: Lexical access is defined as the activation of the information related to words (phonological, semantic or shape information) when auditory and visual input (images or written words) concur.

Operational definition: Lexical access was measured through the visual preference for visual input when auditory input was perceived. For this purpose, Proportion of Total Looking time (PTL) was used since it provides participants' attention percentage toward the target stimulus while other stimuli are displayed simultaneously. Additionally, the Looking time-course (LTC) was considered as a supplementary measurement. This measurement reveals the time-course of the attention toward the visual stimuli during a trial. Therefore, multiple temporal measures of the fixation of looks to visual stimuli are calculated. More details about these measurements are described in the Measurement of visual preference section.

Main hypothesis

H: Lexical access in the L2 will activate the phonological competitor over the semantic and shape information of words when images and written words are displayed in the L2.

Specific hypotheses

H_1: Lexical access to the phonological competitor over the semantic and shape information of words when images are presented in the L2 will be modulated by L2 proficiency.

H_2: Lexical access to the phonological competitor over the semantic and shape information of words when written words are presented in the L2 will be modulated by L2 proficiency.

Method

Sample

The sample of this research was a non-random sampling by convenience. L2 learners enrolled in the English courses at the National School of Languages, Linguistics and Translation (abbreviated ENALLT in Spanish) were considered only. Students from ENALLT are assessed through a placement test before being enrolled in English courses, therefore, they must demonstrate minimum an A2 level, according to the European Framework of Reference for Languages (Council of Europe, 2001). Accordingly, ENALLT's English courses cover from the A2 to the B2 levels and students are enrolled in one of these levels depending on the results of the placement test. Due to the global pandemic of Covid-19, ENALLT's classes were adapted to online classes so the main researcher sent invitations by mail to ENALLT's English teachers to ask their students to participate in the current research. This invitation was later communicated to the students enrolled with those teachers. This indirect invitation reduced the possibility to obtain a broader sample from ENALLT, nevertheless, it guaranteed that participants were enrolled in this institution. Participants that completed the tests received course credits. The information of the participants recruited is presented below in the Sample section.

Inclusion and exclusion criteria

Native speakers of Spanish (L1) between the ages of 18 to 35 years who were learning English as an L2 and were enrolled in regular courses at ENALLT's English Department at UNAM were included as participants of this study. The students enrolled at ENALLT's English language courses belong to undergraduate programs which are provided inside the *Ciudad Universitaria campus* in Mexico City. It is worth noting that for the objectives of this research, the program students were enrolled in is not a relevant variable.

The exclusion criteria were the following: having a different L1, incomplete tests and participants that wanted to withdraw from the study. In either case, recorded data were eliminated. Participants were notified in the informed consent about the technical requirements for the visual preference task (see technical requirements in the Instruments and Materials section in 2. Eye-tracker). If a participant explicitly commented that they did not meet the technical requirements, the participant was not included in the sample.

Participants were provided with an informed consent in Spanish (participant's L1) which described the procedures and the objectives of the current research. This informed consent was approved by the Ethics Board of the Postgraduate Program in Psychology at UNAM. This document was delivered to participants by mail so they could provide their authorization prior their participation. This document is shown in Appendix B.

Prior to participant recruitment, a size effect analysis indicated that 35 participants were required in the sample of this dissertation to determine a medium size effect (see Appendix A for more details). The sample comprised 73 English learners. Two participants were excluded from the analysis since their ages (53 and 63 years-old) did not meet the inclusion criteria. The final sample consisted of 71 participants (53 female). Participants' mean chronological age was M = 21.6 (SD = 2.4, range = 18-31), the mean age of acquisition of English was M = 11 years-old (SD = 4.8, range = 2-23). Twenty-six students reported that they had studied a third language, and only two of them had studied it for more than 3 years approximately. Additionally, none of the students reported having had an immersion experience in an English-speaking country for more than a month.

As it will be described in the Results section, the current research has two different analyses, the first one includes the visual preference task analyses while the second one explores the language practices related mainly to the L2, provided by a Language Experience Questionnaire. For the analyses related to the visual preference task, 63 participants were considered for analyses since data of eight participants were removed due to data loss as detailed in the Results section. These 63 participants revealed different levels of L2 proficiency. When students are enrolled at ENALLT, they must have an intermediate level of proficiency of English; their proficiency is evaluated with an admission test they must complete before being accepted in the English courses. For the current research, participants' L2 proficiency was assessed with the LexTALE test, which measures the knowledge of English words. According to this test, a beginner to low-intermediate proficiency in English corresponds to scores of 59 or less, and scores of 60 and higher reveal a proficiency of upper-intermediate to advanced levels. Then, participants identified with scores within the beginner level (< 59) in the LexTALE were n = 17, while n = 46 were identified with an upper-intermediate level.

Meanwhile, for the Language Experience Questionnaire, the total sample (n = 71) that was mentioned earlier was considered (as it is detailed in the Results section in Language Experience Questionnaire).

Materials and Instruments

1. *Lexical Test for Advanced Learners of English* (LexTALE; Lemhöfer & Broersma, 2012). This self-administered test measures vocabulary knowledge through a lexical decision task where the participant decides if a word belongs to a particular language, in this case to English (http://www.lextale.com/). This test has 60 words of which 20 are English pseudowords (i.e., words that follow phono-orthographic rules but do not actually exist, e.g., *purage*), and it takes approximately five minutes to complete. Participants' responses show their vocabulary

knowledge in English and provide a general measure of their proficiency in English. That is, proficiency can be identified according to a participant's percentage of correct responses in one of the following levels: advanced (80%-100%), upper-intermediate (60%-79%) and beginner (less than 59%). Lemhöfer and Broersma (2012) reported a reliability of .87 and a validity of .74 for the LexTALE. For the current research, the LexTALE was applied to participants to measure their proficiency in English as an L2. An example of the LexTALE is shown in Appendix C.

2. *Eye-tracker.* Visual preference from participants was recorded through a purchased license from the RealEye platform (https://www.realeye.io/). The RealEye platform uses the webcams installed in laptops or connected through a USB port to detect a participant's eye movements only if the participant agrees to start the test on the platform. Webcams emit infrared diodes that are reflected off the cornea of the eye, this way the system automatically recognizes the eyes and follows them despite head movement in a range of approximately one cubic foot. RealEye records the fixation points and the gaze trajectory at a 60 Hz temporal rate. The average accuracy of visual angle is 30º. The technical requirements to use RealEye are the following: monitor with a display resolution of 1024x986 pixels, PC or laptop with Microsoft Windows 10 or Mac (Macbook, iMac) with MacOS, Google Chrome browser installed, and an integrated webcam or connected through an USB port. RealEye tests cannot be executed in tablets or cellphones. The RealEye platform displays a five-point calibration to ensure the tracking of the participant's eyes. When the RealEye platform is able to track eye movements, the visual stimuli (i.e., images or video) starts to be displayed. The RealEye platform links videos stored on YouTube and the link of the video is saved on the RealEye platform. This way, RealEye shows the video saved on YouTube and the webcam tracks eye movements while the video plays. Similarly, when additional tests are saved in platforms such as Google Forms the link to those tests must be saved on the RealEye platform so participants can continue with those additional tests. Once the link of the video on YouTube and the additional tests are stored on the RealEye platform, a single link becomes available and can be shared with participants.

When a participant accesses the RealEye platform through the link, the video that contains the stimuli of a study is shown first and as soon as the video finishes the additional tests, as the ones in Google Forms, can be accessed so the participant can continue with the rest of the tests in the study. However, it is important to mention that the sampling rate in this online platform could vary depending on the Wi-Fi stability where the participants performed the task. Data treatment criteria for the visual preference task and the decisions to avoid data loss due to the sampling rate are described in the Results section.

3. *Language Experience Questionnaire.* This questionnaire contains items adapted from the Bilingual Language Profile (BLP; Birdsong et al., 2012) and from the Language History Questionnaire (LHQ3; Li et al., 2019). These two self-report surveys collect sociodemographic data and information related to the age of acquisition of the L2, exposure time and use of the L1 and the L2. Additionally, these instruments consider the term "bilingual", which might not reflect the same language practices performed by the L2 learners. The adaptation consisted in selecting questions from the BLP and from the LHQ3 that provide information about L2 language practices. Specifically, sections III and IV from the BLP, and questions 15, 18, 19, and 21 from the LHQ3 were considered and adapted. For instance, both the BLP and the LHQ3 ask about the age of acquisition of the L2, so this aspect was considered in our questionnaire (e.g., *At what age did you start learning English?*). In addition, the BLP and the LHQ3 have a special section where they ask about the frequency of use of the language (L1 or L2) to perform different activities (e.g., listening to the radio, reading for pleasure, social media use). While in the BLP, specifically in section III, the options for frequency are displayed in a list of percentages (e.g., 10%, 20%, until 100%), in the LHQ3, in item 18, the answers are open-ended and based on an estimation of hours made by participants; that is, a participant can answer with numbers or with words the frequency of hours spent doing the listed activities as well as indicate in which language those activities are performed (in the L1 or the L2). For our questionnaire, we asked how often they used Spanish and English to perform different activities (e.g., writing in English),

and we distinguished the frequency of these language practices. We decided to provide three types of options to answer the frequency of the language practices we listed. These options were: a) 0 to 7 hours a week, b) 8 to 15 hours a week, and c) more than 16 hours a week. The rationale behind these three options was related to the time spent in class per week in the English courses at ENALLT which was 6 hours a week, then, we assumed that the minimum hours of exposure for an L2 learner in a formal setting would be around 7 hours a week. So, we hypothesized that beyond that period, a higher exposure and practice of the L2 outside the classroom might be performed by the L2 learners. Regarding the receptive and the productive skills in the L1 and in the L2, we tried to be specific on these aspects; that is, we explored the four skills (writing, reading, listening, and speaking) which could possibly convey L2 learners' language practices. For example, we included a section specifically about the texts that L2 learners might write in the L2 as a productive skill (e.g., *Estimate how many hours you write in English the following type of texts).* The types of texts were divided into five categories: messages on social media, messages on WhatsApp, e-mail messages, personal diary, and assignments from school that could be written using English. Neither the BLP nor the LHQ3 provided this clear distinction on the receptive and productive skills of L2 learners. Then, in our questionnaire we included four sections for each skill; that is, two sections included language practices related to receptive skills such as listening and reading, and two other sections with language practices related to productive skills such as writing and oral production. Each section provided categories as the ones presented above for the writing skill (see Table 4 and Table 5). Lastly, a section about self-assessment on the performance of these skills (listening, reading, writing and oral practice) was included (e.g., *Estimate how comfortable you feel*: when talking to others in English, when reading texts in English, when understanding audios in English, and when writing in English). The options to answer this section were *uncomfortable, rather comfortable, comfortable, very comfortable*.

A total of 21 questions in Spanish integrated this questionnaire and a Google Form was used as an online resource to obtain the answers from participants. The duration of this questionnaire was approximately 7 minutes (for further details of the instrument see Appendix D).

Experimental scenery

The experimental sessions were carried out online due to the Covid-19 pandemic; that is, each participant performed the tests of this research at home on their personal computer in the following order: the visual preference task, the Language Experience Questionnaire, and the LexTALE described above in the Materials and Instruments section.

Participants that met the technical requirements (e.g., PC or laptop screen mounted with a webcam) were included in the sample. Participants were advised to sit in a well-lit place for the visual preference task, and to rest their chin on their hands to avoid tiredness during the task. When this task was finished, participants were directed automatically to a Google Form with the remaining tests (the Language Experience Questionnaire, and the LexTALE). If participants had doubts, these were solved by email prior the performance of the tests.

Experimental design

To provide evidence for the current research, four experiments were proposed to explore lexical access in Spanish (L1) and in English (L2) under two modalities: images and written words; that is: Experiment 1 presented images in the L1, Experiment 2 presented written words in the L1, Experiment 3 displayed images in the L2, and Experiment 4 displayed written words in the L2. Further details of each experiment are explained below.

Experiment 1. Lexical access in the L1, Images modality

The objective of Experiment 1 was to describe if lexical access activates the phonological information over the semantic and shape information when images are presented in the L1. A visual preference for the phonological information is expected when auditory and visual input are perceived in the L1 as reported in Huettig and McQueen's (2007) study, then, for the current research, we anticipate that participants will show a visual preference for the phonological information related to the spoken word in their L1. Thus, Experiment 1 explored this processing through the images modality, and the auditory input (the spoken word) was presented in Spanish (participants' L1). So, the hypothesis for this Experiment stated that the presentation of images in the L1 would promote a larger visual preference for the phonological information over the semantic and shape information by L2 learners.

Stimuli selection

Spoken words were selected from *Corpus del Español Mexicano Contemporáneo* (CEMC, n.d.) which exhibits written extracts in Spanish from literature, journalism, scientific and technical texts, political and religious discourses, to name a few. The absolute frequency (AB) of words, provided by the CEMC, was considered. Therefore, words with an AB of 50 to 458 were included in the list, and only concrete nouns with a maximum length of nine letters or three syllables were included. Furthermore, it was corroborated that the selected spoken words existed in the Word Association Norms for Mexican Spanish (*Normas de Asociación de Palabras para el Español de México*; Arias-Trejo y Barrón-Martínez, 2014). If the spoken word did not exist in this database, it was eliminated from the final selection.

Phonological competitors or cohorts. These were concrete nouns that share the same consonantal onset and the vowel nucleus, following the procedure of Huettig and McQueen (2007). The spoken words in Spanish were taken from a dictionary of Spanish (Real Academia Española, 2014). For instance, the spoken word <u>***cas***</u>*a* /'ka.sa/ [house] shares a phonological overlap with the first three phonemes of the cohort <u>***cas***</u>tor /kas.'tor/ [beaver], while other words share only the first two phonemes (e.g., <u>***ve***</u>stido /βɛs.ˈti.ðo/ [dress] with the cohort <u>***ve***</u>ntana /bɛn.ˈta.na/ [window]. These cohorts were semantically unrelated to the spoken word according to the Word Association Norms for Mexican Spanish (Arias-Trejo y Barrón-Martínez, 2014). Additionally, Levenshtein's phonological and orthographic distance between spoken words and Spanish cohorts was measured and the Levenshtein's distance mean was *M* = 3.06 (range, 1-5, *SD* = 1.11). That is, there is from one to five letters of difference between the spoken words and cohorts. In order to observe if the phonological overlap followed a normal distribution, specifically, in the consonantal onset and in the vowel nucleus a Shapiro-Wilk test was performed. The results revealed that the spoken words $W(18) = .741$, $p < .001$ and Spanish cohorts $W(18) = .662$, $p < .001$, did not follow a normal distribution (see Appendix E -Tests of Normality for further details on syllable and character length of spoken words, cohorts, semantic competitors, and distractors). A non-parametric Friedman test of differences among repeated measures was conducted, and no statistical differences were observed in the syllable length of the Spanish cohorts, semantic competitors, shape competitors and distractors, $X^2(3) = .2.17$, $p = .536$. Furthermore, no differences were observed in the character length of the Spanish cohorts, semantic competitors, shape competitors and distractors ($X^2(3) = 3.25$, $p = .354$). Additionally, a Friedman's test was carried out to compare the total Levenshtein's distance between spoken words *vs.* semantic competitors, shape competitors and distractors, resulting in a significant difference among the distributions of the distance of these words ($X^2(3) = 29.90$, $p < 001$). A post hoc analysis with a Wilcoxon signed-ranks test was carried out and significant differences were observed in Levenshtein's measure between the distance of spoken words and semantic competitors (*Mdn* = 6.00) *vs.* spoken words and Spanish cohorts (*Mdn* = 3.00; $Z = 3.78$, $p < .001$); the distance between spoken words and distractors (*Mdn* =5.00) *vs.* spoken words and Spanish cohorts (*Mdn* = 3.00; $Z = 3.42$, $p < .001$); and the distance between spoken words and shape competitors *vs.* spoken words and Spanish cohorts ($Z = 3.43$, $p = .001$). No other significant differences were observed. Therefore, Spanish cohorts were statistically different from the competitors: shape, semantic and distractors. See Appendix E in a) Experiment 1- Spoken words, competitors, and distractors, for further details on syllable and character length.

Shape competitors share an outline or visual characteristics with the spoken word (e.g., a spoken word such as *casa (house)* shares the contour of *flecha (arrow)*). So, the researcher looked on the internet for objects of images that could resemble the objects of the spoken words selected previously. In order to ensure that the shape competitors' stimuli were selected correctly, a validation study was carried out with thirteen different participants who were not part of the sample of this research but shared similar characteristics; that is, 18 to 25 year-old (*M* = 21.84; *SD* = 1.81) college students from the Psychology Faculty at UNAM participated in this study prior to the Covid-19 pandemic. Eleven were female students and two were male students. Images were presented using the software PsychoPy version 3 installed on a laptop. This study was carried out in Spanish and instructions were provided on a slide where it was explained that each participant had to rate how many visual characteristics one image shared with another object. A Likert scale was used for this purpose, where 1 meant "little" and 5 meant "a lot". The display of each screen (in PsychoPy) was as follows: a question was presented at the top of the screen, such as: How many visual characteristics does a balloon share with a light bulb? Then, the image of a light bulb was presented and below this image were the numbers 1, at the left of the screen, and 5, at the right of the screen, with a gray line between them to represent the Likert scale. Participants used the laptop mouse pad to respond, therefore, participants made use of their index finger to move the selection of each response. A blue arrow was displayed to show the direction of the response, that is, if the blue arrow moved to the extreme right of the screen, then the response was coded as 5 "a lot" (see Appendix F for an example of the display on PsychoPy). As soon as a participant was certain of their answer, they had to press the spacebar key to move to the next screen. Two examples were included to see if each participant understood the instructions and to demonstrate the use of the Likert scale with the mouse pad. In total, 36 displays that represented the shape competitor for the spoken words of the experiments of this research were presented to each participant (see detailed list in Table 1 and Table 2). *Results:* Since responses were coded from 1 to 5, where 1 meant "little" and 5 "too much", the medians were coded to analyze participant's responses to each shape competitor included in this validation study. As a result, twenty-five objects (69%) obtained values from 3 to 5, and 11 objects (31%) got values from 2 to 1. This means that more than half of the objects selected as shape competitors for the spoken words share more visual characteristics than the rest of the objects. Nevertheless, it was necessary to leave out the objects with values from 2 to 1 due to the difficulty to find suitable shape competitors matches for the spoken words (see Appendix G for further details).

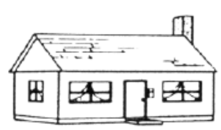
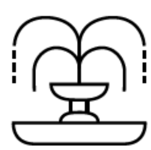
Semantic competitors were chosen from the Word Association Norms for Mexican Spanish (Arias-Trejo y Barrón-Martínez, 2014; in: http://www.labpsicolinguistica.psicol.unam.mx/Base/index.html). This open access database provides word associates in Mexican Spanish (e.g., *casa* could be semantically associated with *sillón*). In this database, the associative strength to the input is offered, which indicates the percentage of participants that answered that *sillón* [armchair] is related, or associated semantically, to the word *house* [casa]. Semantic competitors in Spanish were chosen with a lower associative strength (less than 2%) to avoid a larger visual preference for this information over the phonological information, as demonstrated in a similar study where the semantic competitor attracted more looks (Rodríguez-Lázaro et al., 2019). Moreover, recent evidence has shown that associates activate semantic information regardless of the level of association, that is, lower levels of association between words also facilitate the processing of semantic information (Aschenbrenner & Yap, 2019; Fairs et al., 2021). It is important to mention that words such as *freedom* were not considered and only concrete nouns such as *car* were selected due to the physical properties that concrete words have since they can be represented visually in images. See Appendix H for further details of the associative strength of the semantic competitors with the spoken words.

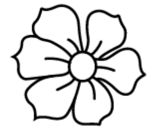
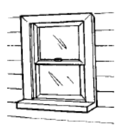
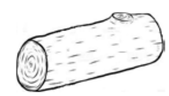
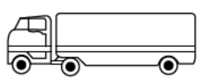
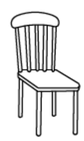
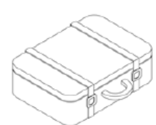
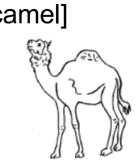
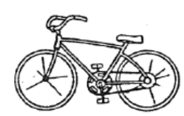
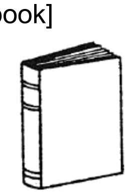
Distractors are not related phonologically, visually nor semantically to the spoken word. Phonological relation was avoided by ensuring that the Spanish cohort was the only word in the trial that shared the same first syllable with the spoken word. Semantic association was avoided by consulting in the Word Association Norms for Mexican Spanish that the distractor object was not associated semantically to the spoken word according to these norms. Special care was taken regarding the visual shape competitor to avoid similar features with the spoken word or with the rest of the competitors.

Stimuli. Images of objects related to the spoken word (not displayed) were presented and had the following characteristics: a cohort in Spanish, a shape competitor, a semantic competitor, and a distractor**.** Experiment 1 had twenty-eight trials of which eighteen were of interest while the rest were considered filler trials. Table 1 shows target trials for Experiment 1.

Table 1

Target trials for Experiment 1

Target trials considered for Experiments 1 and 2				
Spoken word	*Spanish cohort/ Phonological competitor*	*Semantic competitor*	*Shape Competitor*	*Distractor*
1. casa /ˈka.sa/ [house]	castor /kas.ˈtoɾ/ [beaver] 	sillón [armchair] 	flecha [arrow] 	dona [donut] 
2. puerta /ˈpwɛɾ.ta/ [door]	puerco /ˈpwɛɾ.ko/ [pig] 	llave [key] 	espejo [mirror] 	sartén [pan] 
3. planta /ˈplan.ta/ [plant]	playa /ˈpla.ʝa/ [beach] 	casa [house] 	fuente [fountain] 	nube [cloud] 

4. estrella /ɛs.ˈtre.ʝa/ [star]	estufa /ɛs.ˈtu.fa/ [stove] 	planeta [planet] 	flor [flower] 	cortina [curtain] 
5. huevo /ˈwe.βo/ [egg]	hueso /ˈwe.so/ [bone] 	pan [bread] 	balón [american football] 	cactus [cactus] 
6. vestido /βɛs.ˈti.ðo/ [dress]	ventana /bɛn.ˈta.na/ [window] 	camisa [shirt] 	reloj [hourglass] 	tronco [trunk] 
7. cama /ˈka.ma/ [bed]	camión /ka.ˈmjõŋ/ [truck] 	silla [chair] 	maleta [suitcase] 	piña [pineapple] 
8. caja /ka.xa/ [box]	camello /ka.me.ʝo/ [camel] 	jitomate [tomato] 	hielo [ice] 	bicicleta [bike] 
9. barco /ˈbar.ko/ [boat]	barba /ˈβar.βa/ [beard] 	ola [wave] 	volcán [volcano] 	libro [book] 

10. conejo
/ko.ˈne.xo/
[rabbit]

concha
/ˈkõn.ʧa/
[seashell]


lechuga
[lettuce]

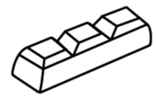

tijeras
[scissors]


paleta
[lollipop]


11. tren
/ˈtrɛn/
[train]

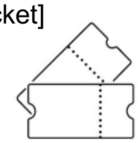
trenza
/ˈtrɛn.sa/
[braid]


avión
[plane]


chocolate
[chocolate bar]


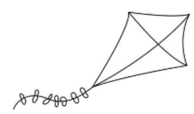
barril
[barrel]


12. bolsa
/ˈbol.sa/
[bag]

boleto
/bo.ˈlɛ.to/
[ticket]


mochila
[backpack]

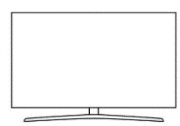

camiseta
[shirt]


papalote
[kite]


13. ventana
/bɛn.ˈta.na/
[window]

ventilador
/bɛn.ti.la.ˈðor/
[fan]


espejo
[mirror]


pantalla
[screen]


periódico
[newspaper]


14. plato
/ˈpla.to/
[plate]

playera
/pla.ˈʝɛ.ɾa/
[t-shirt]


cereal
[cereal]

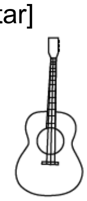

disco
[disc]

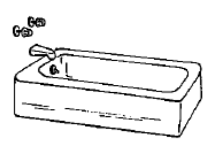

lavadora
[washing machine]

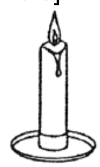
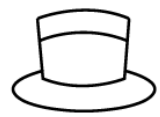
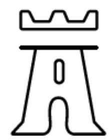

15. botella
/bo.ˈte.ʝa/
[bottle]

bota
/ˈbo.ta/
[boot]


vaso
[glass]


guitarra
[guitar]


tina
[bathtub]


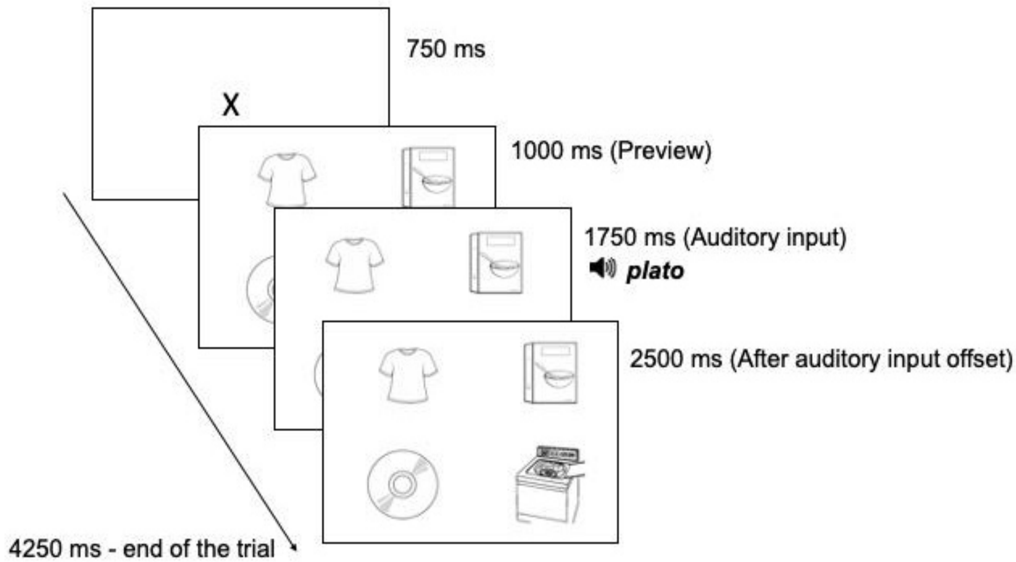
16. mesa /ˈme.sa/ [table]	melón /me.ˈlon/ [cantaloupe] 	cuchara [spoon] 	tortuga [turtle] 	globo [balloon] 
17. pastel /pas.ˈtɛl/ [cake]	pasta /ˈpas.ta/ [pasta] 	vela [candle] 	sombrero [hat] 	árbol [tree] 
18. iglesia /i.ˈɣle.sja/ [church]	iglú /i.ˈɣlu/ [igloo] 	campana [bell] 	torre [tower] 	ardilla [squirrel] 

Visual stimuli. A standard resolution of 1080 x 1440 pixels within a resolution of 72 pixels per inch (3.5 squared cm) was considered for the visual stimuli. Objects representing the spoken words, semantic and shape competitors, and distractors were depicted visually as images in black and white format as shown in Table 1. Four images were placed in a quadrant, where each image occupied a corner as in Figure 5, and the spoken words were not displayed as in Huettig and McQueen's (2007) study. Images were selected from databases, such as: Pérez and Navalón (2003), Snodgrass and Vanderwart (1980), and Szekely et al. (2004). Images that were not found in these bases were purchased from Shutterstock, an internet supplier of images and pictures. Consequently, a validation of these purchased images was performed, prior to the Covid-19 pandemic, to ensure that the images of cohorts and competitors were representative objects. This validation prevented the use of unrepresentative images within the final stimuli selection. For this validation, a naming task was carried out (Chabal & Marian, 2015). 15 English students from ENALLT, who were not part of the final sample but shared similar characteristics, were recruited to participate in this study. Participants were able to decide to remain anonymous or to share their gender and age information. Seven participants were male, eight were female, and the rest remained anonymous. Participants' ages ranged from 19 to 32 years (*M* = 22.8, *SD* = 3.58). This task was performed during the last 20 minutes of a class at ENALLT, and the images stimuli were not associated with the topics of the class. The teacher of this class was not present in the classroom and the author of this dissertation handed the task in photocopies to participants. These photocopies had the printed images from Shutterstock. Each image was followed by a blank space so participants could write the name of the object preferably in English (see Appendix I for an example of the task). Participants were instructed to not look up the words on their mobile phones nor ask classmates about the images whose names they could not recall. *Results:* Seventy images were presented and the ones with 60% of naming consistency among participants were considered for the final stimuli selection (see Table 1). Images with 59% or less were eliminated from trials or used in filler trials.

The display of the visual stimuli was randomized and counterbalanced across four fixed positions in every trial to avoid learning strategies from participants. That is, competitors were displayed the same number of times during the presentation of Experiment 1.

Figure 5

Example of the temporal distribution of each trial of Experiment 1



Auditory stimuli. Twenty-eight spoken words were presented, such as *casa* /'ka.sa/ *(house)* but were not shown amid the visual stimuli. The spoken words were recorded digitally with the voice of a male native speaker of Spanish without highlighting the pronunciation of these words. Auditory stimuli were recorded with Adobe Audition software at 44100 Hz and 16-bits. Files were edited and normalized to adjust amplitude, volume, and noise reduction.

Experimental design. Each Experiment consisted of twenty-eight trials of which 18 were of interest (see Table 1 for further details). As in Mishra and Singh's (2016) study, the visual stimuli were displayed before the onset of the auditory input and each object had a gaze likelihood of .25. Each trial lasted 4250 ms, and Figure 5 shows the temporal distribution.

Experiment 2: Lexical access in the L1, Written Words modality

The objective of Experiment 2 was to describe if lexical access activates the phonological information over the semantic and shape information when written words are presented in the L1. As observed in Huettig and McQueen's (2007) study, when written words were presented in participants' L1, a visual preference for the phonological information of words was shown and this suggests that the orthography and phonology embedded in words becomes active and competes over the semantic and shape information of words. Similarly, as postulated in the

BLINCS model, the ortho-lexical and phono-lexical levels become active since these levels analyze the written words perceived either in the L1 or in the L2. Then, orthography and phonology are expected to be activated first, second by the semantics of words (Shook & Marian, 2013). Therefore, it is assumed that L2 learners will show a visual preference for the phonological information of words in Spanish, more specifically to the cohorts of the spoken words. Then, the hypothesis for this Experiment suggests that the presentation of written words in the L1 would promote a larger visual preference for the phonological information over the semantic and shape information by L2 learners.

Stimuli. Stimuli were the same as the ones described in Experiment 1.

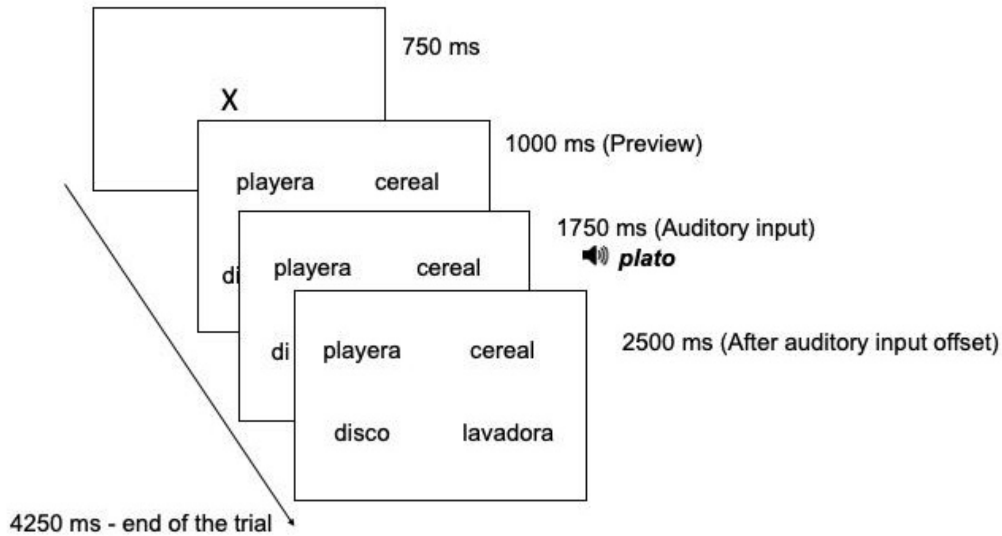
Visual stimuli. Written words in Spanish with the same characteristics described in Experiment 1 were displayed.

Auditory stimuli. Spoken words were said in Spanish as detailed in Experiment 1.

Experimental design. The experimental design is similar to Experiment 1, but instead of objects related to the spoken words, written words in Spanish were displayed, as shown in Figure 6.

Figure 6

Example of a trial of Experiment 2



Experiment 3. Lexical access in the L2, Images modality

The objective of Experiment 3 was to describe if lexical access activates the phonological information over the semantic and shape information when images are presented in the L2. For this Experiment, it was expected that the presentation of images in the L2 would promote a larger visual preference for the phonological information over the semantic and shape information by L2 learners. Spoken word presentation in Experiment 3 is based on Huettig and McQueen's (2007) study, where spoken words were not displayed amid the visual stimuli but were presented as spoken words. Therefore, images of objects that are related to the spoken word in the phonological, shape and semantic level were presented as competitors of lexical access activation in an L2. It could be argued that L2 proficiency is as an important factor in lexical access that promotes a visual preference for the phonological information related to the spoken words over the semantic information in the L2 (Mishra & Singh, 2016; Canseco-González et al., 2010). Nonetheless, if L2 proficiency does not determine lexical access processing with a visual preference for the phonological information of words in the L2, then, a different visual preference for other information related to words could be observed, for instance, a visual preference for the semantic information of words in the L2 (Mishra & Sigh, 2016; Rodríguez-Lázaro et al., 2019).

Stimuli selection

Spoken words were English nouns with high frequency of use selected from the SUBTLEXus database (Brysbaert & New, 2009). This database provides information regarding the frequency of appearance of English words in the subtitles in films and TV series from the US. The frequency of use for the spoken words for the current research was taken from the Zipf value index described in the SUBTLEXus. This measure divides the frequency of use of words in different ranges of values: a. values from 1 to 3 indicate low-frequency words (frequencies of 1 per million words and lower) and b. values from 4 to 7 indicate high-frequency words (with frequencies of 10 per million words and higher) (van Heuven et al., 2014). For this research, words within the values from 4 to 7 were considered, then, in this first initial selection 160 words were chosen. Afterward, nouns with a length of 9 letters or three syllables were chosen to facilitate processing of short words when perceived (Carreiras, et al., 2006), and within this last criterion 22 words were selected.

Phonological competitors or cohorts (nouns in English that shared the same consonantal onset and the vowel nucleus, following the procedure of Huettig and McQueen (2007), with the 22 spoken words) were selected from a bilingual dictionary (Macmillan Education, 2002). For instance, the spoken word ***che***_ese_ /**tʃi**z/ shares a phonological overlap with the first three phonemes of the cohort ***chi***_cken_ /ˈ**tʃɪ**kən/, while other words shared only the first two phonemes (e.g., ***co***_ke_ /koʊk/ with cohort ***co***ne /koʊn/). These cohorts were semantically unrelated to the spoken word, according to the University of South Florida Free Association Norms (Nelson, McEvoy & Schreiber, 1998). Then, 22 phonological competitors that shared the first syllable of the spoken words were selected.

Semantic competitors were chosen according to the University of South Florida Free Association Norms (Nelson et al., 1998). This is a free word database that can be retrieved from the website: http://w3.usf.edu/FreeAssociation/, and which provides the semantic relations or associations within words according to English speakers (e.g., *cheese* was semantically associated with *milk*). Furthermore, appendix B from the University of South Florida Free Association Norms, offers the Forward Cue-to-Target-Strength (FSG as abbreviated in Nelson et al., 1998), which is a measure that provides the proportion of speakers that produced a word associated (e.g., *milk*) when a cue-word (e.g., *cheese*) was presented (Nelson et al., 1998). There are different levels of association between words: a low, a moderate, and a strong association; in other words, these levels of association reveal how many English speakers produced *milk* when *cheese* was presented, so the larger the number of speakers that produced *milk* the stronger the association with the word *cheese*. For the current research, a moderate association (an FSG range from 0.010 to 0.050) between the words associated to the spoken words was considered (de Salles et al., 2009). This decision was made under the assumption that a strong association (an FSG higher than 0.55) would imply faster processing (Aschenbrenner & Yap, 2019), that is, a noticeable visual preference for strong associates of the spoken word over the other competitors (phonological and shape) when they are displayed simultaneously. Then, 22 semantic competitors related to the spoken words were selected. See Appendix H for further details of associative strength.

Shape competitors share an outline or visual characteristics with the spoken word (e.g., a spoken word like *cheese* shares the contour of a *sponge*). These shape competitors are unrelated both semantically and phonologically to the other competitors and the validation study for the shape competitors is detailed in Experiment 1.

In order to ensure that the words in English were familiar to participants, a validation of these words (spoken word, English cohorts, and semantic competitors; 66 in total) was carried out, prior to the Covid-19 pandemic. This validation was done to prevent using unfamiliar words for the final stimuli selection for Experiments 3 and 4. Four groups of L2 learners from ENALLT were selected to participate in this validation; the groups had thirteen, twenty, twenty-three and twenty-seven students, respectively. Two groups were from the lowest levels of the English courses and two from the highest levels. Previous authorization from their teachers to apply the vocabulary exercise was obtained. Teachers provided the last 20 minutes of one class for this exercise. Before the application of this exercise, students were told the purpose of it, and they were free to decide whether they wanted to provide personal information, such as name, age, gender, and e-mail (to receive the results and feedback of their performance in the vocabulary exercise). Also, they were told that their results would not affect their final grade in the language course. Students were instructed to translate into Spanish the words in English included in the exercise without the help of a dictionary and to leave in blank the words they did not know or did not understand. Students in general answered this exercise in approximately 15 minutes and could leave the classroom once they finished the vocabulary exercise. The students that provided personal information were later contacted by mail to provide them with feedback regarding their performance in the vocabulary exercise. Additionally, general results for each group were delivered to each teacher without disclosing any personal information of the participants. Four different sheets with the spoken words, English cohorts, semantic competitors, and distractors considered for Experiments 3 and 4 were designed and distributed randomly to the students. Spoken words and cohorts and distractors were presented in a list (see an example of the exercise in Appendix J). *Results*: Eighty-five students were recruited. However, the data from two participants were eliminated from the analysis since their answers were incomplete. As a result, 83 students, who were not part of the final sample of this research but shared similar characteristics, participated in this validation. That is, college students enrolled at ENALLT's English courses with ages ranging from 18 to 40 years participated in this study (M = 22.7; SD = 5.80). Thus, thirty-one female students, 19 male students and 33 that decided to remain anonymous were considered for the analysis. Words that had a correct Spanish translation frequency of 55% or higher were considered in the final stimuli for Experiments 3 and 4, while those with 54% or less were eliminated. Final stimuli selection is presented in Table 2.

Distractors were not related phonologically, visually nor semantically to the spoken word. Phonological relation was avoided by ensuring that the English cohort was the only word in the trial that shared the same first syllable with the spoken word. Semantic relation was avoided by consulting Appendix B from the University of South Florida Free Association Norms, that is, the distractor object was not associated semantically to the spoken word according with these norms. Special care was taken regarding the visual shape competitor to avoid similar features with the spoken word or with the rest of the competitors.

Additionally, to validate the cohorts chosen for this Experiment, Levenshtein's phonological and orthographical distance between spoken words and phonological competitors (cohorts) was measured to calculate how many characters are different between words to observe the phonological and orthographical overlap between words (Carrasco-Ortiz, et al., 2012; Levenshtein, 1975), in this case between spoken words and English cohorts. Levenshtein's mean distance between spoken words and English cohorts was M = 2.50 (range, 1-5, SD = 1.24). That is, there is from one to five letters of difference between the spoken words and cohorts, so the shorter the difference between these words the lesser the phonological and orthographical distance. To observe if the phonological overlap followed a normal distribution, specifically, in the consonantal onset and in the vowel nucleus a Shapiro-Wilk test was performed. The results revealed that the spoken words $W(18) = .638$, $p < .001$ and English cohorts $W(18) = .767$, $p < .001$, did not follow a normal distribution (see Appendix E -Tests of Normality for further details on syllable and character length of spoken words, cohorts, semantic competitors, and distractors). A non-parametric Friedman test of differences among repeated measures was conducted and no statistical differences were observed among the syllable length of the English cohorts, semantic competitors, shape competitors and the distractors ($X^2(3)$ = .310, p = .958). Furthermore, no differences were observed in the character length of the English cohorts, semantic competitors, shape competitors and distractors ($X^2(3)$ =.248, p = .969). Additionally, a Friedman's test was carried out to compare the total Levenshtein's distance between spoken words *vs.* semantic competitors, shape competitors and distractors, resulting in a significant difference among the distributions of the distance of these words ($X^2(3) = 26.65$, $p <$ 001). A post hoc analysis with a Wilcoxon signed-ranks test was carried out, and statistically significant differences were observed in Levenshtein's measure between the distance of spoken words and semantic competitors (*Mdn* = 4.00) *vs.* spoken words and English cohorts (*Mdn* = 2.00; $Z = 3.687$, $p < .001$); the distance between spoken words and distractors (*Mdn* = 5.00) *vs.* spoken words and English cohorts (*Mdn* = 2.00; $Z =3.42$, $p = .001$); and the distance between spoken words and shape competitors (*Mdn* = 4.00) *vs.* spoken words and English cohorts (*Mdn* = 2.00; $Z = 3.43$, $p = .001$). No other significant differences were observed. Therefore, English cohorts were statistically different from the shape competitors, semantic competitors, and distractors. See Appendix E: a) Experiment 3-Spoken words, competitors, and distractors for further details on syllable and character length.

Stimuli. Each trial has four objects. These four objects are: an English cohort (an object with a phonological overlap in the first syllable with the spoken word [phonological competitor], e.g. the spoken word cheese /tʃiz/ shares the first syllable of the cohort chicken /ˈtʃɪkən/); a shape competitor (an object with a similar outline to the spoken word, e.g., the contours of cheese and a sponge are similar); a semantic competitor (an object related semantically to the spoken word, e.g. cheese and milk); and lastly, a distractor (a word unrelated to the three previous objects or to the spoken word, e.g. hammer). Twenty-eight trials with four objects each, of which 18 were of interest and the rest considered as distractors, were be presented (see Table 2).

Visual stimuli. Images shared the same characteristics detailed in Experiment 1 and these images were included in the validation study described in Experiment 1.

Auditory stimuli. Twenty-eight spoken words (e.g., *cheese*) were presented but not shown amid the visual stimuli. The spoken words were recorded digitally with the voice of a male native speaker of English without highlighting the pronunciation of these words. Voice recording and editing was similar as in Experiment 1.

Experimental design. Twenty-eight trials of which 18 were of interest and the rest were considered as filler trials were displayed. Experimental design and temporal distribution were similar to Experiment 1 and Figure 7 shows an example of each trial.

Figure 7

Example of the temporal distribution of each trial of Experiment 3

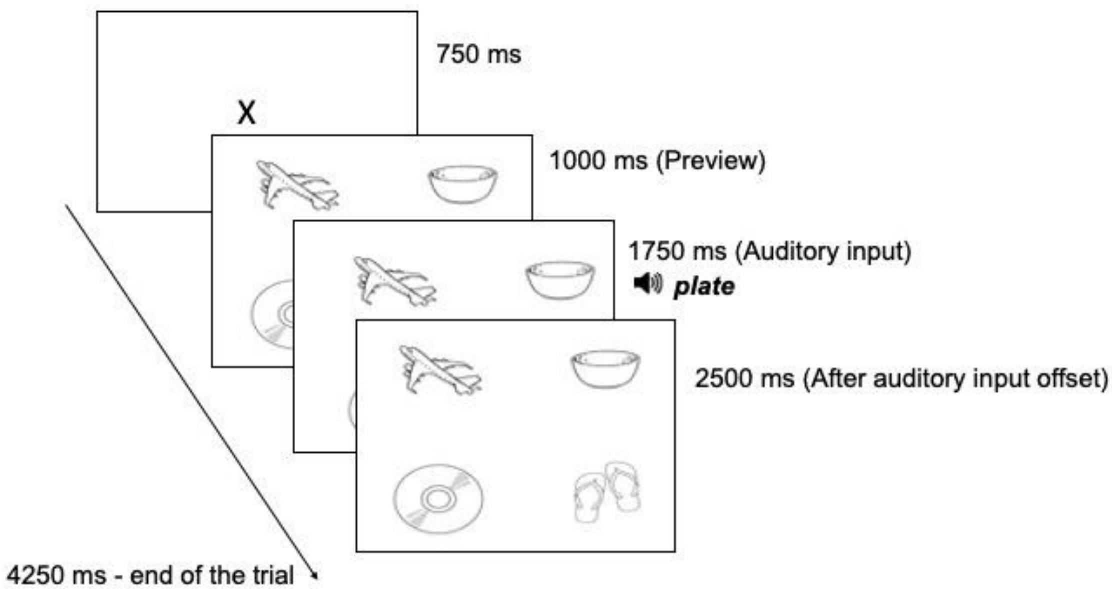
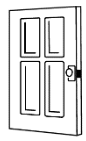
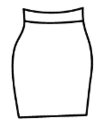
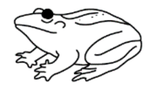
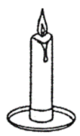
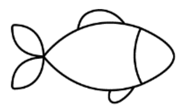
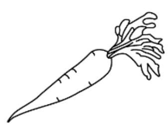
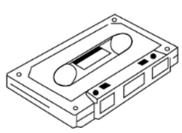
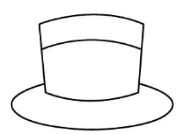
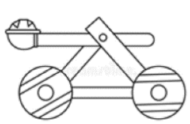
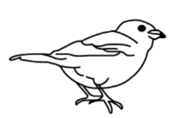
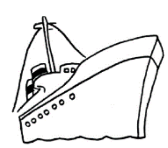
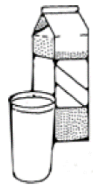
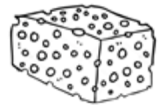
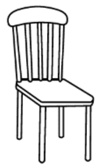
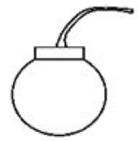
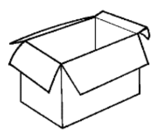
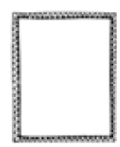
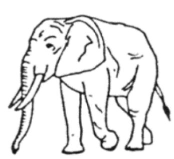
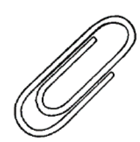
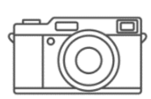
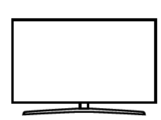


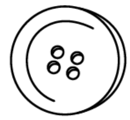
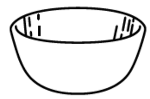
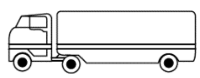
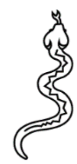
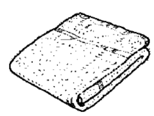
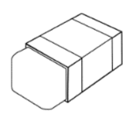
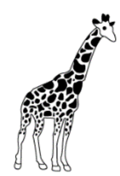
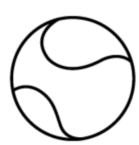
Table 2

Target trials for Experiment 3

Target trials considered for Experiments 3 and 4				
Spoken word	*English cohort/ Phonological competitor*	*Semantic competitor*	*Shape Competitor*	*Distractor*

1. beer /bɪr/	bee /bi/	nut	cup	dress
				
2. bell /bel/	bed /bed/	door	skirt	frog
				
3. candy /ˈkændi/	candle /ˈkændəl/	almond	fish	shoe
				
4. car /kɑr/	carrot /ˈkærət/	bridge	rabbit	pen
				
5. castle /ˈkæsəl/	cassette /kəˈsɛt/	throne	hat	ruler
				
6. cat /kæt/	catapult /ˈkætəˌpʌlt/	bird	pear	ship
				

7. cheese /tʃiz/	chicken /ˈtʃɪkən/ 	milk 	sponge 	hammer 
8. cherry /ˈtʃɛri/	chair /tʃɛr/ 	strawberry 	bomb 	pencil 
9. coke /koʊk/	cone /koʊn/ 	pizza 	violin 	shovel 
10. letter /letˈər/	lettuce /ˈlɛtɪs/ 	box 	mirror 	umbrella 
11. peanut /ˈpiˌnʌt/	piano /piˈænoʊ/ 	elephant 	snowman 	clip 
12. photo /ˈfoʊtoʊ/	phone /foʊn/ 	camera 	screen 	soup 

13. planet /ˈplænɪt/	plant /plænt/	star	button	cab
				
14. plate /pleɪt/	plane /pleɪn/	bowl	disc	sandals
				
15. road /roʊd/	rose /roʊz/	truck	snake	coin
				
16. soap /soʊp/	sofa /ˈsoʊfə/	towel	eraser	giraffe
				
17. medal /ˈmɛdəl/	medicine /ˈmɛdəsɪn/	trophy	ball	sock
				
18. mouth /maʊθ/	mouse /maʊs/	lipstick	banana	scissors
				

Experiment 4: Lexical access in the L2, Written Words modality

The objective of Experiment 4 was to describe if lexical access activates the phonological information over the semantic and shape information when written words are presented in the L2. According to the BLINCS model written words activate the phono-lexical and ortho-lexical levels which are related to the orthography, phonology, and semantics in an L2, as in the L1 (Shook & Marian, 2013; Mishra & Singh, 2016). The difference between the phono-lexical and the ortho-lexical levels is that, in the former, words' syllabic structures are analyzed (i.e., consonant-vowel-consonant or CVC) while in the latter the orthographic particularities of each language are analyzed and distinguished (e.g., *photo* in English, although the pronunciation of *photo* is similar in Spanish it has a different orthography, *foto*). The relation between these levels is that phonological access is more evident when presenting a written word (Huettig & McQueen, 2007). So, it is assumed that after the spoken word is perceived a visual preference for the cohort competitor (i.e., the word with phonological and orthographic similarity) would be shown by L2 learners due to the proficiency acquired in the L2. Nevertheless, if a visual preference for another competitor such as the semantic competitor is revealed then this could reveal that phonological information does not become active when written words are presented to L2 learners**.** Therefore, it was predicted that Experiment 4, that is, the presentation of written words in the L2, would promote a larger visual preference for the phonological information over the semantic and shape information by L2 learners.

Stimuli. Stimuli were the same as the ones described in Experiment 3.

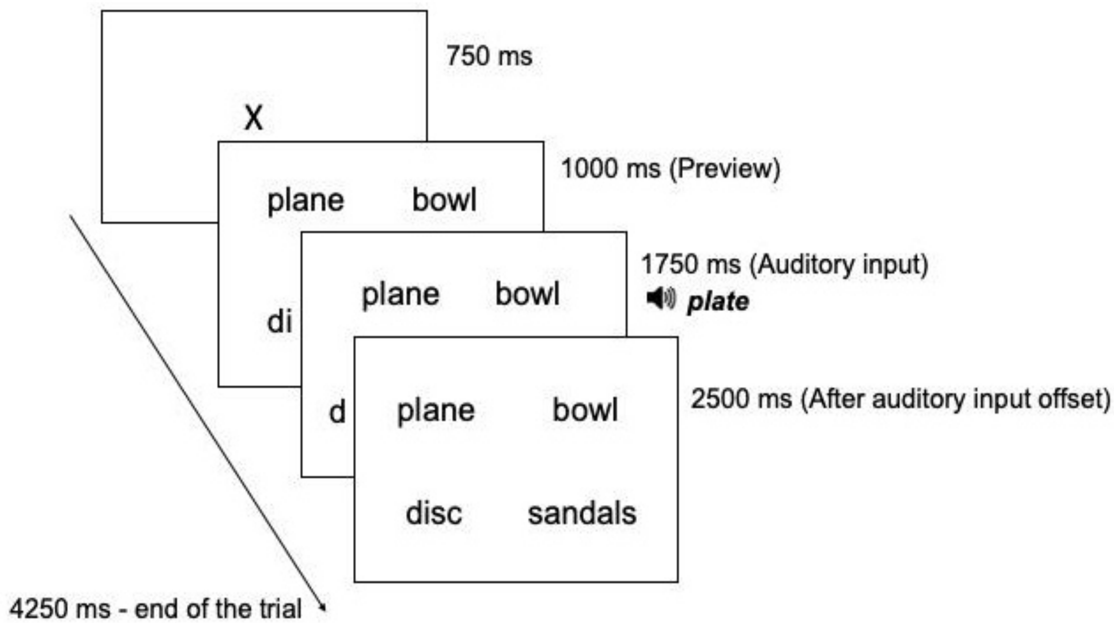
Visual stimuli. Written words (names of the objects) were displayed on the screen instead of images as in Experiment 3. These words had a size of 20 in Arial Lowercase font (Huettig & McQueen, 2007) and were fixated in a quadrant. The spoken word was not included in the presentation of these words. The positions of the images were randomized and counterbalanced in every trial.

Auditory stimuli. These were the same as detailed in Experiment 3.

Experimental design. The experimental design is similar to Experiment 3 and Figure 8 shows an example of a trial and its temporal distribution.

Figure 8

Example of the temporal distribution of each trial of Experiment 4



General Procedure

Four sequences were created to counterbalance the modality (images and written words) of each Experiment. Trials of each Experiment were randomized to avoid learning strategies from participants; that is, each sequence included the four experiments of the current dissertation and stimuli were displayed the same number of times during the presentation of these sequences. A total of 112 trials (72 trials of interest and 40 fillers) in each sequence were presented as follows:

Sequence A: Experiment 1, Experiment 2, Experiment 3, and Experiment 4

Sequence B: Experiment 2, Experiment 1, Experiment 4, and Experiment 3

Sequence C: Experiment 3, Experiment 4, Experiment 1, and Experiment 2

Sequence D: Experiment 4, Experiment 3, Experiment 2, and Experiment 1

A pool of L2 learners that were enrolled in English courses at ENALLT received an electronic invitation via email to participate in this study. The message contained the Informed consent to participate in the research, which was attached as a Word document (Appendix B). This document explained the technical requirements for the visual preference task with RealEye. L2 learners sent by mail the Informed consent with digital signatures as an agreement to participate in the study. Once the Informed consent was received, the researcher replied with a message that included a video that was used as an example of the visual preference task so participants could have a better idea of the task, a test taking guide in a pdf document, so participants could read this guide before taking the visual preference task (see Appendix K), and the link to start the visual preference task. Each participant was randomly assigned to a sequence (A, B, C, or D) so each participant saw only one sequence with the four experiments. The Experiment participants were assigned to was decided before delivering the link emitted by the RealEye platform to them; this link directed participants to the visual preference task.

Once the participants introduced the link in the Chrome browser and pressed the Enter button, the RealEye platform asked to provide access to the webcam so the calibration of eye movements could start. The calibration included five points that were presented on four corners and a fixation point in the center of the screen. This calibration's aim was to correctly detect participants' eyes movements. If the calibration was not achieved, a RealEye window with recommendations was displayed; those recommendations included sitting closer to the webcam, finding an illuminated spot, and, when ready, starting the calibration again. Once the calibration was achieved, the visual preference task started. Instructions for the task were given in Spanish, and participants only had to look at the screen (e.g., *Gracias por participar. Ahora comenzará el video. Siéntate cómodo, utiliza audífonos, apoya tu cabeza para que no la muevas y asegúrate de tener buena iluminación, por favo*r. [Thanks for your participation. The video will start now. Sit comfortably, use headphones, rest your head so you avoid any movement and make sure to have good lighting, please.]). When they finished the task, participants were directed automatically to the Google Form: https://forms.gle/F7mWoUwLQHnj6Esa7, which had the remaining tests displayed in the following order: the Language Experience Questionnaire and the LexTALE. Once participants finished these tests in the Google Form, they could see the results in the Google Form section “Answers”, or, if participants required personalized answers, the researcher delivered an email with the feedback of the LexTALE responses. The total duration of the visual preference task, the Language Experience Questionnaire and the LexTALE was approximately 25 minutes.

Measurement of the visual preference task

Visual preference is a non-invasive technique accepted by diverse authors to explore lexical access and its processing (Weber & Cutler 2004; Yee & Sedivy, 2006; Huettig & McQueen, 2007; Mishra & Singh, 2016; Huettig et al., 2011b; Canseco-Gonzalez et al., 2010). Likewise, this technique provides data with ecological validity; that is, it resembles the way visual and auditory input are perceived in a real-life situation (Huettig et al., 2011b). Generally, in visual preference studies, the visual stimuli displayed is delimited by an area of interest, which establishes the limits of analysis of the looking fixation points or the gaze trajectory when visual stimuli are displayed on a screen. In each Experiment the areas of interest were defined from the size of each visual stimuli (720 x 540 pixels).

The visual preference measures that were considered for this dissertation are:

1. *Proportion of total looking time* (*PTL*). This measurement provides a participant’s percentage of attention toward the stimulus of interest while other stimuli are displayed simultaneously. The formula to obtain this proportion is: [P+Sh+S+D]/T, where (P) is the total time of attention to the phonological competitor plus (Sh) the total time of attention to the shape competitor plus (S) the total time of attention to the semantic competitor plus (D) the total time of attention to the distractor divided by (T) the total sum of the particular competitor-and distractor-fixation proportions (Huettig & McQueen, 2007).

2. *Looking time-course (LTC)* was considered as a supplementary measurement. This measurement reveals the time-course of the attention toward the competitors *vs.* the distractor stimuli during a trial. Therefore, multiple temporal measures of the fixation of looks to visual stimuli is calculated (LTC: C/[C1+C2+C3+D], where C is each competitor and D is the distractor). The proportion of looks to the three competitors and to the distractor were calculated every 100 ms (Huettig & McQueen, 2007).

A customized software to observe data from the RealEye platform was created by two members of the Psycholinguistics Lab under the name of PsyGaze. This program processes the raw gazes recorded in CSV files from RealEye and provides an Excel document to facilitate data processing. This Excel document shows different measures such as: Total Time of Looking, Proportion of Total Looking Time, Longest Look to stimuli, among others. Further details about the data treatment obtained through PsyGaze are described below in the Data treatment criteria for the visual preference task section.

Results

The main objective of the current research was to describe L2 learners' lexical access to the phonological, semantic and shape information of words through the images and written words modalities. The first part of this section shows the results obtained in the visual preference task, and the second part, displays the results of the Language Experience Questionnaire to explore the language practices that participants perform concerning the use of English as an L2 outside the language classroom.

The Visual Preference Task

Data treatment criteria for the visual preference task

As mentioned earlier in the Sample section, 71 participants completed the visual preference task. A total of 33,744 trials were obtained, so filler trials were removed first (n = 16,361). A preliminary observation of the data indicated irregularities in the temporality of the trials, thus, we decided to perform a frame inspection to corroborate the temporality of each trial presented in each Experiment with Adobe Premiere Pro (www.adobe.com). Each trial should have lasted 128 frames, which means that the total time of each trial should have been 0:05:03ms. Accordingly, we detected 50 trials that were above or below 1SD from the frames and timing duration, so we decided to remove those trials (*n* = 4,677) from the databases to avoid temporality problems in the analyses. Later, we scanned the databases to explore data loss due to technical faults and we removed participants with more than 20% of trials with data loss (*n* = 11,698), so 8 participants were deleted from the databases. Then, our database included 1008 trials for the final analyses with 63 participants. The final sample of participants that were included in the analyses of the visual preference task is described in Table 3**.** In addition, Appendix L shows a balanced distribution of the trials in the four experiments for the statistical analyses.

Table 3

Demographics of participants included in the visual preference task analyses

	Mean (SD)	*Range*	*SE*
Age	21.76 (2.4)	19-31	.308
AoA L2	10.97 (4.9)	2-23	.623
L2-Years of exposure	10.79 (4.6)	1-21	.588
LexTALE	63.77 (6.9)	50-76	.871

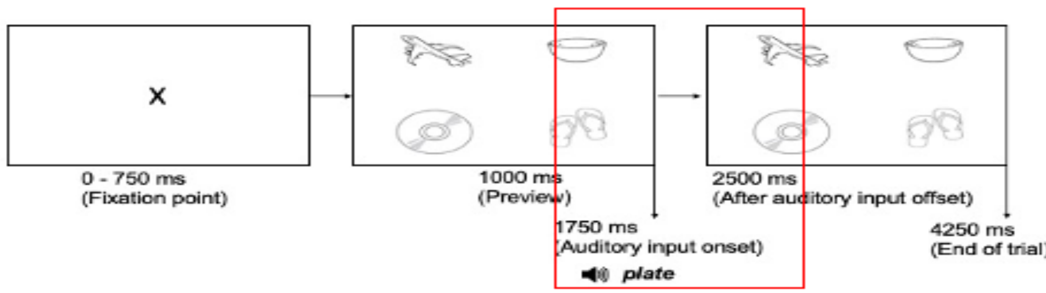
Note: n = 63 (46 female). AoA L2 = Age of Acquisition of the L2.

Time-windows analyses

Figure 9 shows the temporality in the time-windows analyses (red square) to observe the proportion of looks to competitors performed by participants. The Proportion of Total Looking (PTL) time is a measure commonly used in visual preference studies to describe the proportion of time that participants observed a stimulus while other stimuli were presented simultaneously. PTL of the four experiments is displayed in eighteen-time-windows, each of 100 ms, in the following order: two-time windows show the preview phase before the onset of the spoken word (-100, and -200 ms), the third time-window is the onset of the spoken word, which is indicated with 0 ms, and the following fifteen time-windows display the PTL to the objects/written words after the onset of the spoken word. These fifteen time-windows that follow the onset of the spoken word are subdivided into two windows for statistical analyses purposes as it will be explained in the lines below, that is, Window 1 shows the results from the onset of the spoken word until 800 ms, and Window 2 displays from 800 until 1500 ms.

Figure 9

Temporality of the time-windows analyses



Additionally, since the data averaged from the time-windows did not meet a normal distribution according to the Kolmogorov-Smirnov normality test (see Appendix M), a Wilcoxon signed-ranks test for repeated measures was performed (see the results in Appendix N). This Wilcoxon test was used to assess the time course of the visual preference for competitors with a hypothesized value of .25 due to the chance level with the four objects/written words displayed on screen, that is, the chance level for a visual preference for a competitor is 1 out 4 in a time-window, then, values above .25 represent a higher PTL to a competitor. Results with statistical significance are indicated with an asterisk (*) in each graph.

Experiment 1. Lexical access in the L1, Images modality

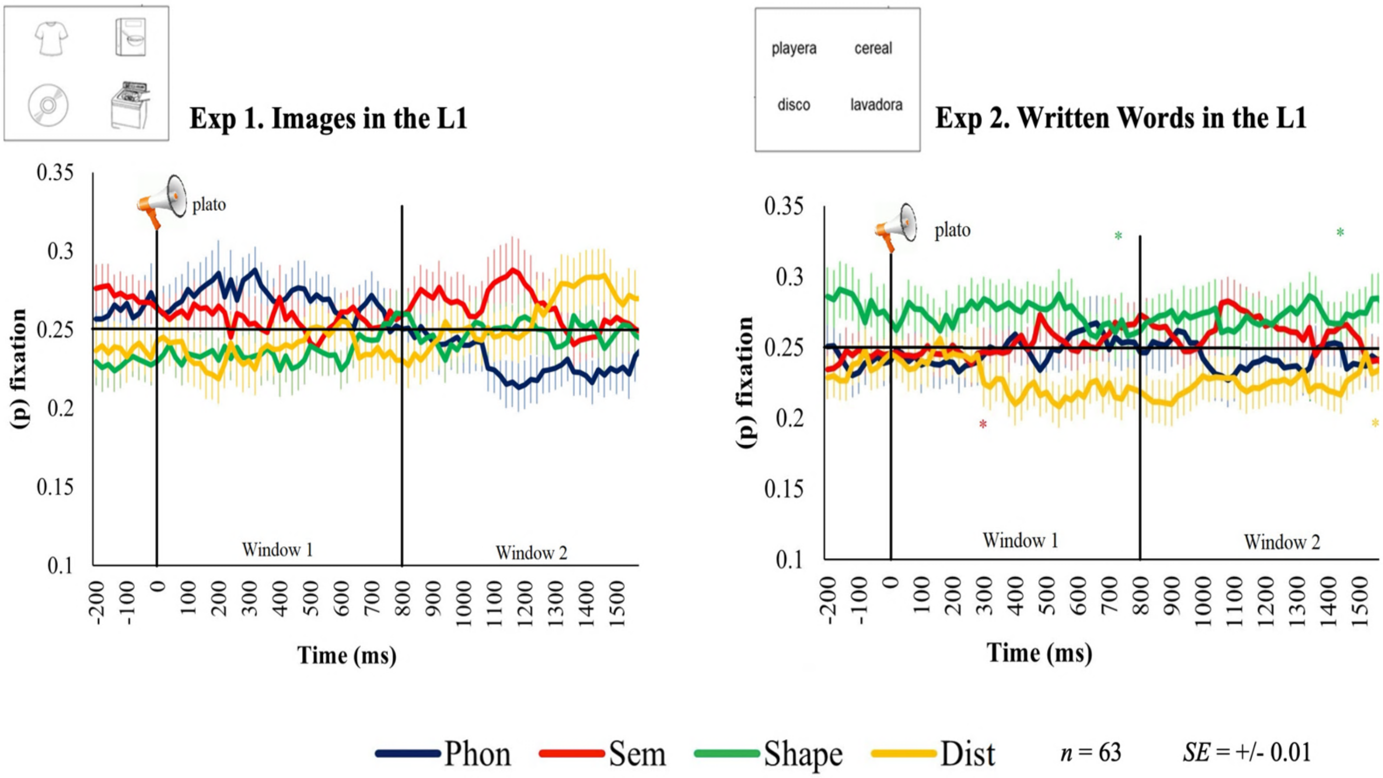
Figure 10 shows that Experiment 1 elicits a visual preference for the phonological competitors above chance after the onset of the spoken word, when images related to a word in the L1 (Spanish), were presented. That is, participants showed a visual preference for the image of a t-shirt (*playera* in Spanish) when the spoken word *plato* was heard and a statistically significant result toward this competitor was found 300 ms after the onset of the spoken word. Also, the phonological competitor revealed that below chance in two time-windows was statistically significant (i.e., 1200 ms, and 1400 ms). These results provide evidence to support the hypothesis of Experiment 1 where the presentation of images in the L1 appears to promote a larger visual preference for phonological information over semantic and shape information by L2 learners.

Experiment 2. Lexical access in the L1, Written Words modality

Figure 10 exhibits that Experiment 2 activates a visual preference from participants toward the shape competitors when written words related to a word in the L1 (Spanish) were presented. So, when the spoken word *plato* was heard a visual preference for the written word *disco* was revealed. Two statistically significant results of the visual preference for the shape competitors were found at 700 ms and 1400 ms. These results demonstrate that the hypothesis of Experiment 2 of the current dissertation must be rejected since larger attention to the shape competitor was observed instead of to the phonological competitor.

Figure 10

Time-windows results for Experiments 1 and 2



Note: PTL for competitors is displayed on the y-axis; time windows are displayed on the x-axis. The onset of the spoken word is at 0 ms. Phon: phonological competitor (blue), Sem: semantic competitor (red), Shape: Shape competitor (green), and Dist: Distractor (yellow). The horizontal line indicates chance level, that is, competitors above this horizontal line attracted more looks. Below this line, looks at stimuli were random. Statistically significant results, according to the Wilcoxon signed-rank test for repeated measures are indicated = *$p \leq .05$. SE= Standard Error: 0.01. $N = 63$.

Experiment 3. Lexical access in the L2, Images modality

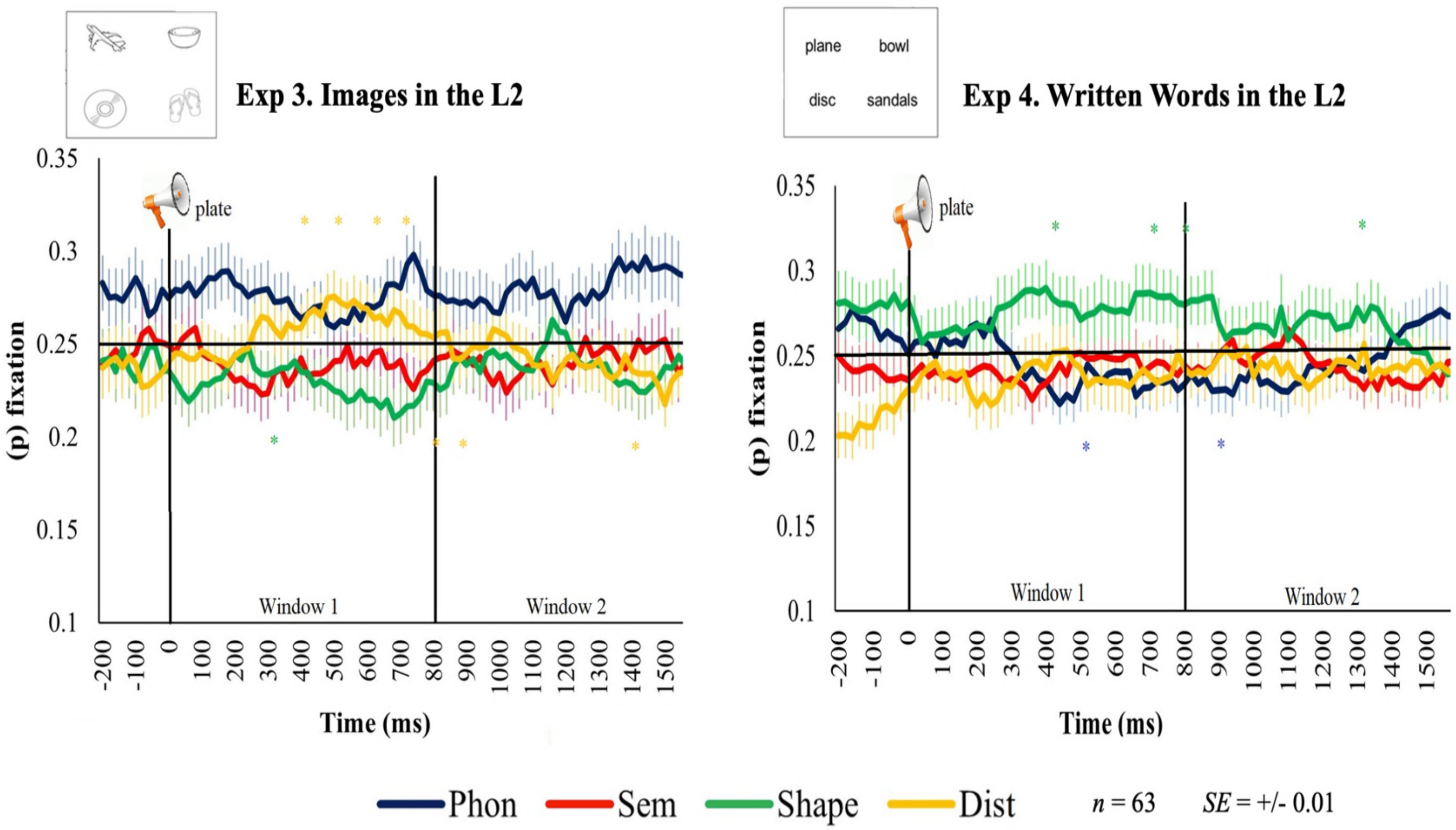
We can observe in Figure 11 that, in Experiment 3, after the onset of the spoken word *plate* in the L2, the phonological competitors, such as *plane*, attracted more looks from participants while the other competitors showed no effect of fixations after the onset of the spoken words. This visual preference was sustained until the end of Window 2. Nevertheless, the distractors attracted looks above chance and statistically significant results were revealed in Window 1 above chance, but in Window 2 three statistically significant results were observed, which might suggest an inhibition effect toward the distractors in this Window. These results provide evidence to accept the main hypothesis of the current dissertation and the specific hypothesis of Experiment 3, where a larger visual preference for the phonological competitor was expected.

Experiment 4: Lexical access in the L2, Written Words modality

In Figure 11, we can observe that, in Experiment 4, shape competitors attracted more looks. That is, after the onset of the spoken word *plato*, the written word *disc* revealed a visual preference from participants, and statistically significant results were observed in Window 1 and in Window 2. In addition, the phonological competitors revealed statistically significant results below chance, which might suggest an inhibition effect toward these competitors in the Written Words modality in the L2. These results appear to suggest that there is a different access to lexical information between the participants in the Huettig and McQueen (2007) study and the L2 learners of English of the current study. These results demonstrate that the main hypothesis of the current dissertation and the specific hypothesis of Experiment 4 must be rejected since larger attention to the shape competitor was observed instead of to the phonological competitor. Lastly, in Figure 12, we can observe the four experiments and the differences in the lexical access in each experiment.

Figure 11

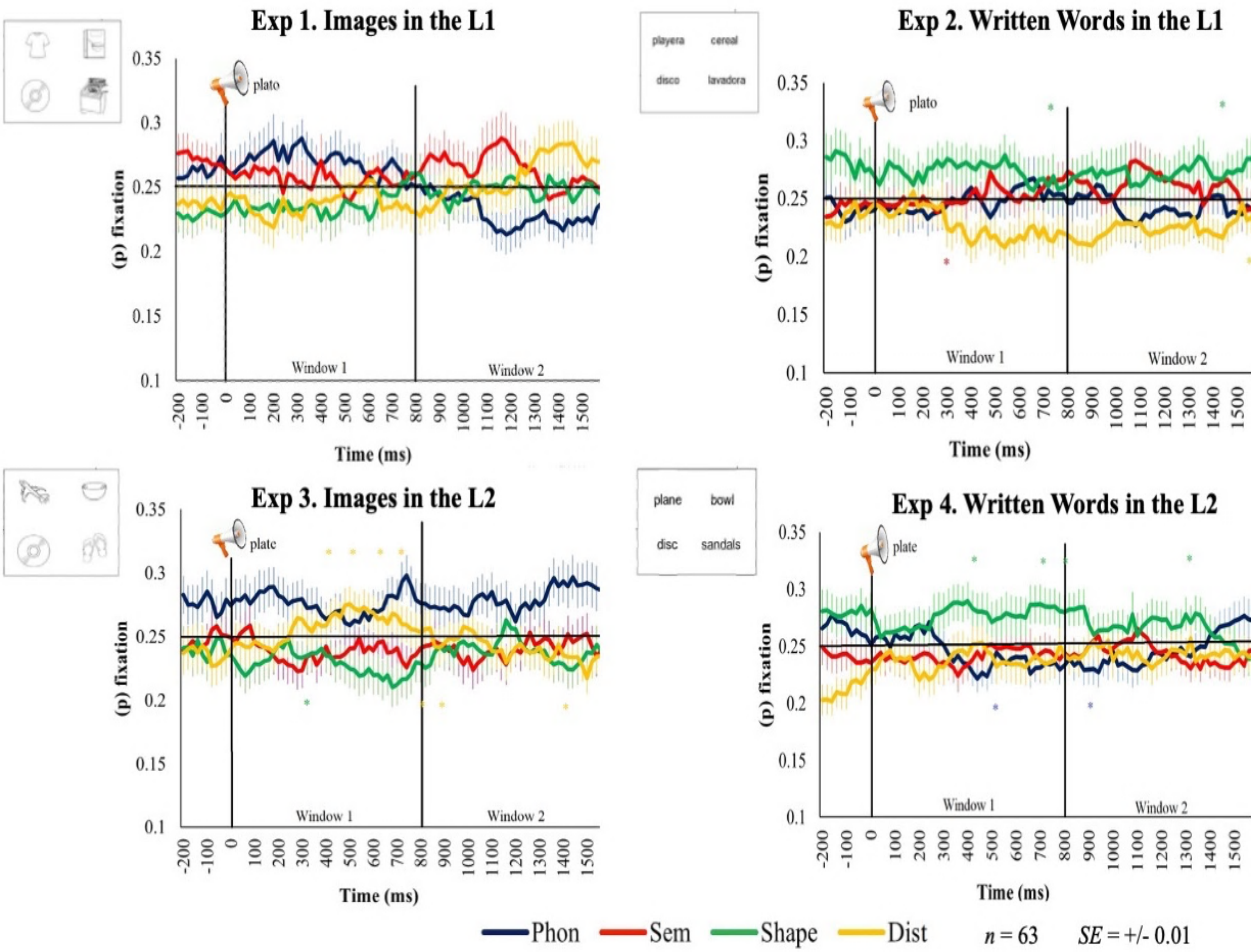
Time-windows results for Experiments 3 and 4



Note: PTL for competitors is displayed on the y-axis; time windows are displayed on the x-axis. The onset of the spoken word is at 0 ms. Phon: phonological competitor (blue), Sem: semantic competitor (red), Shape: Shape competitor (green), and Dist: Distractor (yellow). The horizontal line indicates chance level, that is, competitors above this horizontal line attracted more looks. Below this line, looks at stimuli were random. Statistically significant results, according to the Wilcoxon signed-rank test for repeated measures are indicated = **p* ≤ .05. SE= Standard Error: 0.01. *N* = 63.

Figure 12

Time-windows results for the four experiments



Note: PTL for competitors is displayed on the y-axis; time windows are displayed on the x-axis. The onset of the spoken word is at 0 ms. Phon: phonological competitor (blue), Sem: semantic competitor (red), Shape: Shape competitor (green), and Dist: Distractor (yellow). The horizontal line indicates chance level, that is, competitors above this horizontal line attracted more looks. Below this line, looks at stimuli were random. Statistically significant results, according to the Wilcoxon signed-rank test for repeated measures are indicated = *$p \leq .05$. SE= Standard Error: 0.01. $N = 63$.

Additionally, it was explored if there were differences between participants according to their L2 proficiency: low-intermediate (*n* =17) and upper-intermediate (*n* = 46). These results showed similar patterns to the ones presented in Figure 12 in the four experiments, where a larger visual preference for the phonological competitor in Experiments 1 and 3 was observed. Meanwhile, in Experiments 3 and 4 a larger visual preference for the shape competitor was revealed (see Appendix O for further details).

To confirm if L2 proficiency had an effect on the lexical processing observed in the four experiments we performed Mixed-effects analyses.

Mixed effects analyses

To explore the relationship between the variables of interest of this research, a mixed effects analysis was carried out and the following were included as fixed factors: type of competitor (phonological, semantic, shape and distractor), type of experiment (Images *vs*. Written Words), type of language (Spanish *vs*. English), and L2 proficiency. We considered as random effects the within-subjects interaction and the average of PTL in each time-window, where .25 indicates a higher probability of fixation toward a competitor. Then, the PLT was considered as the dependent variable for these models and two temporal windows (1 and 2). Data were analyzed using R version 4.2.0 (R Core Team, 2022) with the glmmPQL package. Time-windows were divided to observe if there were differences regarding the temporality of the lexical access, then, Window 1 includes from 0 ms (the onset of the spoken word) to 800 ms after the onset of the spoken word. Window 2 includes from 801 to 1500 ms. The main results showed that Window 2 (800-1500 ms) provided a statistically significant interaction in Experiment 3 (Images in the L2), where L2 proficiency modulated the lexical access toward the phonological competitor over the semantic and shape competitors. Further details are explained below.

Window 1

In Window 1 (0-800 ms), no interaction was observed between the type of competitor, type of experiment, and L2 proficiency (β = -0.085, SE = 0.238, z = 0.312, p = 0.071). More specifically, type of competitor, type of experiment (Images), type of language (Spanish), and L2 proficiency were contrasted, and no statistical differences were observed between the phonological competitor and the distractor ($t(52) = 3.051$, $p = 0.201$), or between the semantic competitor and the distractor ($t(57) = 2.163$, $p = 0.0751$), nor between the shape competitor and the distractor ($t(55) = 2.224$, $p = 0.0701$).

Additionally, type of competitor, type of experiment (Images), type of language (English), and L2 proficiency were contrasted and no statistical differences were observed between the phonological competitor and the distractor ($t(56) = 2.346$, $p = 0.0875$), or between the semantic competitor and the distractor ($t(51) = 3.154$, $p = 0.0842$), nor between the shape competitor and the distractor ($t(51) = 1.987$, $p = 0.0897$).

When types of experiments (Exp. 2-Written Words in the L1 and Exp.3- Written Words in the L2) were contrasted, no interaction was found between type of competitor, type of language, and L2 proficiency ($\beta = -0.0821$, SE = 0.3213, $z = 0.285$, $p = 0.087$). Moreover, Experiment 2-Written Words in the L1, revealed no differences between the phonological competitor and the distractor ($t(58) = 2.854$, $p = 0.0754$), or between the semantic competitor and the distractor ($t(55) = 3.155$, $p = 0.0911$), nor the shape competitor and the distractor ($t(52) = 2.148$, $p = 0.0874$). Similarly, no differences were found in the Experiment 4-Written Words in the L2, between the phonological competitor and the distractor ($t(52) = 2.313$, $p = 0.0749$), or between the semantic competitor and the distractor ($t(51) = 1.987$, $p = 0.0936$), however, a statistically significant difference between the shape competitor and the distractor was found ($t(52) = 2.145$, $p = 0.0415$).

Window 2

In Window 2 (801-1500 ms), a statistically significant interaction was observed between Experiments 1 and 3 (Images in the L1 and in the L2, respectively), L2 proficiency and type of competitor ($\beta = -0.0798$, SE = 0.215, $z = 0.187$, $p = 0.0451$). More specifically, in Experiment 3-Images in the L2, revealed a statistically significant difference between the phonological competitor and the distractor ($t(58) = 1.961$, $p = 0.0454$), but no differences were observed between the semantic competitor and the distractor ($t(57) = 2.876$, $p = 0.0736$) or between the shape competitor and the distractor ($t(55) = 2.321$, $p = 0.0658$). In contrast, in Experiment 1-Images in the L1, no significant differences were observed between the phonological competitor and the distractor ($t(54) = 1.985$, $p = 0.0641$), or between the semantic competitor and the distractor ($t(55) = 2.143$, $p = 0.0874$), nor between the shape competitor and the distractor ($t(52) = 2.214$, $p = 0.0893$). These results provide robust evidence to accept the specific hypothesis of Experiment 3 and the main hypothesis of the current dissertation, where L2 proficiency has an effect toward the lexical access of words in the L2, specifically, the activation of phonological information in the L2.

In addition, no interaction was observed between L2 proficiency, type of experiment Experiments 2 and 4 (Written Words in the L1 and in the L2, respectively) and type of competitor ($\beta = -0.0754$, SE = 0.142, $z = 0.147$, $p = 0.077$). For Experiment 2-Written Words in the L1, no differences were found between the phonological competitor and the distractor ($t(54) = 1.954$, $p = 0.0821$), or between the semantic competitor and the distractor ($t(55) = 2.955$, $p = 0.0816$), nor between the shape competitor and the distractor ($t(52) = 3.248$, $p = 0.0874$). Similarly, no differences were found between the phonological competitor and the distractor ($t(54) = 0.813$, $p = 0.0631$), or between the semantic competitor and the distractor ($t(52) = 2.102$, $p = 0.0841$), nor between the shape competitor and the distractor ($t(50) = 2.301$, $p = 0.0705$). No other interactions were found.

Language Experience Questionnaire (English language use)[1]

As mentioned before in the Materials and Instruments section, this was a tailor-made instrument since we intended to find evidence using items from instruments with a theoretical background of the L2, such as the ones in the BLP and in the LHQ3. The data analyses for the Language

[1] The results of this section are reported in a manuscript in the journal *Lenguaje 51*(2), to be published in July 2023.

Experience Questionnaire included 71 participants (53 female), some of which were excluded from the eye-tracking analysis (*n* =63; see the Visual Preference Task section for further details). Participants' mean chronological age was *M* = 21.6 (*SD* = 2.4, range = 18-31), the mean age of acquisition of English was *M* = 11 years-old (*SD* = 4.8, range = 2-23). Participants' mean English proficiency, according to their score of the LexTALE test, was *M* = 63.3 (*SD* =7.0, range= 48-76), revealing that, on average, these participants showed an upper-intermediate level of proficiency of English. Twenty-six students reported that they had studied a third language, and only two of them had studied it for more than 3 years approximately. Additionally, none of the students reported having had an immersion experience in an English-speaking country for more than a month.

Analyses were performed with the Statistical Package for the Social Sciences Statistics, version 25 (IBM Corp., 2017). There were no missing values in the data since the Google Forms answers were set as required. This section focuses only on **10** questions that inquired about participants' English use (questions 12 to 21 from Appendix D, however for further details about participants' responses see Appendix P).

The current analyses aimed to explore which language practices are important for learners of English outside the classroom to know if those language practices relate to the improvement of their proficiency in the L2. Therefore, two types of analyses were performed to find evidence about the language practices that are performed by the L2 learners, with the adapted questionnaire. The first part of the results shows the analysis carried out with an Exploratory Factorial Analysis with the overall sample to observe if the questionnaire could show reliable results. The second part displays a Multiple Regression Analysis to explore which language practices could predict higher proficiency scores in the L2.

First, the internal consistency of this adapted questionnaire was analyzed to assess the factors (language practices) performed by L2 learners that could explain an improvement in their proficiency. As detailed earlier, this adapted questionnaire integrated five different sections (components); four of which related to the language practices in areas such as 1. Writing, 2. Reading, 3. Listening, and 4. Oral practice. Section 5 was a Self-assessment regarding performance in the four language areas. These five components offered different possibilities of when the L2 learners could perform the language practices (e.g., *Estimate how many hours a week you write in English the following type of texts: messages on social media, messages on WhatsApp, e-mail messages, personal diary, and assignments from school*). In total, 23 items were presented to participants, and these items were analyzed with a Cronbach's alpha to explore the internal consistency of the Language Experience Questionnaire; this measure revealed an alpha of α=.81, which indicates a high reliability (Cronbach, 1951) for this questionnaire. This result evidenced that the instrument could provide reliable participant information and assess the correlations among items.

A Cronbach's alpha was performed for each of the five components to explore the reliability and internal consistency of each component that integrated this questionnaire. Thus, three components (n = 15 items) showed an acceptable reliability (see Table 4 for further details) with an overall Cronbach's alpha of α= .81, so these three components (Writing Practice, Reading Practice, and Listening Practice) were highly reliable to continue with the analyses. Later, these three components, which shared the same type of responses (e.g., a) 0 to 7 hours a week; b) 8 to 15 hours a week, and c) more than 16 hours a week) were introduced into an Exploratory Factor Analysis (EFA). This EFA helped to observe which questionnaire components described best the L2 learners' language practices outside the classroom.

Subsequently, an EFA was conducted with an extraction of the Principal Components Analysis with Varimax rotation with Kaiser normalization, and absolute values below .40 were discarded (de Winter et al., 2009; Aráuz, 2015).

Table 4
Cronbach's alfa reliability measures, means and standard deviations for the Language Experience Questionnaire components

Component	Number of items	Initial Cronbach's alpha	*Mean*	*SD*
1. Writing practice (WP) (Estimate the hours you write documents in English [e.g., personal diaries])	6	**.65**	6.75	1.23
2. Reading practice (RP) (Estimate the hours you read material in English [e.g., social media])	5	**.62**	6.79	1.7
3. Listening practice (LP) (Estimate the hours you listen to material in English [e.g., music])	4	**.70**	6.62	1.7
4. Oral practice (OP) (Estimate the hours you speak in English [e.g., with friends])	4*	.40	3.56	.806
5. Self-assessment performance of these skills (SC) (e.g., Estimate how comfortable you feel when talking to others in English)	4	.53	10.56	1.84

Note: *An item from the OP component was deleted since the Matrix of Covariance revealed a zero score: Estimate the hours you speak in English [e.g., with family], therefore, only 3 items were considered for analyses. Values in bold indicate an acceptable reliability according to Cronbach's alpha.

The results of the first EFA model, indicated that the Keiser-Meyer-Olkin (KMO) test, which describes the proportion of variance among variables, postulates that values between 0.8 and 1 indicate an adequate sampling. In the current results, the KMO obtained was .71, which is a moderate value (Spicer, 2005). In addition, Bartlett's test of sphericity, which indicates the correlation between the variables, was significant ($X^2(105) = 450.59$, $p < 0.001$) with a variance of 70.75% within the first five components. Nevertheless, a closer look at the Anti-Image Matrix, the Communalities, and the Rotated Component Matrix, provided additional information of whether the evaluated items fit adequately into the model. In the Anti-Image Matrix, 2 items with correlations below .600 were detected, those items were not suitable for the factor analysis since values above .600 denote a stronger correlation with the other items (de Winter et al., 2009). In the Communalities table, 2 items, with values below .40 were detected, which indicated that these items would not contribute strongly to the model due to the proportions of the variance provided by the other components. Finally, in the Rotated Component Matrix three items with loadings below .600 were found, and these low loadings could provide a false imprecision of the items' consistency (Aráuz, 2015). So, these confounding items (n = 7) were eliminated.

A new EFA was performed again without those 7 items and the same criteria to perform the EFA were applied as detailed above. A KMO of .68 was obtained, and a significant Bartlett sphericity test ($X^2(28) = 191.73$, $p < 0.001$) with 57% of variance within the first two components. Values in the Anti-Image Matrix were above .600. The Communalities showed two items below .500, and one of these items was correspondingly identified in the Rotated Component Matrix without loadings. Then, these two items were deleted for the following EFA with the remaining 6 items. The final EFA revealed a KMO of .65 and a significant Bartlett sphericity test ($X^2 = 160.55$, df = 15, $p < 0.001$) with 70% of variance within the first two components. Table 4 shows the components and loadings obtained in the Rotated Component Matrix for the final EFA.

These results suggest the results obtained in the final EFA should be interpreted with caution due to the moderate values from the KMO (Spicer, 2005) and no generalization of these results should be assumed. Nevertheless, this first part of the results provided an insight for the following analyses. Then, as it can be observed in Table 5, the final EFA revealed two components related to the language practices of English as an L2: one is related to academic activities (ACA) and the second one to spare time activities (SPA). A final Cronbach's alpha analysis was performed to observe if these two components were reliable for the following analyses. Then, with only these two components (n = 6) an alpha of α= .77 was obtained, which indicated an acceptable reliability (Cronbach, 1951) for these components for further analyses. The first component (ACA) includes RP and LP activities while the second one (SPA) includes

WR and LP, so the results obtained with the final EFA shed light on the language practices that could be considered in the Multiple Regression Analysis to provide information on which predictor had a main effect on the L2 proficiency of this sample.

Table 5
Final EFA Rotated Component Matrix

Final Components	Component		Communalities		
	1	2	Initial	Extracted	Anti-image correlation
RP-ACA-1. Estimate how many hours a week you read in English the following type of text [Academic textbooks]	0.907		1.000	0.736	.606[a]
RP-ACA-2. Estimate how many hours a week you read in English the following type of text [Academic or specialized papers]	0.897		1.000	0.480	.636[a]
LP-ACA-3. Estimate how many hours a week you listen to material in English related to your field of study [Videos in YouTube]	0.704		1.000	0.814	.810[a]
WR-SPA-1. Estimate how many hours a week you write in English [E-mail messages]		0.841	1.000	0.835	.677[a]
LP-SPA-2. Estimate how many hours a week you listen to material in English [Podcasts of different topics]		0.815	1.000	0.706	.633[a]
LP-SPA-3. Estimate how many hours a week you listen to material in English [Movies]		0.688	1.000	0.625	.602[a]
Eigenvalues	2.91	1.28	-	-	-
% of variance	48.51	21.41	-	-	-

Note: The extraction method was made with the Principal Component Analysis, and the rotation method was made with Varimax with the Keiser normalization. The rotation converged in three iterations. [a] Measures of sampling adequacy (MSA). ACA: Academic activities. SPA: Spare time activities.

The two components obtained from the final EFA (see Table 5) were integrated by six items that shared the same type of responses, so no standardization of these responses was needed to run the regression analysis. Instead, the participants' responses for each item were summarized to create two new variables; that is, the three items from the Academic activities (ACA) component were summarized and a new variable called "ACA_summ" was created in the database. Similarly, the participants' responses to the items from the Spare time activities (SPA) component were summarized and a new variable was created (see Table 5 for further information). These two new variables (ACA_summ and SPA_summ) were introduced with the Enter method as predictors into the regression analysis where proficiency was the dependent variable. The results indicated that the two predictors explained only .097% of the variance ($F(2,68) = 3.66$, $p < .0.03$, $R^2 =.097$, $R^2_{adjusted} =0.07$). In addition, it was found that these predictors lacked statistical significance by the regression coefficient (ACA, β =.82, t (68) = 1.50, B =.189, 95% CI [-0-266-1.91], p=n.s.; SPA, β =1.190, t (68) = 1.48, B = .186, 95% CI [-0.410-2.790], p=n.s.). Even though the model was statistically significant, these results were not clear evidence of the effect of these components had on language proficiency. Then, it was decided to have a closer look at the interaction of the ACA and SPA variables including variables such as chronological age, gender, and age of acquisition of English. Then, a multiple regression with the Enter method with the variables ACA_summ, SPA_summ, chronological age, gender, and age of acquisition of English as predictors of the language proficiency, as the dependent variable, was conducted. The results demonstrated that these predictors explained 23% of the variance ($F(5,65) = 3.93$, $p < .0.004$, $R^2 =.232$, $R^2_{adjusted} =.173$). In addition, it was found that the only predictors with statistical significance by the regression coefficient were SPA_summ and chronological age (SPA_summ, β = 2.04, t (65) = 2.45, B =.316, 95% CI [.379-3.70], p=.017; chronological age, β =1.14, t (65) = 3.11, B = .383, 95% CI [0.401-1.82], p=.003); therefore, age of acquisition of English and gender of participants did not contribute to the model. These results demonstrated that the SPA component provided an important effect on language proficiency.

Subsequently, a multiple regression model was performed with the Enter method to examine whether the predictors: chronological age and the three items from the SPA component (see Table 6 for further details) provided information as potential predictors for language proficiency in the L2. This model explained 20% of the variance (F(4,66) = 4.32, p < .0.004, R^2 =.208, $R^2_{adjusted}$ =.160). It was found that the only predictors with statistical significance by the regression coefficient were chronological age and LP-SPA-3 (chronological age, β = 1.10, t (66) = 3.83, B =.380, 95% CI [.453-1.76], p=.001.; LP-SPA-3, β =2.71, t (66) = 2.00, B = .41, 95% CI [0.016-5.48], p=.049).

Table 6
Mean, standard deviations and correlations of the variables introduced in the regression analyses

Variable	*Mean*	*DS*	*r*
LexTALE score-L2 proficiency	63.36	7.06	--
Age of acquisition of English	11.07	4.85	**-0.31***
Gender	1.25	0.43	0.124
Chronological age	21.62	2.42	**0.312****
ACA_summ	4.42	1.61	**0.261***
SPA_summ	4.01	1.10	**0.259***
RP-ACA-1. Estimate how many hours a week you read in English the following type of text [Academic textbooks]	1.44	0.62	**0.256***
RP-ACA-2. Estimate how many hours a week you read in English the following type of text [Academic or specialized papers]	1.49	0.60	**0.232***
LP-ACA-3. Estimate how many hours a week you listen to material in English related to your field of study [Videos in YouTube]	1.49	0.65	0.185
WR-SPA-1. Estimate how many hours a week you write in English [E-mail messages]	1.11	0.36	0.173
LP-SPA-2. Estimate how many hours a week you listen to material in English [Podcasts of different topics]	1.15	0.40	0.180
LP-SPA-3. Estimate how many hours a week you listen to material in English [Movies]	1.75	0.62	**0.241***

Note: Correlations with the LexTALE score (*r*). * Correlations were significant at the p < .05 level and ** at the p < .001 level.

The last model provided evidence on the main factors related to language practices and language proficiency. That is, the chronological age and the language practice of watching movies were both indicators that promoted a higher score in the LexTALE test. The following part of the results examines if higher proficiency in the L2 learners is explained by variables of chronological age and the frequency of watching movies in English (LP-SPA-3).

LexTALE test

As previously explained in the Instruments and Material section, this test provides information about the proficiency of English according to the percentage of correct responses divided in three levels: advanced level (80-100), upper-intermediate level (60-79) and beginner level (less than 59). Table 7 shows the results of the participants' L2 proficiency.

Table 7
LexTALE score

Level of proficiency in English	Frequency (%)	Range
1. Beginner-lower-intermediate level	21 (30)	48-59
2. Upper-intermediate level	50 (70)	60-78

Note: n = 71

As it can be observed in Table 7, 50 participants were identified in the upper-intermediate level of English, therefore, these participants were considered to have a higher proficiency in the L2 while 21 participants were identified within a beginner-lower-intermediate level, indicating a lower proficiency in the L2. Then, a multiple regression model was carried out with the Enter method to survey if chronological age and LP-SPA-3 variables would predict a high English proficiency of within the sample. Then, L2 learners with scores from 60 and above in the LexTALE score variable were selected for this model. The results of the model revealed that the predictors chronological age and LP-SPA-3 explained 35% of the variance ($F(2,46) = 3.24$, $p <$ .0.048, R^2 =.124, $R^2_{adjusted}$ =.086). It was found that the only predictor with statistical significance by the regression coefficient was chronological age (β = .692, t (46) = 2.53, B =.370, 95% CI [.143-1.24], p=.015). Then, this model indicated that with the upper-intermediate L2 learners (n =

50) the chronological age variable was related to a higher proficiency, that is, an increase in chronological age, on average, would increase L2 proficiency (for further details of the graphs of all these regression models see Appendix Q).

In summary, the results section of the Language Experience Questionnaire showed that the most frequent activities performed by the L2 learners outside the classroom are the ones related to the ACA (e.g., reading academic textbooks), and the SPA (e.g., listening to podcasts) areas. Additionally, it can be observed that as chronological age increases, L2 proficiency increases and L2 learners with a high L2 proficiency perform more frequently the activity of listening to English through movies in their spare time, that is, outside the classroom.

Discussion

The main objective of this research was to describe lexical access and its possible relationship with L2 proficiency in L2 learners of English, specifically, in college-native speakers of Spanish. To accomplish this objective, a visual preference task was used where visual and auditory input concurred, and eye movements were tracked to observe the preference for the visual stimuli that were presented in the task. That is, a spoken word was heard (auditory input) and images and written words were shown as visual stimuli. These images and written words were related to the auditory input at the phonological and semantical levels; an image or a written word that shared physical features with the spoken word and a distractor—an image or a written word with no relation to the spoken word nor the other stimuli—were also presented. Spoken words and stimuli were presented in the L1 and in the L2 under different experiments to explore differences or similarities in lexical access in each language. Thus, the main prediction was that L2 learners would show a larger lexical access for the phonological competitor over the semantic and shape information of words in the L2 when these were presented as images and written words.

Additionally, a Language Experience Questionnaire, adapted from the Bilingual Language Profile (BLP; Birdsong et al., 2012) and from the Language History Questionnaire (LHQ3; Li et al., 2019), was applied to obtain sociodemographic and qualitative information from participants to know more about their language practices in the L2 outside the language classroom. This adapted questionnaire provided information about the variables related to the participants of this research that might promote a higher proficiency in the L2 in order to provide a broader understanding of the results of the visual preference task.

The first part of the Discussion is related to the results of the visual preference task, and the second part examines the participants' language practice of the L2.

The Visual Preference Task

The current research used an online visual preference task to examine lexical access processing of images and written words related to a spoken word in participants' L1 (Spanish) and L2 (English). Participants were L2 learners of English who had not had an immersion experience in the L2 but had learned English in a formal context at school.

This study had four experiments to explore lexical access in Spanish (L1) and English (L2) under two modalities: images and written words; that is: Experiment 1 presented images in the L1, Experiment 2 presented written words in the L1, Experiment 3 displayed images in the L2, and Experiment 4 displayed written words in the L2.

In Experiments 1 and 2, participants first showed a visual preference for a phonological competitor and later they showed a preference for a semantic competitor (in Experiment 1) but sustained visual preference for a shape competitor (in Experiment 2). Correspondingly, in Experiments 3 and 4, which explored lexical access in the L2, greater attention to the phonological competitor in the L2 was observed in Experiment 3, and greater attention to the shape competitor was seen in Experiment 4.

Lexical Access in the L1 (Spanish)

The objective of examining lexical access in Spanish was to describe if there was a visual preference for the phonological information over the semantic and shape information when images and written words were presented concurrently with a related spoken word.

In Experiment 1 (images in the L1), the prediction was that a visual preference for the phonological information related to the spoken word would be prevalent. The results indicated that participants' attention to the phonological competitor prevailed, followed by attention to the semantic competitor. This attention indicates that semantic information becomes active when a related spoken word is heard. However, the attention to the semantic information was preceded by attention to the phonological information instead of attention to the shape information, as reported in previous studies (Huettig & McQueen, 2007).

The results in Experiment 1 show that phonology was activated first, suggesting that the presentation of images requires phonological information for the activation of words in the L1. Phonological information being activated first is in line with cognitive models such as the TRACE model (McClelland & Elman, 1986), which postulate that when we recognize a spoken word, there is a continuous activation of phonological information. Then, the prediction established for Experiment 1 has reliable evidence with our results of the lexical access in Spanish when images related to a spoken word are displayed.

In contrast, a larger lexical activation of the shape information was observed in Experiment 2 (written words in the L1). The processing of the written word modality could suggest that the orthographical transparency of Spanish leads to automatic processing of phonology when written words are perceived, which promotes the processing and activation of non-linguistic information, such as the visual features of an object related to a spoken word.

In Experiment 2, semantic information also became active but not as predominantly as the shape information. Regardless of this outcome, the results provide evidence that there is a strong relationship between the conceptual knowledge of the recognized spoken word and the visual features, such as the shape information (Huettig & McQueen, 2007) of the objects we know in one language. The activation of semantic information in both experiments demonstrates that in order to retrieve the meaning of an object, an immediate recognition of the phonological information is required; that is, phonology is activated first to access the semantic information (as observed in Experiment 1), while the shape information of objects contributes to activating the semantic information (as in Experiment 2).

Jamal et al. (2012) found that when participants were reading words in Spanish, neuroimaging indicated greater activation of the left middle temporal gyrus, which is associated with semantic processing, than of the middle temporal gyrus, which is related to phonological processing. Their results suggested that semantic processing is more readily available due to the orthographical transparency of Spanish, which requires fewer resources for phonological processing when a written word is perceived. The study of Jamal et al. (2012) provides a possible explanation of the differences found in Experiments 1 and 2 in the current study. That is, in Experiment 1, when participants heard the spoken word and the images related to that word were presented, the activation of the phonology (i.e., first syllable of the spoken word) was more relevant to retrieve than the information embedded in the other competitors. Then, participants might have retrieved the phonological features of the spoken words as soon as they were perceived, and its orthographical elements, since only images were visually displayed and available in Experiment 1.

In contrast, in Experiment 2, when the names of the objects (e.g., orthography) were displayed, and available, participants found it more relevant to retrieve the shape information of the spoken word than its phonological features due to the orthographical transparency in Spanish.

It is important to note that a methodology similar to Huettig and McQueen's (2007) Experiments 2 and 4 of with Dutch speakers using a visual world paradigm was used in the current research. Our results in Experiment 1 (images in the L1) are different from the ones reported by Huettig and McQueen (2007), where lexical access was activated initially by the shape competitor and followed by the semantic competitor, but a lack of attention to the phonological competitor was observed. This might suggest that Spanish and Dutch activate different lexical access routes when a spoken word is heard and objects related to that spoken word are displayed concurrently. That is, while in Spanish lexical access initiates with the activation of phonology and semantic information is activated later, in Dutch, the presentation of images activates first the shape information of an object and the semantic information is activated later, but the phonological information might not need to be activated for lexical access to words.

The contrast of lexical access processing between Spanish and Dutch might be related to orthographical differences in these languages. According to Schaars et al. (2017), Dutch has a moderately transparent orthography, so that the mapping of sounds to letters might be consistent (i.e., grapheme-phoneme correspondence), while for transparent languages such as Spanish the relationship between orthography and phonology (i.e., grapheme-phoneme correspondence) is consistent due to a regular mapping of letters to sounds (Suárez-Coalla et al., 2020). Then, Dutch, which is a less transparent language than Spanish, might require more support from phonology in the written word modality, which might affect the comprehension of a word or the activation of an incorrect word candidate, as postulated by the TRACE model (McClelland & Elman, 1986). Participants in the Huettig and McQueen (2007) study were more attentive to the phonology of the written names of objects. However, we suggest that when the written names of objects are perceived in Spanish, the retrieval of the visual features that resemble the object of the spoken word is more active than the phonology.

In conclusion, lexical access in the L1 (Spanish) activates different information of words, such as the phonology, depending on the modality of the presentation (images or written words) when a related spoken word is heard.

Lexical Access in the L2 (English)

The objective of examining lexical access in L2 learners of English with no immersion experience was to describe if there was a visual preference for phonological information over semantic and shape information when images and written words were presented concurrently with a related spoken word in the L2 (English).

It was expected that in Experiment 3 (images in the L2) and Experiment 4 (written words in the L2) the phonological competitor would attract more looks than the other competitors. Our prediction was correct for Experiment 3 but not for Experiment 4. Since English is considered an opaque language (orthographical inconsistencies affect the phonological transparency, unlike in Spanish; Lindner et al., 2022), L2 learners of English might thus find it challenging to master the differences in phonology between the L1 and the L2. In Experiment 3 (images in the L2), the results show sustained activation of phonological information. This activation is in line with the TRACE model (McClelland & Elman, 1986) and with the BLINCS model (Shook & Marian, 2013), which simulates the activation of words in the L1 and the L2. According to the latter, when an image is perceived visually, the phonology of the name of the object is the first to be activated, and this activation propagates cascade processing to other levels, such as the semantic one, which integrates the meaning of the words in the L1 and in the L2. In the current research, L2 learners showed significant phonological activation of the L2 words that were similar in pronunciation to the one perceived audibly. However, we did not find attentional shifts to the other competitors, except to the distractor. It is possible that attention was directed to the distractor to confirm that its image was not related phonologically to the spoken word, since it later returned to the phonological competitor. L2 learners might thus be distinguishing the phonological inconsistencies in English due to their L2 proficiency, which might require more cognitive resources (Jamal et al., 2012) to enable lexical access processing in the L2. Moreover, the mixed-effects analysis demonstrated that in Experiment 3 (in Window 2), L2 proficiency was an important factor to sustain a larger visual preference toward the phonological competitor. Then, our results suggest that a higher proficiency in the L2 conveys a lexical specialization of the phonological information of the words in the L2, and this might be the reason for a larger visual preference toward the images that were related to the phonological competitor. Additionally, we have found evidence to support the BLINCS model which postulates that visual information (e.g., images of objects) activate words in the L2 at different levels, such as the linguistic and non-linguistic information of the words. That is, the linguistic information related to an object (e.g., phonology) activates the non-linguistic information of an object (e.g., images) that was previously stored in the L2. So, it is expected that a word in the L2, same as in the L1, activates different levels of information (Shook & Marian, 2013).

In Experiment 4 (written words in the L2), the results demonstrate a sustained lexical activation of the shape information of words, but it is interesting to note that it was preceded by the phonological activation of words in the L2. This finding resembled the results of Experiment 4 in Huettig and McQueen (2007), where phonology was activated in the early stages of the trajectory of looks and it was sustained after the spoken word was heard. However, no other attentional shifts to the other competitors were observed in the current research. Then, the results of Experiments 3 and 4 could suggest that the lexical links in the processing of words in the L2 are still in development, and that the quality of the representations of the words in the L2 (Perfetti, 2007) might be in continuous construction. Even though we measured L2 proficiency and found it to be similar among participants, its effect was not evident in the mixed-effects analysis when Experiment 4 was analyzed, so the lack of immersion in the L2 may be contributing to slower development of the lexical representations than in studies with L2 learners in an immersion context (Botezatu et al., 2021) or with bilinguals (Mishra & Singh, 2016). Then, participants' proficiency in the L2 might be playing a role in the lexical activation of words in Experiment 4 (written words modality). In other words, the L2 proficiency of our participants might be providing a limited overview to observe the activation of the phonological information embedded in the words of the L2, at least in Experiment 4. It could be predicted that in more proficient L2 learners the activation of phonological information could be perceived in the early stages of the written words modality in English.

As for the BLINCS model, we might suggest that the written words modality in our participants activated longer the physical properties that resembled the spoken word that was heard, that is, the linguistic information (i.e., the spoken word) activated the non-linguistic information (i.e., shape competitor) related to the spoken word, which is the opposite of Experiment 3 (images in the L2) and more similar to Experiment 2 (written words in the L1). Future studies could explore if the similarities in the lexical activation of the shape information of the words in Experiment 2 and in Experiment 4 are influenced by the lexical processing of the L1 or if the lack of immersion in the L2 is the main effect that is hindering a larger visual preference for the phonological competitor when written words are presented.

However, as Huettig and McQueen (2007) hypothesize, the preference for the shape competitor might also imply activation of the semantic information embedded in words. The current research supports the notion that the shape information of words can, in a way, activate semantic processing when reading words in Spanish, as found by Cortés-Monter et al. (2017) in eight-year-old Mexican children, using a similar manipulation as Huettig and McQueen (2007). Cortés-Monter et al. (2017) found that L1 speakers showed a visual preference for the semantic competitor when images were displayed, and a visual preference for the phonological competitor when written words were displayed. However, only children with high reading skills showed additional attention to the semantic competitor in the written word modality. Interestingly, these authors found a visual preference for the shape competitor in the less skilled readers when the written words were displayed; we also found this visual preference for shape information in the L1 and the L2 in the written word modalities. This preference might suggest that in Spanish, the activation of shape information of words is predominant, which could influence L2 lexical processing.

The results of the current research suggest that differences in lexical access processing might be affected by the modality of the stimulus presentation. That is, when images are presented concurrently with a spoken word in the L1, phonology is activated first, and then the semantic information of words is processed, whereas in the L2, when images are presented concurrently with a spoken word in the L2, phonological information is prioritized, since L2 learners may experience greater cognitive demand to process spoken words. When written words are presented concurrently with a spoken word in Spanish as L1, the activation of shape information demands more attention than phonological information since Spanish is a transparent language. Similarly, when written words are displayed concurrently with a spoken word, but in English as L2, the shape information of the objects demands more of the L2 learners' attention to corroborate the physical properties of the object perceived audibly, or in other words, to have access to the non-linguistic information about the object that was heard.

These findings have implications for L2 acquisition in a formal situation such as ENALLT's English courses. According to Perfetti (2007), the quality of the representations of the lexicon should activate the phonology, the orthography, and the semantics, leading to the correct identification of a word. However, experience in a language might be a relevant factor for lexical access processing: that is, the more extensive the experience in an L2, the greater the quality of word representation. L2 learners might thus be improving their lexical representations of objects as they progress in their L2 learning through different means, such as formal learning or informal practice, like reading books for pleasure in the L2 (Choi & Nunan, 2018).

More research is needed to explore lexical access processing in L2 learners without immersion experience in the L2 since the current research is by no means exhaustive. Nevertheless, the results obtained have provided evidence of the cascade lexical processing of words in the L1 and the L2 in learners of English without an immersion experience in the L2.

Language Practice Questionnaire

The main objective of this questionnaire was to analyze whether L2 proficiency was influenced by language practice outside the classroom, and whether the frequency of that practice was related to L2 proficiency. To identify which types of language practice promoted greater L2 proficiency, a language experience questionnaire was adapted with questions from the Bilingual Language Profile (BLP) and the Language History Questionnaire (LHQ3). This adaptation included the elements related to the receptive and productive abilities that are common among L2 learners (Council of Europe, 2001) with no immersion experience. The information obtained from this adapted questionnaire showed L2 learners' language practice in two main areas: academic activities and spare time activities.

The academic activities (ACA) results were expected, that is, L2 learners reported that reading academic textbooks and specialized papers and listening to videos related to their fields of study were among the most frequent activities for practicing English outside the classroom. These activities are common among college students in Mexico City who frequently read academic texts in English as supporting material for their coursework and to reinforce knowledge related to their majors. This is in line with the finding of Verhoeven (1990) who indicated that reading in an L2 favors its development and this can be observed with the results of this dissertation.

The second language practice that was frequently performed by the L2 learners was spare time activities (SPA). This was an interesting outcome due to the combination of language practices that were observed; that is, one type was related to productive abilities (writing e-mail messages) and the other to receptive abilities with two types of materials in English (listening to podcasts and movies). L2 learners may have been communicating more frequently by email because of the Covid-19 pandemic, which was taking place during the current research. Moreover, language practice using the internet to listen to podcasts and movies appears to be beneficial for L2 learners. Thus, digital audios and videos available on websites can be considered as authentic material for learning practice in English outside the classroom. This practice promotes exposure to the natural use of the target language, and increases knowledge of other cultures (Beresova, 2015), which might provide additional motivation to increase L2 proficiency (De Wilde, 2019; Olsson, 2012; Sundqvist, 2009, 2016; Lee, 2019; Choi & Nunan, 2018).

The second part of the results (with the regression models) explored which parts of the ACA and SPA predicted greater proficiency in the L2. The main results revealed that age and the SPA of listening to English by watching movies showed an important effect on language proficiency. Additionally, with the results obtained from this sample, one important conclusion is that an increase in age and in the frequency of watching movies in English promotes greater proficiency in the L2. This assumption suggests that with increasing age L2 learners progressively find more opportunities to practice the L2 in informal settings like with movies. Albiladi et al. (2018) found that movies were perceived as authentic and effective material to practice different abilities in the L2, at least with college students. Bahrani et al. (2014) explored the quality and frequency of exposure to audiovisual material and found that L2 learners of English with low proficiency preferred watching animation, while those with high proficiency preferred to watch longer news programs. The quality of these programs was considered in relation to their modification of authentic material, that is, in animation, characters' voices are often modified and language simplified, but not in news programs.

In addition to these findings, it is noteworthy that in the current research the variable of age of L2 acquisition was not a predictor for greater proficiency, which contradicts evidence from previous studies that suggest that early learning of an L2 promotes greater proficiency (Costa & Sebastián-Gallés, 2014; Marian et al., 2018; Bialystok et al., 2008; Botezatu et al., 2021). However, in these studies the experience of immersion has been found to positively influence L2 proficiency. For instance, Saito (2015) demonstrated that early acquisition of the L2 promotes near-native pronunciation and prosody, while late acquisition was related to better language use on the grammatical and lexical levels. A higher level of motivation in late L2 learners, however, played an important role in finding opportunities to practice. Participants in the current dissertation reported they had never experienced an immersion situation in the L2, that is, they had learned English only in school, which is an important limitation to exposure in informal settings of the L2.

Nevertheless, the current research demonstrates that with the frequency of language practice, such as watching and listening to audiovisual materials like podcasts and movies in English, most of the participants (n = 50) had acquired an upper-intermediate level of English which might have led to a higher proficiency in the L2. It is noteworthy that exposure to audiovisual material such as movies increased with age. The importance of age was supported by the regression analysis using only the L2 learners with high proficiency, which indicates that greater exposure to the L2 positively affects proficiency (Luk et al., 2011; Kroll et al., 2015; Bialystok et al., 2005).

Finally, participants' self-assessment of their receptive and productive abilities in English did not correlate with their proficiency. It is likely that the self-assessment ratings in the adapted questionnaire, used in the current research, were not accurately evaluating the L2 learners' self-assessment of their performance. Gaffney (2018) suggested several potential causes of inaccurate self-assessment that might be playing a role. These include psychological or individual factors, such as a lack of confidence, or aspects of personality, such as introversion. Gaffney (2018) found that when self-assessment of L2 performance is correlated with instruments that assess personality traits (e.g., "make friends easily"), extroverted participants showed a higher self-assessment of performance on the L2 than their introverted counterparts. Similarly, Andrade (2019) described an ongoing debate about the difficulties of defining and conceptualizing self-assessment in students, due to the affective mechanisms that might influence their perception of achievement in learning, which was not the scope of the current research. However, these concerns could be considered in future studies to provide a better understanding of the factors influencing L2 learners with low proficiency. As Marian et al. (2021) noted, possible factors affecting the validity of self-reported measures include the language ability being rated, the proficiency level of the L2 learner, and age.

In sum, the current research suggests that the adaptation of instruments intended for bilinguals, like the BLP and the LHQ3, provides useful and reliable information about L2 learners' language practice. Even though no evidence was found on the effects of age of L2 acquisition on proficiency, it was revealed that age has a positive effect. Interestingly, this relationship between age and proficiency encourages L2 learners to find opportunities for spare time practice, which leads to greater exposure to authentic material outside the classroom, such as with movies.

Lastly, the visual preference task provided useful information regarding the lexical activation in the L1 and the L2, nevertheless, lexical activation is embedded with other factors, such as L2 proficiency which depends on the language practices that L2 learners perform to improve their L2 acquisition. Then, the language practices in the L2 that were important for the sample of this research to improve the L2 proficiency were revealed through a complementary instrument (the Language Experience Questionnaire). So, the current research provides an overview of different aspects of L2 learners with no immersion experience in the L2 in Mexico City, specifically college students enrolled at ENALLT that are learning English as an L2.

Conclusion

The current dissertation described lexical access in the L1 and in the L2 to the phonological, semantic and shape information of words through images and written words in L2 learners through a visual preference task. Additionally, it explored L2 learners' language practice outside the classroom and it evaluated the relationship of the frequency of that practice to L2 proficiency.

On the one hand, the results of the visual preference task demonstrated that L2 learners show differences in lexical access processing in four experiments, where images and written words were displayed in the L1 and the L2. When images in the L1 and in the L2 were displayed concurrently with a spoken word, a visual preference for the phonological competitor was observed, suggesting lexical access to the phonology of the words. Importantly, this effect was sustained in the lexical processing of the words in the L2. In contrast, when written words in the L1 and in the L2 were displayed concurrently with a spoken word, lexical access processing to the shape competitor was observed in both languages, and, interestingly, this process was largely sustained. However, additional research is needed to determine whether the reported pattern of visual preference found in L2 learners of English of this study is similar to that of other L2 learners.

On the other hand, it was found that there are two main areas where L2 learners practice the L2 outside the classroom more frequently: in academic and spare time activities. The first area is related to the academic life in which the L2 learners of this sample are immersed, and the second reveals the importance of learning outside the classroom through activities that provide authentic exposure to the L2, such as listening to podcasts and watching movies. The spare time activity of watching movies in English was related to greater proficiency, and the frequency of this activity increased with age. We conclude that as L2 learners increase in age, their L2 proficiency is greater and is predominantly affected by exposure to audiovisual material such as movies in the L2. Nevertheless, we recommend caution in interpreting these results since other variables that were not accounted in this research might be playing an important role, such as the movie genres that L2 learners watch and that promote L2 practice or if L2 learners watch the movies in isolation or with other family members. Additional studies to closely survey the types of language practices that help increase proficiency in L2 learners are needed.

Limitations and Suggestions for Future Research

The current research has different limitations. It is possible that other variables might be affecting the quality of lexical access processing in L2 learners. For example, the approach used by their classroom teachers to introduce vocabulary, such as the use of dictionaries in the classroom (Lopera, 2019), or the use of authentic images to explain the meaning of a word (Macedonia, 2015), could affect L2 learners' lexical acquisition of English. These variables were beyond the scope of this study, so further research is needed to investigate this question. Additionally, future studies could include a longitudinal approach to assess lexical access processing in L2 learners across their lifespan.

This study was carried out during the Covid-19 pandemic, when classes were conducted online, reducing the possibilities for interaction and oral participation. This situation may have affected the results. It would be interesting to replicate this study once students return to in-person classes to compare the effects of L2 lexical access and language practice in in-person and online learning. Also, at a time when the Covid-19 pandemic has highlighted the importance of using online tools, different approaches are needed to observe whether L2 learners' language practice with these tools leads to greater proficiency in receptive and productive abilities.

Lastly, this research was conducted outside the Psycholinguistics Laboratory where the obtention of data is controlled, so it might be advisable to replicate the current research in the controlled experiments that are offered in a Laboratory to validate the results presented in this dissertation.

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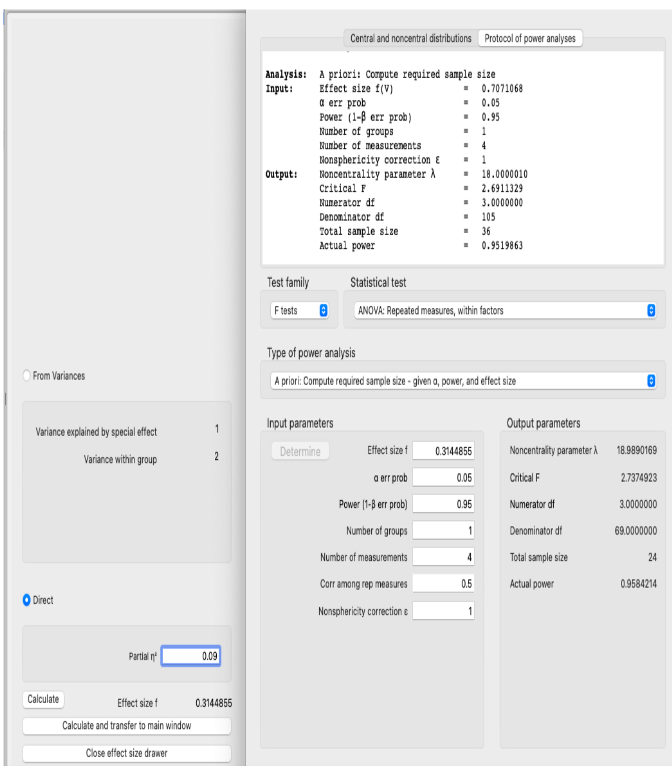
Appendix A. Sample Size Effect Analysis

A size effect analysis was performed to consider the number of participants for this research. This analysis was accomplished through G*Power 3.1 software, which is an open resource available on the website: http://www.gpower.hhu.de/. Size effect can be small (from .0 to .0009), medium (from .0010 to .0588) or large (from .0589 to .1379) depending on the magnitude of the effect (Cohen, 1988), which is automatically calculated by G*Power.

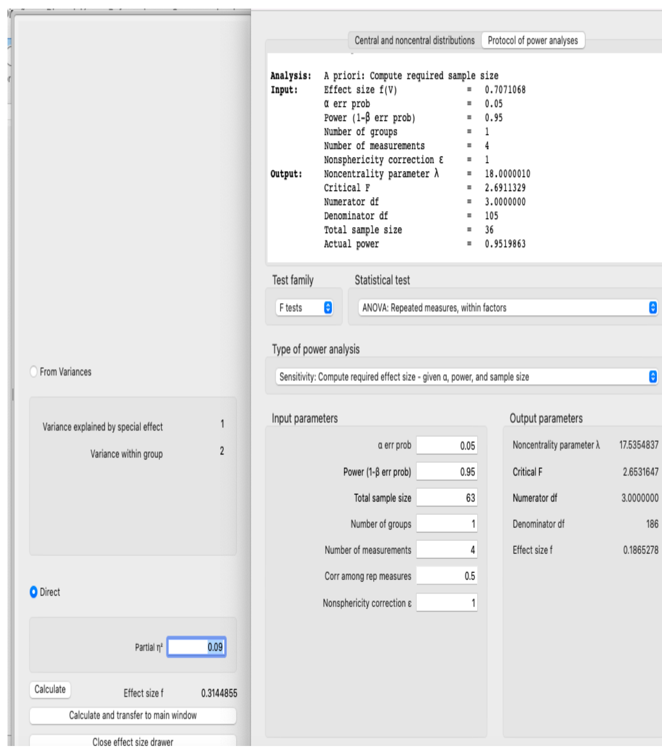
The analysis considered the statistical test that will be used for this research: ANOVA for repeated measures, within factors. We calculated a $\eta_p^2 = 0.09$ according to the Cortés-Monter, Angulo-Chavira, and Arias-Trejo (2017) study which used a methodology similar to the one in Huettig and McQueen (2007), which is being used in the current dissertation.

For this research, the following procedures were considered: a margin of error (α =.05), the probability of a type error II (1- β = 0.95), and the numerator (degrees of freedom of the error, which is the number of repeated measurements, that is, four experiments of the visual preference task minus one: n = 4-1 = 3). The results showed that there is 95% chance of correctly rejecting the null hypothesis of no difference with a total of 36 participants, and the effect size was f = 0.18, which is a medium effect to generalize the results of this research. Then, a medium effect means that the results and the analysis of this dissertation cannot be generalized to other samples (see A from G*Power for more details). Likewise, sensitivity analyses that considered the 63 participants included for statistical analyses showed an effect size f= 0.18, which is a medium effect size (see B for more details).

A



B



Appendix B. Informed consent

Consentimiento Informado para participar en una investigación

Título del proyecto: El acceso al léxico y su relación con la proficiencia en una segunda lengua

Investigadora principal: Mtra. Alma Luz Rodríguez Lázaro, correo electrónico: almaluzrl@enallt.unam.mx

Sede donde se realizará el estudio: La aplicación será totalmente en línea a través de ligas de sitios electrónicos que puede realizar en casa siempre y cuando acepte que se active la cámara de video para registrar los movimientos de la mirada que son objeto de estudio en esta investigación. Debido a esto, se requiere:

1. Navegador web Google Chrome
2. PC / Laptop con Microsoft Windows 10 o Mac (Macbook, iMac) con MacOS
3. Cámara web integrada para computadora portátil o cámara web USB
4. La resolución de pantalla requerida es de 1024x968 píxeles o más.
5. Este estudio no se puede realizar en un dispositivo móvil (teléfono inteligente) ni tableta

Todos los interesados en participar deben firmar el consentimiento informado antes de que se apliquen las pruebas contempladas para esta investigación. Dado que la aplicación de las pruebas de este proyecto se realiza de manera remota, el correo electrónico será el medio de comunicación entre la investigadora y los participantes. Su consentimiento para participar en la presente investigación se dará por entendido al firmar y recibir una copia de la presente forma. La firma que proporcione puede ser digital, o bien, puede imprimir el archivo, firmarlo y enviarlo en formato PDF o en imagen por correo electrónico a la investigadora.

Riesgos o molestias asociados con el estudio

En esta investigación no existe riesgo para la salud del participante, conforme a la Norma Oficial Mexicana NOM-012-SSA3-2012. Este estudio se enmarca en el nivel de **riesgo mínimo** para los participantes debido a que se recopilarán datos del movimiento ocular por medio de una técnica no invasiva como lo es el rastreo de la mirada. Esta técnica conductual registra los movimientos de los ojos a través de una cámara que puede seguir el movimiento de la pupila cuando se presentan videos en una pantalla. En las siguientes páginas se dan más detalles sobre el estudio y las pruebas que realizaría en caso de que usted decida de manera voluntaria, participar en este estudio.

Justificación del Estudio

Uno de los intereses de la Psicolingüística es conocer qué representaciones de las palabras se activan en una lengua. Cuando escuchamos “mesa”, puede activarse información fonológica (p. ej., la pronunciación del fonema /m/ de *mesa*), el significado de la palabra, e inclusive la representación visual que asemeja a una mesa (p. ej. la imagen de una tabla con cuatro patas).

Objetivo del Estudio

El objetivo de este estudio es describir, a través del rastreo de la mirada, los componentes que se activan al escuchar una palabra.

Procedimiento del estudio

A través de un video se presentarán palabras e imágenes. Durante la presentación de este video se registrará el movimiento de la mirada con *RealEye* (https://www.realeye.io/) que es una

plataforma en línea para realizar estas investigaciones de rastreo ocular y no es necesario descargar el software de RealEye en su computadora.
De acuerdo con las políticas de privacidad de esta plataforma, no se guardan las imágenes de las caras de los participantes por lo que su privacidad queda protegida conforme a lo indicado en la página de RealEye: https://www.realeye.io/about/privacy/. Para llevar a cabo este estudio, la investigadora le enviará por correo electrónico a los participantes una liga que proporciona RealEye.
Posterior al video de la plataforma RealEye, se enlazará automáticamente a un Formulario de *Google (https://forms.gle/F7mWoUwLQHnj6Esa7)* donde se encuentra una prueba que realizarán los participantes. La prueba es: LexTALE (Lemhöfer & Broersma, 2012). Esta prueba estima el nivel de inglés de una persona a través del reconocimiento de palabras del inglés.
La duración total de la aplicación (incluyendo registro de la mirada y la prueba en el Formulario de Google) es de 25 minutos.

Beneficios del estudio

Los resultados brindarán evidencia sobre la activación de palabras en español e inglés en alumnos universitarios que estudian inglés como segunda lengua. Las investigaciones de este tipo ayudan a generar nuevas propuestas de enseñanza del vocabulario en los estudiantes de segundas lenguas para mejorar su aprendizaje.

En tanto, los resultados de estas pruebas son informativos y no tienen como propósito la detección de problemas o tratamientos psicológicos de los participantes.
Por otro lado, tanto para la prueba LexTALE se brindarán los porcentajes que indican el conocimiento de vocabulario del inglés. Por ejemplo, si un participante obtiene entre el 80% al 100% de respuestas correctas en esta prueba, se le considera con un conocimiento avanzado del vocabulario en inglés. A su vez, un conocimiento intermedio se ubica entre el 60 y 79% de respuestas correctas, y un conocimiento bajo de vocabulario se ubica con porcentajes menores al 59%.

Se entregarán los resultados de las pruebas a todos los participantes y se eliminarán los datos inconclusos o de aquellos participantes que lo soliciten. Los datos serán analizados de manera grupal para fines académicos; se respetará la confidencialidad y el anonimato de los participantes.

Observaciones:

- Recibirá respuesta a cualquier pregunta, duda y aclaración acerca de los procedimientos, riesgos, beneficios y otros asuntos relacionados con la investigación.
- Si decide participar en el estudio puede retirarse en el momento que lo desee.
- Su participación en la investigación no tiene costo económico.

Este estudio ha sido avalado por el Comité de Ética del Programa de Maestría y Doctorado en Psicología de la Universidad Nacional Autónoma de México.

Appendix B. Continued

Si desea más información sobre la naturaleza de la investigación, por favor comuníquese con Alma Luz Rodríguez Lázaro, responsable de la investigación al correo: almaluzrl@enallt.unam.mx

Nota: En caso de que existiera algún tipo de dependencia, ascendencia o subordinación del participante al investigador, que le impida otorgar su consentimiento libre, éste debe ser obtenido por otro miembro del equipo de investigación. (Reglamento de la Ley General de Salud en Materia de Investigación para la Salud 02-02-2014).

Carta de Consentimiento Informado

Yo, (nombre completo del participante) ____, comprendo la información anterior y mis preguntas han sido contestadas de manera satisfactoria. También me han informado que los datos obtenidos en el estudio pueden ser publicados o difundidos con fines científicos. Acepto participar en este estudio de investigación. Recibiré una copia firmada de esta forma de consentimiento.

____ __________________

Firma del participante o representante Legal **Fecha**

____ __________________

Testigo (Firma, nombre y relación con el participante) **Fecha**

____ __________________

Testigo (Firma, nombre y relación con el participante) **Fecha**

Investigador responsable:

He explicado a ____ en qué consiste el estudio, cuáles son sus objetivos, los riesgos y beneficios que implica su participación. Declaro que conozco la normatividad para realizar investigación con seres humanos y me apego a ella.

____

Alma Luz Rodríguez Lázaro
Firma del investigador **Fecha**

Appendix C. Example of the LexTALE test

Appendix D. Language experience questionnaire.
Translation of the questions in English are in brackets []. *Results of this questionnaire are displayed in Appendix O.*

Uso de lenguas en contextos sociales [Use of languages in social contexts]
Las preguntas de esta sección servirán para obtener información sobre el uso de las lenguas que dominas en contextos sociales. [This section aims to obtain information about the languages that you use in social contexts.]

0. Uso de audífonos en la tarea de RealEye [Headphone use during the RealEye task]
Sí [Yes]
No
No recuerdo [Can't recall]

1. Género [Gender]
Mujer [Female]
Hombre [Male]
Prefiero no decirlo [Rather not say]

2. Edad [Age] ____

3. ¿Trabajas además de estudiar? [Besides studying, do you work?]
Sí [Yes]
No

4. Lengua materna [First language]
Español [Spanish]
Otra [Other]

5. Si tu lengua materna no es el español, ¿cuántos años has estudiado español en la escuela? [If Spanish is not your first language, how long have you studied Spanish at school?]

6. Estima tu conocimiento de español. [Estimate your knowledge of Spanish]
Cero 0-1-2-3-4-5 **Perfecto**

7. Estima la cantidad de horas a la semana en las que escribes en español [Estimate how many hours a week you write material in Spanish]

	0 a 7 horas a la semana [0 to 7 hours a week]	8 a 15 h horas a la semana [8 to 15 hours a week]	Más de 16 horas a la semana [More than 16 hours a week]
a. Mensajes en redes sociales [Messages on social media (e.g., Facebook, Twitter)]			
b. Mensajes en Whatsapp [Messages on WhatsApp]			
c. Mensajes de correos [E-mail messages]			
d. Diarios personales [Personal diary]			
e. Trabajos de escuela [School assignments]			
f. Artículos científicos [Academic papers]			

Appendix D. Continued

8. Estima la cantidad de horas a la semana en las que lees material en español [Estimate how many hours a week you read in Spanish]

	0 a 7 horas a la semana [0 to 7 hours a week]	8 a 15 h horas a la semana [8 to 15 hours a week]	Más de 16 horas a la semana [More than 16 hours a week]
a. Redes sociales [Social media]			
b. Libros (p. ej. novelas) [Books (e.g., novels)]			
c. Artículos académicos o especializados [Academic or specialized papers]			
d. Libros académicos [Academic textbooks]			
e. Videojuegos [Videogames]			

9. Estima la cantidad de horas a la semana en las que escuchas material en español [Estimate how many hours a week you listen to material in Spanish]

	0 a 7 horas a la semana [0 to 7 hours a week]	8 a 15 h horas a la semana [8 to 15 hours a week]	Más de 16 horas a la semana [More than 16 hours a week]
a. Música [Music]			
b. Películas [Movies]			
c. Podcasts de diferentes temas [Podcasts of different topics]			
d. Materiales especializados en tu área de estudio como videos en YouTube [Specialized materials in your field of study (e.g.,YouTube videos]			

Appendix D. Continued

10. Estima la cantidad de horas a la semana en las que platicas en español [Estimate how many hours a week you speak in Spanish]

	0 a 7 horas a la semana [0 to 7 hours a week]	8 a 15 h horas a la semana [8 to 15 hours a week]	Más de 16 horas a la semana [More than 16 hours a week]
a. Familia [with family]			
b. Amigos [with friends]			
c. Escuela [at school]			
d. Trabajo [at work]			

11. ¿En qué habilidad del español te sientes más cómodo? [How comfortable do you feel when..]

	Nada cómodo [Uncomfortable]	Poco cómodo [Rather comfortable]	Cómodo [Comfortable]	Muy cómodo [Very comfortable]
a. Platicar con otros en español [talking to others in Spanish]				
b. Leer materiales en español [reading texts in Spanish]				
c. Comprender audios en español [understanding audios in Spanish]				
d. Escribir en español [writing in Spanish]				

12. Además del inglés, ¿has estudiado otra lengua? [Besides English, have you ever studied another language?]
Sí (favor de responder la pregunta 13) [Yes, go to question 13]
No (pasa a la pregunta 14) [No, go to question 14]

13. ¿Qué otra lengua aprendiste y cuánto tiempo la estudiaste? [Which other language have you studied and for how long?]

14. ¿A qué edad comenzaste a estudiar inglés? [At what age did you start studying English?]

15. Estima tu conocimiento de inglés [Estimate your knowledge of English]
Cero 0-1-2-3-4-5 **Perfecto**

16. ¿En qué nivel de inglés te ubicas actualmente? [Which is your current English level?]
Principiante [Beginner]
Intermedio [Intermediate]
Intermedio avanzado [Upper-intermediate]
Avanzado [Advanced]

Appendix D. Continued

17. Estima la cantidad de horas a la semana en las que escribes en inglés [Estimate how many hours a week you write in English]

	0 a 7 horas a la semana [0 to 7 hours a week]	8 a 15 h horas a la semana [8 to 15 hours a week]	Más de 16 horas a la semana [More than 16 hours a week]
a. Mensajes en redes sociales [Messages on social media (e.g., Facebook, Twitter)]			
b. Mensajes en Whatsapp [Messages on WhatsApp]			
c. Mensajes de correos [E-mail messages]			
d. Diarios personales [Personal diary]			
e. Trabajos de escuela [School assignments]			
f. Artículos científicos [Academic papers]			

18. Estima la cantidad de horas a la semana en las que lees material en inglés [Estimate how many hours a week you read material in English]

	0 a 7 horas a la semana[0 to 7 hours a week]	8 a 15 h horas a la semana [8 to 15 hours a week]	Más de 16 horas a la semana [More than 16 hours a week]
a. Redes sociales [Social media]			
b. Libros (p. ej. novelas) [Books (e.g., novels)]			
c. Artículos académicos o especializados [Academic or specialized papers]			
d. Libros académicos [Academic textbooks]			
e. Videojuegos [Videogames]			

Appendix D. Continued

19. Estima la cantidad de horas a la semana en las que escuchas material en inglés [Estimate how many hours a week you listen to material in English]

	0 a 7 horas a la semana [0 to 7 hours a week]	8 a 15 h horas a la semana [8 to 15 hours a week]	Más de 16 horas a la semana [More than 16 hours a week]
a. Música [Music]			
b. Películas [Movies]			
c. Podcasts de diferentes temas [Podcasts of different topics]			
d. Materiales especializados en tu área de estudio como videos en YouTube [Specialized materials in your field of study (e.g., YouTube videos]			

20. Estima la cantidad de horas a la semana en las que platicas en inglés [Estimate how many hours a week you speak in English]

	0 a 7 horas a la semana [0 to 7 hours a week]	8 a 15 h horas a la semana [8 to 15 hours a week]	Más de 16 horas a la semana [More than 16 hours a week]
a. Familia [with family]			
b. Amigos [with friends]			
c. Escuela [at school]			
d. Trabajo [at work]			

21. ¿En qué habilidad del inglés te sientes más cómodo? [How comfortable do you feel when...]

	Nada cómodo [Uncomfortable]	Poco cómodo [Rather comfortable]	Cómodo [Comfortable]	Muy cómodo [Very comfortable]
a. Platicar con otros en español [talking to others in English]				
b. Leer materiales en español [reading texts in English]				
c. Comprender audios en español [understanding audios in English]				
d. Escribir en español [writing in English]				

Appendix E. Syllable and character length of spoken words, cohorts, semantic competitors, and distractors of Experiments 1 and 3

a) Experiment 1- Spoken words, competitors, and distractors

Spoken word	Syllable length	Character length	Spanish cohort	Syllable length	Character length	Semantic competitor	Syllable length	Charact er length	Shape competitor	Syllable length	Charact er length	Distractor	Syllable length	Character length
1. casa /ˈka.sa/ [house]	2	4	castor /kas.ˈtor/ [beaver]	2	6	sillón [armchair]	2	6	flecha [arrow]	2	6	dona [donut]	2	4
2. puerta /ˈpwɛr.ta/ [door]	2	6	puerco /ˈpwɛr.ko/ [pig]	2	6	llave [key]	2	5	espejo [mirror]	3	6	sartén [pan]	2	6
3. planta /ˈplan.ta/ [plant]	2	6	playa /ˈpla.ʝa/ [beach]	2	5	casa [house]	2	4	fuente [fountain]	2	6	nube [cloud]	2	4
4. estrella /ɛs.ˈtre.ʝa/ [star]	3	8	estufa /ɛs.ˈtu.fa/ [stove]	3	6	planeta [plane]	3	7	flor [flower]	1	4	cortina [curtain]	3	7
5. huevo /ˈwe.βo/ [egg]	2	5	hueso /ˈwe.so/ [bone]	2	5	pan [bread]	1	3	balón [american football]	2	5	cactus [cactus]	2	6
6. vestido /βɛs.ˈti.ðo/ [dress]	3	7	ventana /bɛ̃n.ˈta.na/ [window]	3	7	camisa [shirt]	3	6	reloj [hourglass]	2	5	tronco [trunk]	2	6
7. cama /ˈka.ma/ [bed]	2	4	camión /ka.ˈmjõŋ/ [truck]	2	6	silla [chair]	2	5	maleta [suitcase]	3	6	piña [pineapple]	2	4
8. caja /ka.xa/ [box]	2	4	camello /ka.me.ʝo/ [camel]	3	7	jitomate [tomato]	4	8	hielo [ice]	2	5	bicicleta [bike]	4	9
9. barco /ˈbar.ko/ [boat]	2	5	barba /ˈβar.βa/ [beard]	2	5	ola [wave]	2	3	volcán [volcano]	2	6	libro [book]	2	5
10. conejo /ko.ˈne.xo/ [rabbit]	3	6	concha /ˈkõn̪.ʧa/ [seashell]	2	6	lechuga [lettuce]	3	7	tijeras [scissors]	3	7	paleta [lollipop]	3	6
11. tren /ˈtrɛ̃n/ [train]	1	4	trenza /ˈtrɛ̃n.sa/ [braid]	2	6	avión [plane]	2	5	chocolate [chocolate bar]	4	9	barril [barrel]	2	6
12. bolsa /ˈβol.sa/ [bag]	2	5	boleto /βo.ˈle.to/ [ticket]	3	6	mochila [school bag]	3	7	camiseta [t-shirt]	4	8	papalote [kite]	4	8
13. ventana /bɛ̃n.ˈta.na/	3	8	ventilador /βɛ̃n.ti.la.ˈðor/	4	10	espejo [mirror]	3	6	pantalla [TV screen]	3	8	periódico [newspaper]	4	9

[window]			[fan]											
14. plato /pla.to/ [plate]	2	5	playera /pla.ˈʝɛ.ra/ [t-shirt]	3	7	cereal [cereal)	2	6	disco [disc]	2	5	lavadora [washing machine]	4	8
15. botella /bo.ˈte.ʝa/ [bottle]	3	7	bota /ˈbo.ta/ [boot]	2	4	vaso [glass)	2	4	guitarra [guitar]	3	8	tina [bathtub]	2	4
16. mesa /ˈme.sa/ [table]	2	4	melón /me.ˈlon/ [canteloupe]	2	5	cuchara [spoon)	3	7	tortuga [turtle]	3	7	globo [ballon]	2	5
17. pastel /pas.ˈtɛl/ [cake]	2	6	pasta /ˈpas.ta/ [pasta]	2	5	vela [candle)	2	4	sombrero [hat]	3	8	árbol [tree]	2	5
18. iglesia /i.ˈɣle.sja/ [church]	3	7	iglú /i.ˈɣlu/ [igloo]	2	4	campana [bell)	3	7	torre [tower]	2	5	ardilla [squirrel]	3	7

b) Experiment 1 – Filler trials

Filler Spoken word	Syllable length	Character length	Filler	Syllable length	Character length	Filler	Syllable length	Character length	Filler	Syllable length	Character length	Filler	Syllable length	Character length
1. trompeta	3	8	zapato	3	6	brocha	2	6	cobija	3	6	pasto	2	5
2. libro	2	5	escalera	4	8	llanta	2	6	piña	2	4	jardín	2	6
3. cigarro	3	7	raqueta	3	7	globo	2	5	mango	2	5	piedra	2	6
4. piñata	3	6	licuadora	4	9	maleta	3	6	audífonos	4	9	servilleta	4	10
5. dona	2	4	tambor	2	6	canasta	3	7	patín	2	5	ballena	3	7
6. foco	2	4	plancha	2	7	sandwich	2	8	clip	1	4	banca	2	5
7. gancho	2	6	ojo	1	3	piano	2	5	carriola	3	8	buzón	2	5
8. cepillo	3	7	tarjeta	3	7	sopa	2	4	escritorio	4	10	panqueques	3	10
9. guante	2	6	cacahuate	4	9	toalla	2	6	collar	2	6	pulpo	2	5
10. limón	2	5	tenis	2	5	pluma	2	5	almohada	4	8	semáforo	4	7

Appendix E. Continued

c) Experiment 1- Levenshtein distance

Spoken word	Levenshtein distance (Spoken word *vs.* Spanish cohort)	Levenshtein distance (Spoken word *vs.* Semantic competitor)	Levenshtein distance (Spoken word *vs.* Shape competitor)	Levenshtein distance (Spoken word *vs.* Distractor)
1. casa /ˈka.sa/ [house]	3	6	5	5
2. puerta /ˈpwɛr.ta/ [door]	2	6	6	5
3. planta /ˈplan.ta/ [plan]	2	4	4	6
4. estrella /ɛs.ˈtre.ʝa/ [star]	4	6	7	6
5. huevo /ˈwe.βo/ [egg]	1	5	5	6
6. vestido /βɛs.ˈti.ðo/ [dress]	4	6	6	6
7. cama /ˈka.ma/ [bed]	3	4	4	3
8. caja /ka.xa/ [box]	5	7	5	7
9. barco /ˈbar.ko/ [boat]	2	5	6	5
10. conejo /ko.ˈne.xo/ [rabbit]	3	7	6	5
11. tren /ˈtrɛ̃n/ [train]	2	4	9	5
12. bolsa /ˈβol.sa/ [bag]	3	5	6	7
13. ventana /bɛ̃n.ˈta.na/ [window]	5	6	4	8
14. plato /pla.to/ [plate]	4	6	4	6
15. botella /bo.ˈte.ʝa/ [bottle]	3	7	6	5
16. mesa /ˈme.sa/ [table]	3	5	6	5
17. pastel /pas.ˈtɛl/ [cake]	2	5	6	4
18. iglesia /i.ˈɣle.sja/ [church]	4	6	7	6

Appendix E. Continued
Experiment 3

a) Experiment 3- Spoken words, competitors, and distractors

Spoken word	Syllable length	Character length	English cohort	Syllable length	Character length	Semantic competitor	Syllable length	Character length	Shape competitor	Syllable length	Character length	Distractor	Syllable length	Character length
1. beer /bɪr/	1	4	bee /bi/	1	3	nut	1	3	cup	1	3	dress	1	5
2. bell /bel/	1	4	bed /bed/	1	3	door	1	4	skirt	1	5	frog	1	4
3. candy /ˈkændi/	2	5	candle /ˈkændəl/	2	6	almond	2	6	fish	1	4	shoe	1	4
4. car /kɑr/	1	3	carrot /ˈkærət/	2	6	bridge	1	6	rabbit	2	6	pen	1	3
5. castle /ˈkæsəl/	2	6	cassette /kəˈsɛt/	2	8	throne	1	6	hat	1	3	ruler	2	5
6. cat /kæt/	1	3	catapult /ˈkætəˌpʌlt/	3	8	bird	1	4	pear	1	4	ship	1	4
7. cheese /tʃiz/	1	6	chicken /ˈtʃɪkən/	2	7	milk	1	4	sponge	1	6	hammer	2	6
8. cherry /ˈtʃɛri/	2	6	chair /tʃɛr/	1	5	strawberry	3	10	bomb	1	4	pencil	2	6
9. coke /koʊk/	1	4	cone /koʊn/	1	4	pizza	2	5	violin	3	6	shovel	2	6
10. letter /let′ər/	2	6	lettuce /ˈlɛtɪs/	2	7	box	1	3	mirror	2	6	umbrella	3	8
11. peanut /ˈpiˌnʌt/	2	6	piano /piˈænoʊ/	3	5	elephant	3	8	snowman	2	7	clip	1	4
12. photo /ˈfoʊtoʊ/	2	5	phone /foʊn/	1	5	camera	3	6	screen	1	6	soup	1	4
13. planet /ˈplænɪt/	2	6	plant /plænt/	1	5	star	1	4	button	2	6	cab	1	3
14. plate /pleɪt/	1	5	plane /pleɪn/	1	5	bowl	1	4	disc	1	4	sandals	2	7
15. road /roʊd/	1	4	rose /roʊz/	1	4	truck	1	5	snake	1	5	coin	1	4
16. soap /soʊp/	1	4	sofa /ˈsoʊfə/	2	4	towel	2	5	eraser	3	6	giraffe	2	7
17. medal /ˈmɛdəl/	2	5	medicine /ˈmɛdəsɪn/	3	8	trophy	2	6	ball	1	4	sock	1	4
18. mouth /maʊθ/	1	5	mouse /maʊs/	1	5	lipstick	2	8	banana	3	6	scissors	2	8

Appendix E. Continued

b) Experiment 3- Filler trials

Filler Spoken word	Syllable length	Character length	Filler	Syllable length	Character length	Filler	Syllable length	Character length	Filler	Syllable length	Character length	Filler	Syllable length	Character length
1. skate	1	5	trumpet	2	7	owl	1	3	pancakes	2	8	nose	1	4
2. egg	1	3	shorts	1	6	printer	2	7	ticket	2	6	octopus	3	7
3. hot dog	2	6	apple	1	5	die	1	3	belt	1	4	straw	1	5
4. stove	1	5	ring	1	4	boot	1	4	comb	1	4	bench	1	5
5.diamond	2	7	juice	1	5	stapler	2	7	map	1	3	bone	1	4
6. ear	1	3	sneakers	2	8	palm	1	4	bread	1	5	card	1	4
7. knife	1	5	avocado	4	7	crayon	2	6	leaf	1	4	bat	1	3
8. vest	1	4	calendar	3	8	carrot	2	6	pillow	2	6	napkin	2	6
9.sweater	2	7	jar	1	3	radio	2	5	dinosaur	3	8	carrot	2	6
10.glove	1	5	flag	1	4	brick	1	5	tire	1	4	cupcake	2	7

c) Experiment 3- Levenshtein distance

Spoken word	Levenshtein distance (Spoken word *vs.* English cohort)	Levenshtein distance (Spoken word *vs.* Semantic competitor)	Levenshtein distance (Spoken word *vs.* Shape competitor)	Levenshtein distance (Spoken word *vs.* Distractor)
1. beer /bɪr/	1	4	4	4
2. bell /bel/	2	4	5	4
3. candy /ˈkændi/	2	5	5	5
4. car /kɑr/	3	6	5	3
5. castle /ˈkæsəl/	3	5	4	5
6. cat /kæt/	5	4	3	4
7. cheese /tʃiz/	4	6	5	5
8. cherry /ˈtʃɛri/	3	6	6	4
9. coke /koʊk/	1	5	5	4
10. letter /letʼər/	3	6	5	7
11. peanut /ˈpiˌnʌt/	3	5	7	6
12. photo /ˈfoʊtoʊ/	2	6	6	4
13. planet /ˈplænɪt/	1	5	6	5
14. plate /pleɪt/	1	5	4	6
15. road /roʊd/	2	4	4	4
16. soap /soʊp/	2	4	5	6
17. medal /ˈmɛdəl/	5	6	5	5
18. mouth /maʊθ/	2	7	6	8

Appendix E. Continued

d) Tests of Normality

Experiment 1	Shapiro-Wilk		
	W	*df*	*p*
Experiment 1_Syllable length_SPOKEN WORD	0.638	18	0.000
Experiment 1_Character lenght_SPOKEN WORD	0.864	18	0.014
Experiment 1_Syllable length_ENGLISH COHORT	0.767	18	0.001
Experiment 1_Character length_ENGLISH COHORT	0.915	18	0.106
Experiment 1_Syllable length_SEMANTIC COMPETITOR	0.737	18	0.000
Experiment 1_Character length_SEMANTIC COMPETITOR	0.901	18	0.060
Experiment 1_Syllable length_SHAPE COMPETITOR	0.699	18	0.000
Experiment 1_Character length_SHAPE COMPETITOR	0.862	18	0.013
Experiment 1_Syllable length_DISTRACTOR	0.726	18	0.000
Experiment 1_Character length_DISTRACTOR	0.888	18	0.035

Experiment 3	Shapiro-Wilk		
	W	*df*	*p*
Experiment 3_Syllable length_SPOKEN WORD	0.741	18	0.000
Experiment 3_Character lenght_SPOKEN WORD	0.895	18	0.047
Experiment 3_Syllable length_ENGLISH COHORT	0.662	18	0.000
Experiment 3_Character length_ENGLISH COHORT	0.846	18	0.007
Experiment 3_Syllable length_SEMANTIC COMPETITOR	0.838	18	0.006
Experiment 3_Character length_SEMANTIC COMPETITOR	0.926	18	0.166
Experiment 3_Syllable length_SHAPE COMPETITOR	0.863	18	0.014
Experiment 3_Character length_SHAPE COMPETITOR	0.920	18	0.127
Experiment 3_Syllable length_DISTRACTOR	0.688	18	0.000
Experiment 3_Character length_DISTRACTOR	0.911	18	0.091

e) Experiment 1. Levenshtein distance

Tests of Normality- Levenshtein distance between spoken words, competitors, and distractors. Experiment 1	Shapiro-Wilk		
	W	*df*	*p*
Levenshtein distance (Spoken word *vs.* English cohort) Cond. 1	0.883	18	0.030
Levenshtein distance (Spoken word *vs.* Semantic competitor)	0.871	18	0.018
Levenshtein distance (Spoken word *vs.* Shape competitor)	0.920	18	0.132
Levenshtein distance (Spoken word *vs.* Distractor)	0.893	18	0.044

f) Descriptive Statistics

Experiment 1. Levenshtein distance	*N*	*M*	*SD*	Min	Max	Percentiles		
						25th	50th (Median)	75th
Levenshtein distance (Spoken word *vs* English cohort)	18	2.50	1.249	1	5	1.75	2.00	3.00
Levenshtein distance (Spoken word *vs* Shape competitor)	18	5.00	0.970	3	7	4.00	5.00	6.00
Levenshtein distance (Spoken word *vs* Semantic competitor)	18	5.17	0.924	4	7	4.00	5.00	6.00
Levenshtein distance (Spoken word *vs* Distractor)	18	4.94	1.259	3	8	4.00	5.00	6.00

Appendix E. Continued

g) Experiment 1. Levenshtein distance -Wilcoxon signed-ranks test

Test Statistics[a]

	Levenshtein distance (Spoken word *vs.* Semantic competitor) - Levenshtein distance (Spoken word *vs.* English cohort) Cond 1	Levenshtein distance (Spoken word *vs.* Distractor) - Levenshtein distance (Spoken word *vs.* Shape competitor)	Levenshtein distance (Spoken word *vs.* Distractor) - Levenshtein distance (Spoken word *vs.* English cohort) Experiment 1	Levenshtein distance (Spoken word *vs.* Distractor) - Levenshtein distance (Spoken word *vs.* Semantic competitor)	Levenshtein distance (Spoken word *vs.* Shape competitor) - Levenshtein distance (Spoken word *vs.* English cohort) Experiment 1	Levenshtein distance (Spoken word *vs.* Shape competitor) - Levenshtein distance (Spoken word *vs.* Semantic competitor)
Z	-3.687[b]	-.144[c]	-3.429[b]	-.733[c]	-3.435[b]	-.775[c]
p	0.000	0.886	0.001	0.463	0.001	0.439

a. Wilcoxon Signed Ranks Test; b. Based on negative ranks; c. Based on positive ranks.

h) Experiment 3. Levenshtein distance

Tests of Normality- Levenshtein distance between spoken words, competitors, and distractors	Shapiro-Wilk		
	W	*df*	*p*
Levenshtein distance (Spoken word *vs.* Spanish cohort)	0.926	18	0.163
Levenshtein distance (Spoken word *vs.* Semantic competitor)	0.888	18	0.036
Levenshtein distance (Spoken word *vs.* Shape competitor)	0.876	18	0.022
Levenshtein distance (Spoken word *vs.* Distractor)	0.927	18	0.169

i) Descriptive Statistics

Experiment 3. Levenshtein distance	*N*	*M*	*SD*	Minimum	Maximum	Percentiles		
						25th	50th (Median)	75th
Levenshtein distance (Spoken word *vs.* Spanish cohort)	18	3.06	1.110	1	5	2.00	3.00	4.00
Levenshtein distance (Spoken word *vs.* Shape competitor)	18	5.67	1.283	4	9	4.75	6.00	6.00
Levenshtein distance (Spoken word *vs.* Semantic competitor)	18	5.56	0.984	4	7	5.00	6.00	6.00
Levenshtein distance (Spoken word *vs.* Distractor)	18	5.56	1.149	3	8	5.00	5.50	6.00

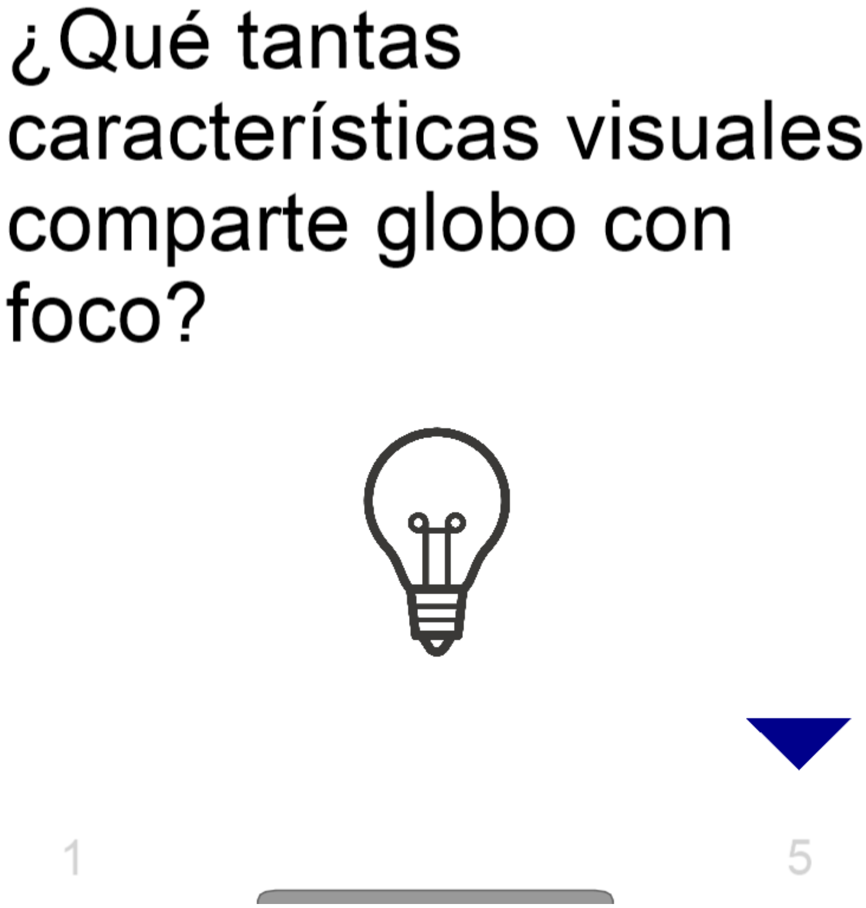
Appendix E. Continued

j) Experiment 3. Levenshtein distance -Wilcoxon signed-ranks test

Test Statistics[a]						
	Levenshtein distance (Spoken word *vs.* Semantic competitor) - Levenshtein distance (Spoken word *vs.* Spanish cohort)	Levenshtein distance (Spoken word *vs.* Distractor) - Levenshtein distance (Spoken word *vs.* Shape competitor)	Levenshtein distance (Spoken word *vs.* Distractor) - Levenshtein distance (Spoken word *vs.* Spanish cohort)	Levenshtein distance (Spoken word *vs.* Distractor) - Levenshtein distance (Spoken word *vs.* Semantic competitor)	Levenshtein distance (Spoken word *vs.* Shape competitor) - Levenshtein distance (Spoken word *vs.* Spanish cohort)	Levenshtein distance (Spoken word *vs.* Shape competitor) - Levenshtein distance (Spoken word *vs.* Semantic competitor)
Z	-3.785[b]	-.213[c]	-3.714[b]	-.091[b]	-3.468[b]	-.182[c]
p	0.000	0.831	0.000	0.927	0.001	0.856

a. Wilcoxon Signed Ranks Test; b. Based on negative ranks; c. Based on positive ranks.

Appendix F. Screen example of the PsychoPy task for the validation study for shape competitors



Appendix G. List of shape competitors to the spoken words with median value
Words in bold have low values (from 1 to 2). The first 18 trials belong to Experiments 3 and 4.

Trial	Experiment	Spoken word	Shape competitor	Median
1	3	beer	cup	5
2	3	**bell**	**skirt**	**2**
3	3	**candy**	**fish**	**2**
4	3	**car**	**rabbit**	**1**
5	3	**castle**	**hat**	**2**
6	3	**cat**	**pear**	**1**
7	3	cheese	sponge	5
8	3	cherry	bomb	5
9	3	**coke**	**violin**	**1**
10	3	letter	mirror	5
11	3	peanut	snowman	4
12	3	photo	screen	4
13	3	planet	button	4
14	3	plate	disc	5
15	3	road	snake	5
16	3	soap	eraser	4
17	3	medal	ball	5
18	3	mouth	banana	5
1	1	casa [house]	flecha [arrow]	4
2	1	puerta [door]	espejo [mirror]	4
3	1	planta [plant]	fuente [fountain]	5
4	1	estrella [star]	flor [flower]	4
5	1	huevo [egg]	balón [ball]	5
6	1	**vestido** [dress]	**reloj** [hourglass]	**2**
7	1	cama [bed]	maleta [suitcase]	3
8	1	caja [box]	hielo [ice]	5
9	1	**barco** [boat]	**volcán** [volcano]	**1**
10	1	conejo [rabbit]	tijeras [scissors]	3
11	1	**tren** [train]	**chocolate** [chocolate bar]	**2**
12	1	bolsa [bag]	camiseta [t-shirt]	4
13	1	ventana [window]	screen [pantalla]	4
14	1	plato [plate]	disco [disc]	5
15	1	**botella** [bottle]	**guitarra** [guitar]	**1**
16	1	**mesa** [table]	**tortuga** [turtle]	**2**
17	1	pastel [cake]	sombrero [hat]	4
18	1	iglesia [church]	torre [tower]	4

Appendix H. Associative strength of spoken words and semantic competitors

Experiment 1

	Spoken word	Semantic competitor	Associative strength (%)*
1	casa [house]	sillón [armchair]	0.3311
2	puerta [door]	llave [key]	0.3311
3	planta [plant]	casa [house]	0.6623
4	iglesia [church]	campana [bell]	1.0909
5	mesa [table]	cuchara [spoon]	0.3311
6	estrella [star]	planeta [planet]	0.3311
7	huevo [egg]	pan [bread]	0.3636
8	vestido [dress]	camisa [shirt]	0.3636
9	cama [bed]	silla [chair]	0.09934
10	caja [box]	jitomate [tomato]	0.3311
11	barco [boat]	ola [wave]	0.7273
12	conejo [rabbit]	lechuga [lettuce]	0.9901
13	tren [train]	avión [plane]	0.7273
14	bolsa [bag]	mochila [backpack]	1.4388
15	ventana [window]	espejo [mirror]	0.9901
16	plato [plate]	cereal [cereal]	0.6601
17	botella [bottle]	vaso [glass]	0.3636
18	pastel [cake]	vela [candle]	1.6502

*http://www.labpsicolinguistica.psicol.unam.mx/Base/index.html

Experiment 3

	Spoken Word	Semantic competitor	Forward Cue-to-Target Strength (FSG related to cue; %) *
1	beer	nut	0.01
2	bell	door	0.01
3	candy	almond	0.05
4	car	bridge	0.01
5	castle	throne	0.02
6	cat	bird	0.03
7	cheese	milk	0.02
8	cherry	strawberry	0.04
9	coke	pizza	0.02
10	letter	box	0.02
11	peanut	elephant	0.03
12	photo	camera	0.05
13	planet	star	0.01
14	plate	bowl	0.05
15	road	truck	0.01
16	soap	towel	0.01
17	medal	trophy	0.04
18	mouth	lipstick	0.02

*http://w3.usf.edu/FreeAssociation

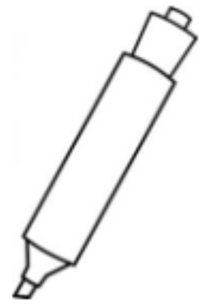
Appendix I. Validation exercise for images from Shutterstock (example)

Nombre:
Edad:
Sexo:

Instrucciones: A continuación se te pide que debajo de cada imágen escribas el nombre del objeto que se presenta

1. 

____

2. 

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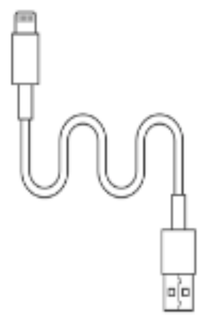
3. 

____

4. 

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5. 

____

6. 

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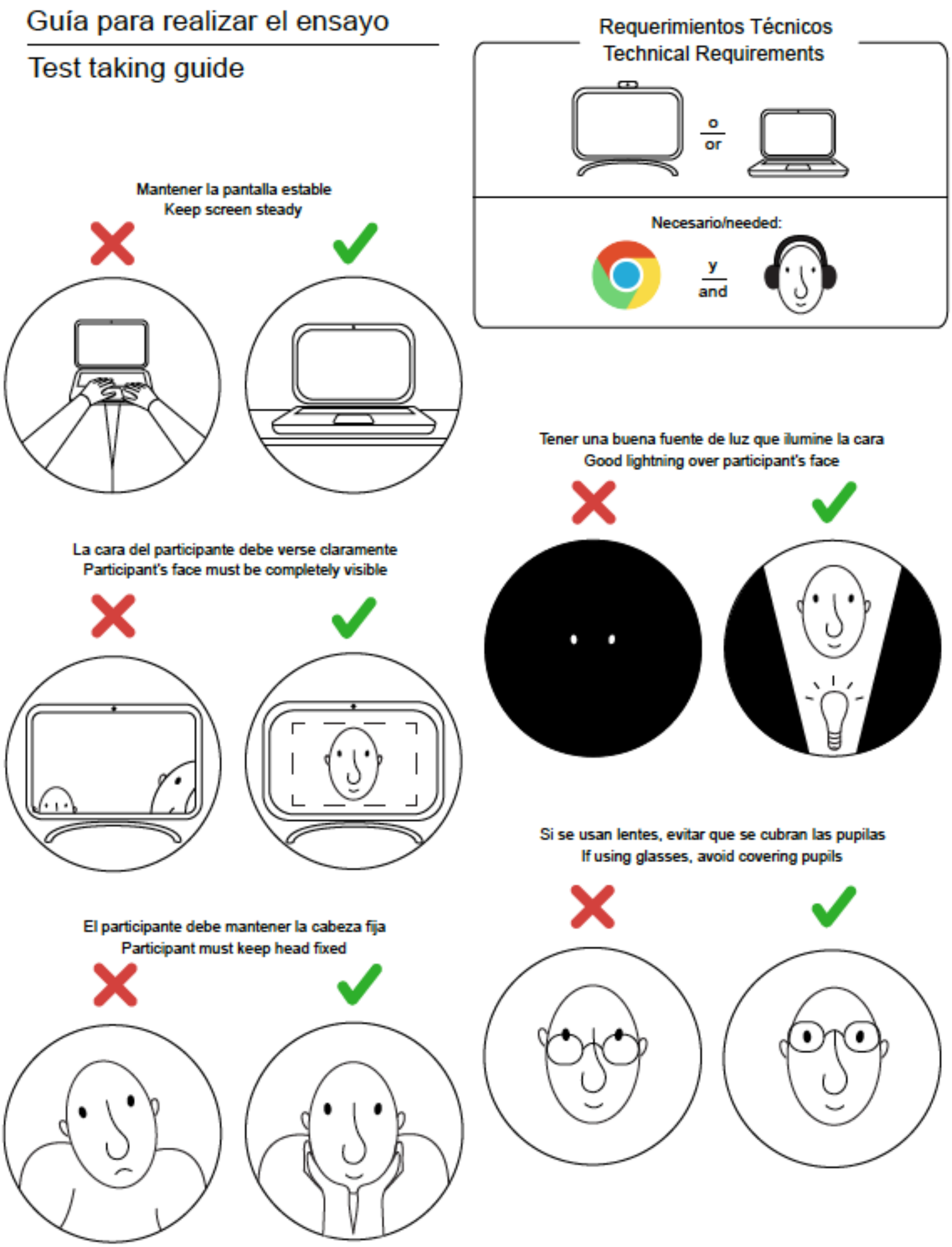
Appendix J. Validation exercise for ENALLT's students (example)

English sentence	Spanish translation
1. Today he thought about candy	
2. Yesterday he bought a coke	
3. Later she cooked the beans	
4. Recently she found a lamb	
5. Tomorrow he'll prepare a sauce	
6. Today he took a pill	
7. Yesterday he thought about wine	
8. Later he saw a car	
9. Today she washed her mouth	
10. Tomorrow he'll buy a phone	

English word	Spanish translation
1. basket	
2. mustache	
3. wineglass	
4. pencil	
5. light bulb	
6. sun	
7. butterfly	
8. gloves	
9. battery	
10. wallet	
11. frog	
12. chair	
13. bird	
14. table	
15. bed	
16. ruler	
17. drawer	
18. trumpet	
19. earrings	

English word	Spanish translation
20. fridge	
21. cookie	
22. egg	
23. sandal	
24. giraffe	
25. tie	
26. bell	
27. orange	
28. vest	
29. spoon	
30. eraser	
31. fork	
32. map	
33. key	
34. turtle	
35. ladder	
36. hanger	
37. glasses	
38. bread	
39. hot dog	

Appendix K. Test taking guide



Appendix L. Distribution of trials in the four experiments (competitors, modality, and language)

A)

Type of competitors	*Frequency*
Phonological competitors	252
Semantic competitors	252
Shape competitors	252
Distractors	252
Total	1008

Note: This table displays the distribution of the type of competitors in the four experiments for statistical analyses.

B)

Type of competitor modality	*Frequency*
Modality: Images	504
Modality: Written words	504
Total	1008

Note: This table displays the distribution of competitor modality in the four experiments for statistical analyses.

C)

Type of competitor language	*Frequency*
Language: Spanish	504
Language: English	504
Total	1008

Note: This table displays the distribution of the competitor language analyzed in the four experiments for statistical analyses.

Appendix M. Kolmogorov-Smirnov normality test of the visual preference task (averaged data)

Test of normality of the time-windows (Four experiments)	Kolmogorov-Smirnov[a]		
	Z	*df*	*p*
Type of experiment and competitors	0.144	360	0.000
Preview of objects/words -200 ms	0.045	360	0.073
Preview of objects/words 100 ms	0.055	360	0.010
Onset of spoken word	0.047	360	0.057
Post view of objects/words 100	0.061	360	0.003
Post view of objects/words 200	0.065	360	0.001
Post view of objects/words 300	0.082	360	0.000
Post view of objects/words 400	0.053	360	0.016
Post view of objects/words 500	0.433	360	0.000
Post view of objects/words 600	0.083	360	0.000
Post view of objects/words 700	0.438	360	0.000
Post view of objects/words 800	0.072	360	0.000
Post view of objects/words 900	0.062	360	0.002
Post view of objects/words 1000	0.078	360	0.000
Post view of objects/words 1100	0.083	360	0.000
Post view of objects/words 1200	0.074	360	0.000
Post view of objects/words 1300	0.092	360	0.000
Post view of objects/words 1400	0.060	360	0.003
Post view of objects/words 1500	0.069	360	0.000

a. Lilliefors Significance Correction

Note: The data averaged from the time-windows did not meet a normal distribution according to the Kolmogorov-Smirnov normality test.

Appendix N. Wilcoxon signed-ranks test for repeated measures

Experiment 1

	Competitor															
	Phon				Sem				Shape				Dist			
Time window	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*
Onset of the spoken word	0.25	.528	.597	0.07	0.27	1.08	.277	0.14	0.23	-1.13	.258	0.14	0.22	-.678	.498	0.09
100 ms	0.27	1.04	.298	0.13	0.25	.207	.836	0.03	0.25	-.863	.388	0.11	0.21	-1.05	.291	0.13
200 ms	0.27	1.12	.260	0.14	0.27	.744	.457	0.09	0.22	-1.25	.208	0.16	0.21	-1.78	.074	0.22
300 ms	0.29	2.24	**.025***	0.28	0.27	-.133	.894	0.02	0.21	-1.69	.089	0.21	0.21	-1.29	.195	0.16
400 ms	0.27	1.18	.237	0.15	0.25	.247	.805	0.03	0.20	-1.86	.062	0.23	0.21	-1.05	.294	0.13
500 ms	0.28	.794	.427	0.10	0.24	-1.13	.258	0.14	0.22	-.790	.429	0.10	0.23	-.004	.997	0.00
600 ms	0.24	.044	.965	0.01	0.26	.701	.481	0.09	0.22	-2.12	**.033***	0.27	0.24	.380	.704	0.05
700 ms	0.27	.922	.357	0.12	0.23	-.225	.822	0.03	0.22	-.620	-535	0.08	0.21	-1.20	.228	0.15
800 ms	0.25	-.053	.958	0.01	0.23	-.123	.902	0.02	0.25	.806	.420	0.10	0.20	-1.87	.061	0.24
900 ms	0.21	-1.43	.151	0.18	0.27	.708	.479	0.09	0.25	-.106	.915	0.01	0.23	-.873	.383	0.11
1000 ms	0.21	-1.42	.155	0.18	0.25	.166	.868	0.02	0.23	-.509	.611	0.06	0.25	-.118	.906	0.02
1100 ms	0.21	-1.48	.137	0.19	0.25	.655	.513	0.08	0.23	-.039	.969	0.01	0.25	-.280	.780	0.04
1200 ms	0.21	-2.29	**.022***	0.29	0.25	.899	.369	0.11	0.27	.523	.601	0.07	0.23	-.274	.784	0.03
1300 ms	0.23	-1.75	.080	0.22	0.23	.140	.888	0.02	0.23	-.552	.581	0.07	0.29	1.29	.194	0.16
1400 ms	0.22	-2.21	**.027***	0.28	0.23	-.258	.796	0.03	0.23	-.369	.712	0.05	0.27	1.48	.138	0.19
1500 ms	0.21	-1.69	.090	0.21	0.23	-.097	.923	0.01	0.23	-.162	.871	0.02	0.29	1.12	.259	0.14

Note: Phon = Phonological competitor; Sem = Semantic competitor; Shape = Shape competitor; Dist = Distractor; *Mdn* = Median; *$p \leq .05$; r = effect size measure obtained through Rosenthal Correlation Coefficient (the *z*-value is divided by the square root of the sample size; in Bartz, A.E. (1999). *Basic statistical concepts* (4th ed., p. 19). Merrill.

Appendix N. Continued

Experiment 2

	Competitor															
	Phon				Sem				Shape				Dist			
Time window	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*
Onset of the spoken word	0.27	.928	.353	0.12	0.25	-.134	.894	0.02	0.23	-1.74	.082	0.22	0.23	-1.28	.200	0.16
100 ms	0.29	.993	.321	0.12	0.22	-.604	.546	0.08	0.21	-1.84	.066	0.23	0.23	-.967	.333	0.12
200 ms	0.27	1.38	.165	0.17	0.21	-1.72	.085	0.22	0.20	-1.03	.302	0.13	0.23	-1.13	.255	0.14
300 ms	0.27	1.42	.153	0.18	0.21	-2.56	**.010***	0.32	0.23	-1.27	.204	0.16	0.27	.165	.869	0.02
400 ms	0.27	.934	.350	0.12	0.21	-1.42	.154	0.18	0.23	-.965	.335	0.12	0.23	.003	.997	0.00
500 ms	0.25	.324	.746	0.04	0.23	-1.28	.198	0.16	0.23	-1.59	.110	0.20	0.27	1.12	.259	0.14
600 ms	0.27	.744	.457	0.09	0.23	-1.24	.215	0.16	0.21	-1.92	.054	0.24	0.27	.672	.501	0.08
700 ms	0.27	1.50	.133	0.19	0.21	-1.90	.056	0.24	0.20	-2.28	**.023***	0.29	0.25	.515	.606	0.07
800 ms	0.27	1.06	.286	0.13	0.23	-1.64	.100	0.21	0.25	-1.30	.192	0.16	0.27	.032	.975	0.00
900 ms	0.27	.568	.570	0.07	0.23	-1.39	.164	0.18	0.25	-.971	.332	0.12	0.25	-.590	.555	0.07
1000 ms	.27	.424	.671	0.05	0.21	-1.44	.148	0.18	0.23	-1.03	.300	0.13	0.27	.514	.607	0.06
1100 ms	0.27	1.68	.092	0.21	0.21	-1.20	.229	0.15	0.21	-1.19	.233	0.15	0.23	-1.01	.309	0.13
1200 ms	.27	.539	.590	0.07	0.23	-1.07	.284	0.13	0.25	-.226	.821	0.03	0.25	-.614	.539	0.08
1300 ms	0.27	1.33	.183	0.17	0.23	-.586	.558	0.07	0.21	-1.26	.205	0.16	0.21	-.860	.390	0.11
1400 ms	0.27	1.88	.059	0.24	0.23	-.716	.474	0.09	0.21	-2.18	**.029***	0.27	0.25	-.990	.322	0.12
1500 ms	0.27	1.65	.099	0.21	0.25	-.083	.934	0.01	0.21	-1.69	.090	0.21	0.21	-2.63	**.008***	0.33

Note: Phon = Phonological competitor; Sem = Semantic competitor; Shape = Shape competitor; Dist = Distractor; *Mdn* = Median; *$p \leq .05$; r = effect size measure obtained through Rosenthal Correlation Coefficient (the z-value is divided by the square root of the sample size; in Bartz, A.E. (1999). *Basic statistical concepts* (4th ed., p. 19). Merrill.

Appendix N. Continued

	Experiment 3															
	Competitor															
	Phon				Sem				Shape				Dist			
Time window	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*
Onset of the spoken word	0.23	-.884	.377	0.11	0.25	-.117	.907	0.02	0.27	.936	.349	0.12	0.21	-.420	.675	0.05
100 ms	0.25	-1.00	.316	0.13	0.27	-.192	.848	0.02	0.25	1.08	.279	0.14	0.23	-.520	.603	0.07
200 ms	0.23	-.888	.375	0.11	0.25	-.040	.968	0.01	0.23	.354	.724	0.04	0.27	-.219	.826	0.03
300 ms	0.25	-.634	.526	0.08	0.23	-.504	.614	0.06	0.27	2.06	**.039***	0.26	0.21	-1.50	.134	0.19
400 ms	0.23	-.046	.964	0.01	0.27	.302	.762	0.04	0.27	1.53	.126	0.19	0.21	-2.56	**.010***	0.32
500 ms	0.22	-.856	.392	0.11	0.27	.906	.365	0.11	0.27	1.29	.196	0.16	0.21	-2.47	**.013***	0.31
600 ms	0.27	-.129	.897	0.02	0.23	-.576	.565	0.07	0.27	1.16	.246	0.15	0.21	-2.47	**.013***	0.31
700 ms	0.22	-.703	.482	0.09	0.25	.435	.663	0.06	0.27	.619	.536	0.08	0.21	-2.17	**.030***	0.27
800 ms	0.23	-.676	.499	0.09	0.29	1.63	.103	0.21	0.25	.786	.432	0.10	0.21	-2.31	**.021***	0.29
900 ms	0.23	-.510	.610	0.06	0.25	.676	.499	0.09	0.27	1.73	.082	0.22	0.20	-2.61	**.009***	0.33
1000 ms	0.23	-.716	.474	0.09	0.25	.158	.874	0.02	0.27	1.05	.294	0.13	0.27	-1.11	.264	0.14
1100 ms	0.23	-1.62	.105	0.20	0.29	1.40	.160	0.18	0.25	.378	.706	0.05	0.23	-1.40	.160	0.18
1200 ms	0.25	-.873	.383	0.11	0.25	.410	.682	0.05	0.27	.845	.398	0.11	0.21	-1.92	.054	0.24
1300 ms	0.21	-1.01	.311	0.13	0.27	.770	.442	0.10	0.27	1.39	.163	0.18	0.21	-1.66	.095	0.21
1400 ms	0.23	.004	.997	0.00	0.23	.388	.698	0.05	0.27	1.08	.277	0.14	0.21	-2.52	**.012***	0.32
1500 ms	0.23	-1.11	.264	0.14	0.27	.339	.734	0.04	0.29	1.29	.197	0.16	0.23	-1.52	.128	0.19

Note: Phon = Phonological competitor; Sem = Semantic competitor; Shape = Shape competitor; Dist = Distractor; *Mdn* = Median; *$p \leq .05$; r = effect size measure obtained through Rosenthal Correlation Coefficient (the *z*-value is divided by the square root of the sample size; in Bartz, A.E. (1999). *Basic statistical concepts* (4th ed., p. 19). Merrill.

Appendix N. Continued

Experiment 4

	Competitor															
	Phon				Sem				Shape				Dist			
Time window	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*	*Mdn*	*Z*	*p*	*r*
Onset of the spoken word	0.25	.013	.989	0.00	0.20	-1.46	.143	0.18	0.27	2.13	**.032**	0.27	0.21	-1.46	.142	0.18
100 ms	0.27	.667	.505	0.08	0.21	-1.55	.120	0.20	0.27	.632	.528	0.08	0.23	-.883	.377	0.11
200 ms	0.27	1.20	.228	0.15	0.21	-1.22	.221	0.15	0.27	1.25	.210	0.16	0.21	-1.69	.090	0.21
300 ms	0.25	-.060	.952	0.01	0.21	-1.60	.110	0.20	0.27	1.70	.088	0.21	0.21	-1.09	.275	0.14
400 ms	0.20	-1.43	.152	0.18	0.21	-1.62	.105	0.20	0.29	2.41	**.016***	0.30	0.25	-.282	.778	0.04
500 ms	0.20	-2.31	**.020***	0.29	0.21	-.476	.634	0.06	0.27	1.49	.135	0.19	0.20	-.225	.822	0.03
600 ms	0.21	-1.81	.069	0.23	0.25	-.646	.518	0.08	0.27	1.71	.086	0.22	0.25	-.416	.677	0.05
700 ms	0.21	-1.27	.203	0.16	0.25	-.768	.443	0.10	0.29	2.00	**.045***	0.25	0.20	-.877	.380	0.11
800 ms	0.25	-1.27	-203	0.16	0.21	-.525	.599	0.07	0.27	2.15	**.031***	0.27	0.25	-.217	.828	0.03
900 ms	0.21	-1.98	**.047***	0.25	0.25	-.199	.842	0.03	0.27	1.01	.311	0.13	0.27	.604	.546	0.08
1000 ms	0.23	-1.09	.274	0.14	0.25	-.454	.650	0.06	0.27	1.50	.133	0.19	0.25	-.267	.789	0.03
1100 ms	0.23	-1.82	.068	0.23	0.25	.585	.558	0.07	0.25	.534	.593	0.07	0.25	-.269	.788	0.03
1200 ms	0.23	-.834	.404	0.10	0.25	-.804	.421	0.10	0.27	1.70	.088	0.21	0.23	-1.30	.192	0.16
1300 ms	0.25	-.810	.418	0.10	0.23	-1.21	.224	0.15	0.27	2.17	**.030***	0.27	0.25	-.899	.368	0.11
1400 ms	0.25	.136	.892	0.02	0.25	-1.62	.105	0.20	0.27	1.26	.207	0.16	0.25	-.497	.619	0.06
1500 ms	0.25	.768	.443	0.10	0.21	-1.61	.105	0.20	0.25	.306	.759	0.04	0.25	-.597	.551	0.08

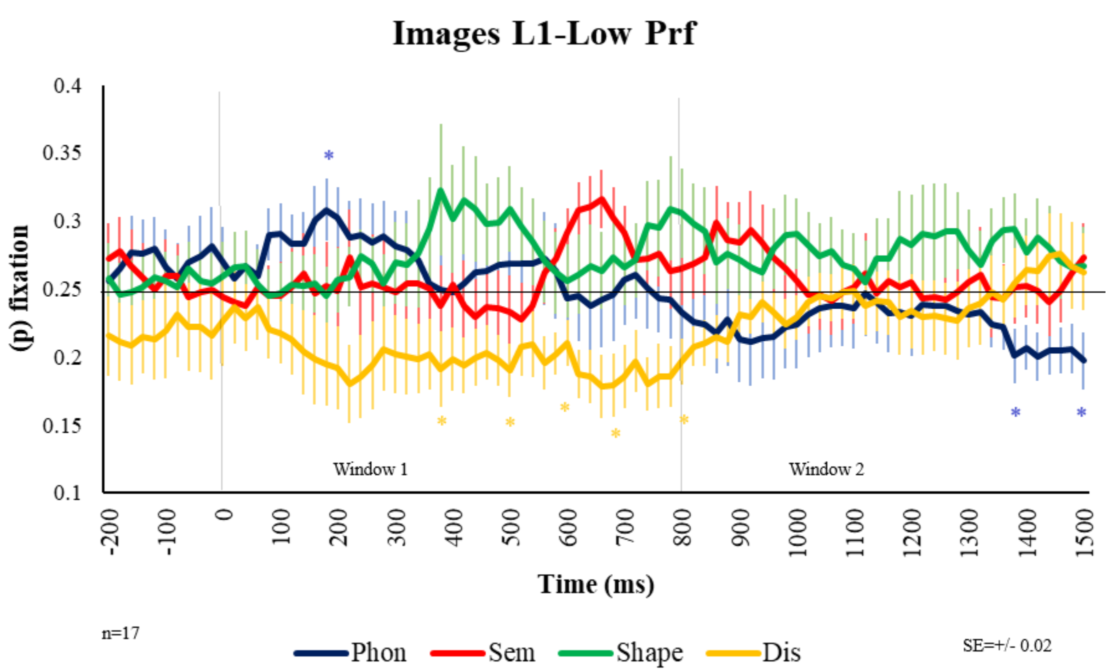
Note: Phon = Phonological competitor; Sem = Semantic competitor; Shape = Shape competitor; Dist = Distractor; *Mdn* = Median; *$p \leq .05$; *r* = effect size measure obtained through Rosenthal Correlation Coefficient (the *z*-value is divided by the square root of the sample size; in Bartz, A.E. (1999). *Basic statistical concepts* (4th ed., p. 19). Merrill.

Appendix O. *Time-windows analyses (Low-intermediate vs. Upper-intermediate L2 Proficiency)*

From Figure 13 to Figure 20, the visual preference of participants with low to intermediate L2 proficiency (*n* =17) are shown. From Figure 15 to Figure 18, the visual preference of participants with upper-intermediate L2 proficiency (*n* = 46) are displayed. These graphs exhibit lexical access through the four experiments: Images and Written words modality in the L1 and L2. PTL for competitors is displayed on the y-axis; time windows are displayed on the x-axis. The onset of the spoken word is at 0 ms. Phon: phonological competitor (blue), Sem: semantic competitor (red), Shape: Shape competitor (green), and Dist: Distractor (yellow). The horizontal line indicates chance level, that is, competitors above this horizontal line attracted more looks. Below this line, looks at stimuli were random. Statistically significant results, according to the Wilcoxon signed-rank test for repeated measures are indicated = *$p \leq .05$. SE= Standard Error: 0.01.

Low-intermediate

Figure 13
Results of Experiment 1- Low-intermediate



Appendix O. Continued

Figure 14

Results of Experiment 2- Low-intermediate

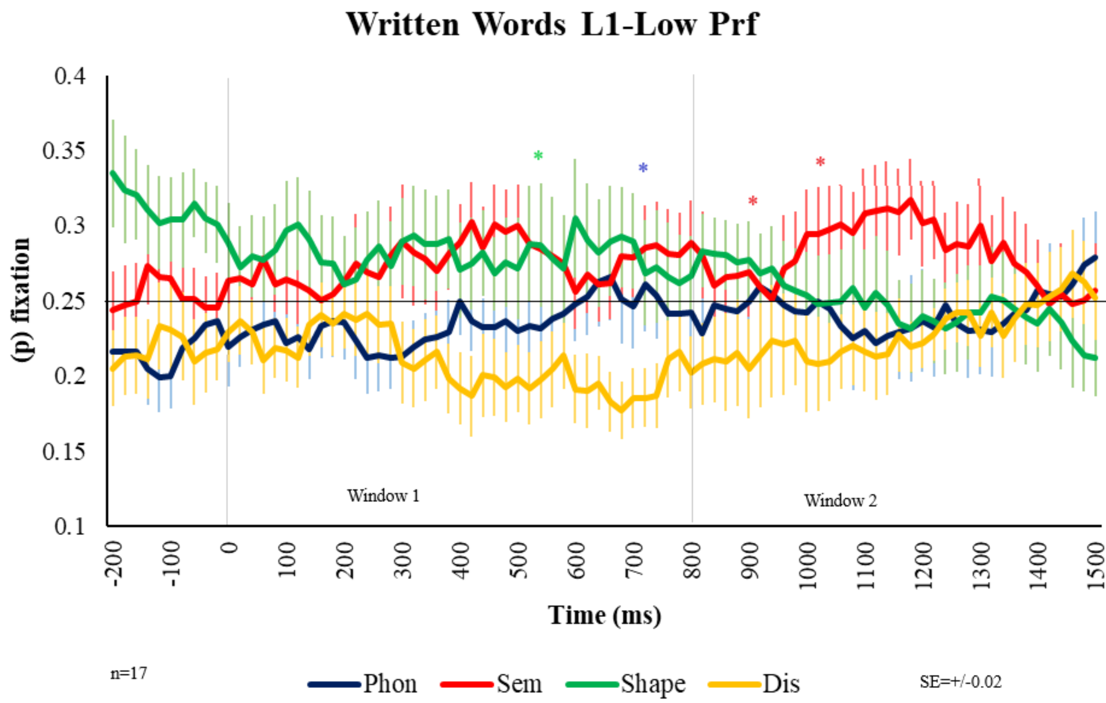
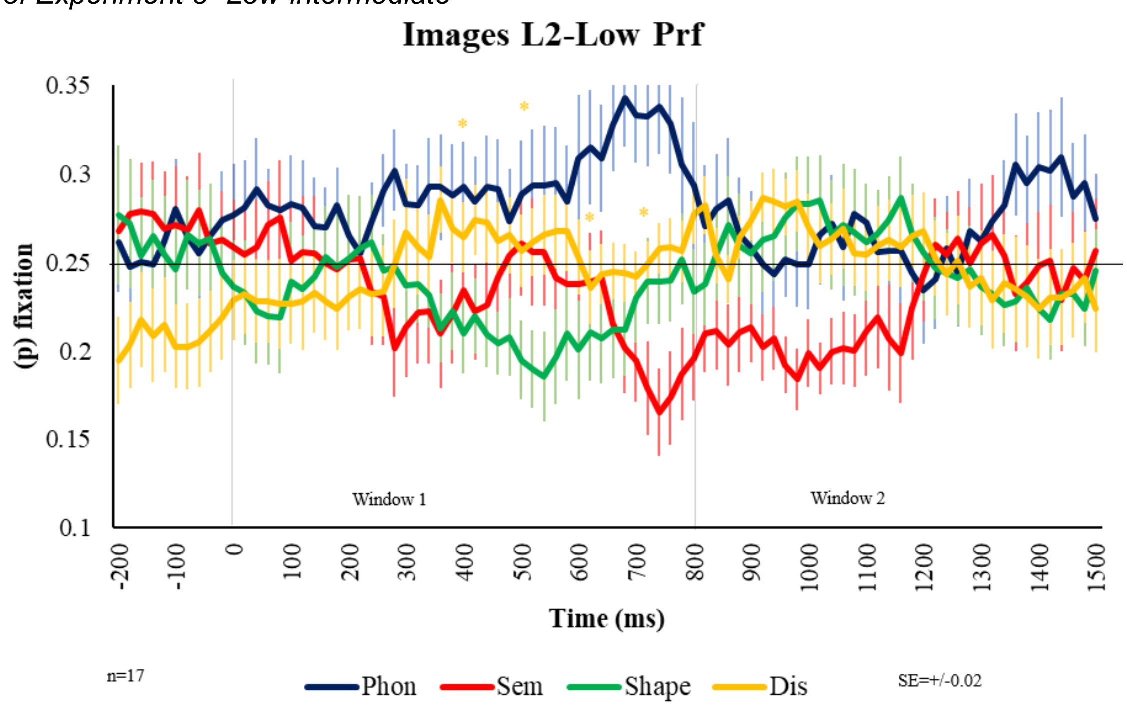


Figure 15

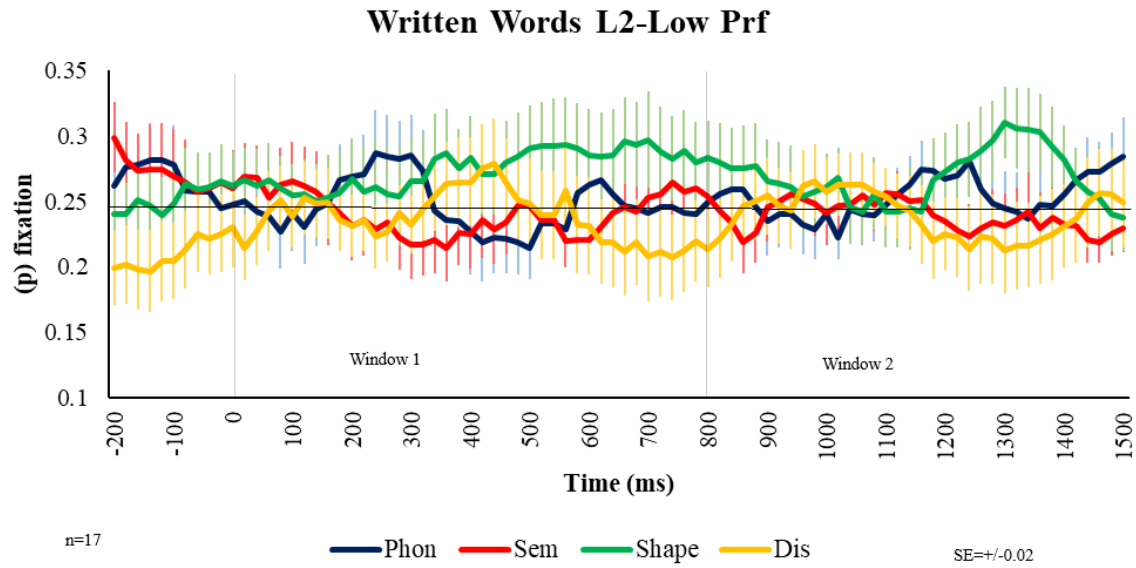
Results of Experiment 3- Low-intermediate



Appendix O. Continued

Figure 16

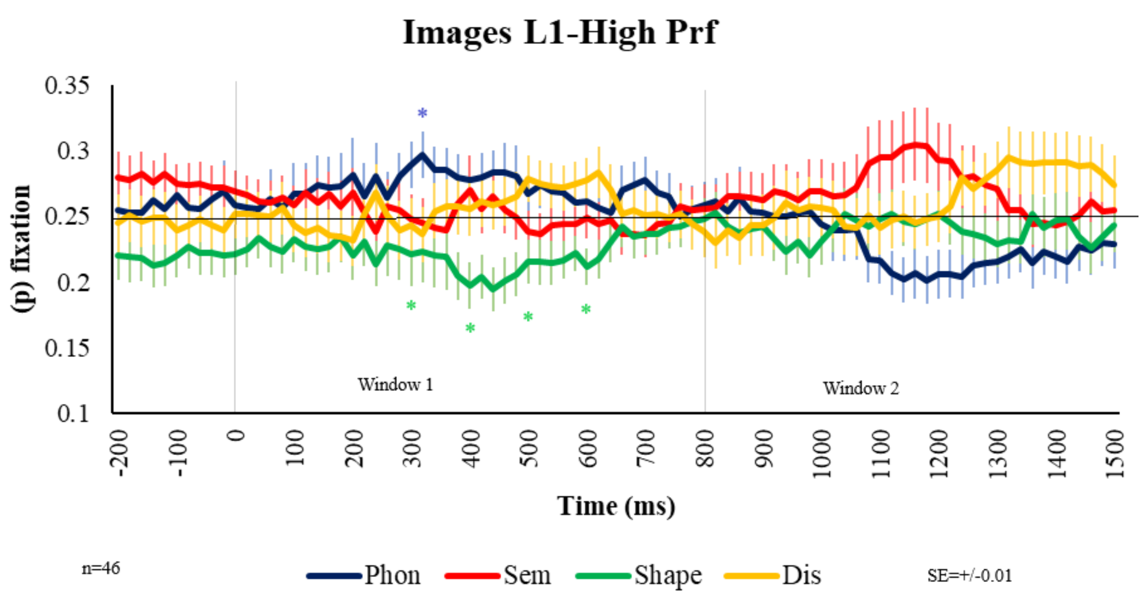
Results of Experiment 4- Low-intermediate



Upper-intermediate

Figure 17

Results of Experiment 1- Upper-intermediate



Appendix O. Continued

Figure 18

Results of Experiment 2- Upper-intermediate

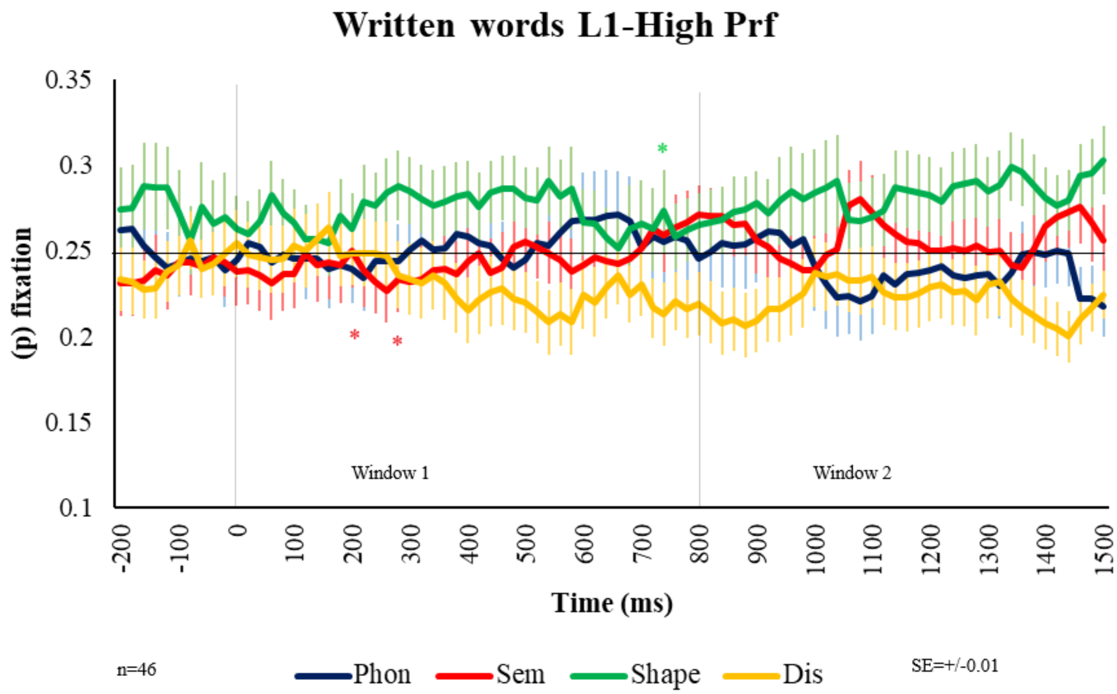
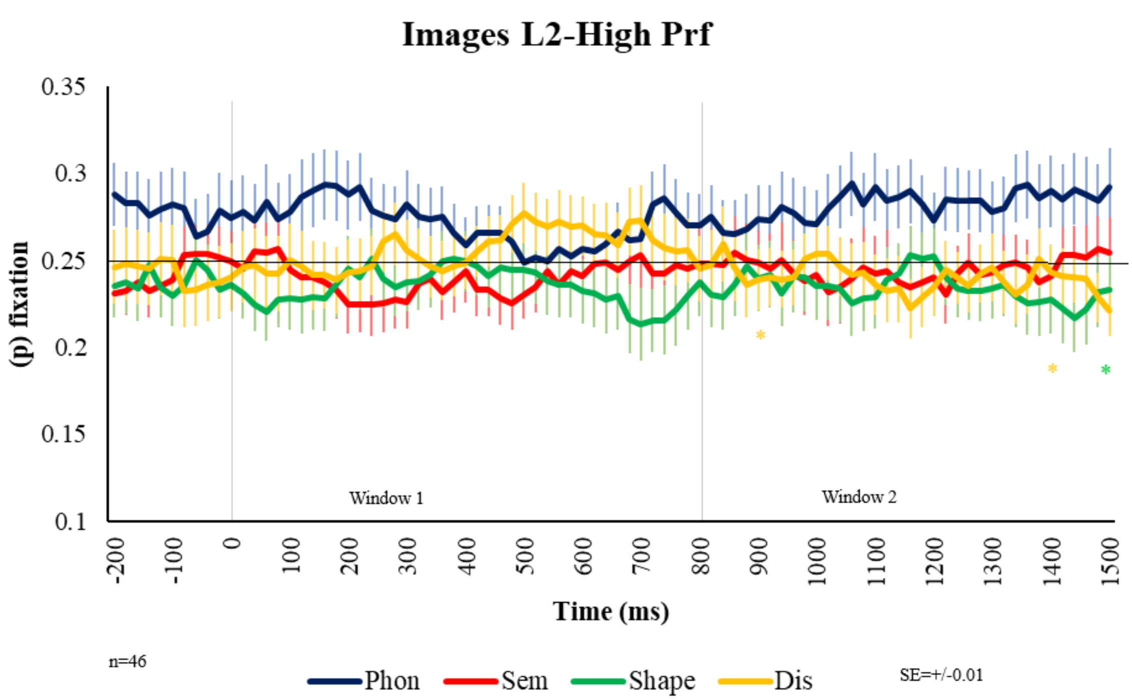


Figure 19

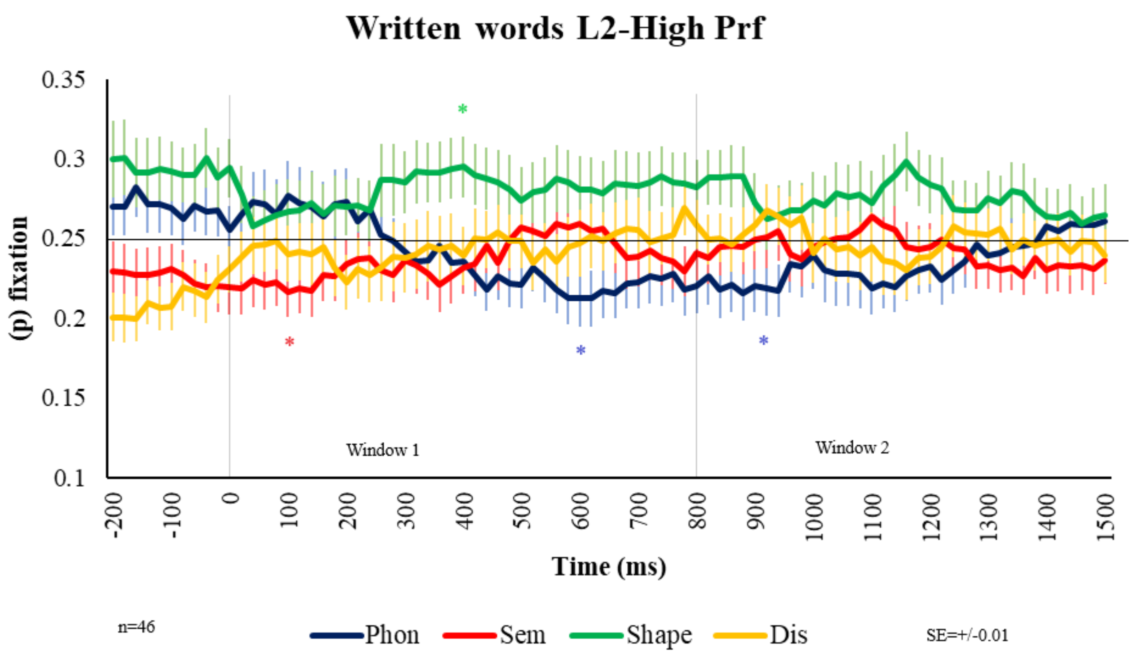
Results of Experiment 3- Upper-intermediate



Appendix O. Continued

Figure 20

Results of Experiment 4- Upper-intermediate



Appendix P. Participants' responses in the Language Experience Questionnaire
Responses in gray indicate higher frequency.

Question 0
Headphone use during the RealEye task

	n	%
No data	5	7
Yes	51	71.8
No	13	18.3
Can't recall	2	2.8
Total	71	100

Question 1
Participants' gender

	n	%
Female	53	74.6
Male	18	25.4
Total	71	100

Question 2
Chronological age of participants

	n	%
18-20	25	35.2
21-23	37	52.1
24-26	5	7
27-29	3	4.3
31	1	1.4
Total	71	100

Question 3
Participants working and studying at the same time

	n	%
Yes	19	26.8
No	52	73.2
Total	71	100

Question 4
Participants' L1

	n	%
Other	0	0
Spanish	71	100
Total	71	100

Appendix P. Continued

Question 6
Estimate your knowledge of Spanish

	n	%
Satisfactory	6	8.5
Good knowledge	45	63.4
Very good knowledge	20	28.2
Total	71	100

Question 7
a. Estimate how many hours a week you write material in Spanish [Messages on social media (e.g., Facebook, Twitter)]

	n	%
0 to 7 hours	33	46.5
8 to 15 hours	11	15.5
More than 16 hours	27	38
Total	71	100

Question 7
b. Estimate how many hours a week you write material in Spanish [Messages on WhatsApp]

	n	%
0 to 7 hours	11	15.5
8 to 15 hours	25	35.2
More than 16 hours	35	49.3
Total	71	100

Question 7
c. Estimate how many hours a week you write material in Spanish [E-mail messages]

	n	%
0 to 7 hours	47	66.2
8 to 15 hours	14	19.7
More than 16 hours	10	14.1
Total	71	100

Question 7
d. Estimate how many hours a week you write material in Spanish [Personal diary]

	n	%
0 to 7 hours	61	85.9
8 to 15 hours	3	4.2
More than 16 hours	7	9.9
Total	71	100

Appendix P. Continued

Question 7
e. Estimate how many hours a week you write material in Spanish [School assignments]

	n	%
0 to 7 hours	14	19.7
8 to 15 hours	26	36.6
More than 16 hours	31	43.7
Total	71	100

Question 7
f. Estimate how many hours a week you write material in Spanish [Academic papers]

	n	%
0 to 7 hours	53	74.6
8 to 15 hours	9	12.7
More than 16 hours	9	12.7
Total	71	100

Question 8
a. Estimate how many hours a week you read material in Spanish [Social media]

	n	%
0 to 7 hours	19	26.8
8 to 15 hours	24	33.8
More than 16 hours	28	39.4
Total	71	100

Question 8
b. Estimate how many hours a week you read material in Spanish [Books (e.g., novels)]

	n	%
0 to 7 hours	34	47.9
8 to 15 hours	28	39.4
More than 16 hours	9	12.7
Total	71	100

Question 8
c. Estimate how many hours a week you read material in Spanish [Academic or specialized papers]

	n	%
0 to 7 hours	26	36.6
8 to 15 hours	34	47.9
More than 16 hours	11	15.5
Total	71	100

Appendix P. Continued

Question 8
d. Estimate how many hours a week you read material in Spanish [Academic textbooks]

	n	%
0 to 7 hours	26	36.6
8 to 15 hours	32	45.1
More than 16 hours	13	18.3
Total	71	100

Question 8
e. Estimate how many hours a week you read material in Spanish [Videogames]

	n	%
0 to 7 hours	63	88.7
8 to 15 hours	4	5.6
More than 16 hours	4	5.6
Total	71	100

Question 9
a. Estimate how many hours a week you listen to material in Spanish [Music]

	n	%
0 to 7 hours	33	46.5
8 to 15 hours	23	32.4
More than 16 hours	15	21.1
Total	71	100

Question 9
b. Estimate how many hours a week you listen to material in Spanish [Movies]

	n	%
0 to 7 hours	43	60.6
8 to 15 hours	19	26.8
More than 16 hours	9	12.7
Total	71	100

Question 9
c. Estimate how many hours a week you listen to material in Spanish [Podcasts of different topics]

	n	%
0 to 7 hours	56	78.9
8 to 15 hours	12	16.9
More than 16 hours	3	4.2
Total	71	100

Appendix P. Continued

Question 9
d. Estimate how many hours a week you listen to material in Spanish [Specialized materials in your study field as Videos in YouTube]

	n	%
0 to 7 hours	32	45.1
8 to 15 hours	30	42.3
More than 16 hours	9	12.7
Total	71	100

Question 10
a. Estimate how many hours a week you speak in Spanish [with family]

	n	%
0 to 7 hours	3	4.2
8 to 15 hours	16	22.5
More than 16 hours	52	73.2
Total	71	100

Question 10
b. Estimate how many hours a week you speak in Spanish [with friends]

	n	%
0 to 7 hours	12	16.9
8 to 15 hours	23	32.4
More than 16 hours	36	50.7
Total	71	100

Question 10
c. Estimate how many hours a week you speak in Spanish [at school]

	n	%
0 to 7 hours	18	25.4
8 to 15 hours	21	29.6
More than 16 hours	32	45.1
Total	71	100

Question 10
d. Estimate how many hours a week you speak in Spanish [at work]

	n	%
0 to 7 hours	43	60.6
8 to 15 hours	7	9.9
More than 16 hours	21	29.6
Total	71	100

Appendix P. Continued

Question 11
a. Estimate how comfortable you feel when talking to others in Spanish

	n	%
Uncomfortable	1	1.4
Rather comfortable	4	5.6
Comfortable	10	14.1
Very comfortable	56	78.9
Total	71	100

Question 11
b. Estimate how comfortable you feel when reading texts in Spanish

	n	%
Comfortable	15	21.1
Very comfortable	56	78.9
Total	71	100

Question 11
c. Estimate how comfortable you feel when understanding audios in Spanish

	n	%
Rather comfortable	1	1.4
Comfortable	10	14.1
Very comfortable	60	84.5
Total	71	100

Question 11
d. Estimate how comfortable you feel when writing in Spanish

	n	%
Rather comfortable	3	4.2
Comfortable	15	21.1
Very comfortable	53	74.6
Total	71	100

Question 12
Besides English, have you ever studied another language?

	n	%
No	45	63.4
Yes	26	36.6
Total	71	100

Appendix P. Continued

Question 13
Time studying another language besides English

	n	%
0-6 months	53	74.6
1-1.5 years	6	8.5
2-3.5 years	11	15.5
6 years	1	1.4
Total	71	100

Question 14
At what age did you start studying English?

Age range	*n*	%
2-8	22	31
9-14	31	44
15-20	16	23
21-26	2	2
Total	71	100

Question 15
Estimate your knowledge of English

	n	%
Satisfactory	18	25.4
Good knowledge	48	67.6
Very good knowledge	5	7
Total	71	100

Question 16
In which level of English, are you currently in?

	n	%
Beginner	2	2.8
Intermediate	38	53.5
Upper-intermediate	30	42.3
Advanced	1	1.4
Total	71	100

Question 17
a. Estimate how many hours a week you write material in English [Messages on social media (e.g., Facebook, Twitter)]

	n	%
0 to 7 hours	64	90.1
8 to 15 hours	7	9.9
Total	71	100

Appendix P. Continued

Question 17
b. Estimate how many hours a week you write material in English [Messages on WhatsApp]

	n	%
0 to 7 hours	70	98.6
8 to 15 hours	1	1.4
Total	71	100

Question 17
c. Estimate how many hours a week you write material in English [E-mail messages]

	n	%
0 to 7 hours	64	90.1
8 to 15 hours	6	8.5
More than 16 hours	1	1.4
Total	71	100

Question 17
d. Estimate how many hours a week you write material in English [Personal diary]

	n	%
0 to 7 hours	69	97.2
8 to 15 hours	2	2.8
Total	71	100

Question 17
e. Estimate how many hours a week you write material in English [School assignments]

	n	%
0 to 7 hours	46	64.8
8 to 15 hours	24	33.8
More than 16 hours	1	1.4
Total	71	100

Question 17
f. Estimate how many hours a week you write material in English [Academic papers]

	n	%
0 to 7 hours	64	90.1
8 to 15 hours	5	7
More than 16 hours	2	2.8
Total	71	100

Appendix P. Continued

Question 18
a. Estimate how many hours a week you read material in English [Social media]

	n	%
0 to 7 hours	43	60.6
8 to 15 hours	25	35.2
More than 16 hours	3	4.2
Total	71	100

Question 18
b. Estimate how many hours a week you read material in English [Books (e.g., novels)]

	n	%
0 to 7 hours	56	78.9
8 to 15 hours	14	19.7
More than 16 hours	1	1.4
Total	71	100

Question 18
c. Estimate how many hours a week you read material in English [Academic or specialized papers]

	n	%
0 to 7 hours	40	56.3
8 to 15 hours	27	38
More than 16 hours	4	5.6
Total	71	100

Question 18
d. Estimate how many hours a week you read material in English [Academic textbooks]

	n	%
0 to 7 hours	45	63.4
8 to 15 hours	21	29.6
More than 16 hours	5	7
Total	71	100

Question 18
e. Estimate how many hours a week you read material in English [Videogames]

	n	%
0 to 7 hours	59	83.1
8 to 15 hours	10	14.1
More than 16 hours	2	2.8
Total	71	100

Appendix P. Continued

Question 19
a. Estimate how many hours a week you listen to material in English [Music]

	n	%
0 to 7 hours	11	15.5
8 to 15 hours	33	46.5
More than 16 hours	27	38
Total	71	100

Question 19
b. Estimate how many hours a week you listen to material in English [Movies]

	n	%
0 to 7 hours	25	35.2
8 to 15 hours	39	54.9
More than 16 hours	7	9.9
Total	71	100

Question 19
c. Estimate how many hours a week you listen to material in English [Podcasts of different topics]

	n	%
0 to 7 hours	61	85.9
8 to 15 hours	9	12.7
More than 16 hours	1	1.4
Total	71	100

Question 19
d. Estimate how many hours a week you listen to material in English [Specialized materials in your study field as videos in YouTube]

	n	%
0 to 7 hours	42	59.2
8 to 15 hours	23	32.4
More than 16 hours	6	8.5
Total	71	100

Question 20
a. Estimate how many hours a week you speak in English [with family]

	n	%
0 to 7 hours	71	100
Total	71	100

Appendix P. Continued

Question 20
b. Estimate how many hours a week you speak in English [with friends]

	n	%
0 to 7 hours	63	88.7
8 to 15 hours	8	11.3
Total	71	100

Question 20
c. Estimate how many hours a week you speak in English [at school]

	n	%
0 to 7 hours	45	63.4
8 to 15 hours	23	32.4
More than 16 hours	3	4.2
Total	71	100

Question 20
d. Estimate how many hours a week you speak in English [at work]

	n	%
0 to 7 hours	68	95.8
8 to 15 hours	3	4.2
Total	71	100

Question 21
a. Estimate how comfortable you feel when talking to others in English

	n	%
Uncomfortable	8	11.3
Rather comfortable	33	46.5
Comfortable	28	39.4
Very comfortable	2	2.8
Total	71	100

Question 21
b. Estimate how comfortable you feel when reading texts in English

	n	%
Uncomfortable	1	1.4
Rather comfortable	7	9.9
Comfortable	47	66.2
Very comfortable	16	22.5
Total	71	100

Appendix P. Continued

Question 21
c. Estimate how comfortable you feel when understanding audios in English

	n	%
Uncomfortable	4	5.6
Rather comfortable	24	33.8
Comfortable	35	49.3
Very comfortable	8	11.3
Total	71	100

Question 21
d. Estimate how comfortable you feel when writing in English

	n	%
Uncomfortable	8	11.3
Rather comfortable	25	35.2
Comfortable	35	49.3
Very comfortable	3	4.2
Total	71	100

LexTALE score

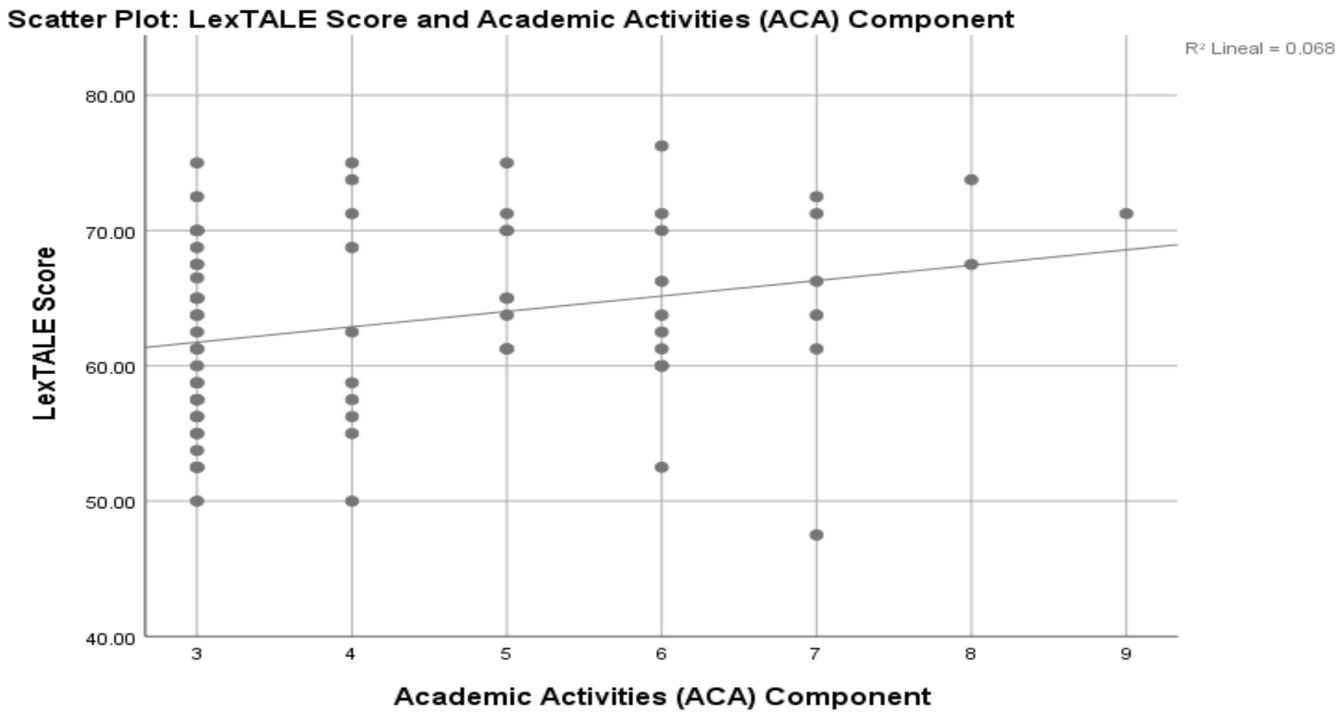
Score range	*n*	Level
48-53	7	Beginner
54-59	14	Beginner
60-66	24	Upper-intermediate
67-72	18	Upper-intermediate
73-78	8	Upper-intermediate
Total	71	

LexTALE proficiency

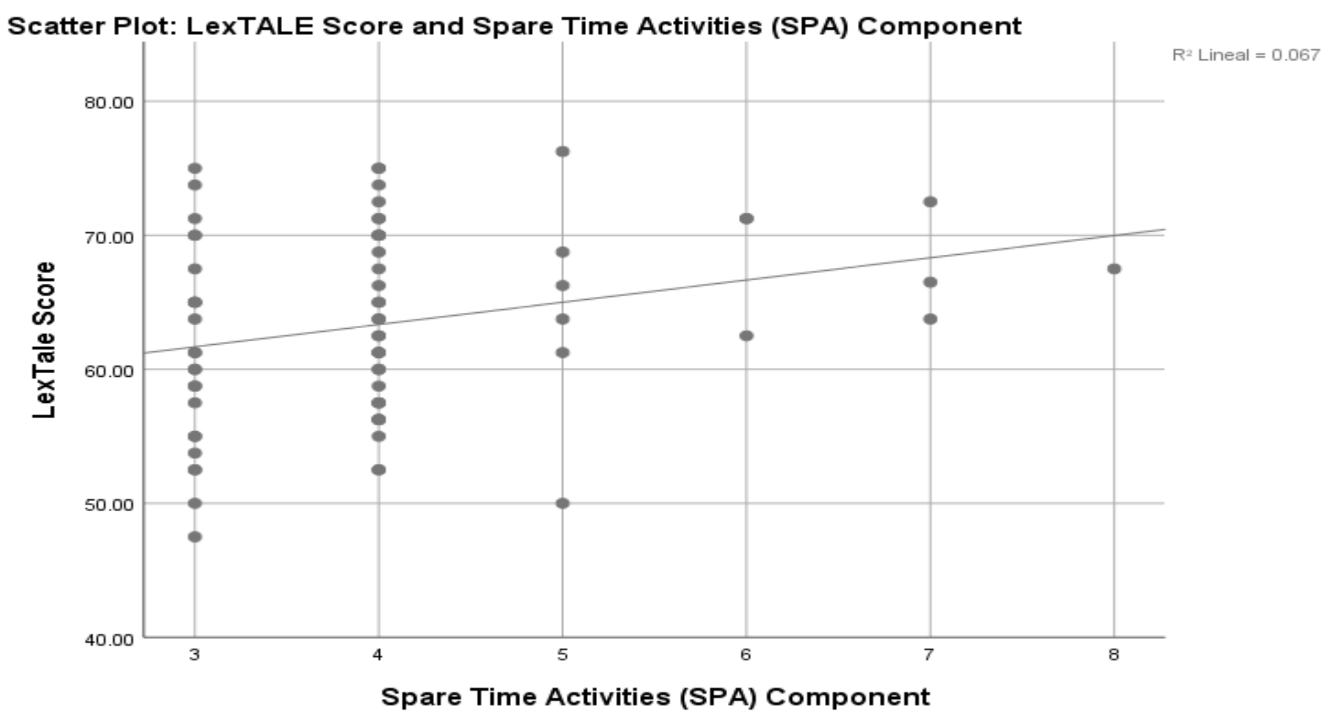
	n	%
Beginner	22	31
Upper-intermediate	49	69
Total	71	100

Appendix Q. Language experience questionnaire (English use/language practice). Regression models graphs

a) LexTALE score * Academic component (n = 71)



b) LexTALE score * Spare time component (n = 71)



Appendix Q. Continued

c) LexTALE score (low *vs*. high) * Frequency of watching movies * Participants' chronological age (*n* = 71)