TRACKING BILINGUAL ACTIVATION IN THE PROCESSING AND PRODUCTION OF SPANISH STRESS

By

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Abstract

Language dominance and language bias (or language mode) are two of the factors that have been proposed to modulate the level of cross-language activation reported in the bilingual language comprehension and language production literature (e.g., Grosjean, 1997; Guo & Peng, 2006; Ju & Luce, 2004; Marian & Spivey, 2003a; Soares & Grosjean, 1984; Spivey & Marian, 1999; Weber & Cutler, 2004). However, it is still unclear whether (and if so, how) these factors modulate both language comprehension and language production, and whether they interact with each other. The current dissertation uses two visual world eye-tracking experiments and an adaptation of this paradigm in speech production to further explore how language bias and a specific aspect of language dominance, namely language proficiency, modulate cross-language activation in bilingual word recognition and production. More specifically, this dissertation investigates the circumstances under which differences in stress placement between Spanish-English cognate words (e.g., *mate**rial*** vs. *ma**te**rial* in Spanish and English, respectively) affect the recognition and production of a Spanish target word (e.g., *ma**te**ria* “subject/matter”). This dissertation compares word recognition experiments with vs. without the explicit presence of the unintended language (English) to see whether competition effects from the English stress pattern are modulated by the language mode (from monolingual to bilingual) in which bilinguals are during the completion of the experiment.

Cross-language activation is examined by manipulating the stress pattern of the cognate competitor in English (always stressed on the last syllable in Spanish). In one condition, the English cognate competitor is stressed on the second syllable, like the Spanish target (e.g., target: *materia*, competitor: *material*). In this condition, the competitor is predicted to interfere with the recognition of the Spanish target but not to interfere with its production. In the other condition,

the English cognate competitor is stressed on the first syllable, and thus differs from the Spanish target (e.g., target: *litera* ‘bunk bed’, competitor: *literal* ‘literal’). In that condition, the English cognate competitor is not predicted to interfere with the recognition of the Spanish word, but to interfere with its production. The effect of language bias on cross-language activation is tested by manipulating the percentage of time the target word in the filler trials is heard in Spanish and English, ranging from 0% to 65% of English during the experimental session. Finally, the effect of language proficiency is assessed using two measures of proficiency (a cloze, i.e., fill-in-the-blank, test and LexTALE) in bilinguals’ second language (L2).

Experiment 1, a visual-world eye-tracking experiment only in Spanish, investigates whether lexical stress can modulate the degree of cross-language activation that bilingual listeners in a monolingual language mode experience in language comprehension. In doing so, Experiment 1 seeks to ascertain whether cross-language activation is indeed observed in a context where bilinguals are expected to function in only one of their languages (Spanish in this case), in line with the nonselective hypothesis of language activation. Another objective of Experiment 1 is to ascertain whether mid-to-high-proficiency English-speaking L2 learners of Spanish (henceforth referred to as the first-language-(L1)-English L2-Spanish group) can make use of suprasegmental cues to stress during online word recognition. The results of the L1-English L2-Spanish bilinguals showed facilitation for cognates, indicating that these listeners activated their L1, even when nothing in the acoustic input or in the testing session should have led them to activate English, in line with the nonselective hypothesis. Furthermore, these bilinguals showed an increasingly small effect of stress as their Spanish proficiency, indicating that lower-proficiency bilinguals can use stress to recognize Spanish words. The L1-Spanish L2-

English bilinguals also used stress to recognize Spanish words, but unlike the L1-English L2-Spanish group, they did not show any evidence of cross-language activation.

Experiments 2 and 3 investigate how language bias and L2 proficiency modulate cross-language activation when bilinguals are in a bilingual language mode. Experiment 2 uses a visual-world eye-tracking experiment with trials in both English (fillers) and Spanish (fillers and experimental trials), and language bias is manipulated as the percentage of time the target word (in filler trials) is produced in either Spanish or English. The results of this experiment show that both the L1-Spanish L2-English and L1-English L2-Spanish groups were influenced by the language bias manipulation (L1-Spanish L2-English: 0% English bias vs. 65% English bias; L1-English L2-Spanish: 0% English bias vs. 65% English bias, 20% English bias vs. 65% English bias). For the L1-English L2-Spanish participants, language bias also modulated the effect of stress, with the stress of the English cognate interfering with the recognition of the Spanish target only in the English-bias condition. Moreover, more proficient L1-English L2-Spanish bilinguals were better at controlling this cross-language activation than less proficient ones. By contrast, English stress did not interfere with L1-Spanish L2-English listeners' lexical access, nor was its effect modulated by these bilinguals' L2 proficiency or by the language bias manipulation.

Finally, using an adaptation of Experiment 2 to elicit word productions, Experiment 3 examines the effects of L2 proficiency and language bias on word production when bilinguals are in a bilingual language mode. Experiment 3 uses the same language bias manipulation as Experiment 2. The results show that both the L1-Spanish L2-English and the L1-English L2-Spanish groups were slower and less accurate at producing the Spanish target word (with the correct stress placement) when the stress pattern of the English cognate competitor differed from that of the Spanish target word than when it was identical to it. For L1-Spanish L2-English speakers, the more proficient they were in English, the least accurate they were in their production of the Spanish target. For L1-English L2-Spanish speakers, the effect of stress was greater in the English bias condition than in the Spanish bias condition.

The findings of this dissertation indicate that language bias modulates cross-language activation in both language comprehension and language production. Furthermore, when the unintended language is the L1, more proficient bilinguals are better at controlling for the degree of L1 activation in the L2 (in comprehension), but when the unintended language is the L2, they are worse at controlling for the degree of L2 activation in the L2 (in word production). Last but not least, language production appears to be more likely to elicit cross-language activation than language comprehension, given that the L1-Spanish L2-English groups showed evidence of cross-language activation from English only in Experiment 3. These findings have implications for models of bilingual activation. The results of Experiments 2 and 3 are in line with the predictions of the Inhibitory Control Model (Green, 1998), which claim that both language bias and proficiency should modulate the initial stages of word activation. The results of this dissertation are also consistent with Grosjean's proposed language mode continuum (Grosjean, 1998), suggesting that Experiments 1 and 2 placed participants at different points of this continuum.

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Chapter 1: Introduction

According to the latest report of *Ethnologue*, close to 7,000 languages exist in the world (Lewis, Simons, & Fennig, 2015). Contact among people of different language groups leads to what we know as bilingualism or multilingualism, that is, the ability to communicate at a functional level in two or more languages. It is estimated that half of the world's population, if not more, is bilingual (Grosjean, 2010). Individuals who know two or more languages need to engage in greater cognitive "gymnastics" than monolinguals, because they must activate the intended language while (at least to some degree) inhibiting[1] the other language. Even in situations where only one language is used, the languages of bilingual and multilingual speakers have been claimed to be active and to interact (for a review, see Kroll, Dussias, Bogulski, & Kroff, 2012). Unclear, however, is how cross-language activation and inhibition take place and what factors modulate them. This dissertation sheds further light on these questions by examining how proficiency in the non-dominant language and language expectation (or language bias) modulate cross-language activation in language comprehension and language production. Although this research focuses exclusively on bilingual activation, the same questions can be raised and the same predictions can be made with multilinguals.

Research done in the past 25 years has shown that bilinguals, including simultaneous bilinguals and early and late second language (L2) learners, activate words in both of their languages even when they consciously intend to use only one language (e.g., Blumenfeld &

[1] Throughout this dissertation, the term "inhibit" is used in a theory-neutral way, without the assumption that a domain-general inhibitory control mechanism is involved.

Marian, 2011; Canseco-Gonzalez et al., 2010; Desmet & Duyck, 2007; Dijkstra, 2005; Marian & Spivey, 2003a, 2003c; Schulpen, Dijkstra, Schriefers, & Hasper, 2003; Weber & Cutler, 2004). So, for bilinguals, as a spoken word in the speech signal unfolds, not only lexical candidates that most closely match the input in the intended language, but also words in the unintended language, become partially activated and compete for recognition. Successful recognition of the speech signal, then, involves inhibiting not only the non-intended word, but also the non-intended language. Importantly, evidence suggests that bilinguals simultaneously activate both lexicons not only in language comprehension, but also during language production (e.g., Costa, Santesteban, & Ivanova, 2006; Costa & Santesteban, 2004; Grainger & Beauvillain, 1987; Jackson, Swainson, Cunnington, & Jackson, 2001; Meuter & Allport, 1999).

Several factors have been proposed to modulate the level of cross-language interference reported in the bilingual language comprehension and language production literature, among which the effects of factors such as language dominance and language bias (or language mode) have been consistently reported (e.g., Grosjean, 1997; Guo & Peng, 2006; Ju & Luce, 2004; Marian & Spivey, 2003a; Soares & Grosjean, 1984; Spivey & Marian, 1999; Weber & Cutler, 2004). Language dominance can be operationalized as whether the unintended language is the native language (L1) or the L2, whether or not the unintended language is used more often than the intended language, and how proficient bilinguals are in both the intended and unintended languages. For example, more cross-language activation has been reported when the unintended language is the L1 and bilinguals are performing the task at hand in their L2 than in the reverse scenario (e.g., Ju & Luce, 2004; Spivey & Marian, 1999; Weber & Cutler, 2004). Prolonged use of the less dominant language (e.g., in a recent L2 immersion), however, may overcome the stronger activation from the L1 (e.g., Duffau, 2008; García-Pentón, et al., 2014; Martino, et al., 2010; Mohades et al., 2012). Finally, bilinguals activate phonologically overlapping words from the unintended language more with increasing proficiency in that language (e.g., Chee, Tan, & Thiel, 1999; Golestani et al., 2006; Guo & Peng, 2006; Jeong et al., 2007; Klein, Watkins, Zatorre, & Milner, 2006; Perani et al., 2003; Silverberg & Samuel, 2004; Weber & Cutler, 2004). Cross-language activation may also be modulated by factors that have been shown to affect language bias, including the interlocutor, the situation, the content of discourse, and the function of the interaction (e.g., Dijkstra & van Hell, 2003; Marian & Spivey, 2003a; Soares & Grosjean, 1984; for discussion, see Grosjean, 1998). For example, the degree of cross-language interference is smaller when bilinguals expect to communicate in only one language than when they expect to communicate in both of their languages.

What remains unclear from previous research, however, is whether (and if so, how) language bias and a specific aspect of language dominance, namely language proficiency, modulate both language comprehension and language production, and whether they interact (e.g., more proficient bilinguals could show less sensitivity to language bias as a result of better controlling for the degree of cross-language activation). A number of models of bilingual activation have been proposed to account for the degree of cross-language activation that bilinguals show under different circumstances. These models make different predictions regarding the role of factors such as language bias to control for this continuous cross-language interference. In this dissertation, two models are considered: the Inhibitory Control Model (Green, 1998) and the Bilingual Interactive Activation Plus (BIA+) Model (Dijkstra & van Heuven, 2002).

The Inhibitory Control Model (Green, 1998) stipulates that bilinguals' two languages are represented by different language tags schemas (established from prior input), which alter the activation levels of lexical representations in a top-down fashion. The model postulates that the activation level of the language schemas is altered by the supervisory attentional system, which works as a domain-general inhibitory control mechanism. According to the Inhibitory Control Model, language tag schemas are the primary source of control in bilingual word activation (for both comprehension and production), so the model predicts an effect of language bias on this activation. Moreover, proficiency is expected to affect the degree to which the word lemmas are activated. That is, the Inhibitory Control Model predicts that both proficiency and language bias will control the level of activation of the unintended language.

Similarly to the Inhibitory Control Model (Green, 1998), the Bilingual Interactive Activation Plus (BIA+) Model (Dijkstra & van Heuven, 2002) represents the bilinguals' two languages with the use of language nodes, by means of which the activation levels of lexical representation can be altered. However, unlike the Inhibitory Control Model, the language nodes in the BIA+ model cannot perform a form of top-down control in early stages of word activation (what Dijkstra & van Heuven refer to as the "word identification system"). The BIA+ Model claims that the activation and inhibition of lexical representations is strictly controlled by the input in this early stage of word recognition. According to this model, language nodes can only influence the output (i.e., word selection) of the "task/decision system". This model was originally proposed to explain bilingual word activation in comprehension tasks, and as such does not make predictions for productions tasks. For comprehension, this model predicts that proficiency will modulate bilingual activation, but language bias should not have such an effect in the early stages of word activation. Thus, both models make different, testable predictions regarding what happens in the early stages of spoken word recognition.

The main objective of this dissertation is to shed new light on bilingual processing by further exploring how language proficiency and language bias affect the way in which bilinguals control the level of activation of their two languages in speech processing and production. Three experiments are conducted that examine how differences in word-level stress placement between two languages (Spanish and English) affect the processing of cognate words in language tasks aimed to put bilinguals into a monolingual or a bilingual language mode.

Research has shown that in languages that have word-level stress, greater activation of words that match the signal both segmentally and suprasegmentally is observed (as compared to words that only match the signal segmentally) for both native speakers (e.g., Cooper, Cutler, & Wales, 2002; Soto-Faraco, Sebastián-Galles, & Cutler, 2001) and, to some extent, L2 learners (e.g., Martínez-García, Van Anne, Brown, & Tremblay, n.d.; Tremblay, 2008). However, it is unclear whether stress placement that differs between two languages can interfere with the recognition of cognate words (as compared to non-cognate, control words and cognate words with non-interfering stress placement). Stress provides an interesting test for examining bilingual activation because Spanish and English have a number of words that share the same (orthographic) segments (i.e., cognates) but do not have the same stress pattern (e.g., the word *material*, which has the same meaning in both languages, has second-syllable stress in English but final stress in Spanish). In this case, we expect that the corresponding segmental make-up of the cognate words would make them highly activated in both languages. Bilingual listeners' ability to use stress to recognize Spanish words should thus be contingent on their ability to use Spanish stress to inhibit the English competitor.

This research examines the degree of lexical competition that cognates with similar vs. different stress patterns in Spanish and English create for bilinguals English-Spanish speakers. It does so using the visual world eye-tracking paradigm and an adaptation of this paradigm in speech production. Participants included native speakers of Spanish at a mid-proficiency level in English (henceforth, L1-Spanish L2-English bilinguals) and native speakers of English at a mid-to-high level of proficiency in Spanish (henceforth, L1-English L2-Spanish bilinguals). A first, Spanish-only experiment (Experiment 1) investigated whether lexical stress can modulate the degree of cross-language activation that bilingual listeners in a monolingual language mode experience in comprehension. It did so by examining whether the presence of the cognate competitors with interfering stress would influence the recognition of Spanish words in a task where English is not explicitly activated. Two additional, Spanish-English experiments (Experiments 2-3) investigated whether the effect of stress on the degree of cross-language activation would be stronger once participants are in a bilingual language mode. More specifically, it examined whether the presence of cognate competitors with interfering stress placement would influence the recognition of Spanish words in a task where participants would expect to hear (Experiment 2) or produce (Experiment 3) more Spanish than English or more English than Spanish (language bias). All three experiments also examine how L2 proficiency modulates cross-language activation in the task. In determining whether bilinguals can inhibit the stress pattern of the unintended language (English) when recognizing or producing Spanish target words, this research contributes to a better understanding of how language proficiency and language bias modulate cross-language activation in auditory word recognition and in word production.

This dissertation is organized as follows: Chapter 2 reviews the main findings on bilingual language activation, and Chapter 3 reviews the literature on listeners' use of stress in lexical access; Chapter 4 presents the general design of the current study; Chapters 5-7 describe the methods and present the results of Experiments 1-3 (respectively); Chapter 8 provides a general discussion of the current findings, returns to models of bilingual activation, and concludes this dissertation.

Chapter 2: Bilingual Activation

2.1 Factors Affecting Bilingual Activation

Existing research on the factors affecting bilingual activation has tested both comprehension and production of speech using different tasks and language combinations (e.g., Colomé & Miozzo, 2010; Ju & Luce, 2004; Kroll, Bobb, Misra, & Guo, 2008; Marian & Spivey, 2003a, 2003b; Schulpen et al., 2003; Spivey & Marian, 1999; Weber & Cutler, 2004). However, the findings of this previous research have been mixed, leaving the door open for more research to try to understand how language proficiency and language bias affect how bilinguals control the level of activation of their two languages during comprehension and production. In this section, the main findings of this bilingual language comprehension and production literature are summarized.

2.1.1 Language Comprehension

Research on cross-language activation in language comprehension is clear in showing that lexical activation is not language selective: Bilinguals activate their two languages in parallel during language comprehension (e.g., Ju & Luce, 2004; Marian & Spivey, 2003b; Schulpen et al., 2003; Spivey & Marian, 1999; Weber & Cutler, 2004). Considering that the pool of alternatives that a bilingual listener activates doubles (because both languages are activated in parallel), the word recognition process may be more challenging for someone with a good command of two languages, increasing the normal demands of word processing.

One common paradigm that has been used to investigate bilingual activation is the visual world eye-tracking paradigm. This methodology provides good temporal resolution of the activation of words that closely match the acoustic input (Allopenna, Magnuson, & Tanenhaus, 1998). Spivey and Marian (1999) were among the first to implement this paradigm to better understand the time course of bilingual activation during spoken word comprehension. In their study, Spivey and Marian (1999) (see also Marian & Spivey, 2003a, 2003b) presented Russian-English bilinguals with a visual display consisting of four objects, and asked participants to manipulate one of the objects (the target) while doing the task in either English or Russian (in different blocks). The interesting manipulation consisted of selecting an English target word (e.g., *marker*) that shared an onset with and would be phonetically similar to the Russian name of one of the other objects in the display (e.g., *marka*, "stamp"). The authors found that upon hearing the target word *marker*, Russian-English bilinguals made eye-movements to the between-language competitor (*marka*). These results clearly indicate that bilinguals automatically activated both the English and the Russian lexicons when processing English words. Similar results were found in a block where participants completed the task in Russian: Upon hearing *marku* ('stamp'), Russian-English bilinguals also looked at the *marker*.

This pattern of parallel activation has since been replicated with other combinations of languages: with Dutch-English bilinguals (Weber & Cutler, 2004), Spanish-English bilinguals (Canseco-Gonzalez et al., 2010; Ju & Luce, 2004), French-English bilinguals (Pivneva, Mercier, & Titone, 2014), and Japanese-English bilinguals (Cutler, Weber, & Otake, 2006). Importantly, the size of this cross-language activation effect has been shown to vary based on several factors, including whether the task is conducted in the L1 or the L2 (i.e., Marian & Spivey, 2003a), how proficient bilingual listeners are in the L2 (e.g., Mishra & Singh, 2016; Silverberg & Samuel, 2004), whether the input and bilingual listeners' lexical representation closely match (Ju & Luce, 2004), and whether bilingual listeners expect to hear only one or both of their languages (Grosjean, 1998; Marian & Spivey, 2003a).

One study that reports different degrees of cross-language activation in the L1 and in the L2 is that of Spivey and Marian (2003a). The authors used two eye-tracking experiments (one in participants' L1 and the other in their L2) to examine spoken language processing in Russian-English bilinguals (native speakers of Russian with an advanced level of proficiency in English). The authors presented participants with visual displays consisting of four objects (as described for Spivey and Marian (1999)'s study) and asked them to manipulate one of the objects (the target) while doing the task in either English or Russian. The main manipulation of the study was the inclusion of a competitor object whose name was phonologically similar to the name of the target object (e.g., *plum* in the English-only experiment) in Russian (e.g., *plat'e* 'dress'). The authors compared competitor fixations from this interference condition to fixations in a control condition where no objects overlapped phonologically with the target. The results showed that upon hearing the target word *plug*, Russian-English bilinguals made eye-movements to the between-language competitor (*plat'e*). This effect was statistically significant when the experiment was conducted in the participants' L2 (English), with interference coming from participants' L1 (Russian); when the experiment was conducted in participants' L1 (Russian), there was just a trend in the participants' L2 (English) interfering with their recognition of the Russian target object. These results clearly indicate that bilinguals automatically activated both lexicons when processing words, but that this effect was modulated by factors such as language dominance (L1 vs. L2).

This effect of language dominance, operationalized as whether the unintended language is the L1 or the L2, has since been replicated using other tasks and language combinations: maze task with Chinese-English bilinguals (Wang, 2015) and lexical decision tasks with Spanish-English bilinguals (Litcofsky, Tanner, & van Hell, 2015). However, as mentioned earlier, language dominance can also be operationalized as how proficient bilinguals are in the intended and unintended language. A number of studies have indeed reported effects of language proficiency on the degree of cross-language activation in bilingual lexical processing.

Using an eye-tracking paradigm similar to the one described for the previous studies, Mishra and Singh (2016) investigated how L2 proficiency affected the activation of phonologically related words in two groups of Hindi-English bilinguals. Participants were native speakers of Hindi with either a low- or high-level of proficiency in English. They completed one experiment, with the two languages (either their L1 or their L2) presented in different blocks. During each experimental session, they were presented with a four-picture display on a screen that contained or did not contain the target word. Participants' task was to click on the picture representing the target word if the target word was indeed present on the screen, and otherwise ignore that trial. The main manipulation was in the trials where the target was not on the screen: In those trials, the display contained a picture whose name in the other language partially matched the acoustic input of the translation of that same word into the non-target language. For example, in the Hindi experiment (where they expected to observe some interference from English), the target would be a word such as *gulab* ('rose'), not present in the display, and among the four pictures in the display, one represented a *rope*. The reasoning was as follows: If participants were simultaneously translating the words, the partial overlap between the translation of the target word and the competitor word on the screen would produce more fixations to this picture as compared to any of the other pictures presented in the same display. The results confirmed these predictions (e.g., greater proportions of fixations to the *rope* after hearing *gulab*) in both the Hindi and the English experiments, that is, whether or not the experiment was conducted in the L1 or in the L2. However, and importantly, the effect observed in the Hindi experiment was stronger in the group with a higher proficiency in English than in the group with a lower level of proficiency in English.

The results of this study provided further evidence that bilingual activation is non-selective and that L2 proficiency modulates the degree of cross-language interference. Similar results have also been reported in word recognition tasks that did not use the visual-world eye-tracking paradigm: priming tasks with Spanish-English bilinguals (Silverberg & Samuel, 2004) and self-paced reading tasks with Dutch-English bilinguals (Bultena, Dijkstra, & van Hell, 2014). Note, however, that not all studies of bilingual lexical activation report effects of L2 proficiency (e.g., Durlik, Szewczyk, Muszy, & Wodniecka, 2016).

The degree of cross-language competition has also been found to depend, at least in part, on the precise match between the input and the bilingual's mental representation of the words. Using an eye-tracking experiment, Ju and Luce (2004) manipulated the voice onset time (VOT) of Spanish words to make them consistent with stops in either Spanish or English, the two languages of the bilinguals tested. Their study included competitor pictures whose English names were phonologically similar to the Spanish targets (e.g., *playa* 'beach' and *pliers*). Their results indicated that Spanish-English bilinguals showed greater evidence of cross-language competition (i.e., more fixations to the picture with the phonologically similar English name) when the target words contained English-appropriate voice onset times. These results have been taken to suggest that the level of cross-language competition effects may depend, at least in part, on the precise match between the acoustic-phonetic information in the input and the bilingual's mental representation of the words. These findings are in line with those reported in previous bilingual cross-language phone perception studies, suggesting that bilinguals are sensitive to subtle acoustic-phonetic differences (e.g., Flege, 1984, 1991; Flege & Hammond, 1982), with this information reducing cross-language interference in word recognition.

An additional factor that has been shown to modulate cross-language activation is language bias. Language bias, also referred to by Grosjean (1998) as language mode, is the collection of external factors that determine the language expectations that bilinguals have in a particular communicative task. According to Grosjean (1998), the degree of cross-language interference that bilinguals experience should be determined by where on the language mode continuum these bilinguals are. To illustrate, if a bilingual expects the interlocutor to address him in only one language, then cross-language activation is expected to be weak; conversely, if a bilingual expects to be code-switching between his/her two languages, then cross-language activation is expected to be stronger.

Marian and Spivey took language mode into account when explaining the different results obtained in their two studies (Marian & Spivey 1999; 2003a). Recall that, in the first study (Marian & Spivey 1999), there was evidence of fixations to the between-language competitor independently of whether this competitor was a Russian word (the participants' L1) or and an English word (the participants' L2). However, in the second study, there was just a trend towards English influencing the processing of the Russian target. The authors hypothesized that the bilinguals tested in both languages in the same experimental session and by fluent bilingual speakers (Spivey and Marian, 1999) may have been more on the bilingual end of the language mode continuum, and thus experience greater cross-language competition, than bilinguals tested in only one language and by monolingual speakers (Spivey and Marian, 2003a).

Even when controlling for language mode, however, the authors found evidence of cross-language activation when the unintended language was the L1.

These findings have been claimed to be explained by what Grosjean (1998) described as language mode. In fact, as he proposed it, the variability in the selection of participants, stimuli, tasks, and experimental setting from previous studies may be responsible for the different findings reported in the literature in the strength of cross-language activation. Although the results of Spivey and Marian (1999) suggest that being tested in both languages in the same experimental session may be enough to make participants be in a bilingual language mode, at present it is unclear how fine grained the effect of language bias may be on cross-language competition.

In summary, previous studies on bilingual activation provide clear evidence that bilingual activation in language comprehension is not selective: Bilinguals activate their two languages in parallel during language comprehension. Moreover, this cross-language activation can be influenced by factors such as L2 proficiency and language bias (more competition when bilinguals are more proficient in the unintended language, and more competition when participants are in a bilingual language mode).

We now turn to a review of the findings on bilingual language production and, in doing so, draw parallels between language comprehension and language production in the influence of language dominance (and hypothesized influence of language bias) on cross-language activation.

2.1.2 Language Production

As with language comprehension, research on cross-language activation in language production suggests that lexical activation is also not language selective: Bilinguals activate their two languages in parallel during language production (e.g., Colomé & Miozzo, 2010; Kroll, Bobb, Misra, & Guo, 2008). Speech production involves complex linguistic operations even when speaking in the L1. Speakers need to conceptualize the message they want to convey, activate the words that are semantically and syntactically compatible with the message, plan their articulation, and implement it (Bock & Levelt, 1994). From the perspective of bilingual speakers, speech production is even more complex as they need to handle the challenges associated with bilingual activation.

In a recent study, Colomé and Miozzo (2010) investigated whether lexical activation in language production is also not language selective. They used a picture-picture interference paradigm in Catalan where proficient Spanish-Catalan speakers saw pairs of partially overlapping colored pictures. Participants were instructed to name aloud, in Catalan, the picture that was colored in green. The main manipulation involved the competitor picture on the screen. In the "related" trials, the Spanish name of the competing picture partially overlapped with the target Catalan word. For example, if the target word was the Catalan word *armilla* ('vest'), the competitor picture corresponded to a word that did not show any phonological overlap with the target in Catalan, *esquirol* ('squirrel') but that showed some phonological overlap with the target in Spanish, *ardilla* ('squirrel'). Naming latencies to *armilla* in this "related" condition were compared to naming latencies to *armilla* in a control condition where the competitor picture corresponded to a word that did not overlap with the target in either Catalan (*bec* 'beak') or Spanish (*pico* 'beak'). The results of this study indicated that when naming *armilla* ('vest'), Spanish-Catalan bilinguals were faster when the target appeared together with the picture of an *ardilla* ('squirrel'). These results indicate that bilinguals automatically activated both lexicons also in language production. The facilitative (rather than inhibitory) effect of the overlapping Spanish competitor word was attributed to the phonological similarity of Catalan and Spanish.

This pattern of parallel activation has since been replicated with other combinations of languages: with German-Spanish bilinguals (e.g., Rodriguez-Fornells et al., 2005), Dutch-English bilinguals (e.g., Hermans, Bongaerts, De Bot, & Schreuder, 1998), Korean-Spanish bilinguals (e.g., Costa & Santesteban, 2004), Spanish-English and Tagalog-English bilinguals (e.g., Gollan & Acenas, 2004), among others. In some of these studies, however, the unintended language interfered rather than facilitated word production, whenever the sounds systems of the two languages were very different (for reviews exploring interference in bilingual word production and possible mechanisms employed to control for this cross-language interference, see Moreno, Rodríguez-Fornells, & Laine, 2008; Rodríguez-Fornells, de Diego Balaguer, & Münte, 2006; Ye & Zhou, 2009).

Further evidence of cross-language activation in language production comes from studies on the production of words that are related in form and meaning between the bilinguals' two languages, also known as *cognates*. Such studies have shown that bilinguals who name pictures in one of their two languages do so faster when the pictures refer to words that are cognates in the two languages than when they refer to words that are not cognates (e.g., Costa, Caramazza, & Sebastián-Galles, 2000; Hoshino & Kroll, 2008). These results have been interpreted as indicating that, during speech planning, cognate words receive double activation (from the L1 and the L2), suggesting that lexical candidates in the unintended language are also active. These studies have provided evidence that phonological information from the non-target language is activated in tasks requiring participants to name pictures (for example, the activation of Chinese phonology in Guo and Peng (2006)).

Importantly, as with language comprehension, the size of the cross-language activation effect in language production studies has been shown to be modulated by several factors, including whether the task is conducted in the L1 or in the L2 (e.g., Costa et al., 2000; Hoshino & Kroll, 2008; Rodriguez-Fornells et al., 2005) and how proficient bilingual speakers are in both the intended and the unintended language (e.g., Costa, Caramazza, et al., 2000; Costa, Colomé, & Caramazza, 2000; Costa, Miozzo, & Caramazza, 1999; Costa et al., 2006; Costa & Santesteban, 2004).

The effect of language dominance, operationalized as whether the unintended language is the L1 or the L2, has also been explored in the bilingual language production literature using behavioral tasks (e.g., Costa, Caramazza, et al., 2000; Hoshino & Kroll, 2008). For example, Costa et al. (2000) found that Spanish-English bilinguals were faster at naming pictures in their L2 when the picture represented a shared cognate between the two languages; the corresponding facilitation did not occur in the bilinguals' L1, however, suggesting that the more dominant language (i.e., the L1) is more likely to influence the less dominant language (i.e., the L2) than the reverse scenario. The same pattern of results was found in Hoshino and Kroll (2008), who tested Japanese-English bilinguals' production of cognates in both languages. Furthermore, many bilingual language production studies have shown that L2 production is more effortful than L1 production. This pattern of findings arises when bilinguals produce single words in response to pictures (e.g., Gollan & Ferreira, 2004; Gollan et al., 2008; Hanulová, Davidson, & Indefrey, 2011; Linck, Hoshino, & Kroll, 2008), and also when they produce longer utterances when recounting a story (Towell, Hawkins, & Bazergui, 1996). This effort has been proposed to come from bilinguals' need to inhibit the unintended, more dominant language (i.e., the L1) in order to produce the words (or sentences) in the L2 (e.g., Gollan et al., 2008). These results clearly indicate that bilinguals appear to activate both lexicons before producing the target words, but this effect is modulated by factors such as whether the unintended language is the L1 or the L2.

Again, as mentioned earlier, language dominance can also be operationalized as how proficient bilinguals are in the intended and unintended language. A number of studies have indeed reported effects of language proficiency on the degree of cross-language activation in bilingual language production (e.g., Costa et al., 2000, 2006; Costa & Santesteban, 2004, 2008). Such effects have been demonstrated primarily with tasks involving language switch. Language switch tasks have revealed asymmetrical effects of language switch directionality when bilinguals are more proficient in one of their languages than in the other.

In a series of experiments, Costa and Santesteban (2008) explored the effects of language switch in picture naming tasks. In Experiment 1, Spanish learners of Catalan and Korean learners of Spanish were asked to perform a switching task between their L1 (Spanish or Korean) and their L2 (Catalan or Spanish). The task consisted in naming each picture presented in either their L1 or their L2, and the language of the trial was determined by the color in which the picture appeared. Participants were instructed to name the pictures as quickly and accurately as possible. For the two groups studied, switching from the weaker language (L2) to the more dominant language (L1) was harder than vice versa (i.e., participants produced more disfluencies and were slower in their naming latencies). These results (i.e., a greater switch cost from the L2 to the L1 than from the L1 to the L2) were interpreted as reflecting an L1 inhibition effect, indicating that it was harder to go back to the L1 because the L1 was more strongly inhibited. The authors then used the same design in a second experiment in which they tested highly proficient Spanish-Catalan bilinguals. Again, participants were asked to perform the task in both of their languages. The results of this second experiment differed from those of the first experiment, with highly proficient bilinguals not showing any effect of language switch directionality. Together, these findings reveal an important effect of L2 proficiency on the directionality of language switch costs, with language switch costs becoming more symmetrical when proficiency in both languages is comparable.

Thus, like in language comprehension, lexical activation does not appear to be language selective in speech production. Furthermore, lexical competition from the unintended language and language-switch costs are modulated by the bilinguals' proficiency in the intended and unintended language (more competition when bilinguals are more proficient in the unintended language, and greater switch costs from the L2 to the L1). In theory, one might expect that language bias (or language mode; Grosjean, 1998) may also affect bilingual word production. However, to the best of my knowledge, there are no studies looking at the effect of this factor on bilingual word production. The current study will be among the first studies to directly explore the role of language bias in bilingual word production.

We now turn to models of bilingual lexical activation that have sought to explain cross-language interference effects in comprehension and production.

2.2 Models of Bilingual Lexical Activation

The first accounts of bilingual processing argued that lexical activation was exclusive to the contextually appropriate language system, and that when encountering a word, activation would be restricted to the target language subsystem (e.g., Gerard & Scarborough, 1989; Scarborough, Gerard, & Cortese, 1984). According to these early accounts, bilinguals initially made a decision about the language of the word they expected to hear or wanted to produce, and then activated the appropriate language-selected lexicon. However, it became clear from subsequent research on bilingual lexical processing that lexical activation is in fact not language selective.

More recent models of bilingual activation have instead argued for the language nonselective hypothesis (e.g., the Bilingual Interactive Activation Plus Model (BIA+) (Dijkstra & van Heuven, 2002); the Inhibitory Control Model (Green, 1998); the Language Mode Framework (Grosjean, 1997)). According to this view of bilingual processing, automatic co-activation of information in both linguistic systems is expected to happen in all linguistic contexts. In this view, the representation of a word often gives rise to parallel activation in both languages, and it is highly unlikely to completely suppress the other language. In other words, when encountering a word, the activation happens in both contextually appropriate and contextually inappropriate linguistic subsystems.

Different models of bilingual language processing and production have been proposed over the past two decades. These models have focused on trying to understand how bilingual speakers/listeners reduce the activation of one of their languages such that they can perform the task at hand in the target language, without interference from the non-target language (see Kroll et al. (2012) for a review). For the purpose of the current research, two models of bilingual activation are considered and discussed in detail: the Inhibitory Control Model (Green, 1998) and the Bilingual Interactive Activation Plus (BIA+) Model (e.g., Dijkstra & van Heuven, 2002).

2.2.1 Inhibitory Control Model

The Inhibitory Control Model (Green, 1998) describes bilingual processing as a combination of three individual aspects. First, the model includes a level of control that involves language task schemas. Language task schemas compete to control output from the lexico-semantic system by altering the activation levels of representation and by inhibiting other schemas that are not relevant for the task at hand. Second, the model posits a stage that involves word selection at the lemma level (the level between the conceptual and the phonological levels) by virtue of their language tags. Finally, the model postulates that domain-general inhibitory control plays an important role in the control of bilingual language processing at the lemma level.

These three aspects are visually represented in Figure 1 (Green, 1998; p. 69). To better conceptualize the model, the explanations of each of the stages will be provided together with an example of how the model would explain bilingual processing of language. This will be done by using the example of a bilingual individual who needs to recognize spoken L2 words and respond to them (e.g., select the right picture representing that word).

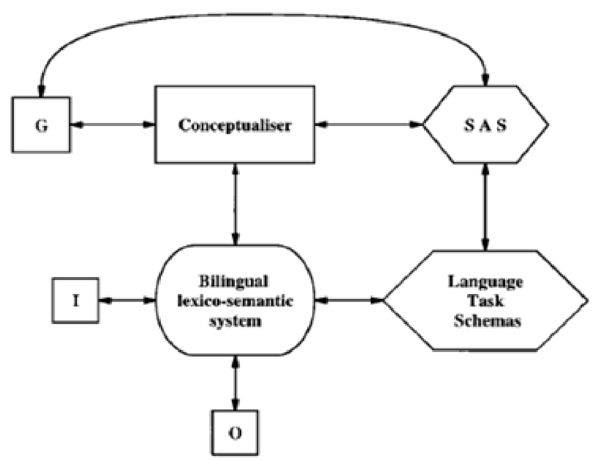

Figure 1: Visual Representation of the Inhibitory Control Model

In the Inhibitory Control Model, a conceptualizer builds conceptual representations (based on information stored in long-term memory), driven by a goal (G on Figure 1) to perform a certain task with the use of the appropriate language. In our example, this stage requires that the conceptualizer recognizes and accesses the meaning of L2 words using the corresponding language schema because its goal is to select the right picture associated with the meaning of that given L2 word.

The supervisory attentional system (SAS on Figure 1) mediates this communicative and planning process. SAS is always present whenever automatic control is insufficient, as in novel tasks, and it operates together with components of the language system, including both the lexico-semantic system and a set of language task schemas. Language task schemas (e.g., word recognition or translation schemas) compete to control the output from the lexico-semantic system. The selection of a given word requires the specification of the target language to be transmitted by SAS to the task schema. In order to achieve this language selection, the system relies on the input (I on Figure 1) from the lexico-semantic system to the SAS. This control mechanism is driven by bottom-up information. The selection process also requires conceptual information to be transmitted to the lexico-semantic system from the conceptualizer. In our example, once the conceptualizer builds conceptual representations based on the goal of the task at hand, the SAS mobilizes inhibitory control resources to globally suppress the L1 (the non-target language). This process is achieved by targeting words with non-target language tags (words belonging to the individual's native language L1 in this example). This inhibition process reduces the risks of interference from the L1 during the recognition of words from the target language L2.

The Inhibitory Control Model thus postulates two levels of control. On the one hand, the Inhibitory Control Model describes (top-down) proactive control, which adapts the level of activation of the target language system as a function of task demand (or task schema). On the other hand, it describes a (bottom-up) reactive control mechanism, which inhibits non-target language representations such that they do not interfere with performance and achievement of the goal (Green, 1998). The Inhibitory Control Model claims that individuals can prepare in advance to perform a given task. However, as inhibition operates reactively (bottom-up), when performing a task in the L2 (for example), competition from the L1 will be present. It is then the task of the SAS to monitor, once the language task schema has been triggered, the level of activation of the unintended language (using top-down mechanisms). Thus, the primary source of top-down control is inhibitory control. In the Inhibitory Control Model, then, inhibition can come from reactive control mechanisms as a function of the input heard or it can come from proactive control mechanisms whose only purpose is to provide inhibitory control.

2.2.2 Bilingual Interactive Activation Plus (BIA+) Model

The Bilingual Interactive Activation Plus (BIA+) Model has been presented as an updated version of the Bilingual Interactive Activation Model (BIA, (Dijkstra & van Heuven, 1998)). This updated version of the model is more explicit with respect to the timing of the bilingual identification word process, the interactions between representations (orthographic, phonological, semantic), and the role of language nodes.

The BIA+ Model proposes a late account of language selection. The model assumes that words in the bilinguals' two languages are stored in an integrated lexicon and that task demands (e.g., the language of the task) do not influence the earliest stages of word recognition. At the time when the word is processed, language cues function to distinguish different alternatives only after simultaneous activation of both languages.

According to the BIA+ Model, the bilingual system consists of two subsystems: the word identification subsystem and the task/decision subsystem. During word identification, also described in the BIA Model, the visual/acoustic input activates the sublexical orthographic/phonological representations of the word entries, represented in Figure 2 from the original BIA Model (Dijkstra & van Heuven, 1998; p. 200). These sublexical representations immediately activate both orthographic/phonological whole-word representations and semantic representations. Finally, language nodes, which indicate words' membership to a particular language, are activated. All of this information is then used in the task/decision subsystem to carry out the remainder of the task at hand.

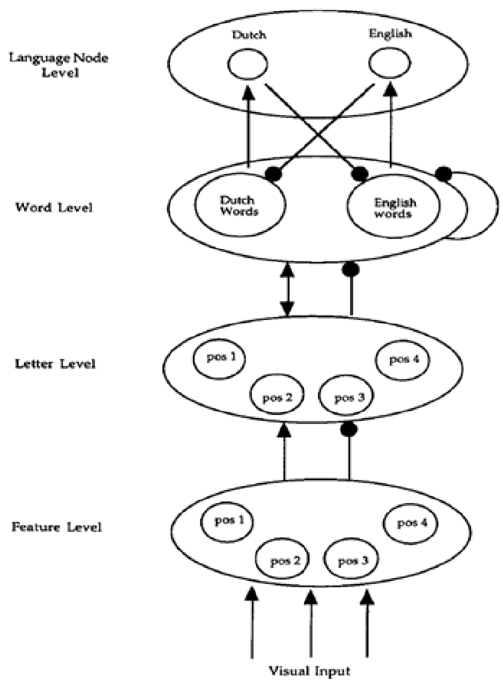

Figure 2: Visual Representation of the BIA Model

More specifically, the word identification subsystem controls lexical access and it is thought to be language nonselective, as potential word choices from both languages are activated in the bilingual brain when exposed to the same stimulus. In this subsystem, we find language nodes (or tags), which provide a representation for the target language based on the information from bottom-up orthographic, semantic, and phonological word identification processes. The existence of these nodes enables bilingual individuals to avoid interference from the non-target language while they process the other language. Language nodes control for the potential interference generated by non-target language representations. In this subsystem, the frequency of word use by the bilingual is expected to affect the resting potential activation. Basically, those words that a bilingual uses more frequently in a given language are going to be activated more rapidly in that language than in the other language.

The original BIA Model combined top-down inhibitory control of lexical activation with a mechanism for coding for which language a word belongs to, represented by language nodes. That is, given sufficient processing, only representations associated with the appropriate language will remain activated, as modulated by the language nodes. However, the updated BIA+ Model describes the relative activation of the language nodes (or even "of the languages") as being completely dependent upon activation from other linguistic representations (e.g., lexical input and context) and becoming available late during (isolated) bilingual word processing. In other words, in the BIA+ Model, these language nodes do not constrain lexical activation early in the word recognition process. In fact, studies suggest that this information appears too late to affect the word selection process (e.g., Dijkstra, Timmermans, & Schriefers, 2000).

With respect to the task/decision subsystem, the model postulates that it determines which actions must be executed for the task to be completed based on the relevant information that becomes available once the word identification process has been completed (information provided by the word identification subsystem). Notice that this subsystem involves executive processes such as monitoring and control, but it does not imply top-down effects from the task/decision system on the identification system (which activates lexemes based on bottom-up information) early in the word recognition process. Comparing more directly the two subsystems just described, the BIA+ Model assumes that the word identification subsystem is affected by linguistic information (defined as the effects of lexical, syntactic, or semantic sources (e.g., sentence context)), while the task/decision subsystem can be influenced by non-linguistic information (such as those arising from instruction, task demands, or participant expectancies). Figure 3 provides a visual representation of the two subsystems described in the BIA+ Model (Dijkstra & van Heuven, 2002; p. 182).

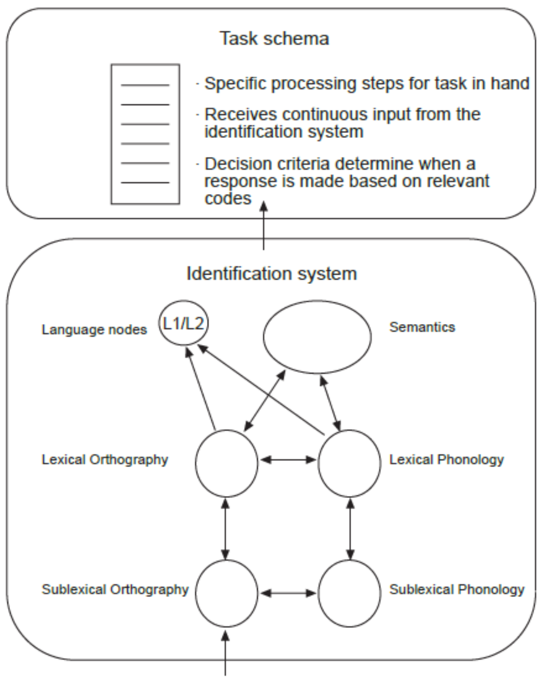

Figure 3: Visual Representation of the BIA+ Model

2.3 Assessing the Effects of Language Proficiency and Language Bias on Cross-Language Activation in Language Comprehension and Language Production

Given the aforementioned discussion of the literature on bilingual language comprehension and language production, it remains unclear how language (here, L2) proficiency and language bias modulate bilinguals' activation of bilinguals' two language systems, whether the two factors interact (e.g., more proficient bilinguals could show less sensitivity to language bias as a result of better controlling for the degree of cross-language activation), and whether (and if so, how) the degree of involvement of these factors differ in language comprehension vs. language production. Experiments in which bilinguals are asked to work in both of their languages (i.e., in a bilingual language mode) may lead to more cross-language competition as compared to tasks in which they are only supposed to work in only one language and where the other language is not explicitly mentioned (i.e., in a monolingual language mode), but such an effect may depend in part on their L2 proficiency, and it may be stronger in language comprehension or language production, depending on the degree of control over cross-language activation that bilinguals can exert in these two types of tasks.

Importantly, the two models considered in the current dissertation (the Inhibitory Control Model (Green, 1998) and the BIA+ Model (Dijkstra & van Heuven, 2002) make different predictions regarding the mechanisms employed to control cross-language interference in the initial stages of word recognition. While the Inhibitory Control Model predicts that early cross-language activation would be modulated by both language proficiency and language bias, the BIA+ Model claims that the activation and inhibition of lexical representations is strictly controlled by the input early in the word recognition process; thus, in this model, no effect of language bias is expected in early cross-language activation. Moreover, the Inhibitory Control

Model predicts that the same factors will influence both language comprehension and language production, whereas the BIA+ model does not make explicit predictions regarding bilingual word production.

This dissertation uses the visual world eye-tracking paradigm to further explore constraints on parallel language activation in bilingual lexical processing. Its primary goal is to understand how factors such as L2 proficiency and language bias influence bilinguals in their control of the level of activation of their two languages. In order to do so, L1-Spanish L2-English and L1-English L2-Spanish participants were tested to examine how differences in word-level stress between the two languages affect their word recognition in Spanish. Moreover, an adaptation of this paradigm was implemented in speech production to determine how the same factors control bilingual activation during word production.

The next chapter reviews existing research on native and non-native listeners' use of stress in lexical access.

Chapter 3: Stress as a Cue for Word Recognition

The speech processing system is extremely efficient: In order to recognize words successfully, it uses all available information in the signal to activate the (intended) target word and inhibit the (unintended) lexical competitors. One such type of information is word-level stress. Several studies have shown that in languages that have word-level stress (e.g., Spanish, Dutch, and English), stress constrains lexical access (e.g., Cooper et al., 2002; Cutler & Pasveer, 2006; Cutler, Wales, Cooper, & Janssen, 2007; Soto-Faraco et al., 2001). During online word recognition, as a spoken word unfolds, lexical candidates that most closely match the input segmentally become partially activated and compete most strongly with the target word for recognition (e.g., Luce & Pisoni, 1998; Luce, 1986; Marslen-Wilson & Warren, 1994). In languages that have word-level stress, greater activation of words that match the signal both segmentally and suprasegmentally is observed as compared to words that match the signal only segmentally (e.g., Cooper et al., 2002; Soto-Faraco et al., 2001).

This section discusses the most relevant literature on the use of word-level stress as a cue to lexical identity in native and non-native word recognition, with special attention to Spanish and English, the two languages spoken by the bilinguals in the present study.

3.1 Word-Level Stress as a Cue to Native Word Recognition

Spanish has several morphologically unrelated minimal pairs that differ only in word stress, for example ***sá**bana* ‘bed sheet’ vs. *sa**ba**na* ‘savannah’ and ***lú**cido* ‘lucid’ vs. *lu**ci**do* 'shone'.[2] If we take into account verbs, stress becomes very important in Spanish, as listeners have to recognize this information in order to understand verb forms, as the subject pronoun is optional (e.g., ***can****to* 'I sing' vs. *can****tó*** 'he/she sang'). In addition to these minimal pairs, Spanish has several words that overlap segmentally up to a specific point in the word but differ in stress placement (e.g., *ma****te****ria* 'subject/matter' vs. *mate****rial*** 'material'). Thus, overall, stress has a rather high functional load in Spanish.

As in many other languages, Spanish stress is cued by means of three acoustic parameters: fundamental frequency (F0), duration, and intensity. All three parameters have been shown to be important in the production and perception of Spanish stress. F0 is described as the primary stress cue, while duration and intensity are considered secondary cues (e.g., Llisterri, Machuca, de la Mota, Riera, & Ríos, 2002a, 2002b, 2003). As a secondary cue, duration has been claimed to be a stronger cue than intensity in all but the word-final syllable; higher intensity is used to cue stress in the final syllable, because duration would not be an informative cue in that position given word-final lengthening in Spanish (Enríquez, Casado, & Santos, 1989). Importantly, most Spanish dialects do not have vowel reduction. Hence, Spanish stress is realized primarily with suprasegmental cues. In Spanish, stress placement can be predicted by abstract, complex stress assignment rules (Harris, 1969): For nouns, the rule states that stress falls on the last syllable if it ends with a consonant other than [n] or [s], and otherwise on the penultimate syllable (Harris, 1969).

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[2] In all the examples provided in this proposal, bolded syllables indicate the location of primary stress; accent marks are provided where they appear in the Spanish orthography.

Given its high functional load, Spanish listeners should make active use of stress information when recognizing Spanish words. Soto-Faraco et al. (2001) investigated whether word stress indeed constrains lexical access for native Spanish listeners. In a cross-modal priming lexical decision task, participants were presented with word onset fragments as auditory primes. The word onset fragments consisted of the first two syllables of word pairs that were segmentally identical up to the onset of the third syllable, were not semantically and/or morphologically related, and differed in stress pattern (e.g., ***prín**cipe* 'prince' vs. *prin**ci**pio* 'beginning'). After the auditory presentation of the segmentally ambiguous fragments of words, participants saw a string of letters presented in the middle of the screen, and they had to decide whether or not this string was a real word in Spanish. The experiment included three conditions: (i) in the match condition, the auditory prime fragment was the first two syllables of the visual target word and thus matched the target word both segmentally and in stress (e.g., prime: ***prin**ci-*; target: ***prín**cipe*); (ii) in the mismatch condition, auditory prime fragment was the first two syllables of a competitor word that matched the visual target word segmentally but mismatched it in stress (e.g., prime: *prin**ci**-* from *prin**ci**pio*; target: ***prín**cipe*); (iii) and in the control condition, auditory prime fragment came from a word that was unrelated to the visual target word (e.g., prime: *mos**qui**-* from *mosquito* 'mosquito'; target: ***prín**cipe*). Results show that the auditory primes matching the target word both segmentally and suprasegmentally (i.e., in stress) speeded up response times as compared with the unrelated control primes. Furthermore, the auditory prime fragments that were segmentally identical to but mismatched the target word in stress placement slowed down response times as compared to unrelated primes, suggesting lexical competition from the word from which the prime had been extracted. This pattern of results suggests that Spanish listeners use word stress information in lexical access.

This pattern of results was replicated in Dutch by van Donselaar, Koster, and Cutler (2005). As in Spanish, word-level stress is also contrastive in Dutch, and it is mainly marked suprasegmentally (unlike Spanish, Dutch has vowel reduction in some words). In Dutch, there is a strong tendency for stress to occur word-initially, which is a cue effectively exploited by listeners in this language in speech segmentation (Cutler & Norris, 1988; Vroomen, Tuomainen, & de Gelder, 1998). In a partial replication of Soto-Faraco et al. (2001), van Donselaar et al. (2005) used pairs of words like ***oc**topus* 'octopus' and *Ok**to**ber* 'October,' which are matched segmentally for the first two syllables but differ with respect to stress position. They presented participants with a visual word target to be recognized, which was preceded by: (i) an auditory prime consisting of the first two syllables of the same word (e.g., prime: *ok**to**-* from *Ok**to**ber* 'October'; target: *Ok**to**ber* 'October'); (ii) an auditory prime of two syllables that came from a word matching the visual target in segments but mismatching it in stress (e.g., prime: ***oc**to-* from *octopus* 'octopus'; target: *Ok**to**ber* 'October'); and (iii) an auditory control prime consisting of the first two syllables of a word that was unrelated to the visual target word (e.g., prime: *eufo-* from *euforie* 'euphoria'; target: *Ok**to**ber* 'October'). Their results paralleled the findings reported by Soto-Faraco et al. (2001), with faster response times when the auditory prime matched the visual word both segmentally and suprasegmentally than when the auditory prime matched visual word only segmentally. Moreover, the mismatch condition yielded slower response times as compared with the control condition, suggesting lexical inhibition from the competitor words from which the fragments had been extracted, similar to Soto-Faraco et al.'s (2001) study.

Reinisch, Jesse, and McQueen (2010) extended these findings using the visual world eye-tracking paradigm, which allowed them to see the moment-by-moment processing of stress information. In such a task, they showed that Dutch listeners used stress as soon as it became available in the signal, such that they began to disambiguate the target word (e.g., ***oc**topus* 'octopus') from its stress competitor (e.g., *Ok**to**ber* 'October') before the segmental information provided all the necessary cues for disambiguation (for similar results with response times, see Cutler and Van Donselaar (2001)).[3]

The results of these studies suggest that, in languages that have word-level stress and little or no vowel reduction (respectively, Dutch and Spanish), stress constrains lexical access by increasing the activation of those lexical candidates that match the signal both segmentally and suprasegmentally and by treating those candidates that match the signal only segmentally as lexical competitors. However, these results leave open the possibility that suprasegmental cues to stress constrain lexical access only in languages where these cues do not coincide with segmental cues, specifically spectral cues in the vowel (i.e., vowel reduction). A case in point is English. In English, although stressed syllables have higher F0, longer duration, and higher intensity, their vowels are also less likely to be centralized than unstressed syllables (e.g., Beckam, 1986; Fry, 1954; Lehiste, 1959; Lieberman, 1960). In other words, English stress shows an interdependence between segmental and suprasegmental cues. As a result, changing stress placement affects both the segmental and suprasegmental characteristics of words, yielding very few minimal pairs that can be distinguished based solely on suprasegmental cues (e.g., ***fore**bear* 'ancestor' vs. *for**bear*** 'to persist'; Cutler, 1986).

Experimental studies looking at how native speakers of English use stress for word recognition have found that English listeners assign greater weight to segmental cues than to

[3] In a separate experiment with monosyllabic primes, the authors found facilitation for matching primes, but they did not find facilitation for mismatching ones.

suprasegmental cues to distinguish among competing words. For example, using a cross-modal priming task, Cutler (1986) tested priming effects for word pairs such as ***fore**bear* and *for**bear***. In the task, participants were presented with an auditory sentence; at some point during the sentence, a visual target (a string of letters) appeared on a screen, and participants had to decide whether or not that string of words was a real English word. Words were manipulated such that they were either semantically related to the target word they heard (e.g., ‘ancestor’ for ***fore**bear* and ‘tolerate’ for *for**bear***) or unrelated (e.g., “ancestor” for *for**bear***). The results of her study showed equivalent priming for both stress patterns: The auditory stimulus ***fore**bear* equally facilitated the processing of *ancestor* and *tolerate*, the two semantically related words to, respectively, ***fore**bear* and *for**bear***. Results were taken to suggest that, in the absence of segmental cues, stress does not constrain English listeners’ lexical access.

Although English has very few minimal pairs that differ only suprasegmentally, it has many words that overlap segmentally up to a specific point in the word but have different stress placement (e.g., *mystery* and *mistake*). It is therefore unclear whether suprasegmental cues to stress can modulate word recognition at an earlier point in the word (i.e., prior to the segmental disambiguation point). Cooper et al. (2002) examined this specific issue, and found that native English listeners can indeed exploit suprasegmental information in spoken-word recognition. The participants completed two cross-modal priming tasks and a word identification task (the word-identification experiment will be discussed in the next section). Using a cross-modal fragment priming study similar to that of Soto-Faraco et al. (2001) and van Donselaar et al. (2005), the authors tested native English listeners’ processing of words whose first syllable contrasted in primary vs. secondary stress (e.g., ***ad**miral* vs. *admi**ra**tion*) or in stress vs. no stress (e.g., ***mu**sic* vs. *mu**se**um*). Participants performed a lexical decision task. They listened to sentences ending with the first two syllables of these word pairs (i.e., the prime) (e.g., *We were sure the word was **ad**mi-*), and then saw a word on the computer screen. They were instructed to decide as quickly and accurately as possible if the word they saw was a real English word. As their stimuli, they used fragments from word pairs that do not show segmental cues to stress (without vowel reduction or with vowels that have similar segmental realizations in stressed and unstressed syllables). The stimuli were presented in three conditions: (i) in the match condition, the auditory prime fragment consisted of the first or first two syllables of the visual target word (e.g., prime: ***ad**mi*- from ***ad**miral*, target: ***ad**miral*; prime: ***mu**-* from ***mu**sic*, target: ***mu**sic*); (ii) in the mismatch condition, the auditory prime fragment was the first or first two syllables of a competitor word that matched the visual target word segmentally but mismatched it in stress (e.g., prime: *admi*- from *admi**ra**tion*, target: ***ad**miral*; prime: *mu*- from *mu**se**um*, target: ***mu**sic*). Finally, a control condition was included in which the auditory prime fragment came from a word that was unrelated to the visual target word (e.g., prime: *propo*- from *proposition*, target: ***ad**miral*; prime: *expla*- from *explanation*, target: ***mu**sic*).

Their results showed that, when the auditory prime matched the target both segmentally and suprasegmentally, there was greater activation of the target than its competitor (e.g., ***ad**miral* was shown to activate ***ad**mi*- (from '***ad**miral*') to a greater extent than *admi*- (from '*admi**ra**tion*'), and ***music*** was shown to activate ***mu-*** (from *'**mu**sic'*) to a greater extent than *mu*- (from *'mu**se**um'*)). However, the mismatching prime did not result in slower response times to the target as compared to the unrelated condition (i.e., no inhibition found). The lack of inhibition was taken to indicate that English listeners do make some use of stress, but not to the same degree as native Spanish or Dutch listeners. Hence, even in languages where vowel reduction co-varies with stress placement, listeners seem to use suprasegmental cues to stress to recognize words, at least to some degree (enough to further activate the target over the competitor, but not enough to yield lexical competition).

Existing evidence, thus, suggests that native speakers of languages with word-level stress use this cue for word recognition, but their reliance on suprasegmental cues to stress differs based on how much suprasegmental information contributes to lexical identity in the language. As discussed herein, this dissertation examines the use of stress cues in Spanish words as a diagnosis for cross-language activation in L2 learners' word processing and production: Assuming that bilingual English-Spanish listeners can also use stress to recognize Spanish words (as demonstrated below and in this research), the current study investigates whether cognate words that differ in stress placement in the L1 and L2 interfere with L2 word recognition and production processes. We therefore turn to a review of the most relevant literature on L2 learners' use of stress in word recognition.

3.2 Stress as a Cue to Word Recognition in L2 Learners

Most research has focused on the use of stress in English or Spanish. Some of this research has examined whether native speakers of French, a language without word-level stress, can encode stress phonologically and use it to access words in languages with word-level stress, such as Spanish and English. Prominence in French consistently falls on the last syllable of the phrase (e.g., Jun & Fougeron, 2002; Welby, 2006). Therefore, prominence does not provide relevant information for distinguishing between segmentally identical competing words. Native French listeners have indeed been found to experience difficulty perceiving stress in foreign languages (e.g., Dupoux, Peperkamp, & Sebastián-Gallés, 2001) and using it to recognize words in the L2 (e.g., Dupoux, Sebastián-Gallés, Navarrete, & Peperkamp, 2008; Tremblay, 2008, 2009).

French listeners' difficulty in perceiving stress in non-words (e.g., Dupoux et al., 2001) has given rise to the question of whether French-speaking L2 learners of languages such as Spanish and English can use stress in lexical access. Dupoux et al. (2008) looked at whether stress would constrain French and Spanish listeners' lexical access. In their study, participants completed a speeded lexical decision task, which included word and non-word minimal pairs where the non-words were incorrectly stressed Spanish words (e.g., ***ro**pa* 'clothing' vs. **ro**pa***). The results of this study showed that L2 learners' accuracy was only slightly above chance level. While they were good at identifying the real words (and proficiency was in this case a good predictor of overall accuracy), they were less accurate in identifying incorrectly stressed words as non-words in Spanish, and their accuracy for these non-words did not improve with increased proficiency. The authors interpreted these findings (and those of a different, sequence-encoding experiment) as suggesting that native French listeners cannot encode phonetically variable word stress in short-term memory, and as a result, do not use stress in lexical access.

Tremblay (2008) also explored this issue with French Canadian L2 learners of English. In her study, a partial replication of Cooper et al. (2002)'s word-identification experiment (discussed next) was used, in which both French L2 learners of English and native English listeners completed a cross-modal word identification task. During the task, participants heard a semantically ambiguous sentence ending with the first syllable of a word (e.g., *Very few still remembered the* **mys**/*mis*-). Immediately afterwards, they were presented with two words on the screen (e.g., ***mys**tery* vs. *mis**take***) and were asked to identify the word they thought the last syllable in the sentence belonged to. Segmentally, the first syllable of the two words was the same, but it differed with respect to whether or not it was stressed. The results showed that the L2 learners were less accurate than the native listeners in using stress for lexical access (the most advanced L2 learners reached 59.4% accuracy when the prime was stressed and 58% when it was unstressed, while native speakers got 72.8% and 64.9% accuracy, respectively). Importantly, not proficiency, but length of immersion in the L2 environment, was found to be a good predictor of L2 learners' ability to use English stress for lexical access, with learners with more immersion time making use of stress in lexical access. Thus, it seems that even when stress is not instantiated in the native language, L2 learners can still learn to use it for L2 lexical access.

Other studies have found that L2 learners whose L1 has word-level stress can use stress in L2 lexical access. In their study, Cooper et al. (2002) tested Dutch L2 learners of English with two cross-modal lexical decision tasks (described in the previous section) and a cross-modal word-identification task. Dutch and English are similar prosodically and use the same suprasegmental cues to mark stressed syllables, but English has more vowel reduction than Dutch. Given the similarities between the two languages and the high level of proficiency of their participants, the authors predicted that both groups would pattern similarly. Cooper et al. (2002) used fragments from word pairs that did not contain segmental cues to stress (fragments without vowel reduction or with vowels that had similar segmental realizations in stressed and unstressed syllables). On the cross-modal lexical decisions tasks (described in the previous section), Dutch L2 learners of English performed just like native English listeners.

The cross-modal word identification task was somewhat different from the cross-modal lexical decision tasks. Participants heard the first syllable of words that contained either stress or no stress in this position (e.g., ***mu**sic* vs. *mu**se**um*). They listened to sentences ending with the first syllable of one of the words in the word pairs (e.g., *We were sure the word was* **mu**-), and then saw two words (e.g., “music,” “museum”). Participants were instructed to identify the word they thought completed the sentence they heard. The results showed that both Dutch L2 learners of English and native English listeners performed above chance, and in fact, the learners were more accurate than the native listeners in selecting the correct word after the segmentally ambiguous fragment (about 80% when the truncated word contained stress vs. about 65%, when the fragment did not have the cue to stress). The authors attribute these results to Dutch listeners being more sensitive to prosodic information than English listeners given that there is not as much vowel reduction in Dutch as compared to English.

The fact that stress is cued with both segmental and suprasegmental information in English raises the question of whether English-speaking L2 learners of another language with word-level stress (e.g., Spanish) can shift their reliance from primarily segmental cues (vowel reduction) to suprasegmental cues when recognizing L2 words that differ in stress. This question was addressed by a recent study, looking at intermediate-to-advanced English L2 learners of Spanish (Martínez-García et al., n.d.). In a partial replication of Soto-Faraco et al. (2001) but using a cross-modal word identification task like the one used in Cooper et al. (2002) and Tremblay (2008), the authors found that native Spanish listeners and intermediate-to-advanced English-speaking L2 learners of Spanish performed virtually identically on a corresponding Spanish task, with stressed fragments (e.g., auditory fragment: *por**ta**-*; visually presented word to select from: *por**ta**da* or *porta**dor***) similarly constraining lexical access for both groups.[4] Thus, L2

[4] However, in that study, unstressed fragments (e.g., auditory fragment: *porta-*; visually presented word to select from: *por**ta**da* and *porta**dor***) did not constrain lexical access for either group. These results were attributed to the fact that the presence of stress (a positive cue) constrains lexical access more than the absence of stress (a negative cue).

learners showed evidence of being able to learn to use suprasegmental cues to stress also in Spanish. Moreover, there was evidence of learning in the study, with L2 learners showing increased sensitivity to stress as their proficiency and lexical knowledge in Spanish increased. This suggests that English-speaking L2 learners of Spanish can use Spanish stress when recognizing Spanish words.

This dissertation takes advantage of the fact that intermediate-to-advanced English L2 learners of Spanish can use stress in L2 word recognition (as found by Martínez-García et al., n.d.) to further explore how differences in word-level stress between the two languages (Spanish and English) affect bilingual activation. Stress is an interesting linguistic phenomenon to investigate bilingual activation, because Spanish and English have a number of words that share corresponding segments (cognates) but do not have the same stress pattern. For example, the word *material*, which has the same meaning in both languages, has second-syllable stress in English (*ma**te**rial*) but final stress in Spanish (*mate**rial***). The similar segmental makeup of these two words is likely to result in the English word being activated even in a Spanish task, and the different stress placement in the English word may interfere with participants' use of (the correct) Spanish stress when recognizing and producing the Spanish word, with this degree of interference being potentially larger if English is the L1 than if it is the L2. Using such cognates thus allows us to maximize the possibility of finding bilingual lexical activation (even in a situation in which English is not expected to be activated), which in turn will make it possible to examine the factors that modulate the degree to which L1-Spanish L2-English and L1-English L2-Spanish participants can inhibit the non-target language. We now turn to the research questions investigated in the current study and to the general experimental design that was adopted.

Chapter 4: The Current Study

Recent findings have shown that in any linguistic context, bilinguals' languages are active and interact, yet bilinguals manage to inhibit the non-target language (for a review, see Kroll et al. (2012)). As discussed in Chapter 2, plenty of evidence exists that bilinguals' languages are activated in parallel fashion, even when the context in which communication takes place requires them to function using only one of their two languages, that is, even in a monolingual language mode. Hence, successful communication involves minimizing interference from the unintended language.

Language proficiency and language bias have been proposed to influence the degree of cross-language activation that bilinguals show. To date, however, it remains unclear how both L2 proficiency and language bias modulate bilinguals' activation of their two language systems, whether these two factors interact, and whether (and if so, how) the degree of involvement of these factors differs in language comprehension vs. language production.

4.1 Research Questions

The primary goal of this study is to examine whether, and the conditions under which, L2 proficiency and language bias affect the way in which L1-Spanish L2-English and L1-English L2-Spanish bilinguals control the level of activation of their two languages. The specific research questions that the current study intends to address are:

1. Does lexical stress modulate cross-language activation in:
    a) L1-Spanish L2-English bilinguals' comprehension of Spanish-English cognate words in a monolingual language mode?

b) L1-English L2-Spanish bilinguals' comprehension of Spanish-English cognate words in a monolingual language mode?

2. (How) does L2 proficiency modulate cross-language activation in:

a) L1-Spanish L2-English bilinguals' comprehension of Spanish-English cognate words in:

1. a monolingual language mode?
2. a bilingual language mode?

b) L1-English L2-Spanish bilinguals' comprehension of Spanish-English cognate words in:

1. a monolingual language mode?
2. a bilingual language mode?

c) L1-Spanish L2-English bilinguals' production of Spanish-English cognate words in a bilingual mode?

d) L1-English L2-Spanish bilinguals' production of Spanish-English cognate words in a bilingual mode?

3. (How) does language bias modulate cross-language activation in:

a) L1-Spanish L2-English bilinguals' comprehension of Spanish-English cognate words?

b) L1-English L2-Spanish bilinguals' comprehension of Spanish-English cognate words?

c) L1-Spanish L2-English bilinguals' production of Spanish-English cognate words?

d) L1-English L2-Spanish bilinguals' production of Spanish-English cognate words?

4. (How) do the effects of L2 proficiency and language bias on bilinguals' cross-language activation interact in:
   a) L1-Spanish L2-English bilinguals' comprehension of Spanish-English cognate words?
   b) L1-English L2-Spanish bilinguals' comprehension of Spanish-English cognate words?
   c) L1-Spanish L2-English bilinguals' production of Spanish-English cognate words?
   d) L1-English L2-Spanish bilinguals' production of Spanish-English cognate words?
5. Do differences between comprehension and production exist in how L2 proficiency and language bias modulate cross-language activation in:
   a) L1-Spanish L2-English bilinguals?
   b) L1-English L2-Spanish bilinguals?

To answer these questions, the current research investigates bilingual processing using the visual world eye-tracking paradigm and an adaptation of this paradigm in speech production. It does so by examining how differences in word-level stress placement between Spanish and English affects the processing of cognate words in language tasks with one language (where participants are in a monolingual language mode) vs. two languages (where participants are in a bilingual language mode). In all experiments, the critical conditions have a Spanish target word and a Spanish-English cognate competitor word. The stress pattern of the competitor word in Spanish always mismatched the Spanish target in stress (e.g., target: *ma**te**ria* 'matter'; competitor: *mate**rial*** 'subject'). The stress pattern of the English cognate competitor word was manipulated such that it would match the Spanish target (e.g., target: *ma**te**ria*; competitor:

*mate**rial***) or mismatch the Spanish target (e.g., target: *li**te**ra* ‘bunk bed’; competitor: *lite**ral*** ‘literal’).[5] This type of design was used to examine whether the different stress placement of the English cognate competitor word would affect bilingual listeners’ recognition and production of the Spanish target word. To examine the effect of L2 proficiency on the degree of cross-language activation anticipated from the cognate words, two measures of participants’ proficiency were taken: a cloze (i.e., fill-in-the-blank) test, and the LexTALE task (for L1-Spanish L2-English bilinguals) and a corresponding version of it in Spanish (for L1-English L2-Spanish bilinguals) (Lemhöfer & Broersma, 2012). Finally, language bias was manipulated by controlling how often participants would hear the Spanish-English cognate target word in Spanish or in English (in the filler trials). This created a bias towards expecting more or less of English in the task itself, allowing us to determine how this language bias manipulation affected cross-language activation in the processing of the experimental trials (where the target word was always in Spanish and the competitor word was a Spanish-English cognate).

The next sections describe the experimental design used in this dissertation as well as the participants tested.

4.2 Overall Procedure

The study required participants to come to the lab three times, with at least two days in between visits (to avoid priming effects, as some of the stimuli were repeated in the different experiments). During the first visit to the lab, participants signed the consent form, completed a

[5] In these two examples, the stressed syllable in Spanish is marked in bold, while the English stress pattern for the cognate words is underlined to emphasize how they match or mismatch the stress pattern of the Spanish target word.

background questionnaire, took Experiment 1 (a visual world eye-tracking experiment in Spanish), and completed the cloze test (Brown, 1980 in English and a combination of the MLA Cooperative Language Text (Spanish Embassy, Washington, DC, USA) and the *Diploma de Español como Lengua Extranjera* (Educational Testing Service, Princeton, NJ, USA) in Spanish). The first visit took approximately 1 hour to complete. During this first session, measures were taken to reduce the likelihood that participants would expect to hear any English (e.g., the instructions were given in Spanish, the experimenter spoke to the participants only in Spanish, etc.). In other words, as much as it was feasible to do so, participants were put in a Spanish monolingual language mode (since most of the L1-English L2-Spanish participants were tested in the US, they were otherwise surrounded by their native language). During the second visit, participants completed Experiment 2 (a visual world eye-tracking experiment in both Spanish and English) and a Spanish or English version of the LexTALE task (the Spanish version is under development; the English LexTALE is published in Lemhöfer & Broersma, 2012). The second visit to the lab took approximately 40 minutes to complete. During the third visit, participants completed Experiment 3 (a production task adapted from the visual-world eye-tracking paradigm in both Spanish and English) and a word-familiarity rating task. The third visit took approximately 30 minutes to complete.

4.3 Participants

Two groups of participants were tested: A group of 48 native speakers of Spanish with a mid-proficiency level in English (referred to as L1-Spanish L2-English), tested at the University of Valencia (Spain), and a group of 40 mid-to-high-proficiency English-speaking L2 learners of Spanish (referred to as L1-English L2-Spanish), most of whom were tested in the Second

Language Processing and Eye-Tracking (L2PET) lab at the University of Kansas. The main purpose of having these two groups was to determine how bilingual activation may depend on whether the unintended language is the L1 (as in the case of our L1-English L2-Spanish group) or the L2 (as in the case of our L1-Spanish L2-English group). We also sought to determine how individual differences in L2 proficiency influenced the degree of cross-language interference for each group. However, since the two groups of participants tested are ultimately not comparable (the two groups differed in both their L2 proficiency scores and their L2 experience), the two groups are described separately and, accordingly, the results of the three experiments are reported separately for each group.

4.3.1 L1-Spanish L2-English Group

This group included 48 native speakers of Castilian Spanish. Thirty-six of the 48 participants reported being bilingual speakers of Spanish and Catalan (given the location of the university where the data were collected).[6] However, all of the bilingual participants reported having acquired both of their languages at birth and speaking Spanish most of the time in their daily lives. In fact, in the language background questionnaire, all of them reported being Spanish-dominant. Even though we made sure that participants were native speakers of Spanish or at least Spanish-dominant, we do not expect their knowledge of Catalan to pose a problem for this study. Spanish and Catalan cue stress similarly, with both languages using primarily suprasegmental information to realize stress, such that stressed syllables in isolated words have

[6] The other 12 participants reported having studied Catalan at school and/or at the university and claimed being high-proficient in this language.

higher pitch, longer duration, and greater intensity than unstressed syllables in both languages (e.g., Gavaldà-Ferré, 2007; Ortega-Llebaria, del Mar Vanrell, & Prieto, 2010). Some dialects of Catalan have some vowel reduction, but Valencian, the dialect spoken by the speakers in this group, reduces the number of possible vowels only from seven (/a ɛ e i ɔ o u/) to five (/a e i o u/) in unstressed environments, merging [ɛ] into [e] and [ɔ] into [o]. This is unlike other dialects of Catalan (e.g., Central Catalan) that only distinguish among [i], [u], and [ə] in unstressed position (Gavaldà-Ferré, 2007).

All of the participants in this group were adult mid-proficiency L2 speakers of English, and 26 of them reported having studied other languages (Italian, French, Portuguese, Latin, Japanese, or German) to different degrees of proficiency.[7] Their proficiency in English was assessed using a cloze test (Brown, 1980) and the LexTALE task (Lemhöfer & Broersma, 2012). The original version of the cloze test consists of a passage from a specialized text (about Neanderthals) with 50 open-ended blanks. However, in order to control for the degree of difficulty of the test (as compared with the Spanish proficiency test), a multi-choice version of it was created. For each blank, we created three distracter options by selecting three incorrect responses among the most frequent incorrect responses that 132 previous test takers (native speakers of French and Spanish) had provided when taking the test. For each blank, participants were asked to choose among 4 choices, one of which was the correct word. The order of the

[7] It was not possible to control for the bilinguals' level of proficiency in other languages. However, all participants reported having learned L2 English or L2 Spanish before any other non-native language and being more proficient in L2 English or L2 Spanish than in any other non-native language. Thus, it was not expected that bilinguals' knowledge of these other languages would have a strong effect on the results reported in the current study.

multiple choices was randomized during the test. This English proficiency test can be found in Appendix A.

LexTALE is a proficiency test that targets vocabulary knowledge by using a lexical decision task. In a study on Dutch and Korean learners of English, LexTALE was found to be a good predictor of vocabulary knowledge (as measured by L1-L2 and L2-L1 translations) and to be a better measure of English proficiency than self-ratings (as measured by two thorough and extensive proficiency tests, the TOEIC and the Quick Placement Test) (Lemhöfer & Broersma, 2012). The test comprises 60 trials (40 real words and 20 nonce words) and participants are instructed to decide whether a string of letters presented in the screen is an existing English word or not by pressing one of two keyboard keys (F for "no" and J for "yes," labelled as "no" and "yes" respectively). The original test includes three practice test items not considered in the final score. We administered the test in Paradigm (Tagliaferri, 2005) by downloading the item list and instructions for proper implementation and by randomizing the presentation of the test stimuli. There was no time limit for the lexical decision, so participants could take as much time as needed to make their decision. Participants were also instructed that the experiment used British English spelling, but that they should not let minor differences such as "realise" instead of "realize" confuse them. The English version of LexTALE, including the instructions used, is included in Appendix B. The test was scored as follows: The percentage of correct responses, corrected for the unequal proportion of real and nonce words, were averaged for these two item types, following the formula: (number of real words correct/40*100 + number of nonce words correct/20*100) / 2. From both measures of proficiency, a composite proficiency score was created by averaging the participants' percent accuracy on both measures. Doing so provided us with a global estimate of the participants' proficiency and vocabulary size in English. Using written measures of proficiency also made it possible to avoid the potential circularity that would be associated with using an aural/oral task as a predictor of performance on other aural/oral tasks (as Experiments 1 and 2).

All participants filled out a short language background questionnaire, providing relevant biographical and language learning information. As reported in Table 1, on average the L1-Spanish L2-English bilinguals started learning English after the age of 9 (which is the normal age at which English is introduced in the curriculum in Spain), had studied English for an average of 13 years, and lived in an English-speaking country for an average of only 4 months. This language-background information is consistent with the fact that these bilinguals scored in the mid-proficiency range of our composite proficiency measure (average of the cloze test and the LexTALE scores). Seventy percent of the participants also reported having a majority of nonnative speakers as their English instructors.

Furthermore, the L1-Spanish L2-English bilinguals were asked to rate their familiarity with the English version of the Spanish-English identical cognates used as competitor words in the main experiments on a scale from 0 (I have never seen/heard this word) to 5 (I have seen/heard this word, I know what it means, and I can provide a definition for it), implemented in Paradigm software (Perception Research Systems, Inc.; Tagliaferri, 2005). These familiarity ratings indicated that these participants were highly familiar with all the cognate words used in the three experiments.[8,9] Moreover, the L1-Spanish L2-English bilinguals' lexical familiarity

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[8] Given that lexical familiarity did not improve any of the statistical models on the experimental data, it will not be discussed further.
[9] However, L1-Spanish L2-English bilinguals' knowledge of stress placement in the English cognate competitor was not assessed. It is thus possible that these participants did not know the stress placement of the English cognate

correlated with their proficiency scores. The word familiarity task can be found in Appendix C, including the exact instructions.

Table 1: Background Information, L1-Spanish L2-English Group

	Age of acquisition	**Years of L2 instruction**	**Length of immersion (months)**	**L2 Proficiency (averaged score)**	**Word familiarity (/5)**
Mean	9.9	13.1	4.3	59.0%	4.6
SD	1.4	4.1	7	9.8%	0.5
Min	9	4	0	42.4%	3
Max	17	20	36	85.8%	5

4.3.2 L1-English L2-Spanish Group

All of the 40 L1-English L2-Spanish participants were native speakers of English with no significant exposure to Spanish or other languages before puberty (age of acquisition range: 9-21, as seen in Table 2). The majority of the L2 learners of Spanish were graduate students in the Department of Spanish and Portuguese at the University of Kansas, upper level undergraduate students majoring in Spanish, or high school Spanish teachers recruited from the Lawrence community by word-of-mouth. All of the participants in this group were tested in the Second Language and Eye-Tracking Laboratory (L2PET) at the University of Kansas, except for four of

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competitors in the task, especially since 70% of them reported having non-native English instructors.

them, who were tested at the University of Valencia. These four participants were study-abroad students in a summer program in Valencia, originally students from Iowa State University.[10]

The L1-English L2-Spanish bilinguals' proficiency in Spanish was assessed with a 50-item test combination of the MLA Cooperative Language Text (Spanish Embassy, Washington, DC, USA) and the *Diploma de Español como Lengua Extranjera* (Educational Testing Service, Princeton, NJ, USA). This is a 50-item multiple choice test; the first 30 questions focused on lexical information, while the last 20 question were centered on grammatical aspects of the language. The Spanish proficiency test can be found in Appendix D.

Moreover, participants in this group completed a LexTALE task in Spanish that we created at the University of Kansas in collaboration with Drs. Kristin Lemhöfer and Mirjam Broersma. The test contains a total of 120 trials (80 real words and 40 nonce words) and the words selected for the test have the same characteristics as those used in the English version (part of speech, average lemma frequency, and average orthographic length).[11] All Spanish words contained the proper diacritics. The test was implemented and the results analyzed as described for the English LexTALE. The Spanish version of LexTALE, including the instructions used, is included in Appendix E. As with the previous group of participants, using both measures of proficiency allowed us to create a composite proficiency score that would provide a global estimate of both proficiency and vocabulary size in Spanish, and using written proficiency tests

[10] All the analyses were run with and without these four participants, but the statistically significant effects remained the same. Thus, all the results reported in this dissertation included these four participants.

[11] The Spanish test is longer than the English test for piloting purposes; ultimately, the number of test items will be reduced so that the Spanish LexTALE matches the English LexTALE (we are currently collecting data that will allow us to determine the best words to keep in the final version).

allowed us to avoid the potential circularity of using test that targets the same outcome as that tested in the main experiments.

All participants filled out a short language background questionnaire, providing relevant biographical and language learning information. As reported in Table 2, on average participants started learning Spanish after the age of 14 (thus, a bit later than the participants in the L1-Spanish L2-English group), had studied Spanish for an average of 8.1 years, and lived in a Spanish-speaking country for an average of 11 months (again, differences emerge between the two groups). This language-background information is consistent with the fact that the L1-English L2-Spanish bilinguals scored in the mid-to-high range on our composite proficiency measure. These participants were also very familiar with the experimental items (both the competitor Spanish-English cognate words and non-cognate Spanish target words) used in the main experiments.[12] As was the case of the L1-Spanish L2-English group, the L1-English L2-Spanish bilinguals' lexical familiarity correlated with their proficiency scores.[13] The word familiarity task can be found in Appendix F (the translation of the different levels of familiarity is the same as that in English reported in Appendix C).

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[12] Recall that stress placement in Spanish is highly regular and predictable, and it follows abstract, complex stress assignment rules (Harris, 1969). For nouns, stress falls on the last syllable if it ends with a consonant other than [n] or [s], and otherwise on the penultimate syllable (Harris, 1969). This means that, even if a participant is not familiar with the word, he/she is still expected to be able to use stress in word recognition and production given the regularity of stress placement in Spanish.

[13] As the models with the averaged proficiency score better explained the experimental data obtained, in this dissertation we report only the results with the averaged proficiency score as individual difference variable.

Table 2: Background Information, L1-English L2-Spanish Group

	Age of acquisition	**Years of L2 instruction**	**Length of immersion (months)**	**L2 Proficiency (averaged score)**	**Word familiarity (/5)**
Mean	14.1	8.1	11	73.5%	4.2
SD	3.4	3.8	16.9	14.1%	0.7
Min	9	1	0	39.4%	2.6
Max	21	16	85	93.1%	4.9

The information provided in Tables 1-2 makes it clear that the two groups of participants tested are ultimately not comparable (they differed in both their L2 proficiency scores and their L2 experience). Thus, as previously mentioned, the results of the three experiments will be reported separately for each group.

Chapter 5: Experiment 1: Spanish-Only Visual-World Eye-Tracking Study

5.1 Introduction

As described in earlier chapters of this dissertation, bilinguals activate words in both of their languages even when they intend to use only one language (e.g., Blumenfeld & Marian, 2011; Canseco-Gonzalez et al., 2010; Desmet & Duyck, 2007; Dijkstra, 2005; Marian & Spivey, 2003; Schulpen, Dijkstra, Schriefers, & Hasper, 2003; Weber & Cutler, 2004). This finding is consistent with the nonselective hypothesis of bilingual activation: Lexical representations in both language systems are automatically activated, even in circumstances where the unintended language is not explicitly used (for a review, see Kroll et al. (2012)).

Experiment 1 aimed to answer our first research question: Does lexical stress modulate the degree of cross-language activation that L1-Spanish L2-English and L1-English L2-Spanish bilinguals listeners in a monolingual language mode experience in comprehension? By answering this question, Experiment 1 sought to confirm that bilingual activation would be observed even in a situation where bilinguals are expected to function in only one of their two languages (Spanish in this case)—that is, even when bilinguals are in a monolingual language mode—in line with the nonselective hypothesis of bilingual activation. Furthermore, Experiment 1 sought to confirm that intermediate-to-advanced English-speaking L2 learners of Spanish could indeed use suprasegmental cues to stress during online word recognition, at least when the competitor word is not a Spanish-English cognate, in line with the results of Martínez-García et al. (n.d.).

Experiment 1 uses the visual-world eye-tracking paradigm to assess the degree of cross-language interference caused by Spanish-English cognates in the recognition of Spanish target words. In doing so, this experiment examined whether the recognition of Spanish words would indeed be influenced by competition from English words that differ from Spanish in their stress placement.

5.2 Materials

The experimental items included a total of 32 Spanish trisyllabic nouns with regular stress placement in one of two competitor conditions. Following the Spanish stress rule, the target was always the word with stress on the penultimate syllable (e.g., *a**sa**do* ‘roasted’, or *ma**te**ria* ‘matter/subject’), and this target was presented on the screen together with a possible competitor (one competitor at a time; the two possible competitors were never seen in the same display). In the *stress mismatch* condition (experimental condition), the competitor was a word in which the first two syllables were segmentally identical to but suprasegmentally different from the target word, with the competitor word ending with a consonant other than /n/ or /s/ and thus having word-final stress (e.g., *asa**dor*** ‘rotisserie’, or *mate**rial*** ‘material’). If stress is used incrementally to constrain lexical access, the target and competitor words in this condition should be disambiguated as early as the second syllable given that the target, but not the competitor, was stressed in this position. In order to determine whether stress is used to constrain lexical access as soon as it is perceived, a second competitor condition, the *stress match* condition, was created. In this stress match condition (control condition), the target and competitor words also differed in the last segment (e.g., *a**sa**dos* ‘roasted (pl)’, or *ma**te**rias* ‘matter/subject (pl)’) but had the same stress pattern (penultimate).

Given that the competitor word with the same stress pattern was always semantically related to the target (its plural form), we included only target words for which both competitors were semantically related to the target. In this case, semantic relatedness should not bias lexical activation in one competitor condition more than in the other. Comparing the levels of competition between these two conditions would allow us to examine the moment-by-moment processing of Spanish stress. If stress is used incrementally to disambiguate between words that are temporarily ambiguous at the segmental level, then only in the stress mismatch condition should the target and competitor words be disambiguated as early as the second syllable, with participants showing less lexical competition in the stress mismatch condition than in the stress match condition. If stress is not used to constrain lexical access, then the two conditions should elicit a similar amount of lexical competition, as both target and competitors would be disambiguated upon reaching the last syllable.

Crucially, this experiment was designed to test whether the moment-by-moment processing of stress would be modulated by the presence of a Spanish-English cognate competitor whose English pronunciation matched the Spanish target in stress. Half of the 32 experimental items belonged to a non-cognate condition, with none of the words on the screen being a Spanish-English cognate. The remaining half belonged to the Spanish-English cognate condition, with the English stress of the critical competitor word matching that of the Spanish target.[14] For example, as described earlier, the stress patterns of the words *ma**te**ria* ('matter/subject') and *mate**rial*** differ in Spanish (second vs. third syllable stress). However, the Spanish word *ma**te**rial* is also a word in English, but with second syllable stress in English (same stress pattern as the target *ma**te**ria* in Spanish). It was thus expected that these orthographic

[14] Note that for many test items in the cognate condition, the target was a pseudo-cognate (i.e., its form and meaning overlapped to some degree between the two languages). It was not possible to avoid pseudo-cognates given the limited number of Spanish words that overlap in their first two syllables but that differ in stress.

cognates would activate both Spanish and English pronunciations and thus both stress patterns (third syllable in Spanish, second syllable in English), with participants needing to inhibit the non-target stress pattern (i.e., the English stress pattern) to correctly recognize the Spanish target word as early as in the second syllable. An example test item for the non-cognate condition is shown in Table 3 and for the cognate condition in Table 4. The experimental items can be found in Appendices G and H for the non-cognate condition and in Appendices I and J for the cognate condition.

Table 3: Example Stimuli in the Non-Cognate Condition, Experiment 1

	Stress-mismatch (experimental) condition		Stress-match (control) condition	
Auditory Stimulus	Visually Presented Word Choice		Visually Presented Word Choice	
	Target	**Competitor**	**Target**	**Competitor**
	"asado" 'roast'	"asador" 'rotisserie'	"asado" 'roast'	"asados" 'roast (pl)'
*a**sa**do* 'roast'	**Distracter 1**	**Distracter 2**	**Distracter 1**	**Distracter 2**
	"camisas" 'shirt (pl)'	"camisones" 'nightshirt (pl)'	"camisón" 'nightshirt'	"camisones" 'nightshirt (pl)'

Table 4: Example Stimuli in the Cognate Condition, Experiment 1

	Stress-mismatch (experimental) condition		Stress-match (control) condition	
Auditory Stimulus	Visually Presented Word Choice		Visually Presented Word Choice	
	Target	**Competitor**	**Target**	**Competitor**
*ma**te**ria* ‘matter/subject’	“materia” ‘matter/subject’	“material”	“materia” ‘matter/subject’	“materias” ‘matter/subject (pl)
	Distracter 1	**Distracter 2**	**Distracter 1**	**Distracter 2**
	“parados” ‘unemployed (pl)	“paradores” ‘inn (pl)’	“parador” ‘inn’	“paradores” ‘inn (pl)’

In summary, the stress match and mismatch conditions served the purpose of evaluating the degree to which listeners use stress in lexical access. The non-cognate and cognate conditions served the purpose of evaluating whether cognates, whose stress pattern in English matches the Spanish target, cause an increase in lexical competition.

The log frequency of the target and competitor words was obtained using the subtitle token corpus in EsPal (Duchon, Perea, Sebastián, Martí, & Carreiras, 2013), provided by the Basque Center on Cognition, Brain and Language. In the non-cognate condition, competitor words in the two stress conditions (stress match and stress mismatch) were not statistically different in either frequency ($t(30)<|1|$) or length (they had the same average length). The same was true of the competitor words in the cognate condition (frequency ($t(30)=1.21$, $p>.05$) and length ($t(30)<|1|$)). It was also the case that in the stress mismatch condition, the non-cognate and cognate competitors did not differ statistically in either frequency ($t(30)=–1.92$, $p>.05$) or length ($t(30)=–1.05$, $p>.05$); similarly, in the stress match condition, the non-cognate and cognate competitors did not differ significantly in either frequency ($t(30)<|1|$) or length ($t(30)<|1|$). The comparison of the two target words yielded the same pattern of results (frequency: ($t(30)=1.23$, $p>.05$), length: ($t(30)<|1|$)).[15]

The target and competitor words were presented orthographically on the screen, together with two distracter items. These distracter words were created such that the number of plural and singular nouns and the number of heavy vs. light final syllables in the singular form would be balanced.[16] For example, in the stress match condition, target and competitor words such as *a**sa**do-a**sa**dos* 'roast (singular and plural)' would be presented with distracter words such as *cami**són*** and *cami**so**nes* 'nightshirt (singular and plural)'). The distracter words followed the same structure as the experimental items: Their first two syllables were segmentally identical but differed in stress pattern. Distracter words did not overlap in form or meaning with the target and competitor words, and all of them were words in Spanish. Even though some of the distracter words were also pseudo-cognate in English and Spanish (e.g., *cami**són*** and *cami**sole***), this is not expected to cause any problem in the current study, because these words did not overlap in form or meaning with the target word heard in the speech signal; if anything, the pseudo-cognate status of some of the distracter words may have helped reduce participants' bias towards the Spanish-English cognate competitor. The distracters created for the non-cognate and cognate conditions are provided in Appendices E to H.

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[15] It was not possible to match the frequency of the target and each of the competitors, because words stressed on the penultimate syllable (that is, the target words in this study) tend to be more frequent than words with final stress. This should not pose any problems, in that fixations to the target word were never compared to fixations to the competitor word; instead, it was fixations to the two types of competitors that were compared.

[16] In Spanish, heavy syllables are syllables ending with a consonant other than /n/ or /s/; light syllables are all other syllables.

This experiment also included 96 filler trials. The filler items followed the same design as that described for the experimental items: Each display contained a word that in the singular form had a light final syllable (penultimate stress), a word in the plural form whose singular form also ended with a light final syllable (penultimate stress), a singular word with a heavy final syllable (final stress), and a plural word whose form in the singular had a heavy final syllable (third syllable stress). However, the filler items differed from the experimental items in that the target word was always a word other than the singular word with the final light syllable. The filler target words were also presented with different competitor types, with the whole experiment being balanced for the number of times each type of word (singular vs. plural, light vs. heavy final syllable) was the target in the auditory stimuli. Moreover, filler trials in which the target word was a Spanish-English cognate were also included. Thus, throughout the experiment, participants could not use strategies to figure out which of the four words would be the target word prior to hearing the target word. Appendix K provides the complete list of filler items for Experiment 1.

All nouns exhibited the appropriate Spanish diacritics. Spanish marks irregular stress placement with the use of diacritics (e.g., *cami**són*** ‘nightshirt’ which should have penultimate stress placement according to the Spanish stress rule). However, as none of the experimental items included irregularly stressed nouns, participants could not use this as a cue to know where stress fell in the critical items. Two different lists were used such that each participant would see each target with only one competitor type (e.g., participants assigned to List 1 would see ***asa**do-a**sa**dos* ‘roast (singular and plural),’ whereas participants assigned to List 2 would see *a**sa**do-asa**dor*** ‘roast-rotisserie’). Each list contained 16 experimental items in the non-cognate condition (8 with a stress match competitor and 8 with a stress mismatch competitor) and 16 experimental items in the cognate condition (8 with a stress match competitor and 8 with a stress mismatch competitor).

The auditory stimuli were recorded by a female native speaker of Castilian Spanish (from Galicia, in northwest Spain) using an Electro-Voice N/D 767 cardioid microphone and a Marantz Portable Solid State Recorder (PMD 671) in the anechoic chamber at the University of Kansas, Lawrence. Tokens were recorded in isolation to try to avoid coarticulatory effects. Each token was repeated twice, with a long pause in between repetitions.

5.3 Procedure

This experiment was conducted during participants' first visit to the lab. Participants were comfortably seated in an isolated room facing a computer screen. Participants completing the experiment at the University of Valencia had their eye movements recorded by a desktop-mounted Eyelink 1000 (www.sr-research.com) at a sampling rate of 1000 Hz (eye-movement information was recorded every millisecond). Participants completing the experiment at the University of Kansas had their eye movements recorded by a head-mounted Eyelink II (www.sr-research.com) at a sampling rate of 250 Hz (eye-movement information was recorded every 4 milliseconds). In both cases, participants wore headphones, and they were seated at approximately 23 inches from the computer screen.

Each trial was structured as follows: Participants first saw the four orthographic words for 4,000 ms, which they were instructed to silently read. The words then disappeared, and a fixation cross appeared and stayed on the screen for 500 ms. As the fixation point disappeared, the same four words reappeared on the screen and participants simultaneously heard the target word through headphones. Participants were asked to click on the word that matched the acoustic input as quickly and accurately as possible. A visual representation of the procedure followed in each trial is presented in Figure 4.

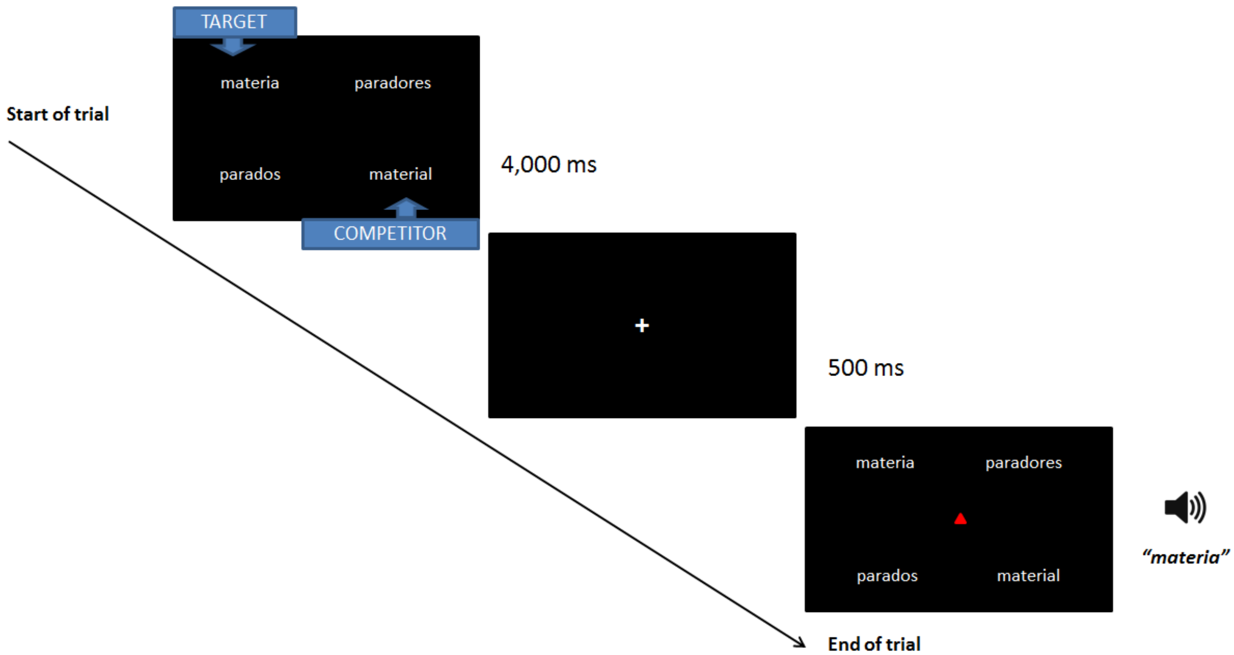

Figure 4: Visual Example of a Trial in Experiment 1

Each session began with four practice trials. The practice items followed the same structure as the experimental items described in the previous section. No feedback was provided during the practice session. This short practice session allowed participants to become familiar with the experimental procedure. The actual experiment began right after the practice session.

The experiment (including the practice session) consisted of 132 trials presented in four different blocks. Each block contained eight experimental trials (four in the non-cognate condition and four in the cognate condition) and 24 filler trials. The position of the target and competitor words in the display and the order of the test items (experimental, filler) were randomized across trials.

5.4 Data Analysis

Fixations were included in the analysis only if participants selected the target or competitor word as their response (as determined by their mouse clicks). Including fixations in which participants selected the competitor is warranted on the grounds that the stress and cognate status manipulations were intended to modulate the degree of lexical competition that bilingual listeners experienced, and trials with competitor selection were trials in which participants indeed experienced a larger degree of lexical competition. Of all the trials included in the analysis, only 9 trials for the L1-Spanish L2-English group (or 0.005% of the data) and 5 trials for the L1-English L2-Spanish group (or 0.003% of the data) were trials in which participants clicked on the competitor word, and the majority of these trials were indeed from the stress-match condition (7/9 for the L1-Spanish L2-English group; 4/5 for the L1-English L2-Spanish group), where participants were expected to show more lexical competition. In this experiment, participants always selected either the target or competitor word, so all fixations were ultimately included in the analysis.

Participants' eye fixations were analyzed as follows. Eye movements in each of the four regions of interest (corresponding to the four orthographic words) were analyzed from 0 to 1,500 ms. Given that it takes approximately 200 ms. for listeners to program and launch an eye movement (Hallett, 1986), statistical analyses were conducted on eye movements recorded after 200 ms of the target-word onset. Proportions of fixations to the target and competitor words were averaged within two time windows: A pre-disambiguation time window corresponding to the first two syllables of the target word (e.g. *ma**te***-, *li**te***-), with a delay of 200 ms to account for the time it takes eye movements to reflect speech processing (on average from 200 ms to 430 ms, with the time window offset being calculated on an item-by-item basis); and a post-disambiguation time window corresponding to the rest of the trial up until 1,500 ms (on average from 430 ms to 1,500 ms, with the time window onset being calculated on an item-by-item basis). “Disambiguation” thus refers to the point in time at which the target and competitor differed *segmentally*. The averages in fixations for each time window were computed on an item-by-item basis. Eye fixations in the first time window will reveal whether listeners show sensitivity to the manipulated factors *before* the target and competitor word disambiguate segmentally in the signal.

Statistical analyses were conducted on the log-odd-transformed *difference* between the averaged proportions of fixations to the target and the averaged proportions of fixations to the competitor (for each time window). Using this difference measure (rather than proportions of fixations) factors out differences in relative speed with which both target and competitor words are fixated over distracter words, thus better reflecting the lexical activation process, and also making the comparison between the different conditions more straightforward. Linear mixed-effects models were conducted on these differences using the lme4 package of R (for discussion, see Baayen (2008)). The models were conducted on these differences in target and competitor fixations separately for each time window, examining the effect of stress condition (stress match vs. stress mismatch, with stress match as the baseline), cognate status (non-cognate vs. cognate, contrast coded as, respectively, 0.5 and –0.5), proficiency (arcsine transformed and centered), and all two- and three-way interactions. Different models were run for the two groups (L1-Spanish L2-English and L1-English L2-Spanish bilinguals), because the two groups were not sufficiently well matched in their L2 proficiency and L2 experience for a direct comparison of the two groups to be interpreted straightforwardly. For each dataset, the effect of each predictor was assessed using log-likelihood tests comparing models with and without that predictor; in each case, the simplest model with the best fit was kept. All models included participant, test item, and list as crossed random variables.

5.5 Predictions

This experiment examined whether L1-Spanish L2-English and L1-English L2-Spanish bilinguals would experience interference from Spanish-English cognate competitors that, in English, have the same stress placement as the Spanish target word, even if English was not used in the experiment. This experiment also investigated whether L1-Spanish L2-English and L1-English L2-Spanish listeners could use stress when recognizing non-cognate Spanish target words.

The moment-by-moment processing of stress was evaluated by comparing the effects of the two competitor types (stress match vs. stress mismatch). If stress is used online to constrain lexical access, lower proportions of target fixations and higher proportions of competitor fixations should be found in the stress match condition as compared to the stress mismatch condition. This would indicate that listeners could use stress cues as early as the second syllable to disambiguate between the target and competitor words (since these two words differ suprasegmentally). If the results found in Martínez-García et al. (n.d.) hold for eye-tracking data (they should), we should find that L1-Spanish L2-English and L1-English L2-Spanish bilinguals pattern similarly, indicating that they can use stress as a cue for word recognition, at least in the non-cognate condition. In addition to an effect of stress, we expect an interaction between stress (match vs. mismatch) and cognate status (cognate vs. non-cognate), such that the effect of stress should be greater in the non-cognate condition as compared to the cognate condition, and the effect of cognate should be greater in the stress mismatch condition than in the stress match condition. This prediction stems in part from the literature showing evidence of cross-language activation (for a review, see Kroll et al. (2012)).

5.6 Results

This section begins with a description of the results found for the L1-Spanish L2-English group, with the results for the pre- and post-disambiguation time windows reported separately.

5.6.1 L1-Spanish L2-English Group

Figure 5 presents the L1-Spanish L2-English listeners' proportions of target (solid lines), competitor (dashed lines), and distracter (dotted lines) fixations in the stress match (red) and stress mismatch (black) conditions, separately for the non-cognate and cognate conditions.

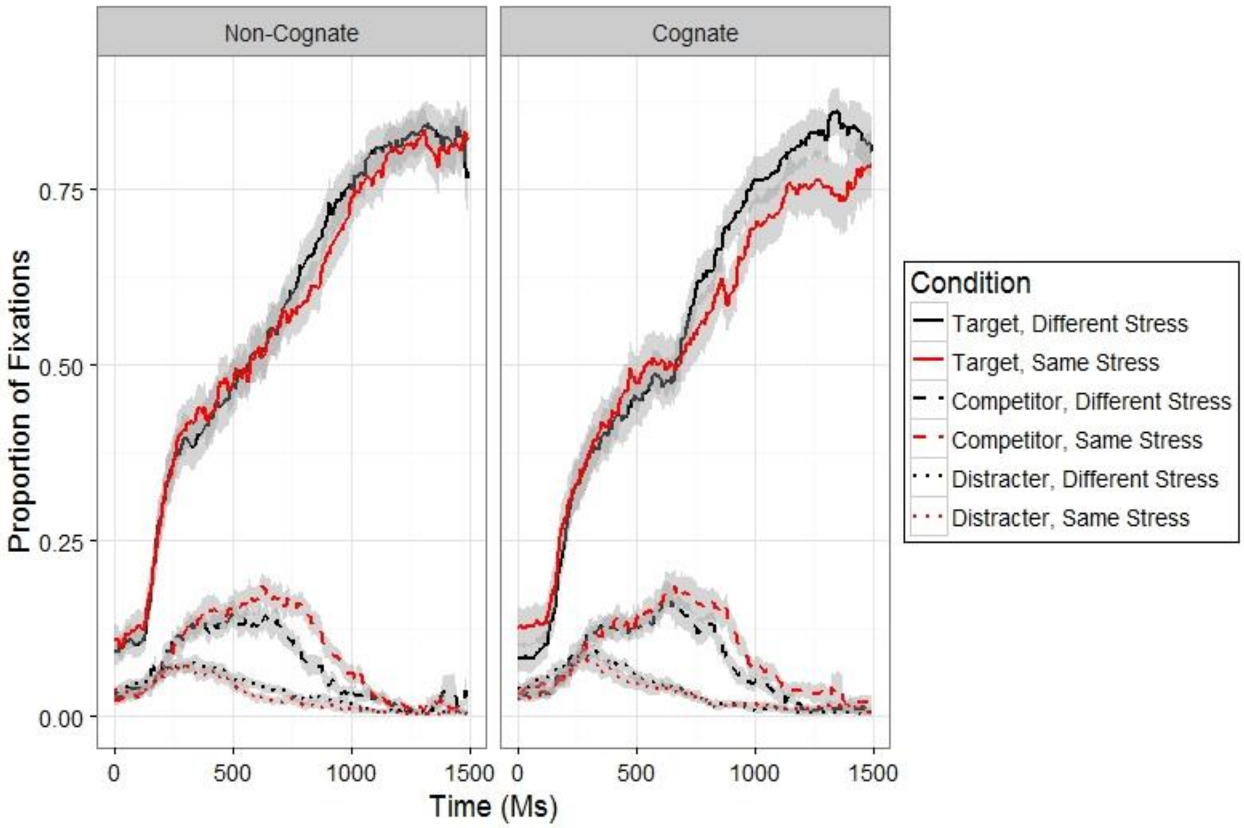

Figure 5: Proportion of Fixations, L1-Spanish L2-English group, Experiment 1

Since statistical analyses were conducted on the differences between proportions of target fixations and proportions of competitor fixations, the L1-Spanish L2-English listeners' fixations are also plotted as such. Figure 6 presents these differences in fixations in the stress match (red) and stress mismatch (black) conditions, separately for the non-cognate and the cognate conditions. The two vertical lines represent the averaged pre-disambiguation time window.

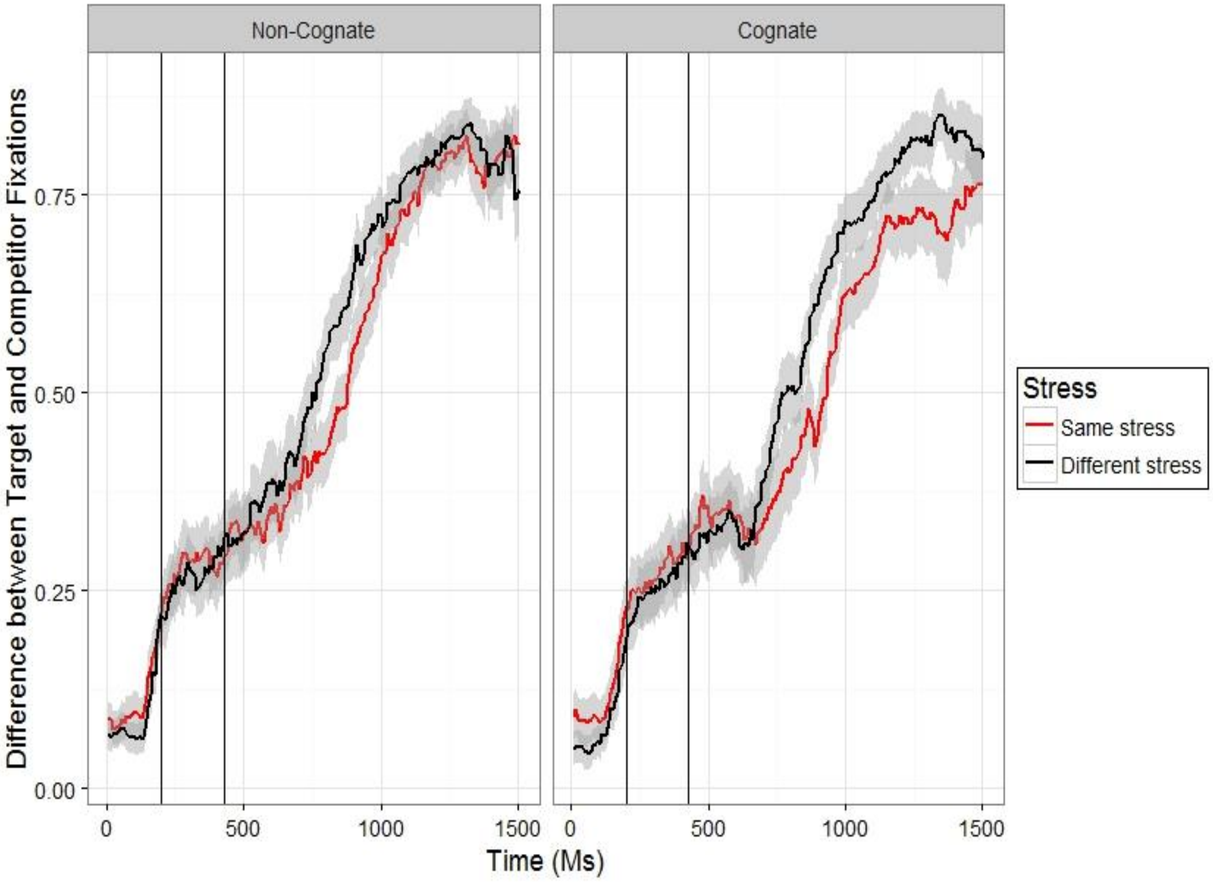

Figure 6: Difference between Target and Competitor Fixations, L1-Spanish L2-English Group, Experiment 1

5.6.1.1 Pre-Disambiguation Time Window

For the pre-disambiguation time window, the best model on L1-Spanish L2-English group's difference in fixations included stress (match vs. mismatch), cognate status (non-cognate vs. cognate), and proficiency as fixed factors, as well as the two-way interaction between proficiency and cognate status. Table 5 presents the results of this model.

Table 5: Mixed-Effects Linear Model Results, L1-Spanish L2-English Group, Pre-Disambiguation Time Window, Experiment 1

Variable	**Estimate (SE)**		***t***	***p***
(Intercept)	0.03	(.004)	6.65	<.001
Stress	0.002	(.003)	<|1|	>.1
Cognate Status	0.001	(.003)	<|1|	>.1
Proficiency	0.03	(.03)	1.05	>.1
Cognate Status x Proficiency	–0.03	(.02)	–1.19	>.1

Note: $df = 1504$; $\alpha = .05$

The model summarized in Table 5 revealed no significant effect or interaction in this first time window. This indicates that, when the signal was segmentally ambiguous (but differed in terms of stress placement) between the target and competitor word, the L1-Spanish L2-English participants did not make use of stress to disambiguate between the two competing words, nor were they affected by the presence of a Spanish-English cognate word with interfering stress pattern in their L2.

5.6.1.2 Post-Disambiguation Time Window

For the post-disambiguation time window,[17] the best model for the L1-Spanish L2-English group's difference in fixations included stress (match vs. mismatch), cognate status

[17] The post-disambiguation time window included a window ranging from the end of the second syllable to 1,500 ms post target-word onset. In this analysis, as well as in those reported later on in the dissertation, different results may have been obtained if a smaller post-disambiguation time window had been chosen (e.g., looking only at the effects emerging in the window corresponding to the duration of the third syllable of the target word, with a delay of 200 ms).

(non-cognate vs. cognate), and proficiency as fixed factors, as well as the two-way interaction between proficiency and stress. Table 6 presents the results of this model.

Table 6: Mixed-Effects Linear Model Results, L1-Spanish L2-English Group, Post-Disambiguation Time Window, Experiment 1

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	0.57	(.03)	16.25	<.001
Stress	0.04	(.02)	2.44	<.02
Cognate Status	0.07	(.28)	<|1|	>.1
Proficiency	–0.02	(.02)	–1.38	>.1
Stress x Proficiency	0.22	(.16)	1.39	>.1

Note: $df = 1504$; $\alpha = .05$

The model summarized in Table 6 revealed only a main effect of stress condition. This indicates that, right after the point in time at which the speech signal disambiguates segmentally between the target and competitor word, the L1-Spanish L2-English participants showed a larger difference between target and competitor fixations (indicating *less* lexical competition) in the stress mismatch condition than in the stress match condition. This pattern of results indicates that our participants showed sensitivity to Spanish stress and used it in lexical access, though not predictively. However, these listeners were not affected by the presence of a Spanish-English cognate word with an interfering stress pattern in their L2.

5.6.2 L1-English L2-Spanish Group

Figure 7 presents the L1-English L2-Spanish listeners' proportions of target (solid lines), competitor (dashed lines), and distracter (dotted lines) fixations in the stress match (red) and stress mismatch (black) conditions, separately for the non-cognate and cognate conditions.

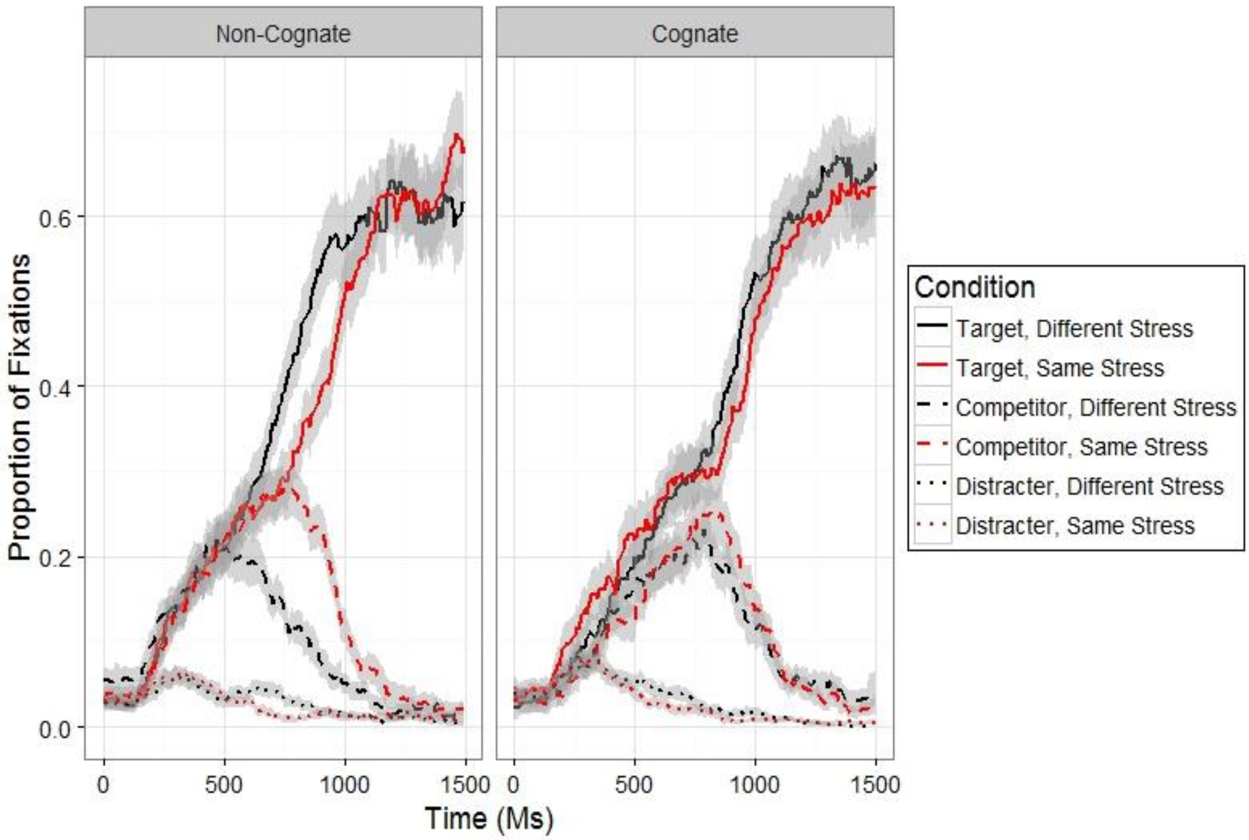

Figure 7: Proportion of Fixations, L1-English L2-Spanish Group, Experiment 1

Since statistical analyses were conducted on the differences between proportions of target fixations and proportions of competitor fixations, the L1-English L2-Spanish listeners' fixations are also plotted as such. Figure 9 presents this difference in the stress match (red) and stress mismatch (black) conditions, separately for the non-cognate and cognate conditions. Again, the vertical lines represent the averaged pre-disambiguation time window.

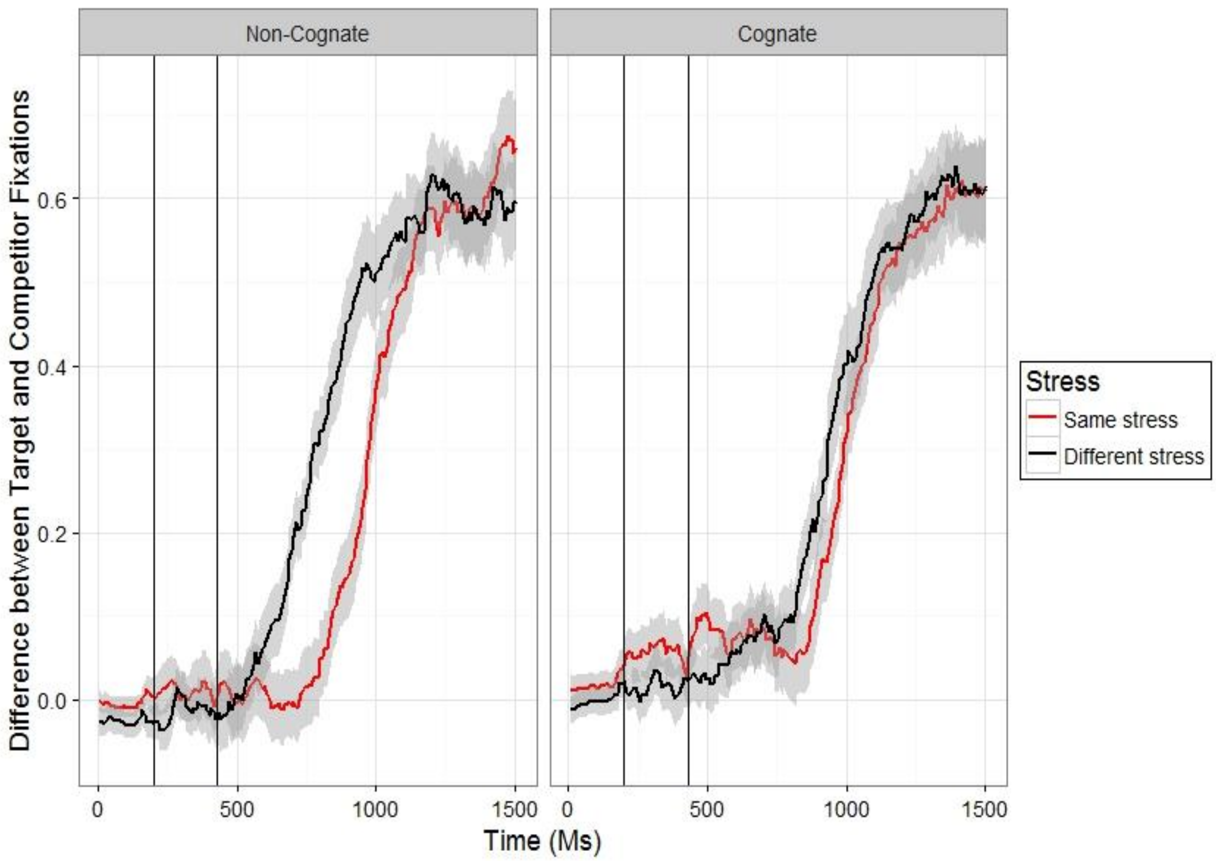

Figure 8: Difference between Target and Competitor Fixations, L1-English L2-Spanish Group, Experiment 1

5.6.2.1 Pre-Disambiguation Time Window

For the pre-disambiguation time window, the best model for the L1-English L2-Spanish group's difference in fixations included stress (match vs. mismatch), cognate status (non-cognate vs. cognate), and proficiency as fixed factors, as well as the two-way interaction between proficiency and stress. Table 7 presents the results of this model.

Table 7: Mixed-Effects Linear Model Results, L1-English L2-Spanish Group, Pre-Disambiguation Time Window, Experiment 1

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	–0.02	(.09)	–2.15	<.001
Stress	0.15	(.09)	1.58	>.1
Cognate Status	–0.04	(.02)	–1.84	<.06
Proficiency	0.23	(.09)	2.41	<.05
Stress x Proficiency	–0.21	(.11)	–1.94	<.052

Note: *df* = 1280; α = .05

The model summarized in Table 7 revealed a marginal effect of cognate status, a main effect of proficiency, and a marginal interaction between stress and proficiency. The marginal effect of cognate status suggests a trend for L1-English L2-Spanish participants to show a smaller difference between target and competitor fixations (indicating *more* lexical competition) in the non-cognate condition than in the cognate condition for the stress match items (the baseline). Given the lack of interaction between stress and cognate status, this means the simple effect of cognate can also be generalized to the stress mismatch items. The main effect of proficiency indicates that the L1-English L2-Spanish listeners showed a larger difference in fixations (indicating *less* lexical competition) as their proficiency in Spanish increased. Finally, the interaction between stress and proficiency, illustrated in Figure 8, indicates that proficiency modulated lexical activation only in the stress match condition. As a result, the effect of stress also decreased as listeners' Spanish proficiency increased.

These pre-disambiguation time window results indicate that only the lower-proficiency L1-English L2-Spanish listeners could make use of stress to disambiguate between the target and competitor words. L1-English L2-Spanish listeners were also affected by the presence of a Spanish-English cognate word, but that effect was true of both the stress match and stress mismatch conditions, suggesting that the target and competitor words were disambiguated more rapidly in the cognate condition than in the non-cognate condition.

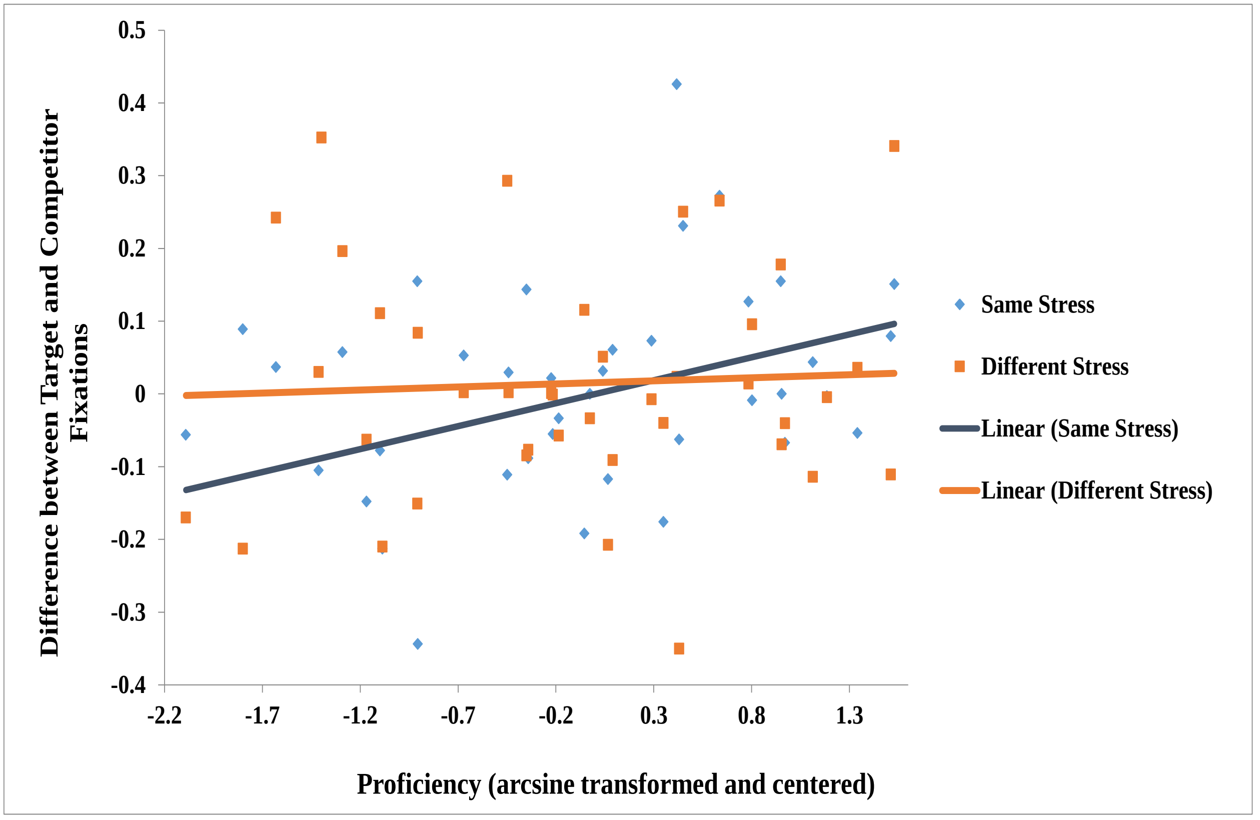

Figure 9: Interaction between Stress and Proficiency, L1-English L2-Spanish group, Experiment 1

5.6.2.2 Post-Disambiguation Time Window

For the post-disambiguation time window, the best model on the L1-English L2-Spanish group's difference in fixations included stress (match vs. mismatch), cognate status (non-cognate vs. cognate), and proficiency as fixed factors, as well as the two-way interaction between proficiency and stress. Table 8 presents the results of this model.

Table 8: Mixed-Effects Linear Model Results, L1-English L2-Spanish Group, Post-Disambiguation Time Window, Experiment 1

Variable	**Estimate (SE)**		***t***	***p***
(Intercept)	0.1	(.11)	$<\lvert 1 \rvert$	>.1
Stress	0.12	(.06)	1.87	<.06
Cognate Status	–0.02	(.02)	–1.2	>.1
Proficiency	0.24	(.13)	1.83	<.07
Stress x Proficiency	–0.03	(.09)	$<\lvert 1 \rvert$	>.1

Note: *df* = 1208; α = .05

The model summarized in Table 8 revealed only two marginal effects: a marginal effect of stress and a marginal effect of proficiency. The marginal effect of stress suggests a trend for L1-English L2-Spanish participants to show a larger difference between target and competitor fixations (indicating *less* lexical competition) in the stress mismatch condition than in the stress match condition. The marginal effect of proficiency suggests a trend for participants to show a larger difference between target and competitor fixations (indicating *less* lexical competition) as their proficiency in Spanish increased. This pattern of results indicates that L1-English L2-Spanish participants showed a trend towards using stress in the recognition of Spanish words after the segmental disambiguation of the speech signal. Furthermore, in the post-disambiguation time window, they were no longer affected by the presence of a Spanish-English cognate word on the screen.

5.7 Discussion and Conclusion

The main objective of Experiment 1 was to determine whether stress differences between Spanish-English orthographically identical cognates would trigger the activation of the English stress pattern in a task where only Spanish was heard, and whether (and if so, how) L2 proficiency would modulate this cross-language activation. This experiment thus sought to provide additional evidence for the nonselective hypothesis of bilingual lexical activation, which claims that cross-language activation occurs even when bilinguals are in a bilingual language mode.

We predicted an interaction between stress (match vs. mismatch) and cognate status (non-cognate vs. cognate), such that the effect of stress would be greater in the non-cognate condition than in the cognate condition, and the effect of the cognate status would be greater in the stress mismatch condition than in the stress match condition. However, the only effect involving cognate status that was found was a marginal effect of cognate status for the L1-English L2-Spanish group in the pre-disambiguation time window, indicating that this group showed greater differential proportions of fixations in the cognate condition than in the non-cognate condition, irrespective of the stress pattern of the competitor word in Spanish (match, mismatch).

Thus, one question that arises is why we did not find an interaction between stress and cognate status. When activating the English pronunciation of the cognate, listeners activated not only the stress pattern (and the corresponding suprasegmental correlates) of the English word, but also the *segmental* makeup of the English word, including instances of vowel reduction in the English pronunciation of these words. For example, the word *mate**rial*** in English contains a reduced vowel in the first syllable; listeners may thus have activated this reduced vowel in the first syllable of the English competitor word. One possibility is that by the time L1-English L2-Spanish listeners heard the second syllable of the Spanish target word (where the stress manipulation would produce the cross-language interference), they already had enough segmental information to help them reduce the level of activation (and thus, of interference) from

English (i.e., the Spanish target, e.g., *ma**te**ria*, does not have a reduced vowel in its first syllable). If listeners tuned in to segmental information more than to suprasegmental information, hearing a full vowel in the first syllable of the Spanish target might be enough to decrease lexical competition from the English competitor word, potentially eliminating the interaction that was predicted for this study. Since the majority of unstressed syllables are reduced in English, this is not something that could be controlled for.

The present study found differences in the degree of lexical competition that cognates and non-cognates create. Many studies have shown that cognates and non-cognates are processed differently in comprehension (e.g., de Groot, 1992; Lalor & Kirsner, 2001; Lemhoefer, Dijkstra, & Michel, 2004; Sánchez-Casas, García-Albea, & Davis, 1992, among others). These studies have reported that cognates are generally recognized more rapidly and more easily because they receive more activation due to their existence in the bilingual's two languages (see Desmet & Duyck, 2007, for a review). Similar results were found in the current study. In the cognate condition, the competitor word was the only word that had all of its orthography consistent with both Spanish and English, but many of the target words were nonetheless pseudo-cognates: Some of their orthography was shared between the two languages (e.g., *ma**te**ria* 'matter'). It is thus not surprising that the competition between the target and competitor words was resolved more rapidly in the cognate condition than in the non-cognate condition. Assuming that cognates and pseudo-cognates receive a greater level of activation due to overlap in the bilingual's two languages, they should indeed be recognized more rapidly than non-cognates.

Findings of cross-language activation in the bilingual lexical processing literature have been reported for different language combinations (Canseco-Gonzalez et al., 2010; Cutler et al., 2006; Ju & Luce, 2004; Marian & Spivey, 2003a; Mercier, Pivneva, & Titone, 2014; Spivey &

Marian, 1999; Weber & Cutler, 2004). In most of these studies, the size of this cross-language effect varied based on several factors, such as whether the task was conducted in the L1 or L2 (i.e., Marian & Spivey, 2003a), listeners' proficiency in both languages, and their frequency of use of both languages (Blumenfeld & Marian, 2011; Canseco-Gonzalez et al., 2010; Mercier, 2013). It is likely that the target and competitor words were disambiguated more rapidly in the cognate condition than in the non-cognate condition for the L1-English L2-Spanish listeners but not for the L1-Spanish L2-English listeners due to the differential strengths of lexical activation in L1 Spanish as compared to L2 Spanish. In order to understand this difference, we need to look at the characteristics of each group of participants. On the one hand, the L1-Spanish L2-English group was formed with native speakers of Spanish who lived in Spain at the time of the experimental testing and who had an intermediate level of proficiency in English; hence, these speakers were dominant in Spanish. On the other hand, the L1-English L2-Spanish were native speakers of English, living in Kansas at the time of testing, with an intermediate-to-advanced level of proficiency in Spanish, but still dominant in English. It seems that more cross-language interference was found when the unintended language was the dominant (here, native) language (L1-English L2 Spanish) than when it was the non-dominant (here second) language (L1-Spanish L2 English).

One limitation of the current study is that L1-Spanish L2-English listeners' knowledge of English stress was not assessed. We controlled for L1-Spanish L2-English listeners' familiarity with the test items; however, knowing the word does not necessarily entail knowing exactly where stress falls in that word (given how irregular stress placement is in English, at least as compared to Spanish). It is possible that the L1-Spanish L2-English bilinguals did not show an effect of stress interference because they did not know where stress should fall in the English words used in the current study. Further research should assess bilinguals' knowledge of stress placement in the L2 when stress is irregular and cannot be easily predicted on the basis of the phonological and morphological structure of the word.

This experiment also examined whether mid-to-high proficiency English-speaking learners of Spanish (and native Spanish listeners) can use stress to recognize Spanish words. An open question in the literature had been whether English-speaking L2 learners of another language with word-level stress (e.g., Spanish) could shift their reliance from primarily segmental cues (vowel reduction) to suprasegmental cues when recognizing words differing in stress. Previous studies had indicated that native speakers of English could indeed rely just on suprasegmental information, at least to some degree, when processing their native language (Cooper et al., 2002). In a more recent study using an offline task, it was shown that English-speaking L2 learners of Spanish can learn to use suprasegmental cues to stress also in Spanish (Martínez-García et al., n.d.). With this experiment, we extended these findings and showed that English-speaking L2 learners of Spanish can also exploit these suprasegmental cues to stress in Spanish during an online task, at least at lower ends of the proficiency continuum.

The results of the L1-English L2-Spanish group showed greater target activation in the stress match condition as proficiency increased. One might instead expect proficiency to influence target activation in the mismatch condition, reflecting Spanish learners' increased ability to use stress in word recognition as a higher proficiency in Spanish. One possible explanation of these results is that with increasing proficiency in Spanish, L1-English L2-Spanish listeners may become better able to use fine-grained acoustic information to distinguish between the target and competitor words in the stress match condition (i.e., the singular form of the target word and the plural form of the same word as competitor) before the actual disambiguation. That is, small differences in the segmental properties of the first two syllables of the target and competitor words might provide subtle cues to disambiguation that more proficient learners of Spanish might be better able to pick up. However, a detailed acoustic examination of the same singular and plural nouns could not be undertaken in the present study since the experimental target words were recorded only in their singular form. This is a question that therefore remains open for further research. Note that since the distribution of singular and plural words was counterbalanced throughout the experiment (in auditory stimuli as well as in the display), it is unlikely that more proficient L1-English L2-Spanish listeners' enhanced performance in the stress match condition can be attributed to their improved ability to anticipate trials that have a singular target rather than a plural target.

A surprising finding of this study is that the L1-Spanish L2-English listeners did not use stress predictively to recognize Spanish target words. In theory, the late effect of stress could reflect lexical integration rather than early stages of word activation. Accordingly, the processing system would process segmental and suprasegmental information incrementally, but it would need to resort to lexical hypothesis formation prior to making any phonetic decision, in line with Klatt's proposal (Klatt, 1979). What this process would imply for the current study is that L1 Spanish listeners could detect stress differences in the input but use them only once they accessed their mental lexicon and found that the input matches their existing lexical entry. The main problem with this argumentation, however, is that L1-English L2-Spanish listeners did show evidence of making early use of stress prior to segmental disambiguation, as suggested by the stress-by-proficiency interaction they displayed in the pre-disambiguation time window. Since English is not a language that makes greater use of suprasegmental information than Spanish (cf. Soto-Faraco et al., 2001, vs. Cooper et al., 2002), a lexical integration account of

L1-Spanish L2-English listeners' results would leave unexplained the L1-English L2-Spanish listeners' results. It therefore seems more prudent to conclude that the L1-Spanish L2-English bilinguals did not show early use of stress information for other, likely methodological, reasons that should be explored in further research.

In conclusion, the findings of Experiment 1 indicate that L1-English L2-Spanish bilinguals show evidence of activating the L1 (as suggested by the cognate effect) even when nothing in the acoustic input or in the testing session made them think that they should be activating English words—that is, even when they were closer to the monolingual end of the language mode continuum. Moreover, the findings of Experiment 1 provided evidence that English-speaking L2 learners of Spanish could use stress in the recognition of Spanish words. Experiments 2 and 3, described in detail in the following two chapters of this dissertation, investigated whether L2 proficiency and language bias modulate the degree of cross-language activation (from stress interference) that bilingual listeners in a bilingual language mode experience in comprehension and production, respectively.

Chapter 6: Experiment 2: Spanish-English Visual-World Eye-Tracking Study

6.1 Introduction

Experiment 1 provided evidence of cross-language activation in language comprehension for L1-English L2-Spanish listeners in a monolingual language mode (effect of cognate), but there was no evidence indicating that stress modulates cross-language activation for either group. These results raise the question of whether stress would modulate cross-language activation in comprehension for listeners in a bilingual language mode. Thus, Experiment 2 was created to investigate whether L2 proficiency and language bias modulate the degree of cross-language activation (from stress interference) that bilingual listeners in a bilingual language mode would experience in comprehension, and whether (and if so, how) they interact. Previous studies have found that both L2 proficiency and language bias modulate cross-language activation in comprehension and that L2 proficiency also has an effect in word production (e.g., Costa et al., 2000; Costa, Colomé, & Caramazza, 2000; Costa, Miozzo, & Caramazza, 1999; Costa et al., 2006; Costa & Santesteban, 2004; Grosjean, 1998; Hoshino & Kroll, 2008; Marian & Spivey, 2003a; Mishra & Singh, 2016; Rodriguez-Fornells et al., 2005; Silverberg & Samuel, 2004). However, it remains unclear whether these two factors interact, and whether (and if so, how) the influence of these two factors differ depending on whether bilinguals are performing a comprehension or a production task.

The effect of language bias was investigated by manipulating the likelihood of occurrence of a particular language in the experiment. For this experiment, participants also completed a visual-world eye-tracking task in which they saw four orthographic words presented in the screen, heard one of those four words, and clicked on the corresponding word. However, in this experiment, participants heard both Spanish words and English words: In the Spanish-bias condition, participants heard more Spanish words than English words; in the English-bias condition, participants heard more English words than Spanish words. In both conditions, the critical trials were Spanish trials. If language bias modulates cross-language activation, a larger degree of cross-language activation should be observed in the English-bias condition than in the Spanish-bias condition.

Experiment 2 also used stress differences between Spanish and English words to investigate cross-language activation. The findings of Experiment 1 indicated that L1-Spanish L2-English and L1-English L2-Spanish listeners could use stress as a cue in word recognition. Hence, the second experiment no longer uses a stress match condition to assess listeners' use of stress in word recognition. Instead, it focuses on the degree of interference of Spanish-English cognates by manipulating the stress placement of the English cognate word so that it coincides with or differs from that of the Spanish target. Thus, Experiment 2 was designed to determine whether L2 proficiency and language bias modulates cross-language activation (as evidenced by the degree of interference of Spanish-English with a different stress pattern) in L1-Spanish L2-English and L1-English L2-Spanish comprehension of Spanish-English cognate words.

6.2 Materials

The stimuli of Experiment 2 were similar to those described in Chapter 5 for Experiment 1. The experimental conditions of this second eye-tracking experiment included a total of 24 Spanish trisyllabic nouns with regular stress placement always presented together with a competitor with a different stress pattern (as the stress mismatch competitor described in Experiment 1). As was the case with Experiment 1, the target in the experimental items was always the word with stress on the penultimate syllable (e.g., *li****te****ra* 'bunk bed', or *ma****te****ria* 'matter/subject'). Unlike Experiment 1, however, Experiment 2 included both Spanish and English trials, and was designed to determine how the greater likelihood of hearing one language over the other in the task influenced the moment-by-moment processing of Spanish targets in the presence of Spanish-English cognate competitors. The competitor words in this experiment included only Spanish-English cognates. To distinguish the effect of stress from the effect of cognate, half of the stimuli belonged to a stress-interference condition (where the stress pattern of the Spanish-English cognate competitor matches that of the Spanish target word), and the remaining half belonged to a no-stress-interference condition (where the stress pattern of the Spanish-English cognate competitor differed from that of the Spanish target word).

The stimuli in the stress-interference condition were the same stress mismatch target and competitor words as those used in the cognate, stress-mismatch condition of Experiment 1. Recall that in this condition, the cognate competitor (e.g., *mate****rial*** as competitor for the target *ma****te****ria*) showed a mismatch in stress placement between the English word and the Spanish word: While the competitor word has final stress in Spanish, it has the same stress pattern as the Spanish target word in English. This experiment included this cognate, stress-mismatch condition as well as a condition where the cognate word had a stress pattern in English that should not create any interference with the recognition of the Spanish target word (this will be referred to as the no-stress-interference condition). For example, both the Spanish and the English pronunciation of the cognate competitor *lite****ral*** differs in stress from the Spanish target (*lite****ral*** is stressed on the third syllable in Spanish but on the first syllable in English). Thus, unlike competitor words in the stress-interference condition, those in the no-stress-interference condition are not expected to interfere as much with the recognition of the Spanish target word.

If the English pronunciation of the cognate competitor is activated, listeners may in fact distinguish the target from the competitor words as early as in the first syllable (where both languages already differ with respect to stress pattern). An example test item for the stress-interference condition is shown in Table 9, and an example test item for the no-stress-interference condition is shown in Table 10.

Table 9: Example Stimuli in the Stress-Interference Condition, Experiment 2

Auditory Stimulus	**Visually Presented Word Choice**	
	Target	**Competitor**
*ma**te**ria* ‘matter/subject’	“materia” ‘matter/subject’	“material” ‘rotisserie’
	Distracter 1	**Distracter 2**
	“seguido” ‘non-stop’	“seguidor” ‘follower’

Table 10: Example Stimuli in the No-Stress-Interference Condition, Experiment 2

Auditory Stimulus	**Visually Presented Word Choice**	
	Target	**Competitor**
*li**te**ra* ‘bunk bed’	“litera” ‘bunk bed’	“literal”
	Distracter 1	**Distracter 2**
	“otoño” ‘fall’	“otoñal” ‘fall-like’

As with Experiment 1, the log frequency of the target and competitor words was obtained using the subtitle token corpus in EsPal (Duchon et al., 2013), provided by the Basque Center on Cognition, Brain and Language. Target words in the two stress conditions did not differ statistically in either frequency ($t(22)=1.53$, $p>.05$) or length ($t(22)<|1|$). A comparison of the competitor words in the two stress conditions yielded the same pattern, with no significant difference in either frequency ($t(22)<|1|$) or length ($t(22)<|1|$). All the experimental items are included in Appendices L and M.[18]

Target and competitor words were presented orthographically on the screen together with two distracter items. These distracter words were created to mirror the structure of the experimental items. Specifically, distracters had the same phonological structure as the target and competitor words, but neither word was a Spanish-English cognate. The distracters also included a word in the singular form with penultimate stress (e.g., *o**to**ño* 'fall') and a singular word with final stress (*oto**ñal*** 'autumnal') in Spanish. Both distracter words were segmentally identical in their first two syllables but differed in stress pattern.[19] All distracter words for the experimental items are included in Appendix L and M with the corresponding experimental items.

Experiment 2 included 136 filler trials. The design of the filler items was similar to that described for the experimental items. In each case, there was always a Spanish target word (e.g., *probador*, *materno*) paired with a Spanish-English identical cognate (e.g., *probable*, *maternal*), with fillers being created such that half of the test items in the experiment had a target word with final stress and the other half had a target word with penultimate stress in Spanish. Importantly, in the filler trials, a Spanish-English cognate word was always the target word (half

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[18] As with Experiment 1, it was not possible to match the frequency of the target and each of the competitors. This should not be problematic, however, in that fixations to the target and fixations to the competitor will never be compared.

[19] Since Experiment 2 did not have a stress match condition, where the Spanish competitor had the same stress pattern as the Spanish target word but in the plural form, it was not necessary to have plural distracter words in Experiment 2. Thus, distracter words differed only in their syllable structure and in their corresponding stress pattern.

of them with final –CV syllable, as in *probable*, and the other half with –CVC final syllable, as in *maternal*), and it was heard either in Spanish or in English (as described in more detail in the next section).

There were 40 filler trials in which the target cognate was a word ending in a light final syllable in Spanish (e.g., *probable*), and 96 filler trials in which the target was a word with a heavy final syllable in Spanish (e.g., *maternal*). More target words with a heavy final syllable were necessary as fillers in order to balance the number of times each type of stress pattern was heard by the participants throughout the experiment. Two distracter words, following the same structure as the one described for the target and competitor words, were also present on the screen. The distracter words of the filler trials were also segmentally ambiguous during the first two syllables, but they did not overlap in form or meaning with the target and competitor words, and all of them were words only in Spanish. Given the limited number of minimal pairs following these constraints, some of the words that were used as distracters for the filler trials included Spanish-English pseudocognates, which are cognate words that follow the rules of the Spanish orthography (e.g., *suce**sión***, 'succession', *pro**duc**to* 'product', or *di**ver**so* 'diverse'). Appendix N provides the complete list of filler items for Experiment 2.

All nouns exhibited the appropriate Spanish diacritics. Spanish marks irregular stress placement with the use of diacritics. None of the experimental items included any diacritic that could give participants a cue as to where stress would fall. As will be described in more detail below, the main manipulation of Experiment 2 was the percentage of time the target word of the filler trials (the identical Spanish-English cognates) was heard in either Spanish or English.

The same female Spanish native speaker (from Spain) who recorded the words for Experiment 1 also recorded the words for Experiment 2 in both English and Spanish. The same speaker was selected to do both recordings to make sure that the identity of the speaker could not be used as an external cue to the language of the trial. This speaker was a near-native speaker of English, and was judged by two native speakers of English (naïve to the purpose of the current investigation) as not having much of a foreign accent in English.[20] The recording was done using an Electro-Voice N/D 767 cardioid microphone and a Marantz Portable Solid State Recorder (PMD 671) in the anechoic chamber at the University of Kansas, Lawrence. Tokens were recorded in isolation to try to avoid coarticulatory effects. Each token was repeated twice, with a long pause in between repetitions.

6.3 Procedure

Experiment 2 was conducted during participants' second visit to the laboratories. Participants were comfortably seated in an isolated room facing a computer screen. As in Experiment 1, participants completing the experiment at the University of Valencia had their eye movements recorded by a desktop-mounted Eyelink 1000 (www.sr-research.com) with a sampling rate of 1000 Hz (eye-movement information was recorded every millisecond). Participants completing the experiment at the University of Kansas had their eye movements recorded by a head-mounted Eyelink II (www.sr-research.com) with a sampling rate of 250 Hz (eye-movement information was recorded every 4 milliseconds).

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[20] A native Spanish speaker who learned English as an L2 was preferred over a simultaneous Spanish-English bilingual because such bilinguals have been shown to produce speech differently from monolinguals in both their languages (e.g., their voice onset time in the two languages often differs from that observed in monolinguals) (e.g., Flege, 1987; Sancier & Fowler, 1997). Since the target language in the present study was Spanish, having a native Spanish speaker whose Spanish was not influenced by English was considered more important than having a speaker whose English was more native-like.

The structure of each trial was the same as that described for Experiment 1. In each trial, participants first viewed the four orthographic words for 4,000 ms, which they were instructed to silently read. The words then disappeared, and a fixation cross appeared and stayed on the screen for 500 ms. As the fixation point disappeared and the same four words reappeared on the screen, participants heard the target word through headphones and clicked on the word that matched the acoustic input as quickly and accurately as they could. Each session began with four practice trials. The practice items followed the same structure as the experimental items described in the previous section. No feedback was provided during the practice session. This short practice session allowed participants to become familiar with the experimental procedure. The real experiment began right after the practice session.

This experiment differed from Experiment 1 in that the language of the target words in the filler trials could be either Spanish or English. Participants were quasi-randomly divided into two groups: one group who completed a version of the experiment that would bias participants towards expecting to hear more Spanish words (Spanish-bias group), and another group who completed a version of the experiment that would bias participants towards expecting to hear more English words (English-bias group). Within each L1, the two bias groups did not differ in L2 proficiency (L1-Spanish L2-English group: $t(23)=-1.5$, $p>.05$, L1-English L2-Spanish group: $t(19)<|1|$) or on other individual differences measures (e.g., age of acquisition (L1-Spanish L2-English group: $t(23)=-1.3$, $p>.05$, L1-English L2-Spanish group: $t(19)<|1|$), immersion in the L2 environment (L1-Spanish L2-English group: $t(23)<|1|$, L1-English L2-Spanish group: $t(19)<|1|$), years of instructions (L1-Spanish L2-English group: $t(23)=-1.63$, $p>.05$, L1-English L2-Spanish group: $t(19)<|1|$)).

The language bias was created by manipulating the language in which participants would hear the target word (identical Spanish-English cognate) in the filler trials (both groups saw the same display of words).

Spanish-bias condition: Participants assigned to the Spanish-bias group heard 80% of the target words in Spanish and only 20% in English (throughout the experiment). Experiment 2 thus differed from Experiment 1 in the fact that it included trials in English, which were expected to make participants more likely to activate the English phonology of the Spanish-English cognate words. In order to create a bias towards expecting more Spanish words than English words, the first block contained only filler items. From a total of 40 filler trials in the first block, 32 had a Spanish target word (the Spanish-English cognate was produced in Spanish), whereas the remaining 8 trials had an English target word (the Spanish-English cognate was produced in English). In order to reduce the likelihood that participants would strategically pay attention to only one type of word (e.g., paying attention only to words with a final heavy syllable in Spanish), the trials within this first block were balanced. For the 32 Spanish trials, the target word for 16 of them had a final heavy syllable and was thus stressed on the last syllable (e.g., *orien**tal***), and the target word for the other 16 had a light final syllable in Spanish and was thus stressed on the penultimate syllable (e.g., *ba**na**na*). For the remaining eight English trials, the target word for four of them had first-syllable stress (e.g., ***pri**mate*) and the target word for the remaining four had second-syllable stress (e.g., *au**ro**ra*). The remaining blocks followed the same structure, but they included the experimental items as part of the 16 Spanish trials with a light final syllable in Spanish, half of which were from the stress-interference condition, and the other half from the no-stress-interference condition. The language manipulation was also present in the four practice trials, with only one trial being heard in English.

English-bias condition: Participants assigned to this group heard most of the target words in English, so we expected to observe greater competition from the Spanish-English cognate competitor in this condition than in the Spanish-bias condition. In order to create a bias towards expecting more English trials than Spanish trials, the first block also contained only filler items. From a total of 40 filler trials in the first block, 32 had an English target word (i.e., the Spanish-English cognate was produced in English), and only eight had a Spanish target word. In order to avoid participants developing strategies, the types of trials in each block were also balanced. For 16 of the 32 English trials, the target word had first-syllable stress in English (e.g., ***pri**mate*), and the target word for the remaining16 trials second-syllable stress (e.g., *au**ro**ra*). For the Spanish trials, four of the eight trials had a target word with a final heavy syllable and thus was stressed on the final syllable (e.g., *orien**tal***), and the remaining four trials had a light final syllable and thus was stressed on the penultimate syllable (e.g., *ba**na**na*). The experimental items were presented in the last three blocks (four experimental trials from each condition in each block). In order not to bias participants towards the word with a final light syllable (the target of the experimental items), each block included eight trials in which the target was a word with a final heavy syllable. Thus, the remaining three blocks in the English-bias condition each included 16 trials in Spanish and 24 trials in English. Hence, in the English-bias condition, it was not possible to maintain the 80%-20% bias (for English and Spanish, respectively) throughout the experiment, because each block needed to include Spanish trials in which the target was a word with a final heavy syllable (otherwise, participants could predict, even before hearing the stress placement, which word would be the Spanish target). Thus, the first block had an 80%-20% bias, but the second, third, and fourth blocks had a 60%-40% bias, yielding an overall 65%-35% bias for the complete experiment in the English-bias condition.

Ultimately, the two experiments differed in the language biases that they imposed on listeners. Hence, lexical competition effects should differ between the two experiments if listeners are influenced by these biases. The distribution of trials in each bias condition is summarized in Table 11.

Table 11: Summary of the Trial Distribution in the Two Bias Conditions

	Spanish-Bias Condition	**English-Bias Condition**
Block 1	40 Trials: • 8 English trials ○ 4 → 1st syllable stress ○ 4 → 2nd syllable stress • 32 Spanish trials ○ 16 → light final syllable ○ 16 → heavy final syllable	40 Trials: • 8 Spanish trials ○ 4 → light final syllable ○ 4 → heavy final syllable • 32 English trials ○ 16 → 1st syllable stress ○ 16 → 2nd syllable stress
Blocks 2, 3, and 4	40 Trials: • 8 English trials ○ 4 → 1st syllable stress ○ 4 → 2nd syllable stress • 32 Spanish trials ○ 8 experimental trials ▪ 4 no-stress-interference ▪ 4 stress-interference ○ 8 → light final syllable ○ 16 → heavy final syllable	40 Trials: • 16 Spanish trials ○ 8 experimental trials ▪ 4 no-stress-interference ▪ 4 stress-interference ○ 8 → heavy final syllable • 24 English trials ○ 12 → 1st syllable stress ○ 12 → 2nd syllable stress

The test included a total of 164 trials (including the four practice trials). The position of the target and competitor words on the screen was randomized, as was the order of presentation of each trial, to ensure that participants could not predict which word would be heard next and where that word would be located on the screen.

6.4 Data Analysis

Fixations were included in the analysis only if participants selected the target or competitor word as their response (as determined by their mouse clicks). Again, including fixations in which participants selected the competitor is warranted on the grounds that the English stress manipulation was intended to modulate the degree of lexical competition that bilingual listeners experienced, and trials with competitor selection were trials in which participants indeed experienced a larger degree of lexical competition. Of all the trials included in the analysis, only 5 trials for the L1-Spanish L2-English group (or 0.003% of the data) and 14 trials for the L1-English L2-Spanish group (or 0.009% of the data) were trials in which participants clicked on the competitor word, and the majority of these trials were indeed from the English-bias condition (2/5 for the L1-Spanish L2-English group; 9/14 for the L1-English L2-Spanish group), where participants were expected to show more lexical competition. In this experiment, participants always selected either the target or competitor word, so all fixations were ultimately included in the analysis.

Participants' eye fixations were analyzed as they were for Experiment 1. Eye movements in each of the four regions of interest (corresponding to the four orthographic words) were analyzed from 0 to 1,500 ms. Given that it takes approximately 200 ms. for listeners to program and launch an eye movement (Hallett, 1986), statistical analyses were conducted on eye movements recorded after 200 ms of the target-word onset. Proportions of fixations to the target and competitor words were averaged within two time windows: A pre-disambiguation time window corresponding to the first two syllables of the target word (e.g. *ma**te**-*, *li**te**-*), with a delay of 200 ms to account for the time it takes eye movements to reflect speech processing (on average from 200 ms to 445 ms on average, with the time window offset being calculated on an item-by-item basis); and a post-disambiguation time window corresponding to the rest of the trial up until 1,500 ms. (on average from 445 ms to 1,500 ms, with the time window onset being calculated on an item-by-item basis). “Disambiguation” thus refers to the point in time at which the target and competitor differed *segmentally*. The averages in fixations for each time window were computed on an item-by-item basis. Eye fixations in the first time window will reveal whether listeners show sensitivity to the manipulated factors *before* the target and competitor word disambiguate segmentally in the signal.

Statistical analyses were conducted on the log-odd-transformed *difference* between the averaged proportions of fixations to the target and the averaged proportions of fixations to the competitor (for each time window). Using this difference measure (rather than proportions of fixations) factors out differences in relative speed with which both target and competitor words are fixated over distracter words, thus better reflecting the lexical activation process and also making the comparison between the different conditions more straightforward. Linear mixed-effects models were conducted on these differences using the lme4 package of R (for discussion, see Baayen (2008)). The models were conducted on these differences in target and competitor fixations separately for each time window, examining the effect of English stress condition (stress-interference vs. no-stress-interference, with no-stress-interference as the baseline), language bias (Spanish-bias vs. English-bias, with Spanish-bias as the baseline), proficiency (arcsine transformed and centered), and all two- and three-way interactions. Different models were run for the two groups of participants (L1-Spanish L2-English and L1-English L2-Spanish bilinguals), because the two groups were not sufficiently well matched in their L2 proficiency and L2 experience for a direct comparison of the two groups to be interpreted straightforwardly. For each dataset, the effect of each predictor was assessed using log-likelihood tests comparing models with and without that predictor; in each case, the simplest model with the best fit was kept. All models included participant and test item as crossed random variables.

6.5 Predictions

This experiment investigated whether cross-language competition would be modulated by the stress pattern of the English cognate competitor word (no-stress-interference vs. stress-interference), L2 proficiency, and language bias when listeners were in a bilingual language mode. If stress modulates the degree of cross-language activation, we should find a simple effect of stress, with greater differential proportions of fixations in the no-stress-interference condition than in the stress-interference condition in the Spanish-bias condition (baseline). This would indicate that both languages are activated in parallel, and only by means of the acoustic information present in the signal can the activation of the unintended language (English in this case) be reduced.

If language bias modulates cross-language activation, we should find a significant interaction between language bias and English stress. Such an interaction would most likely reveal that the effect of stress is greater in the English-bias group than in the Spanish-bias group. We may also find a simple effect of language bias, with greater differential proportions of fixations in the English-bias condition than in the Spanish-bias condition in the no-stress-interference condition (baseline). This would indicate that the ease with which the Spanish target is activated depends on the likelihood of hearing Spanish throughout the experiment. In other words, finding a simple effect of language bias but no interaction between language bias and English stress would indicate that language bias does not modulate the degree of cross-language interference produced by the stress manipulation; it only modulates how rapidly the Spanish target is recognized. Finally, we may find that the effects of stress and language bias are modulated by L2 proficiency. For stress, such an interaction is expected to reveal that participants can more easily reduce the degree of cross-language activation in the stress interference condition as their proficiency in the L2 decreases (for L1-Spanish L2-English listeners) or increases (for L1-English L2-Spanish listeners). For language bias, more proficient bilinguals could show less sensitivity to language bias as a result of better controlling for the degree of cross-language activation.

The main purpose of this dissertation is to further explore how factors such as L2 proficiency and language bias modulate cross-language activation in spoken word comprehension. As such, this dissertation has implications for models of bilingual activation. The two main models considered in this study (the Inhibitory Control Model (Green, 1998) and the BIA+ Model (Dijkstra & van Heuven, 2002) make different predictions regarding the factors that influence the early stages of word recognition during bilingual comprehension tasks. While finding an effect of (or interaction with) L2 proficiency would be consistent with the claims of both the BIA+ Model and the Inhibitory Control Model, only the Inhibitory Control Model predicts an effect of (or interaction with) language bias in early stages of word recognition (i.e., in the pre-disambiguation time window).

6.6 Results of Experiment 2

As with Experiment 1, this section begins with a description of the results found for the L1-Spanish L2-English group, with the results for the pre- and post-disambiguation time windows reported separately.

6.6.1 L1-Spanish L2-English Group

Figure 10 presents the L1-Spanish L2-English listeners’ proportions of target (solid lines), competitor (dashed lines), and distracter fixations (dotted lines) in the stress-interference (red) and no-stress-interference (black) conditions, separately for the Spanish-bias and the English-bias groups.

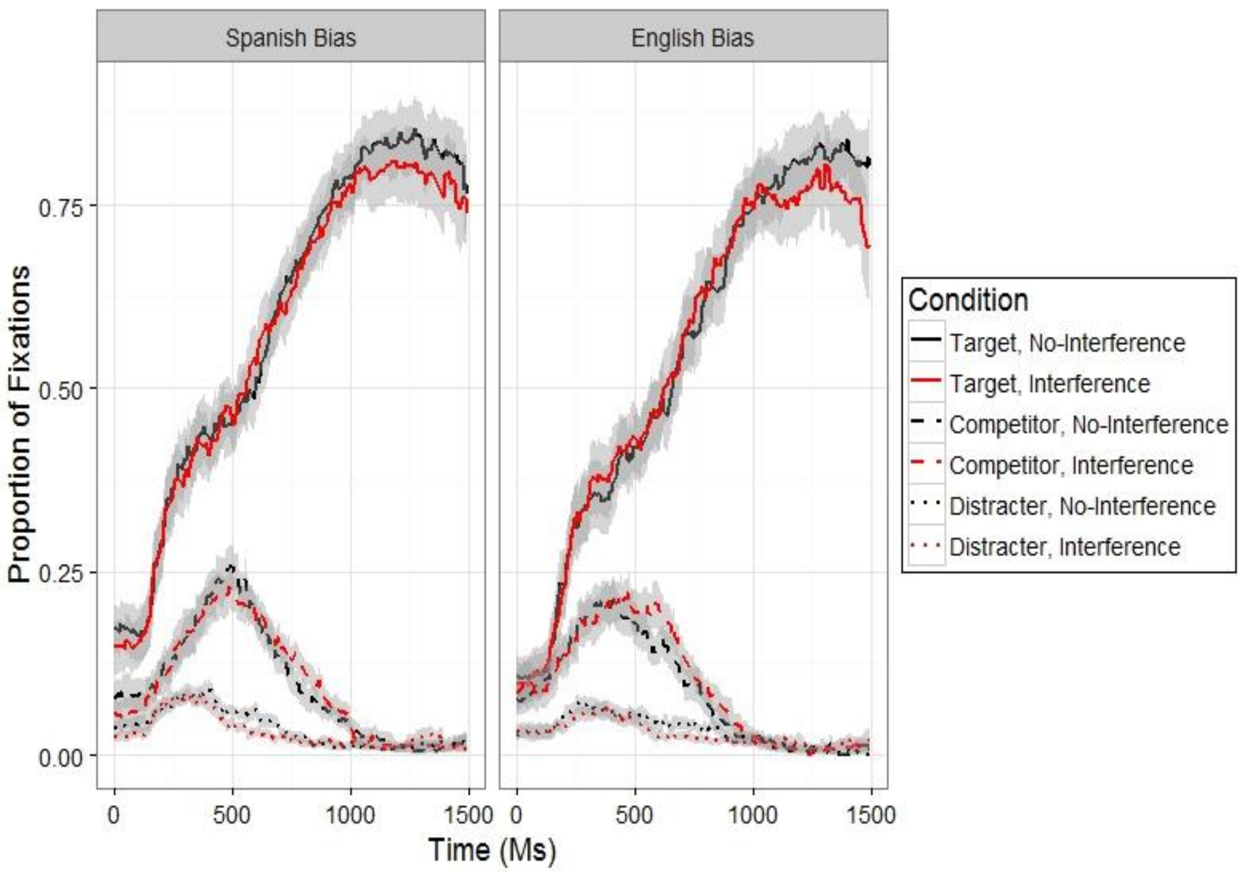

Figure 10: Proportion of Fixations, L1-Spanish L2-English Group, Experiment 2

Since statistical analyses were conducted on the differences between proportions of target fixations and proportions of competitor fixations, the L1-Spanish L2-English listeners' fixations are also plotted as such. Figure 11 presents these differences in fixations in the stress-interference (black) and no-stress-interference (red) conditions, separately for the Spanish-bias and the English-bias groups. The two vertical lines represent the pre-disambiguation time window.

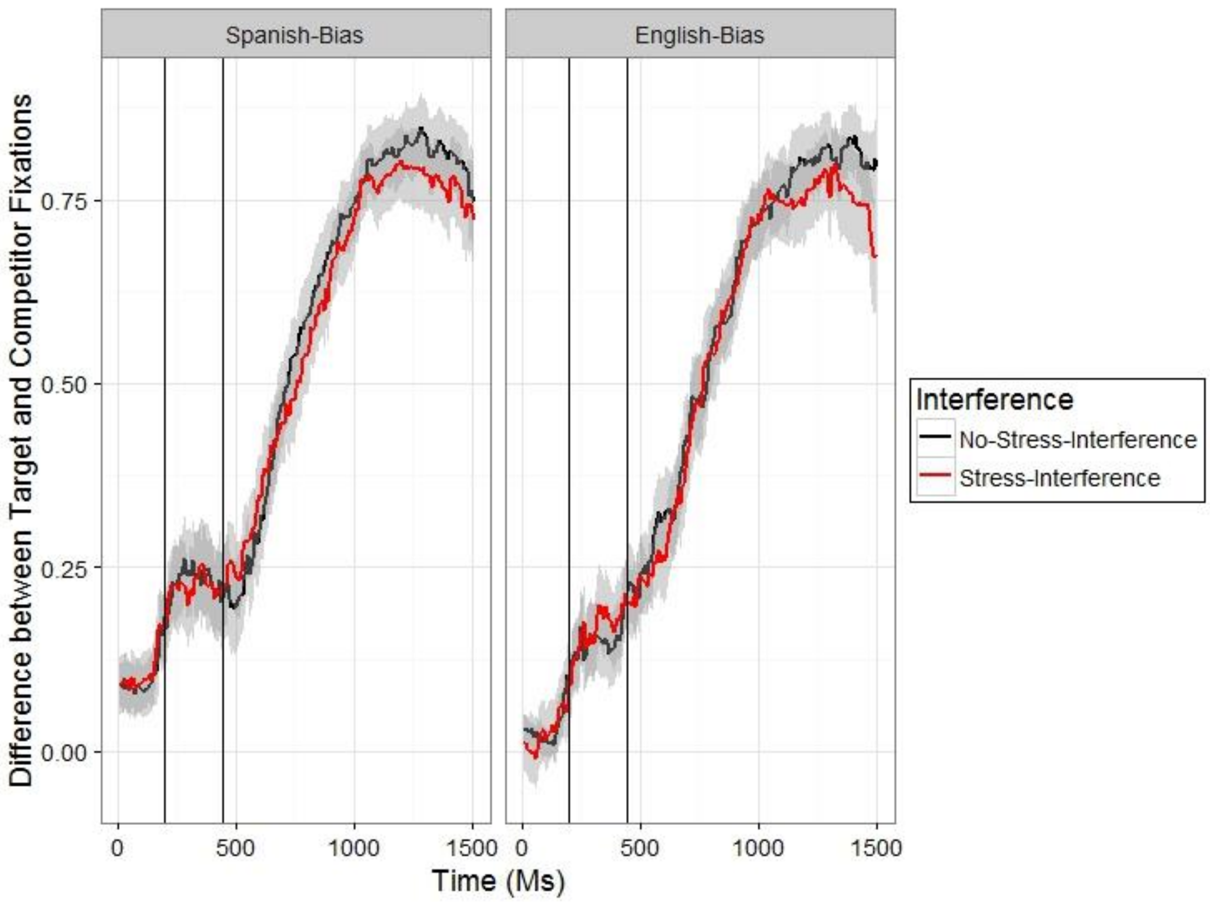

Figure 11: Difference between Target and Competitor Fixations, L1-Spanish L2-English Group, Experiment 2

6.6.1.1 Pre-Disambiguation Time Window

For the pre-disambiguation time window, the best model on L1-Spanish L2-English group's difference in fixations included English stress (no-stress-interference vs. stress-interference), language bias (Spanish-bias vs. English-bias), and proficiency as fixed factors, as well as the two-way interaction between proficiency and language bias. Table 12 presents the results of this model.

Table 12: Mixed-Effects Linear Model Results, L1-Spanish L2-English Group, Pre-Disambiguation Time Window, Experiment 2

Variable	**Estimate (SE)**	***t***	***p***
(Intercept)	0.02 (.006)	4.09	<.001
English Stress	0.001 (.003)	<|1|	>.1
Language Bias	–0.01 (.006)	–1.04	>.1
Proficiency	–0.08 (.04)	–1.81	>.1
Language Bias x Proficiency	0.09 (.05)	1.61	>.1

Note: *df* = 1128; α = .05

The model summarized in Table 12 revealed no significant effect or interaction in this first time window. This indicates that, when the signal was segmentally ambiguous (but differed in terms of stress placement) between the target and competitor word, the L1-Spanish L2-English participants were not affected by the presence of a Spanish-English cognate word with interfering stress pattern in their L2, and this effect was not modulated by either language bias or L2 proficiency.

6.6.1.2 Post-Disambiguation Time Window

For the post-disambiguation time window, the best model for the L1-Spanish L2-English group’s difference in fixations included English stress (no-stress-interference vs. stress-interference), language bias (Spanish-bias vs. English-bias), and proficiency as fixed factors, as well as the two-way interaction between English stress and proficiency. Table 13 presents the results of this model.

Table 13: Mixed-Effects Linear Model Results, L1-Spanish L2-English Group, Post-Disambiguation Time Window, Experiment 2

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	0.06	(.04)	14.35	<.001
English stress	–0.01	(.03)	<|1|	>.1
Language Bias	–0.04	(.06)	<|1|	>.1
Proficiency	0.24	(.04)	<|1|	>.1
English Stress x Proficiency	0.21	(.03)	1.19	>.1

Note: *df* = 1127; α = .05

The model summarized in Table 13 also revealed no significant effect or interaction in this second time window. This indicates that the L1-Spanish L2-English participants were not affected by the presence of a Spanish-English cognate word with interfering stress pattern in their L2, and this effect was not modulated by either language bias or L2 proficiency.

6.6.2 L1-English L2-Spanish Group

Figure 12 presents the L1-English L2-Spanish listeners' proportions of target (solid lines), competitor (dashed lines), and distracter fixations (dotted lines) in the stress-interference (red) and no-stress-interference (black) conditions, separately for the Spanish-bias and the English-bias groups.

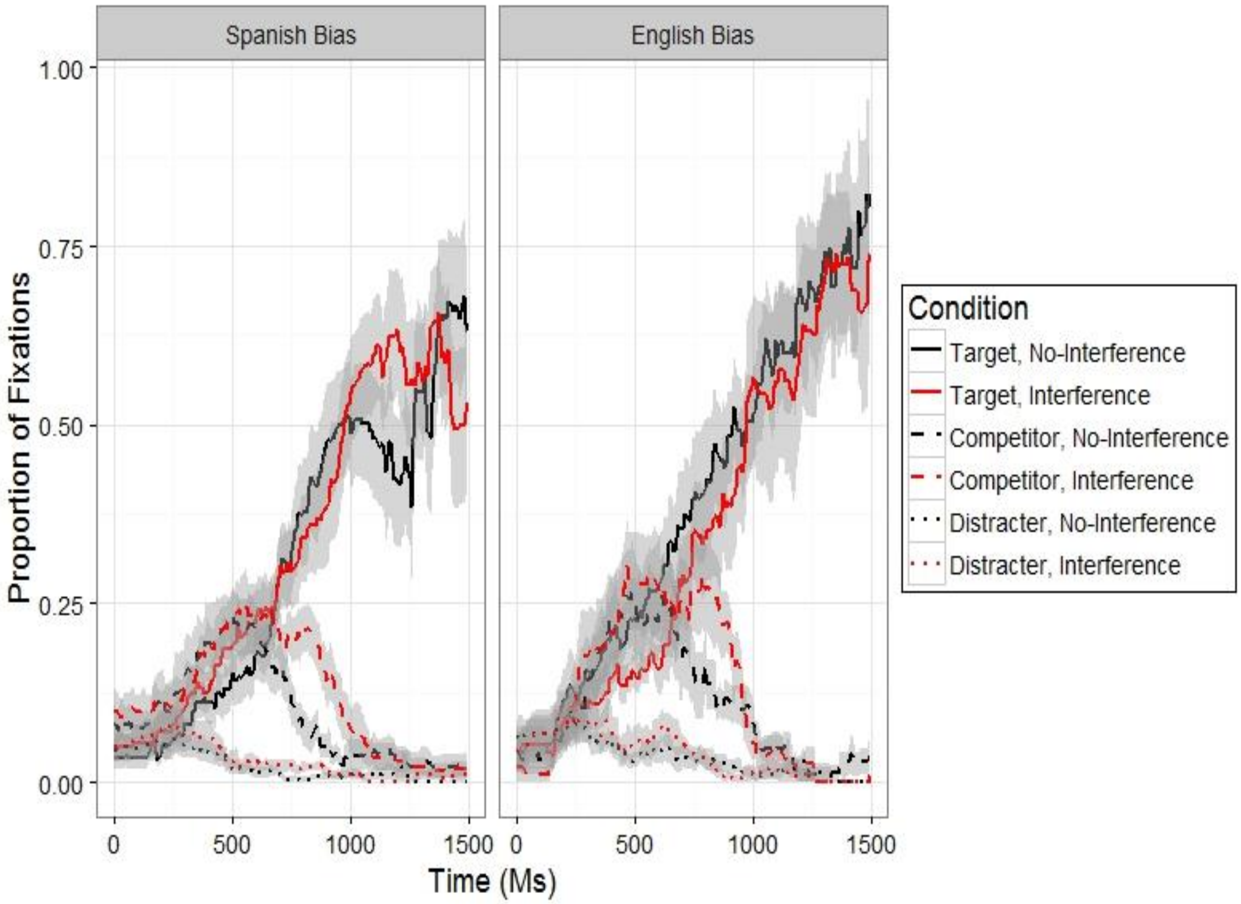

Figure 12: Proportion of Fixations, L1-English L2-Spanish Group, Experiment 2

Since statistical analyses were conducted on the differences between proportions of target fixations and proportions of competitor fixations, the L1-English L2-Spanish listeners' fixations are also plotted as such. Figure 13 presents these differences in fixations in the stress-interference (black) and no-stress-interference (red) conditions, separately for the Spanish-bias and the English-bias groups. The two vertical lines represent the average pre-disambiguation time window.

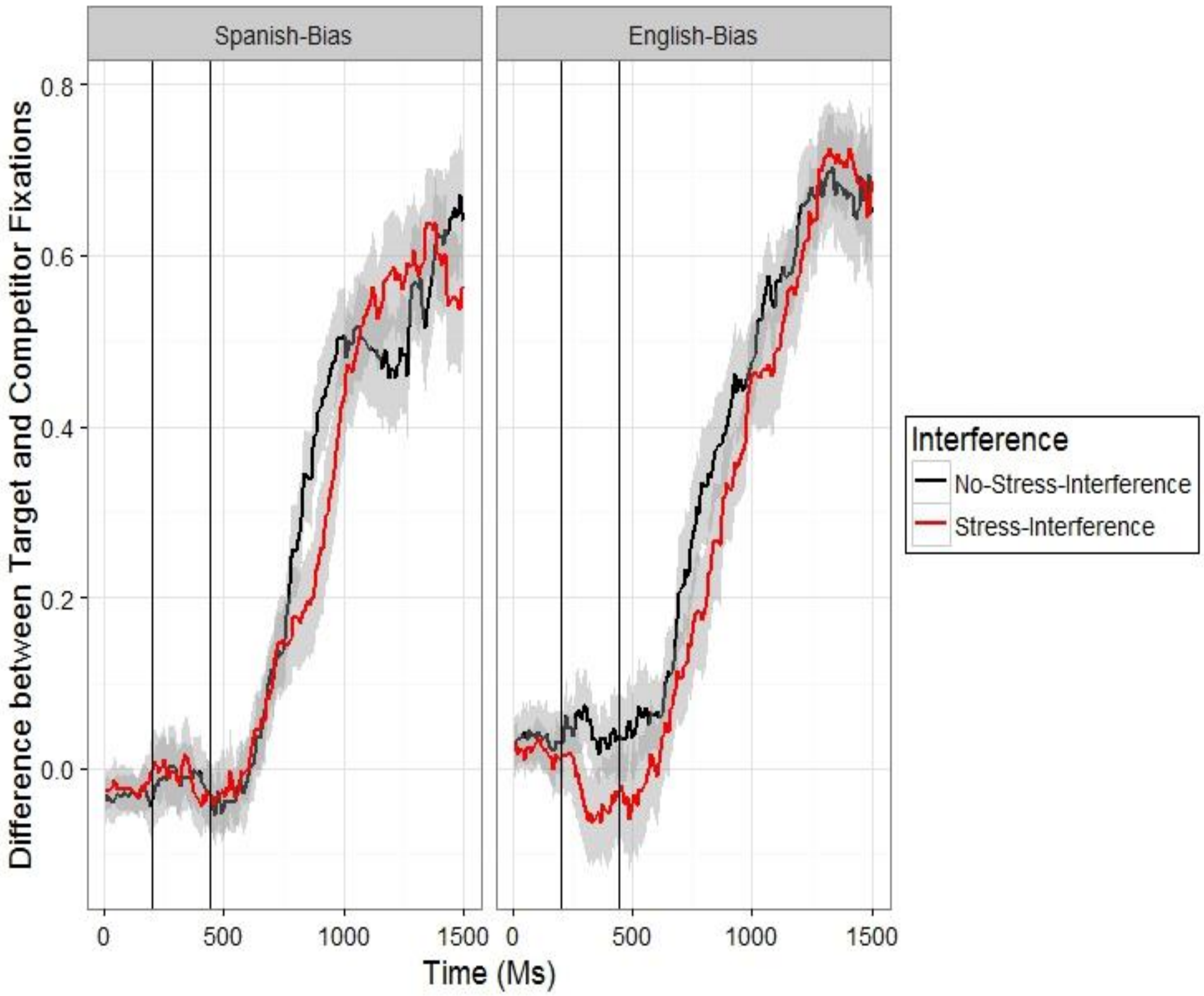

Figure 13: Difference between Target and Competitor Fixations, L1-English L2-Spanish Group, Experiment 2

6.6.2.1 Pre-Disambiguation Time Window

For the pre-disambiguation time window, the best model for the L1-English L2-Spanish group's difference in fixations included English stress (no-stress-interference vs. stress-interference), language bias (Spanish-bias vs. English-bias), and proficiency as fixed factors, as well as the two-way interaction between English stress and language bias, and the three-way interactions between English stress, language bias, and proficiency. Table 14 presents the results of this model.

Table 14: Mixed-Effects Linear Model Results, L1-English L2-Spanish Group, Pre-Disambiguation Time Window, Experiment 2

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	–0.26	(.23)	–1.13	>.1
English stress	0.41	(.29)	1.39	>.1
Language Bias	0.5	(.3)	1.64	>.1
Proficiency	0.29	(.29)	1.02	>.1
English stress x Language Bias	–1.13	(.38)	–3.01	<.003
English stress x Proficiency	–0.54	(.36)	–1.51	>.1
Language Bias x Proficiency	–0.46	(.36)	–1.29	>.1
English stress x Language Bias x Proficiency	1.19	(.44)	2.73	<.007

Note: $df = 960$; $\alpha = .05$

The model summarized in Table 14 revealed a significant two-way interaction between English stress and language bias, and a significant three-way interaction between English stress, language bias, and proficiency. The two-way interaction between English stress and language bias indicates that the stress effect was larger in the English-bias condition than in the Spanish-bias condition; that is, there were lower differential proportions of fixations (indicating *more* lexical competition) in the stress-interference condition than in the no-stress-interference condition, and this difference was larger when participants heard more English words as compared to when they heard more Spanish words.

In order to better understand the significant three-way interaction, linear mixed-effects models were run separately on the two language bias groups. For these subsequent models, for both language bias groups, the best model included English stress (stress-interference vs. no-stress-interference) and proficiency as fixed factors, as well as the two-way interaction between English stress and proficiency. Table 15 reports the results obtained for the Spanish-bias group, and Table 16 reports the results obtained for the English-bias group.

Table 15: Follow-Up Mixed-Effects Linear Model Analysis, L1-English L2-Spanish Group, Pre-Disambiguation Time Window, Spanish Bias, Experiment 2

Variable	**Estimate (SE)**		***t***	***p***
(Intercept)	–0.29	(.22)	–1.36	>.1
English stress	0.46	(.23)	1.63	>.1
Proficiency	0.34	(.27)	1.27	>.1
English stress x Proficiency	–0.6	(.34)	–1.75	>.1

Note: $df = 480$; $\alpha = .05$

Table 16: Follow-Up Mixed-Effects Linear Model Analysis, L1-English L2-Spanish Group, Pre-Disambiguation Time Window, English Bias, Experiment 2

Variable	**Estimate (SE)**		***t***	***p***
(Intercept)	0.15	(.2)	<|1|	>.1
English stress	–0.49	(.19)	–2.61	<.009
Proficiency	–0.1	(.21)	<|1|	>.1
English stress x Proficiency	0.46	(.2)	2.27	<.024

Note: $df = 480$; $\alpha = .05$

The results reported in Table 15 revealed no significant effect or interaction. This indicates that the L1-English L2-Spanish participants in the Spanish-bias group were not affected by the presence of a Spanish-English cognate word, and this effect did not depend on their proficiency in Spanish. The results reported in Table 16, on the other hand, showed a simple effect of interference and a two-way interaction between English stress and proficiency in the English-bias group. The simple effect of English stress indicates that the stress-interference condition produced lower differential proportions of fixations (indicating *more* lexical competition) than the no-stress-interference condition. The interaction between English stress and proficiency indicates that the effect of stress interference was modulated by proficiency in Spanish: As their proficiency in Spanish increased, participants' differential proportions of fixations increased (indicating *less* lexical competition) only in the stress interference condition; consequently, the effect of stress decreased as proficiency in Spanish improved. This interaction is illustrated in Figure 14.

These results suggest that L1-Spanish L2-English participants who were more proficient in Spanish were better able to minimize the interfering effect of English stress.

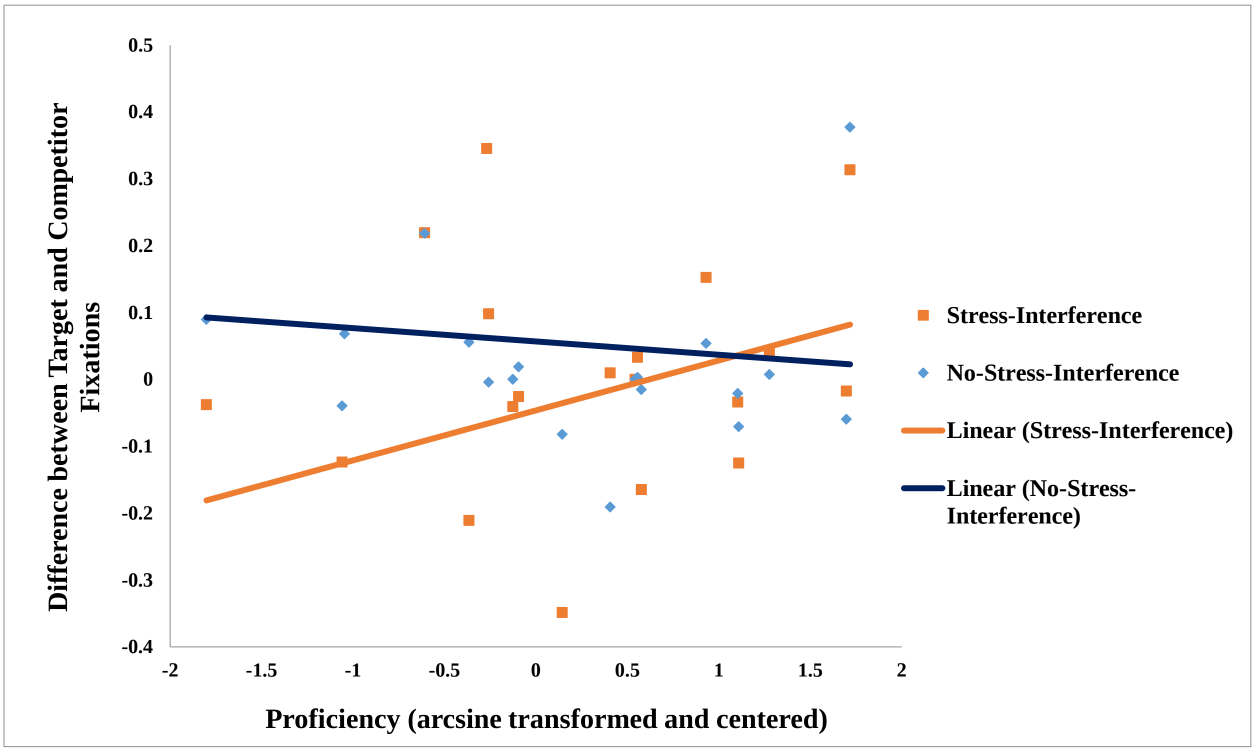

Figure 14: Interaction between English Stress and Proficiency, L1-English L2-Spanish group, English bias, Experiment 2

6.6.2.2 Post-Disambiguation Time Window

For the post-disambiguation time window, the best model on the L1-English L2-Spanish group's difference in fixations included English stress (no-stress-interference vs. stress-interference), language bias (Spanish-bias vs. English-bias), and proficiency as fixed factors, as well as a two-way interaction between English stress and language bias, and a three-way interactions between English stress, language bias, and proficiency. Table 17 presents the results of this model.

Table 17: Mixed-Effects Linear Model Results, L1-English L2-Spanish Group, Post-Disambiguation Time Window, Experiment 2

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	0.26	(.16)	1.62	>.1
English stress	–0.02	(.12)	<|1|	>.1
Language Bias	0.01	(.25)	<|1|	>.1
Proficiency	0.07	(.19)	<|1|	>.1
English stress x Language Bias	–0.38	(.19)	–1.98	<.048
English stress x Proficiency	0.02	(.14)	<|1|	>.1
Language Bias x Proficiency	0.06	(.28)	<|1|	>.1
English stress x Language Bias x Proficiency	0.37	(.22)	1.71	>.1

Note: $df = 959$; $\alpha = .05$

The model summarized in Table 17 revealed only a two-way interaction between English stress and language bias. This two-way interaction indicates that L1-English L2-Spanish listeners showed lower differential proportions of fixations (indicating *more* lexical competition) in the stress-interference condition than in the no-stress-interference condition, and this difference was larger when participants heard more English words as compared to when they heard more Spanish words. Follow-up analyses conducted separately on the Spanish-bias group and the English-bias group revealed a significant effect of English stress only in the English-bias condition ($t(19)=-1.13$, $p<.05$). This suggests that more competition emerges in the stress-interference condition than in the no-stress interference condition only when participants hear more English words than Spanish words throughout the experiment.

6.7 Comparison of Experiments 1 and 2

Using the same words in the cognate, stress mismatch condition of Experiment 1 and the stress-interference condition of Experiment 2 allows us to further assess the effect of language bias on word recognition. In this section, an analysis is reported that compares lexical activation in circumstances where participants did not hear any English (Experiment 1) and in circumstances where participants heard some English (20% English in the Spanish-bias group condition, 65% English in the English-bias group condition). For this additional analysis, mixed-effects linear models were conducted on the difference between participants' proportions of target and competitor fixations separately for the pre-disambiguation and post-disambiguation time windows. Fixed effects included language bias (no English, 20% English, 65% English, with the no-English (Experiment 1) condition serving as the baseline), L2 proficiency (arcsine transformed and centered), and the two-way interaction between language bias and L2 proficiency. Again, we report the results of these analyses separately for the two groups.

6.7.1 L1-Spanish L2-English Group

Figure 15 presents L1-Spanish L2-English listeners' difference between proportions of target and competitor fixations in the three language bias conditions: No-English (Experiment 1 in black), 20% English (red) and 65% English (blue). The two vertical lines represent the average pre-disambiguation time window.

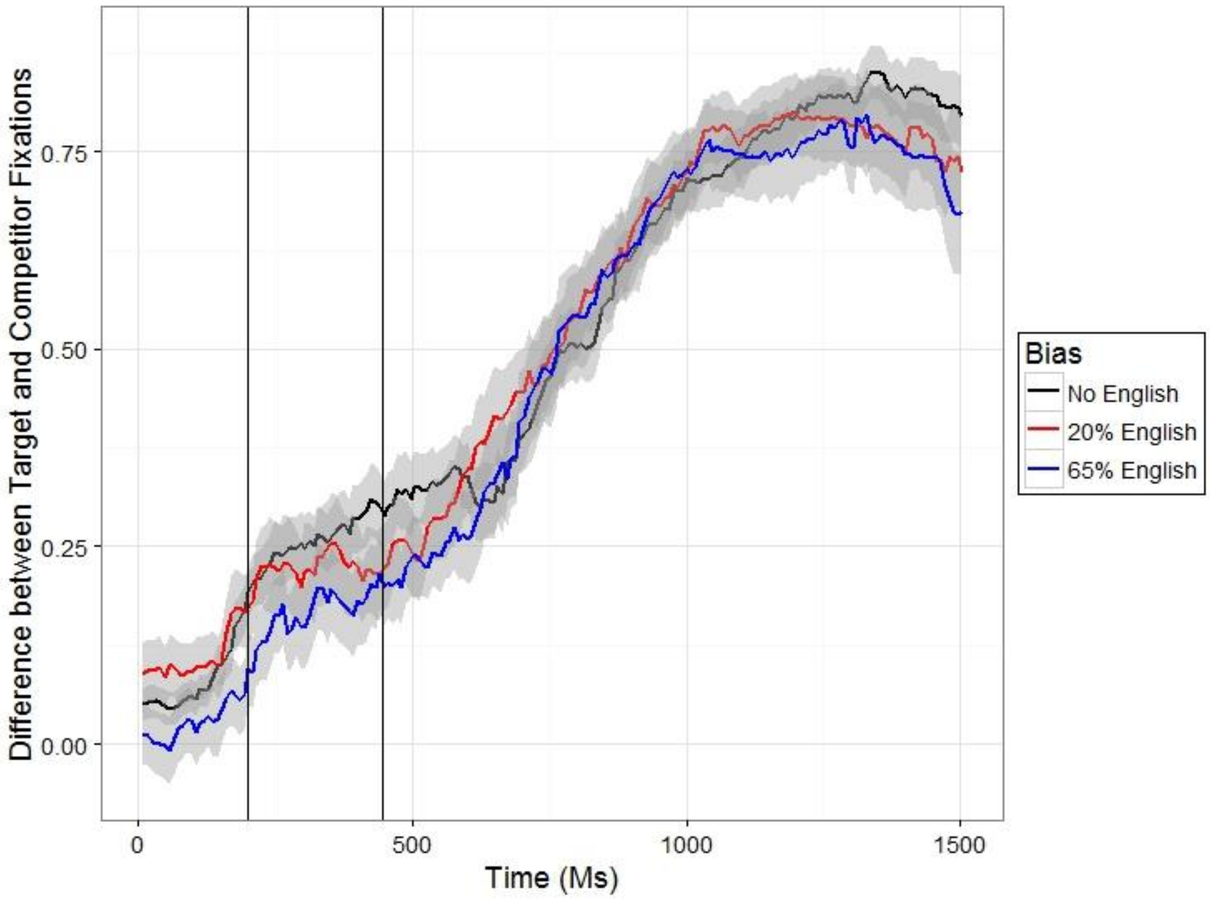

Figure 15: Difference between Target and Competitor Fixations, L1-Spanish L2-English Group, Cognate (Experiment 1) and Stress-Interference (Experiment 2) Conditions

6.7.1.1 Pre-Disambiguation Time Window

For the pre-disambiguation time window, the best model on the L1-Spanish L2-English group's difference in fixations included language bias (no English vs. 20% English, no English vs. 65% English) and proficiency as fixed factors, as well as the two-way interaction between language bias and proficiency. Table 18 presents the results of this model.

Table 18: Mixed-Effects Linear Model Results Comparing Experiments 1 and 2 (Cognate, Stress Mismatch and Stress-Interference Conditions), L1-Spanish L2-English Group, Pre-Disambiguation Time Window

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	0.27	(.04)	6.47	<.001
Language Bias (20% English)	–0.06	(.05)	–1.2	>.1
Language Bias (65% English)	–0.11	(.05)	–2.29	<.02
Proficiency	–0.17	(.33)	<|1|	>.1
Language Bias (20% English) x Proficiency	–0.64	(.45)	–1.41	>.1
Language Bias (65% English) x Proficiency	0.56	(.42)	1.34	>.1

Note: $df = 680$; $\alpha = .05$

The model summarized in Table 18 revealed a simple effect of language bias when comparing the 65%-English condition to the no-English condition. This main effect indicates that the L1-Spanish L2-English listeners showed a smaller difference between proportions of target and competitor fixations in the 65%-English condition (Experiment 2) than in the no-English condition (Experiment 1). This pattern of results indicates that the presence of a large number of English trials slowed down L1-Spanish L2-English listeners' word recognition. These results differ from those of Experiment 2 alone, where L1-Spanish L2-English listeners did not show any effect of language bias.

6.7.1.2 Post-Disambiguation Time Window

For the post-disambiguation time window, the best model on the L1-Spanish L2-English group's difference in fixations was the model that included only the intercept, that is, a model that did not include any fixed factors (or interactions). This indicates that there were no differences among the different conditions in this second time window.

6.7.2 L1-English L2-Spanish Group

Figure 16 presents the L1-English L2-Spanish listeners' difference between proportions of target and competitor fixations in the three bias conditions: No English (Experiment 1 in black), 20% English (red) and 65% English (blue). The blue box represents the pre-disambiguation time window.

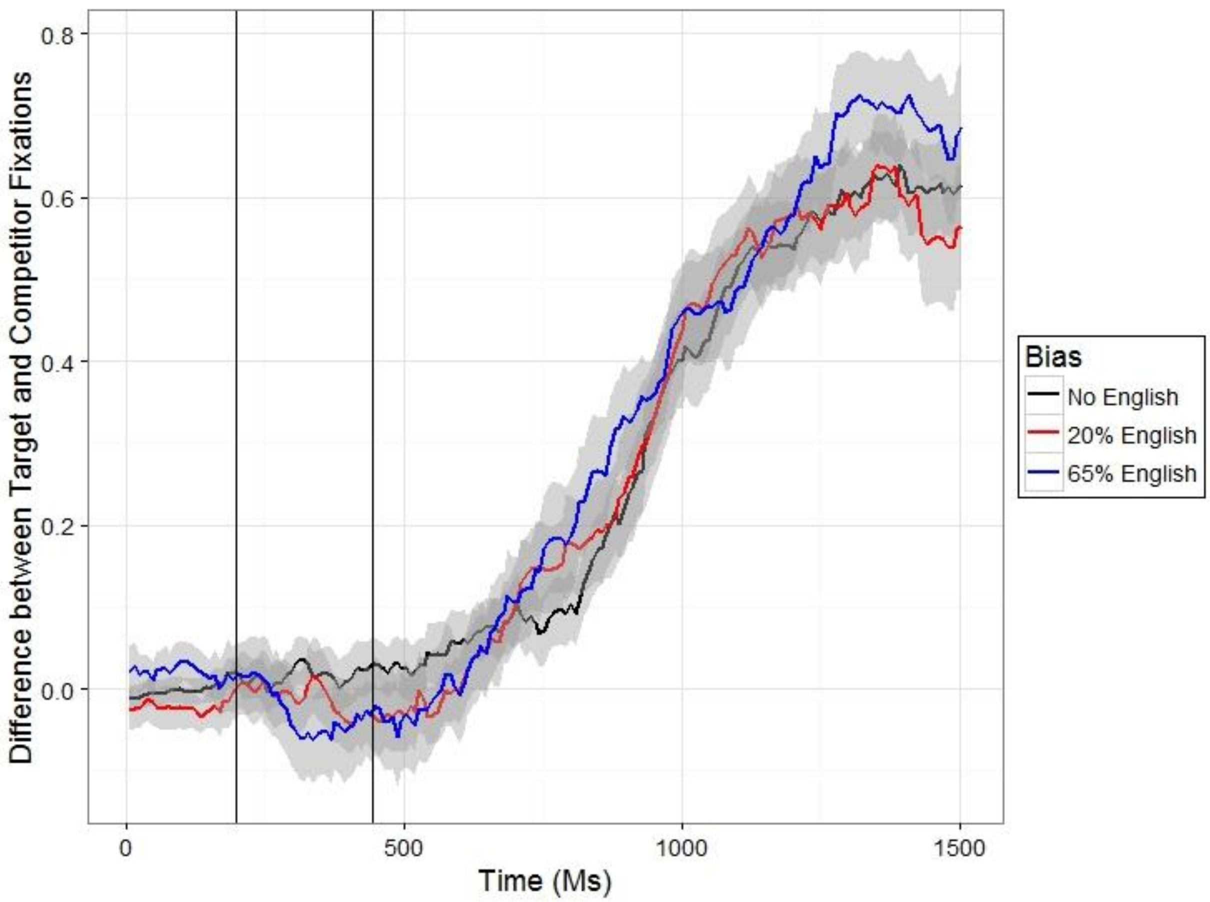

Figure 16: Difference between Target and Competitor Fixations, L1-English L2-Spanish Group, Cognate (Experiment 1) and Stress-Interference (Experiment 2) Conditions

6.7.2.1 Pre-Disambiguation Time Window

For the pre-disambiguation time window, the best model on the L1-English L2-Spanish group's difference in fixations included language bias (no English vs. 20% English, no English vs. 65% English) and proficiency as fixed factors, as well as the two-way interaction between language bias and proficiency. Table 19 presents the results of this model.

Table 19: Mixed-Effects Linear Model Results Comparing Experiments 1 and 2 (Cognate, Stress Mismatch and Stress-Interference Conditions), L1-English L2-Spanish Group, Pre-Disambiguation Time Window

Variable	**Estimate (SE)**		***t***	***p***
(Intercept)	0.02	(.12)	<|1|	>.1
Language Bias (20% English)	–0.2	(.14)	–1.39	>.1
Language Bias (65% English)	–0.49	(.17)	–2.92	<.004
Proficiency	–0.01	(.13)	<|1|	>.1
Language Bias (20% English) x Proficiency	0.24	(.17)	1.44	>.1
Language Bias (65% English) x Proficiency	0.48	(.18)	2.61	<.009

Note: $df = 520$; $\alpha = .05$

The model summarized in Table 19 revealed a simple effect of language bias (the 65%-English condition differed from the no-English condition) and a two-way interaction between language bias and proficiency for the 65%-English condition. The simple effect of bias indicate that the L1-English L2-Spanish participants showed a smaller difference between their proportions of target and competitor fixations in the 65%-English condition than in the no-English condition. The two-way interaction between language bias and proficiency for the 65%-English condition indicates that as proficiency in Spanish increased, the L1-English L2-Spanish group showed larger differential proportions in the 65%-English condition, but not so much in the no-English condition; consequently, the effect of language bias decreases with increasing Spanish proficiency. This interaction is illustrated in Figure 17.

These results suggest that for L1-English L2-Spanish listeners, the explicit presence of a large number of English trials in the task also slowed down the recognition of the Spanish target.

Furthermore, with increasing proficiency in Spanish, L1-English L2-Spanish listeners tend to show better control of the amount of interference caused by the presence of English in the experiment, especially in the 65%-English condition.

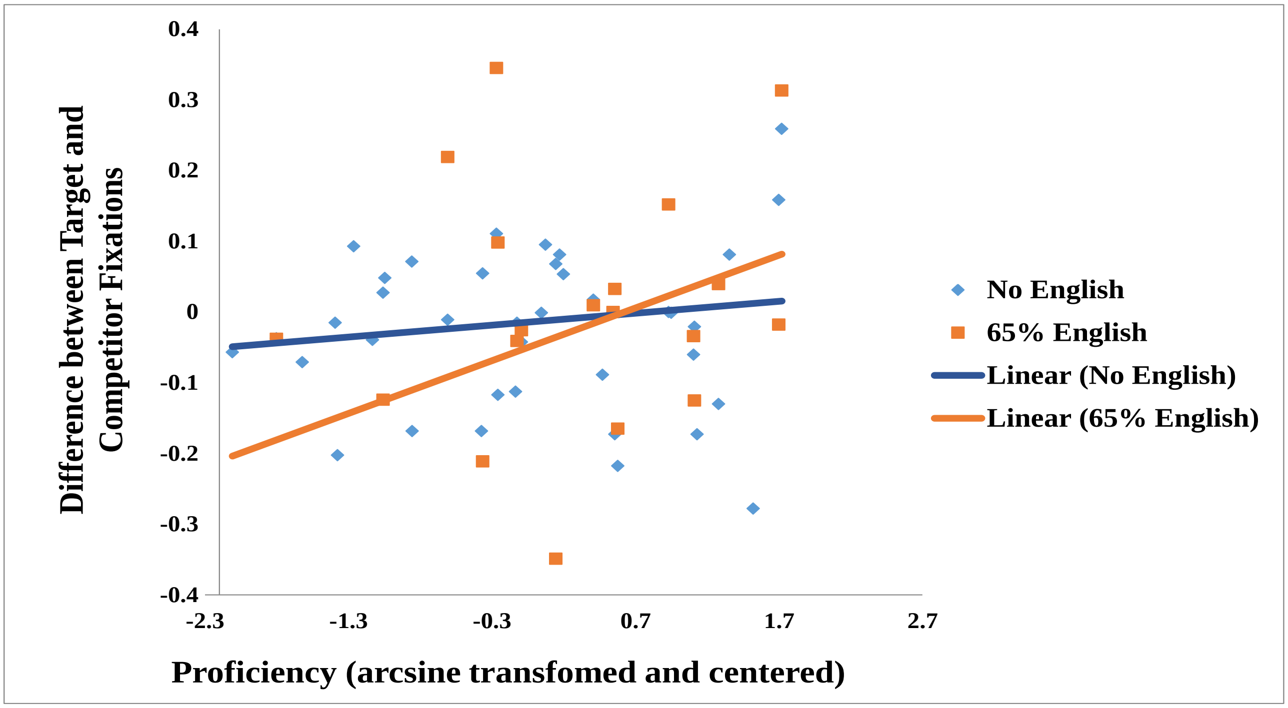

Figure 17: Interaction between Language Bias and Proficiency, L1-English L2-Spanish Group, Cognate (Experiment 1) and Stress-Interference (Experiment 2) Conditions

6.7.2.2 Post-Disambiguation Time Window

For the pre-disambiguation time window, the best model on the L1-English L2-Spanish group's difference in fixations included language bias (no English vs. 20% English, no English vs. 65% English) and proficiency as fixed factors. Table 20 presents the results of this model.

Table 20: Mixed-Effects Linear Model Results Comparing Experiments 1 and 2 (Cognate, Stress Mismatch and Stress-Interference Conditions), L1-English L2-Spanish Group, Post-Disambiguation Time Window

Variable	**Estimate (SE)**		***t***	***p***
(Intercept)	0.1	(.1)	<|1|	>.1
Language Bias (20% English)	–0.02	(.03)	<|1|	>.1
Language Bias (65% English)	0.02	(.03)	<|1|	>.1
Proficiency	0.26	(.12)	2.26	<.029

Note: *df* = 520; α = .05

The model summarized in Table 20 revealed only a simple effect of proficiency. This indicates that in the post-disambiguation time window, participants showed a larger difference between their proportions of target and competitor fixations (indicating *less* lexical competition) as their proficiency in Spanish increased.

6.8 Discussion and Conclusion

The main objective of this experiment was to determine whether L2 proficiency and language bias modulate the degree of cross-language activation (from stress interference) that bilingual listeners in a bilingual language mode experience in comprehension. Effects of these two factors have been reported in the literature on bilingual comprehension (e.g., Grosjean, 1997; Guo & Peng, 2006; Ju & Luce, 2004; Marian & Spivey, 2003a; Soares & Grosjean, 1984; Spivey & Marian, 1999; Weber & Cutler, 2004). This study also explored whether (and if so, how) these two factors interact.

We predicted a significant interaction between language bias and English stress, with the effect of stress being greater in the English-bias group than in the Spanish-bias group. We also anticipated the possibility that the effects of stress and language bias would be modulated by L2 proficiency. For stress, we predicted that participants would more easily reduce the degree of cross-language activation in the stress-interference condition as their proficiency in the L2 decreased (for L1-Spanish L2-English listeners) or increased (for L1-English L2-Spanish listeners). For language bias, we predicted that more proficient bilinguals could show less sensitivity to language bias as a result of better controlling for the degree of cross-language activation.

The results partially supported these predictions. In both the pre- and post-disambiguation time windows, the L1-English L2-Spanish participants in the English-bias condition showed more lexical competition in the stress-interference condition than in the no-stress-interference condition, with this effect being modulated by their proficiency in Spanish. By contrast, no effect of stress was found for L1-English L2-Spanish participants in the Spanish-bias condition, and no effect of stress or language bias (or interaction between the two) was found for the L1-Spanish L2-English participants. Language bias was also found to influence word recognition in the analysis comparing the results of the cognate, stress mismatch condition of Experiment 1 and those of the stress-interference condition of Experiment 2. In this second analysis, the L1-English L2-Spanish group showed slower recognition of the Spanish target in the 65%-English condition than in the no-English condition, and so did the L1-Spanish L2-English group. This suggests that the more English bilingual listeners were forced to activate throughout the experiment, the slower they were in recognizing the Spanish target. Language bias appears to influence not only bilingual lexical activation, but also overall word-recognition speed.

These findings are in line with those reported in previous comprehension studies looking at the effects of language bias (e.g., Marian & Spivey, 2003a; Spivey & Marian, 1999). Marian & Spivey (2003a) hypothesized that the bilinguals in their first study (Spivey & Marian, 1999), who were tested in both languages in the same experimental session and by fluent bilingual speakers, may have been more sensitive to the similarities between the two languages during the experiment, and thus experience greater cross-language competition, than the bilinguals in their second study (Marian & Spivey, 2003a), who were tested in only one language and by monolingual speakers. In both studies, though, there was evidence of cross-language activation when the unintended language was the L1, as in the current study.

Overall, the L1-Spanish L2-English group appears to have been less influenced by the presence of English trials than the L1-English L2-Spanish group, in that language bias influenced the former group from 0 to 65% but not from 20% to 65% (unlike the L1-English L2-Spanish group, who showed an effect of language bias in the first analysis). As with Experiment 1, it is likely that the stress-interference manipulation of the competitor word interfered with the recognition of the Spanish target for the L1-English L2-Spanish listeners but not for the L1-Spanish L2-English listeners in Experiment 2 due to the differential strengths of lexical activation in L1 Spanish as compared to L2 Spanish. These findings are in line with those of previous studies showing that the size of cross-language activation varies depending on whether the task is conducted in the L1 or in the L2 (i.e., Marian & Spivey, 2003a) and depending on how proficient bilingual listeners are in the L2 (e.g., Mishra & Singh, 2016; Silverberg & Samuel, 2004). As was discussed for Experiment 1, the L1-Spanish L2-English listeners may also not have shown an effect of stress interference if they were not sufficiently familiar with the stress placement of the competitor words included in the study. However, the results of Experiment 3, an adaptation of Experiment 2 but in which participants instead produced the Spanish targets, suggest otherwise (in that experiment, the L1-Spanish L2-English group did show a significant effect of stress; for details, see Chapter 7). Hence, from the present results, we conclude that cross-language interference is simply stronger when the unintended language is the

L1 than when it is the L2. Further research should investigate whether the strength of activation of the L1 is considerably weakened with L1-Spanish L2-English participants who instead live in an English-speaking country, while controlling by the knowledge of stress pattern of English words.

One interesting question that arises from the language bias manipulation used in the current study is whether participants in the English-bias condition might have been using different strategies from those in the Spanish-bias condition when performing the task. Given that we needed to control for syllable type and stress placement in the filler trials, the percentage of Spanish and English trials in the English-bias condition was not the reverse from that in the Spanish-bias condition (35% Spanish vs. 65% English in the former; 80% Spanish vs. 20% English in the latter). It is possible that participants in English-bias group, rather than expecting to activate more English than Spanish, considered the likelihood of hearing each language to be similar, and thus expected both languages across trials. Although this possibility cannot be ruled out, it does not undermine the interpretation of the current results: The more English participants heard, the more cross-language interference they showed.

Not only language bias, but also L2 proficiency, was found to affect cross-language activation in the L1-English L2-Spanish participants. As predicted, the effect of stress-interference was modulated by L2 proficiency, with L1-English L2-Spanish listeners in the English-bias condition showing less lexical competition in the stress-interference condition as their Spanish proficiency increased (pre-disambiguation time window). Also for L1-English L2-Spanish listeners, L2 proficiency additionally modulated the effect of language bias, with listeners showing a reduced effect of language bias as their proficiency increased, largely due to their enhanced ability to control cross-language activation in the English-bias condition. Previous studies have indeed shown that L2 proficiency modulates cross-language activation from the L1 (e.g., Mishra & Singh, 2016; Silverberg & Samuel, 2004). The current findings thus provide further evidence in support of the claim that more proficient L2 listeners exert better control over the degree of cross-language activation from the L1, particularly so in a task where the language that is unintended in the critical trials is heard in much of the experiment (English bias).

In contrast to the L1-Spanish L2-English group, L2 proficiency did not modulate the effect of stress interference for the L1-Spanish L2-English group. Unlike our predictions, more proficient L1-Spanish L2-English participants did not show a larger degree of stress interference as their proficiency in English increased. One possibility is that the hypothesized greater activation of the L1 and lesser activation of their L2 may have made proficiency effects less likely to emerge in a task where the interference comes from the L2 rather than from the L1. Alternatively, the L1-Spanish L2-English listeners may not have been sufficiently proficient in English to trigger cross-language competition from their L2, thus nullifying any effect of proficiency. The L1-Spanish L2-English participants tested in this study had minimal experience living in an English environment. In future studies, testing more advanced L1-Spanish L2-English participants and/or testing them in an environment where the L2 is used would provide more conclusive evidence regarding the effect of L2 proficiency on cross-language activation when the unintended language is the L2 rather than the L1.

The results of this experiment are compatible with the Inhibitory Control Model (Green, 1998). According to this model, bilinguals' two languages are represented by different language tags schemas (established from prior input), which alter the activation levels of lexical representations in a top-down fashion. The model postulates that the activation level of the language schemas is altered by the supervisory attentional system, which works as a domain-general inhibitory control mechanism. According to the Inhibitory Control Model, language tag schemas are the primary source of control in bilingual word activation (for both comprehension and production), so the model predicts an effect of language bias on this activation. Moreover, proficiency is expected to affect to degree to which the word lemmas are activated. That is, the Inhibitory Control Model predicts that both proficiency and language bias will control the level of activation of the unintended language, as found in this study. The model does not make specific predictions as to whether proficiency and language bias should interact, but a priori such an interaction is not inconsistent with the model.

In principle, the BIA+ Model (Dijkstra & Van Heuven, 2002) does not straightforwardly predict the results obtained in the comprehension task. This model represents the bilinguals' two languages with the use of language nodes, by means of which the activation levels of lexical representation can be altered. However, unlike the Inhibitory Control Model, the language nodes in the BIA+ model cannot perform a form of top-down control in early stages of word activation. The BIA+ Model claims that the activation and inhibition of lexical representations is strictly controlled by the input in this early stage of word recognition. According to this model, language nodes can only influence the output (i.e., word selection) of the "task/decision system". For comprehension, this model predicts that proficiency will modulate bilingual activation, but language bias should not have such an effect in the early stages of word activation.

One limitation of the present design for testing the BIA+ Model (Dijkstra & Van Heuven, 2002), however, is that in each trial of Experiment 2, participants were given 4,000 ms to read the words on the screen and activate their phonological realizations (at least in Spanish but, in principle, also English for the Spanish-English cognates) before they heard any acoustic information leading them to the target. Since this preview time likely influenced the activation of the words on the screen, it could be argued that what the eye-tracking data is capturing is, indeed, not the early word activation stage, but rather the word selection stage. If the eye-tracking data were deemed not to represent the early stages of word activation, then the current results would also be in line with the predictions of the BIA+ model.

Another possible limitation of Experiment 2 is in the interpretation of the nature of the effect stress shown by the L1-English L2-Spanish group: It is unclear whether the effect shown is an effect of stress interference or stress facilitation. For instance, it could also be the case that the no-stress-interference helped listeners rule out the interference from the English stress pattern as early as in the first syllable (where the English words would have been stressed, but which the acoustic input did not show this pattern). This would indicate that, in fact, being able to inhibit the English stress interference earlier in the word makes it easier for participants to reduce the level of cross-language interference. Possibly, both stress facilitation and stress interference may also be going on from, respectively, the no-stress-interference and stress-interference conditions. Further research should seek to tease these two possibilities apart.

In conclusion, the findings of Experiment 2 indicate that language bias and L2 proficiency modulate the degree of cross-language activation shown by bilinguals, and they interact such that L2 proficiency is more likely to influence cross-language activation when the unintended language is more often used (English bias) than when it is less often used (Spanish bias). Experiment 3, described in detail in the next chapter, provided a test for determining whether factors such as language bias and L2 proficiency modulate cross-language activation in bilingual speech production when bilinguals are in a bilingual language mode.

Chapter 7: Experiment 3: Spanish-English Switching Production Task

7.1 Introduction

Experiment 2 showed that both L2 proficiency and language bias modulated the degree of cross-language activation (from stress interference) that L1-English L2-Spanish listeners in a bilingual language mode experienced in language comprehension. Experiment 3 investigates whether these two factors also modulate cross-language activation when bilingual speakers in a bilingual language mode produce language. Whereas previous comprehension studies have found that both L2 proficiency and language bias modulate bilingual activation (e.g., Grosjean, 1998; Marian & Spivey, 2003a; Mishra & Singh, 2016; Rodriguez-Fornells et al., 2005; Silverberg & Samuel, 2004), existing word production studies report only effects of L2 proficiency (e.g., Costa et al., 2000; Costa, Colomé, & Caramazza, 2000; Costa, Miozzo, & Caramazza, 1999; Costa et al., 2006; Costa & Santesteban, 2004; Hoshino & Kroll, 2008). Thus, the effect of language bias on word production still needs to be studied. Importantly, no other study has explored how both L2 proficiency and language bias influence bilingual language activation in word production, and whether (and if so, how) they interact.

This experiment uses an experimental design similar to that of Experiment 2, but instead of hearing a target word in Spanish or English, participants produce the target word in Spanish or in English. Participants completed an adaptation of the visual-world eye-tracking task in which they saw four orthographic words presented in the screen, one of which was signaled with a circle. Participants were asked to name the word in the circle. In addition to being signaled by the circle, the target word appeared in one of two colors: blue or red. Participants were asked to name the word in English if it appeared in blue or in Spanish if it appeared in red. Thus, Experiment 3 was designed to determine whether L2 proficiency and language bias modulates cross-language activation in L1-Spanish L2-English and L1-English L2-Spanish production of Spanish words in the presence of Spanish-English cognate words with interfering stress pattern in English and how these two factors may interact with each other.

7.2 Materials

The test items of Experiment 3 were the same as those described in Chapter 6 for Experiment 2. In the experimental conditions, participants also saw a total of 24 Spanish trisyllabic nouns with regular stress placement always presented together with a competitor with a different stress pattern. As was the case with Experiments 1 and 2, the target in the experimental items was always the word with stress on the penultimate syllable (e.g., *li**te**ra* 'bunk bed', or *ma**te**ria* 'matter/subject').

Experiment 2 included a stress-interference condition, where the stress pattern of the English cognate competitor (e.g., *mate**rial***) matched that of the Spanish target word and was expected to interfere with the recognition of the Spanish target word. Whereas this stress-interference condition was expected to increase lexical competition in comprehension (Experiments 1-2), it is not expected to interfere with word naming in production (Experiment 3), because the stress pattern of the English cognate competitor and Spanish target is the same. Hence, for Experiment 3, this condition is referred to as the no-stress-interference condition. Half of the test items belonged to this no-stress-interference condition, and the remaining half belonged to a stress-interference condition, where the stress pattern of the English cognate competitor differed from that of the Spanish target (e.g., *lite**ral***) and thus where interference from the English stress pattern was expected. If participants activate the English stress pattern, they should produce the Spanish target word *more slowly* and *less accurately* in the stress-interference condition (e.g., *li**te**ra*) than in the no-stress-interference condition (e.g., *ma**te**ria*).

The same language-bias manipulation described for Experiment 2 was used in Experiment 3, with two versions of the experiment being created: a Spanish-bias version in which only 20% of the trials were in English, and an English-bias version in which 65% of the trials were in English. The test items were distributed in the same way across Experiments 2-3. As in Experiment 2, participants were assigned to either a Spanish-bias condition or an English-bias condition, whichever condition they were assigned to in Experiment 2.

In order to reduce the probability that participants would do the task based on what they remember from Experiment 2, the presentation of target-competitor word pairs and distracter word pairs was randomized such that even though participants saw the same words in Experiments 2-3, they did not see the same array of four words (e.g., if, in Experiment 2, participants saw "materia", "material," "seguido," and "seguidor" on the screen, in Experiment 3 they saw "materia," "material," "chupete," and "chupetón"). All the stimuli, including experimental items, distracters, and filler trials, can be found in Appendices L, M, and N respectively.

7.3 Procedure

Experiment 3 was conducted during participants' third visit to the laboratories. Participants were comfortably seated in an isolated room, facing a computer screen and wearing a Sennheiser ME 3-EW headset EW microphone. Paradigm software (Perception Research Systems, Inc.; Tagliaferri, 2005) was used to present the visual stimuli and record participants' word productions. Similarly to Experiments 1 and 2, participants first saw the four orthographic words for 4,000 ms, which they were instructed to silently read; then, a fixation cross appeared in the middle of the screen for 500 ms; after the fixation cross disappeared, the same four words reappeared on the screen, one of them in a circle and in color. Participants were asked to read the circled word aloud in the language signaled by the color, and do so as quickly and accurately as possible. Paradigm began recording voice data once the screen with the circled word appeared, and the sample length was specified to 2,000 ms. to make sure the complete word would be recorded. The recording volume was readjusted before each new participant.

The language bias in this experiment was created by presenting the target word in one of two colors to let participants know in which language they should read it. If the circled word appeared in red, participants had to read it in Spanish; if the circled word was in blue, they had to read it in English. Participants were carefully instructed about this color manipulation, and they had four practice trials to ensure that they indeed read the target words in the intended language. Practice trials followed the same procedure as the filler trials, including the language-bias manipulation. The main experimenter stayed next to the participants during this practice session to make sure they were following the instructions and read the target word in the appropriate language. After the practice session, participants were reminded of the color coding to ensure they would not read the words in the wrong language. This short practice session allowed participants to become familiar with the procedures and with the presence of English trials. The actual experiment began right after the practice session.

7.4 Data Analysis

Paradigm (Tagliaferri, 2005) saved each individual word production as a separate .wav file in the participant's data folder. Each individual recording (for the experimental trials) was visually inspected and analyzed using PRAAT (Boersma & Weenink, 2010). Two different dependent variables were analyzed: (1) accuracy (whether participants produced the correct target word, in the correct language, and with the correct stress pattern); and (2) naming latencies (how much time participants needed to begin producing the word—from when the circled word appeared on the screen to the onset of the word produced).

Individual production files were further coded for two additional variables: false starts and disfluencies (that is, cases where participants started producing a word but then changed their minds, and cases were the produced words were broken up by a pause). Word productions that were affected by false starts or disfluencies were excluded from the analysis of the accuracy and naming latency data (which excluded a total of 0.09% of the data in the L1-Spanish L2-English group and 0.73% of the L1-English L2-Spanish group). Due to technical problems, the recordings of one L1-Spanish L2-English and one L1-English L2-Spanish participant were not saved, which led to the loss of 2.9% of the data in the L1-Spanish L2-English group and 2.5% of the data in the L1-English L2-Spanish group. Trials where the wrong word was read or where the word was read in the wrong language were also excluded from analysis of the accuracy and naming latency data (which excluded a total of 0.53% of the data in the L1-Spanish L2-English group and 0.83% of the L1-English L2-Spanish group). In total, 3.52% of the data was excluded for the L1-Spanish L2-English group and 4.06% of the data was excluded for the L1-English L2-Spanish group.

Word productions that remained in the analyses were coded for accurate or inaccurate stress placement by two different raters (a native speaker of Spanish with very little knowledge of English and a native speaker of English with very little knowledge of Spanish, both naïve to the purpose of the current dissertation). Naïve raters were used to make sure that judgements would not be biased due to familiarity with the test items, conditions, and languages tested. The overall agreement between the two raters was 98.2%, and those cases in which there was no consensus were excluded from the analysis (which excluded a total of 1.8% of the remaining data, mostly from the L1-English L2-Spanish group). The analysis of the naming latencies included only words that had been judged to be produced with the correct stress placement.

The two dependent variables were analyzed with linear mixed-effects models for the continuous variable (naming latencies) and logit mixed-effects models for the binomial variable (accuracy) using the lme4 package of R (Baayen, 2008). The models examined the effect of English stress (no-stress-interference vs. stress-interference, with the no-stress-interference condition as the baseline), language bias (Spanish-bias vs. English-bias, with Spanish-bias as the baseline), proficiency (arcsine transformed and centered), and all two- and three-way interactions. As with the previous experiments, different models were run for the two groups (L1-Spanish L2-English and L1-English L2-Spanish bilinguals). For each dataset, the effect of each predictor was assessed using log-likelihood tests comparing models with and without that predictor; in each case, the simplest model with the best fit was kept. All models included participant and test item as crossed random variables.

7.5 Predictions

This experiment investigated whether cross-language competition would be modulated by the stress pattern of the English cognate competitor word (no-stress-interference vs. stress-interference), L2 proficiency, and language bias (Spanish-bias vs. English-bias) during a production task.

If English stress modulates the degree of cross-language activation, we should find a simple effect of English stress, with less accurate and slower responses in the stress-interference condition than in the no-stress-interference condition in the Spanish-bias condition (baseline). This would indicate that both languages are activated in parallel before the word in the correct language (here, Spanish) is produced. If language bias also modulates cross-language activation, we should also find a significant interaction between stress and language bias may also be found. Such an interaction would most likely indicate that the effect of stress is greater in the English-bias group than in the Spanish-bias group. We may also find a simple effect of language bias, with less accurate and slower response times in the English-bias condition than in the Spanish-bias condition in the no-stress-interference condition (baseline). As with Experiment 2, this would indicate that the ease with which the Spanish target word is produced depends on the likelihood of producing other Spanish target words throughout the experiment: The more Spanish is produced, the more accurately and more rapidly the Spanish target is produced. In other words, finding a simple effect of language bias but no interaction between language bias and English stress would indicate that language bias does not modulate the degree of cross-language interference produced by the stress manipulation; it only modulates how accurately and rapidly the Spanish target is recognized. Finally, we may find that the effects of stress and language bias are modulated by L2 proficiency. For stress, such an interaction is expected to reveal that participants can more easily reduce the degree of cross-language activation in the stress interference condition as their proficiency in the L2 decreases (for L1-Spanish L2-English listeners) or increases (for L1-English L2-Spanish listeners). For language bias, more proficient bilinguals could show less sensitivity to language bias as a result of better controlling for the degree of cross-language activation.

While the main purpose of this dissertation is to further explore how factors such as L2 proficiency and language bias modulate cross-language activation, it also has implications for models of bilingual activation. In line with the predictions outlined in Experiment 2, the Inhibitory Control Model (Green, 1998) predicts a main effect of (or interaction with) language bias and L2 proficiency for both comprehension and production, whereas the BIA+ Model (Dijkstra & van Heuven, 2002) does not make predictions for production, as the model was originally proposed for comprehension.

7.6 Results of Experiment 3

Similarly to Experiments 1 and 2, this section begins with a description of the results found for the L1-Spanish L2-English group, with the accuracy and naming latency results reported separately.

7.6.1 L1-Spanish L2-English Group

7.6.1.1 Stress Placement Accuracy Results

This section presents the participants' stress placement accuracy results, as coded by the aforementioned two raters. Whenever participants made a stress placement error, they followed one of two possible strategies: In the no-stress-interference condition, they produced the stress pattern of the Spanish cognate competitor (e.g., producing *ma**te**ria* as *mate**ria***, as if it were similar to *mate**rial*** in Spanish); and in the stress-interference condition, they produced the stress pattern of the English cognate competitor (e.g., producing *li**te**ra* as ***li**tera*, as if it were similar to ***li**teral* in English). This indicates that, as intended by the experimental design, the competitor word interfered in some way with the correct retrieval of the stress pattern of the Spanish target word.

Figure 18 presents the L1-Spanish L2-English participants' accuracy in the no-stress-interference (dark grey) and stress-interference (red) conditions, separately for the Spanish-bias and the English-bias groups.

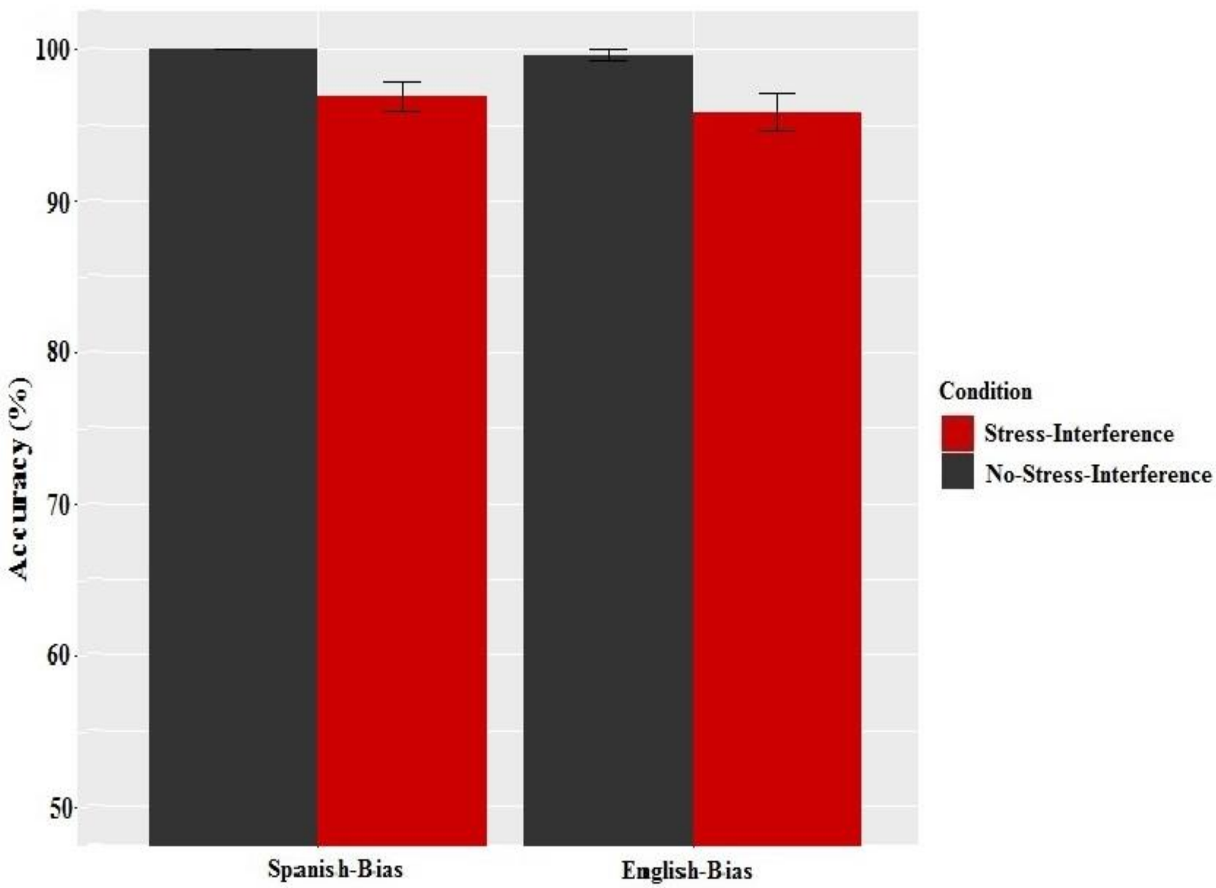

Figure 18: Accuracy Results, L1-Spanish L2-English Group, Experiment 3

The best model on L1-Spanish L2-English group's accuracy results included English stress (no-stress-interference vs. stress-interference), language bias (Spanish-bias vs. English-bias), and proficiency as fixed factors, as well as the two-way interaction between language bias and proficiency. Table 21 presents the results of this model.

Table 21: Logit Mixed-Effect Model Results, L1-Spanish L2-English Group, Accuracy, Experiment 3

Variable	**Estimate (SE)**		***z***	***p***
(Intercept)	6.91	(1.11)	6.45	<.001
English stress	–3.12	(1.01)	–3.09	<.01
Language Bias	–0.53	(0.5)	–1.07	>.1
Proficiency	–7.57	(3.27)	–2.3	<.021
Language Bias x Proficiency	6.99	(4.1)	1.5	>.1

Note: $df = 1080$; $\alpha = .05$

The model summarized in Table 21 revealed a simple effect of English stress and a main effect of proficiency. This indicates that L1-Spanish L2-English participants were more accurate when the English cognate competitor word had the same stress pattern as the Spanish target than when the English cognate competitor had a different stress pattern from the Spanish target in the Spanish-bias condition (the baseline). Given the lack of interaction between English stress and language bias, the effect of stress thus generalized to the two language bias conditions. The results also show that L1-Spanish L2-English participants' accuracy decreased as their proficiency in English increased. Since this effect did not interact with stress or language bias, it can be generalized to both the two stress conditions and the two language bias conditions. This indicates that, the more proficient in English participants were, the less accurate they were in their production of Spanish words, irrespective of stress or language bias.

These results indicate that the L1-Spanish L2-English participants showed evidence of interference from the English stress pattern in language production, but that neither language bias nor L2 proficiency modulated the degree of interference. These results differ from those reported for Experiment 2, where the L1-Spanish L2-English participants did not show evidence of interference from the English stress pattern in language comprehension.

7.6.1.2 Naming Latency Results

Figure 19 presents the L1-Spanish L2-English participants' naming latencies in the no-stress-interference (dark grey) and stress-interference (red) conditions, separately for the Spanish-bias and the English-bias groups.

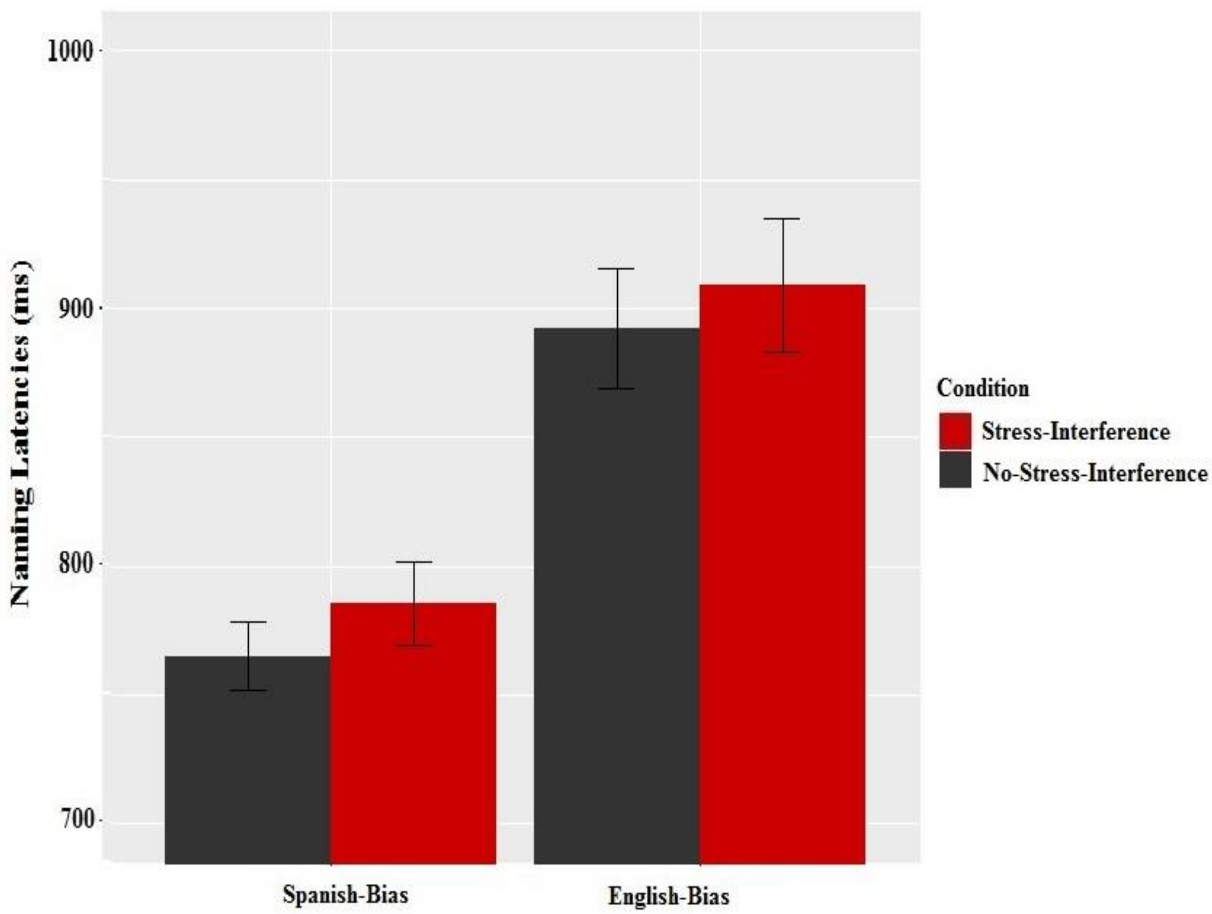

Figure 19: Naming Latency Results, L1-Spanish L2-English Group, Experiment 3

The best model on L1-Spanish L2-English group's naming latencies included English stress (no-stress-interference vs. stress-interference), language bias (Spanish-bias vs. English-bias), and proficiency as fixed factors, as well as the two-way interaction between proficiency and language bias. Table 22 presents the results of this model.

Table 22: Mixed-Effects Linear Model Results, L1-Spanish L2-English Group, Naming Latencies, Experiment 3

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	763.02	(19.98)	38.2	<.001
English stress	18.91	(8.07)	2.34	<.02
Language Bias	–128.92	(27.33)	4.72	<.001
Proficiency	–192	(186.71)	–1.03	>.1
Language Bias x Proficiency	143.78	(252.2)	<|1|	>.1

Note: $df = 1104$; $\alpha = .05$

The model summarized in Table 22 revealed a simple effect of English stress and a simple effect of language bias but no interaction between the two. The simple effect of English stress indicates that L1-Spanish L2-English participants were faster when the English cognate competitor word had the same stress pattern as the Spanish target than when the English cognate competitor had a different stress pattern from the Spanish target in the Spanish-bias condition (the baseline). The simple effect of language bias indicates that L1-Spanish L2-English participants were slower in the English-bias condition than in the Spanish-bias condition for the condition where the cognate competitor word has the same stress as the Spanish target (baseline). Given the lack of interaction between English stress and language bias, the effect of stress generalized to the two language bias conditions and the effect of language bias generalized to the two stress conditions.

This pattern of results confirm that L1-Spanish L2-English participants showed evidence of cross-language activation from the English stress pattern of the cognate competitor, and were overall slower at retrieving and producing the Spanish target when the experiment included more English trials than when it included fewer English trials but, again, neither language bias nor L2 proficiency modulated this effect.

7.6.2 L1-English L2-Spanish Group

7.6.2.1 Stress Placement Accuracy Results

Figure 20 presents the L1-English L2-Spanish participants' accuracy in the no-stress-interference (dark grey) and stress-interference (red) conditions, separately for the Spanish-bias and the English-bias groups.

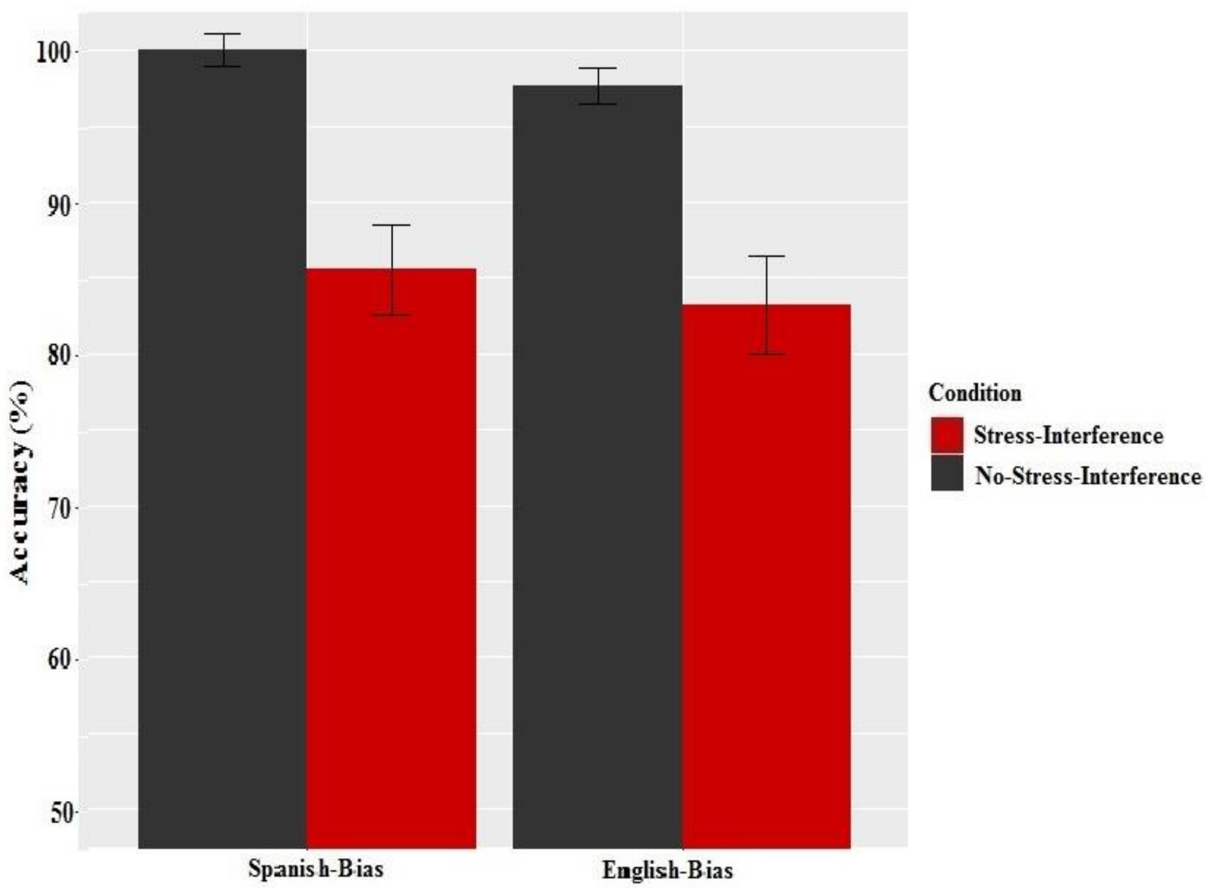

Figure 20: Accuracy Results, L1-English L2-Spanish Group, Experiment 3

The best model on L1-English L2-Spanish group's accuracy results included English stress (no-stress-interference vs. stress-interference), language bias (Spanish-bias vs. English-bias), and proficiency as fixed factors, as well as the two-way interaction between language bias and proficiency. Table 23 presents the results of this model.

Table 23: Logit Mixed-Effect Model Results, L1-English L2-Spanish Group, Accuracy, Experiment 3

Variable	**Estimate (SE)**	***z***	***p***
(Intercept)	4.45 (1.01)	4.44	<.001
English stress	–2.64 (0.4)	–6.73	<.001
Language Bias	–1.1 (1.45)	<|1|	>.1
Proficiency	0.6 (1.05)	<|1|	>.1
Language Bias x Proficiency	0.74 (1.61)	<|1|	>.1

Note: $df = 913$; $\alpha = .05$

The model summarized in Table 23 revealed a simple effect of English stress. This indicates that L1-English L2-Spanish participants were more accurate when the English cognate competitor word had the same stress pattern as the Spanish target than when the English cognate competitor had a different stress pattern from the Spanish target in the Spanish-bias condition (the baseline). Given the lack of interaction between English stress and language bias, the effect of stress thus generalized to the two language bias conditions.

This pattern of results suggests that L1-English L2-Spanish participants also showed evidence of cross-language activation from the English stress pattern in their production of the Spanish target word, but that this effect was not modulated by either language bias or L2 proficiency.

7.6.2.2 Naming Latency Results

Figure 21 presents the L1-English L2-Spanish participants' naming latencies in the -no-stress-interference (dark grey) and stress-interference (red) conditions, separately for the Spanish-bias and the English-bias groups.

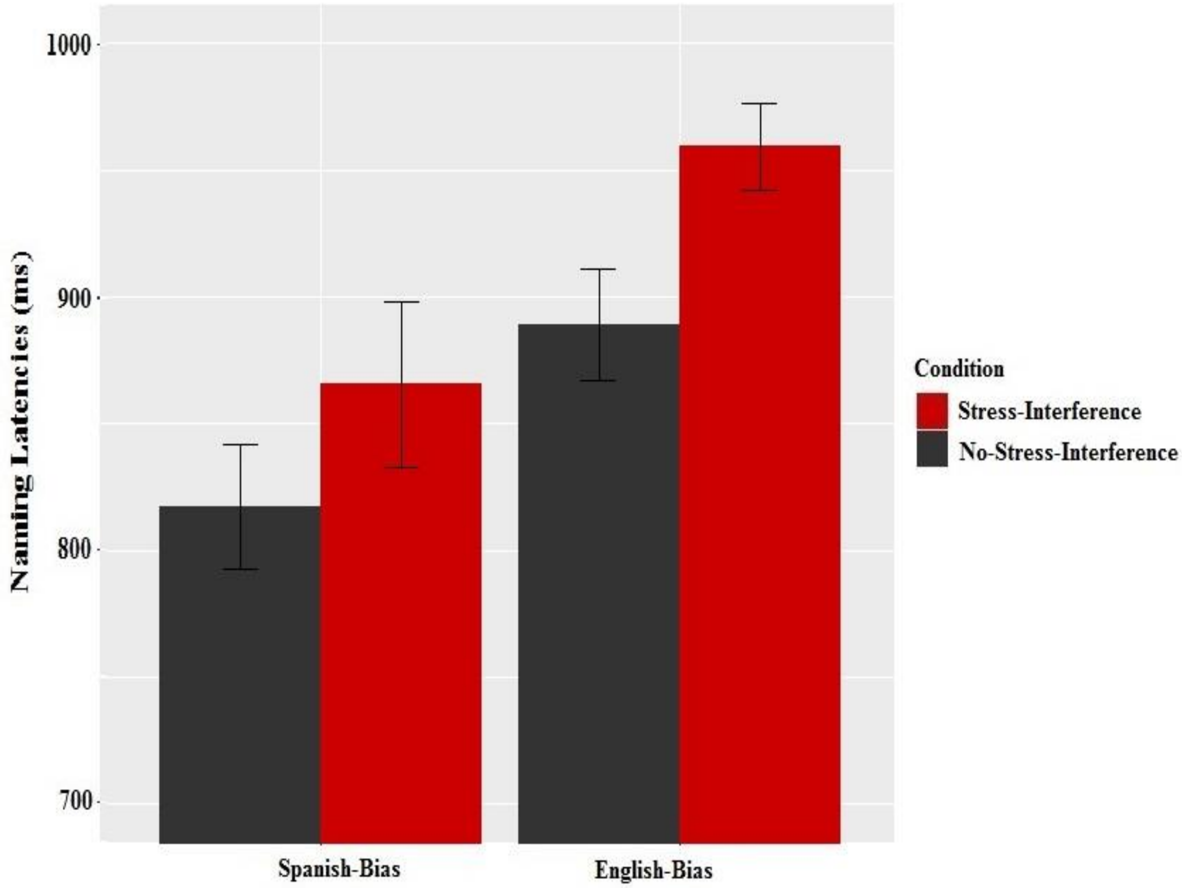

Figure 21: Naming Latency Results, L1-English L2-Spanish Group, Experiment 3

The best model on L1-English L2-Spanish group's naming latency results included English stress (no-stress-interference vs. stress-interference), language bias (Spanish-bias vs. English-bias), and proficiency as fixed factors, as well as the two- and three-way interactions between proficiency, stress facilitation, and language bias. Table 24 presents the results of this model.

Table 24: Mixed-Effects Linear Model Results, L1-Spanish L2-English Group, Naming Latency, Experiment 3

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	874.68	(98.15)	8.91	<.001
English stress	–35.29	(48.17)	<|1|	>.1
Language Bias	–59.58	(162.27)	<|1|	>.1
Proficiency	–59.49	(115.8)	<|1|	>.1
English stress x Language Bias	178.91	(80.79)	2.21	<.025
English stress x Proficiency	97.92	(57.05)	1.29	>.1
Language Bias x Proficiency	144.29	(179.87)	<|1|	>.1
English stress x Language Bias x Proficiency	–206.68	(89.26)	–2.32	<.019

Note: *df* = 913; α = .05

The model summarized in Table 24 revealed a two-way interaction between English stress and language bias, as well as a three-way interaction between English stress, language bias, and proficiency. The two-way interaction between English stress and language bias shows a greater effect of English stress in the English-bias condition than in the Spanish-bias condition.

In order to better understand the two- and three-way interactions, linear mixed-effects models were run separately on the two language bias conditions. For the two conditions, the best model included English stress (no-stress-interference vs. stress-interference) and proficiency as fixed factors, as well as the two-way interaction between English stress and proficiency. Table 25 reports the results obtained for the Spanish-bias condition, and Table 26 reports the results of the English-bias condition.

Table 25: Follow-Up Mixed-Effects Linear Model Analysis, L1-English L2-Spanish Group, Naming Latency, Spanish Bias, Experiment 3

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	866.12	(109.66)	7.9	<.001
English stress	–59.78	(50.41)	<|1|	>.1
Proficiency	–34.68	(50.4)	<|1|	>.1
English stress x Proficiency	102.13	(59.72)	1.71	<.09

Note: $df = 475$; $\alpha = .05$

Table 26: Follow-Up Mixed-Effects Linear Model Analysis, L1-English L2-Spanish Group, Naming Latency, English Bias, Experiment 3

Variable	**Estimate**	**(SE)**	***t***	***p***
(Intercept)	807.64	(110.56)	7.31	<.001
English stress	148.1	(61.52)	2.41	<.017
Proficiency	88.06	(117.12)	<|1|	>.1
English stress x Proficiency	–109	(65.09)	–1.61	<.097

Note: $df = 438$; $\alpha = .05$

The results of these follow-up models showed only a simple effect of English stress and only in the English-bias condition. This effect indicates that L1-English L2-Spanish participants were faster at naming the target word in the no-stress-interference condition than in the stress-interference condition. The trend towards interactions between English stress and proficiency indicate that the effect of English stress in the Spanish-bias condition is larger with increasing proficiency in Spanish but that in the English-bias condition is smaller with increasing proficiency in Spanish. Since these trends are very weak, they will not be discussed further.

7.7 Discussion and Conclusion

The main objective of Experiment 3 was to determine whether (and if so, how) factors such as language bias and L2 proficiency modulate bilingual word production. Experiment 3 sought to determine whether the findings reported for Experiment 2 would extend to the production domain in a situation where bilinguals are also in a bilingual language mode. Experiment 2 showed that language bias modulated both L1-Spanish L2-English and L1-English L2-Spanish listeners' word recognition, and for the latter group, language bias interacted with proficiency such that listeners showed an increasing ability to minimize cross-language interference in the English bias condition and a decreased effect of language bias as their proficiency in Spanish increased. However, in Experiment 2, only L1-English L2-Spanish listeners showed interference from the English stress pattern in word recognition; L1-Spanish L2-English listeners did not. Previous research on literate bilinguals' word production has consistently shown that language proficiency modulates cross-language activation in word production tasks (e.g., Gollan & Ferreira, 2004; Gollan et al., 2008; Hanulová, Davidson, & Indefrey, 2011; Linck, Hoshino, & Kroll, 2008), including when the unintended language is the L2 and the intended language is the L1 (e.g., Gollan & Ferreira, 2004; Towell, Hawkins, & Bazergui, 1996). By contrast, the effects of language bias in bilingual word production had not yet been explored. Hence, this was the first study to examine whether language bias modulates bilingual word production, and whether (and if so, how) it interacts with L2 proficiency.

As with Experiment 2, we predicted a significant interaction between language bias and English stress, with the effect of stress being greater in the English-bias group than in the Spanish-bias group. We also anticipated the possibility that the effects of stress would be modulated by L2 proficiency, with participants more easily reducing the degree of cross-language activation in the stress-interference condition as their proficiency in the L2 decreased (for L1-Spanish L2-English listeners) or increased (for L1-English L2-Spanish listeners). Finally, given the results of Experiment 2, we predicted that more proficient bilinguals would show a reduced effect of language bias as a result of their control of cross-language activation in the English-bias condition.

The results also partially supported these predictions. They revealed that the L1-Spanish L2-English group showed evidence of cross-language activation in language production. Participants in this group were less accurate when the English cognate competitor word had a different stress pattern from the Spanish target than when the English cognate competitor had the same stress pattern as the Spanish target, independently of language bias (for the accuracy results). This indicates that the stress pattern of the English cognate competitor interfered with the L1-Spanish L2-English speakers' production of the Spanish targets.[21] The L1-Spanish L2-English speakers' overall accuracy also decreased as their proficiency in English increased, indicating that, the more proficient in English these participants were, the less accurate their production of the Spanish target was (irrespective of stress or language bias). The L1-Spanish L2-English speakers' naming latencies also showed an effect of stress, and additionally showed an effect of language bias, with these participants being slower when the experiment included more English trials than when it included fewer English trials. The L1-English L2-Spanish speakers showed similar evidence of cross-language activation: They were less accurate when the English cognate competitor word had a different stress pattern from the Spanish target than

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[21] Hence, the lack of effect of English stress in Experiment 2 is unlikely to be due to these speakers' insufficient knowledge of the stress patterns of the English cognate competitors.

when the English cognate competitor had the same stress pattern as the Spanish target, independently of language bias. The naming latency results showed an interaction between language bias and English stress condition, with the effect of stress being significant only in the English-bias condition. These results suggest that interference from English stress influenced bilingual word productions both when the unintended language (English) was the L2 and when it was the L1. These findings are consistent with those of previous production studies reporting cross-language activation from both bilinguals' L1 and L2 (e.g., Dussias, 2003; Jared & Kroll, 2001).

Contrary to the results of Experiment 2, the stress manipulation in Experiment 3 affected both the L1-English L2-Spanish group and the L1-Spanish L2-English group: The L1-Spanish L2-English group showed interference from their L2 in Experiment 3, which they did not show in Experiment 2. These results may have emerged for two reasons. One possibility is that the current production task may have elicited more cross-language interference from English than the comprehension task in Chapter 6 because participants had to actively engage in the production of English words in the filler trials of the production experiment. In other words, producing words in both languages may have increased the activation of the English cognate competitor more than comprehending words in both languages. A second possibility is that participants may have less control over cross-language activation in language production than in language comprehension. In Experiment 2, the L1-Spanish L2-English did not show evidence of interference from the English stress pattern. This may be due to their better control of the level of activation of the unintended language in comprehension, where lexical activation is based to a large degree on the acoustic input. To tease apart these two possible explanations, one would need to conduct the production counterpart of Experiment 1, where no English was used explicitly in the task. If L1-Spanish L2-English speakers were to show interference from English stress also in such a task, we could conclude that bilinguals exert a greater degree of control over cross-language activation in comprehension than in production. Future studies should seek to answer this open question.

The results of Experiment 3 are compatible with the Inhibitory Control Model (Green, 1998), according to which language bias and L2 proficiency control the level of activation of the unintended language in both comprehension and production, as found in this study. Recall that the BIA+ Model (Dijkstra & Van Heuven, 2002), which was originally proposed to explain bilingual word activation in comprehension tasks, does not make direct predictions for productions tasks such as the current one.

Like Experiment 2, one limitation of Experiment 3 is in the interpretation of the nature of the effect stress shown by the L1-Spanish L2-English and L1-English L2-Spanish groups. Whereas the effect of stress that L1-Spanish L2-English group shows is likely to be an effect of stress interference (i.e., native speakers should not need cross-language activation to be at least accurate in their productions), it is unclear whether the corresponding effect shown by the L1-English L2-Spanish group is also an effect of stress interference. For instance, it could also be an effect of stress facilitation, with the no-stress-interference condition in fact facilitating the production of the Spanish target; possibly, both stress facilitation and stress interference may also be going on from, respectively, the no-stress-interference and stress-interference conditions. Further research should seek to tease these two possibilities apart.

In conclusion, the findings of Experiment 3 indicate that English stress modulates L1-Spanish L2-English and L1-English L2-Spanish bilinguals' cross-language activation during bilingual word production, and this effect is modulated by language bias only in the L1-English

L2-Spanish group during bilingual word production. Importantly, evidence of cross-language activation was found both from the L1 to the L2 and from the L2 to the L1. The next chapter provides a comprehensive discussion of all the findings reported in the current dissertation.

Chapter 8: General Discussion and Conclusion

Several factors have been proposed to modulate the level of cross-language interference reported in the bilingual language comprehension and language production literature, among which the effects of factors such as language dominance and language bias have been consistently reported (e.g., Grosjean, 1997; Guo & Peng, 2006; Ju & Luce, 2004; Marian & Spivey, 2003a; Soares & Grosjean, 1984; Spivey & Marian, 1999; Weber & Cutler, 2004). What remains unclear from previous research, however, is whether (and if so, how) language proficiency and language bias modulate both language comprehension and language production, and whether they interact with each other. The current study used two visual world eye-tracking experiments and an adaptation of this paradigm in speech production to further explore how language bias and L2 proficiency modulate cross-language activation in bilingual word recognition and bilingual production.

This dissertation research examined how factors such as language bias and L2 proficiency influenced L1-Spanish L2-English and L1-English L2-Spanish bilinguals' ability to inhibit English words while performing comprehension and production tasks in Spanish. More specifically, it investigated the circumstances under which differences in stress placement between Spanish-English cognate words (e.g., *mate**rial*** vs. *ma**te**rial* in Spanish and English, respectively) affected Spanish word recognition and production. This dissertation compared word recognition experiments with vs. without the explicit presence of the unintended language (English) to see whether competition effects from the English stress pattern differed depending on whether participants were closer to the monolingual or to the bilingual end of the language mode continuum.

This cross-language interference effect was examined by manipulating the stress pattern of the cognate competitor in English (in Spanish, the cognate competitor was always stressed on the last syllable). In one stress condition, the English cognate competitor was stressed on the second syllable, like the Spanish target. In this condition, the competitor was predicted to interfere with the recognition of the Spanish target but not to interfere with the production of the Spanish target. In the other stress condition, the English cognate competitor was stressed on the first syllable, and thus differed from the Spanish target. In that condition, the English cognate competitor was not predicted to interfere with the recognition of the Spanish word, but it was predicted to interfere with its production. The effect of language bias on cross-language activation was tested by manipulating the percentage of time the target word in the filler trials was heard in Spanish and English, that is, manipulating the language that bilinguals would expect to hear over the course of the experiment. Finally, the effect of L2 proficiency was assessed using two measures of proficiency (a cloze, i.e., fill-in-the-blank, test and a vocabulary test (LexTALE)).

Experiment 1, a visual-world eye-tracking experiment only in Spanish, sought to answer the question of whether lexical stress modulates the degree of cross-language activation that L1-Spanish L2-English and L1-English L2-Spanish bilinguals experience in a monolingual language mode. In doing so, Experiment 1 sought to ascertain whether bilingual activation would be observed even in a situation where bilinguals are expected to function in only one of their two languages (Spanish in this case), in line with the nonselective hypothesis of bilingual activation. Moreover, Experiment 1 aimed to confirm that intermediate-to-advanced English-speaking L2 learners of Spanish (the L1-English L2-Spanish group) could make use of suprasegmental cues to stress during online word recognition, at least when the competitor word was not a Spanish-

English cognate. The results showed that the L1-English L2-Spanish bilinguals activated their L1 (as suggested by the marginal cognate effect they showed) even when nothing in the acoustic input or in the testing session made them think that they should be activating English, thus providing additional support for the nonselective hypothesis. By contrast, the L1-Spanish L2-English group did not show any evidence of cross-language activation, although stress did modulate lexical access. Furthermore, the results confirmed that English-speaking L2 learners of Spanish could use stress to recognize Spanish words, with the effect of stress decreasing with increasing Spanish proficiency. That is, stress modulated lexical access in this group, but it did not appear to modulate cross-language activation (as there was no interaction between stress and cognate status).

Experiment 2 was explicitly designed to test how language bias and L2 proficiency modulate cross-language activation in a bilingual word recognition task, using a visual-world eye-tracking experiment with trials in both English (fillers) and Spanish (fillers and experimental trials). It specifically investigated whether these two factors modulate the degree of cross-language activation (from stress interference) that bilingual listeners in a bilingual language mode experience in comprehension. The results of this experiment showed that both the L1-Spanish L2-English and L1-English L2-Spanish groups were influenced by the language bias manipulation (L1-Spanish L2-English: 0% English bias vs. 65% English bias; L1-English L2-Spanish: 0% English bias vs. 65% English bias, 20% English bias vs. 65% English bias). For the L1-English L2-Spanish participants, language bias also modulated the effect of stress (with the stress of the English cognate interfering with the recognition of the Spanish target only in the English-bias condition), and more proficient bilinguals were better at controlling this cross-language activation than less proficient ones.

Finally, using an adaptation of the visual-world eye-tracking paradigm to elicit word production, Experiment 3 examined the effects of language bias and L2 proficiency on bilingual word production. Specifically, Experiment 3 investigated whether L2 proficiency and language bias also modulate the degree of cross-language activation (from stress interference) that bilingual listeners in a bilingual language mode experience in production. The same manipulations as those described for Experiment 2 were employed in this experiment. The results showed that both the L1-Spanish L2-English and the L1-English L2-Spanish groups were slower and less accurate at producing the Spanish target word (with the correct stress placement) when the stress pattern of the English cognate competitor differed from that of the Spanish target word than when it was identical to it. For L1-Spanish L2-English speakers, the more proficient they were in English, the least accurate they were in their production of the Spanish target. For L1-English L2-Spanish speakers, the effect of stress was modulated by language bias, as it was greater in the English bias condition than in the Spanish bias condition.

The following sections further discuss these results and their implications based on the current literature on cross-language activation and current models of bilingual activation. This chapter ends by outlining the main contributions of this dissertation and proposing ideas for future research on bilingual activation.

8.1 Factors Affecting Bilingual Activation: Comprehension and Production

The main objective of this dissertation was to shed new light on bilingual processing by further exploring how L2 proficiency and language bias affect the way in which bilinguals control the level of activation of their two languages. It was unclear, from the previous literature, how both L2 proficiency and language bias would modulate bilinguals' activation of bilinguals' two language systems, whether the two factors would interact, and whether (and if so, how) the degree of involvement of these factors would differ in language comprehension vs. language production.[22]

The results confirmed that language bias modulated cross-language activation in both bilingual word comprehension and word production and that this effect was further modulated by L2 proficiency in comprehension. The results of Experiment 2 (comprehension) and Experiment 3 (production) showed that the L1-English L2-Spanish group showed more cross-language activation from the stress interference condition in the English-bias condition than in the Spanish-bias condition, with this cross-language activation decreasing as their proficiency in Spanish increased (in Experiment 2). The L1-Spanish L2-English bilinguals were also affected by the language bias manipulation, with the Spanish target and competitor words being disambiguated later in the English-bias condition of Experiment 2 than in the cognate, stress mismatch condition of Experiment 1, where no English was heard. Furthermore, these speakers' word productions were also affected by their proficiency in English, with greater proficiency in English resulting in poorer target stress placement in Spanish. These results indicate that, the more English the participants were forced to activate, the more cross-language interference there was, and thus the more difficult it was to disambiguate between the Spanish target and competitor words (comprehension) or to retrieve the Spanish target over its competitor

[22] The production task (Experiment 3) was created to mirror the format of the visual-world eye-tracking task (Experiment 2). However, considering that these two tasks yielded very different dependent variables (eye movements vs. accuracy rates and latencies), it was not possible to directly compare the results of Experiments 2 and 3. For this reason, conclusions are drawn on the basis of whether language bias and L2 proficiency similarly affected performance in comprehension and in production.

(production). Why differences emerged between the two groups will be discussed in the next subsection.

Language bias and L2 proficiency had already been proposed as factors modulating the level of cross-language interference reported in the bilingual language comprehension and language production literature (e.g., Grosjean, 1997; Guo & Peng, 2006; Ju & Luce, 2004; Marian & Spivey, 2003a; Soares & Grosjean, 1984; Spivey & Marian, 1999; Weber & Cutler, 2004). However, the present study was the first to directly examine whether these two factors would also interact: It showed that more proficient bilinguals were better at controlling for the degree of cross-language activation, thus reducing the effect of language bias as their L2 proficiency increased. Additionally, this study was the first to investigate whether (and if so, how) the degree of involvement of these factors would differ in language comprehension vs. language production: It showed that language production is more likely to show evidence of cross-language activation than language comprehension (based on the effect of stress interference shown by the L1-Spanish L2-English group only in the production experiment). There may be other factors that may be further influencing the degree of cross-language activation in the two groups of bilinguals examined in this study, e.g., individual differences in inhibitory control, as proposed by the Inhibitory Control Model (Green, 1998)); however, these factors should be further explored in future research.

One additional question that remains open for further research is how the directionality of a language switch affects cross-language activation. Experiments 2 and 3 contained both Spanish targets and English targets. This means that in both experiments, there were instances of language switch vs. no-language switch, with some Spanish trials immediately following a English trial (language switch) and with other Spanish trials immediately following a Spanish trial (no language switch). When creating Experiments 2 and 3, we focused on creating language bias conditions that would be as balanced as possible with respect to the stress position (final vs. penultimate) and syllable structure (heavy vs. light). Language switch was not a factor that we investigated, so the number of language-switch trials and no-language-switch trials was not perfectly distributed across conditions and groups. On the one hand, this prevented a robust analysis of the data with language switch as a predictor of participants' responses; on the other hand, this raises the question of whether some of the effects reported in this dissertation could be attributed in part to language switch. Appendices O and P present the distribution of the language switch variables for the different groups and conditions, for Experiments 2 and 3, respectively. For most conditions and groups, the distribution of experimental items that initiated vs. did not initiate a language switch was not significantly different between the stress-interference and no-stress-interference conditions; when this distribution was significantly different, it was not in a direction that was confounded with the manipulation of English stress or it was in a condition where no effect of English stress was found anyway (for details, see Appendices O and P). Thus, we are confident in the nature of the effects of English stress reported in this study. Future studies should try to tease apart the contributions of language bias and language switch in the modulation of cross-language activation.

8.2 Direction of the Linguistic Interference (L1 vs. L2)

The L1-Spanish L2-English and L1-English L2-Spanish bilinguals tested in this study were not directly compared, because the two groups were not sufficiently well matched in their L2 proficiency and L2 experience for a direct comparison to be interpreted straightforwardly. For this reason, experimental effects were interpreted separately for each group. Notwithstanding the limitations of this approach, an indirect comparison of the effects found for the two groups allowed us to specify whether the strength of cross-language interference differs as a function of whether it comes from bilinguals' L1 or from the bilinguals' L2 and whether it is modulated differently by the different factors.

The main difference that emerged between the L1-Spanish L2-English and L1-English L2-Spanish participants was in bilingual word comprehension. In Experiments 1 and 2, the stress-interference manipulation of the competitor word interfered with the recognition of the Spanish target for the L1-English L2-Spanish listeners, but not for the L1-Spanish L2-English listeners. One possible explanation for this difference is the differential strengths of lexical activation in L1 Spanish as compared to L2 Spanish, which is directly related to the language dominance of the two groups: L1-Spanish L2-English participants were dominant in Spanish (i.e., they spoke Spanish as their L1, they were at an intermediate level of proficiency in English, and lived in a Spanish-speaking environment at the time of the study), and the L1-English L2-Spanish participants were dominant in English (i.e., they spoke English as their L1, they were at an intermediate-to-advanced proficiency in Spanish, and they lived in an English-speaking environment at the time of the study). This language dominance is likely responsible for why the L1-English L2-Spanish participants experienced more cross-language interference from the unintended language (English) than L1-Spanish L2-English participants in the comprehension experiments. Although participants' insufficient knowledge of the stress pattern of the English cognate competitors could also explain the lack of effect of stress (or interactions with stress) in Experiment 1, it cannot explain the lack of effect of stress (or interactions with stress) in Experiment 2, as such an effect was found for Experiment 3, which used the exact same words as Experiment 2. Thus, we conclude that cross-language interference is simply stronger when the unintended language is the L1 than when it is the L2. Future studies should compare the L1-Spanish L2-English participants tested in this study to L1-Spanish L2-English listeners tested in an English-speaking country. Comparing the results of these groups would allow us to corroborate whether cross-language interference can also come from the L2 in language comprehension. Including a task in which participants' knowledge of the stress patterns of the critical words would also be important.

Crucially, both groups patterned more similarly in the production task (Experiment 3). That is, both the L1-Spanish L2-English and L1-English L2-Spanish bilinguals showed clear evidence of cross-language activation coming from the interfering stress pattern of the English cognate competitor. As discussed in Chapter 7, this effect might have emerged for a few reasons. One possibility is that our production task may have elicited more cross-language interference from English than our comprehension task because participants had to actively engage in the production of English words in the filler trials of the production experiment. In other words, producing words in both languages may increase the activation of the English cognate competitor more than comprehending words in both languages. Alternatively, participants may have more control over cross-language activation in language comprehension than in language production. Further research should seek to tease these two possible interpretations apart.

8.3 Models of Bilingual Activation

The findings reported in this dissertation have some implications for models of bilingual activation. Two models were considered: the Inhibitory Control Model (Green, 1998) and the Bilingual Interactive Activation Plus (BIA+) Model (Dijkstra & van Heuven, 2002).

The Inhibitory Control Model (Green, 1998) stipulates that bilinguals' two languages are represented by different language tags schemas (established from prior input), which alter the activation levels of lexical representations in a top-down fashion. The model postulates that the activation level of the language schemas is altered by the supervisory attentional system, which works as a domain-general inhibitory control mechanism. According to the Inhibitory Control Model, language tag schemas are the primary source of control in bilingual word activation (for both comprehension and production), so the model predicts an effect of language bias on this activation. Moreover, proficiency affects to degree to which the word lemmas are activated. Thus, for the current study, the Inhibitory Control Model predicted that both proficiency and language bias would control the level of activation of the unintended language.

Similarly to the Inhibitory Control Model (Green, 1998), the Bilingual Interactive Activation Plus (BIA+) Model (Dijkstra & van Heuven, 2002) represents the bilinguals' two languages with the use of language nodes, by means of which the activation levels of lexical representation can be altered. However, unlike the Inhibitory Control Model, the language nodes in the BIA+ model cannot perform a form of top-down control in early stages of word activation (what Dijkstra & van Heuven refer to as the "word identification system"). The BIA+ Model claims that the activation and inhibition of lexical representations is strictly controlled by the input in the early stages of word recognition. According to this model, language nodes can only influence the output (i.e., word selection) of the "task/decision system". This model was originally proposed to explain bilingual word activation in comprehension tasks, and as such does not make predictions for productions tasks. For the current comprehension experiments, this model predicted that proficiency would modulate bilingual activation, but language bias would not have such an effect in the early stages of word activation.

The results of Experiment 2 were in line with the predictions of the Inhibitory Control Model (Green, 1998). In this second experiment, for L1-English L2-Spanish listeners, the effect of stress interference was modulated by language bias (the effect was stronger in the English-bias condition), and this interaction was further modulated by proficiency in Spanish (more proficient L1-English L2-Spanish listeners had better control of cross-language activation in the English-bias condition than less proficient listeners). The Inhibitory Control Model can therefore provide a straightforward explanation of the results found in this study. By contrast, the BIA+ Model (Dijkstra & Van Heuven, 2002), in principle, did not predict the results obtained in the comprehension task, though one could argue the stages of word recognition captured by participants' eye movements did not reflect the initial stages of word activation, in that participants had some time to read the words on the screen before they heard the Spanish target. It would therefore be important to replicate this study without this preview time to see if the observed pattern of results remains the same.

The results of this dissertation are also consistent with Grosjean's proposed language mode continuum (Grosjean, 1998). Language mode, as defined by Grosjean, is the state of activation of bilinguals' two languages at a given point in time. Bilinguals' language mode may range from a monolingual language mode to a bilingual language mode depending upon the activation levels of a bilingual's two languages. Factors such as the interlocutor, the situation, the content of discourse, and the function of the interaction are claimed to influence bilinguals' position on the language mode continuum (e.g., Dijkstra & van Hell, 2003; Marian & Spivey, 2003a; Soares & Grosjean, 1984). The language bias effects reported in the comparison of the cognate, stress mismatch condition of Experiment 1 and the stress-interference condition of Experiment 2 (no English vs. 65% English) are consistent with this language mode continuum, and suggest that Experiments 1 and 2 (comprehension) placed participants at different points of this continuum: While participants in the first experiment were closer to a Spanish monolingual mode (as several measures were taken to ensure they would not expect any English in the experiment), they were closer to a bilingual language mode in the second experiment, especially for participants in the English-bias group. Of course, since most of the L1-English L2-Spanish participants completed the experiment in the United States, it was not possible to create a language mode that was unequivocally Spanish monolingual. Further research should seek to replicate these findings with L1-English L2-Spanish listeners tested in a Spanish-speaking country, where they would be more likely to be in a monolingual Spanish mode.

8.4 Concluding Remarks and Future Directions

The present study provided a systematic investigation of how both L2 proficiency and language bias modulate bilinguals' activation of their two language systems, whether the two factors interact, and whether (and if so, how) the degree of involvement of these factors differ in language comprehension vs. language production. This dissertation research examined how these factors influenced L1-Spanish L2-English and L1-English L2-Spanish bilinguals' ability to inhibit English words while performing a task in Spanish.

This dissertation research was just a first step towards understanding the mechanisms that bilinguals employ to control the level of activation of their two languages. More research is needed in order to further understand how additional factors such as language switch and inhibitory control interact with those investigated in this study, and the implications that these effects may have for the use of bottom-up and top-down mechanisms in bilingual activation. Among some possible ways to extend the current line of research, future studies could also investigate how the degree of phonetic similarity between the word in the Spanish speech signal and the competitor words in English and Spanish modulates bilingual activation. In Experiment 1, the effect of stress was only marginally significant. It was hypothesized that listeners may have picked up on small differences in the segmental properties of the first two syllables of the target and competitor words to disambiguate between the target and competitor words. The target and competitor words used in this study showed not only suprasegmental differences, but also segmental differences (e.g., voice onset time (VOT) differences, the presence of vowel reduction in the English pronunciation of these words). In order to further understand bilingual activation, future research should try to explain how "similar" the words in two different languages need to be in order to produce bilingual activation, and what kind of cues listeners can use to distinguish between the two languages.

The present dissertation provided evidence that L1-English L2-Spanish bilinguals activate the phonological representations of their two languages in parallel in both comprehension and production, and they have better control over interference from the unintended language (English) when it is at its strongest (English bias) as their proficiency in the intended language (Spanish) increases. This raises the questions of whether (and if so, how) proficiency would also modulate other factors that have been deemed to influence cross-language activation, for example language switch. Future studies could try to develop tasks and test paradigms that would examine both the effect of language bias and the effect of language switch as a function of L2 proficiency.

Finally, while the present dissertation has advanced our understanding of the factors that guide bilingual activation in low-to-intermediate Spanish L2 learners of English and intermediate-to-advanced English L2 learners of Spanish, future research should also evaluate the extent to which individual-level cognitive factors, such as inhibitory control, impact bilingual activation.

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Appendix A: English Cloze Test

In the following text, some of the words have been replaced by blanks numbered 1 through 50. First, read the complete text in order to understand it. Then reread it and choose the correct word to fill each blank from the answer sheet. Mark your answers by circling your choice on the answer sheet, not by filling in the blanks in the text.

<u>Man and His Progress</u>

Man is the only living creature that can make and use tools. He is the most teachable of living beings, earning the name of Homo sapiens. (1) __________ ever restless brain has used the (2) __________ and the wisdom of his ancestors (3) __________ improve his way of life. Since (4) __________ is able to walk and run (5) __________ his feet, his hands have always (6) __________ free to carry and to use (7) __________. Man's hands have served him well (8) __________ his life on earth. His development, (9) __________ can be divided into three major (10) __________, is marked by several different ways (11) __________ life.

Up to 10,000 years ago, (12) __________ human beings lived by hunting and (13) __________. They also picked berries and fruits, (14) __________ dug for various edible roots. Most (15) __________, the men were the hunters, and (16) __________ women acted as food gatherers. Since (17) __________ women were busy with the children, (18) __________ men handled the tools.

In a (19) __________ hand, a dead branch became a (20) __________ to knock down fruit or to (21) __________ for tasty roots. Sometimes, an animal (22) __________ served as a club, and a (23) __________ piece of stone, fitting comfortably into (24) __________ hand, could be used to break (25) __________ or to throw at an animal. (26) __________ stone was chipped against another until (27) __________ had a sharp edge. The primitive (28) __________ who first thought of putting a (29) __________ stone at the end of a (30) __________ made a brilliant discovery: he (31) __________ joined two things to make a (32) __________ useful tool, the spear. Flint, found (33) __________ many rocks, became a common cutting (34) __________ in the Paleolithic period of man's (35) __________. Since no wood or bone tools (36) __________ survived, we know of this man (37) __________ his stone implements, with which he (38) __________ kill animals, cut up the meat, (39) __________ scrape the skins, as well as (40) __________ pictures on the walls of the (41) __________ where he lived during the winter.

(42) __________ the warmer seasons, man wandered on (43) __________ steppes of Europe without a fixed (44) __________, always foraging for food. Perhaps the (45) __________ carried nuts and berries in shells (46) __________ skins or even in light, woven (47) __________. Wherever they camped, the primitive people (48) __________ fires by striking flint for sparks (49) __________ using dried seeds, moss, and rotten (50) __________ for tinder. With fires that he kindled himself, man could keep wild animals away and could cook those that he killed, as well as provide warmth and light for himself.

Cloze Test Answer Sheet

1)	**a.**	his	**b.**	man	**c.**	they	**d.**	when
2)	**a.**	strength	**b.**	creativity	**c.**	knowledge	**d.**	tool
3)	**a.**	that	**b.**	is	**c.**	it	**d.**	to
4)	**a.**	man	**b.**	then	**c.**	childhood	**d.**	years
5)	**a.**	for	**b.**	on	**c.**	out	**d.**	by
6)	**a.**	feel	**b.**	become	**c.**	been	**d.**	use
7)	**a.**	tools	**b.**	it	**c.**	anything	**d.**	objects
8)	**a.**	on	**b.**	along	**c.**	since	**d.**	during
9)	**a.**	one	**b.**	it	**c.**	which	**d.**	they
10)	**a.**	section	**b.**	periods	**c.**	events	**d.**	era
11)	**a.**	during	**b.**	of	**c.**	living	**d.**	to
12)	**a.**	first	**b.**	prehistoric	**c.**	all	**d.**	every
13)	**a.**	collecting	**b.**	picking	**c.**	fishing	**d.**	eating
14)	**a.**	or	**b.**	make	**c.**	they	**d.**	and
15)	**a.**	often	**b.**	commonly	**c.**	time	**d.**	frequently
16)	**a.**	that	**b.**	a	**c.**	some	**d.**	the
17)	**a.**	usually	**b.**	then	**c.**	the	**d.**	that
18)	**a.**	while	**b.**	the	**c.**	so	**d.**	and
19)	**a.**	man's	**b.**	woman	**c.**	man	**d.**	one
20)	**a.**	hammer	**b.**	tool	**c.**	person	**d.**	way
21)	**a.**	reach	**b.**	look	**c.**	dig	**d.**	make
22)	**a.**	bone	**b.**	hoof	**c.**	carcass	**d.**	body
23)	**a.**	sharp	**b.**	simple	**c.**	little	**d.**	carved
24)	**a.**	their	**b.**	one	**c.**	an	**d.**	the
25)	**a.**	it	**b.**	nuts	**c.**	up	**d.**	fruits
26)	**a.**	silex	**b.**	one	**c.**	usually	**d.**	he
27)	**a.**	he	**b.**	it	**c.**	both	**d.**	that
28)	**a.**	male	**b.**	species	**c.**	human	**d.**	man
29)	**a.**	sharp	**b.**	pointy	**c.**	shard	**d.**	chipped
30)	**a.**	stick	**b.**	wood	**c.**	tool	**d.**	branch
31)	**a.**	successfully	**b.**	could	**c.**	has	**d.**	had
32)	**a.**	more	**b.**	brilliant	**c.**	very	**d.**	great
33)	**a.**	in	**b.**	of	**c.**	with	**d.**	out
34)	**a.**	knife	**b.**	ground	**c.**	tool	**d.**	technique
35)	**a.**	kind	**b.**	development	**c.**	progress	**d.**	humanity
36)	**a.**	have	**b.**	had	**c.**	did	**d.**	has
37)	**a.**	that	**b.**	about	**c.**	by	**d.**	only
38)	**a.**	made	**b.**	had	**c.**	could	**d.**	used to
39)	**a.**	easily	**b.**	and	**c.**	also	**d.**	to
40)	**a.**	many	**b.**	carving	**c.**	by	**d.**	draw
41)	**a.**	hut	**b.**	location	**c.**	house	**d.**	cave

42)	**a.**	on	**b.**	in	**c.**	during	**d.**	for
43)	**a.**	vast	**b.**	green	**c.**	the	**d.**	grassy
44)	**a.**	shelter	**b.**	home	**c.**	house	**d.**	goal
45)	**a.**	they	**b.**	tribe	**c.**	women	**d.**	nomads
46)	**a.**	without	**b.**	for	**c.**	or	**d.**	to
47)	**a.**	baskets	**b.**	them	**c.**	grains	**d.**	fabrics
48)	**a.**	set	**b.**	made	**c.**	make	**d.**	did
49)	**a.**	for	**b.**	it	**c.**	light	**d.**	and
50)	**a.**	wood	**b.**	food	**c.**	fruit	**d.**	herbs

Answer Key: Cloze Test

1)	**a.**	His	**26)**	**b.**	one
2)	**c.**	Knowledge	**27)**	**b.**	it
3)	**d.**	To	**28)**	**d.**	man
4)	**a.**	Man	**29)**	**a.**	sharp
5)	**b.**	On	**30)**	**a.**	stick
6)	**c.**	Been	**31)**	**d.**	had
7)	**a.**	Tools	**32)**	**c.**	very
8)	**d.**	During	**33)**	**a.**	in
9)	**c.**	Which	**34)**	**c.**	tool
10)	**b.**	Periods	**35)**	**b.**	development
11)	**b.**	Of	**36)**	**a.**	have
12)	**c.**	All	**37)**	**c.**	by
13)	**c.**	Fishing	**38)**	**c.**	could
14)	**d.**	And	**39)**	**b.**	and
15)	**a.**	Often	**40)**	**d.**	draw
16)	**d.**	The	**41)**	**d.**	cave
17)	**c.**	The	**42)**	**b.**	in
18)	**b.**	The	**43)**	**c.**	the
19)	**a.**	man's	**44)**	**b.**	home
20)	**b.**	Tool	**45)**	**c.**	women
21)	**c.**	Dig	**46)**	**c.**	or
22)	**a.**	Bone	**47)**	**a.**	baskets
23)	**a.**	Sharp	**48)**	**b.**	Made
24)	**d.**	The	**49)**	**d.**	And
25)	**b.**	Nuts	**50)**	**a.**	wood

Total points possible: 50

Advanced	40 to 50
Intermediate	30 to 39
Low	0 to 29

Appendix B: English LexTALE

Instructions

This test consists of about 60 trials, in each of which you will see a string of letters. Your task is to decide whether this is an existing English word or not. If you think it is an existing English word, you click on "yes", and if you think it is not an existing English word, you click on "no".

If you are sure that the word exists, even though you don't know its exact meaning, you may still respond "yes". But if you are not sure if it is an existing word, you should respond "no".

In this experiment, we use British English rather than American English spelling. For example: "realise" instead of "realize"; "colour" instead of "color", and so on. Please don't let this confuse you. This experiment is not about detecting such subtle spelling differences anyway.

You have as much time as you like for each decision. This part of the experiment will take about 5 minutes.

If everything is clear, you can now start the experiment.

Word List

1.	memsible	nonce	31.	screech	real
2.	kermshaw	nonce	32.	savoury	real
3.	alberation	nonce	33.	shin	real
4.	plaudate	nonce	34.	fluid	real
5.	spaunch	nonce	35.	allied	real
6.	exprate	nonce	36.	slain	real
7.	rebondicate	nonce	37.	recipient	real
8.	skave	nonce	38.	eloquence	real
9.	kilp	nonce	39.	cleanliness	real
10.	interfate	nonce	40.	dispatch	real
11.	crumper	nonce	41.	ingenious	real
12.	magrity	nonce	42.	bewitch	real
13.	abergy	nonce	43.	plaintively	real
14.	proom	nonce	44.	hasty	real
15.	fellick	nonce	45.	lengthy	real
16.	destription	nonce	46.	fray	real
17.	purrage	nonce	47.	upkeep	real
18.	pulsh	nonce	48.	majestic	real
19.	quirty	nonce	49.	nourishment	real
20.	pudour	nonce	50.	turmoil	real
21.	scornful	real	51.	carbohydrate	real
22.	stoutly	real	52.	scholar	real
23.	ablaze	real	53.	turtle	real
24.	moonlit	real	54.	cylinder	real
25.	lofty	real	55.	censorship	real
26.	hurricane	real	56.	celestial	real
27.	flaw	real	57.	rascal	real
28.	unkempt	real	58.	muddy	real
29.	breeding	Real	59.	listless	real
30.	festivity	Real	60.	wrought	real

Appendix C: English Word Familiarity Task

Instructions

In this task, your job is to rate your familiarity with the words presented by clicking on the appropriate number.

0 = I have never seen/heard this word.

1 = I have occasionally seen/heard this word, but I don't know what it means.

2 = I have frequently seen/heard this word, but I don't know what it means.

3 = I have occasionally seen/heard this word and I know what it means in context, but I could not provide a definition for it.

4 = I have frequently seen/heard this word and I know what it means in context, but I could not provide a definition for it.

5 = I have seen/heard this word, I know what it means, and I can provide a definition for it.

Press the space bar to start with some practice trials.

Stimuli

1	personal	15	principal
2	tribunal	16	eventual
3	auditor	17	notarial
4	selector	18	ideal
5	angular	19	cultural
6	material	20	creator
7	literal	21	flexional
8	industrial	22	dictator
9	productor	23	alcohol
10	potencial	24	familiar
11	natural	25	elector
12	mineral	26	labrador
13	inventor	27	terminal
14	colonial	28	director

Appendix D: Spanish Cloze Test

Multiple Choice Test

Each of the following sentences contains a blank indicating that a word or phrase has been omitted. Select the choice that best completes the sentence.

1. Al oír del accidente de su buen amigo, Paco se puso __________.
a. alegre b. fatigado c. hambriento d. desconsolado

2. No puedo comprarlo porque me_______________.
a. falta b. dan c. presta d. regalan

3. Tuvo que guardar cama por estar _____________.
a. enfermo b. vestido c. ocupado d. parado

4. Aquí está tu café, Juanito. No te quemes, que está muy _____________.
a. dulce b. amargo c. agrio d. caliente

5. Al romper los anteojos, Juan se asustó porque no podía _______ sin ellos.
a. discurrir b. oír c. ver d. entender

6. ¡Pobrecita! Está resfriada y no puede ________________.
a. salir de casa b. recibir cartas c. respirar con pena d. leer las noticias

7. Era una noche oscura sin _______.
a. estrellas b. camas c. lágrimas d. nubes

8. Cuando don Carlos salió de su casa, saludó a un amigo suyo: -Buenos días,____.
a. ¿Qué va? b. ¿Cómo es? c. ¿Quién es? d. ¿Qué tal?

9. ¡Qué ruido había con los gritos de los niños y el _______ de los perros!
a. olor b. sueño c. hambre d. ladrar

10. Para saber la hora, don Juan miró el __________.
a. calendario b. bolsillo c. estante d. despertador

11. Yo, que comprendo poco de mecánica, sé que el auto no puede funcionar sin _.
a. permiso b. comer c. aceite d. bocina

12. Nos dijo mamá que era hora de comer y por eso ____________.
a. fuimos a nadar b. tomamos asiento c. comenzamos a fumar d. nos acostamos pronto

13. ¡Cuidado con ese cuchillo o vas a ____________ el dedo!
a. cortarte b. torcerte c. comerte d. quemarte

14. Tuvo tanto miedo de caerse que se negó a ___________ con nosotros.
a. almorzar b. charlar c. cantar d. patinar

15. Abrió la ventana y miró: en efecto, grandes lenguas de ______ salían llameando de las casas.
a. zorros b. serpientes c. cuero d. fuego

16. Compró ejemplares de todos los diarios pero en vano. No halló ____________.
a. los diez centavos b. el periódico perdido c. la noticia que deseaba d. los ejemplos

17. Por varias semanas acudieron colegas del difunto profesor a ________ el dolor de la viuda.
a. aliviar b. dulcificar c. embromar d. estorbar

18. Sus amigos pudieron haberlo salvado pero lo dejaron ______________.
a. ganar b. parecer c. perecer d. acabar

19. Al salir de la misa me sentía tan caritativo que no pude menos que _________ a un pobre mendigo que había allí sentado.
a. pegarle b. darle una limosna c. echar una mirada d. maldecir

20. Al lado de la Plaza de Armas había dos limosneros pidiendo ________.
a. pedazos b. paz c. monedas d. escopetas

21. Siempre maltratado por los niños, el perro no podía acostumbrarse a ________ de sus nuevos amos.
a. las caricias b. los engaños c. las locuras d. los golpes

22. ¿Dónde estará mi cartera? La dejé aquí mismo hace poco y parece que el necio de mi hermano ha vuelto a _______.
a. dejármela b. deshacérmela c. escondérmela d. acabármela

23. Permaneció un gran rato abstraído, los ojos clavados en el fogón y el pensamiento ________ ______.
a. en el bolsillo b. en el fuego c. lleno de alboroto d. Dios sabe dónde

24. En vez de dirigir el tráfico estabas charlando, así que tú mismo ____________ del choque.
a. sabes la gravedad b. eres testigo c. tuviste la culpa
d. conociste a las víctimas

25. Posee esta tierra un clima tan propio para la agricultura como para _________.
a. la construcción de trampas b. el fomento de motines
c. el costo de vida d. la cría de reses

26. Aficionado leal de obras teatrales, Juan se entristeció al saber _____________ del gran actor.
a. del fallecimiento b. del éxito c. de la buena suerte d. de la alabanza

27. Se reunieron a menudo para efectuar un tratado pero no pudieron __________.
a. desavenirse b. echarlo a un lado c. rechazarlo d. llevarlo a cabo

28. Se negaron a embarcarse porque tenían miedo de ___________.
a. los peces b. los naufragios c. los faros d. las playas

29. La mujer no aprobó el cambio de domicilio pues no le gustaba ____________.
a. el callejeo b. el puente c. esa estación d. aquel barrio

30. Era el único que tenía algo que comer pero se negó a ______________.
a. hojearlo b. ponérselo c. conservarlo d. repartirlo

Cloze Test

In the following text, some of the words have been replaced by blanks numbered 1 through 20. First, read the complete text in order to understand it. Then reread it and choose the correct word to fill each blank from the answer sheet. Mark your answers by circling your choice on the answer sheet, not by filling in the blanks in the text.

El sueño de Joan Miró

Hoy se inaugura en Palma de Mallorca la Fundación y Joan Miró, en el mismo lugar en donde el artista vivió sus últimos treinta y cinco años. El sueño de Joan Miró se ha ________________ (1). Los fondos donados a la ciudad por el pintor y su esposa en 1981 permitieron que el sueño se _________________(2); más tarde, en 1986, el Ayuntamiento de Palma de Mallorca decidió __________________(3) al arquitecto Rafael Moneo un edificio que ________________(4) a la vez como sede de la entidad y como museo moderno. El proyecto ha tenido que _____________(5) múltiples obstáculos de carácter administrativo. Miró, coincidiendo _______________(6) los deseos de toda su familia, quiso que su obra no quedara expuesta en ampulosos panteones de arte o en __________________(7) de coleccionistas acaudalados; por ello, en 1981, creó la fundación mallorquina. Y cuando estaba ________________(8) punto de morir, donó terrenos y edificios, así como las obras de arte que en ellos _____________(9).

El edificio que ha construido Rafael Moneo se enmarca en _______(10) se denomina "Territorio Miró", espacio en el que se han ______________(11) de situar los distintos edificios que constituyen la herencia del pintor.

El acceso a los mismos quedará _________________ (12) para evitar el deterioro de las obras. Por otra parte, se _________________(13), en los talleres de grabado y litografía, cursos ______________(14) las distintas técnicas de estampación. Estos talleres también se cederán periódicamente a distintos artistas contemporáneos, _______(15) se busca que el "Territorio Miró" _______(16) un centro vivo de creación y difusión del arte a todos los _________________ (17).

La entrada costará 500 pesetas y las previsiones dadas a conocer ayer aspiran ________(18) que el centro acoja a unos 150.000 visitantes al año. Los responsables esperan que la institución funcione a _____________(19) rendimiento a principios de la _______________ (20) semana, si bien el catálogo completo de las obras de la Fundación Pilar y Joan Miró no estará listo hasta dentro de dos años.

Cloze Test Answer Sheet

1. a. cumplido	b. completado	c. terminado
2. a. inició	b. iniciara	c. iniciaba
3. a. encargar	b. pedir	c. mandar
4. a. hubiera servido	b. haya servido	c. sirviera
5. a. superar	b. enfrentarse	c. acabar
6. a. por	b. en	c. con
7. a. voluntad	b. poder	c. favor
8. a. al	b. en	c. a
9. a. habría	b. había	c. hubo
10. a. que	b. el que	c. lo que
11. a. pretendido	b. tratado	c. intentado
12. a. disminuido	b. escaso	c. restringido
13. a. darán	b. enseñarán	c. dirán
14. a. sobre	b. en	c. para
15. a. ya	b. así	c. para
16. a. será	b. sea	c. es
17. a. casos	b. aspectos	c. niveles
18. a. a	b. de	c. para
19. a. total	b. pleno	c. entero
20. a. siguiente	b. próxima	c. pasada

Answer Key: Multiple Choice Test

1. d	11. c	21. a
2. a	12. b	22. c
3. a	13. a	23. d
4. d	14. d	24. c
5. c	15. d	25. d
6. a	16. c	26. a
7. a	17. a	27. d
8. d	18. c	28. b
9. d	19. b	29. d
10. d	20. c	30. d

Answer Key: Cloze Test

1. a	8. c	15. b
2. b	9. b	16. b
3. a	10. c	17. c
4. c	11. b	18. a
5. a	12. c	19. b
6. c	13. b	20. b
7. b	14. a	

Total points possible: 50

Advanced	40 to 50
Intermediate	30 to 49
Low	0 to 29

Appendix E: Spanish LexTALE

Instrucciones

Esta prueba consiste en cerca de 120 pruebas experimentales. En cada una de ellas verás una serie de letras. Tu tarea es decidir si se trata de una palabra en español o no. Si crees que es una palabra que existe en español, pulsa "sí ", y si crees que no lo es, pulsa "no".

Si estás seguro/a de que la palabra existe, a pesar de que no sepas el significado, aún puedes responder "sí". Si no estás seguro de si se trata de una palabra existente o no, debes responder "no".

Tienes todo el tiempo que necesites para tomar cada decisión. Esta parte del experimento dura unos 5 minutos.

Presiona la barra espaciadora para empezar con unas palabras de práctica.

Word List

1.	enfima	nonce	61.	gaita	real
2.	comatrición	nonce	62.	pericial	real
3.	feñoral	nonce	63.	nutrido	real
4.	departación	nonce	64.	logro	real
5.	traspecar	nonce	65.	catalizador	real
6.	torado	nonce	66.	eminentemente	real
7.	telentar	nonce	67.	abeto	real
8.	papilera	nonce	68.	escribano	real
9.	árter	nonce	69.	remojo	real
10.	arnería	nonce	70.	evaluar	real
11.	trisme	nonce	71.	frondoso	real
12.	permidir	nonce	72.	gritar	real
13.	pesta	nonce	73.	mazo	real
14.	quirio	nonce	74.	horda	real
15.	bener	nonce	75.	suplantar	real
16.	órtico	nonce	76.	egoísmo	real
17.	torbe	nonce	77.	encaje	real
18.	magnitidio	nonce	78.	tumbado	real
19.	saraz	nonce	79.	vigilia	real
20.	desponsar	nonce	80.	cebado	real
21.	farial	nonce	81.	puerco	real
22.	empartadero	nonce	82.	globo	real
23.	roñetón	nonce	83.	ebrio	real
24.	policónica	nonce	84.	devenir	real
25.	agonar	nonce	85.	surgimiento	real
26.	morisno	nonce	86.	feminista	real
27.	rebortar	nonce	87.	relámpago	real
28.	montanés	nonce	88.	entredicho	real
29.	arter	nonce	89.	arranque	real
30.	ingento	nonce	90.	detener	real
31.	eligente	nonce	91.	franqueza	real
32.	aclazar	nonce	92.	sobretodo	real
33.	clopo	nonce	93.	ende	real
34.	ulivio	nonce	94.	trama	real
35.	nodar	nonce	95.	beca	real
36.	medarne	nonce	96.	efigie	real
37.	reasio	nonce	97.	respetado	real
38.	petrilación	nonce	98.	entrañable	real
39.	fiobe	nonce	99.	terrenal	real
40.	subiner	nonce	100.	acervo	real
41.	depuesto	real	101.	hídrico	real
42.	célebre	real	102.	endeble	real
43.	captar	real	103.	tildado	real
44.	escuadra	real	104.	profeta	real

45. paulatinamente real
46. obrador real
47. fiabilidad real
48. pulgada real
49. refuerzo real
50. fomento real
51. íntegro real
52. idolatría real
53. faz real
54. flujo real
55. lavar real
56. enojo real
57. ilustrado real
58. abultado real
59. espanto real
60. oriundo real
105. masivamente real
106. continental real
107. trucha real
108. antología real
109. poseído real
110. retraso real
111. brotar real
112. centrar real
113. infame real
114. estrado real
115. heredar real
116. yerno real
117. galo real
118. cándido real
119. colegiado real
120. temido real

Appendix F: Spanish Word Familiarity Task

Instrucciones

En este experimento, tu tarea consiste en indicar tu familiaridad con cada de las palabras presentadas. Para hacerlos harás click con el ratón en el número apropiado.

0 = Nunca he visto/escuchado esta palabra.

1 = La he visto/escuchado con anterioridad, pero no conozco su significado.

2 = La he visto/escuchado frecuentemente, pero no conozco su significado.

3 = La he visto/escuchado en otras ocasiones y sé lo que significa en contexto, pero no podría definirla.

4 = La he visto/escuchado con frecuencia y sé lo que significa en contexto, pero no podría definirla.

5 = He visto/escuchado esta palabra, sé lo que significa, y puedo definirla.

Stimuli

1 seguido
2 familia
3 creador
4 tribunal
5 industria
6 asado
7 directo
8 vecinal
9 parroquia
10 palomar
11 ganado
12 asador
13 elector
14 familiar
15 cultural
16 naranja
17 director
18 mirador
19 ideal
20 dictado
21 naranjal
22 natura
23 seguidor
24 selecto
25 electo
26 cultura
27 colonial
28 evento
29 audible
30 notarial
31 dictador
32 flexible
33 alcohol
34 notario
35 terminal
36 material
37 pasador
38 tribuna
39 auditor
40 literal
41 natural
42 persona
43 potencial
44 principal
45 minero
46 vecino
47 creada
48 alcoba
49 parroquial
50 flexional
51 labrador
52 ganador
53 paloma
54 sembrador
55 industrial
56 pescador
57 invento
58 sembrado
59 portada
60 personal
61 angular
62 materia
63 inventor
64 termita
65 portador
66 mirada
67 ventanal
68 dineral
69 potencia
70 pesadez
71 pesado
72 eventual
73 jugada
74 pescado
75 ventana
76 mineral

77	litera
78	idea
79	productor
80	selector
81	dinero
82	principio
83	angula
84	jugador
85	colonia
86	producto
87	pasado
88	labrado

Appendix G: Experimental and Distracter Stimuli, Experiment 1, Non-Cognate Condition, List 1

	Target – Penultimate	Competitor 1 – Final	Distracter 1	Distracter 2
1	asado (roast)	asador (rotisserie)	camisones (nightshirt, pl)	camisas (shirt, pl)
2	vecino (neighbor)	vecinal (neighboring)	orinales (potty, pl)	orinas (urine, pl)
3	ganado (cattle/won)	ganador (winner)	fingidores (feigner, pl)	fingidas (feigned, pl)
4	dinero (money)	dineral (fortune)	ofensores (offender, pl)	ofensas (offense, pl)
5	jugada (play)	jugador (player)	boletines (bulletin, pl)	Boletos (ticket, pl)
6	ventana (window)	ventanal (picture)	aspectuales (aspectual, pl)	aspectos (appearance, pl)
7	mirada (look)	mirador (viewpoint)	senadores (senator, pl)	senados (senate, pl)
8	naranja (orange)	naranjal (orange grove)	unidades (unity, pl)	unidos (united, pl)
9	paloma (pidgeon)	palomar (dovecote)	honradeces (honesty, pl)	honrados (honest, pl)
10	parroquia (parish)	parroquial (parochial)	especiales (special, pl)	especies (species, pl)
11	pesado (heavy, masc)	pesadez (bore)	hormonales (hormonal, pl)	hormonas (hormone, pl)
12	pescado (fish)	pescador (fisherman)	vaginales (vaginal, pl)	vaginas (vagina, pl)
13	portada (cover)	portador (carrier)	minerals (mineral, pl)	mineros (miner, masc/pl)
14	seguido (straight)	seguidor (fan)	coroneles (colonel, pl)	coronas (crown, pl)

15	sembrado (seeded plot)	sembrador (sowing)	culturales (cultural, pl)	culturas (culture, pl)
16	pasado (past)	pasador (hairclip)	inquietudes (inquietude, pl)	inquietos (restless, pl)

Appendix H: Experimental and Distracter Stimuli, Experiment 1, Non-Cognate Condition, List 2

	Target – Penultimate	**Competitor 2 – Penultimate**	**Distracter 1**	**Distracter 2**
1	asado (roast)	asados (roast, pl)	camisón (nightshirt)	camisones (nightshirt, pl)
2	vecino (neighbor)	vecinos (neighbor, pl)	orinal (potty)	orinales (potty, pl)
3	ganado (cattle/won)	ganados (cattle/won, pl)	fingidor (feigner)	fingidores (feigner, pl)
4	dinero (money)	dineros (money, pl)	ofensor (offender)	ofensores (offender, pl)
5	jugada (play)	jugadas (play, pl)	boletín (bulletin)	boletines (bulletin, pl)
6	ventana (window)	ventanas (window, pl)	aspectual (aspectual)	aspectuales (aspectual, pl)
7	mirada (look)	miradas (look, pl)	senador (senator)	senadores (senator, pl)
8	naranja (orange)	naranjas (orange, pl)	unidad (unity)	unidades (unity, pl)
9	paloma (pidgeon)	palomas (pidgeon, pl)	honradez (honesty)	honradeces (honesty, pl)
10	parroquia (parish)	parroquias (parish, pl)	especial (special)	especiales (special, pl)
11	pesado (heavy, masc)	pesados (heavy, masc/pl)	hormonal (hormonal)	hormonales (hormonal, pl)
12	pescado (fish)	pescados (fish, pl)	vaginal (vaginal)	vaginales (vaginal, pl)
13	portada (cover)	portadas (cover, pl)	mineral (mineral)	minerals (mineral, pl)
14	seguido (straight)	seguidos (straight, pl)	coronel (colonel)	coroneles (colonel, pl)

15	sembrado (seeded plot)	sembrados (seeded plot, pl)	cultural (cultural)	culturales (cultural, pl)
16	pasado (past)	pasados (past, pl)	inquietud (inquietude)	inquietudes (inquietude, pl)

Appendix I: Experimental and Distracter Stimuli, Experiment 1, Cognate Condition, List 1

	Target – Penultimate	Competitor 1 – Final	Distracter 1	Distracter 2
1	colonia (colony/cologne)	colonial (colonial)	maduros (mature, pl)	madureces (maturity, pl)
2	evento (event)	eventual (eventual)	literas (bunk bed, pl)	literales (literal, pl)
3	creada (created, fem)	creador (creator)	mariscos (seafood, pl)	mariscales (marshal, pl)
4	dictado (dictation)	dictador (dictator)	ejemplos (example, pl)	ejemplares (exemplary, pl)
5	electo (elected)	elector (elector)	humildes (humble, pl)	humildades (humility, pl)
6	potencia (energy)	potencial (potential)	otoños (fall, n/pl)	otoñales (fall, adj/pl)
7	selecto (selected)	selector (selector)	inicios (beginning, pl)	iniciales (initial, pl)
8	idea (idea)	ideal (ideal)	colosos (colossus, pl)	colosales (colossal, pl)
9	industria (industry)	industrial (industrial)	sepulcros (sepulcher, pl)	sepulcrales (sepulchral, pl)
10	producto (product)	productor (producer)	historias (history/story, pl)	historiales (record, pl)
11	invento (invent)	inventor (inventor)	teatros (theater, pl)	teatrales (theatrical, pl)
12	notario (notary)	notarial (notarial)	esencias (essence, pl)	esenciales (essential, pl)
13	materia (subject/matter)	material (material)	parados (unemployed, pl)	paradores (tourist hotel, pl)
14	directo (direct)	director (director/conductor)	batallas (battle, pl)	batallones (battalion, pl)

15	familia (family)	familiar (familiar)	proyectos (project, pl)	proyectiles (projectile, pl)
16	tribuna (tribune)	tribunal (tribunal)	helados (ice-cream, pl)	heladores (freezing, pl)

Appendix J: Experimental and Distracter Stimuli, Experiment 1, Cognate Condition, List 2

	Target – Penultimate	Competitor 1 – Penultimate	Distracter 1	Distracter 2
1	colonia (colony/cologne)	colonias (colony/cologne, pl)	madurez (maturity)	madureces (maturity, pl)
2	evento (event)	eventos (event, pl)	literal (literal)	literales (literal, pl)
3	creada (created, fem)	creadas (created, fem/pl)	mariscal (marshal)	mariscales (marshal, pl)
4	dictado (dictation)	dictados (dictation, pl)	ejemplar (exemplary)	ejemplares (exemplary, pl)
5	electo (elected)	electos (elected, pl)	humildad (humility)	humildades (humility, pl)
6	potencia (energy)	potencias (energy, pl)	otoñal (fall, adj)	otoñales (fall, adj/pl)
7	selecto (selected)	selectos (selected, pl)	inicial (initial)	iniciales (initial, pl)
8	idea (idea)	ideas (idea, pl)	colosal (colossal)	colosales (colossal, pl)
9	industria (industry)	industrias (industry, pl)	sepulcral (sepulchral)	sepulcrales (sepulchral, pl)
10	producto (product)	productos (product, pl)	historial (record)	historiales (record, pl)
11	invento (invent)	inventos (invent, pl)	teatral (theatrical)	teatrales (theatrical, pl)
12	notario (notary)	notarios (notary, pl)	esencial (essential)	esenciales (essential, pl)
13	materia (subject/matter)	materias (subject/matter, pl)	parador (tourist hotel)	paradores (tourist hotel, pl)
14	directo (direct)	directos (direct, pl)	batallón (battalion)	batallones (battalion, pl)

15	familia (family)	familias (family, pl)	proyectil (projectile)	proyectiles (projectile, pl)
16	tribuna (tribune)	tribunas (tribune, pl)	helador (freezing)	heladores (freezing, pl)

Appendix K: Filler Words, Experiment 1 (Targets and Competitors)

	Target	Competitor	Distracter 1	Distracter 2
1	compresión (crushing)	compresa (compress)	cargadores (charger, pl)	cargados (charged, pl)
2	mejillón (mussel)	mejilla (cheek)	dotaciones (amount, pl)	dotados (gifted, pl)
3	incisión (incision)	inciso (insert)	pantalones (trouser, pl)	pantanos (swamp, pl)
4	posesión (possession)	poseso (obsessed)	objeciones (objection, pl)	objetos (object, pl)
5	infantil (childish)	infante (infant)	votadores (voter, pl)	votados (voted, pl)
6	omisión (omission)	omiso (omitted)	animales (animal, pl)	animes (anime, pl)
7	profesión (profession)	profeso (on purpose)	testadores (testador, pl)	testados (tested, pl)
8	conductor (driver)	conducto (pipe)	ilegales (illegal, pl)	ilesos (uninjured, pl)
9	natural (natural)	natura (nature)	picadores (chopper, pl)	picados (punctured, pl)
10	reducción (reduction)	reducido (reduced)	estatales (state, adj/pl)	estados (state, pl)
11	ocasión (opportunity)	ocaso (sunset)	patatales (potato field)	patatas (potato, pl)
12	oficial (official/officer)	oficio (profession)	noticiones (bombshell, pl)	noticias (news, pl)
13	medieval (medieval)	medievo (Middle Ages)	actitudes (attitude, pl)	activos (active, pl)
14	accesión (assent)	acceso (access)	salariales (salary, adj/pl)	salarios (salary, pl)

15	distinción (distinction)	distancia (distance)	cantidades (quantity, pl)	cantinas (canteen, pl)
16	pelotón (squad)	pelota (ball)	compulsiones (compulsion, pl)	compuertas (floodgate, pl)
17	bananal (banana field)	bananas (banana, pl)	cardadores (hair comb, pl)	cardado (combed)
18	confusión (confusion)	confuso (confusing, pl)	voladores (flyer, pl)	volado (projecting)
19	principal (main)	principios (start, pl)	tostadores (toaster, pl)	tostado (toasted)
20	personal (personal)	personas (person, pl)	arrozales (rice field, pl)	arrobo (ectasy)
21	cerebral (cerebral)	cerebros (brain, pl)	tabacales (tobacco field, pl)	tabaco (tobacco)
22	conversión (conversion)	conversos (converse, pl)	capitales (capital, pl)	capota (car top)
23	difusión (diffusion)	difusos (diffused, pl)	concejales (city councilman, pl)	consejo (advice)
24	obsesión (obsession)	obsesos (obsessed, pl)	retracciones (retraction, pl)	retrato (portrait)
25	diversión (amusement)	diversos (diverse, pl)	pimentones (paprika, pl)	pimiento (pepper)
26	matador (matador)	matados (killed, pl)	interiores (interior, pl)	interno (intern)
27	espiral (spiral)	espiras (lap, pl)	notaciones (notation, pl)	notable (notable)
28	procesión (procession)	procesos (process, pl)	retadores (challenging, pl)	retablo (altarpiece)
29	comercial (commercial)	comercios (business, pl)	colaciones (comparison, pl)	colada (laundry)

30	saltador (jumper)	saltados (jumped, pl)	eslabones (link, pl)	eslavo (Slav)
31	catador (taster)	catados (tasted, pl)	asesores (consultant, pl)	aseo (bathroom)
32	latitud (latitude)	Latidos (beat, pl)	radiadores (radiator, pl)	radiante (splendid)
33	caballos (horse, pl)	caballo (horse)	avidez (greed)	avideces (greed, pl)
34	esposos (husband, pl)	esposo (husband)	contractual (contractual)	contractuales (contractual, pl)
35	cunetas (curb, pl)	cuneta (curb)	fumador (smoker)	fumadores (smoker, pl)
36	latinos (latino, pl)	latino (latino)	temporal (storm)	temporales (storm, pl)
37	cursillos (lecture series, pl)	cursillo (lecture series)	infusión (infusion)	infusiones (infusion, pl)
38	granizos (hail, pl)	granizo (hail)	clonación (clonation)	clonaciones (clonation, pl)
39	pelusas (fluff, pl)	pelusa (fluff)	nadador (swimmer)	nadadores (swimmer, pl)
40	roperas (wardrobe, pl)	ropera (wardrobe)	ladrador (barker)	ladradores (barker, pl)
41	pasillos (corridor, pl)	pasillo (corridor)	donación (donation)	donaciones (donation, pl)
42	sopletes (blowtorch, pl)	soplete (blowtorch)	aridez (aridity)	arideces (aridity, pl)
43	espaldas (back, pl)	espalda (back)	subvención (subsidy)	subvenciones (subsidy, pl)
44	acuerdo (agreement)	acuerdo (agreement)	albañil (builder)	albañiles (builder, pl)

45	hallazgos (discovery, pl)	hallazgo (discovery)	percutor (hammer)	percutores (hammer, pl)
46	equipos (team, pl)	equipo (team)	dirección (direction)	dirección (direction)
47	bodegas (winery, pl)	bodega (winery)	celador (porter)	celador (porter)
48	bebidas (drink, pl)	bebida (drink)	contracción (contraction)	contracciones (contraction, pl)
49	barrigas (belly, pl)	barrigón (potbellied)	pedrea (minor prizes)	pedregales (rocky ground, pl)
50	borrachos (drunk, pl)	borrachín (boozer)	oriente (east)	orientales (eastern, pl)
51	cabezas (head, pl)	cabezón (stubborn)	receta (recipe)	recitales (recital, pl)
52	caseros (landlord, pl)	caserón (big ramshackle house)	litigio (contention)	litorales (coast, pl)
53	chaquetas (jacket, pl)	chaquetón (short coat)	receso (break)	recesiones (recession, pl)
54	cucharas (spoon, pl)	cucharón (ladle)	sumiso (submissive)	sumisiones (submission, pl)
55	folletos (pamphlet, pl)	folletín (melodrama)	posible (possible)	posiciones (position, pl)
56	juguetes (toy, pl)	juguetón (playful)	devoto (devoted)	devociones (devotion, pl)
57	maletas (suitcase, pl)	maletín (briefcase)	edicto (edict)	editores (editor, pl)
58	orejas (ear, pl)	orejón (dried peach/apricot)	locura (insanity)	locutores (announcer, pl)
59	pelucas	peluquín	abrigo	abridores

	(wig, pl)	(toupee)	(coat)	(opener, pl)
60	solteras (single, fem/pl)	solterón (bacherlo)	morada (home/purple)	moradores (inhabitant, pl)
61	medallas (medal, pl)	medallón (medallion)	perenne (evergreen)	perejiles (parsley, pl)
62	abusos (abuse, pl)	abusón (bully)	agreste (wild)	agresores (attacker, pl)
63	intrusos (intruder, pl)	intrusión (intrusion)	ascenso (promotion)	ascensores (elevator, pl)
64	sucesos (event, pl)	sucesión (succession)	represa (dam)	represores (repressive, pl)
65	abejones (drone, pl)	abeja (bee)	ligeros (light, pl)	ligerez (lightness)
66	abismales (huge, pl)	abismo (abyss)	sobacos (armpit, pl)	sobacal (underarm)
67	semanales (weekly, pl)	semana (week)	obispos (bishop, pl)	obispal (related to bishops)
68	coladores (strainer, pl)	colado (in love)	carcomas (woodworm, pl)	carcamal (decrepit)
69	bordadores (Needleman, pl)	bordado (embroidery)	neuronas (neuron, pl)	neuronal (neuronal)
70	borradores (rubber, pl)	borrado (condition)	lucibles (glowing, pl)	lucidez (lucidity)
71	domadores (tamer, pl)	domado (tamed)	vendidos (sold, pl)	vendedor (seller)
72	labradores (farmer, pl)	labrado (cultivated)	comicios (election, pl)	comisión (commission)
73	dispersiones (dispersion, pl)	disperse (unfocused)	galantes (gallant, pl)	galardón (award)

74	chuletones (steak, pl)	chuleta (chop)	maracas (maraca, pl)	maratón (marathon)
75	cantorales (group of singers, pl)	cantora (singer)	canallas (despicable, pl)	canalón (gutter)
76	narradores (narrator, pl)	narrados (narrated, pl)	hospital (hospital)	hospicio (hostel)
77	pecadores (sinner, pl)	pecados (sin, pl)	carnaval (carnival)	carnaza (ground bait)
78	protectors (protector, pl)	protestas (complaint, pl)	delantal (apron)	delante (in front)
79	pastorales (pastorals, pl)	pastoras (shepherd, pl)	comunión (communion)	comuna (commune)
80	canelones (cannellone, pl)	canelas (cinnamon, pl)	palmeral (palm tree field)	palmera (palm tree)
81	redondeles (circle, pl)	redondos (round, pl)	alcacil (artichoke)	alcalde (major)
82	vencedores (winner, pl)	vencidos (defeated, pl)	espadón (broadsword)	espada (sword)
83	cazadores (hunter, pl)	cazados (hunted, pl)	caridad (charity)	caricia (caress)
84	callejones (alley, pl)	callejas (narrow street, pl)	secesión (secession)	seseo (seseo)
85	calderones (cauldron, pl)	calderas (boiler, pl)	paladar (palate)	palada (shovelful)
86	salvadores (rescuer, pl)	salvados (saved, pl)	chupetón (slurp)	chupete (pacifier)
87	fundadores (founder, pl)	fundador (founder)	abajo (downhill)	abanos (type of cigar, pl)
88	comprensiones	comprensión	marino	maridos

	(understanding, pl)	(understanding)	(marine)	(husband, pl)
89	pulsadores (push button, pl)	pulsador (push button)	escala (scale)	escamas (scale 'fish', pl)
90	dimensiones (dimension, pl)	dimensión (dimension)	entrada (entry)	entrañas (guts, pl)
91	revolcones (tumble, pl)	revolcón (tumble)	revuelo (disturbance)	revueltos (srambled eggs, pl)
92	condiciones (condition, pl)	condición (condition)	pirata (pirate)	pirañas (piranha, pl)
93	colisiones (collision, pl)	colisión (collision)	espigo (ear 'wheat')	espinos (hawthorn, pl)
94	amistades (friendship, pl)	amistad (friendship)	balido (bleating)	batidos (milkshake, pl)
95	colofones (colophon, pl)	colofón (colophon)	cosita (little thing)	colitis (little tale, pl)
96	socavones (subsidence, pl)	socavón (subsidence)	acera (sidewalk)	aceros (iron, pl)

Appendix L: Experimental and Distracter Stimuli, Experiment 2, Stress-Interference Condition, and Experiment 3 Stress-Facilitation Condition

	Target - Penultimate	**Competitor – Final**	**Distracter 1**	**Distracter 2**
1	colonia (colony/cologne)	colonial (colonial)	helado (ice-cream)	helador (freezing)
2	evento (event)	eventual (eventual)	mirada (look)	mirador (viewpoint)
3	electo (elected)	elector (elector)	paloma (pidgeon)	palomar (dovecote)
4	directo (direct)	director (director)	parroquia (parish)	parroquial (parochial)
5	selecto (selected)	selector (selector)	asado (roast)	asador (rotisserie)
6	idea (idea)	ideal (ideal)	pesado (heavy, masc)	pesadez (bore)
7	industria (industry)	industrial (industrial)	pescado (fish)	pescador (fisherman)
8	invento (invent)	inventor (inventor)	ventana (window)	ventanal (picture window)
9	notario (notary)	notarial (notarial)	portada (cover)	portador (carrier)
10	materia (subject/matter)	material (material)	seguido (straight)	seguidor (fan)
11	familia (family)	familiar (familiar)	pasado (past)	pasador (hairclip)
12	tribuna (tribune)	tribunal (tribunal)	marisco (seafood)	mariscal (marshal)

Appendix M: Experimental and Distracter Stimuli, Experiment 2, No-Stress-Interference Condition, and Experiment 3, No-Stress-Facilitation Condition

	Target - Penultimate	Competitor – Final	Distracter 1	Distracter 2
1	principio (principle)	principal (principal)	camisa (shirt)	camisón (nightshirt)
2	persona (person)	personal (personal)	comuna (commune)	comunión (communion)
3	labrado (cultivated)	labrador (labrador)	espada (sword)	espadón (broadsword)
4	angula (elver)	angular (angular)	maduro (mature)	madurez (maturity)
5	alcoba (alcove)	alcohol (alcohol)	ganado (cattle/won)	ganador (winner)
6	audible (audible)	auditor (auditor)	caricia (caress)	caridad (charity)
7	flexible (flexible)	flexional (flexional)	comicio (election)	comisión (commission)
8	termita (termite)	terminal (terminal)	dinero (money)	dineral (fortune)
9	litera (bunk bed)	literal (literal)	otoño (fall, n)	otoñal (fall, adj)
10	minero (miner, masc)	mineral (mineral)	chupete (pacifier)	chupetón (slurp)
11	natura (nature)	natural (natural)	obispo (bishop)	obispal (related to bishops)
12	cultura (culture)	cultural (cultural)	vecino (neighbor)	vecinal (neighboring)

Appendix N: Filler Words, Experiments 2 and 3 (Targets, Competitors, and Distracters)

	Target	Competitor	Distracter 1	Distracter 2
1	banana (banana)	bananal (banana field)	pedrea (minor prize)	pedregal (rocky ground)
2	suspense (suspense)	suspensión (suspension)	litigio (contention)	litoral (litoral)
3	balance (balance)	balanzón (vessel)	locura (insanity)	locutor (announcer)
4	escape (escape)	escabel (footrest)	abrigo (coat)	abridor (opener)
5	alfalfa (alfalfa)	alfajor (pastry sweet)	morada (home/purple)	morador (inhabitant)
6	voluble (voluble)	voluntad (choice)	perenne (evergreen)	perejil (parsley)
7	adorable (adorable)	adoración (adoration)	agreste (wild)	agressor (attacker)
8	terrible (terrible)	terriblez (terrible, n)	ascenso (promotion)	ascensor (elevator)
9	probable (probable)	probador (fitting room)	represa (dam)	represor (repressive)
10	irritable (irritable)	irritador (irritating)	receso (break)	recesión (recession)
11	variable (variable)	variación (variation)	sumiso (submissive)	sumisión (submission)
12	mutable (mutable)	mutación (mutation)	posible (possible)	posición (position)
13	notable (notable)	notación (notation)	devoto (devoted)	devoción (devotion)
14	usable (usable)	usador (user)	carcoma (woodworm)	carcamal (decrepit)

15	culpable (culpable)	culpación (blame)	lucible (glowing)	lucidez (lucidity)
16	durable (durable)	duración (duration)	vendido (sold)	vendedor (seller)
17	horrible (horrible)	horridez (horrific)	válido (valid)	validez (validity)
18	curable (curable)	curación (recover)	canalla (despicable)	canalón (gutter)
19	palpable (palpable)	palpación (touch)	palmera (palm tree)	palmeral (palm tree field)
20	portable (portable)	portalón (gangway)	alcalde (major)	alcacil (artichoke)
21	potable (potable)	potador (meter)	comida (food)	comedor (dinning room)
22	sensible (sensible)	sencillez (simplicity)	señora (Mrs)	señorial (lordly)
23	sociable (sociable)	sociedad (society)	carnaza (groundbait)	carnaval (carnival)
24	soluble (soluble)	solución (solution)	inciso (insert)	incisión (incision)
25	testable (testable)	testador (testator)	poseso (obsessed)	posesión (possession)
26	armada (armada)	armador (ship owner)	omiso (omitted)	omisión (omission)
27	aurora (aurora)	auroral (aurora, adj)	profeso (on purpose)	profesión (profession)
28	calibre (caliber)	calidez (warmth)	amigo (friend)	amistad (friendship)
29	bodega (bodega)	bodegón (tavern)	reducido (reduced)	reducción (reduction)

30	corona (corona)	coronel (colonel)	ocaso (sunset)	ocasión (opportunity)
31	malaria (malaria)	malabar (juggling)	oficio (profession)	oficial (official/officer)
32	saliva (saliva)	salitral (salty)	distancia (distance)	distinción (distinction)
33	mimosa (mimosa)	mimosón (affectionate)	pelota (ball)	pelotón (squad)
34	novena (novena)	novedad (novelty)	converso (converse)	conversión (conversion)
35	papaya (papaya)	papayal (papaya field)	difuso (diffused)	difusión (diffusion)
36	cacique (cacique)	caciquil (tyrannical)	obseso (obsessed)	obsesión (obsession
37	primate (primate)	primacial (supremacy)	diverso (diverse)	diversión (amusement)
38	perfume (perfume)	perfumar (to put perfume on)	colada (laundry)	colación (comparison)
39	agenda (agenda)	agenciar (to negotiate)	bañado (bathed)	bañador (swimsuit)
40	debate (debate)	debatir (to discuss)	retablo (altarpiece)	retador (challenging)
41	inferno (inferno)	inferior (to infer)	tabaco (tobacco)	tabacal (tobacco plantation)
42	fusible (fusible)	fusilar (to execute by firearm)	cardado (combed)	cardador (hair comb)
43	legible (legible)	legislar (to legislate)	volado (projecting)	volador (flyer)
44	visible (visible)	visitar (to visit)	tostado (toasted)	tostador (toaster)

45	acacia (acacia)	acallar (to silence)	consejo (advice)	concejal (city councilman)
46	eclipse (eclipse)	eclipsar (to eclipse)	retrato (portrait)	retracción (retraction)
47	enclave (enclave)	enclavar (to nail)	picado (punctured)	picador (chopper)
48	sublime (sublime)	sublimar (to exalt)	compuerta (floodgate)	compulsión (compulsion)
49	aspectual (aspectual)	aspecto (aspect)	eslabón (link)	eslavo (Slav)
50	muscular (muscular)	músculo (muscle)	asesor (consultant)	aseo (bathroom)
51	oriental (oriental)	oriente (orient)	saltador (jumper)	saltado (jumped)
52	original (original)	origen (origin)	catador (taster)	catado (tasted)
53	proverbial (proverbial)	proverbio (proverb)	confusión (confusion)	confuso (confusing)
54	accidental (accidental)	accidente (accident)	compresión (crushing)	compresa (compress)
55	imperial (imperial)	imperio (empire)	cargador (charger)	cargado (charged)
56	primordial (primordial)	primordio (original)	dotación (amount)	dotado (gifted)
57	memorial (memorial)	memoria (memory)	pantalón (trouser)	pantano (swamp)
58	tutorial (tutorial)	tutora (tutor)	notición (bombshell)	noticia (news)
59	matador (matador)	matado (killed)	pimentón (paprika)	pimiento (pepper)

60	exterior (exterior)	externo (extern)	arrozal (rice field)	arrobo (ecstasy)
61	cerebral (cerebral)	cerebro (brain)	barrigón (potbellied)	barriga (belly)
62	arterial (arterial)	arteria (artery)	borrachín (boozer)	borracho (drunk)
63	hormonal (hormonal)	hormona (hormone)	cabezón (stubborn)	cabeza (head)
64	conductor (conductor)	conducto (conduct)	caserón (big ramshackle house)	casero (landlord)
65	informal (informal)	informe (report)	chaquetón (short coat)	chaqueta (jacket)
66	neuronal (neuronal)	neurona (neuron)	cucharón (ladle)	cuchara (spoon)
67	editor (editor)	edipo (Oedipus)	folletín (melodrama)	folleto (pamphlet)
68	preceptor (preceptor)	precepto (precept)	juguetón (playful)	juguete (toy)
69	impostor (impostor)	imposta (molding)	maletín (briefcase)	maleta (suitcase)
70	inductor (inductor)	indulto (pardon)	orejón (dried peach/apricot)	oreja (ear)
71	consular (consular)	consulta (enquiry)	peluquín (toupee)	peluca (wig)
72	granular (granular)	granuja (rogue)	solterón (bachelor)	soltera (single)
73	insular (insular)	insulto (insult)	medallón (medallion)	medalla (medal)
74	ocular (ocular)	oculto (hidden)	abusón (bully)	abuso (abuse)

75	monitor (monitor)	monito (small monkey)	intrusión (intrusion)	intruso (intruder)
76	medieval (medieval)	medievo (Middle Ages)	sucesión (succession)	suceso (event)
77	arsenal (arsenal)	arsénico (arsenic)	abejón (drone)	abeja (bee)
78	capital (capital)	capítulo (chapter)	abismal (huge)	abismo (abyss)
79	cardinal (cardinal)	cardiaco (cardiac)	manantial (spring)	manada (herd)
80	corporal (corporal)	corpóreo (physical)	colador (strainer)	colado (in love)
81	decimal (decimal)	décimo (tenth/lottery ticket)	picador (sinner)	pecado (sin)
82	pedestal (pedestal)	pedestre (walking)	canelón (cannellone)	canela (cinnamon)
83	universal (universal)	universo (universe)	redondel (circle)	redondo (round)
84	provincial (provincial)	provincia (province)	capataz (foreman)	capazo (large basket)
85	recital (recital)	recibo (invoice)	corredor (runner)	correo (mail)
86	protector (protector)	protesta (complaint)	sobacal (underarm)	sobaco (armpit)
87	vertical (vertical)	vertido (spill)	vencedor (winner)	vencido (defeated)
88	relator (relator)	relato (story)	cazador (hunter)	cazado (hunted)
89	instructor (instructor)	instruido (well-informed)	callejón (alley)	calleja (narrow street)

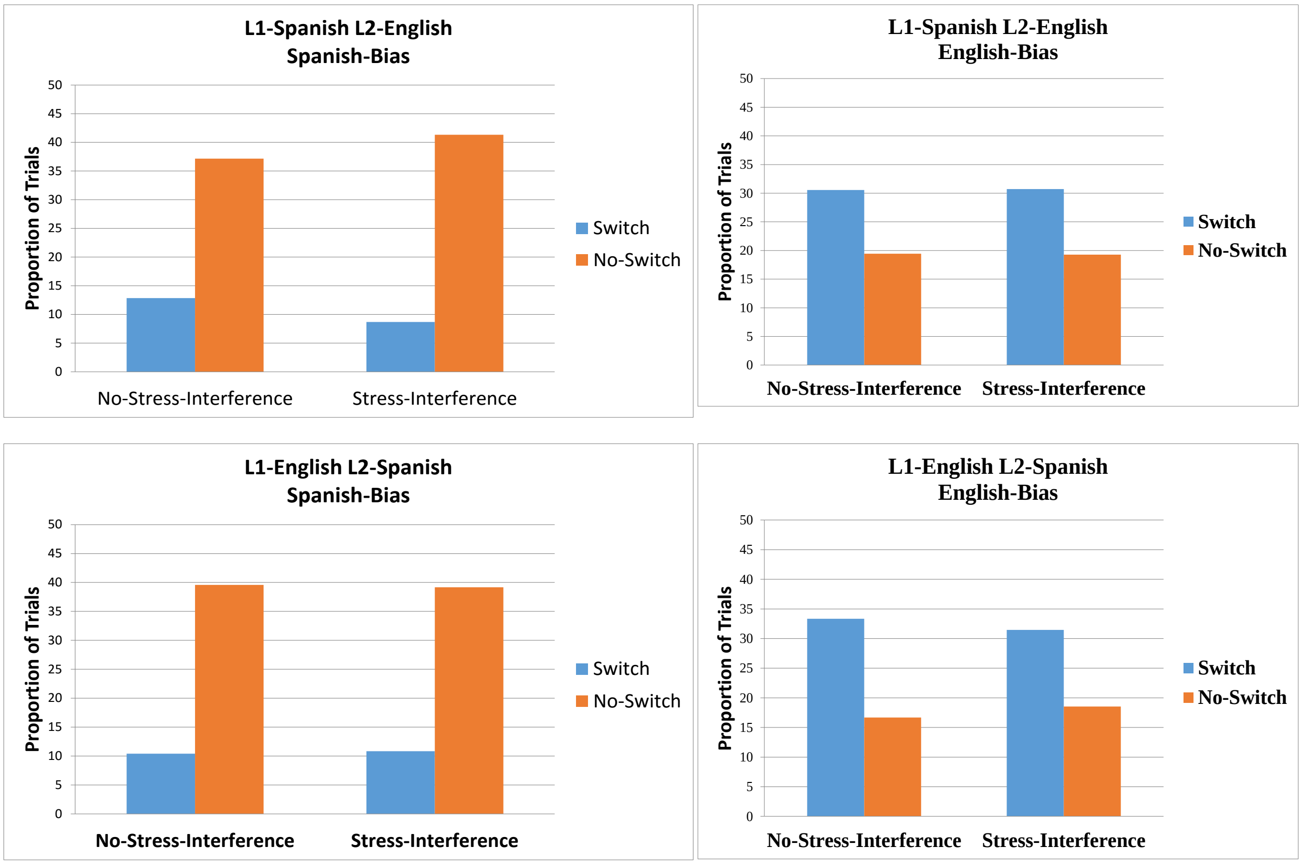
90	anterior (anterior)	antena (antenna)	calderón (cauldron)	caldera (boiler)
91	festival (festival)	festivo (festive)	salvador (rescuer)	salvado (saved)
92	inferior (inferior)	inferido (inferred)	narrador (narrator)	narrado (narrated)
93	marginal (marginal)	marginado (alienate)	balancín (rocking chair)	balanza (scale)
94	posterior (posterior)	posteado (posted)	productor (producer)	producto (product)
95	regular (regular)	reguero (irrigation ditch)	comedor (dinning room)	comedia (comedy)
96	bisector (bisector)	biselado (beveled)	orador (orator)	oraje (weather)
97	coeditor (coeditor)	coeditado (copublished)	posador (inn owner)	posada (inn)
98	reactor (reactor)	reacio (unwilling)	vividor (scrounger)	vivido (lived)
99	destructor (destructor)	destrueque (change)	amador (lover)	amaño (deceit)
100	detector (detector)	detenido (prisoner)	roedor (rodent)	roete (type of wine)
101	erector (erector)	erecto (erected)	aguador (water carrier)	aguado (watery)
102	extractor (extractor)	extracto (excerpt)	lavador (sink)	lavado (washing)
103	obstructor (obstructor)	obstruído (blocked)	jurador (someone who curses)	jurado (jury)
104	receptor (receptor)	receta (receipt)	fumador (smoker)	fumata (white smoke)

105	redactor (redactor)	redada (raid)	legador (donor)	legado (legacy)
106	adverbial (adverbial)	adverbio (adverb)	pagador (payer)	pagado (paid)
107	ancestral (ancestral)	ancestro (ancestor)	pelador (peeler)	pelado (bald)
108	celestial (celestial)	celeste (light blue)	regador (watering can)	regalo (gift)
109	conceptual (conceptual)	concepto (concept)	regidor (councilor)	regido (governed)
110	consensual (consensual)	consenso (consent)	domador (tamer)	domado (trained)
111	contextual (contextual)	context (context)	tocador (dresser)	tocado (headdress)
112	dialectal (dialectal)	dialecto (dialect)	alusión (allusion)	alubia (bean)
113	doctrinal (doctrinal)	doctrina (doctrine)	rebelión (rebellion)	rebelde (rebel)
114	doctoral (doctoral)	doctora (doctor, fem)	conexión (connection)	conexo (connected)
115	maternal (maternal)	materno (mother's side)	medición (measuring)	medida (measurement)
116	marital (marital)	marido (husband)	datación (dating)	datado (dated)
117	lateral (lateral)	latente (dormant)	vocación (vocation)	vocablo (word)
118	tropical (tropical)	tropiezo (tumble)	andador (walkway)	andado (walked)
119	trimestral (trimestral)	trimestre (trimester)	curador (curator)	curado (aged)

120	seminal (seminal)	semilla (seed)	fijador (gel)	fijado (fixed)
121	residual (residual)	residuo (residue)	girador (drawer)	girado (spined)
122	parietal (parietal)	pariente (relative)	medidor (meter)	medido (measured)
123	pastoral (pastoral)	pastora (shepherd, fem)	obrador (workshop)	obrado (created)
124	paternal (paternal)	paterno (father's side)	nadador (swimmer)	nadado (swam)
125	palatal (palatal)	palada (shovelful)	tirador (handle)	tirado (stranded)
126	parental (parental)	pareja (couple)	gustación (tasting)	gustazo (great pleasure)
127	musical (musical)	música (music)	opresión (oppression)	opreso (oppressed)
128	circular (circular)	círculo (circle)	cohesión (connection)	cohete (rocket)
129	reflector (reflector)	reflejo (reflection)	jugador (player)	jugada (play)
130	animal (animal)	anime (anime)	lamparón (large grease spot)	lámpara (lamp)
131	vaginal (vaginal)	vagina (vagina)	sembrador (sowing)	sembrado (seeded plot)
132	hospital (hospital)	hospicio (hospice)	mejillón (mussel)	mejilla (cheek)
133	potencial (potential)	potencia (energy)	palidez (paleness)	pálido (pale)
134	transistor (transistor)	tránsito (traffic)	parador (tourist hotel)	parado (unemployed)

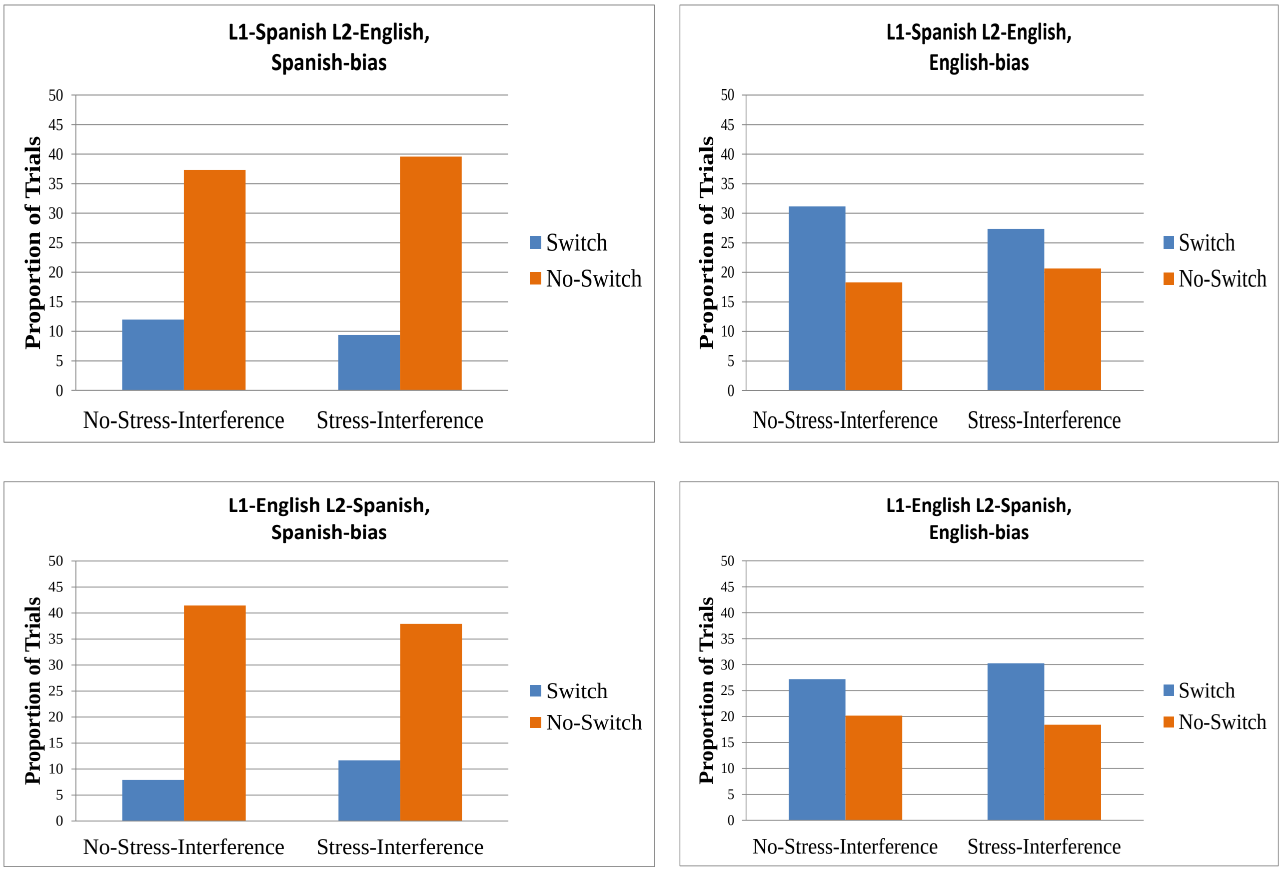
135	funeral (funeral)	fúnebre (mournful)	naranjal (orange grove)	naranja (orange)
136	general (general)	género (genre)	paladar (palate)	palabra (word)

Appendix O: Proportion of Trials with Language Switch vs. No-Language Switch in Experiment 2 for the L1-Spanish L2-English and L1-English L2-Spanish Groups in the Spanish-Bias and English-Bias Conditions



A chi-square test of homogeneity was performed to examine whether the proportion of switch and no-switch trials differed between the two English stress conditions (stress-interference vs. no-stress interference). A different chi-square test was performed separately for each L1-bias group (e.g., for the L1-Spanish L2-English group in the Spanish- and English-bias conditions separately). Three of the four groups did not show statistically significant differences between the two stress conditions (L1-Spanish L2-English, English-bias group (X^2(576) = <|1|, *p* >.1), L1-English L2-Spanish, Spanish-bias group (X^2(480) = <|1|, *p* >.1), L1-English L2-Spanish, English-bias group (X^2(480) = <|1|, *p* >.1)), but the other group did show a different distribution of switch and no-switch trials between the two stress conditions (L1-Spanish L2-English, Spanish-bias group (X^2(576) = 6.21, p <.01)): There were relatively more no-switch trials than switch trials in the stress-interference condition than in the no stress-interference condition. However, the directionality of this difference does not pose a confound for this study: Since the no-switch trials are predicted to cause less lexical competition from the English cognate competitor but the stress-interference condition is expected to cause more lexical competition from the English cognate competitor, language switch cannot explain any interfering effect of stress found in this study.

Appendix P: Proportion of Trials with Language Switch vs. No-Language Switch in Experiment 3 for the L1-Spanish L2-English and L1-English L2-Spanish Groups in the Spanish-Bias and English-Bias Conditions



A chi-square test of homogeneity was performed to examine whether the proportion of switch and no-switch trials differed between the two English stress conditions (stress-interference vs. no-stress interference). A different chi-square test was performed separately for each L1-bias group (e.g., for the L1-Spanish L2-English group in the Spanish- and English-bias conditions separately). Three of the four groups did not show statistically significant differences between the two stress conditions (L1-Spanish L2-English, Spanish-bias group ($X^2(566) = 2.2$, $p > .1$), L1-Spanish L2-English, English-bias group ($X^2(566) = 2.03$, $p > .1$), L1-English L2-Spanish, English-bias group ($X^2(475) = 1.03$, $p > .1$)), but the other group did show a different distribution of switch and no-switch trials between the two stress conditions (L1-English L2-Spanish, Spanish-bias group ($X^2(475) = 4.2$, $p < .04$)): There were relatively more switch trials than no-switch trials in the stress-interference condition than in the no stress-interference condition. However, this difference does not pose a problem for this study, since no effect of stress emerged in the L1-English L2-Spanish, Spanish-bias group.