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SWITCHING LANGUAGE DOMINANCE: WHAT THE PLASTICITY OF LANGUAGE CHANGE WITHIN BILINGUALS TELLS US ABOUT LANGUAGE PROCESSING AND COGNITION

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Abstract

After extended immersion in a second language (L2) environment, some bilinguals become more proficient in the L2 than in the native language. This switch of language dominance can be observed under a variety of circumstances and at different points in the lifespan, e.g., following immigration or after growing up with a minority language and then entering school in which instruction is delivered in the majority language. Although there has been previous research on immersion experience, very little attention has been paid to switches of language dominance, either for language processing or for its cognitive consequences. The present study examined native Spanish speakers living in the US who have become proficient in English as the L2. Immersed in a largely monolingual environment, some bilinguals have become dominant in English, thereby switching language dominance. Spanish-English bilinguals who have switched language dominance in this context were compared to Spanish-English bilinguals who maintained dominance in Spanish and also to native English speakers with Spanish as the L2, and to monolingual speakers of English. Participants were given a set of language processing tasks and also cognitive measures to assess working memory and inhibitory control. Critically, the language processing tasks were those used in past research on immersion showing that at the lexical level, immersed L2 speakers inhibit their L1 (Linck et al., 2009) and at the sentential level, immersed L2 speakers adopt L2 parsing preferences when processing sentences in the L1 (Dussias & Sagarra, 2007). In the current study, participants named drawings of common objects, and performed a verbal fluency task, in which they produced as many exemplars of a specified category within 30 seconds (e.g., name fruits, animals, etc.). In addition, participants performed a self-paced reading task in English and Spanish, as a measure of syntactic processing. Gender-specific information within relative clauses were manipulated to force either high or low attachment. The use of specific gender information typically overrides other preferences but when a reader is forced to ignore the normally preferred strategy, there is a processing cost. The results reveal distinct consequences of language dominance for the lexicon and grammar. During the verbal fluency task, all bilingual groups produced more exemplars in their dominant language. That is, Spanish-English bilinguals who have become dominant in English name more exemplars of categories in English than their native language Spanish, unlike Spanish-English bilinguals, who remain dominant in Spanish, who show the opposite pattern, producing more exemplars in the native language. The findings of this study have implications for claims about the plasticity of the language system across an individual's life experience. They also raise a set of questions concerning the way in which past research has categorized bilinguals on the basis of native language status alone.

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Dedication

To My Family:
My parents, Ann Lucas and Ernst Peters
My sister, Natalie Hunter
My awesome nieces and nephew, Paige, Jenson and Brynleigh

Chapter 1: Background and Introduction

Due to an evermore-interconnected world and the need to compete in a global economy, people are finding themselves not only learning multiple languages, but also living immersed in second language (L2) environments. With an increase in multilingual communities, it has become necessary for researchers to better understand how people learn and acquire an L2. In addition, further research is needed to identify consequences that may arise during language processing as a result of learning a second language or even living immersed in a non-native environment.

A previously held assumption presupposed that the first language (L1) system was autonomous and that learning an L2 would not critically affect native language processing. However, research in the area of bilingualism and L2 learning has shown that critical changes can occur throughout the entire language system at both behavioral and neural levels of processing (Köpke & Schmid, 2004; Mechelli et al., 2004). Additionally, recent studies have shown that even brief immersion in an L2 environment may create inhibition of the L1 for a period of time, affecting both lexical access and processing speeds (e.g., Linck, Kroll, & Sunderman, 2009). These findings suggest that the native language is not fixed, but rather, permeable to systemic changes as a result of increasing skill in the L2 and changes in the language context (e.g., Dussias & Sagarra, 2007).

Moreover, research on L2 acquisition and bilingualism has mainly focused on how a person acquires and processes an L2 (De Groot & Van Hell, 2005; Hahne & Friederici, 2001; McLaughlin, Osterhout, & Kim, 2004; Sunderman & Kroll, 2006). On the other end of the spectrum, research on first language attrition, or the loss of the L1, has concentrated on how a bilingual speaker may actually lose access to aspects of their L1 after a period of time in an L2 environment (see Schmid, 2009, for a review of recent studies on attrition following lengthy immersion in the L2). Few studies have actually investigated the linguistic and cognitive consequences for the period of time that occurs between the stages of L2 acquisition and the first signs of L1 attrition. More specifically there is a lack of research that examines to what extent do extended periods of time in an L2 environment affect the maintenance and use of a bilingual's two languages.

Previous bilingual research has also often focused on either the lexical or grammatical levels of processing independently without examining the relationship that exists between them (see Clahsen & Felser, 2006 for L2 grammar, & see Gollan, Montoya, & Werner, 2002 for research on the bilingual lexicon). Given that the linguistic system can be susceptible to changes, simultaneously measuring lexical and syntactic processing within the same bilingual provides a crucial way to investigate how different components within the linguistic system change due to long term exposure to an L2 environment.

The current research investigated the changes to both lexical and sentence processing for a group of highly proficient Spanish-English bilinguals, immersed in an English-speaking environment. In addition, this study examined whether distinct consequences due to L2 immersion emerged at the different levels of processing in the linguistic systems, and how differences in language dominance influenced the observed consequences.

Before describing the specific tasks and methods of the current study, I will provide an overview of the main findings from previous research on lexical access and bilingual sentence processing. I will focus particularly on theories of speech production because the current experiment includes two lexical production tasks. Additionally, I will provide a theoretical background on parsing preferences for relative clause attachment paradigms. Finally, I will present an overview of additional factors influencing a bilingual's language experience such as age of acquisition (AoA), which may affect the maintenance and use of the native language during extended immersion in a L2 environment.

Bilingual Language Processing

Lexical Access in Bilingual Speech Production

In general, theories of bilingual comprehension propose that the linguistic system responsible for bilingual comprehension functions in a manner of non-specific language selection (Dijkstra, 2005; Dijkstra & van Heuven, 2002). That is to say that when a bilingual speaker encounters a word string, information from both languages becomes active through bottom-up processing. This assumption is not surprising, as a person engaged in listening or reading does not have the ability to control the next word presented to them. Production on the other hand is different. This form of communication is entirely under the power of the speaker and knowing what word will be produced next should be an easy task. Specifically, a bilingual who wants to produce a word in one particular language should show no problem in successfully completing this task. Although bilinguals report more tip-of-the-tongue (TOT) experiences than monolinguals (See Gollan & Acenas, 2004 for a review on bilingual TOT states), they are able to participate in normal speech activities with little to few errors. Nevertheless, there is a continued debate within production research concerning how a bilingual is able to correctly pick the right lexical form in any given situation since they have two or more words available for each concept (Costa, 2005). Most researchers agree that both candidates from the unintended language become active. Nevertheless, a question still exists as to the process in which these candidates, from the unintended language, are selected during speech planning and production. In this section, I will provide background information concerning previous models of speech production. Overall I will focus on the processes involved in lexical activation and selection for bilingual production models, examine the main questions and differences concerning theories of language specific and language non-specific selection mechanisms, and finally provide experimental evidence in support for each opposing model.

Many bilingual researchers are interested in how a person with two languages is able to not only activate and choice a target word, but how they might navigate the activation and selection process when they have two potential items for each concept. Some of the assumptions underlying bilingual production models include the belief , that information from the conceptual and phonological levels becomes activated in parallel, including semantically and phonologically related words. In general, the language of the output is established during the level of conceptual activation (De Bot, 1992; Green, 1998). Nevertheless, the specific language cue applied during the activation of conceptual representations does not limit the activation of lexical and phonological information from the unintended language from becoming activated in parallel (Hermans, 2000; Poulisse & Bongaerts, 1994). A continuing debate within bilingual language processing research concerns the mechanism that allows a bilingual to speak a word in the intended language. Two competing models, language specific and language non-specific selection theories, have emerged attempting to explain how a bilingual resolves this potential conflict and is able to successfully speak in one intended language at a time. Language selective models propose that only words from the target language that have become active compete for selection and that cross-language activation of semantically or phonologically related words in the unintended language do not affect or influence bilingual speech production (Costa, Miozzo, & Caramazza, 1999; McNamara & Kushnir, 1972). Studies in support of the language selective model argue that while both languages are active during language processing, the selection mechanism is blind to the activation of the non-target language and does not affect performance during lexical access (Costa, 2005). According to this model, bilinguals should be able to actively select the target language, eliminating the possible interference produced by semantically or phonologically related nodes.

Despite this evidence, recent studies on production provide overwhelming support for a model of language non-selectivity in bilingual language processing. Unlike the language selective model, models of nonselectivity for both comprehension and production propose that the words from the two languages are activated in parallel and compete for selection in bilingual language planning (Green, 1998; Kroll, Bobb, Misra, & Guo, 2008). In addition, evidence of parallel activation during lexical production has been observed in both native language (Caramazza, 1997; Levelt, Roelofs, & Meyer, 1999) and second language processing (Costa, Colomé, Gómez, & Sebastián-Gallés, 2003). Two main experimental paradigms, picture-word interference and picture naming tasks have been used to examine theories of lexical access and parallel processing in bilingual production research. I will focus on results from previous studies using the picture-naming paradigm, because this is one of the two production tasks incorporated into the current study.

Bilingual research has utilized cross-linguistic similarities to investigate whether both languages are activated during production and comprehension tasks (See Van Hell & de Groot, 2008 for a review on bilingual comprehension tasks). For example, some languages share cross-linguistic features at both the phonological and semantic levels called cognates. These are words that have similar lexical form and meaning in both languages such as the word *banana* in English and Spanish. Theories of non-specific language selection propose that when bilinguals encounter a cognate, they are able to activate the concept faster because both words share similar form and meaning in both languages. That is, converging activation across the two languages allows bilinguals to map the concept to word more quickly. In a study, incorporating picture naming, Costa, Caramazza, and Sebastian-Galles (2000) examined whether cognate status influenced lexical production in two groups, Catalan-Spanish and Spanish-Catalan bilinguals. In this task, participants had to name pictures in Spanish that were either cognates or noncognates, with the prediction that cognate words should be named faster if there is parallel activation through the phonological level of lexical access. The results of this study showed that both bilingual groups named pictures that were cognates across Spanish and Catalan faster, than the pictures that showed a noncognate word. Because the bilinguals' naming performance was sensitive to cognate status, it can be assumed that the phonological segments comprising cognate words received converging activation from language nodes within each language. These results provide support for theories of non-specific language selection, and suggest that even when naming in only one language (Spanish in this experiment), both words and their sublexical phonological segments from the unintended language are activated and compete for selection. Replication of the cognate effect, facilitation in picture naming for cognates words, has been replicated in other studies involving bilinguals who have languages, such as Japanese and English, that do not share the same type of language script (Hoshino & Kroll, 2008)

Additionally, Costa et al. (2000) also compared how proficiency in the naming language modulated the effect of cognate status on lexical access. The results of this analysis indicated that the difference in naming latencies for pictures that were cognates or noncognates in the dominant (Spanish for the Spanish-Catalan bilinguals) versus non-dominant language (Spanish for the Catalan-Spanish bilinguals) differed, such that the magnitude of the cognate effect was larger when bilinguals had to name pictures in their non-dominant language, than their dominant language. Costa et al. argued that this finding makes sense under the assumptions from the cascaded activation model of lexical access proposed by Peterson and Savoy (1998) and the Revised Hierarchical Model (RHM) proposed by Kroll and Stewart (1994). Peterson et al. (1998) suggested that phonological nodes should receive a proportional amount of activation based on the amount of activation of the corresponding lexical node. The RHM is a model of transfer at the lexical level and proposes that when a person begins to learn an L2 they map translation equivalents from L2 to the L1 in order to access concepts (Kroll et al., 1994). As a bilingual becomes more proficient in the L2, connections start to develop and strengthen between L2 words and their corresponding concepts. The bilingual then no longer needs to access information in the L2, by using the L1 translation route. Taken together, these theories of cascading activation and bilingual lexical transfer would suggest that cognates named in the less dominant language should receive larger amounts of activation from its translation, speeding up phonological activation, and thus response times of the word, in the non-dominant language (Costa et al., 2000). One questions remains whether bilinguals, living immersed in an L2 environment and who have switched language dominance becoming more proficient in the L2, will name cognates faster in their ‘dominant’ language, providing further evidence of non-selective theories of language processing within bilinguals.

Another factor influencing lexical access concerns the role of frequency in bilingual speech production. As previously mentioned above, there is a general assumption that frequently used words should be easier and faster to access and name than less frequently used words. Some researchers investigating bilingual speech production have begun to investigate if there is a relationship between the frequency of a word and the speed of lexical access using both verbal fluency and picture naming tasks. Using the verbal fluency task, Gollan, Montoya, and Werner

(2002) investigated the consequences associated with bilingual lexical access in Spanish-English bilinguals during speech production. In this study, participants named as many exemplars from a particular semantic category and from the same beginning letter category in both Spanish and English. The results of the study indicated that bilingual speakers named fewer exemplars in both languages compared to monolinguals, suggesting that there is a disadvantage for bilinguals in lexical retrieval. Gollan et al. (2002) proposed the “weaker-links” model, which assumes because bilinguals must spread activation and attention over a larger set of vocabulary, they speak words in each language less frequently, thereby creating weaker connections between lexical items. For example, a Spanish-English bilingual has two words for the concept of “dog”, *perro* and *dog*, while a Spanish monolingual only has one word, *perro* that they use to associate with the mental representation they have of this animal. Because a bilingual is able to use the English word *dog* in some circumstances and the Spanish translation *perro* in other cases, the weaker-links model suggests that a bilingual’s concept-to-word link for both *dog* and *perro* are weaker than a monolingual’s one connection because the links are divided between two words, whereas the monolingual only has one choice.

In another study, Gollan, Montoya, Cera, and Sandoval (2008) examined how language dominance may influence the relationship between frequency and lexical access during bilingual speech processing. Gollan et al. (2008) examined differences in picture naming latencies for both high versus low frequency words, as well as between monolinguals and Spanish-English bilinguals, dominant in their L2 English. The results of the study showed both a frequency and group effect, such that high frequency words were named faster than low frequency words and monolinguals named pictures faster than bilinguals. Additionally, bilinguals named low frequency words slower than high frequency words overall, which Gollan et al. argues provides further support for the weaker links hypothesis. When examining language dominance effects, bilinguals named pictures faster in their dominant language, English, than in their non-dominant language, Spanish. Furthermore, bilinguals showed a larger magnitude for the frequency effect for the non-dominant language. Taken together, these results provide evidence in favor of decreased frequency use and language dominance effects for bilingual speech production.

The disadvantages in lexical retrieval identified by Gollan et al. (2002, 2008) are in line with the observation that bilingual children also appear to have reduced vocabulary relative to their monolingual counterparts (e.g., Bialystok, 2005). However, it is also notable that most of the bilingual participants in the Gollan et al. study were heritage speakers. For example a Spanish heritage speaker is initially born into a Spanish speaking home, then educated in English almost exclusively starting at the age of 5. Heritage speakers often show signs of both L1 attrition and switching language dominance, becoming more proficient in the L2, English. In comparison to other types of bilinguals, heritage speakers are generally not educated in their native language and show an asymmetric pattern in language proficiency, where they are more proficient in the L2. This suggests that the results from the studies by Gollan et al. may be illustrating the linguistic consequences some heritage speakers undergo, and not the pattern for general bilingual lexical access. One possibility is that lack of complete L1 acquisition creates further processing costs for a heritage speaker and may adjudicate the previous findings on reduced lexical access proposed by Gollan and colleagues. Further examination is needed to identify whether the reduced frequency of lexical items may be an attribute of a unique bilingual population, living immersed in the L2 their entire lives.

Nevertheless, a question still remains concerning the process by which a bilingual is able to actively select the target word. Unlike a monolingual speaker, who has only phonological and semantically related words competing for selection, bilinguals have the translation equivalents as well to weed through. Similar to monolingual production models, one view incorporates the notion that even though they become activated in parallel, the selection mechanism is able to block out the activation of lexical items from the non-target language (Costa, 2005). Models of non-specific language selection mechanisms propose that the selection mechanism is sensitive to the activation level of translation equivalents of the target word as well, and that competition from these words creates possible lexical interference (Hermans, 2000). Additional research, in support of a model of non-selectivity, suggests that successful selection of the target word results from the employment of a control mechanism that aids in inhibiting competitors from the unintended language (Green, 1998; Kroll, Bobb, Misra & Guo, 2008).

To investigate these two different views on lexical selection, researchers have used picture-word interference and language-switching tasks to investigate the existence of an inhibitory mechanism involved in bilingual production. In picture-word interference tasks, participants name a simple line drawing, which is accompanied by a lexical word that they are told to ignore. Researchers have manipulated the distractor word to be either phonologically or semantically related to the picture name in the unintended language to examine how a bilingual may resolve potential competition between competitors. Costa et al. (1999) found facilitation in naming of phonologically related pictures, and argues this result provides support against the existence of an inhibitory control mechanism. Nevertheless, because this task potentially engages both bottom up (with presentation of the lexical word distractor) and top down (picture presentation activates conceptual information as previously discussed) processes, the results found by Costa et al. do not provide clear evidence in favor of specific language selection models (Kroll et al. 2008). Meuter and Allport (1999) used a language switching task and predicted that if an inhibitory mechanism was engaged during lexical selection due to competition, then there should be a processing cost in naming latencies when switching from naming in the more dominant to less dominant language, then vice versa. Meuter and Allport found that bilinguals showed this asymmetrical switch cost, as it is often referred to, when a bilingual named Arabic numbers in the L1 after previously naming a number in the L2. Nevertheless, additional studies examining the validity of the asymmetrical switch cost have found inconclusive results and suggest that asymmetric switch costs may not account for how bilinguals resolve potential competition during lexical access (Finkbeiner, Almeida, Janssen, & Caramaza, 2006; Gollan & Ferreira, 2007).

The current proposal will focus on production at the lexical level, as it has been shown to demonstrate the clearest effects of immersion from data in previous studies (Linck et al., 2009). A study by Linck et al. (2009) examined the effect that short-term immersion in an L2 environment may have on a second language learner's L1. In this study, two groups of second language learners performed a set of comprehension and production tasks. Both groups of learners were native English speakers, but one group was exposed to Spanish in the classroom only and the other group was studying abroad in Spain. Participants completed a translation recognition task and a verbal fluency task in both languages. In the translation recognition task, a Spanish word would appear on the computer screen followed by an English word. Participants were asked to decide whether the English word was the translation of the Spanish word. Previous studies have indicated that bilinguals at different levels of L2 proficiency exhibit interference when presented with lexical-neighbor distractors in the translation-recognition task (Sunderman & Kroll, 2006). On the translation recognition task, participants were presented with two word pairs and had to decide whether they were translations of each other. The immersed group exhibited no interference to lexical-neighbor distractors, indicating there was a very small difference between the mean reaction times for the distractors and control words. In the verbal fluency task, participants were asked to provide as many exemplars for a given semantic category (e.g., animals, fruits, etc.) as possible in 30 seconds. For the verbal fluency task, the immersed group studying abroad in Spain provided fewer exemplars in the L1 than the classroom learners, even though English was the native and dominant language for both groups. To test the influence of immersion on the current findings, Linck et al. retested the participants in the immersed group 5 months after returning to the L1 environment. The group's performance on the verbal fluency task improved only for L1 production, maintaining the same level of L2 performance. The group however showed little to no interference in the translation recognition task to lexical-neighbor distractors, similar to the results from the original tests during immersion.

Linck et al. (2009) proposed that an inhibitory account for lexical access could account for the observed results. Based on this theory, bilinguals and L2 learners may exhibit a reduction in L1 lexical access during L2 immersion. Additionally, the significant interference found for the immersed group during the translation-recognition task provides support for an active inhibitory mechanism that decreases access to the L1 during L2 use. The findings from both comprehension and production tasks in this experiment support the claims for an inhibitory mechanism and provide further evidence for the role that immersion plays in bilingual lexical access.

For bilinguals who are immersed in an L2 environment, the need to control the use of the two languages may be critical. The results from the study by Linck et al. (2009) provide theoretical implications for the role immersion may have on language dominance and the maintenance of a bilingual's two languages, particularly his or her first language. In that particular study, the students had only been immersed in an L2 environment for a short period of time and were already demonstrating obvious suppression of the native language when accessing words in the L2. The study by Linck et al. and the inhibitory account provide support for the assumption of plasticity within language, specifically in bilingualism. The suppression of the L1 after a short period of time, as seen in the aforementioned study, supports the theory that over a bilingual's lifetime, lexical access, proficiency, and dominance are subject to change depending on other factors, including length of immersion and type of language environment.

Based on the previous theoretical findings about bilingual lexical access in production, the current project seeks to examine a group of Spanish-English bilinguals at different levels of proficiency while immersed in an L2 environment. Participants in this study will perform both a picture naming and verbal fluency task in both languages to test previous theories of bilingual lexical access during speech production, taking into account the role of dominance and cross-linguistic features such as cognates during speech production. Additionally, examining a group of bilinguals during an extended L2 immersion experience should provide a better look at the debate concerning the selection mechanisms and possible inhibitory processes employed during lexical access and how the presence of these may influence bilingual language production.

Bilingual Sentence Processing

Research on monolingual sentence parsing strategies found that different languages use distinct parsing strategies when reading and comprehending sentences (Cuetos & Mitchell, 1988). Specifically, unlike native English speakers, Cuetos et al. (1988) found that native Spanish speakers did not exhibit a preference for the Late Closure strategy proposed by Frazier (1987). The general assumption under the Late Closure strategy suggested that subsequent information parsed in a sentence, will attach to the current phrase or clause being currently processed (Frazier, 1987). The cross-linguistic differences found in parsing strategies initiated a string of research that sought to replicate and reexamine how speakers of various languages may process sentential information differently (Brysbaert & Mitchell, 1996; Mitchell & Cuetos, 1991).

For example, Carreiras and Clifton (1999) conducted an eyetracking study that examined the parsing preferences for monolingual speakers of Spanish and English. To study the parsing strategies for each language group, Carreiras et al. (1999) manipulated gender cues to examine each language group's preference for relative clause disambiguation, known as high or low attachment. For example, consider the sentence: *Peter fell in love with the daughter of the psychologist who studied in California.* If asked who studied in California, native Spanish speakers, preferring high attachment, say it was the daughter, whereas native English speakers, preferring low attachment, say that it was the psychologist. Participants performed a self-paced reading task in their native language that contained two different noun phrases (NPs) following the main verb. If a participant prefers high attachment, he or she will attach the final relative clause, manipulated by gender, to the first noun phrase, NP1. If a participant prefers low attachment, he or she will attach the relative clause to the closest noun phrase, NP2.

Example of using gender to force high attachment:

La policía arrestó a la hermana del criado que dio a luz recientemente dos gemelos.

The police arrested the sister of the handyman who recently gave birth to twins.

Example of using gender to force low attachment:

La policía arrestó al hermano de la niñera que dio a luz recientemente dos gemelos.

The police arrested the brother of the nursemaid who recently gave birth to twins.

To measure relative clause attachment preferences, Carreiras et al. (1999) measured the total reading time for the critical region, or disambiguating information, for each sentence. They found that native Spanish speakers read the sentences faster if the gender of the relative clause matched the gender of the first noun phrase, indicating a preference for high attachment. When Spanish speakers read sentences that forced them to attach low, their reading times were significantly slower. English monolinguals showed the opposite pattern, indicating a preference for low attachment. That is, English speakers read the critical region part of the sentence faster if the relative clause attached to the second noun phrase, rather than the first noun phrase.

Studies examining these conditions for bilingual speakers have reported mixed findings with respect to parsing preferences. Fernandez (2003) found that attachment preferences for both monolingual Spanish speakers and Spanish-English bilinguals changed based on the length of the relative clause. Previous research on monolingual sentence processing suggested that the length of the relative clause could influence how a speaker parsed sentences, either attaching low to shorter clauses or attaching high for lengthier clauses (Fodor, 1998). In the study by Fernandez (2003), Spanish monolinguals showed a preference for NP1 attachment when the relative clause phrase was longer than for shorter versions. The bilingual participants showed a similar pattern of attachment but only when reading sentences in English. The results for the bilingual participants reading Spanish sentences remains inconclusive. Fernandez suggested that the inconclusive results within the Spanish data might be due to other factors such as frequency of reading in each language. She suggested that the language in which a bilingual reads the most may influence the parsing strategies in sentence processing, as most of the bilinguals reported reading more in English than in their dominant language Spanish. The results of this study suggest a need for a more sensitive look at bilingual sentence processing and how a bilingual's language dominance may influence parsing strategies.

Further evidence from studies of sentence processing suggests that L2 immersion affects parsing preferences during sentence comprehension not only in the second language, but also in the native language as well. Dussias and Sagarra (2007) examined bilingual speaker's parsing preferences for low or high relative clause attachment when reading in both Spanish and English, using materials similar to those used by Carreiras et al. (1993). They found that native Spanish speakers, who have been immersed in English in the United States (an L2 environment for them), begin to also prefer low attachment when they read sentences not only in English, the L2, but also in their native language, Spanish. These results demonstrate the permeability of a bilingual's two language systems and how long-term exposure to an L2 can modify syntactic preferences, even in his or her native language. The critical question that remains is whether native Spanish speakers who have switched language dominance to English will reveal a preference for low attachment not only when reading English as the L2 but also in their L1, Spanish, as previously reported.

The next chapter will present the outline and methodology for the current study.

Chapter 2: General Directions and Methodologies

The two aspects of bilingual processing that have been previously reviewed in the introduction, lexical access and sentence processing, have, for the most part, been conducted independently of one another. In addition, there has been little research addressing the influences of L2 immersion on the maintenance and use for each of a bilingual's two languages. Simultaneously analyzing lexical processing and grammatical parsing strategies together within the same immersed speaker provides new information about how L2 immersion influences the relative dominance of a bilingual's two languages. If extended L2 immersion has the consequence of influencing a bilingual's language dominance we can ask the manner in which this may impacts bilingual speech production and sentence parsing strategies.

There are three main goals in the current study that will be outlined. The first goal is to examine how L2 immersion influences bilingual lexical processing for a group of relatively proficient, Spanish-English bilinguals. Previous immersion research proposes that bilinguals will exhibit slight processing costs to the native language while immersed in an L2 environment (Linck et al. 2009). The previous study examined advanced L2 learners of Spanish during a brief study abroad experience. The current study looks to examine whether this finding can be replicated for a group of highly proficient Spanish-English bilinguals during an extended L2 immersion experience. If short periods of L2 immersion produce an inhibitory effect on native language processing, one question remains whether this findings will be observed after a much longer period of immersion.

In addition, the second goal of the current study is to investigate if differences in language dominance modulate the reported lexical performance data. After an extended period of time in an L2 environment, it can be assumed that some of theses Spanish-English bilinguals may in fact become more dominant in English than their L1, Spanish. While the Spanish-English bilinguals in this experiment may share the same native and second language, differences in language experience may in fact influence and change overall processing strategies and performance in each of the two languages. Thus, analyzing the performance of the bilingual group separately according to dominance may reveal distinct patterns of processing in each language, which were nevertheless concealed during previous analyses. Specifically, if processing costs are observed for lexical access for the immersed Spanish-English group, one question remains whether dominance modulates this relationship. That is, a group of Spanish-English bilinguals who have become dominant in their L2 English may not show the same degree of inhibitory processing influence as a group of Spanish-English bilinguals who have remained dominant in their native language. After lengthy L2 immersion experience, the need for increased inhibition of the native language may decrease over time, reducing the overall processing speed.

Finally, the third goal of this study is to examine the effect of extended immersion in the L2 for sentential parsing strategies in each of the bilingual's two languages. Previous research has demonstrated that immersion in an L2 environment can change patterns of sentence parsing even when reading sentences in the native language (Dussias & Sagarra, 2006). The current study examined whether this same pattern can be observed for another set of Spanish-English bilinguals immersed in an English language environment. Additionally, this experiment investigated whether performance on a sentence-processing task exhibit similar patterns of language dominance. Specifically, one question was whether those participants who had become English-dominant would also show native English parsing preferences for both English and Spanish sentence processing.

Four groups of speakers participated in the current study. Initially, the linguistic performance for a group of Spanish-English bilinguals immersed in a monolingual English environment was examined. The Spanish-English bilinguals were then divided into different language dominance groups, English-dominant and Spanish-dominant. Information concerning the assessment of language dominance will be further discussed later in the methodology section. Finally, the performance of these two different dominance groups was then compared to two native English control groups: one English monolinguals and the other advanced L2 learners of Spanish.

All bilingual participants performed a battery of tests in both Spanish and English to assess lexical access, sentence processing, and nonlinguistic cognitive performance. The monolingual participants performed all tasks in English only. Lexical access and proficiency were measured using a picture naming task and a verbal fluency task; a self-paced reading task measured sentence processing by examining relative clause attachment preferences; and a Flanker task and Operation Span Task (O-Span) assessed individual differences such as executive control and working memory. The current chapter outlines the participants and methodology used in the study.

Method

Participants

Four different language groups participated in the current set of experiments. In general, this study compared the linguistic and cognitive performance of two groups of Spanish-English bilinguals while immersed in an L2 environment to two Native English control groups. A total of 48 Spanish-English bilinguals participated in the study, some of who have become dominant in their L2 English (Group 1: $N = 26$) and some who have maintained dominance in the native language (Group 2: N = 22). In addition, two control groups were included in this study to use as comparisons to the performance by the group of Spanish-English bilinguals. The first control group consisted of nine native English speakers who were advanced L2 learners of Spanish. The other control group consisted of 10 monolingual English speakers with minimal or no experience learning an L2. All of the participants were recruited from either the Pennsylvania State University or from the University of Texas El Paso.

Tasks and Materials

Language history questionnaire. All participants completed a paper version of a language history questionnaire (Li, Sepanski, & Zhao, 2006). Participants provided self-ratings for their proficiency in all languages they speak across four different domains including reading, writing, speaking, and comprehending categories. Self-ratings were completed using a scale from 1 to 10, where 1 indicated low proficiency and 10 indicated high proficiency. In addition, the participants provided descriptive information about themselves and their use of each language, including questions concerning the age at which they began learning an L2 (AoA), how long they had been immersed in an L2 environment, and the percent of time spent daily using each language. See Appendix A for a copy of the language history questionnaire used in this study.

Verbal fluency task. Participants performed a verbal fluency task in which they were asked to produce as many exemplars of a specified category as they could think of in 30 seconds. Participants named examples of items belonging to eight different semantic categories, including fruits, vegetables, colors, clothes, musical instruments, body parts, furniture, and animals. Participants were told to avoid using proper names (e.g., Toyota) or plural variations of the same word (e.g., carrot/carrots), as they would be excluded from future data analyses. When participants began the task, they first saw a fixation cross "+"

which was then proceeded by an audible beep. This sound indicated that a 30-second naming period had started. After 30 seconds had elapsed, another audible beep, identical to the earlier one, sounded indicating that the naming interval had ended. Bilinguals named item examples for two practice categories and then four experimental categories for each language, for a total of ten categories, eight of which were included in statistical analyses. Monolinguals named item examples for two practice categories and then four experimental categories only in English, for a total of 6 categories. Type of category was counterbalanced across languages and participants within the bilingual groups, and across participants only within the monolingual group. The language of production for a particular category was also counterbalanced across the bilingual participants. Verbal fluency scores were calculated based on the mean number of exemplars produced per language block.

Simple picture naming task. Participants completed a simple picture-naming task. In this task, participants named drawings of common objects. The selected pictures came from the normed database by Snodgrass and Vanderwart (1989). Pictures were black and white simple lined drawings of various objects. All participants saw 72 pictures, with the bilingual group having two blocks, one for each language, Spanish and English. The monolingual group had two blocks as well, but named all 72 pictures in English.

Within the set of 72, there were two types of pictures, cognates and non-cognates. Cognates are lexical items that share similar phonological and semantic information across languages. In this experiment, cognates were those lexical items that shared similar phonological and semantic information across Spanish and English (e.g. *piano* is the same in both Spanish and English). Non-cognates are lexical items that do not have any common features across the two languages (e.g. *dog* in English vs. *perro* in Spanish). Within the 72 pictures presented in this task, there were a total of 24 cognates and 48 non-cognates. As previously mentioned cognates are thought to increase activation of the word and thus should reveal faster reaction times in behavioral measures.

In addition to the 72 critical items, all language groups completed a practice session to familiarize themselves with the task before the experiment began. Bilingual participants saw 20 practice items, 10 items per language block, while monolinguals only received 10 practice items. When the task began, a fixation cross "+" appeared before each picture. Participants were instructed to press the space bar to view the line drawing. When the picture appeared, the onset of the participant's voice caused the picture to disappear from view. Participants were told to name each picture as quickly and as accurately as possible. Monolingual participants only named pictures in their native language English. For the other three bilingual groups, the language of naming was counterbalanced across participants, such that some participants first named pictures in Spanish then English and others named pictures in the reverse order. The response time to name a picture (in milliseconds) and the percent accuracy (out of 100%) were calculated as the dependent measures. Reaction times that were 2.5 standard deviations above or below a participant's mean, as well as any responses that were more than 3000 ms were excluded from the data analysis.

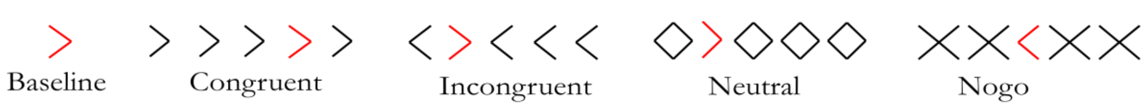
Sentence processing task. Participants completed a self-paced reading task, in which they read sentences one word at a time, advancing to the next word by pressing the space bar. They were instructed that true/false comprehension questions would appear randomly throughout the experiment, so they should read the sentences carefully for meaning. Before beginning to read each sentence, participants saw the word "READY" in the English condition or "LISTO" in the Spanish condition, centered in the middle of the computer screen. After pressing the space bar the first word of the sentence replaced the word “READY”. The rest of the words in the sentence appeared one word at a time in the middle of the screen. The participants were told they could read each sentence as fast or slow as they wanted, but were encouraged to try to read at their normal reading rate in order to gauge normal sentence processing times.

Each participant read two blocks of 48 sentences, with a total of 96 sentences for the entire task. Monolinguals read all 96 sentences in English only. Bilinguals read one block in each language, with the order of the languages counterbalanced across participants. For each block of 48 sentences, there were five practice sentences, 15 filler sentences, and 27 experimental sentences. All sentences were counterbalanced for language presentation (bilingual groups only), sentences type (filler or experimental), and type of disambiguation (low or high).

Sentences followed a general formula that included two post-verbal noun phrases (NP) in the form: *NP1 of the NP2 + Relative Clause (RC)*. The NPs were always human beings and expressed opposite gender, such that, if the NP1 was a male gendered noun, than the NP2 would be a female gendered noun. All the Spanish NPs expressed gender by an added suffix, for example -*a* for females and -*o* for males, such as the Spanish word for daughter and son, *hija* and *hijo* respectively. Because English does not denote gender by using suffixes, the English NPs used in the experiment expressed gender either intrinsically through semantics (e.g., *daughter* or *son*), or had the word *female*/*male* in front of the noun (e.g., *female lawyer*). The two NPs were then followed by a relative clause that contained gender information forcing either low or high attachment. For the Spanish sentences, the RC included the grammatical structure copula (also known as a linking verb) plus a predicative adjective, which described either the NP1 or NP2. Specifically, the linking verb phrase, *estar* (to be) + adjective, conveyed the gendered information through the manipulated suffix ending of the adjective. Thus, the gender of the predicate adjective would only match the gender of the NP1 or NP2 and force the participant to attach the RC accordingly to the correct one. An example of the manipulated noun phrases and RC for Spanish sentences would be: *la hija del maestro que estaba enfermo(a*), (English translation: the daughter of the teacher who was sick). Because English does not have grammatical gender, the RC contained possessive pronouns, which were manipulated. In this case, the RC possessive pronoun was either *his* or *her* and shared the same gender as either the NP1 or NP2. An example of the manipulated noun phrases and RC for English sentences would be: *the daughter of the King who had her(his)*…

Sentences varied in the type of relative clause attachment preference (low or high). As previously mentioned, the gender information within the relative clause phrase was manipulated in a certain way either to describe the first noun phrase, which is called high attachment, or the second noun phrase, low attachment. Using the provided examples, low attachment preference for the English sentence would have the possessive pronoun be *his*, referring to the *King*, the NP2. In the Spanish sentence, low attachment preference would be when the adjective was masculine, *enfermo*, and refer to the *maestro*. In the high attachment preference, the RC can only attach to the first noun phrase. In the provided examples, the possessive pronoun for the English sentence would then be *her* and refer to *daughter*; in the Spanish sentence the adjective would be *enferma* and refer to the word *hija*. See Appendix B for a set of sample experimental sentences. All critical items (predicative adjective/possessive pronoun/) occurred at least three words before the end of the sentence, so that no item was located at the word final position. For this experiment and the conducted analyses, the adjective and possessive pronoun start what is called the disambiguating region. Both the Spanish adjective and the English pronoun disambiguate which noun phrase the relative clause will attach to. Thus when a participant arrives at the disambiguating region, they are forced to attach the relative clause information to only one of the noun phrases, based on gender congruency. As previously mentioned in the literature review, different languages show an overall preference for either low or high relative clause attachment. This experiment examines the processing costs at the sentence level for different bilinguals when they are forced to attach the relative clause to the non-preferred attachment site.

Flanker task. The flanker task measures a participant's level of inhibitory control. In this task, the stimuli, a red arrow (i.e., < or >), was presented either by itself (the baseline trial) or in a row surrounded by four distracters. Participants were instructed to indicate the direction (right or left) of the red arrow as quickly and accurately as possible, while ignoring the distracters items. Participants indicated their response by either clicking the right portion of the computer mouse when the arrow was facing right, or left the left portion of the mouse when the arrow was facing left. The distractors, surrounding the stimuli, were either pointing in the same or opposite direction as the red arrow. The participants saw six types of blocks: 2 *Baseline*; 2 *Go/No Go*; 2 *Congruent/Incongruent*; and 1 *Mixed Block*. In the *Baseline* condition, only a single red arrow appeared on the computer screen. In the *Go/No Go Trials*, participants indicated the direction in which the arrow was pointing during the 'Go' (Neutral) trials and withheld their response during the 'No Go' trials. During a 'Go/No Go' trial, participants saw the arrow flanked by four black diamonds. During the 'No Go' trial, participants saw the arrow flanked by four black X's. In the Congruent/Incongruent block, participants saw either 'Congruent' trials, where four black arrows facing the same direction surround the red target arrow, or the 'Incongruent' trial, where four black arrows facing the opposite direction surround the red target arrow. Participant's responses were measured for both reaction time (ms) and accuracy of response.



Operation span task. Participants also completed an Operation Span task (O-SPAN) that assessed working memory capacity (Turner & Engle, 1989). In this task, participants saw simple arithmetic sequences (e.g., (9 * 2) -7 = 11) and had to decide if the presented mathematical equation was true by pressing YES or false by pressing NO. After making a judgment, participants were presented with a word and told to remember it for later recall. Following a series of equations, with a maximum number of five sequences, participants had to recall the words that were presented in that particular block. The words in the O-Span task were presented in the language that was identified as the dominant language in the language history question (i.e., English words for English dominant participants and Spanish words for Spanish dominant participants).

Participants' operation spans were calculated by determining the total number of words correctly recalled for trials when they had answered the mathematical prompt correct. The O-Span was used as a way to match groups of participants within the study, as well as a way to identify whether individual differences in working memory may influence language processing. Specifically, working memory may influence a person's sentence parsing and ability to maintain certain information in mind over long periods of time.

Dominance assessment**.** The Spanish-English bilingual group was split into two different dominance groups. Based on research about L1 attrition (Schmid, 2009), an assumption can be made that bilinguals who are immersed in an L2 environment for an extended period of time, may in fact begin to loss access to the native language, thus becoming more dominant in their L2. There have been various ways to categorize a bilingual's language dominance including by native language status, that is whatever the L1 is will be the dominant language; grammatical exams testing for both L1 and L2 knowledge; self-reported L1 and L2 proficiency scores; and performance measures. The current experiment took a performance-based approach and assessed language dominance using one of the lexical tasks. While self-reported ratings are often reliable measures of language proficiency, using performance-based measures assesses dominance categorization based on actual performance and not self-reported estimations. In addition, the current experiment intends to investigate how dominance may effect the active state of language processing, thus in this case self-reported measures may not capture or predict a bilingual's performance at different levels of processing.

In order to assess dominance effects on language processing, the Spanish-English bilinguals were categorized based on their performance on a verbal fluency task. The verbal fluency task was used as an indicator of language dominance because it measures a bilinguals' ability to retrieve words and tells us about the availability of each of the languages. Additionally, unlike the picture-naming task included in this study, the verbal fluency task is under the participant's control. That is, participants are simply asked to name as many exemplars from a particular semantic category, but have full control over the types of exemplars they can produce for each block. The picture-naming task identifies the relative speed of lexical access, and is controlled by the experimenter. The participant has no idea what picture will be displayed next. Using the verbal fluency as a means of language dominance allows a natural performance-based measure of lexical access.

Participants who produced more exemplars in the L1 (Spanish) than the L2 (English) were considered to be dominant in their native language, Spanish. Participants who produced more exemplars in the L2 were thus considered to be dominant in English. Participants, who produced an equal amount of exemplars in both languages, were deemed to be English-dominant, due to influence from the surrounding English environment. Participant's verbal fluency scores will be later analyzed in comparison to picture naming data, as well as the self-reported language ratings provided in the language history questionnaire to ensure convergence across measures.

Apparatus

Each experimental task was presented on a PC computer using E-prime version 2.0 software. All words and instructions were presented on a white screen with black Courier New font. Participants were tested individually in quiet rooms. In tasks that required spoken responses such as Picture Naming & Verbal Fluency, participants were recorded using a microphone and digital recording device from the onset of speaking. In the other computer tasks, participants indicated their responses through button presses on the computer keyboard.

Predictions

The goal of the present study is to examine the role of L2 immersion and language dominance have during language processing for a group of Spanish-English bilinguals. The predictions for each of the language groups are outlined separately for each experimental task.

Verbal fluency task. For the verbal fluency task, the Spanish-English bilinguals should produce significantly more exemplars in Spanish than English, based on native language status alone. Based on theories of inhibitory control, the Spanish-English bilinguals should produce more exemplars in Spanish than English; however the difference between the two languages should be much smaller if active inhibition of the native language occurs during an L2 immersion experience. Additionally, each group of Spanish-English bilinguals should produce more exemplars in the more dominant language. Specifically, the Spanish-English bilinguals who have become dominant in English should produce more exemplars in English than Spanish, while those bilinguals who have remained Spanish-dominant should produce more exemplars in

Spanish than English. Additionally, in terms of inhibitory processes, the English-dominant group should shower a larger difference between the number of exemplars produced in English and Spanish, than the Spanish-dominant group. This prediction is based on the fact that the English-dominant group is now dominant in the language of the surrounding environment and needs to engage in less active inhibition of the native language, because it is no longer as strong as the L2 English.

When compared to the native English groups, the two Spanish-English bilinguals, despite language dominance, should produce slightly fewer exemplars in English. The current study will test the ‘Weaker Links’ theory proposed by Gollan et al. (2002). If this theory, which proposes a bilingual lexical deficit, is true, then all three bilingual groups should produce fewer exemplars in both languages than the native English group produces. However, if a lexical deficit does not characterize the majority of bilingual lexical processing, than the bilingual groups should produce the same amount of exemplars in their dominant language as the native English group does.

Picture naming task. For this lexical task, the Spanish-English bilinguals should produce faster reaction times (RT)s and be more accurate when naming pictures in Spanish, than in English. This prediction is based upon native language status alone and the assumption that a bilingual will perform more accurately in their native language. Additionally, the Spanish-English bilinguals should be only slightly faster and more accurate to name pictures in Spanish than in English due to active inhibition of the native language during L2 immersion. Once split by language dominance, the English-dominant group is predicted to be faster naming pictures in English than Spanish, and the Spanish-dominant group should be faster to name pictures in Spanish than English. However due to active inhibition of Spanish, the Spanish-dominant group should be only slightly faster in Spanish than English, while the English-dominant should show an overall larger difference between production languages. The cross-group comparison should reveal that the English-Spanish bilinguals are faster and more accurate in naming pictures in English, their L1, than Spanish. Based on the 'Weaker Links' theory (Gollan et al., 2002), the monolingual English group should be more accurate and produce faster RTs for naming pictures in English, in comparison to the performance of the three bilingual groups in their dominant language. However, if there is no evidence for a disadvantage during lexical access, then all bilinguals should name pictures in their dominant language as fast as the monolinguals name pictures in English.

Finally, the picture naming analyses should reveal a cognate facilitation effect for all bilingual groups. Specifically, bilingual participants should be faster to name pictures of cognate words (e.g. words that share overlapping semantic and phonological features) than pictures of non-cognate words. Based on theories of non-specific lexical access, both of a bilingual's two languages are active even when intending to produce a word in only one language. Pictures of cognate words are faster to name for bilinguals because they use converging activation from both languages in the linguistic system, which ultimately speeds up lexical access. Monolingual participants should show no sign of cognate facilitation, as they have no experience with cross-language activation. Taking dominance into consideration, previous research proposes that bilinguals will exhibit a larger cognate facilitation effect in the less dominant language (Heredia, 1997). Based on this evidence, the bilinguals in the current study should also show a similar pattern, with a larger cognate facilitation effect seen in the non-dominant language.

Relative clause attachment task. Based on the results of previous relative clause attachment studies by Dussias et al. (2007), the current study predicts that Spanish-English bilinguals immersed in an L2 environment will also begin to show a preference for low attachment, their L2 parsing strategies, in both English and Spanish. That is, they will produce faster RTs over the disambiguating region when reading relative clauses that force low attachment.

When language dominance is taken into consideration, both dominance groups are predicted to read sentences faster in the low attachment condition. However due to longer L2 immersion time, the English-dominant group should exhibit larger processing costs, longer RTs, than the Spanish-dominant group when reading sentences in the high attachment condition. Based on research on native English speaker's attachment preferences (See Carreiras & Clifton, 1993), the two native English groups are predicted to exhibit an overall preference for low attachment when reading English sentences, producing faster RTs for this attachment type. Additionally, the English-Spanish bilingual group is predicted to not show a change in syntactic processing strategy for Spanish due to lack of immersion experience.

The next portion of this paper will outline the overall results for each task across all language groups. The results and statistical analyses for the language profile, verbal fluency, and picture-naming task are presented in full in the subsequent chapter, Chapter 3. The results and statistical analyses for the sentence processing and individual difference measures are described in Chapter 4.

Chapter 3 Language Profile and Lexical Processing Results

Language Profile

Spanish-English bilinguals. The following results pertain to the Spanish-English bilingual group. In total, there were 48 Spanish-English bilinguals. A set of paired sample t-tests compared the language ratings for each of the skill types (Reading, Writing, Speaking, and Listening) for each language (Spanish and English). Theses analyses revealed a significant difference for reading, writing, and listening skills for Spanish and English. The Spanish-English bilinguals rated themselves as being more proficient in reading, speaking, and listening Spanish skills in comparison to their English ratings [Reading: t (1, 47) = 2.12, p = .039; Speaking: t (1, 47) = 5.59, p = .000; Listening: t (1, 47) = 3.55, p = .001]. No significant difference was observed for writing skills for the different language ratings [t (1, 47) = 1.62, p = .112]. A separate paired sample t-test indicated that the bilinguals rated themselves as being more proficient in Spanish (M = 8.8) than English (M = 8.1) [t (47) = 3.41, p = .001]. When the Spanish-English bilinguals completed the experiment, they were an average of 25.1 years old, had begun learning English at the age of 8.3 years, and had lived immersed in an L2 environment for approximately 11.2 years. Table 1 shows the means for self-reported language ratings across the four different rating types (reading, writing, speaking and listening) in both the L1 Spanish, and the L2 English. In addition, the means for participant age, year of L2 acquisition, and length of L2 immersion.

Table 1

Language History Questionnaire Data for Spanish-English Bilinguals

Measure	*Spanish-English* *N = 48*
Age (Years)	25.1 (7.8)
L1 Self-Ratings (10 pt scale)	
Reading	8.6 (1.6)
Writing	8.2 (1.8)
Speaking	9.1 (1.4)
Listening	9.1 (1.4)
Mean	8.8 (1.4)
L2 Self-Ratings (10 pt scale)	
Reading	8.1 (1.4)
Writing	7.8 (1.6)
Speaking	8.0 (1.5)
Listening	8.3 (1.5)
Mean	8.1 (1.4)
Age Began L2 (Years)	8.3 (5.2)
Years of L2 Immersion	11.2 (8.7)

Note. Standard deviations are in parentheses.

Spanish-English bilinguals by dominance group. The 48 Spanish-English bilinguals were then split by language dominance[1] such that of the 48 participants, 26 produced more exemplars in the L2 English than the L1, Spanish, and were deemed English-dominant. The other 22 participants were deemed Spanish-dominant. Table 2 shows the means for self-reported ratings for reading, writing, speaking and listening in the L1 and the L2, as well as general descriptive information previously mentioned. Overall, the Spanish-dominant and English-dominant bilingual groups were matched on age and L1 self-assessed ratings. Significant differences were observed for L2 self-assessed ratings, age of L2 acquisition, and length of

[1] Language dominance assessment was previously explained in Chapter 2.

immersion in an L2 speaking environment. Each of the statistical analyses will now be explained in detail.

A one-way ANOVA examined differences in age, the dependent variable, for the between-subjects variable, dominance group (English-dominant vs. Spanish-dominant). No significant difference in age was observed for dominance groups, F (1, 47) = 1.80, p = .187. To examine differences in age of L2 acquisition (in years), a one-way ANOVA, with language dominance group as the independent variable, revealed a significant difference between groups, F (1, 47) = 6.51, p = .014. On average, the English-dominant group learned their L2 earlier (M = 6.7) than the Spanish-dominant group (M = 10.3). Another one-way ANOVA was performed with length of L2 immersion (in years) as the dependent variable and language dominance group as the independent variable. This analysis showed a significant difference in L2 immersion length, F (1, 47)= 7.87, p = 0.007, with English-dominant bilinguals being immersed in the L2 longer (M = 14.3) than the Spanish-dominant bilinguals (M = 7.6).

A set of one-way ANOVAs was performed examining the differences in self-reported language ratings across Spanish and English and for different skill types (reading, writing, speaking, listening). These analyses revealed no significant differences across the four different language skills in Spanish, suggesting that the two dominance groups were matched in their native language proficiency. Significant differences were observed for each of the L2 ratings. On average, the English-dominant group rated themselves as more proficient than the Spanish-dominant group across all four language skills [Reading: F (1,46) = 9.37, p = .004; Writing: F (1,46) = 6.61, p = .013; Speaking: F (1,46) = 6.03, p = .018; and Listening F (1,46) = 3.80, p = .057]. Overall, both the English-dominant and Spanish-dominant bilinguals rated themselves similarly in their Spanish proficiency skills ($M_{English\text{-}Dominant}$ = 8.8 vs. $M_{Spanish\text{-}Dominant}$ = 8.7).

However, the English-dominant group rated themselves on average higher in the L2 English (*M* = 8.5) than the Spanish-dominant bilinguals (*M* = 7.5).

When the Spanish-English bilingual group was split by dominance, distinct patterns for L1 and L2 proficiency, as well as language experience, emerge for each group. Specifically, the Spanish-dominant data indicates a clear pattern for Spanish dominance in their proficiency ratings. While the English-dominant group rated themselves slightly higher in Spanish language skills than English, this difference was very minimal in comparison to the Spanish-dominant group. This group in fact appears to be more balanced overall. In addition, the English-dominant bilinguals learned English significantly earlier than the Spanish-dominant group, and have been immersed in an English environment for a longer period of times. Taken together, these findings suggest that each group may have experienced different language influences, and this difference has the potential to influence how each group processes and uses their two languages. Further analyses utilizing the lexical tasks used in the current study may demonstrate clearer effects of dominance for language processing skills. These analyses will described in the verbal fluency and picture naming results sections later in this section.

Table 2

Language History Questionnaire Data for Spanish-English Bilinguals, by Language Dominance

Measure	*Language Groups* Spanish-English N = 48 [a]	Spanish-Dominant N = 22	English-Dominant N = 26
Age (Years)	25.1 (7.8)	26.7 (8.9)	23.7 (6.6)
L1 Self-Ratings (10 pt scale)			
Reading	8.6 (1.6)	8.7 (1.4)	8.5 (1.7)
Writing	8.2 (1.8)	8.1 (1.8)	8.4 (1.8)
Speaking	9.1 (1.4)	9.1 (1.5)	9.1 (1.3)
Listening	9.1 (1.4)	9.0 (1.5)	9.1 (1.3)
Mean	8.8 (1.4)	9.0 (1.2)	9.0 (1.2)
L2 Self-Ratings (10 pt scale)			
Reading	8.1 (1.4)	7.5 (1.1)	8.6 (1.4)
Writing	7.8 (1.6)	7.2 (1.2)	8.3 (1.8)
Speaking	8.0 (1.5)	7.5 (1.3)	8.5 (1.6)
Listening	8.3 (1.5)	7.9 (1.4)	8.7 (1.4)
Mean	8.1 (1.4)	7.8 (1.0)	8.9 (1.3)
Age Began L2 (Years)	8.3 (5.2)	10.3 (5.6)	6.6 (4.2)
Years of L2 Immersion	11.2 (8.7)	7.6 (6.0)	14.3 (9.6)

Note. Standard deviations are in parentheses.
[a] In this table, the Spanish-English bilinguals are split into two groups, by language dominance. The first column of data is the original data for the group as a whole, before splitting by language dominance. This is done so to be able to visually compare the differences in language profile before and after dominance is taken into account.

Cross language comparisons. The language profiles for both of the Spanish-English dominance groups were then compared to the two control groups, English monolinguals and English-Spanish bilinguals. This comparison is important for two reasons. First, this analysis provides a contrast of English language skills for the two Spanish-English dominance groups with a monolingual English group. Because differences in language processes may differ between monolinguals and bilinguals, a second analysis is necessary with a native English group, who has learned Spanish as an L2. Table 3 shows the mean results for this comparison.

For these analyses there were a total of four different language groups: English Monolinguals, English-Spanish bilinguals, English-Dominant (Spanish-English bilinguals), and Spanish-Dominant (Spanish-English bilinguals)[2]. A one-way ANOVA examined differences in age, the dependent variable, for the between-subjects variable, language group. There was a significant difference in age between language groups, F (3, 66) = 3.49, p = .021. Planned multiple comparisons reveled that the Spanish-dominant group was significantly older (M = 26.7 years) than both the English-Spanish bilinguals and the English monolinguals ($M_{English\text{-}Spanish}$ = 19.9 years and $M_{English\text{-}Monolinguals}$ = 20.0 years; Spanish-dominant vs. English-Spanish, t (1, 29)= 2.26, p = .032; Spanish-dominant vs. English monolinguals, t (1, 30)= 2.35 p = .026).

Next, the age of L2 acquisition was compared using a one-way ANOVA, with language group as the independent variable. This analysis indicated that there was a significant difference between groups, F (2, 56) = 4.38, p = .017. Note that is this case, the L2 was the Spanish language for the English-Spanish group, but the English language for the two Spanish-English dominance groups. The main reason for this analysis is to compare overall L2 experiences despite language type. Multiple comparisons indicated that the English-dominant group, on average, learned their L2 earlier (M = 6.7) than the English-Spanish and Spanish-dominant bilingual groups[3] ($M_{English\text{-}Spanish}$ = 10.7; English-dominant vs. English-Spanish t (1, 33) = -2.53,

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[2] For the rest of the analyses, the Spanish-English bilingual groups when split by language group will be referred by their dominance only. That is, Spanish-English bilinguals who are dominant in English will from now on be called *English-Dominant* and Spanish-English bilinguals who are dominant in Spanish will be called *Spanish-Dominant*.

[3] Statistically significant differences between the English-dominant and Spanish-dominant groups will not be discussed in this section, as they have been previously described in the prior section.

p = .016). The English monolinguals reported not knowing or learning an L2 at any point in their lives and thus were excluded from the analyses.

Differences in length of L2 immersion (in years) were then analyzed using a one-way ANOVA with language group as the independent variable. This analysis showed a significant difference in L2 immersion length, F (2, 56)= 12.62, $p < 0.00$. Post-hoc analyses indicated that both English-dominant and Spanish-dominant groups had been immersed in an L2 environment longer than the English-Spanish group ($M_{English\text{-}Dominant}$ = 14.3 years, $M_{Spanish\text{-}dominant}$ = 7.6 years, and $M_{English\text{-}Spanish}$ = 0.3 years; English-dominant vs. English-Spanish, t (1, 33) = 20.73, $p < 0.00$; Spanish-dominant vs. English-Spanish, t (1, 29) = 16.93, p = .004).

Two separate one-way ANOVAs were performed using language group as the independent variable and the mean English and Spanish self-ratings as the two dependent variables. The results form these two analyses revealed significant differences between groups for English ratings, [F (3, 66) = 10.33, p = .00], and for Spanish ratings, [F (2, 54) = 5.11, $p <$ 0.01]. Post hoc analyses revealed that the English-Spanish bilinguals rated themselves on average significantly higher in English proficiency (M =10.0) than both of the Spanish-English bilingual groups ($M_{English\text{-}Dominant}$ = 8.5 vs. $M_{Spanish\text{-}Dominant}$ = 7.5; English-Spanish vs. English-dominant, t (1, 33) = -2.84, p = .008; English-Spanish vs. Spanish-dominant, t (1, 29) = -6.79, p = .00). There was no statistical difference between the English ratings for the two native English groups. The post hoc analyses also revealed that the Spanish-dominant group had a significantly lower proficiency level compared to all groups. Planned comparisons for the mean Spanish ratings indicated that the English-Spanish group rated their Spanish proficiency skills on average significantly lower (M = 7.1) than both Spanish-English dominance groups ($M_{English\text{-}Dominant}$ = 8.8 vs. $M_{Spanish\text{-}Dominant}$ = 8.7; English-Spanish vs. English-Dominant t (1, 33) = 3.09, p

= .004; English-Spanish vs. Spanish-Dominant, t (1, 29) = 2.80, p = .009). The English monolinguals were not included in the cross-group comparison for Spanish ratings, as they did not report any proficiency of this language. Thus the statistically analysis for the English ratings had all four groups, while the Spanish ratings only included the data provided by the three bilingual groups.

Overall, the cross-language group comparison revealed that the Spanish-dominant bilinguals were slightly older than the two native language group. Additionally, the English-Spanish bilingual group had spent significantly less time in an L2 environment, Spanish, as compared to the length of English immersion experience for both the Spanish-English dominance groups. Not surprisingly, the English-Spanish bilinguals were overall more proficient in English and less proficient in Spanish than the two native Spanish speaker groups. Taken together, these findings provide a spectrum of linguistic variation and differences among L2 experience and suggest that a person's language experience may in fact have an influence in how people experience the word. The lexical tasks data will be discussed next. One questions is whether these different linguistic experiences will emerge during lexical processing in two different tasks, namely verbal fluency and picture naming.

Table 3

Language History Questionnaire Data for All Language Groups

	Language Groups			
Measure	*Spanish-Dominant N=22*	*English-Dominant N=26*	*English-Spanish N=9*	*English Mono N=10*
Age (Years)	26.7 (8.9) *	23.7 (6.6)	19.9 (1.9)	20.0 (1.6)
L1 Ratings (10 pt)				
Reading	8.7 (1.4)	8.5 (1.7)	10.0 (0.0)	9.4 (0.7)
Writing	8.1 (1.8)	8.4 (1.8)	9.9 (0.3)	8.6 (1.4)
Speaking	9.1 (1.5)	9.1 (1.3)	10.0 (0.0)	9.0 (1.2)
Listening	9.0 (1.5)	9.1 (1.3)	10.0 (0.0)	9.1 (1.1)
Mean	9.0 (1.2)	9.0 (1.2)	10.0 (0.1)	
L2 Ratings (10 pt)				
Reading	7.5 (1.1)	8.6 (1.4)	7.9 (5.0)	N.A.
Writing	7.2 (1.2)	8.3 (1.8)	6.9 (2.4)	N.A.
Speaking	7.5 (1.3)	8.5 (1.6)	6.8 (1.4)	N.A.
Listening	7.9 (1.4)	8.7 (1.4)	8.0 (1.4)	N.A.
Mean	7.8 (1.0)	8.9 (1.3)	7.4 (1.0)	N.A.
AoA of L2 (Years)	10.3 (5.6)	6.6 (4.2)	10.7 (5.6)	N.A.
Years in L2	7.6 (6.0)	14.3 (9.6)	0.3 (0.3)	N.A.

Note. Standard deviations are in parentheses.

Verbal Fluency Analyses and Results

Spanish-English bilinguals. The verbal fluency data were coded for accuracy and all errors or repetitions were excluded from any analysis. Figure 2 shows the overall data for the Spanish-English bilingual language group for each language production block. A paired samples *t*-test was used to compare differences in the number of exemplars produced for each language block. The Spanish-English bilinguals produced slightly more exemplars in English (M = 10.5) than in Spanish (M = 10.0). Although, the analysis showed that the difference between languages did not reach significance, t (47) = 1.41, p = .164. In conjunction with the previous language history data, these results indicate that while the Spanish-English bilinguals rated themselves as more proficient in Spanish than English, they actually produced slightly more exemplars in English than Spanish. Nevertheless, as previously observed in the analyses of language proficiency ratings, no significant differences in language block emerged for the verbal fluency data. Thus, splitting the groups by language dominance may offer a finer grain analysis of the extent to which differences in language experience may influence lexical processing.

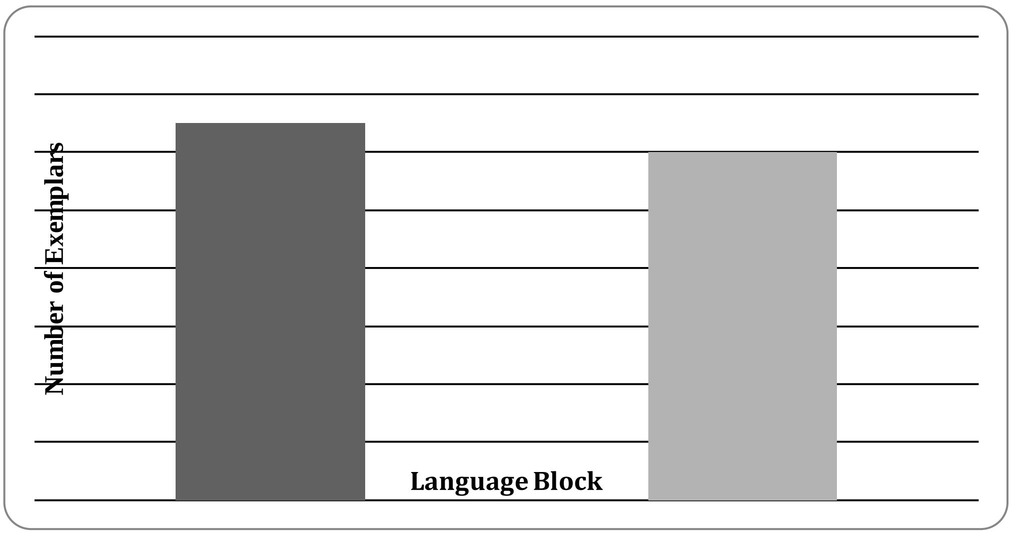

Figure 1.1. Mean number of exemplars produced in English and Spanish for the Spanish-English bilinguals during the verbal fluency task.

Spanish-English bilinguals by dominance group. The bilingual group was than split by language dominance and each group's data are displayed in Figure 1.2[4]. A 2 x 2 repeated measures ANOVA examined the total number of exemplars produced by the participants. Dominance group (Spanish dominant vs. English dominant) was the between-subjects factor and production language (English vs. Spanish) was the within-subjects factor. There was no main effect of production language, F (1,46) = 2.31, p= 0.14, with both groups of Spanish-English

[4] As previously mentioned, language dominance was based on average number of exemplars produced for each language in the verbal fluency task.

bilingual groups producing the same amount of exemplars in both languages ($M_{Spanish\text{-}Dominant}$ = 9.9 vs. $M_{English\text{-}Dominant}$ = 10.6). The interaction between dominance and production language was significant, $F(1,46) = 70.36$, $p = 0.00$. Spanish-English bilinguals who were deemed English-dominant produced more exemplars in English than Spanish ($M_{English}$ = 11.7 and $M_{Spanish}$ = 9.5). Spanish-English bilinguals who were deemed Spanish-dominant produced more exemplars in Spanish than English ($M_{Spanish}$ = 10.7 and $M_{English}$ = 9.2). These results are not surprising, as the verbal fluency scores for the participants were used as indication of language dominance. Nevertheless, the presence of an interaction between language and language group provides statistical evidence that the dominance grouping were accurate and show an overall trend of language dominance.

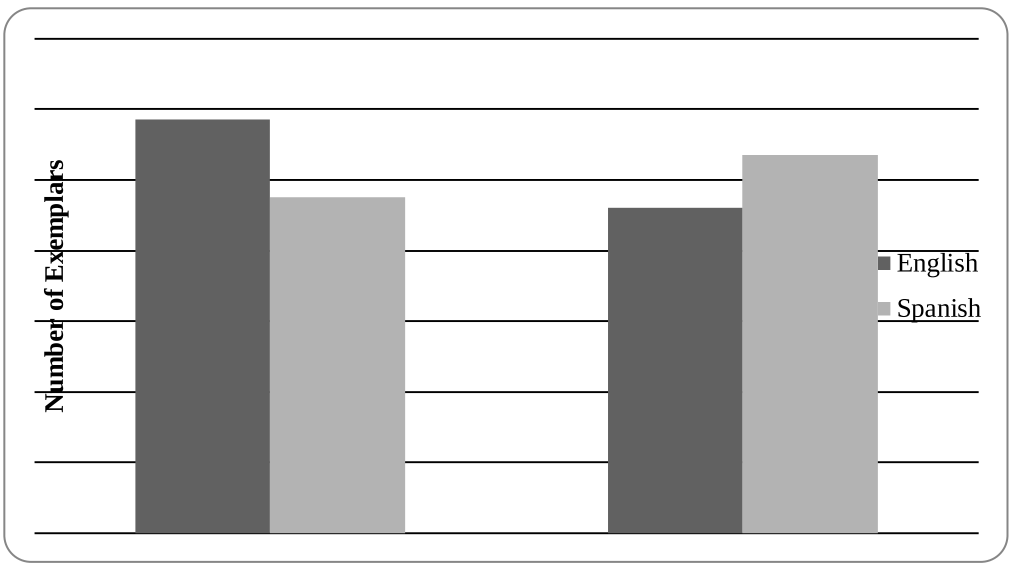

Figure 1.2. Mean number of exemplars produced in English and Spanish for the Spanish-English bilinguals during the verbal fluency task by dominance group.

Cross language group comparison. The performance on the verbal fluency task by the two Spanish-English groups was then compared to the data collected from the two native English control groups. Figure 1.3 shows the mean number of exemplars produced by each language group for each language block. Two one-way ANOVAs were completed for both the English and Spanish data, with number of exemplars produced as the dependent variable and language group as the fixed factor. The analysis for the English verbal fluency data revealed a main effect for language group, $F(1, 63) = 10.15$, $p < .00$. Multiple comparisons revealed that the English-Spanish bilinguals produced significantly more exemplars in English ($M = 12.9$) than both native English monolinguals and the Spanish-dominant bilinguals ($M_{English\ Mono} = 10.8$ vs. $M_{Spanish\text{-}Dominant} = 9.2$; English-Spanish vs. English Monolinguals, $p = .025$). There was no statistically significant difference between the English-dominant bilingual group and both the English-Spanish bilinguals and the English monolingual groups for English verbal fluency score.

The Spanish verbal fluency analysis also revealed a main effect for language group on the amount of exemplars produced, $F(1, 54) = 10.12$, $p = .00$. Multiple comparisons revealed that the English-Spanish groups produced significantly fewer exemplars in Spanish ($M = 6.9$) as compared to both the Spanish-English dominance groups ($M_{English\text{-}Dominant} = 9.5$ vs. $M_{Spanish\text{-}Dominant} = 10.7$; English-Spanish vs. English-Dominant and English-Spanish vs. Spanish-dominant, $p < .00$). There was no significant difference between the two Spanish-English bilinguals in the number of exemplars produced during the Spanish block.

The results of the cross-language group comparison revealed that contrary to previous theories that propose lexical access deficits for bilinguals (See the Weaker Links Theory in Gollan et al., 2002), all three bilingual groups produced a similar amount of exemplars, if not more, in their dominant language than the monolingual group. Furthermore, both the English-Spanish and English-dominant groups produced even more exemplars in English than the monolingual group. These results indicate that there is no evidence in verbal fluency for a bilingual disadvantage in lexical retrieval as proposed by the weaker links theory (Gollan et al., 2008). One possibility is that by splitting the Spanish-English bilinguals into different dominance groups, a clearer view of the effect of language experience on lexical access emerged, that had been previously concealed. Prior experiments may have analyzed verbal fluency scores without taking into account language dominance, thus muddling measurements of lexical access. The proposed lexical deficit view in some previous work may actually be an artifact of averaging across groups that have different language experiences, and not an inherit feature of bilingual language processing.

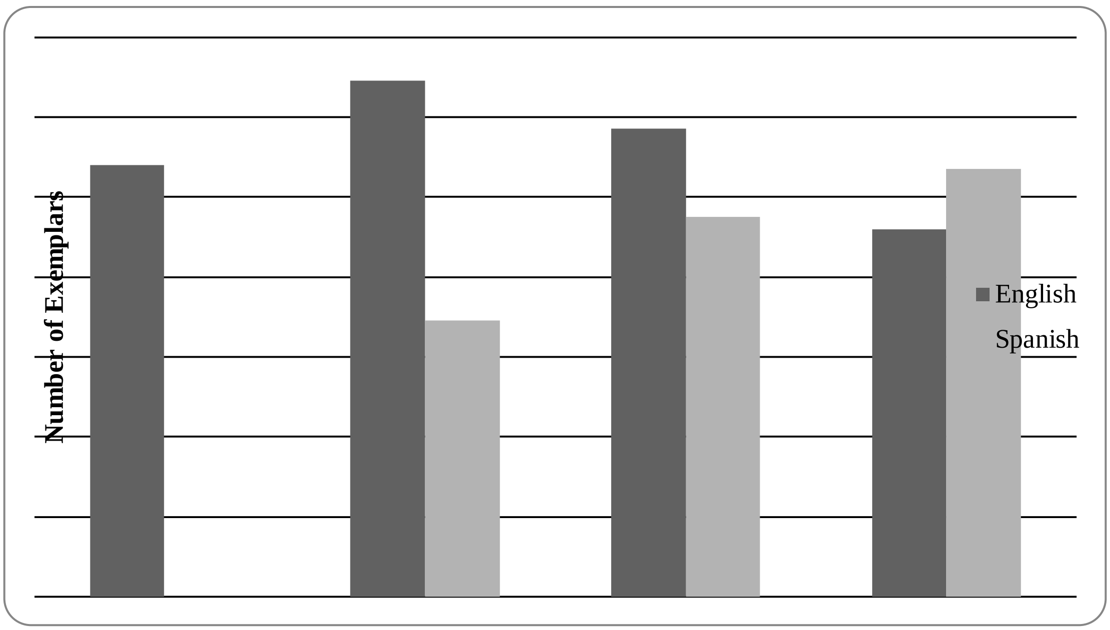

Figure 1.3. Mean number of exemplars produced in English and Spanish for the verbal fluency task by language group.

Picture Naming Analyses

Spanish-English bilinguals. Picture naming data were scored for reaction times (in milliseconds) and accuracy (out of 100 percent). Reaction times (RT)s for naming pictures that were 2.5 standard deviations above or below a participant's mean, more than 3000 ms, or any trial on which a problem was encountered in the recording of spoken responses were excluded from analyses. Separate 2 x 2 repeated measures ANOVAs were performed for both the mean

RT and accuracy data as dependent variables. Cognate status (cognate/noncognate) and production language (English or Spanish) were the within-subjects, independent variables.

Picture naming reaction time analysis. For the mean RT analysis, there was a main effect for cognate status, where cognates were named faster than non-cognates, $F\ (1,47) = 15.44$, $p = 0.00$; $M_{Non\text{-}Cognates} = 1060$ ms vs. $M_{Cognates} = 1000$ ms. Figure 2.1 displays the mean RTs by cognate status and production language for the Spanish-English group. There was no main effect for production language, $F\ (1,47) = 1.16$, $p = .287$. However, there was an interaction such that cognate pictures were named faster than non-cognates in Spanish ($M_{Cognates} = 984$ ms vs. $M_{Non\text{-}Cognates} = 1112$ ms) than in English ($M_{Cognates} = 1016$ ms vs. $M_{Non\text{-}Cognates} = 1009$ ms). In fact, there was no difference in mean latencies for naming non-cognates versus cognates in English.

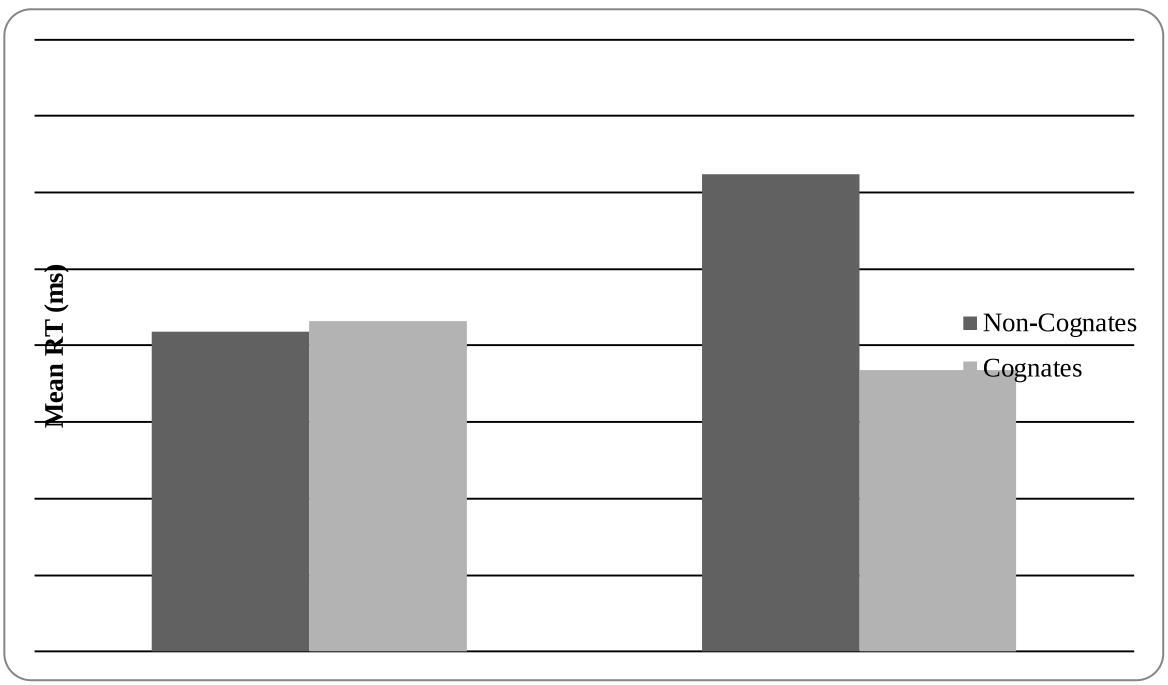

Figure 2.1. Mean RTs (in milliseconds) for Spanish-English bilinguals in the picture-naming task for both English and Spanish across cognate status.

Picture naming accuracy analysis. Accuracy data was scored out of 100 percent. Mean accuracy scores across cognate status and production language are shown in Figure 2.2. The statistical analysis, revealed a main effect of cognate status, $F(1,47) = 7.92$, $p = 0.007$. Spanish-English bilinguals were more accurate in naming cognate pictures than non-cognate pictures ($M_{Cognates} = 87.8\%$ vs. $M_{Non\text{-}Cognates} = 85.3\%$). There was no main effect for language ($F(1,47) < 1$, $p = .352$) and no interaction between language and cognate status ($F(1,47) = 3.12$, $p = .084$).

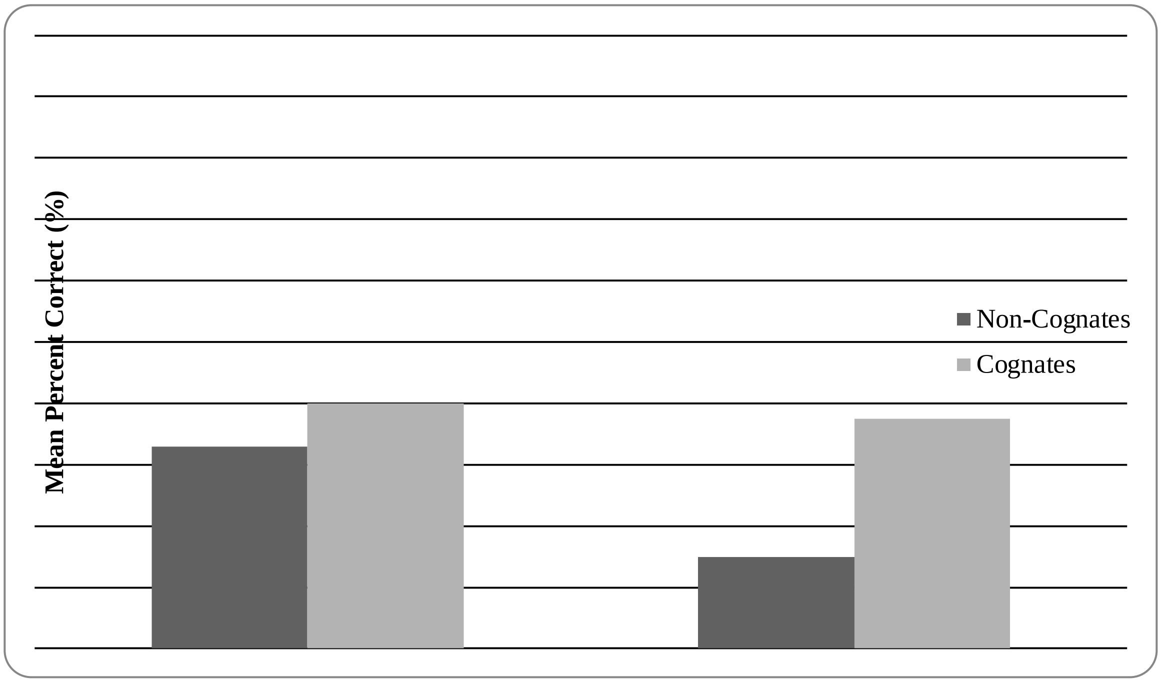

Figure 2.2. Mean accuracy (%) for picture-naming in both English and Spanish across cognate status.

Discussion: Spanish-English bilingual picture naming. When analyzed as a group, the Spanish-English bilinguals named pictures equally fast in English and Spanish. Although, the Spanish-English bilinguals were slightly faster to name pictures in English than Spanish, the analyses failed to reach statistical significance. The accuracy data showed a similar pattern with bilinguals naming pictures equally fast in both languages. These results mirror the previous findings for the verbal fluency task and language proficiency ratings. Finally, the analyses revealed that the Spanish-English bilinguals named cognate pictures faster and more accurately than non-cognate pictures. These results provide support for theories of non-specific selectivity.

Specifically the results indicate that both languages remain active during picture naming, such that activation from both lexicons converge for cognates making them more accessible and thus faster to produce. Nevertheless, examining the picture naming data for each dominance group may provide a clearer picture of how different language experiences affect lexical processing.

Spanish-English bilinguals by dominance group Another set of analyses was completed comparing the mean latency and accuracy for each language dominance group. Separate 2 x 2 x 2 repeated measures ANOVAs were performed comparing the mean RTs and mean accuracy for each different dominance groups. For these analyses, cognate status (cognate vs. non-cognate) and production language (Spanish vs. English) were the within-subjects variables, with dominance group (Spanish-dominant vs. English-dominant) as the between-subjects variable[5].

Picture naming latencies. Figure 2.3 shows the mean picture naming latencies in English and Spanish for the Spanish-English bilinguals, grouped by language dominance. There was a significant two-way interaction for production language and dominance group, F (1,46) = 15.14, p = 0.00. The English dominant group named pictures faster in English than Spanish ($M_{English}$ = 971 ms vs. $M_{Spanish}$ = 1111 ms), while the Spanish-dominant group named pictures faster in Spanish than English ($M_{Spanish}$ = 973 ms vs. $M_{English}$ = 1060 ms). No other significant main effects or interactions were observed.

[5] Main effects and interactions not involving the between-subjects variable, dominance group, will not be discussed here, as they have been previously described in the prior section.

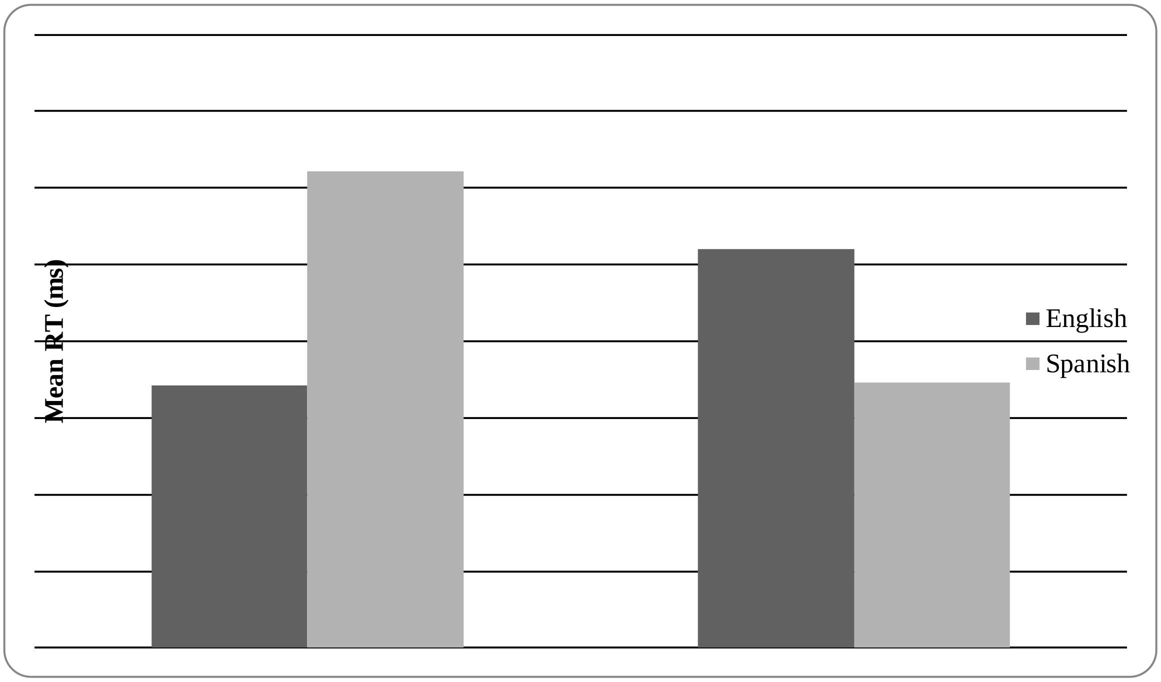

Figure 2.3. Mean RTs (in milliseconds) for Spanish-English bilinguals on the picture-naming task for both English and Spanish across dominance group.

Picture naming accuracy analysis. The picture naming accuracy analyses revealed a significant two-way interaction for production language and dominance group (F (1,46) = 8.21, p = 0.006). The English dominant group named pictures more accurately in English than Spanish ($M_{English}$ = 90.3% vs. $M_{Spanish}$ = 82.8%), while the Spanish-dominant group named pictures more accurately in Spanish than English ($M_{Spanish}$ = 88.1% vs. $M_{English}$ = 83.8%). Figure 2.4 displays the overall mean accuracy for each dominance group by language block. There was a three-way interaction between production language, cognate status and dominance group, F (1,46) = 7.69, p = 0.008. The cognate facilitation effect was largest for the English-Dominant group naming pictures in Spanish. English-dominant bilinguals were more accurate in naming pictures of cognate words than non-cognate words in Spanish, than in English. The English data for this group shows no difference in accuracy across cognate status. The Spanish group shows a similar pattern, but reversed for language. Specifically, the Spanish-dominant participants were more accurate at naming pictures of cognate words than non-cognate words in English than Spanish. The cognate facilitation effect was very minimal in the Spanish picture naming accuracy data. Previous research has indicated that the cognate facilitation will be larger for bilinguals in their less proficient or dominant language (Heredia, 1997). That is, faster naming times for cognate words occur due to the increased activation from the dominant language assisting the production in the less-dominant language. Figure 2.5 displays the mean accuracy scores for both Spanish and English across dominance groups and cognate status.

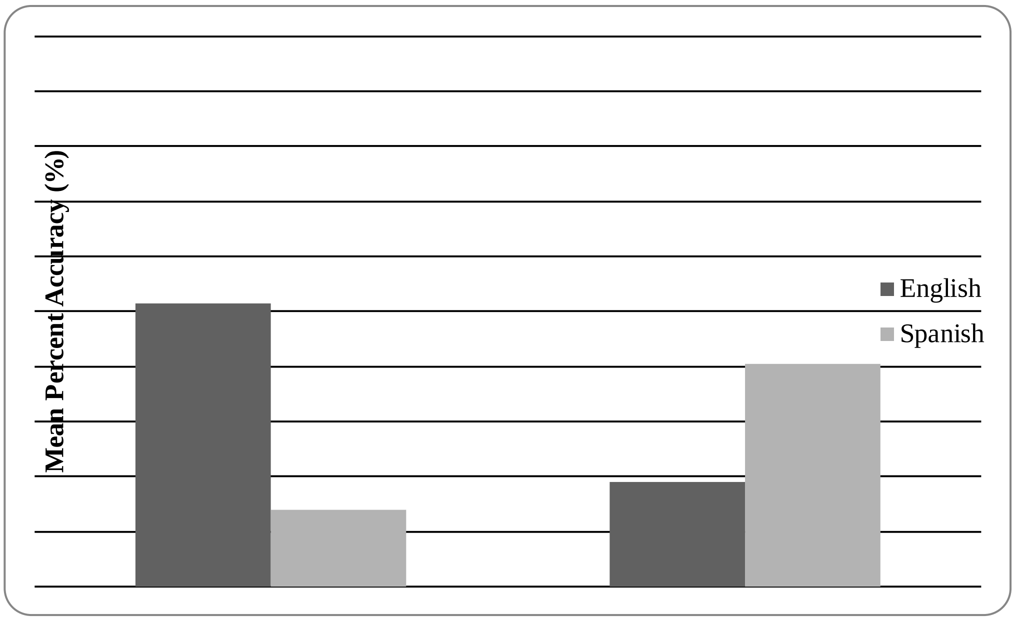

Figure 2.4. Mean accuracy (%) for Spanish-English bilinguals on the picture-naming task for both English and Spanish across dominance group.

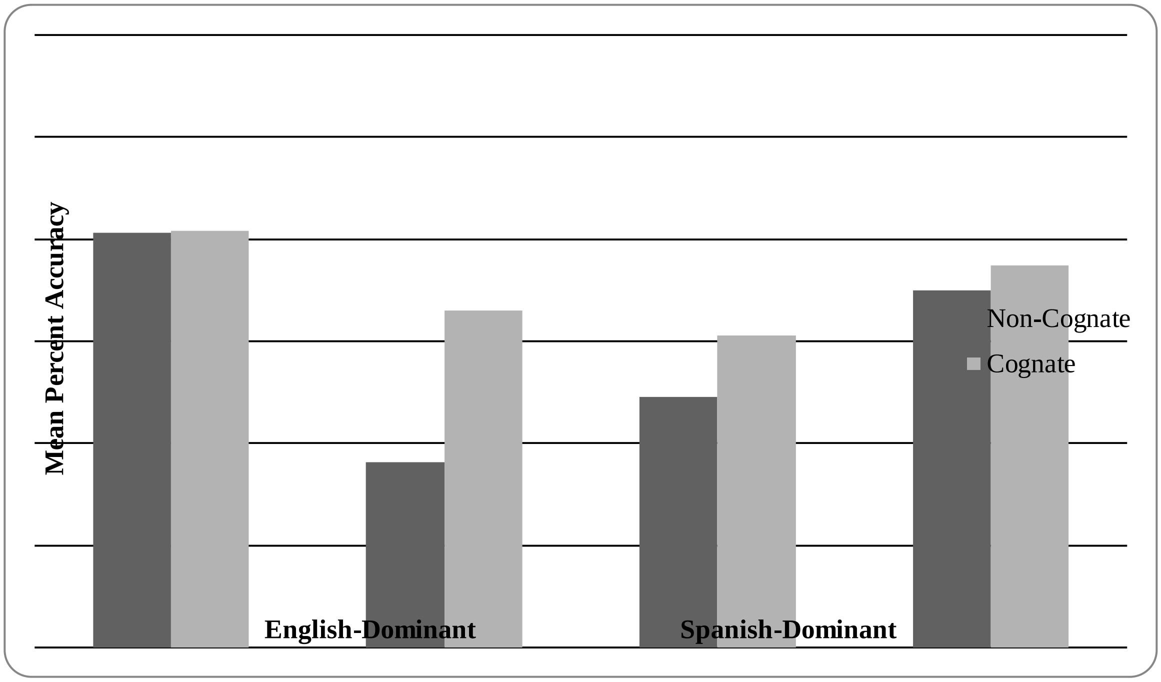

Figure 2.5. Mean accuracy (%) for Spanish-English bilinguals on the picture-naming task for both English and Spanish across dominance group and cognate status.

***Discussion: Spanish-English picture naming analysis by dominance*.** Each dominance group named pictures faster and were more accurate in their dominant language. The English-dominant bilinguals named pictures faster in English than in Spanish. The Spanish-dominant group displayed the opposite pattern, naming pictures faster in Spanish than English. The accuracy analyses display this same pattern for each dominance group. Furthermore, the accuracy data analyses indicated a significant interaction between language, cognate status, and dominance group. These results suggested that the magnitude of the facilitation effect (the difference in RTs between non-cognate and cognate picture naming) was larger for the English-dominant group when naming in Spanish than in English. As previously mentioned, the magnitude of the cognate facilitation effect is larger for the non-dominant language. While the English-dominant bilinguals have Spanish as the native language, the performance data for picture naming, as well as verbal fluency, indicates that they have become more dominant in their L2 English. The previous analyses provide further evidence of the effects of both L2 immersion and language dominance on lexical access. Specifically, these results indicate that Spanish-English bilinguals, who have been immersed in the L2 environment for an extended period of time, may in fact become more dominant, in English. As a result, changes to linguistic processing at the lexical level are predicted for this group, such that lexical access should be easier for the now dominant English language in comparison to Spanish. Finally, the analysis of the mean RT and accuracy data for both English and Spanish picture naming converge with the verbal fluency data to support the initial groupings based on language dominance.

Cross-language groups comparisons. A 2 x 4 repeated measures ANOVA was performed for English picture naming data for both the mean RT and mean accuracy data for each language group. For these anlyses cognate status (noncognate vs. cognate) was the within-subject factor and language group was the between-subjects factor (Monolingual English, English-Spanish, English-Dominant, & Spanish-Dominant). The dependent variables were the mean RT produced when naming English pictures.

Picture naming latencies. There was a significant main effect for cognate status for the difference in RTs, F (1,63) = 19.35, p = .00. English pictures of non-cognate words were actually named faster (M = 915 ms) than cognate words (M = 971 ms). This result is somewhat unexpected, as previous research shows that bilinguals name cognates faster than non-cognates. However, the cognate facilitation effect may not be apparent in the current analyses due to the incorporation of English monolingual data. Based on theories of lexical access, bilinguals name cognates faster due to converging activation from both languages. Monolinguals should not show cognate facilitation because they have had no experience with a second language. Future analyses are needed to examine whether there is something specific about the English words, such as differences in frequency, or a result of differences in language processing skills of the four groups.

The current analyses also revealed a main effect for language group, F (3, 63) = 4.67, p = .005. Post-hoc analyses indicated that the two native English groups named pictures significantly faster than the Spanish dominant group ($M_{English\ Mono}$ = 871, $M_{English\text{-}Spanish}$ = 870, and $M_{Spanish\text{-}Dominant}$ = 1060; English Monolinguals vs. Spanish-Dominant and English-Spanish vs. Spanish-Dominant, p < .00). There was no statistically significant difference between the mean RTs for the English-Dominant group in comparison to any of the language groups (M = 971 ms). Figure 2.6 shows the mean RT for each language group.

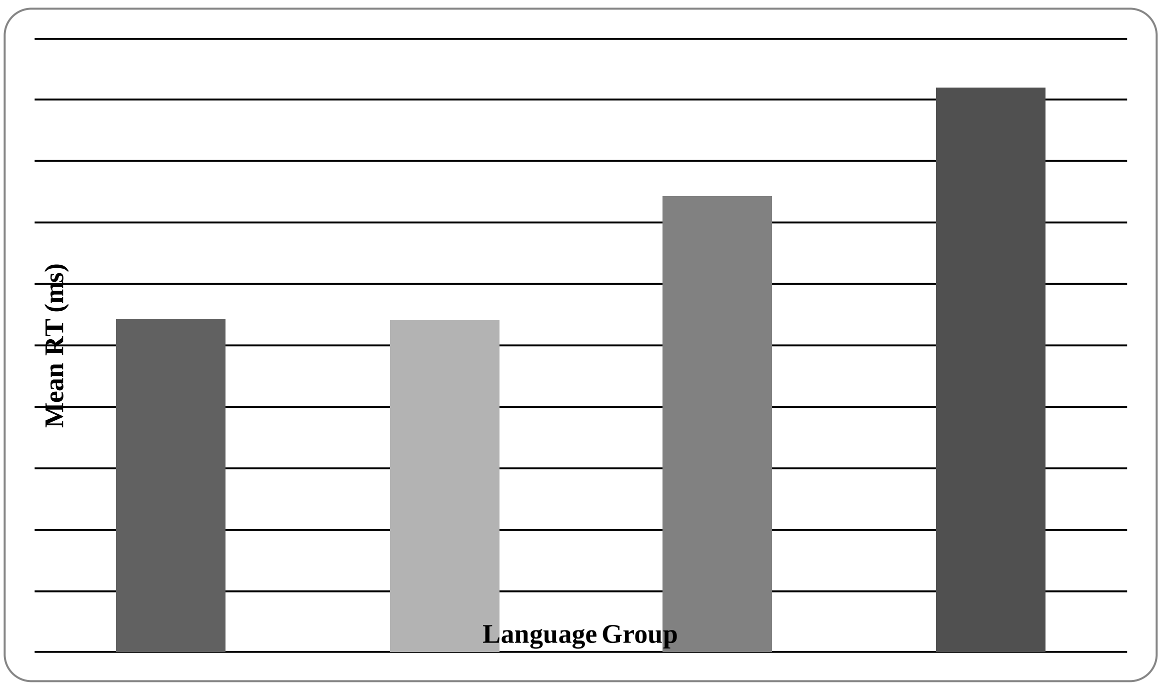

Figure 2.6. Mean RTs (in milliseconds) for English picture-naming task across language group.

There was also a two-way interaction between cognate status and language group, F (3, 63) = 6.25, p = .001. Figure 2.7 shows the mean RT for each language group by cognate status. Based on the pattern of the interaction, there could be something about the English materials used that is not sensitive enough to capture the true nature of the cognate effect. Specifically, this finding indicates that the current task may be underestimating the full cognate effect for the bilingual groups. Further research is needed to clarify these findings.

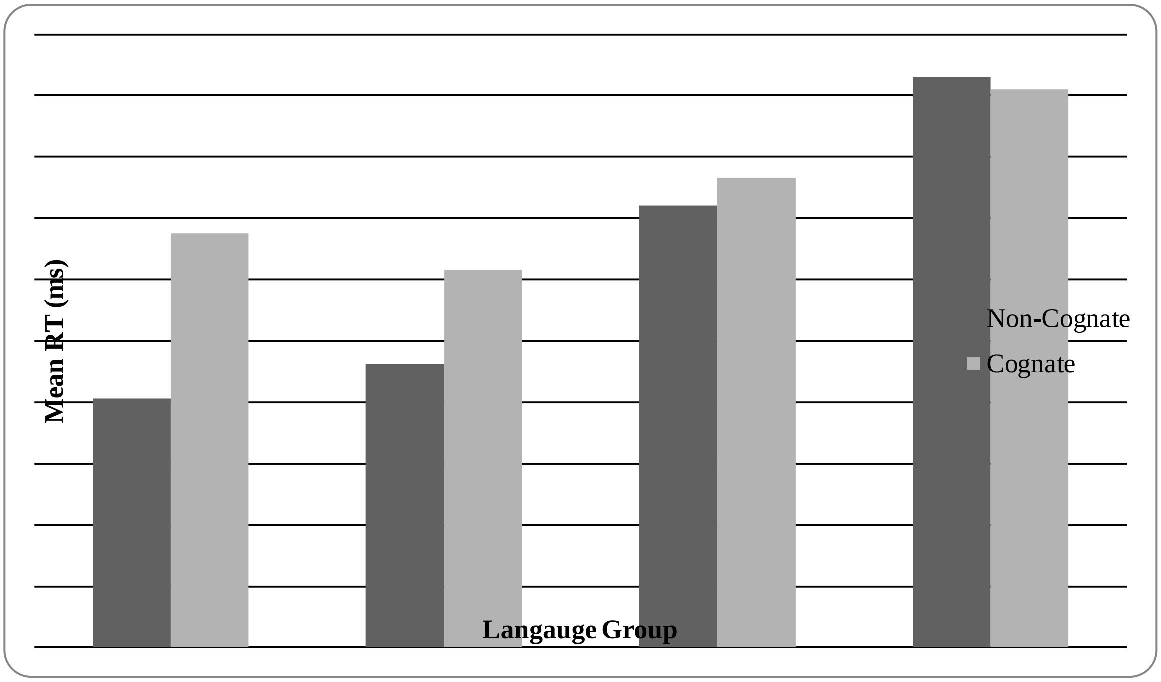

Figure 2.7. Mean RTs (in milliseconds) for English picture-naming task across language group and cognate status.

The Spanish picture naming data for both mean RT and accuracy scores were then analyzed between the three bilingual groups. A 2 x 3 repeated measures ANOVA was performed for mean RTs for Spanish picture naming. Cognate status (Cognate/Non-Cognate) was the within-subjects variable and language group (English-Spanish, English-Dominant, Spanish-Dominant) was the between-subjects variable. The analysis showed both a main effect for language group, F (2, 54) = 14.52, p = .00, and for cognate status, F (1, 54) = 36.58, p = .00. The language group analysis revealed that the Spanish-dominant group named pictures significantly faster (M = 973 ms), than both the English-dominant (M = 1111 ms), and English-Spanish (M = 1307 ms) groups. Figure 2.8 displays the mean RT for Spanish picture naming by language group.

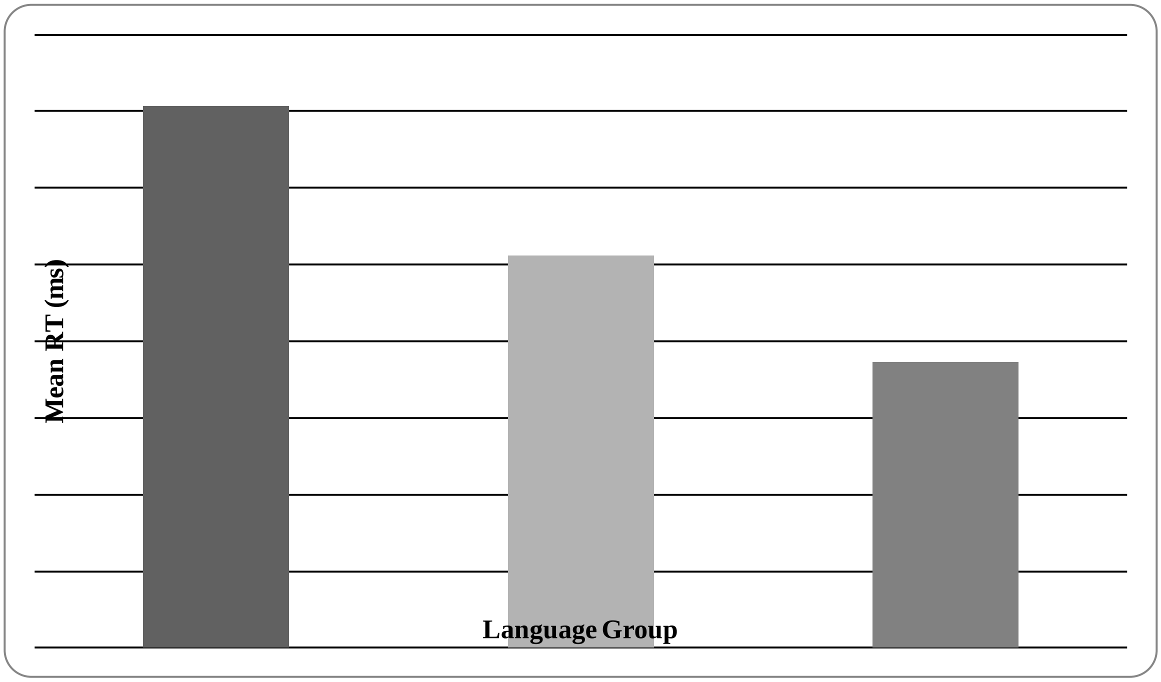

Figure 2.8. Mean RTs (in milliseconds) for Spanish picture-naming task across language group.

The cognate status analysis revealed that all cognate pictures were named significantly faster (*M* = 1054 ms), than non-cognate pictures (*M* = 1207 ms). There was no two-way interaction between language group and cognate status for mean Spanish picture naming RTs. Figure 2.9 displays the data for Spanish picture naming data for all language groups split by cognate status.

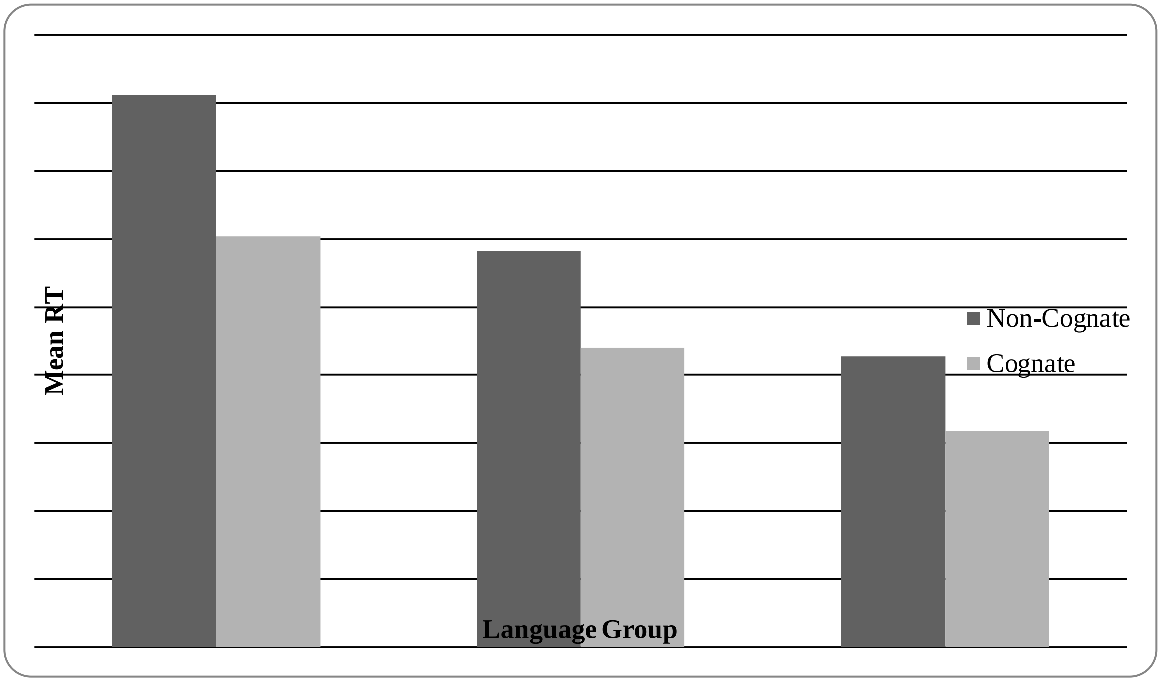

Figure 2.9. Mean RTs (in milliseconds) for Spanish picture-naming task across language group and cognate status.

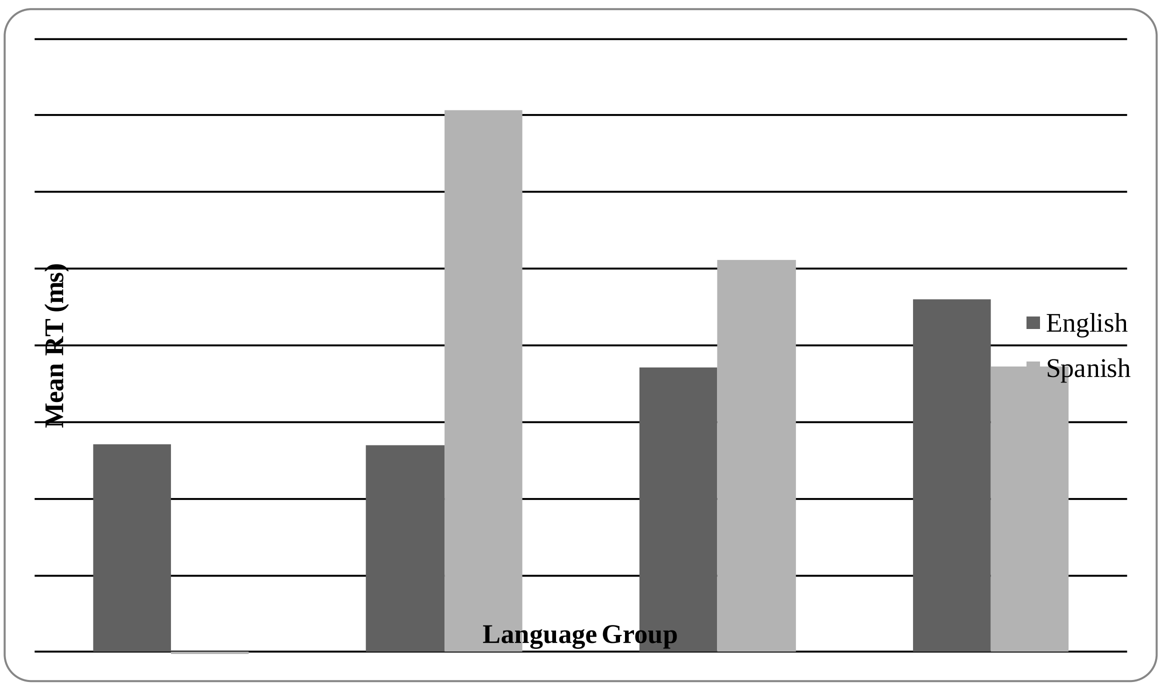

Figure 3.0. Overall mean RTs (in milliseconds) in English and Spanish across all language groups.

***Picture naming accuracy*.** A 2 x 4 repeated measure ANOVA was performed for accuracy scores for the English picture-naming task across all language groups. Cognate status (Cognate vs. Non-Cognates) was the within-subject variable and language group (English Monolinguals, English-Spanish, English-dominant, Spanish-dominant) was the between-subjects variable. There was no main effect for cognate status, as non-cognates pictures (*M* = 89.0%) were named as accurately as cognate pictures (*M* = 90.5%), *F* (1, 63) = 1.39, *p* = .243. There was a main effect for language group, *F* (3, 63) = 4.69, *p* = .005. Multiple comparisons showed that the Spanish-dominant group (*M* = 83.8%) named pictures statistically worse than the English-dominant (*M* = 90.3%) and English-Spanish (95.0%) groups (Spanish-dominant vs. English-dominant, *p* = .009; Spanish-dominant vs. English-Spanish, *p* = .001). There was no significant difference between the English monolinguals and the other three language groups. There was no significant two-way interaction between cognate status and language group, *F* (3,63) < 1, *p* = .691.

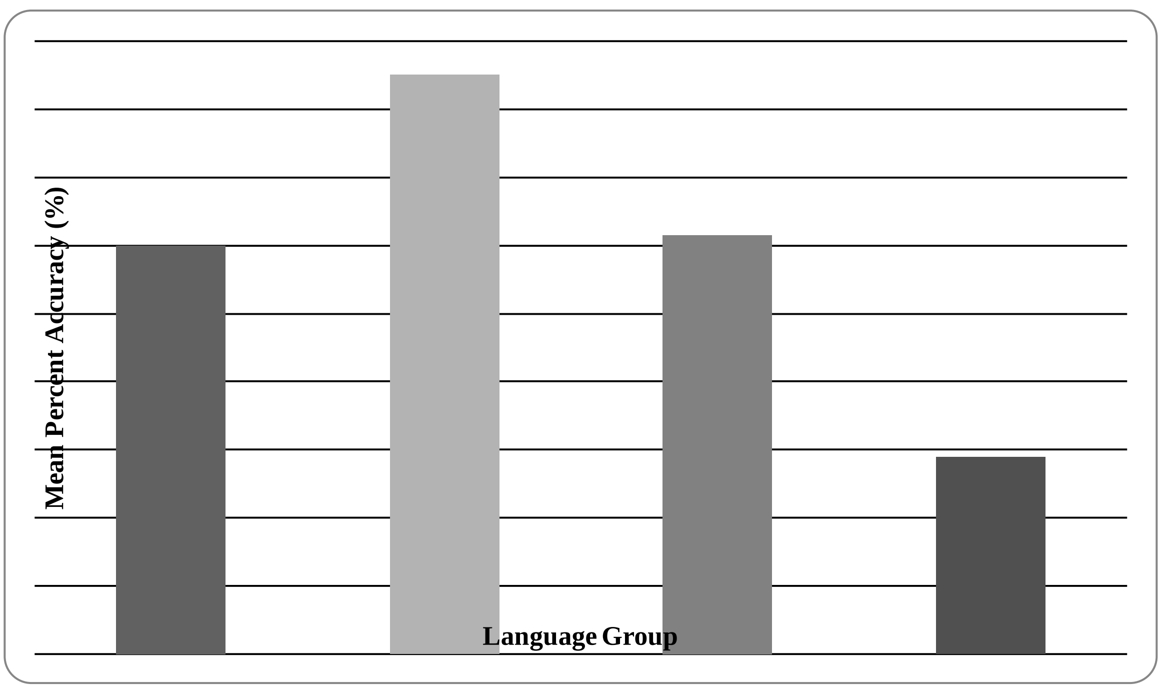

Figure 3.1. Mean percent accuracy (%) for English picture naming for all language groups.

The Spanish picture naming data was then analyzed for accuracy with a 2 x 3 repeated measures ANOVA. Cognate status (Cognate vs. Non-Cognate) was the within-subjects variable and language group (English-Spanish, English-Dominant, Spanish-Dominant) was the between-subjects variable. There was a main effect for language group (F (2,54) = 30.24, p = .00), as well as for cognate status (F (1, 54) = 57.64, p = .00). There was also a significant interaction between cognate status and language group for percent accuracy in Spanish picture naming, F (2,54) = 19.75, p = .00).

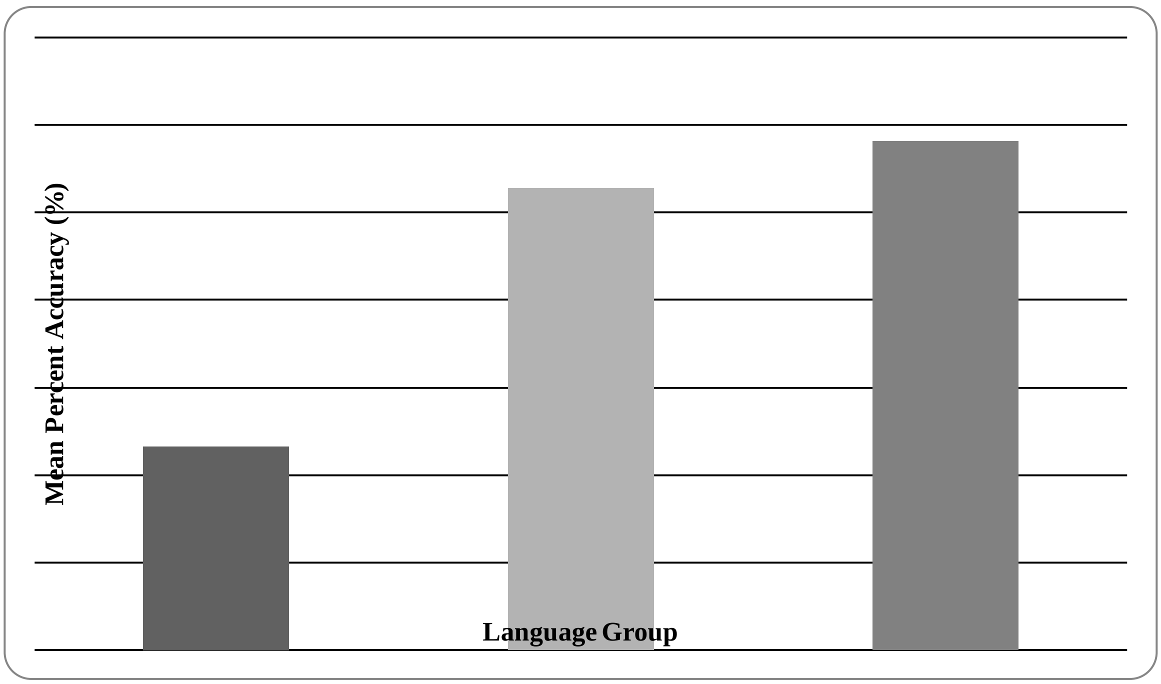

Figure 3.1. Mean percent accuracy (%) for Spanish picture naming accuracy for all language groups.

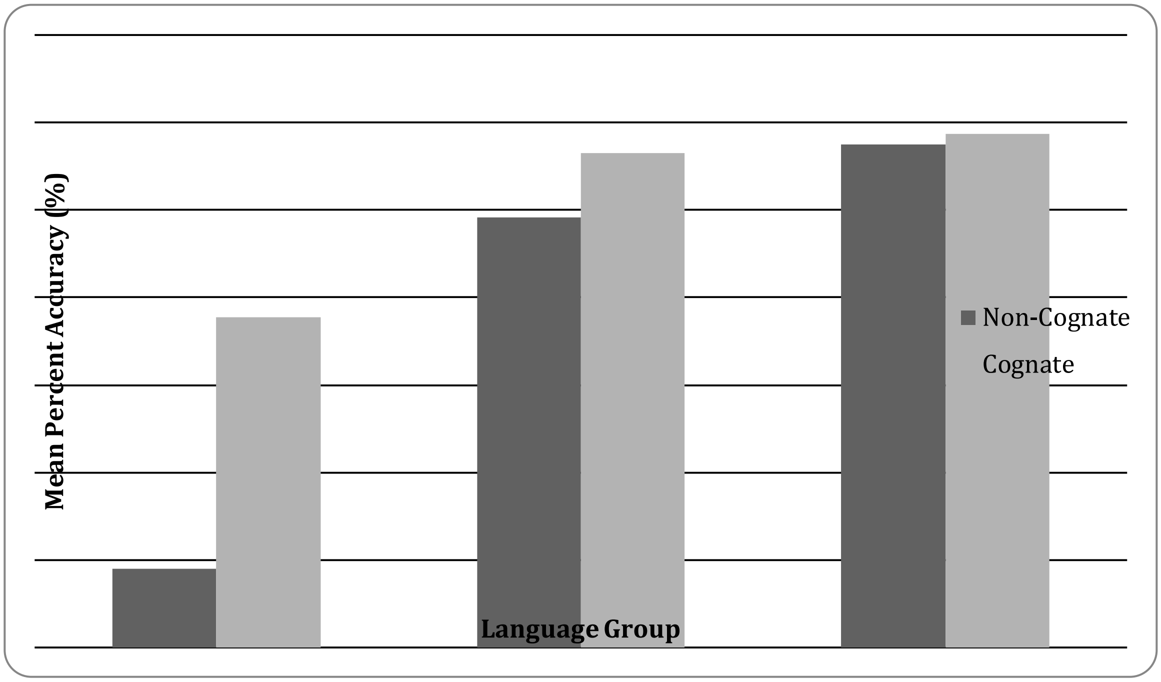

Figure 3.2. Mean percent accuracy (%) for Spanish picture naming accuracy for all language groups across cognate status.

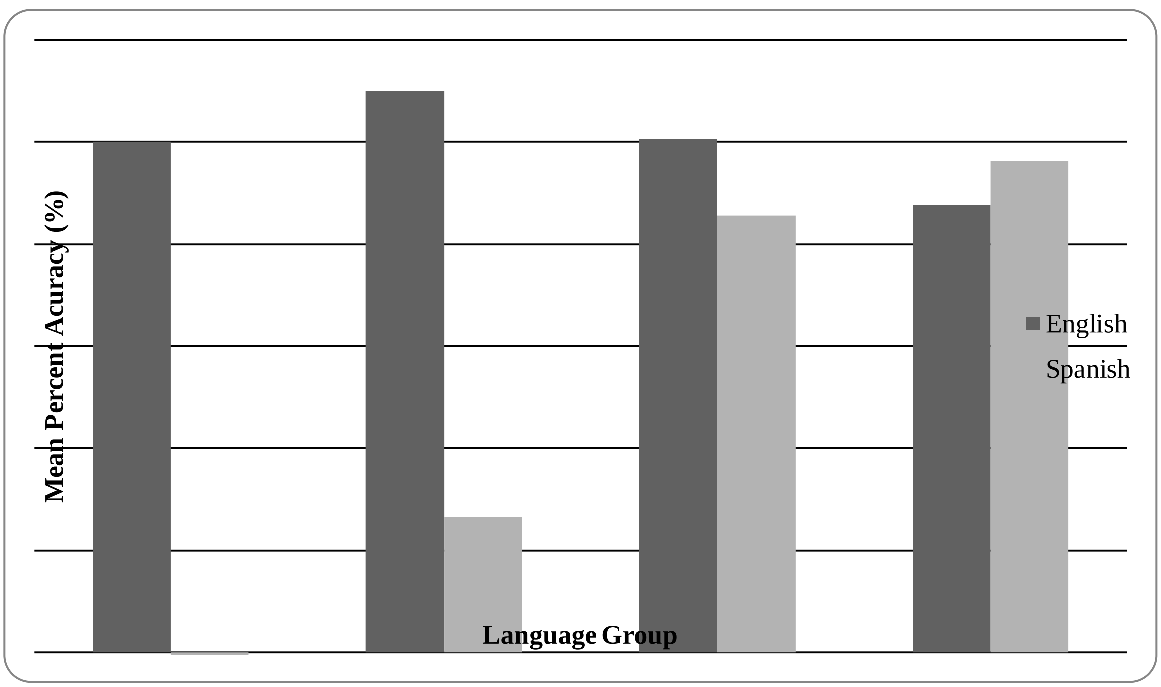

Figure 3.3. Overall mean percent accuracy (%) for English and Spanish picture naming for all language groups.

Chapter 4: Sentence Processing and Individual Difference Measures Results

Sentence Processing Task

The means and standard deviations for each participant's reaction times (in milliseconds) were computed. Any reaction time (RT) that was outside of 2.5 standard deviations of the mean for each participant was excluded from the analysis. Mean RTs were calculated by averaging the reading times for the critical region (the disambiguating word) as well as three words following this region. In addition to latency data, participants answered a set of comprehension questions for filler items. The accuracy data for the comprehension questions was scored out of 100 percent.

Spanish-English bilinguals. The mean correct RT and accuracy data for the Spanish-English bilingual group was analyzed using separate 2 x 2 repeated measures ANOVA with language (English vs. Spanish) and attachment type (high vs. low) as the within-subjects measures.

Response latencies analysis. The analysis revealed a main effect for language, $F(1, 47) = 27.08$, $p = .00$. The Spanish-English bilinguals produced on average faster RTs when reading the disambiguating region in English (M = 437 ms) than in Spanish (M = 522 ms). Figure 4.0 displays the overall pattern for latency data across both English and Spanish sentences. In addition, the statistical analysis revealed no main effect for attachment type and no significant interaction between language and attachment type for mean RTs. The Spanish-English bilinguals showed no attachment preference for English sentences (M_{Low} = 437 ms vs. M_{High} = 436 ms) and a slight preference for high attachment (M = 517 ms) when reading Spanish sentences, than when forced to attach low (M = 527 ms).

Accuracy analysis. The English and Spanish accuracy data for this group was analyzed using a paired samples t-test. The results indicated that there was no significant difference in percent accuracy for comprehension questions in English and Spanish, $t\ (1,47) < 1$, $p = .972$. The participants were as accurate in answering English filler questions ($M = 92.2$ %) as Spanish filler questions ($M = 92.1$ %).

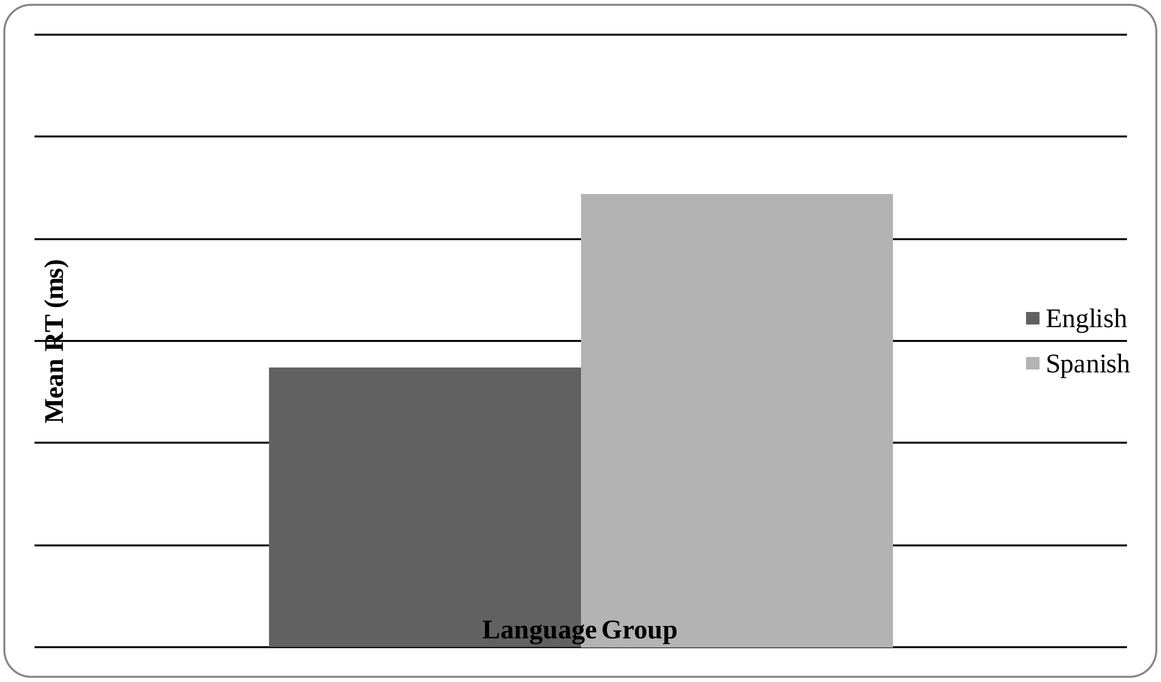

Figure 4.0 Overall mean RT (in milliseconds) for Spanish-English bilinguals when reading the disambiguating region in both Spanish and English.

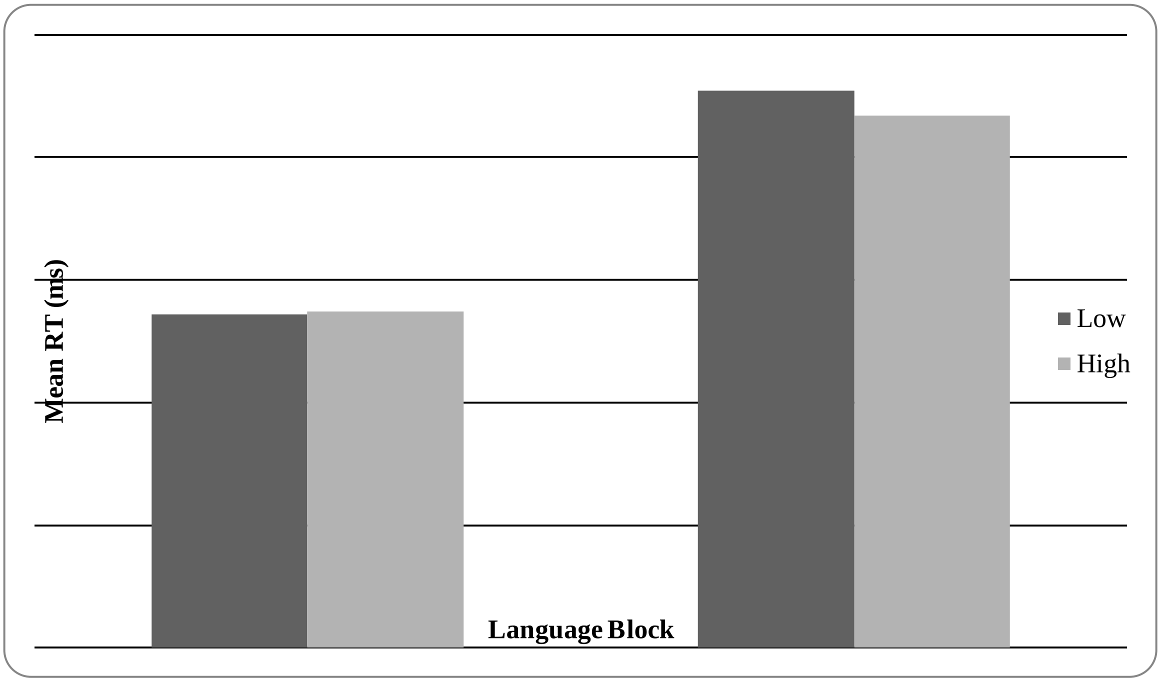

Figure 4.1. Mean RT (in milliseconds) for Spanish-English bilinguals when reading the disambiguating region in both Spanish and English, across attachment type.

***Discussion: Spanish-English bilingual group*.** Contrary to the pattern of results observed for the lexical tasks, the sentence processing data revealed that the Spanish-English bilinguals actually read the disambiguating area in English faster than in Spanish. Analyses revealed no further significant effects. Specifically, the Spanish-English bilinguals did not show a clear preference for either low or high attachment when reading in either language. One explanation for the lack of attachment preference may be a result of extended immersion in a mainly monolingual environment, their L2. In addition, many of the participants reported being in graduate school at Penn State. Most of their graduate student work is also presented in English. This increased exposure to English through the speaking environment and school materials may be an influence to processing speeds when reading English or Spanish, making them able to process English faster than Spanish during reading tasks.

Spanish-English group by dominance. The Spanish-English bilinguals group was then split into two different groups based on language dominance[6]. The mean RT for the disambiguating region and the mean accuracy score for the comprehension questions for each dominance group was analyzed using a 2 x 2 x 2 repeated measures ANOVA. In addition to language (English vs. Spanish) and attachment type (High vs. Low) as within-subjects variables, the new analysis also included dominance group as a between-subjects variable.

Response latencies analysis. The response latency analysis revealed a main effect for language, as previously mentioned above, but no further main effects or interactions for any of the variables. While there were no more statistically significant findings, the pattern of findings from the analysis will be further discussed. The dominance group by language analysis showed that both the Spanish-dominant and English-dominant participants read English sentences faster ($M_{Spanish\text{-}Dominant}$ = 422 ms vs. $M_{English\text{-}Dominant}$ = 483 ms) than Spanish sentences ($M_{Spanish\text{-}Dominant}$ = 483 ms vs. $M_{English\text{-}Dominant}$ = 555 ms). These results are interesting, because although the English-dominant were faster to name pictures in English than Spanish and produced more exemplars in English than in Spanish, they are slower to read the disambiguating region for both languages in comparison to the Spanish-dominant group. Overall, the Spanish-dominant group produced fasters reading RTs for both languages. Mean latency data by group and language are displayed in Figure 4.2.

[6] Please refer to Chapter 2 for language dominance assessment.

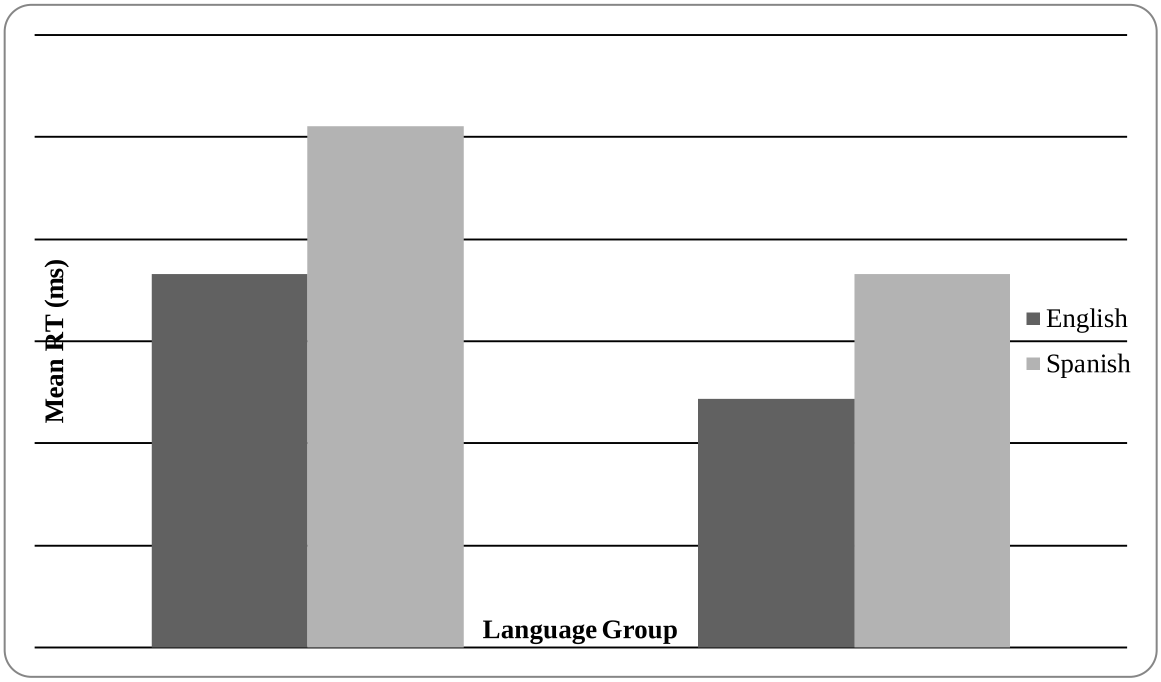

Figure 4.2. Mean RTs (in milliseconds) when reading the disambiguating region by language and across dominance groups.

Once the reading latency data for each language and group is broken down further by attachment, the analysis of the two dominance groups fail to show different patterns for attachment preference in each language. Though not reaching statistical significance, the analysis of the English-dominant group shows a trivial preference for high attachment in both languages (English RTs: M_{High} = 447 ms vs. M_{Low} = 452 ms; Spanish RTs: M_{High} = 546 ms vs. M_{Low} = 563 ms). On the other hand, the Spanish-dominant group shows a slight preference for low attachment when reading sentences in English, but really no preference for Spanish sentences (English RTs: M_{High} = 426 ms vs. M_{Low} = 417 ms; Spanish RTs: M_{High} = 482 ms vs. M_{Low} = 485 ms). Figure 4.3 displays the mean latency data for Spanish-English bilinguals split by dominance group, language, and attachment preference.

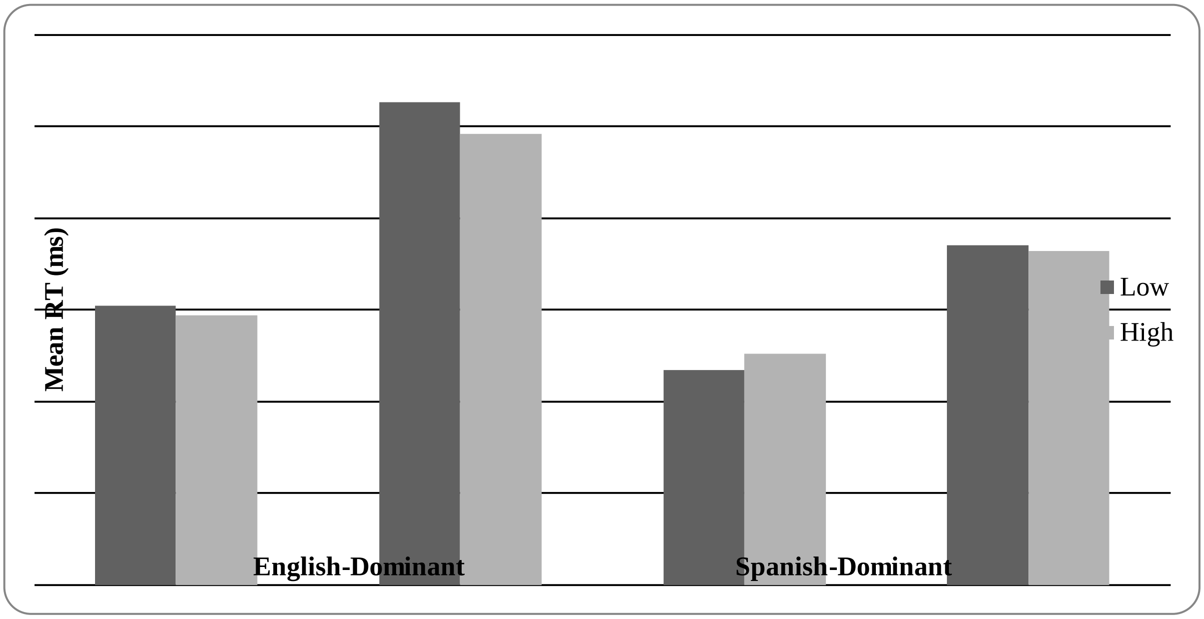

Figure 4.3. Mean RTs (in milliseconds) when reading the disambiguating region across language block, dominance group, and attachment type.

Accuracy analysis. Finally, the accuracy data for the two Spanish-English dominance groups was analyzed. For this analysis, a 2 x 2 repeated measures ANOVA was used with language as the within-subjects variable, dominance group as the between-subject variable, and percent accuracy for filler questions (out of 100%) as the dependent measure. No statistically significant main effects or interactions were observed. The English-dominant group was slightly more accurate in answering English (M = 93.8 %) comprehension questions than Spanish ones (M = 92.4 %). Conversely, the Spanish-dominant group was slightly more accurate in answering Spanish (M = 91.7 %) comprehension questions than English ones (M = 90.1 %). Figure 4.4 shows the mean accuracy score for comprehension questions split by language and dominance group.

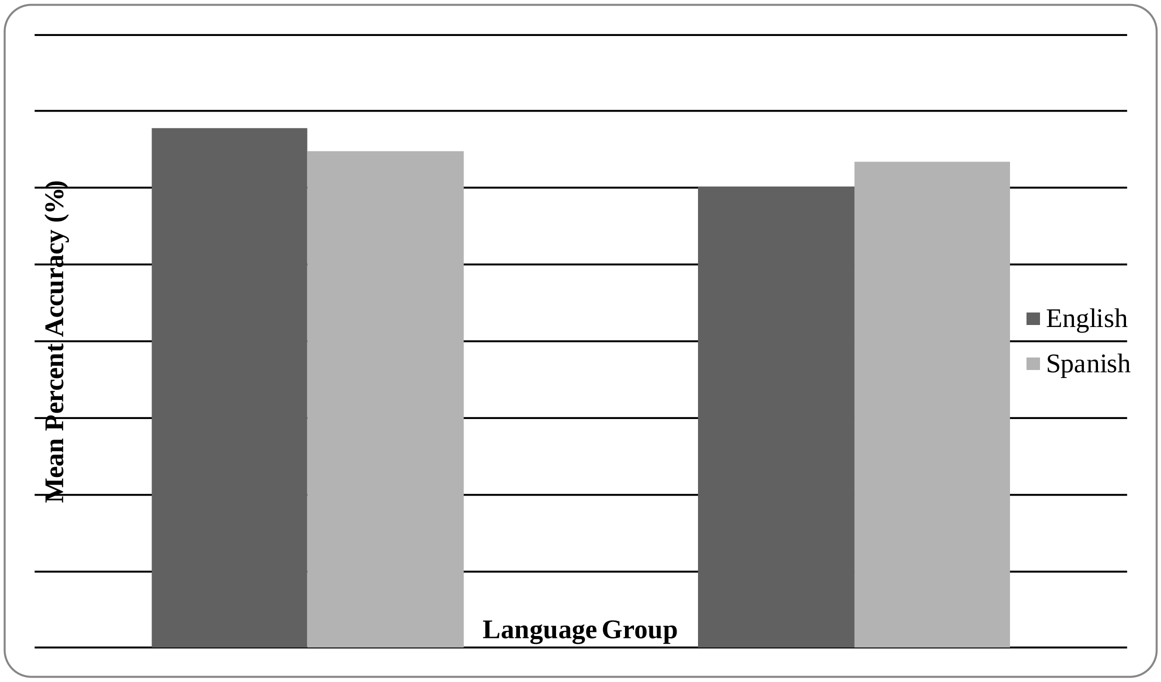

Figure 4.4. Mean percent accuracy (out of 100%) for sentence comprehension questions across language blocks and dominance group.

Discussion: Spanish-English group by dominance. Overall, when the mean latency and percent accuracy data of the Spanish-English bilinguals are split by dominance, no distinct pattern emerged for parsing preferences across the two groups. While the analyses failed to reveal statistical significance, the pattern of data may suggest that the two groups experienced a form of cross-linguistic syntactic priming. Specifically, the actual preference for different attachment styles may have been reduced as a result of the participants reading sentences in both English and Spanish. This lack of preference may be a result of the immersion experience and the need to constantly inhibit the native language Spanish. Further research is needed to elucidate the current patterns of sentence processing.

Cross-language group comparison. The sentence performance for the two Spanish-English dominance groups was then compared to the native English groups. A 2 x 4 repeated measures ANOVA was used to analyze the mean English RTs for the disambiguating region in the sentences and the mean accuracy score for the comprehension questions. Attachment type (High vs. Low) was the within-subjects variable, while language group (English Monolinguals, English-Spanish, English-Dominant, Spanish-Dominant) acted as the between-subjects variable.

***Response latencies analysis*.** The statistical analysis for the response latencies revealed no significant main effect for either attachment type or language group for mean RTs when reading the disambiguating region in English sentences, [Attachment Type: F (1,63) = 2.34, p = .131; Language Group: F (3,63) = 1.51, p = .221]. While the statistical analyses did not reach significance, the overall pattern of latencies for each attachment type and language group will be further discussed. For English sentences, all participants on average read the critical region faster for the low case (M = 405 ms) than when they were forced to attach high (M = 420 ms) to the first noun phrase. While the difference between latency data for attachment type is minimal, the pattern is in the predicted direction for English sentences. When the latency data was compared across language groups, the results showed that the English-Spanish bilinguals actually read the disambiguating region faster (M = 365 ms) than the monolingual English group (M = 414 ms). Figure 4.5 shows the mean RTs for each language group when reading English sentences.

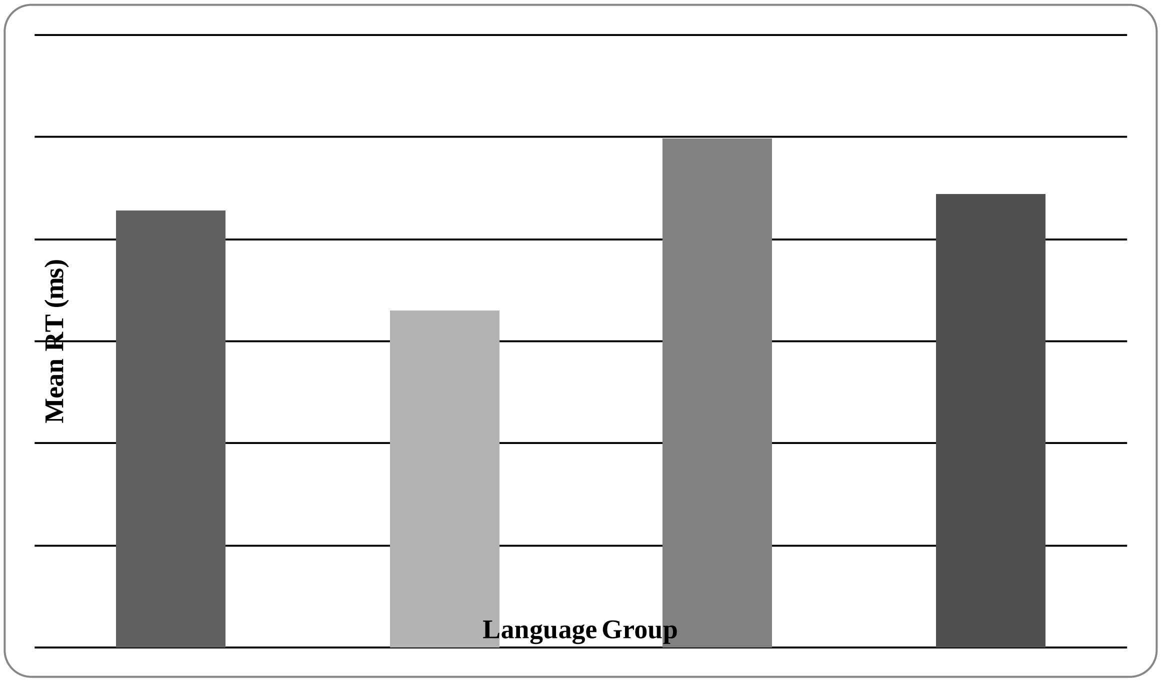

Figure 4.5. Mean RT (in milliseconds) for the disambiguating region in English sentences across language groups.

Additionally, there was no significant interaction for attachment type and language group on the mean reading times, F (3,63) < 1, p = .478. Nevertheless, both native English groups read the disambiguating region faster when the gender information matched the second NP in comparison to the first NP (English Monolingual: M_{High} = 431 ms vs. M_{Low} = 396 ms; English-Spanish: M_{High} = 375 ms vs. M_{Low} = 354 ms). The native English groups showed a processing cost when the relative clause attached high to the first noun phrase, thus suggesting suggest that the native English speakers show a clear preference for low attachment when reading English sentences. The English sentence data provide additional support for previous theories that suggest a low attachment preference for native English speakers (Carreiras & Clifton, 1999). In general, native speakers of English show a preference for low attachment when they encounter two possible sites for noun phrase attachment. On the other hand, neither Spanish-English dominance group showed a pattern for overall attachment preference when reading sentences in

English. The Spanish-dominant bilinguals read the critical region just slightly faster for when forced to attach the relative clause to the NP2, low attachment (*M* = 417 ms), than when forced to attach high (*M* = 426 ms). The English-dominant also showed little difference in reading times for sentences with low attachment (*M* = 447 ms) versus high attachment cases (*M* = 452 ms). The fact that the bilinguals processed sentences in both languages may have encouraged cross-language syntactic priming, minimizing the possible evidence for parsing preferences in English. Figure 4.6 shows the mean RTs for each type of RC attachment type and for each language group for English sentences

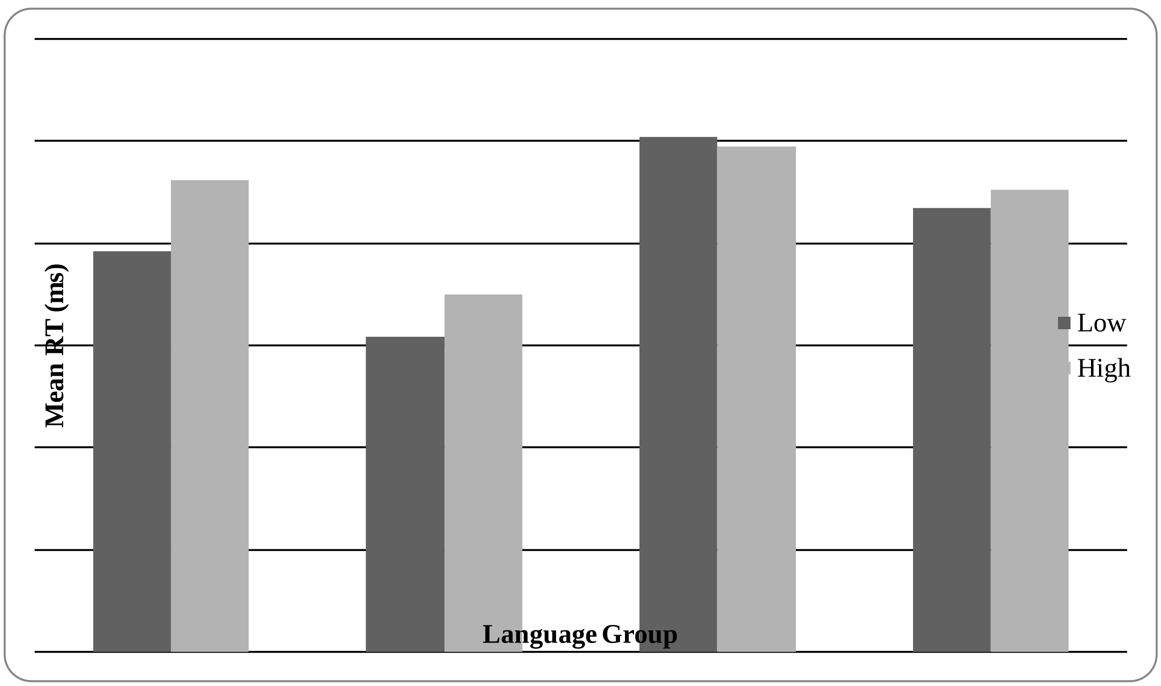

Figure 4.6. Mean RT (in milliseconds) when reading the disambiguating region of English sentences for different RC attachment types and language groups.

A separate 2 x 3 repeated measures ANOVA was used to then analyze the mean RTs for the disambiguating region in Spanish sentences. Attachment type was again used as the within-subjects variable, while language group, as the between subjects variable, only included the three bilingual language groups. There was no data for the English monolinguals, as they did not complete the Spanish sentence block. No main effect for attachment type was present in this analysis, F (1,54) < 1, p = .460. The participants read the disambiguating area just as fast when it forced low attachment (M = 549 ms), as when the gender of the noun phrase forced high attachment (M = 563 ms). Contrary to the aforementioned English RC attachment data, there was a main effect for language group for the Spanish sentences, F (2,54) = 3.58, p = .035. Overall, the Spanish-dominant group read the disambiguating area the faster (M = 483) than both the English-dominant group (M = 555 ms) and the English-Spanish bilinguals (M = 630 ms); however multiple comparisons revealed that the Spanish-dominant group was only significantly faster than the English-Spanish group, p = .01. Figure 4.7 displays the mean RT for each language group when reading the disambiguating region for Spanish sentences.

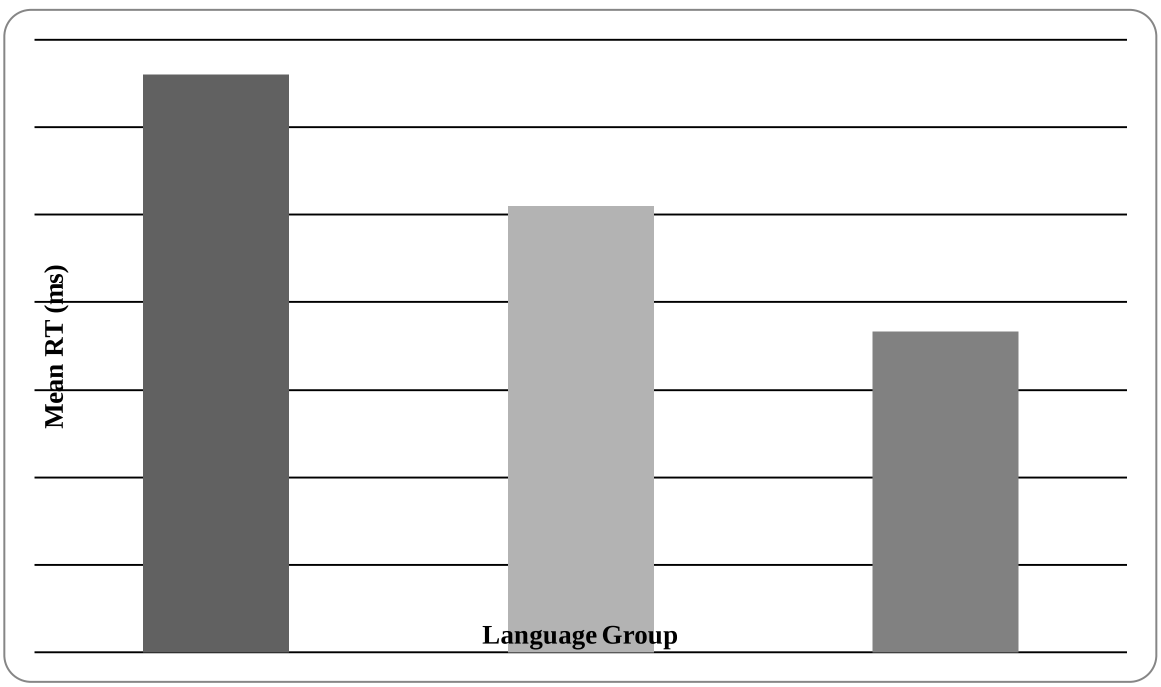

Figure 4.7. Mean RT (in milliseconds) for the disambiguating region across different language groups when reading Spanish sentences.

No two-way interaction between attachment type and language group was observed for differences in Spanish mean RTs for the disambiguating areas, F (2,54) = 1.30, p = .280. The mean RT data across language group and attachment type are displayed in Figure 4.8. Nevertheless, the English-Spanish bilinguals again read the disambiguating region that forced low attachment faster than those sentences that forced high attachment in (M_{Low} = 601 ms vs. M_{High} = 659 ms). These results further demonstrate the English-Spanish group's overall preference for low attachment, despite language block. The two Spanish-English groups again did not show an overall preference for either low or high attachment when reading temporarily ambiguous sentences in Spanish (English-dominant: M_{Low} = 563 ms vs. M_{High} = 546 ms; Spanish-dominant: M_{Low} = 485 ms vs. M_{High} = 482 ms). These results, along with the English data analyses provide further evidence that cross-language syntactic priming and immersion-induced inhibitory processes may be responsible for the lack of relative clause attachment preferences for both the Spanish-English dominance groups. Figure 4. 9 displays the overall mean RT data for each language group for both English and Spanish sentences.

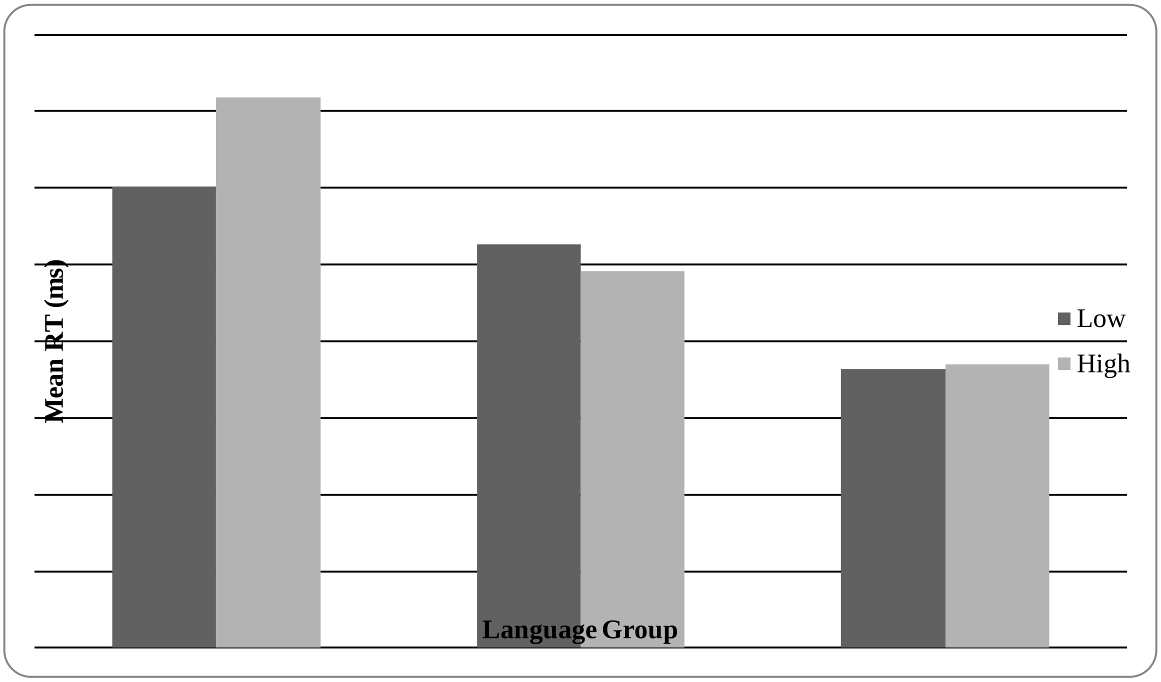

Figure 4.8. Mean RT (in milliseconds) when reading the disambiguating region of Spanish sentences for different RC attachment types and language groups.

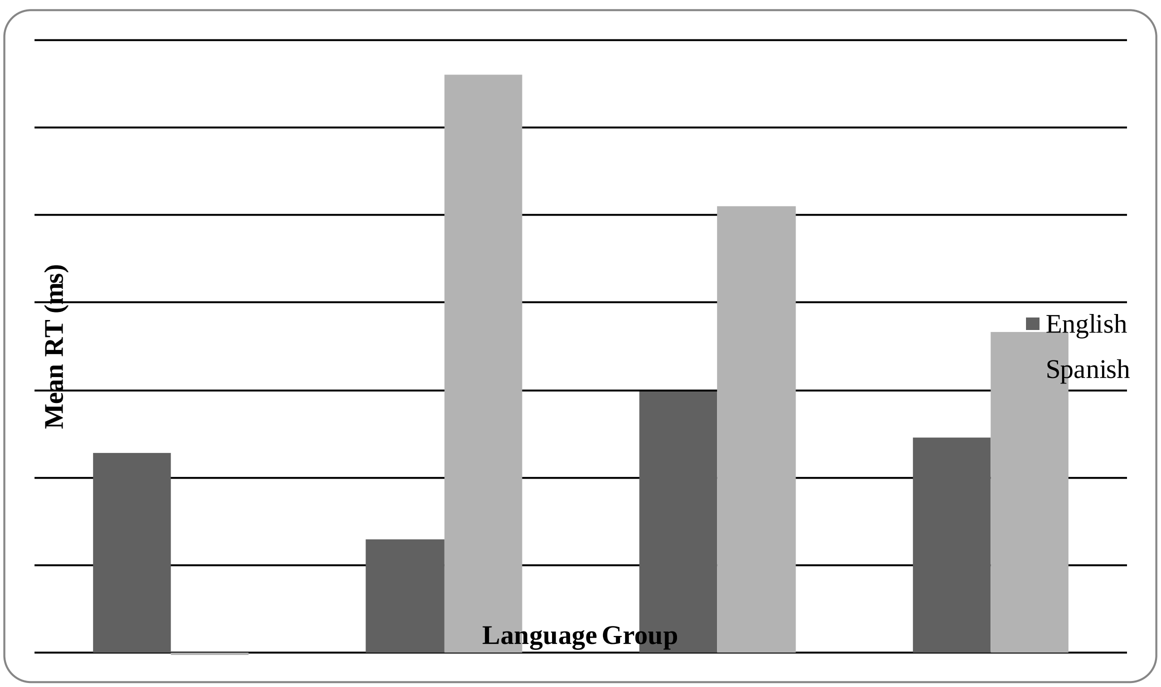

Figure 4.9. Overall mean RT (in milliseconds) for the disambiguating region for both English and Spanish sentences across the different language groups.

***Accuracy analysis*.** The accuracy data for filler comprehension questions was then analyzed across language block (English and Spanish) and language group (English Monolingual, English-Spanish, English-Dominant, and Spanish-Dominant). Two one-way ANOVAs were used to analyze the English and Spanish accuracy data separately. For both analyses, language group acted as the independent variable and percent accuracy for comprehension questions (out of 100%) acted as the dependent measure. The first ANOVA revealed a significant difference in mean English accuracy data between language groups, F (3, 63) = 4.19, p = .009. The English monolinguals were more accurate (M = 95.9%) than the other three language groups ($M_{English\text{-}Spanish}$ = 88.4%, $M_{English\text{-}Dominant}$ = 93.9%, $M_{Spanish\text{-}Dominant}$ = 90.1%). Multiple comparisons indicated that the Monolingual English group was significantly more accurate than both the English-Spanish and Spanish-dominant groups (Monolingual vs. English-Spanish, p = .007; Monolingual vs. Spanish-dominant, p = .012). Additionally, the English-dominant group was more accurate than both the English-Spanish and Spanish-dominant groups (English-Dominant vs. English-Spanish, p = .019; English-Dominant vs. Spanish-Dominant, p = .032).

The second ANOVA analyzed the mean accuracy for Spanish comprehension questions across the three bilingual groups. This analysis revealed a significant difference in accuracy scores between the three language groups, F (2,54) = 4.50, p = .016. Overall, the English-dominant group was slightly more accurate (M = 92.4%) than the Spanish-dominant group (M = 91.7%), and much more accurate than the English-Spanish bilinguals (M = 82.0%) on Spanish comprehension questions. Multiple comparisons indicated that both the Spanish-English dominance groups were significantly more accurate than the English-Spanish bilinguals (English-Dominant vs. English-Spanish, p = .005; Spanish-Dominant vs. English-Spanish, p =

.011). There was no statistically significant difference in accuracy scores between the two Spanish-English dominance groups. Figure 5.0 displays the mean accuracy data for sentence comprehension questions across language groups and language blocks.

***Discussion: Cross-language group analysis*.** Surprisingly, the English-Spanish bilinguals had the worst accuracy score in both English and Spanish compared to the non-native English groups. Overall, all bilingual groups were more accurate at answering comprehension questions in their more dominant language. The English-Spanish and English-dominant groups were more accurate in English than Spanish, and the Spanish-dominant group was slightly more accurate in their dominant language Spanish.

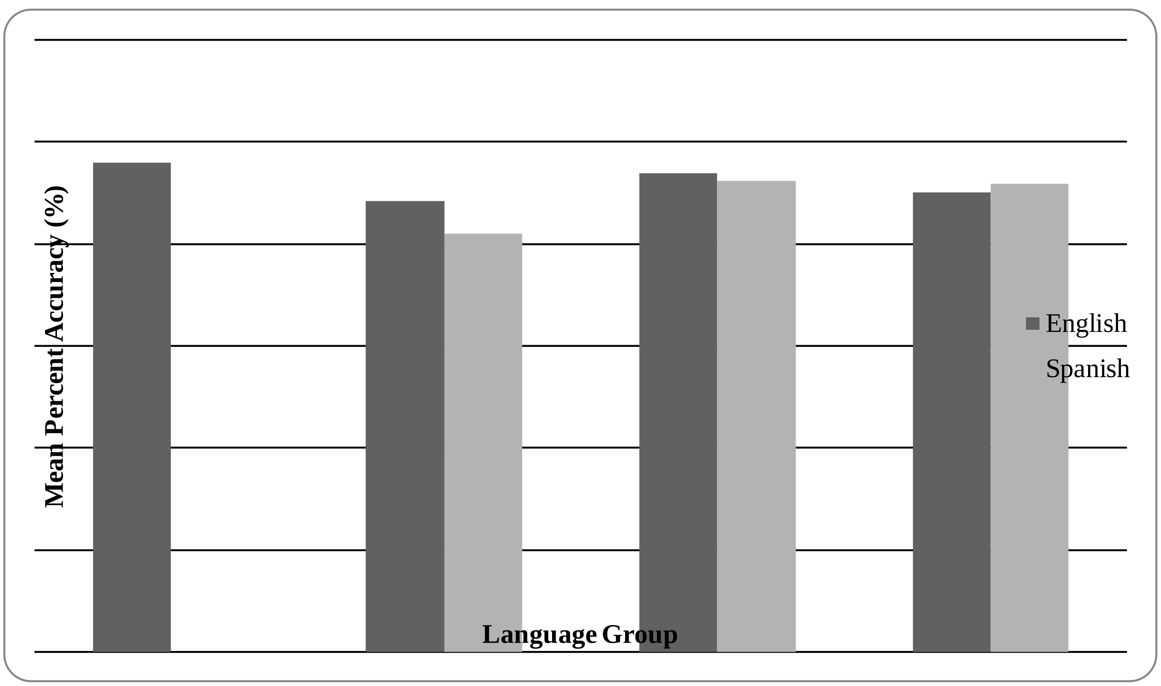

Figure 5.0. Mean percent accuracy (out of 100%) for sentence comprehension questions across language blocks and language groups.

Flanker Data

Mean RTs (in milliseconds) for participants' responses were calculated and trimmed for outliers. Reaction times that fell below or above 2.5 standard deviations away from a participants mean were excluded, as well as incorrect responses and any response that was more than 3000 ms long. The data from this task were analyzed using a 2 x 2 x 4 repeated measures ANOVA in which block type (Block vs. Mix) and trial type (Congruent vs. Incongruent) were the within-subjects factor, with language group as the between-subjects factor.

There was a main effect for block type, F (3, 63) = 30.23, p < .00. Overall, participants produced faster response times for the congruent and incongruent trials during the blocked (M = 543 ms) versus the mixed trials (M = 602 ms). This result is not surprising, as in the mixed trial, participants had to respond to a myriad of different trial types, thus slowing overall response time down. There was also a main effect for trial type, F (3,63) = 269.84, p = .00. Participants were faster to respond to congruent trials (M = 536 ms) than incongruent trials (M = 609 ms). Congruent trials should be faster than incongruent because the distractor chevrons, surrounding the target, are all facing the same direction. The incongruent trials show the target surrounded by chevrons facing the opposite directions. The inconsistency between the direction of the chevrons and target creates potential competition and further inhibitory processes need to be engaged to resolve this conflict and correctly pick the direction of the target.

Further analyses revealed no other significant interactions, specifically including the between-subjects variable of language group. Additionally, the between-subjects factor, language group, analysis revealed no significant difference, F (3, 63) = 1.18, p = .326. Nevertheless, the overall pattern showed that the English-Spanish bilinguals produced faster responses (M = 539 ms) than the other three language groups ($M_{English\text{-}Monolinguals}$ = 568 ms vs. $M_{English\text{-}Dominant}$ = 588 ms vs. $M_{Spanish\text{-}Dominant}$ = 595 ms). Figure 5.1 displays overall mean RT for the Flanker Task by language group. Figure 5.2, displays the mean RTs for block type (Block vs. Mix) across each language group. Finally, Figure 5.3 displays the mean RTs trial type (Congruent vs. Incongruent) across the four different language groups. Overall these results indicate no differences in inhibitory control processes for any language group.

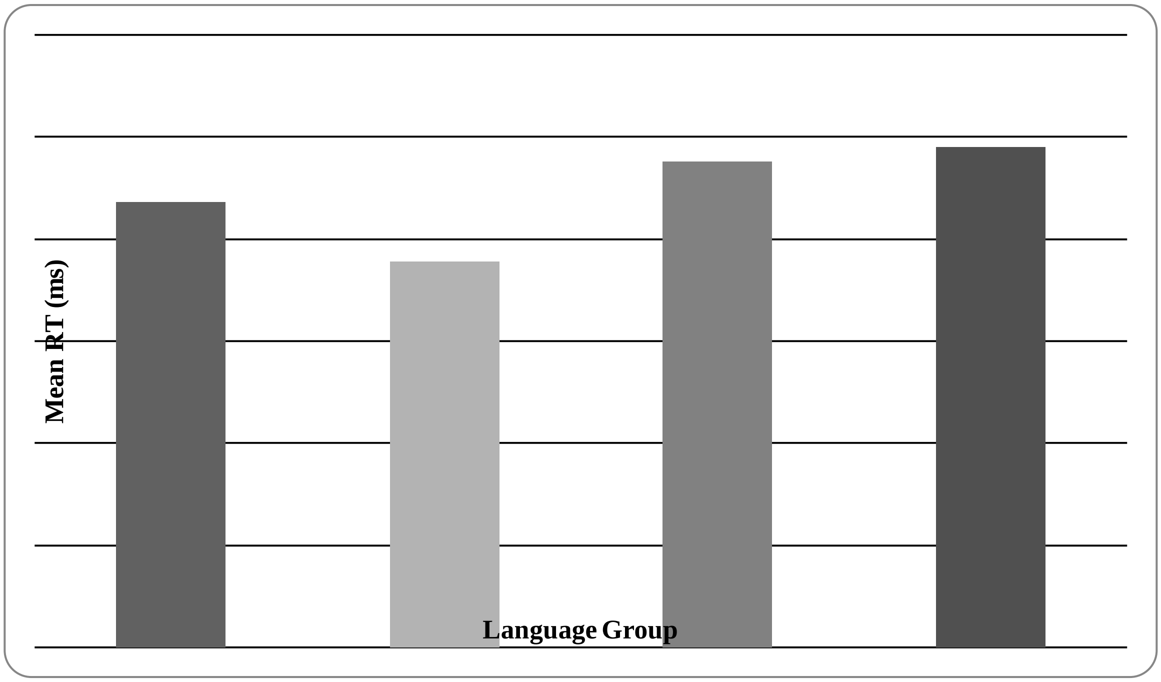

Figure 5.1. Overall mean RTs (in milliseconds) for the Flanker Task by language group.

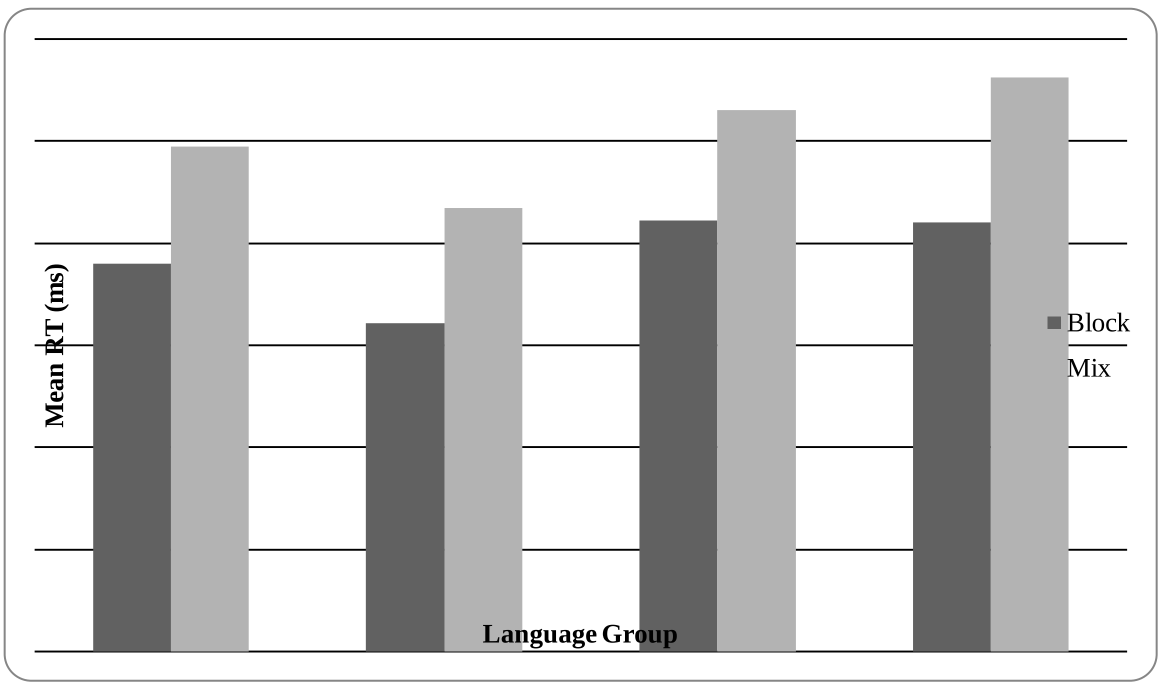

Figure 5.2. Mean RTs (in milliseconds) for the Flanker Task by language group and block type.

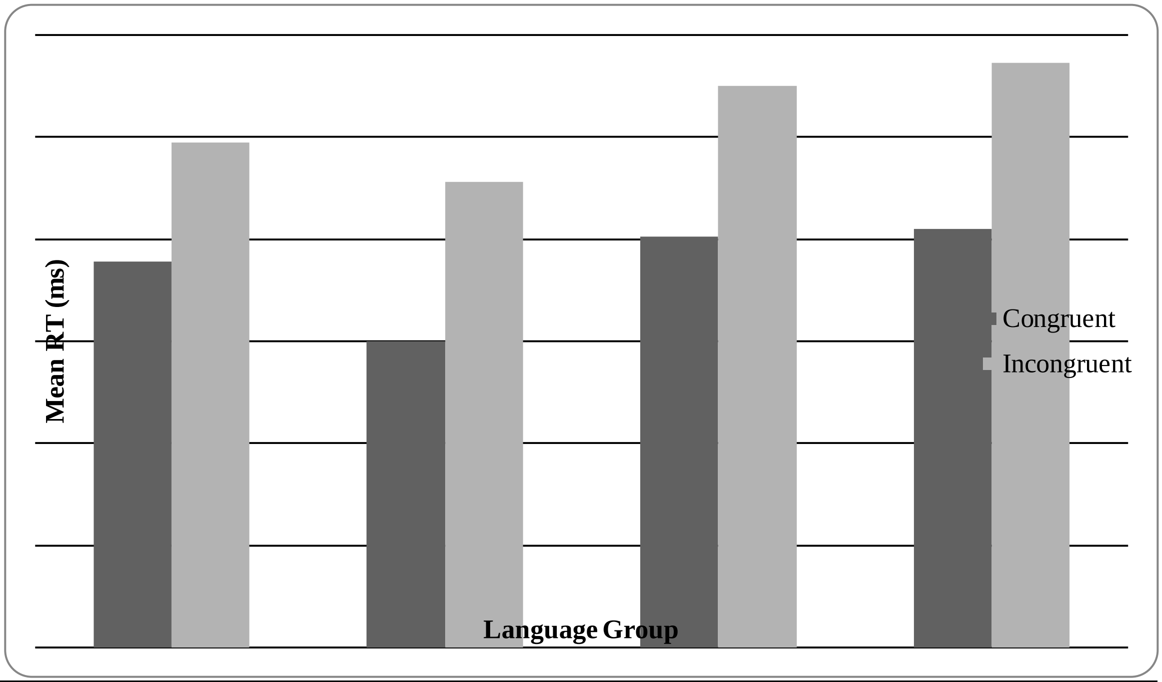

Figure 5.3. Mean RTs (in milliseconds) for the Flanker Task by language group and trial type.

Operation Span Data

Figure 6.0 displays the mean number of words recalled for each language group for the operation span task. A one-way ANOVA was conducted to see if there were any differences in the mean number of words recalled, the dependent variable, for each language group, the between-subjects variable. The analysis revealed a marginal significant difference between language groups, F (3, 63) = 2.67, p = .055. The English-Spanish bilingual group, on average, recalled the most number of words (M = 49.0). The other three language groups recalled a similar amount of words ($M_{English\ Monolinguals}$ = 41.6 vs. $M_{English\text{-}Dominant}$ = 38.6 vs. $M_{Spanish\text{-}Dominant}$ = 40.2). Multiple comparisons showed that the English-Spanish group recalled significantly more words than both the Spanish-English bilingual groups (English-Spanish vs. English-Dominant, p = .007; English-Spanish vs. Spanish-Dominant, p = .024. There was no statistical difference observed between the two native English groups. All three groups performance was comparable, with the English-dominant bilingual group recalling the least amount of words.

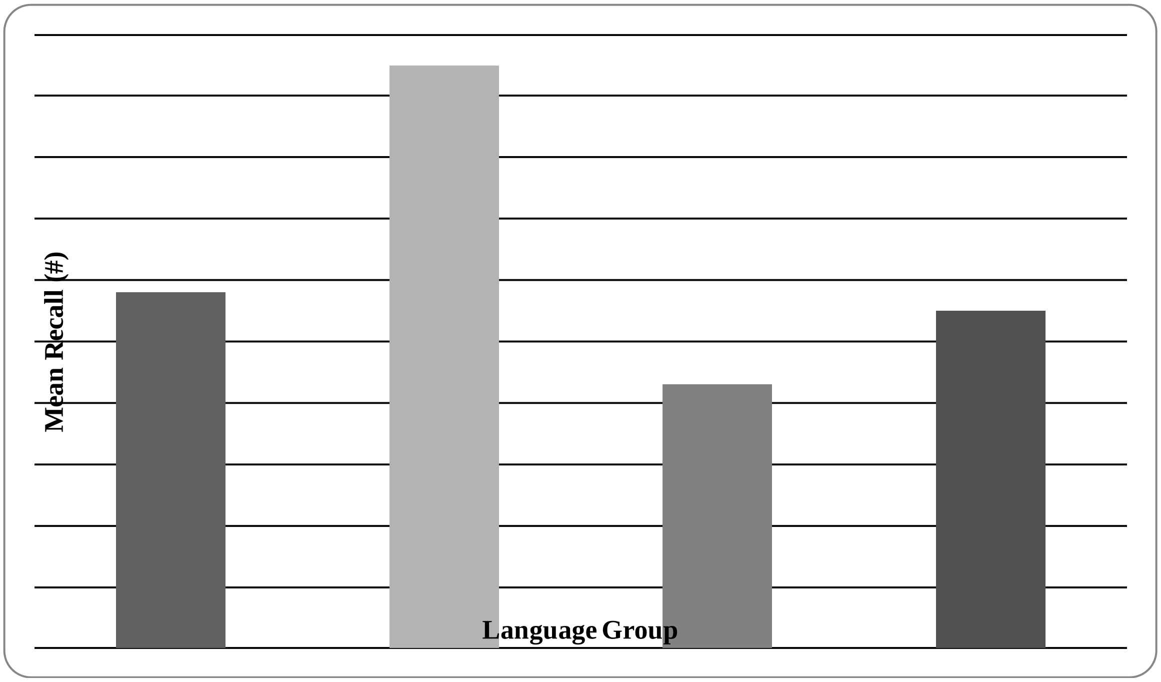

Figure 5.4. Mean number of words (#) recalled for the O-Span task across different language groups.

Chapter 5: General Discussion

This experiment investigated the effect of L2 immersion and language dominance on processing differences at the lexical and syntactic levels for a group of proficient Spanish-English bilinguals. The main goal of this study was three-fold. First, the study examined whether a group of bilingual participants demonstrated effects of active inhibition of the native language during lexical processing, following extended immersion in an English language environment. In addition, this experiment analyzed whether these effects of inhibition during lexical access were modulated by a bilingual's language dominance. Finally, this study investigated if and how extended immersion in the L2 affects sentential processing in each of a bilingual's languages. The overall results indicate that L2 immersion and differences in language dominance can influence and change bilingual language processing at the level of both the lexicon and syntax; however these changes to the linguistic system may prompt different results for language processing for each of these two levels. In this section, the main findings for each part of the experiment will be described and some general conclusions provided. Finally, possible limitations of the study and future directions to take will be outlined throughout each task overview.

The data from the lexical tasks suggest that L2 immersion, L1 inhibition, and language dominance play a role in bilingual lexical access. First, the verbal fluency data for the Spanish-English bilinguals did in fact show evidence for possible L1 inhibition. There were no significant differences in the amount of exemplars produce for each language, meaning that the Spanish-English bilinguals produced nearly the same amount of exemplars in both their L1 Spanish and their L2 English. One explanation for the appearance of balance in lexical production could be that extended immersion in an L2 environment may engage increased inhibition of the dominant

L1. Specifically, the bilingual group may be actively inhibiting their native language while immersed in order to successfully access and use items from their L2 English. As previously mentioned in the introduction, a study by Linck et al. (2009) showed that late L2 learners of Spanish who were immersed in their L2 produced fewer items in their native language during a verbal fluency task, than compared to a group of learners who had no study abroad experience. Nevertheless, this idea cannot be fully supported without further data from a group of Spanish-English bilinguals who are still living within a native language environment. One future direction is to investigate the differences in verbal fluency performance between these groups to verify if bilinguals actively use inhibitory processes while immersed in the non-dominant language.

When the verbal fluency data was broken down by dominance group, evidence for inhibition of the L1 and dominance effects were observed for each group. The overall pattern of results across different language production blocks revealed that bilinguals produced more exemplars in their more dominant language. For example, the English-dominant group produced more exemplars in English than in their native language Spanish. The Spanish-dominant bilinguals showed the opposite pattern, producing more words in Spanish than in English. Nevertheless, the Spanish-dominant group produced the least amount of exemplars in both languages compared to the other bilingual groups. That is the magnitude of the difference in verbal fluency scores across language blocks was smaller for the Spanish-dominant group.

One explanation for the current pattern of results may be based on length of L2 immersion and increased use of inhibitory control, as previously mentioned. While living immersed in the L2, English, the Spanish-dominant group may find themselves needing to inhibit the stronger L1, in order to access and use words in English. It is possible that increased inhibition of the L1 may be creating a slight processing during lexical access performance. On the other hand, the English-dominant group may not reveal this processing cost, because they have been immersed in the L2 environment for a much longer period of time. The English-dominant group may have initially experienced reduced lexical access due to active inhibition of their native language when they first arrived to the English environment; however, over time increased inhibition of the native language permitted easier access to the L2, thus shaping a bilingual's language dominance. Thus, bilinguals who maintain native language dominance may demonstrate a temporary processing cost to lexical access due to active inhibition of the dominant language when immersed in the non-dominant language

Finally the verbal fluency data displayed no evidence for a bilingual disadvantage in lexical access. All bilingual groups produced a similar amount of exemplars, if not more, in their dominant language, as the monolingual group produced in English. These results provide evidence countering the weaker links hypothesis made by Gollan and colleagues (2008), which claims that bilinguals have a disadvantage in lexical retrieval.

A similar pattern of results emerged for the picture naming data. The Spanish-English group named pictures in Spanish and English equally as fast. When the group was split by language dominance, the English-dominant group showed faster processing speeds and were more accurate for naming English pictures in comparison to Spanish pictures, while the Spanish-dominant group showed the opposite pattern. Additionally, the Spanish-dominant group showed an overall smaller difference in naming latencies between production languages than the English-dominant group, providing further evidence that active inhibition of the dominant language may in fact be creating this slight processing cost during lexical access and production. In conjunction with the verbal fluency data, these analyses provide further support for both the effect of native language inhibition during L2 immersion and language dominance on lexical processing.

The cross-group comparison revealed that overall, both native English groups named English pictures significantly faster than the Spanish-dominant group. The English-dominant group also did in fact name picture slightly slower in English than both the monolingual and English-Spanish groups, though this analysis did not reach statistical significance,. This decreasing pattern for English RTs in picture naming coincides with L2 immersion experience and differences in language proficiency. The English-Spanish group was faster to name English pictures than the English-dominant group, who was faster to name pictures than the Spanish-dominant group. Specifically, the English-dominant group, whose native language is Spanish, produced mean RTs in English picture naming that fell between the performance of a group of native English, advanced L2 learners of Spanish, and a group who share their native language, yet remained in most aspects dominant in Spanish. Even though the English-dominant group is highly proficient in their native language Spanish, through extended immersion in an L2 environment, they have become more dominant in English, as expressed through faster processing times for lexical access and increased accuracy for production tasks.

The Spanish picture naming data analyses indicated a similar pattern as observed for the aforementioned English analyses. This time, the English-dominant group named Spanish pictures faster than the English-Spanish group, but slower than the Spanish-dominant bilinguals. Again, there is a decrease in mean RTs with increased proficiency in Spanish across the groups. Although there was no significant interaction between cognate status and language group for Spanish picture naming, the magnitude of cognate facilitation increased as Spanish proficiency decreased. For example, the cognate facilitation magnitude for the English-Spanish group was larger than the English-dominant group. As well, the Spanish-dominant group showed the smallest difference in mean RTs for naming pictures of non-cognates versus cognates in Spanish.

This finding supports previous theories that predict an increase in cognate facilitation in the less-dominant language.

Overall, the reaction time analyses for English and Spanish picture naming reveal the effects of extended L2 immersion on lexical access across different levels of proficiency. Specifically, a group of native Spanish speakers who have been immersed in their L2 English for an extended period of time has actually become more dominant in the L2. Nevertheless, the current pattern of results pose a set of interesting questions about the consequences to processing due to the use of more general cognitive processes. For example, both Spanish-English bilingual groups were actually slower to name pictures in both of their languages as compared to the native English groups. These results suggest that there may be a temporary cost to speech production associated with inhibitory processes, specifically for bilinguals immersed an L2 environment. These results provide possible support for the weaker links theory proposed by Gollan et al. (2008); however a different interpretation involves the role of inhibition and immersion experience. It is possible that immersion in the L2 environment creates a small processing cost in terms of speed and may not be a general feature for all bilinguals. For example, the English-Spanish bilinguals were just as fast to name pictures in English as the monolingual group, providing evidence against the weaker links theory.

The picture naming accuracy data show a similar pattern for both Spanish and English mean response data across language groups. English-dominant bilinguals were more accurate at naming pictures in English than Spanish, while the reverse pattern was observed for the Spanish-dominant group. One difference between the RT and accuracy data was observed in the English-Spanish group. For the accuracy data, this group was actually more accurate at naming pictures than the monolingual English group. While the two groups performed similarly in terms of

English picture naming reaction times, there was a clear difference for the accuracy data. The English-dominant group was also just as accurate in English picture naming as the monolingual group. These findings provide further support against claims of a lexical disadvantage for bilinguals as proposed by the 'Weaker Links' theory (Gollan et al. 2008).

The only group that showed a slight disadvantage in accuracy scores was the Spanish-dominant group. Overall, this group performed slightly worse in both languages. This result provides additional support for the proposed idea that immersion in the L2 may create a processing cost in lexical access due to active inhibition of the native language. One possibility is that the more dominant the native language is, the more inhibition of the L1 is needed to be able to access the less dominant L2. Additionally, with increased immersion experience, the need for inhibition decreases, as observed for the English-dominant group. Taken together, the current pattern of results suggests that not only differences in proficiency skills, but also immersion experience can affect overall processing speeds during lexical access.

Unlike the aforementioned lexical processing tasks, results from the sentence-processing task do not provide clear results concerning the effects of inhibitory control and language dominance. Overall, the Spanish-English bilinguals failed to show a clear attachment preference for either language. They produced similar mean RTs when reading the disambiguating region for both the low attachment and high attachment conditions. These results indicate that the Spanish-English bilinguals did not show an increased processing cost for reading disambiguating information that forced either high or low attachment.

These results are somewhat in line with the initial lexical analyses when the group was compared as a whole, before splitting into different language dominance groups. When analyzed together, the Spanish-English bilinguals in both lexical and syntactic tasks showed no pattern for language-specific processing, that is their performance was similar in both English and Spanish. When the lexical data was then split by language dominance a clear pattern based on dominance emerged for both groups. One question was whether this same dominance-influenced pattern would be present in sentence processing data, specifically if each language dominance group would exhibit a particular attachment preference in either language.

When the sentence data for the Spanish-English bilinguals were split by dominance, no further evidence emerged for relative clause attachment preferences for either group. Both groups showed very trivial differences in RT data for the different attachment types. Thus, the lack of preference observed for the overall group could not be explained merely by differences in language dominance. However, the accuracy data, while it did not reach statistical significance, showed a hint of language dominance influences with each group being slightly more accurate in their dominant language.

One possibility is the lack of clear attachment preference could be due to cross-linguistic syntactic priming, as bilingual participants read both English and Spanish sentences. The effect of reading sentences in both languages could have reduced the overall effect of attachment preferences. Further research is needed to fully comprehend whether the current pattern emerged as an artifact of the study design, or as an indication of increased inhibition. Additionally, differences in the use and mode of each language may further elucidate whether these findings are specific for reading comprehension tasks and cannot not be generalized to writing.

The data from the two Spanish-English dominance groups were then compared to the two native English groups. Overall, the monolingual English participants exhibited a clear preference for low attachment when reading the disambiguating region in English sentences. Specifically, they produced a processing cost, longer RTs, when forced to attach the RC high to the first NP. In comparison, they were much faster to read the disambiguating region that forced low attachment. These results replicate the findings of Carreiras and Clifton (1999) that also illustrated monolingual English speakers' preference to attach disambiguating information to the closest or most recent NP.

Additionally the English-Spanish bilinguals also exhibited a clear pattern for low attachment preference when reading sentences in English and Spanish. They were much faster to read the disambiguating region when the gender information matched that of the second NP. One possibility for the lack of high attachment preference in Spanish for the English-Spanish group could be the low level of L2 proficiency and the lack of immersion experience. Frenck-Mestre (1997) proposed that sentence parsing preferences might be influenced not only by L2 immersion, but also by dominant language proficiency. This idea would support the results from the English-Spanish group, who show a preference native language parsing strategies. Based on the language history information and lexical tasks, the English-Spanish participants were significantly less proficient in Spanish than English. The features of cross-language transfer may arise only in highly proficient bilinguals and specifically those who are immersed in the L2 environment. It would be predicted that if this group were to spend an extended period of time in a Spanish language environment, they would begin to show less of a preference for low attachment, as well as a smaller processing cost when reading sentences that force high attachment for relative clauses.

The current sentence data for the Spanish-English bilinguals, as a whole or split by language dominance group, fail to replicate the findings that Dussias and Sagarra (2007); however the results of this study do raise questions concerning the interaction immersion and dominance has on bilingual sentence processing strategies. Further examination of the current findings are needed to clarify if the lack of preference was an artifact of the experiment, as the participants read sentences in both English and Spanish, or a consequence of increased inhibitory control while immersed in the L2 environment. While the data from this experiment did not replicate the findings from the Dussias and Sagarra study, both experiments reveal that immersion in an L2 environment may change the way a bilingual speaker parses sentences both in the L2 and the native language.

The final results of the current study provide an important perspective on what it means to be dominant in a language and the possible changes in linguistic processing that follow L2 immersion. Overall, the results of this study show more robust results for dominance and L2 immersion experience on lexical level processing than on parsing preferences for the Spanish-English bilingual group. Nevertheless, taken together, the results demonstrate that for both lexical retrieval and parsing, the bilingual’s two languages are open to the influence of the context in which language is learned and used, suggesting that the native language may be neither privileged nor fixed.

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Appendix A

L2 Language History Questionnaire (Version 2.0)

Contact Information:
Name: ____________________ Email: ____________________
Telephone: ____________________ Today's Date: ____________________

Please answer the following questions to the best of your knowledge.

PART A
1. Age (in years):

2. Sex (circle one): Male / Female

3. Education (degree obtained or school level attended):

4(a). Country of origin:

4(b). Country of Residence:

5. If 4(a) and 4(b) are the same, how long have you lived in a foreign country where your second language is spoken? If 4(a) and 4(b) are different, how long have you been in the country of your current residence? (in years)

6. What is your native language? (If you grew up with more than one language, please specify)

7. Do you speak a second language?

__YES my second language is _______________.
__NO (If you answered NO, you need not to continue this form)

8. If you answered YES to question 7, please specify the age at which you started to learn your second language in the following situations (write age next to any situation that applies).

At home: _________

In school: _________

After arriving in the second language speaking country ________

9. How did you learn your second language up to this point? (check all that apply)

(<u>Mainly</u> <u>Mostly</u> <u>Occasionally</u>) through formal classroom instruction.

(<u>Mainly</u> <u>Mostly</u> <u>Occasionally</u>) through interacting with people.

A mixture of both, but (<u>More classroom</u> <u>More interaction</u> <u>Equally both</u>).

Other (specify: ____**).**

10. List all foreign languages you know in order of most proficient to least proficient. Rate your ability on the following aspects in each language. Please rate according to the following scale (write down the number in the table):

Very poor Poor Fair Functional Good Very good Native-like
1 __________ 2__________3__________4___________5__________6__________7__________

Language	Reading proficiency	Writing proficiency	Speaking fluency	Listening ability

11. Provide the age at which you were first exposed to each foreign language in terms of speaking, reading, and writing, and the number of years you have spent on learning each language.

Language	Age first exposed to the language			Number of years learning
	Speaking	Reading	Writing	

12. Do you have a foreign accent in the languages you speak? If so, please rate the strength of your accent according to the following scale (write down the number in the table):

No Accent Very Weak Weak Intermediate Strong Very Strong
1 __________ 2_____________ 3__________ 4____________ 5__________ 6__________

Language	Accent (circle one)	Strength
	Y N	
	Y N	
	Y N	
	Y N	
	Y N	

PART B

13. Estimate, in terms of percentages, how often you use your native language and other languages per day (in all daily activities combined, circle one that applied):

Native language: <25% 25% 50% 75% 100%

Second language:	<25%	25%	50%	75%	100%
Other languages:	<25%	25%	50%	75%	100%

(specify the languages: ____________________)

14. Estimate, in terms of hours per day, how often you are engaged in the following activities with your native and second languages.

Activities	First Language	Second Language	Other Languages (specify ______)
Listen to Radio/ Watching TV:	______(hrs)	______(hrs)	________(hrs)
Reading for fun:	______(hrs)	______(hrs)	________(hrs)
Reading for work:	______(hrs)	______(hrs)	________(hrs)
Reading on the Internet:	______(hrs)	______(hrs)	________(hrs)
Writing emails to friends:	______(hrs)	______(hrs)	________(hrs)
Writing articles/papers:	______(hrs)	______(hrs)	________(hrs)

15. Estimate, in terms of hours per day, how often you speak (or used to speak) your native and second languages with the following people.

	Language	**Hours**
Father:	______________________	______________(hrs)
Mother:	______________________	______________(hrs)
Grandfather(s):	______________________	______________(hrs)
Grandmother(s):	______________________	______________(hrs)
Brother(s)/Sister(s):	______________________	______________(hrs)
Other family members:	______________________	______________(hrs)

16. Estimate, in terms of hours per day, how often you now speak your native and second languages with the following people.

	Language	**Hours**
Spouse/partner:	______________________	______________(hrs)
Friends:	______________________	______________(hrs)
Classmates:	______________________	______________(hrs)
Co-workers:	______________________	______________(hrs)

17. Write down the name of the language in which you received instruction in school, for each schooling level:

Primary/Elementary School: ________

Secondary/Middle School: ________

High School: ________

College/University: ________

18. In which languages do you usually:

Count, add, multiply, and do simple arithmetic? _________________

Dream? _________________

Express anger or affection? _________________

19. When you are speaking, do you ever mix words or sentences from the two or more languages you know? (If no, skip to question 21).

20. List the languages that you mix and rate the frequency of mixing in normal conversation with the following people according to the following scale (write down the number in the table):

Rarely Occasionally Sometimes Frequently Very Frequently
1 _________ 2_____________ 3_________ 4____________ 5____________

Relationship	Languages mixed	Frequency of mixing
Spouse/family members		
Friends		
Co-workers		
Classmates		

21. In which language (among your best two languages) do you feel you usually do better? Write the name of the language under each condition.

	At home	**At work**
Reading	____________	____________
Writing	____________	____________

Speaking ____________ ____________
Understanding ____________ ____________

22. Among the languages you know, which language is the one that you would prefer to use in these situations?

At home ____________
At work ____________
At a party ____________
In general ____________

23. If you have lived or travelled in other countries for more than three months, please indicate the name(s) of the country or countries, your length of stay, and the language(s) you learned or tried to learn.

24. If you have taken a standardized test of proficiency for languages other than your native language (e.g., TOEFL or Test of English as a Foreign Language), please indicate the scores you received for each.

Language	**Scores**	**Name of the Test**
____________	____________	____________
____________	____________	____________
____________	____________	____________

25. If there is anything else that you feel is interesting or important about your language background or language use, please comment below.

PART C

(Do you have additional questions that you feel are not included above? If yes, please write down your questions and answers on separate sheets.)

Appendix B

Sample of sentences used in experiment for each condition.

	Attachment Preference	Example Sentence
1a.	Low	Someone shot the ***butler*** of the **actress** who was putting roses in **her** favorite vase in the foyer.
1b.	Low	Alguien disparó contra ***el criado*** de **la actriz** que era **piadosa** e iba a la iglesia con frecuencia.
2a.	High	Someone shot the **maid** of the ***actor*** who was putting roses in **her** favorite vase in the foyer.
2b.	High	Alguien disparó contra **la criada** de*l* ***actor*** que era **piadosa** e iba a la iglesia con frecuencia.

- Note that the disambiguating information in each sentence is marked in bold and a single underline. The noun phrase (NP) that the disambiguating information attaches to is marked bold and has a double underline. The noun phrase that the disambiguating information does not attach to is marked in bold and italicized.