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An Investigation Of The Individual Differences In Cognitive Factors That Contribute To Bilingual Lexical Disambiguation

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by

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Abstract

The objective of this study was to investigate the effects of working memory capacity, access to subordinate meanings of L1 homonyms and degree of cross-language activation on the access to subordinate meanings of L2 homonyms. In Experiment 1, Spanish-English bilinguals completed a word recognition task which assessed how quickly and accurately they accessed subordinate meanings of English homonyms that were either noncognates (e.g. fast/*rápido*) or cognates (e.g. letter/*letra*) with Spanish. In Experiment 2, another group of Spanish-English bilinguals read sentences while having their eye-movements recorded for measures of lexical access. On the critical trials, sentences contained a homonym that was either a noncognate (e.g. fast/*rápido*) or cognate with Spanish (e.g. letter/*letra*). The context preceding the target word (i.e. homonym) was either biased to the subordinate meaning or neutral. General analyses from Experiments 1 and 2 showed that access to subordinate meanings of cognate homonyms was facilitated compared to access to subordinate meanings of noncognate homonyms. Analyses of the individual differences factors revealed that access to subordinate meanings of L1 homonyms was the most consistent predictor of access to subordinate meanings of L2 homonyms. These findings are discussed in terms of how these individual differences should be taken into account to better model the dynamics of bilingual lexical disambiguation.

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Introduction

Recent research in adult second language learning has demonstrated that semantically-ambiguous words (aka “homonyms”) are harder to learn than unambiguous words because of a lack of one-to-one mapping between meanings across languages (Degani & Tokowicz, 2010). Furthermore, research with monolinguals has shown that the ability to efficiently select relevant meanings of homonym words is a key characteristic of good comprehenders in reading (Gernsbacher & Faust, 1991). Thus, while homonyms may be difficult to learn, it is particularly important that they be acquired well because the efficiency with which they are processed characterizes good readers. In the present experiments I investigated the influence of three individual differences on lexical disambiguation in the second language (L2): (1) working memory capacity, (2) degree of cross-language activation effects observed during word identification and (3) degree of efficiency of accessing subordinate meanings in the first language (L1). I focused specifically on the extent to which these three factors predict the ability of L2 readers to quickly and accurately access the subordinate meanings of homonyms (e.g., accessing the “weapon” meaning of the English homonym *arm*). These factors were examined in both a single-word context (Experiment 1) and a sentence context (Experiment 2). Before describing the present experiments in more detail, I will first review relevant research on the processing of homonyms performed with monolingual participants, in and out of context. Then, I will review relevant research on bilingual studies of lexical disambiguation, and finally, I will discuss how the three proposed cognitive factors might play a role in bilingual lexical disambiguation.

Monolingual Studies on the Processing of Homonyms

Relatively little is known about the cognitive nature of lexical disambiguation in a second language. However, existing models of lexical disambiguation that have been developed based on monolingual data offer an initial framework for studies with bilinguals. Many studies have demonstrated that all meanings of a homonym are activated during initial stages of word recognition (Azuma & Van Orden, 1997; Rodd, Gaskell & Marslen-Wilson, 2002; Beretta, Fiorentino & Poeppel, 2005; Klepousniotou & Baum, 2007). There is also a large body of research addressing the question of whether the presence of a sentence context would allow for selective activation of the context-appropriate meaning only. This body of research has produced disparate findings concerning the role of a sentence context on meaning activation, and thus, researchers have proposed models of lexical disambiguation that differ in whether they allow for the influence of context on pre-lexical (before the word is uniquely retrieved from the lexicon) meaning access. Exhaustive models assume that all meanings of an homonym are exhaustively accessed prelexically, regardless of context (Frazier & Rayner, 1987; Rayner & Duffy, 1986; Swinney, 1979; Seidenberg, Tanenhaus, Leiman & Bienkowski, 1982; Onifer & Swinney, 1981; Swinney, 1979). Selective models, on the other hand, assume that activation of meanings is influenced by context, and a highly constrained context con potentially allow for selective access of the appropriate meaning even prior to completion of lexical retrieval (Simpson & Kreuger, 1991; Tabossi 1988; Tabossi, Colombo & Job, 1987). For example, Tabossi (1988) found that when a context biases the dominant meaning of a homonym by making salient a characteristic feature of it, thus allowing for both dominance and context to converge on the same semantic information, then the subordinate, contextually irrelevant meaning of the homonym is not accessed.

To account for the findings that a sentence context may indeed constrain meaning activation, other models were developed. These models proposed that all meanings of an homonym are accessed, but that the time course of activation of these meanings is influenced by context. These models are referred to as hybrid models (Duffy, Morris & Rayner, 1988; Kawamoto, 1993; Simpson & Burgess, 1985; Twilley & Dixon, 2000; Kawamoto & Zemblidge, 1992). As an example, the Re-ordered Access Model (RAM) (Duffy et al., 1988) assumes that the relative frequency of the meanings of a homonym and the surrounding sentence context will influence the relative time course with which each meaning becomes activated and selected. According to the RAM, the unselected meaning of a homonym passively decays. Other hybrid models exist and they differ in the extent to which they characterize exhaustive access as mandatory or highly likely, and the extent to which the unselected meaning is actively inhibited, or simply decays with time.

The RAM, has been widely used in previous research because it consistently predicts and explains meaning dominance and context effects (Kambe, Rayner and Duffy, 2001; Sereno, Rayner and Posner, 1998; Sereno, Brewer and O´Donnell, 2003). The general methodology employed across these studies has been to monitor readers' eye movements as they read sentences containing semantically homonym homographs (e.g. novel, spring). Duffy, Morris and Rayner (1988) presented participants with either balanced homographs (homonyms with two equally frequent meanings) (e.g., fan) or unbalanced homographs (homonyms with one meaning more frequent than the other) (e.g., fast). When unbalanced homographs were preceded by a neutral context (disambiguating context after the homonyms), fixations were similar to the control, unambiguous words. This suggests that the more dominant meaning of the word was activated early in processing, not allowing the subordinate meaning to compete for selection.

However, when these same words were preceded by a sentence context that biased the subordinate meaning of the word, longer gaze durations were observed, compared to controls. This suggests that the disambiguating context allowed for the subordinate meaning to become activated earlier and to compete for selection with the dominant meaning. This effect has been consistently observed across many studies (Sereno, O'Donnell & Rayner, 2006; Kambe et al., 2001, Duffy, Kambe & Rayner, 2001) and has been called the subordinate bias effect (SBE).

In the present study I capitalized on the reliability of the subordinate bias effect to examine bilingual activation of multiple meanings homonyms. To extend the predictions of the RAM, in particular the subordinate bias effect, to L2 lexical disambiguation, we must take into account the effect of cross-language activation and how it might interact with influences of meaning dominance and context. The potential role of cross-language activation on meaning activation can provide further insight regarding the extent to which meaning activation is necessarily exhaustive or potentially constrained by information from context and/or language membership. Within the interpretive framework of the RAM, the subordinate bias effect occurs because the context supporting the subordinate meaning allows it to compete early on with the default-activated dominant meaning. If cross-language activation allows for subordinate meanings that are shared across a bilingual's two languages (as would be the case for cognate homonyms) to be accessed even earlier in a biased context this might allow the subordinate meaning to be activated sufficiently early to bypass competition from the dominant meaning. This could produce an elimination of the any observable subordinate bias effect.

Cross-language Activation and its Effects on Lexical Disambiguation

Research on bilingual lexical access has now consistently found it to be language-nonselective in nature (e.g., de Bruin, Dijkstra, Chwilla & Schriefers 2001; Dijkstra, de Bruijn, Schriefers, & Brinke 2000; Dijkstra & Van Hell, 2003; Gollan, Forster, & Frost, 1997; Jared & Kroll, 2001; Van Heuven, Dijkstra, Grainger, & Schriefers, 2001; Schwartz, Kroll, & Diaz, 2007). The implication is that, despite a bilingual's intentions to use only one language, both languages are activated in parallel. One source of evidence for non-selectivity is from the large number of studies showing cognate facilitation, in which bilinguals are faster to recognize a cognate such as "piano" in English and Spanish than a control word (Dijkstra, Grainger, & Van Heuven, 1999; Gollan, et al., 1997; Kroll & Stewart, 1994). Another source of evidence is the finding of homograph inhibition, where bilinguals are slower to recognize or name a homograph such as "fin" than a control word (Jared & Szucs, 2002; Dijkstra, Van Jaarsveld, & Ten Brinke, 1998),

A few recent studies have examined the effect of a sentence context on cross-language lexical access to see if it constrains parallel activation of the non-target lexicon (Libben & Titone, 2009; Duyck, Van Assche, Drieghe & Hartsuiker, 2007; Elston-Güttler, 2000; Elston-Güttler, Gunter, Kotz, 2005; Schwartz & Kroll, 2006; Van Hell & de Groot, 2008). These studies have consistently shown that the simple presence of a sentence is not enough to eliminate nonselective, cross-language activation. For example, several studies have demonstrated persistent cognate facilitation effects when cognates were embedded in a low-constraint sentence context (i.e. sentences containing little semantic information leading to the target word) (Duyck et al., 2007; Schwartz &Kroll, 2006; Van Assche, Duyck, Hartsuiker & Diependaele, 2009; Van Hell & de Groot, 2008). These persistent effects have been observed even when the sentences are

presented in the bilingual's dominant first language (Van Assche et al, 2009). On the other hand, processing of the cognate targets appears language selective when targets are embedded in sentence contexts that highly bias their meaning. For example, in two separate studies effects of cognate facilitiation observed in low-constraint sentences were completely eliminated in high-constraint sentences (Schwartz & Kroll, 2006; Van Hell & de Groot, 2008). In other words, the cognate facilitation found in low-constraint sentences was completely eliminated when the same words were embedded in high-constraint sentences. However, recently, Libben and Titone (2009) found evidence for non-selectivity even in high-constrain sentences. It should be noted that these effects were confined to early measures of lexical access (i.e. first fixation durations), suggesting that context may act to limit the time-course of cross-language interactivity.

The sentence context studies summarized above demonstrate that when words share lexical form overlap across languages (cognates and homographs are orthographically similar across languages) their corresponding lexical representations are co-activated. Bilingual sentence context studies have demonstrated that cross-language activation influences lexical access even in the absence of overt form overlap. If the two languages of a bilingual are activated simultaneously during lexical access, even in context, then it is possible that this cross-language activation affects how bilinguals access and activate the multiple meanings of homonyms in general, even when these are not cognates with the non. Studies have directly examined bilingual processing of homonyms in sentence context. Elston-Güttler, Paulmann & Kotz (2005), for example, demonstrated that when the translation of a target word has more than one meaning in the other, non-target, language (it's a homonym in the non-target language) those meanings are activated and influence processing in the target language. They presented German-English participants with German homonyms translated into English to form prime-target pairs (*keifer* in

German has two meanings and thus translates into both “pine” and “jaw”) to test whether competition between the German meanings would cause interference in an English language experiment. Thus, the actual German homonym was not presented, only its’ translations were presented in the non target language. When the prime-target pairs were presented in isolation in a lexical decision task (Experiment 1), the performance of low-proficiency bilinguals showed an inhibitory effect. The authors argued that such results suggest that the two translations of a homonym are connected by inhibitory connections in the mental lexicon.

In Experiment 2, the same materials were presented in a sentence context. The prime word was presented as the last word of the sentence, followed by the target word. In this case, the sentence biased either the dominant or subordinate meaning of the German homonym, and the target was always related to the meaning that was not biased by the sentence. Again, low-proficiency learners showed strong overall inhibitory effects in the ERPs (100-250 ms) and reaction time data. High-proficiency bilinguals, on the other hand, showed no effects on either measure. The authors concluded that the ERP and reaction time effects observed by low-proficiency learners in sentence context make a strong case for a highly integrated lexicon linked at the word form level and a fundamentally non-selective word-recognition system.

Schwartz, Yeh & Shaw (2008) have also examined how cross-language activation influences bilingual lexical disambiguation by testing whether the subordinate bias effect, previously observed in monolingual studies, would increase in magnitude when the ambiguity extends across both languages (by virtue of the homonym also being a cognate). They presented highly proficient Spanish-English bilinguals with sentences that biased the subordinate meaning of an English homonym (e.g. novel – NEW). Thus here, the homonym was presented, in the target language of the experiment. These homonyms were either noncognates (e.g., fast/rápido)

or cognates (novel/novela) with Spanish. Sentences were followed by target words that on critical trials were related to dominant, contextually irrelevant meaning of the homonym (e.g. novel - BOOK). Participants were asked to decide if the follow-up target words were related to the sentence they had just read (thus requiring a "no" response).

Participants exhibited longer reaction times and greater error rates when the last word of the sentence was a homonym and the follow-up target word was related to its dominant meaning. More interestingly, the relative cost of this ambiguity effect was greater when the homonym was also a cognate with Spanish. In other words, an enhanced subordinate bias effect was observed. This suggests that the contextually-irrelevant, dominant meaning received co-activation from both of the bilinguals' languages thus producing more interference.

Taken together these findings suggest that cross-language activation plays a central role in bilingual lexical disambiguation in both single word and sentence processing. Specifically, these findings suggest that activation of homonym meanings are influenced by cross-language activation of translation equivalents in the other language. In the present experiments, I examined the role of cross-language activation and other cognitive factors that influence bilinguals' processing of homonyms with a specific focus on the ability to access subordinate meanings of homonyms. In Experiment 1 I expected that subordinate meanings shared with Spanish (i.e. cognates) would be accessed and recognized faster than noncognate subordinate meanings in a primed lexical decision task. This was expected because the co-activation of the bilinguals' two languages allows subordinate meanings of cognate homonyms to more strongly compete for activation with dominant meanings (e.g. letter – ALPHABET). In Experiment 2 it was hypothesized that the co-activation of cognate subordinate meanings would alter the nature of the SBE in sentence context. More specifically, the co-activation of a cognate subordinate

meaning would enable it to be activated early enough and allow it to bypass competition from the dominant meaning.

L2 Lexical Disambiguation: Individual Difference Factors

I also hypothesized that, in addition to cross-language activation, individual differences in working memory capacity would also influence access to subordinate meanings in an L2.Specifically, I predicted that individual differences in the degree to which bilingual's word recognition performance reflected co-activation of the non-target language (indexed by the magnitude of observed cognate facilitation) would predict how easily bilinguals access subordinate meanings of L2 homonyms particularly when these were also cognates. Since individual differences in lexical access have been found to influence reading (Stanovich 1980; Stanovich, 1986), I hypothesized that there would be individual differences in the degree of cross-language activation, and that it would predict facilitated access to L2 subordinate meanings. Furthermore, because cross-language activation effects have been more consistently observed in isolated than sentence contexts, I also predicted that the degree of the observed cross-language activation would be a significant predictor in a single-word context (Experiment 1) but not in a sentence context (Experiment 2).

In addition to cross-language activation, another factor likely to affect lexical disambiguation in the L2 is working memory capacity. Working memory plays a central role in language because both producing and comprehending language require the processing of a sequence of symbols over time. The process of reading, for example, requires readers to decode individual symbols while constructing meaning for comprehension. These processes tap into working memory resources.

Research with monolinguals has investigated the role of individual differences in working memory capacity in the processing of lexical ambiguity. Miyake, Just and Carpenter (1994), presented participants with sentences in which a balanced or unbalanced homonym was preceded by neutral contexts and disambiguated much later (e.g. "Since Ken really liked the boxer, he took a bus to the nearest pet store to buy the animal). Results showed that when the homonym had one highly frequent meaning, readers with high working memory capacity showed little effect of ambiguity on encountering the disambiguation, irrespective of which meaning of the homonym (dominant or subordinate) turned out to be correct. Participants with low working memory capacity on the other hand, showed a large ambiguity effect when the disambiguation was in favor of the subordinate meaning. Miyake et al., (1994) proposed that participants with high working memory capacity had both interpretations of the homonym readily available, whereas participants with low working memory capacity had only the dominant interpretation available.

Similarly, Gunter, Wagner and Friederici (2003) used event related potentials (ERPs), and found the same ambiguity effect for participants with low working memory capacity as in Miyake et al., (1994). Gunter et al., (2003) presented German-speaking participants with high and low working memory capacities with sentences containing a homonym followed by three words and a disambiguation cue that was either a noun (e.g. a noun related to one of the meanings of the homonym) or a a verb (e.g. a verb related to one of the meanings of the homonym) (e.g., *The tone was by the singer sung*, *when...*). The ERP data revealed that for participants with low working memory capacity the cueing towards the dominant or the subordinate meaning elicited an equivalently large ERP component, suggesting that both meanings were active in working memory. For participants with high working memory capacity,

the dominant disambiguation cue elicited a smaller ERP component than the subordinate one, indicating that for these participants particularly the dominant meaning was active, while the subordinate meaning had been inhibited.

In a study that investigated the role of working memory capacity on L2 lexical disambiguation, Arêas da Luz Fontes and Schwartz (2010), found evidence for a similar role of working memory capacity on homonym processing as seen with monolinguals, as well as an additional role of cross-language activation of cognate meanings on lexical disambiguation, which is unique to bilinguals. Consistent with monolinguals, they found that bilinguals with high working memory capacity were better at inhibiting the inappropriate meaning of homonyms than bilinguals with low working memory capacity. In addition, they found that differences in working memory capacity moderated whether effects of cross-language lexical activation were facilitative or inhibitory in nature. More specifically, bilinguals with high working memory capacity showed better performance in integrating target words into a preceding sentence context when these were cognates across their two languages. This benefit was observed for cognates that had just one meaning across languages (e.g., piano in English and Spanish) as well as cognates that were homonyms in the target language (e.g., novel/*novela* in English and Spanish). Conversely, bilinguals with low working memory capacity showed a cost in performance when integrating target cognate words, even when they converge onto a single semantic representation. This demonstrates that when there are limited working memory resources available, additional activation from the non-target language interferes with lexical processing.

The research reviewed so far clearly demonstrates that individual differences in working memory capacity play an important role in the process of lexical disambiguation for both monolinguals and bilinguals. Therefore, in the present experiments I evaluated how individual

differences in working memory capacity influence L2 lexical disambiguation in both a single-word (Experiment 1) and a sentence context (Experiment 2). Working memory capacity was expected to predict access to subordinate meanings for both cognate homonyms (e.g. letter/letra) and noncognate homonyms (e.g. star/estrella), but only in the sentence context (Experiment 2). Working memory capacity was likely to be a significant predictor in the sentence context only because sentence processing is more taxing on working memory resources than single word recognition. It is relevant to note that the work of Arêas da Luz Fontes and Schwartz (2010) was the first to show the effects of working memory capacity in L2 lexical disambiguation. Thus, a secondary goal of the present studies was to replicate previous findings from Arêas da Luz Fontes and Schwartz (2010).

The last potential factor contributing to L2 lexical disambiguation that was investigated in the present experiments was bilinguals' lexical disambiguation skills in the first language. Specifically, I tested whether access to subordinate meanings in the L1 predicted access to subordinate meanings in the L2. Although research on the transfer of L1 reading skills to L2 reading is quite extensive, there is a lack of research addressing whether lexical disambiguation skills, or the ability to select the appropriate meaning of a homonym, could be transferred across languages.

The concept of transfer has long been of interest in second language reading research. Transfer has been defined as the ability to learn new skills by drawing on previously acquired resources (Genesee, Geva, Dressler and Kamil, 2006). Similarly, Riches and Genesee (2006) suggest that prior linguistic experience should be regarded as a reservoir of knowledge, skills, and abilities that is available when learning a new language as well as literacy skills in that language. Recent psycholinguistic research has provided evidence that readers indeed rely on

their L1 linguistic skills when reading in the L2. For example, L1 reading comprehension is shown to be a significant factor, with a large contribution, in explaining variance in L2 reading comprehension (Van Gelderen, Schoonen, De Glopper, Hulstijn, Simis, Snellings, & Stevenson, 2004). Similarly, students' reading development in the L2, as measured through linguistic knowledge (vocabulary and grammar knowledge) and processing efficiency (speed of word recognition and sentence comprehension) also depended on their L1 reading abilities (Van Gelderen, Schoonen, Stoel, De Glopper, Hulstijn, 2007).

One obstacle to cross-language transfer of skills is relative proficiency in the L2. Walter (2007) compared the performance of lower-intermediate to upper-intermediate French-English bilinguals on an anomaly detection task in both French and English. Anomaly detection tasks require readers to recognize when a later statement in text contradicts an earlier statement. Two types of anomalies were included: anomalies related to main ideas and to subsidiary points of the text. Low-intermediate learners' anomaly detection in the second language declined much more than upper-intermediate learners' for subsidiary points, relative to the performance of the high-intermediate learners. Because lower-intermediate learners' ability to detect both types of anomalies in first language was efficient, the author suggested that the difference in second language comprehension was a problem of transfer, or "access". That is, when reading in the second language, lower-intermediate learners were unable to transfer/access the anomaly detection skill that they deployed well in the first language. In addition to showing the role of proficiency on linguistic transfer, results from this study also demonstrated that specific subskills of reading that aid in comprehension, such as anomaly detection, can be transferred across languages.

In the present study, we tested whether another specific subskill involved in reading in the first language, namely lexical ambiguity resolution, would be transferred to the second language. I hypothesized that access to subordinate meanings in the first language would predict access to subordinate meanings of both cognate and noncognate homonyms. However, L1 lexical disambiguation is hypothesized to be a stronger predictor of cognate homonyms because they are shared across the bilinguals' two languages. Furthermore, L1 lexical disambiguation was expected to be a significant predictor in both single word and sentence contexts because we expect bilinguals to draw on their L1 skills in both types of contexts.

The Present Study

The focus of the present experiments was to investigate the cognitive components that explain lexical access to subordinate meanings of second language homonyms in single word recognition and in a sentence task. Three main factors were expected to predict access to subordinate meanings in the second language: Cross-language activation, L1 lexical disambiguation and working memory capacity. Thus, the primary goal of this study was to address individual differences in how bilinguals access subordinate meanings of L2 homonyms.

In the single word recognition task (Experiment 1) it was hypothesized that access to subordinate meanings of cognate homonyms would be facilitated, compared to noncognate homonyms. The co-activation of common (i.e. cognate) meanings through cross-language lexical activation was expected to facilitate processing compared to non-shared, noncognate meanings. It was also hypothesized that cross-language activation, as well as L1 lexical disambiguation would be significant predictor of access to subordinate meanings of cognate homonyms. For noncognate homonyms, it was hypothesized that only L1 lexical disambiguation would be a

significant predictor. Participants were expected to rely on their L1 expertise to efficiently access subordinate meanings in the L2 for both types of homonyms. Finally, working memory capacity was not expected to be a significant predictor in the isolated context because single word recognition is not very taxing on working memory resources.

In the sentence task (Experiment 2), I hypothesized that working memory capacity, L1 lexical disambiguation and cross-language activation would be significant predictors of access to subordinate meanings of cognate homonyms. For access to subordinate meanings of noncognate homonyms, only working memory capacity and L1 lexical disambiguation were expected to be significant predictors. The process of lexical disambiguation takes up a large amount of cognitive resources; therefore, working memory capacity was expected to be a significant predictor for both types of homonyms. As in the single word recognition task, we expected bilinguals in the sentence task to rely on their L1 lexical disambiguation processing to more proficiently access subordinate meanings in their L2. Finally, cross-language activation was expected to be a significant predictor for access to subordinate meanings of cognate homonyms only, because of the cognate status of the homonyms.

An additional important facet of Experiment 2 was to replicate previous findings from the laboratory, which aimed to provide further evidence of cross-language activation as a factor to be considered for a bilingual model of lexical ambiguity resolution. Therefore, in Experiment 2, it was hypothesized that the co-activation of cognate subordinate meanings would alter the nature of the SBE by allowing the cognate subordinate meaning to be activated sufficiently early to bypass competition from the dominant meaning. In other words, the cognate subordinate meaning was expected to receive additional activation from both the biasing context and from cross-language activation, which would in turn enable this meaning to be activated earlier than

the dominant meaning and strongly enough to eliminate competition from the dominant meaning.

Experiment 1

In Experiment 1 I investigated the specific contribution of individual differences in (1) the degree of cross-language activation observed during lexical access, (2) the relative efficiency in access to subordinate meanings of L1 homonyms and (3) working memory capacity on the efficiency of access of subordinate meanings of L2 homonyms in a single word context. I hypothesized that both degree of cross language activation and lexical access to subordinate meanings of L1 homonyms would be significant predictors of access to subordinate meanings of homonyms in the L2. In addition, these two factors were supposed to be stronger predictors of cognate subordinate meanings than noncognate subordinate meanings. Working memory capacity was not expected to be a significant predictor because single word recognition is not very taxing on working memory resources. Above and beyond the influences of these individual differences, I hypothesized that access to subordinate meanings of cognate homonyms would be facilitated compared to access of subordinate meanings for noncognates since the former would be co-activated across languages.

Methods

Initial Norming Procedures

Prior to conducting the experiments, I conducted a norming study to ensure the homonyms status of selected Spanish words that were to be used in the L1 primed lexical decision task. Thirty-three students from ESOL intermediate and advanced level classes evaluated the relative frequency with which meanings of 269 Spanish homonyms were used, and ensured that they knew all the possible meanings of these homonyms. The initial pool of homonyms was previously normed in Spain (Nievas and Cañas, 1993 and Monzó, 1991). However, it is possible that the meanings produced by participants in Spain differed from the ones used in the border region because of cross-language borrowing.

In this norming procedure, bilinguals were presented with the individual word stimuli and asked to write down all the meanings of that word that came to mind. Participants were asked to come up with words or phrases that described the meanings of the homonyms. For example, for the word "letter," participants could write "a character of the alphabet," or simply, "of the alphabet." Responses were coded according to which meaning was generated first and second (and third or fourth when relevant) and the frequencies were calculated for each of the meanings. In other words, I counted the number of appearances of each meaning as either the first or second meaning generated. The dominant meaning was therefore the one generated more often as the first meaning, and the subordinate, the second most generated. To ensure that even low frequency meanings of the Spanish homonyms would be accounted for participants were given the list of stimulus words with all of their possible meanings after they had generated their own meanings and were asked to check all meanings they used, or thought were used in El Paso.

After all responses were coded, I selected Spanish homonyms for which the subordinate meaning was generated less than 30% of the time and the dominant meaning was generated more than 70%. In addition, only homonyms that had subordinate meanings that were generated or recognized by at least 80% of participants were included in the final pool of words. This led to the selection of 45 items for the list of stimuli materials. However, after checking for the ambiguity of the English translations of the homonyms, 20 items had to be excluded from the list because they had multiple translations in English. Thus, I included 15 additional items which had their subordinate meanings produced or recognized by at least 50% of the participants. The final list of critical Spanish words contained 40 homonyms, which had one dominant and one subordinate meaning, and were ambiguous only in Spanish.

In addition to Spanish homonyms, a set of 125 English homonyms was also normed with responses from a group of 35 students from the ESOL intermediate and advanced level classes. The goal of this norming was to ensure that participants were aware of the possible different meanings of the English homonyms. These words were taken from an extensive list of English homonyms normed in our laboratory. The data collection and coding procedures were identical to the norming of Spanish homonyms. Again, only English homonyms for which the subordinate meaning was generated less than 30% of the time and the dominant meaning were generated for more than 70% of the time were selected. Additionally, only homonyms that had subordinate meanings that were generated or recognized by at least 80% of participants were included. Recall that in the Spanish pool I also included subordinate meanings that were recognized by at least 50% of the participants, thus allowing for a lower recognition criterion. This was necessary because the pool of Spanish homonyms considerably decreased in size after we controlled for variables such as cognate status and ambiguity of translation. The potential problem this causes

is that differences in decision latencies between access to subordinate meanings of Spanish and English homonyms might be confounded by differences in recognition rates. However, because only 15 items (out of 40) were recognized by only 50% of the participants in the norming study, we do not expect this confounding problem.

After applying the above criteria, 88 English homonyms were selected for the list of critical stimuli. This procedure ensured that our target population for the proposed studies knew all of the possible meanings of the English homonyms. Another variable we accounted for in the studies was whether the homonyms were syntactically ambiguous. Because the pool of words had already been much reduced (N=88), syntactically ambiguous items were allowed in the list, but I ensured that they were equally represented across the noncognate and cognate conditions. This was only problematic in the English condition because we had to control for many variables (such as cognate status) that were only relevant to the English materials, which shortened the number of homonyms that could be used in the experiments. Thus, the final pool of words included 13 syntactically ambiguous items in the cognate condition and 15 in the noncognate condition. Because the number of syntactically ambiguous items (i.e. items for which one meaning is a noun and the other is a verb) was very similar across the two critical conditions, it was not expected to be a confounding variable.

To objectively distinguish between cognates and noncognates within the English stimulus list, I used the graphemic similarity algorithm developed by Van Orden (1987) to generate an index of the orthographic similarity of the stimulus words and their Spanish translations. This index gives a measure of how similar two words are in terms of their orthography, in this case the English homonyms and their Spanish translations. Word pairs for which the graphemic

similarity quotient exceeded 0.5 (with a possible range from 0.0 to 1.0) were classified as cognates (e.g. arm/*arma*, letter/*letra*, cabinet/*gabinete*, cane/*caña*).

Participants

One hundred and ten undergraduate Spanish-English bilinguals recruited from the English Speakers of Other Language (ESOL) courses and from the Introduction to Psychology courses at the University of Texas at El Paso participated in the study. Only participants whose responses on the Language Experience and Proficiency Questionnaire (LEAP-Q) reflected proficiency in both English and Spanish, and greater language dominance in Spanish were included in the analyses. I focused on bilinguals who were language dominant in Spanish because I was interested in students at an earlier stage of L2 acquisition, or that were at least still very proficient in their native language. Previous research findings from our laboratory have suggested a shift in language dominance (from Spanish to English) in the UTEP, Introduction to Psychology bilingual population. I wanted to test if the results previously obtained in the laboratory with English-dominant bilinguals would still be observed with a Spanish-dominant population.

Proficiency measures.

To ensure that participants were still dominant in Spanish and that their proficiency in English was sufficient to be included in the study, we used two proficiency measures. As a subjective measure we used the Language Experience and Proficiency Questionnaire (LEAP-Q) (Marian, Blumenfeld & Kaushanaskaya, 2007). Items on this validated measure tap into both language proficiency (self assessed by the respondent) and language-related experiences. Data

from this measure were used to assess how participants perceived their proficiency, competence in both English and Spanish as well as their language preferences. As an objective measure of proficiency, we compared reaction times on the control conditions (i.e. non-homonym, noncognate trials) of the lexical decision tasks in both English and Spanish. Faster reaction times in either language reflected dominance in that language.

To be included in the study, participants had to meet at least one of the following criteria: First, if participants reported Spanish as their dominant language, and their ratings in speaking, reading and comprehending were higher in Spanish than English they were included in the study (n = 76). Second, if participants reported English to be their dominant language, but rated themselves higher in Spanish than English, they were also included in the study (n = 1). Finally, students whose objective measure of proficiency, indicated greater proficiency in Spanish than English were also included in the final sample (n = 3). All these conditions led to an exclusion of 31 participants (28.2%). Therefore, the final group of Spanish-English bilingual students consisted of 79 participants who acquired Spanish earlier than English and who were still more dominant in Spanish than English.

Proficiency data.

Data from the LEAP-Q is summarized in table 1. Participants reported acquiring English (M = 7.0 years of age) later than Spanish (M = 1.1 years of age), $t(73) = -10.11$, $p < .01$. On a scale ranging from one to ten, participants rated their proficiency (averaging across reading, speaking and comprehending) higher in Spanish (M = 8.7) than English (M = 6.4), $t(75) = 4.9$, $p < .01$. Additionally, participants reported being more exposed to Spanish (M = 60%) than English (M = 40%), $t(78) = 6.25$, $p < .01$; reading more in Spanish (M = 53%), $t(76) = 4.70$, $p <$

.01; and speaking more in Spanish (*M* = 70%), $t(76) = 8.8$, $p < .01$. Although participants' subjective measure of proficiency suggested greater proficiency in Spanish, their objective measure of proficiency suggested otherwise. Participants were faster to recognize targets on the related control condition (noncognate, non-homonym) in English (*M* = 850.7) than Spanish (*M* = 1021.5) suggesting that lexical access was faster in their L2 than their L1, $t(69) = -5.35$, $p < .01$. Taken together these results suggest that participants' proficiency across languages was more balanced than what they perceived themselves to be. This difference between the subjective and objective proficiency measures was not expected to be detrimental to the findings of the study; however, it should be noted that although these bilinguals reported Spanish to be their dominant language, they were actually showing the usual pattern of a shift in language dominance, at least in terms of lexical access.

Table 1. Self-rated proficiency, objective proficiency and language background of the Spanish-English bilinguals in Experiment 1.

Self-rated proficiency measures from LEAP-Q		
	Mean (SD)	*Mean (SD)*
	Spanish	English
Speaking	8.8 (1.4)	7.2 (2.0)
Reading	8.4 (1.7)	7.8 (1.6)
Comprehending	9.0 (1.1)	7.9 (1.6)
Percentage of time reported exposed to each language		
	Mean (SD)	*Mean (SD)*
	Spanish	English
Total exposure	60.5 (15.6)	39.5 (14.9)

Reading	53 (17.3)	36.2 (18.8)
Speaking	69 (21.3)	31 (19.1)
Age of acquisition of each language		
	Mean (SD)	*Mean (SD)*
	Spanish	English
	1.1 (.92)	7.0 (4.9)
Mean decision latency on control trials of the lexical decision task		
	Mean (SD)	*Mean (SD)*
	Spanish	English
	850.7 (212.9)	1021.5 (287.1)

Design

The design of Experiment 1 included two parts: (1) a word manipulation, which included the manipulation of the relatedness of the prime-target word pairs, the ambiguity status of the prime words, the cognate status of the prime words and whether the follow-up targets were related to the dominant or subordinate meanings of the ambiguous prime words, and (2) a manipulation of the individual difference factors. The word manipulation was were carried out for a set of English prime-target pairs and generated a 2 (relatedness) X 2 (ambiguity status of the prime word) X 2 (cognate status of homonym) X 2 (meaning instantiated by target) design, which was a completely within-subjects design. The dependent variables for both parts of the design were reaction times and error rates. I first describe characteristics of the word stimuli used for the first part of the design, and then describe how the individual differences measures were obtained for the second part of the design.

Part 1: English word stimuli.

Critical prime-target pairs (n=80). A set of polarized English homonyms (with dominant meanings given 70% of the time or more based on the previously described norming procedures) served as critical prime word stimuli. Half of these homonyms were cognates with Spanish (cabinet/*gabinete*) that had only the subordinate meaning shared across the two languages (e.g., "group of advisors" meaning), and half were noncognates (chest/*cofre*). For each prime word, two prime-target pairs were created. In one pairing, the target was related to the dominant meaning of the prime (e.g. cabinet-KITCHEN; chest- HAIR) and in the second pairing the target was related to the subordinate meaning (e.g., cabinet- ADVISORS; chest-TREASURE). Noncognate homonyms and cognate homonyms were matched in length, frequency and part of speech. Targets were also matched in length, frequency and part of speech. See Table 2 for a summary of the critical words data. Prime-target strength of association was also matched across the two homonym conditions (Nelson, McEvoy, & Schreiber, 1998).

For the unrelated prime-targets pairs, I randomly selected 20 targets that were used in the critical, related condition. This was to ensure that targets were kept constant across the related and unrelated condition, and that any observed effects would be due to the actual relationship between primes and targets. Consequently, to ensure that participants saw any given target word only once, two experimental running lists were created. These targets were paired with unrelated homonym primes (e.g. panel-KITCHEN; husky-HAIR) that were either cognates or noncognates. The overall frequency and length of the primes in the unrelated condition matched the overall frequency and length of the primes in the related condition. See Table 3 for examples of the critical materials used in Experiment 1 and Appendices A, B and C for a complete list of all materials used in Experiment 1.

Table 2. Frequency and length of the primes and targets on the critical and control conditions of the English manipulation of the primed lexical decision task in Experiment 1.

	Related homonyms		**Unrelated homonym**	
	Cognate	Noncognate	Cognate	Noncognate
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Prime Celex frequency	61.6 (59.3)	87.6 (108.8)	72.4 (88.4)	75.2 (121.7)
Prime length*	5.3 (1.7)	4.5 (.93)	5.2 (1,2)	4.7 (1.0)
Target (dominant meaning) Celex frequency	99.6 (102.5)	102.7 (99.3)	70.8 (85.0)	100.4 (94.0)
Target (dominant meaning) length*	5.3 (1.7)	4.3 (.94)	5.8 (1.7)	4.7 (1.2)
Target (subordinate meaning) Celex frequency	69.8 (89.9)	84.5 (79.3)	NA	NA
Target (subordinate meaning) length	5.8 (1.6)	5.3 (1.6)	NA	NA

	Related non-homonyms		**Unrelated non-homonyms**	
	Cognate	Noncognate	Cognate	Noncognate
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Prime Celex frequency	55.8 (61.9)	68.9 (76.0)	41.7 (65.3)	48.9 (38.1)
Prime length*	6.2 (1.5)	4.9 (1.6)	5.9 (1.3)	6.2 (1.4)
Target Celex frequency	163.0 (212.1)	125.8 (169.3)	163.3 (212.1)	133.2 (175.5)
Target length	5.1 (1.5)	5.3 (1.6)	5.0 (1.4)	5.3 (1.3)

Control prime-target pairs (n=80). Control pairs were created using non-homonyms that matched the overall length, frequency and part of speech of the homonyms in the critical condition. Half of these non-homonyms were cognates with Spanish that matched in frequency with the non-cognates. Non-homonym primes were paired with related targets. Related targets were selected from published association norms (Nelson, McEvoy, & Schreiber, 1998). Therefore, cognate and non-cognate prime-target pairs were matched in strength of association. See Table 3 for a summary of the control words data. As with the critical pairs, unrelated pairs were created for the control condition by randomly selecting 20 targets that were kept constant and paired with an unrelated prime. Again, unrelated primes were matched in overall length and frequency with primes from the related condition.

Nonword prime-target pairs (n=200). For the nonword pairs, nonword targets were either paired with a homonym prime (e.g. left-HICE) or with a non-homonym prime (clay-NIST). The stimulus word set was divided into two different lists of 200 prime-target pairs so that participants only saw each critical prime once.

Table 3. Examples of critical English word stimuli used in Experiment 1.

	Related pairs	Unrelated pairs
Noncognate homonym condition		
Target: dominant meaning	chest-HAIR	husky-HAIR
Target: subordinate meaning	chest-TREASURE	husky-TREASURE
Cognate homonym condition		

Target: dominant meaning	cabinet-KITCHEN	panel-KITCHEN
Target: subordinate meaning	cabinet-ADVISORS	panel-ADVISORS
Noncognate non-homonym condition	breath - LUNG	painting- LUNG
Cognate non-homonym condition	actor - STAGE	visible - STAGE

Part 2: Individual differences measures.

Degree of cross-language activation. In order to derive a measure of individual differences in degree of cross-language activation effects observed during word recognition, the English primed lexical decision task included English prime words that were noncognates or cognates with Spanish. The degree of cross-language activation score was a difference score, which was calculated by subtracting reaction times and error rates on cognate non-homonym trials from reaction times and error rates on noncognate non-homonym trials [(cognate non-homonym) – (noncogante non-homonym)]. In this case, negative scores would indicate that cognates were responded to faster than noncognates. Positive scores, on the other hand, would indicate that cognates were responded to slower than noncognates.

Working memory capacity. A Spanish version of the Reading Span test (Daneman and Carpenter, 1980) was used to assess participants' working memory capacity during reading comprehension. Participants were required to read aloud a set of unrelated sentences (13 to 16 words in length) without pausing between sentences. At the end of each set of sentences, participants were asked to recall the last word of each sentence.

Participants read five blocks of sentences of each set size. Sentences were presented in blocks of varying set size, starting from two sentences per set, and increasing up to six sentences per block, or until the participant failed to recall at least three out of five blocks from a particular set size. A participant's reading span score was defined as the highest set size for which the participant correctly recalled all the last words from at least three of the five blocks. Half credit (point) was given if the subject was correct on two out of five sentence blocks.

Participants' working memory span was calculated by counting the highest number of correctly recalled (last) words of at least three blocks of sentences within a given set. If only two blocks were correctly recalled in the next set size, then participants received half a point. For example, if participants correctly recalled at least three blocks of (last) words within the two-sentence set, and failed to recall at least three blocks of the three-sentence set, then his/her span was coded as two. However, if the participant additionally recalled two blocks of the three-sentence sentence, then he/she received half of a point and his/hers span was coded as 2.5. When participants failed to correctly recall three blocks of the first set size (two sentences), then her/his span was coded as one. If at least two blocks were correctly recalled in the two-sentence set participants received a span code of 1.5. Span scores ranged from one to four and averaged 2.01, indicating that participants fell under the mid-span category.

Access to subordinate meanings of L1 homonyms. In order to measure bilinguals' efficiency in accessing subordinate meanings of homonyms in the first language, the Spanish homonyms, whose selection procedure is described earlier, were presented in a Spanish primed lexical decision task. Thus, for a separate set of Spanish prime-target pairs the relatedness of the pairs was manipulated as well as the ambiguity status of the prime and which meaning was

biased by the target, which generated a 2 (relatedness) X 2 (ambiguity status of the prime word) design.

Critical prime-target pairs (n=40). A set of polarized Spanish, non-cognate homonyms (with dominant meanings given 70% of the time or more based on the previously described norming procedures) served as critical prime word stimuli. For each prime word two prime-target pairs were created. In one pairing the target was related to the dominant meaning of the prime (e.g. guarnición - ARROZ) and in the second pairing the target was related to the subordinate meaning (e.g., guarnición - ADORNO).

***Control prime-target pairs (n=40)*.** Control pairs were created by replacing homonym primes with an unrelated control word that was matched in length and frequency with the homonym words, while keeping the same target words (e.g. murciélago - ARROZ; murciélago – ADORNO). See Table 4 for a summary of the critical and control stimuli data.

Table 4. Frequency and length of the homonym and non-homonym primes used in the Spanish manipulation of the primed lexical decision task in Experiment 1.

	Homonym	**Non-homonym**
	Mean (SD)	*Mean (SD)*
Prime LexEsp frequency	146.7 (388.6)	127.7 (218.7)
Prime length	5.7 (1.4)	5.7 (1.3)

***Filler prime-target pairs (n=40)*.** Related and unrelated prime-target filler pairs were also included in the stimulus list. Related filler trials were created using synonyms pairs (e.g. mudanza - PERMUTA). Unrelated filler trials consisted of completely unrelated words (e.g. dinero-LAGO) as well as word pairs in which the prime was a homonym a (e.g. pendiente -

IGLESIA). Filler trials were included in the design so that the presence of a homonym could not cue participants that the follow-up target would be a word. Thus, these fillers kept participants guessing whether the follow up target would a word or non-word.

Nonword target pairs (n=120). For the non-word pairs, non-word targets that obey the orthographic patterns of Spanish were either be paired with a homonym prime (e.g. gota-LLIVE) or with a non-homonym prime (e.g. viento-CIALO).

The stimulus word set was divided into two different lists of 240 prime-target pairs so that participants only saw each target word once. See Table 5 for an example of the Spanish conditions.

Table 5. Examples of the critical Spanish word stimuli used in Experiment 1.

	Related pairs	Unrelated pairs
Critical condition		
Target: dominant meaning	guarnición - ARROZ	murciélago - ARROZ
Target: subordinate meaning	guarnición - ADORNO	murciélago - ADORNO

Procedure

When participants arrived at the laboratory they first signed an informed consent form if they agreed to participate in the study. Next, participants were taken into an individual testing room and were seated in front a computer. All the initial interactions with participants were carried out in English. Research assistants were instructed to not use any code switching in the interaction with the participants to avoid any non-experimental priming of Spanish.

Participants then first completed the English task because English was already active (from the interactions with the researchers) and performance could be altered if the first task required processing in Spanish. Thus, the first task participants completed was the primed lexical decision task in English. In the primed lexical decision task, a stimulus was displayed in the center of the computer screen. A trial began with a center fixation point, followed by a forward mask, in lowercase letters, which was presented for 500 ms. The prime word was then presented in lowercase for 100 ms and replaced immediately by the target, presented in capital letters. The target remained displayed for 3000 ms or until the participant's response. The procedure of this primed lexical decision task replicated the procedure for Frenck-Mestre and Pynte (1997), who used automatic access to meanings of homonyms as a measure of bilingual's proficiency. The task was self-paced so that participants made a key press when they were ready for the next trial. "Yes" responses were made with the right hand and "No" responses were made with the left hand. Participants only saw one of the two experimental lists. Response times to targets and accuracy data were collected. After the English primed lexical decision task participants complete the same task in Spanish.

Next, participants completed the Spanish reading span task. A trial started with a fixation point, followed by the presentation of the sentences. Sentences were presented immediately after each other, without a pause between them. The experimenter pressed the space bar to show the participant each sentence, one at a time, thus controlling the pace of presentation of the sentences. The experimenter pressed the space bar for a new sentence as soon as the participant finished reading the sentence. At the end of each trial participants recalled the last words of the sentences they just read. They were instructed to remember the words in order and say them aloud to the experimenter, who marked the correctly recalled words on a response sheet. The

next trial, with the next set size started when the experimenter pressed the space bar to continue, after participants finished recalling.

After the reading span task, participants completed a Spanish version of the LEAP-Q, which was filled out online on a computer located outside the individual testing room. Finally, participants were thanked for their participation and given a debriefing form, which informed them about the purpose of the study. Participants also had the opportunity of asking questions about the study. Each experimental session lasted about 90 minutes.

Data Analysis Procedures

Reaction times faster than 300 ms were excluded from analysis. Error rates that exceed 60% on either experimental or control trials were also excluded from analysis. This procedure led to the exclusion of 7 participants (9%). Data from one participant was lost due to a computer malfunction. Thus, the results from the primed lexical decision tasks reported below are based on data from 71 participants.

Results

The specific contribution of individual differences in (1) the degree of cross-language activation observed during lexical access, (2) the relative efficiency in access to subordinate meanings of L1 homonyms and (3) working memory capacity on the efficiency of access of subordinate meanings of L2 homonyms in a single word context were addressed in Experiment 1. It was expected that both degree of cross language activation and lexical access to subordinate meanings of L1 homonyms would be significant predictors of access to subordinate meanings of homonyms in the L2. It was also expected that access to subordinate meanings of cognate homonyms would be facilitated compared to access of subordinate meanings for noncognates since the former would be co-activated across languages.

The description of results for Experiment 1 is divided into two sections. In the first section I describe analyses on general effects of the independent variables (homonym status of prime, cognate status of prime and meaning instantiated by the target) irrespective of individual differences. In the second section I describe analyses on individual differences (working memory span, degree of cross-language activation effects, and efficiency of access to subordinate meanings in the L1) in terms of their predictive power of the efficiency of access to subordinate meanings (in terms of target recognition latency and accuracy) in the L2.

Analyses on General Effects of Relatedness, Homonym and Cognate status

Analyses of general effects: Omnibus.

Reaction time data. Reaction times on correct responses were submitted to a 2 X 2 X 2 within-subjects, repeated measures ANOVA, with relatedness between prime and target, homonym status and cognate status of the prime as the within-subjects variables. There was a

main effect of relatedness reflecting faster recognition of targets that were related to primes (*M* = 860.4) relative to targets that were unrelated to primes (*M* = 916.3), [$F(1,71) = 24.4$, *MSE* = 18447, $p < .01$]. The interaction between relatedness and ambiguity was also significant, [$F(1,71) = 5.5$, *MSE* = 10268.1, $p < .05$]. Follow-up paired t-tests revealed that for unrelated the prime-target pairs recognition latencies of target words did not differ across homonym primes and non-homonym primes (*M* = 911.5 and *M* = 921.2 respectively), $t(71) = -.73$, $p > .05$. However, for related prime-target pairs recognition latencies for target words were significantly longer when these were preceded by homonym primes relative to non-homonym primes (*M* = 875.3 and *M* = 845.4 respectively), $t(71) = 2.9$, $p < 01$ (See Figure 1). This suggests that both meanings of the homonym primes were activated and thus slowed down the processing of the related targets. None of the other main effects or interactions were significant, all *p*'s > .05.

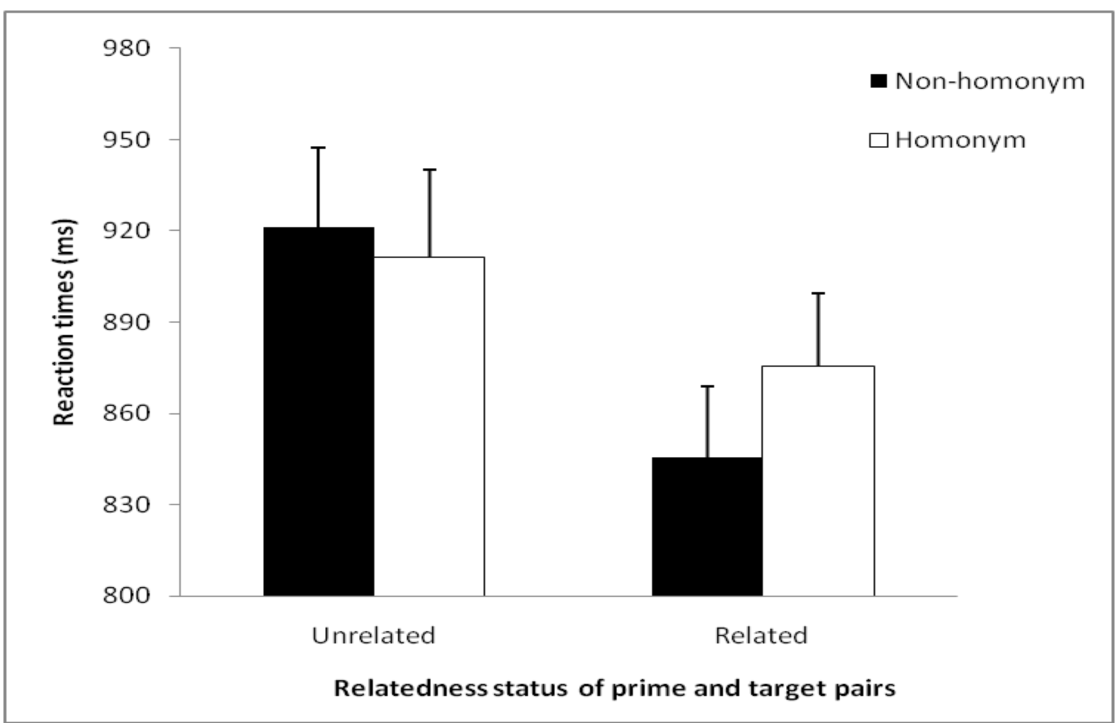

Figure 1. Mean decision latencies on targets preceded by homonym and non-homonym primes in both the related and unrelated conditions of Experiment1. Standard errors are represented in each figure by the error bars attached to each column.

Error rate data. A second 2 (relatedness) X 2 (homonym status) X 2 (cognate status) repeated measures ANOVA was performed on mean percent error rates. The main effect of relatedness was significant, reflecting the higher error rates associated with targets preceded by unrelated primes (M = 7.81), than targets preceded by related primes (M = 3.7), [$F(1,71) = 15.4$, $MSE = 106.3$, $p < .01$]. There was also a main effect of cognate status, demonstrating participants' higher error rates on targets preceded by noncognates (M = 6.2) than cognates (M = 5.3), [$F(1,71) = 5.3$, $MSE = 22$, $p < .05$]. The main effect of cognate status was qualified by an interaction with relatedness, [$F(1,71) = 12.2$, $MSE = 22.7$, $p < .01$] (See Figure 2). Follow-up paired t-tests revealed that when the primes were unrelated to the targets, cognate (M = 8.1) and noncognate (M = 7.6) targets were recognized with similar accuracy, $t(71) = -.98$, $p > .05$. Conversely, when primes and targets were related, participants had lower error rates when targets were preceded by a cognate prime (M = 2.5) than a noncognate prime (M = 4.8), $t(71) = 3.74$, $p < .01$. Neither the main effect of cognate status, nor the other interactions were significant, $p > .05$.

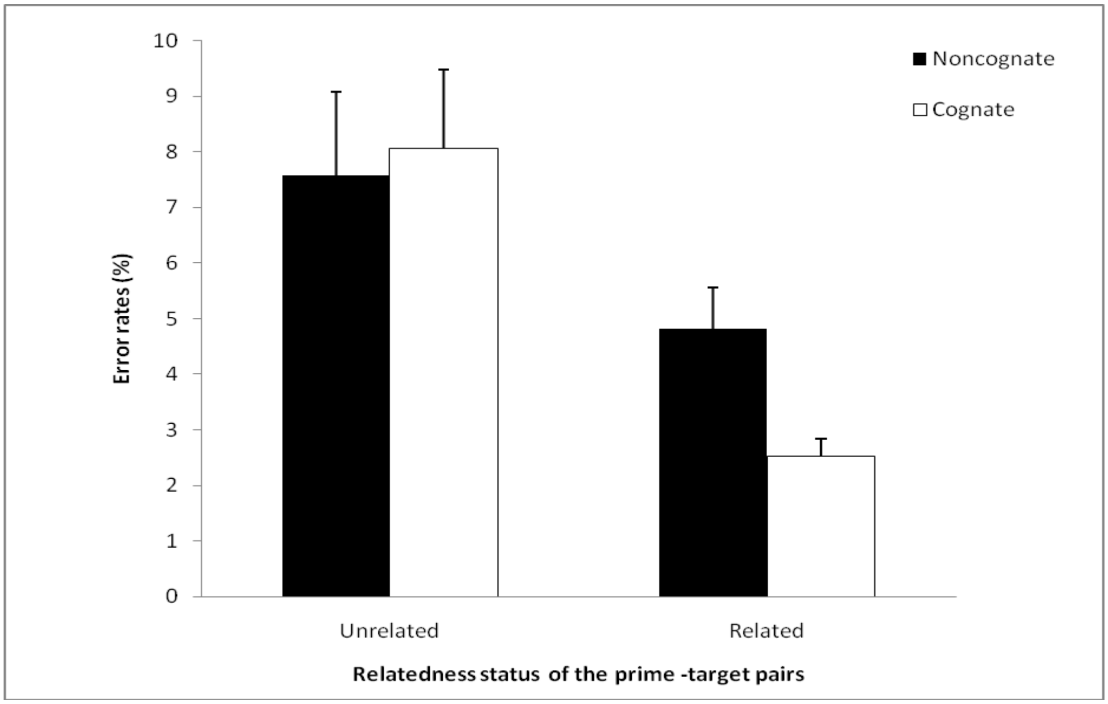

Figure 2. Percent error rates on targets preceded by cognate and noncogante primes in both the related and unrelated conditions Experiment1. Standard errors are represented in each figure by the error bars attached to each column.

In summary, the omnibus analyses revealed a general facilitative effect of prime relatedness, observed in both recognition latency and accuracy. This confirms that the bilingual participants were indeed responsive to the relatedness manipulation of the study. In addition, there was an observed cost associated with the homonyms status of the prime in the latency data, and a facilitation effect for cognate status in the error rates, confirming that participants were also responsive to the ambiguity and cognate status manipulations.

Analyses of General Effects: Homonym Effects as a Function of Cognate Status.

Because the relatedness by ambiguity interaction cited above reflects an average across cognate homonym and noncognate homonym primes, I conducted further analyses within the related condition only to directly assess the role of cognate status. To test the hypothesis that

cognate homonyms would be processed differently than noncognate homonyms, I submitted reaction times on correct responses and percent error rates to a 2X2 repeated measures ANOVA with ambiguity and cognate status of the prime as the within-subjects variable.

Reaction time data. The main effect of ambiguity was significant revealing that participants were slower to recognize targets preceded by homonyms (M = 875.3) than by non-homonyms (M = 845.5), [$F(1,71) = 8.9$, $MSE = 7181.7$, $p < .01$]. This main effect of ambiguity was qualified by an interaction with cognate status, [$F(1,71) = 4.1$, $MSE = 7206.6$, $p < .05$] (See Figure 3). Follow-up paired t-tests revealed that for trials in which the prime word was a non-homonym there was no significant difference in recognition latency of targets as a function of the cognate status of the prime, M = 841.2 for cognate primes, and M = 849.7 for non-cognate primes, $t(71) = .52$, $p > .05$). However, when the primes were homonyms, recognition latencies for target words were significantly slower for cognate primes relative to non-cognate primes, M = 891.5 for cognate primes and M = 859.2 for non-cognate primes, $t(71) = -2.5$, $p < .05$. This suggests that the cognate status of the homonym prime influenced recognition of the target, such that the further competition imposed by cross-language activation dynamics slowed down processing of a related target.

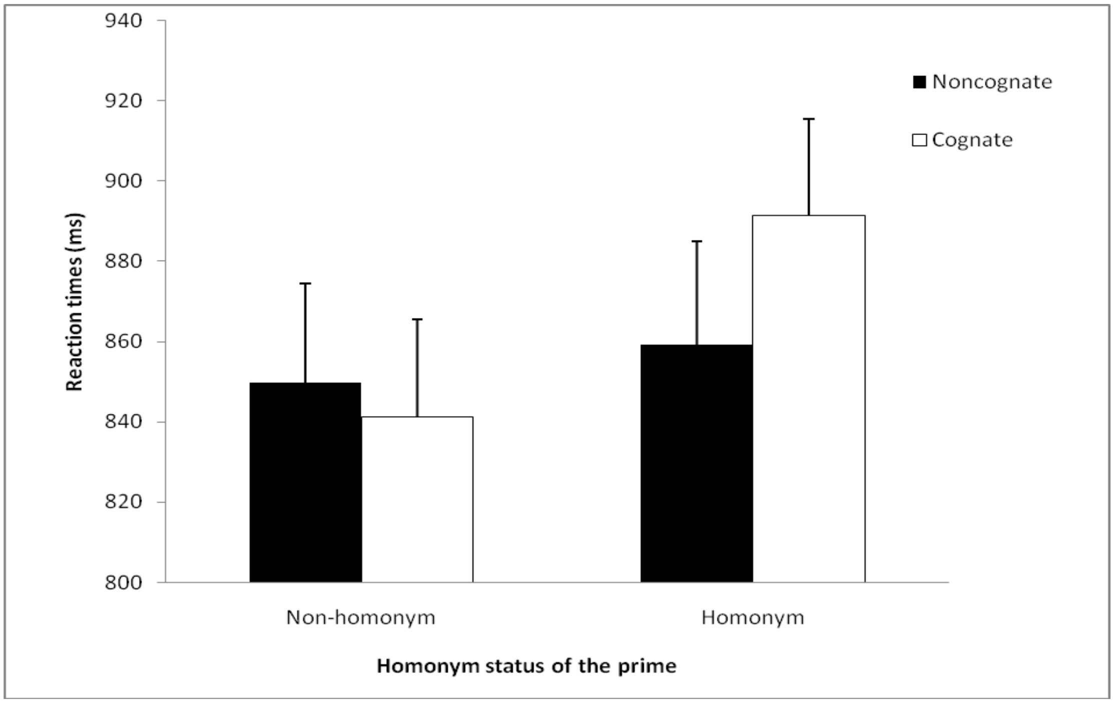

Figure 3. Mean decision latencies on targets preceded by cognate and noncognate primes in both the homonym and non-homonym conditions Experiment1. Standard errors are represented in each figure by the error bars attached to each column.

Error rate data. The 2X2 repeated measures ANOVA performed on the error rates revealed a significant main effect of cognate status, demonstrating that participants were more accurate to recognize targets preceded by cognate primes (*M* = 2.5) than noncognate primes (*M* = 4.8), [$F(1,71) = 13.9$, $MSE = 26.9$, $p < .01$]. Neither the main effect of ambiguity, nor the interaction between ambiguity and cognate status were significant, p > .05. The analyses of homonym effects as a function of cognate status of the primes suggest a cost in the processing of homonyms (i.e. RT) when these are also cognates with the other language, relative to when they are noncognates.

Analyses on General Effects: Access to Homonym Meanings as a Function of Cognate Status

Because the focus of the present study is on how readers access subordinate meanings of homonyms in the second language, depending on whether they are shared or not with the first language, I conducted a final set of analyses on mean target recognition latencies and error rates within the related, homonym prime conditions. In these analyses, I included cognate status of the homonym prime and whether the target word instantiated the dominant or subordinate meaning as independent variables. To test the hypothesis that subordinate meanings would be more easily accessed when they were shared across languages (i.e. a cognate), I submitted mean recognition latencies and error rates to a 2 (cognate versus non-cognate prime) X 2 (subordinate versus dominant meaning) repeated measures ANOVA.

Reaction time data. The ANOVA revealed a main effect of cognate status, [$F(1,71) = 6.2$, $MSE = 12082.8$, $p < .05$], reflecting faster to recognition latencies when targets were preceded by noncognate primes ($M = 859.2$) relative to cognate primes ($M = 891.5$). There was also a main effect of meaning instantiated by the target, which revealed that participants were faster to recognize targets related to the dominant meaning of the homonym ($M = 849.7$), than targets related to the subordinate meaning of the homonym ($M = 901$), [$F(1,71) = 20.3$, $MSE = 9314.1$, $p < .01$]. This is evidence that dominant meanings were activated earlier and thus recognized faster than subordinate meanings. The interaction between cognate status and meaning primed was not significant, $p > .05$, which did not support the hypothesis that subordinates meanings that are shared with Spanish (i.e. cognates) would be accessed and recognized faster than subordinate meanings not shared with Spanish (i.e. noncognates).

Error rate data. In the final set of analyses we submitted error rates to a 2X2 repeated measures ANOVA with cognate status and meaning instantiated by the prime as the within-subjects variables. The main effect of cognate status was significant, demonstrating that participants made more errors when the target was preceded by a noncognate prime (M = 4.9) than a cognate prime (M = 2.8), [F(1,71) = 9.2, MSE = 33.6, p < .01]. This main effect of cognate status was qualified by an interaction with meaning instantiated by the prime, [F(1,71) = 30.2, MSE = 35.9, p < .01]. Follow-up paired t-tests revealed that participants made *more* errors on targets related to subordinate meanings (M = 6.5) than dominant meanings (M = 3.3) of homonyms when the subordinate meanings were not shared with Spanish (i.e. noncognates), t(71) = -3.3, p < .01. On the other hand, participants made *less* errors on targets related to subordinate meanings (M = .57) than dominant meanings (M = 5.1) of homonyms when the subordinate meanings were shared in Spanish (i.e. cognates), t(71) = 7.0, p < .01 (See Figure 4). This supports the hypothesis that access to subordinate meanings of cognate homonyms would be facilitated, relative to noncognate homonyms, because of dynamics of cross-language activation. Results from the analyses on access to homonym meanings as a function of cognate status reveal a facilitative effect of cognate status on access to subordinate meanings of homonyms in the error rate data, but no in the latency data. The lack for support to the hypothesis on the latency data will be discussed later in the discussion section.

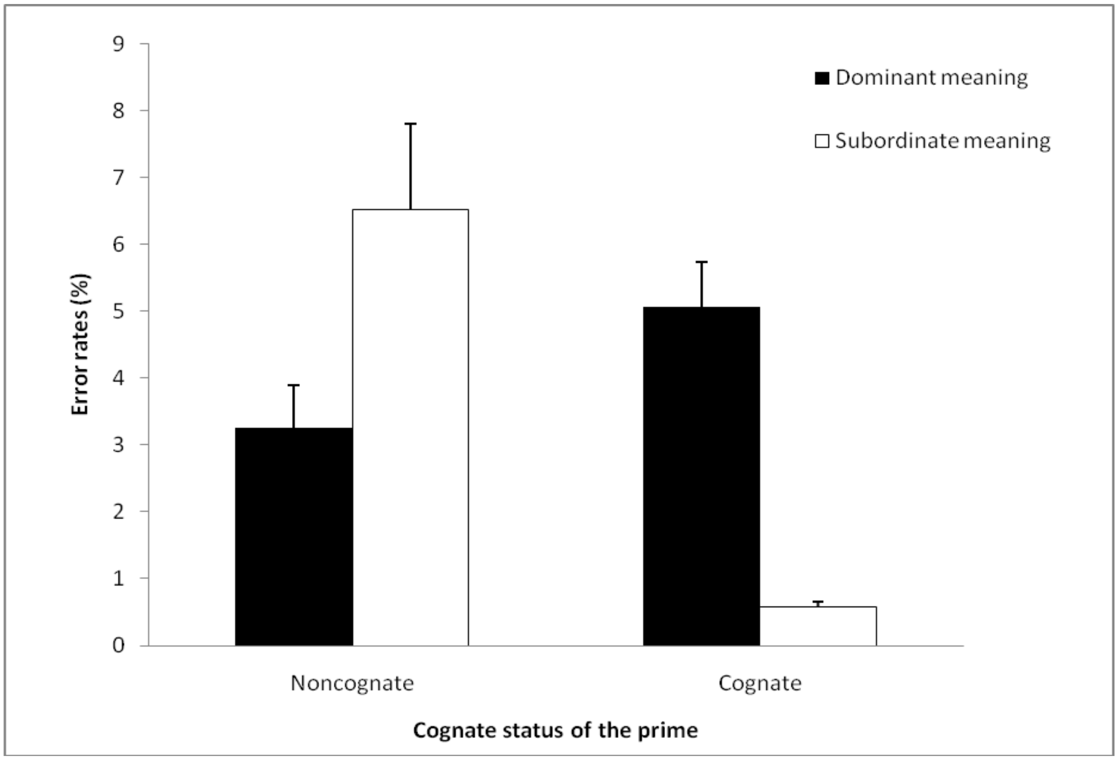

Figure 4. Percent error rates on targets related to either the dominant or suboridnate meanings of cognate or noncognate homonym primes Experiment1. Standard errors are represented in each figure by the error bars attached to each column.

So far, results have demonstrated that when bilinguals disambiguate homonyms in their second language there is a delay in processing when the homonym is a cognate compared to a noncognate. However, when I looked deeper into this interaction and analyzed access to dominant versus subordinate meanings, a distinct pattern of results was observed. Specifically, a pattern of interference was observed when bilinguals accessed subordinate meanings of noncognate homonyms (i.e. meanings not shared across languages), while a pattern of facilitation was observed when they accessed subordinate meanings that were cognates with Spanish, when the meanings were shared across languages.

In the following section, I investigated the degree of contribution of three individual difference measures to access to subordinate meanings of both cognate and noncognate

homonyms: working memory capacity, degree of cross-language lexical activation and access to subordinate meanings of L1 homonyms.

Analyses on Predictive Power of Individual Differences Measures

In the following regression analyses I addressed the question of what are some of the individual differences in cognitive measures that may contribute to the access of subordinate meanings of homonyms, depending on whether they were cognates with Spanish or not. The central objective of this study was to investigate the role and contribution of working memory capacity, degree of cross-language activation and access to subordinate meanings of L1 homonyms to access to subordinate meanings of homonyms in the L2. Thus, I conducted two separate multiple regression analyses for both latency and error rate data, to address how each of the individual differences measures contributed to access to subordinate meanings that were either shared (cognates) or not shared (noncognates) with Spanish. In other words, I tried to predict reaction times and error rates associated with access to subordinate meanings of cognate homonyms, as well as subordinate meanings of noncognate homonyms.

Before entering the measure of access to subordinate meanings of L1 homonyms, I needed to ensure that subordinate meanings were indeed more difficult to process than dominant meanings. Thus, I first conducted a paired sample t-test to verify that subordinate meanings (M = 1027.8, SD = 325.2) would be processed slower than dominant meanings (M = 901.8, SD = 265.9) in the native language, Spanish. That difference was significant, $t(69) = -5.5$, $p < .01$, verifying the manipulation. I also tested whether participants would make more errors on trials where the target was related to the subordinate meaning of the prime (M = 11.6, SD = 12.1), compared to trials where the

target was related to the dominant meaning of the prime (*M* = 7.7, *SD* = 9.6). This difference was also significant, $t(69) = -3.3$, $p < .01$, and suggested that subordinate meanings are more difficult to be accessed. These results verified that my manipulation of meaning instantiated by the target worked and that this factor was appropriate to be used in the regression analysis predicting access to subordinate meanings of L2 homonyms.

For each of the regression analysis the three predictors were entered simultaneously in the first model. These analyses are presented below. The analysis of intercorrelations between the predictors, on both reaction times and error rate data, reflected the somewhat interactive nature of the predictors. In reaction times, degree of cross-language activation and working memory capacity showed a medium size, negative correlation, $r = -.32$, $p < .01$. This correlation suggests that with greater working memory capacity, s smaller degree of cross-language activation is observed. This finding is consistent with Arêas da Luz Fontes and Schwartz (2010), in which bilinguals with high span showed no effects of cross-language activation. In the error rate data, there was smaller, negative correlation between degree of cross-language activation and access to subordinate meanings of L1 homonyms, $r = -.25$, $p < .05$. This suggests that with a greater degree of cross-language activation, participants make fewer errors in accessing subordinate meanings of L1 homonyms. None of the other correlations were significant, all *p*s > .05.

Table 6. Summary of multiple regression analysis performed in Experiment 1 predicting access to subordinate meanings of L2 homonyms from degree of cross-language activation, access to subordinate meanings of L1 homonyms and working memory capacity.

	Access to subordinate meanings of L2 homonyms			
	Noncognates		Cognates	
	Error rates	Reaction times	Error rates	Reaction times
R^2 with all three variable in the model	.26**	.29**	.30**	.32**
Individual predictors	β	β	β	β
Degree of cross-language activation	-.23*	.03	-.29**	.10
Access to subordinate meanings of L1 homonyms	.39**	.55**	.39**	.57**
Working memory capacity	.03	.10	-.18†	.13

Note. *p < .05. **p < .01. †p < .10.

Access to subordinate meanings of noncognate homonyms.

Error rate data. Degree of cross-language activation, access to subordinate meanings of L1 homonyms and working memory span significantly accounted for about 26% of variance in error rates associated with access to subordinate meanings of L2 noncognate homonyms, [R^2 = .26, F(3,66) = 7.5, MSE = 83.12, p < .01] (See Table 6). With all three variables in the model, both degree of cross-language activation and access to subordinate meanings of L1 homonyms were significant individual predictors [β = -.23, t(66) = -2.1, p < .05 and β = .39, t(66) = 3.5, p < .01, respectively]. Thus, for every one standard deviation increase in degree of cross-language activation there is a -.23 decrease in error rates associated with access to subordinate meanings of L2 noncognate homonyms, holding all other variables constant. In addition, for every one standard deviation increase in access to subordinate meanings of L1 homonyms there is a .39

increase in error rates associated with access to subordinate meanings o fL2 noncognate homonyms, holding all other variables constant. The standardized coefficients also suggest that access to subordinate meanings of L1 homonyms is the strongest predictor of error rates associated with access to subordinate meanings of L2 noncognate homonyms (β = .39 for access to subordinate meanings of L1 homonyms, β = -.23 for degree of cross-language activation).

Reaction time data. Degree of cross-language activation, access to subordinate meanings of L1 homonyms and working memory span significantly accounted for about 29% of variance in speed of access to subordinate meanings of L2 noncognate homonyms, [R^2 = .29, $F(3,66)$ = 8.9, MSE = 45747.7, $p < .01$] (See Table 6). Therefore, with all three variables in the model, only access to subordinate meanings of L1 homonyms was a significant individual predictor [β = .55, $t(66) = 5.2$, $p < .01$]. Here, for every one standard deviation increase in access to subordinate meanings of L1 homonyms there is a .55 increase in speed of access to subordinate meanings of L2 noncognate homonyms, while holding all other variables constant.

Access to subordinate meanings of cognate homonyms.

Error rate data. Degree of cross-language activation, access to subordinate meanings of L1 homonyms and working memory span significantly accounted for about 30% of variance in error rates associated with access to subordinate meanings of L2 cognate homonyms, [R^2 = .30, $F(3,66) = 9.3$, MSE = .33, $p < .01$] (See Table 6). Similar to the noncognates, with all three variables in the model, both degree of cross-language activation and access to subordinate meanings of L1 homonyms were significant individual predictors of error rates in accessing subordinate meanings of L2 cognates homonyms[β = -.29, $t(66) = -2.7$, $p <$ 01 and β = .39, t =

3.6, $p < .01$, respectively]. Working memory span only approached significance, [$\beta = -.18$, $t(66) = -1.7$, $p = .09$]. Here, for every one standard deviation increase in degree of cross-language activation there is a -.29 decrease in error rates associated with access to subordinate meanings of L2 cognate homonyms, while holding all other variables constant. Additionally, when holding all other variables constant, every one standard deviation increase in access to subordinate meanings of L1 homonyms there is a .39 increase in error rates associated with access to subordinate meanings of L2 cognate homonyms. The pattern in working memory span suggests that for every one standard deviation increase in working memory span there would be a -.18 decrease in error rates in accessing subordinate meanings of L2 cognate homonyms, holding all other variables constant. The standardized coefficients suggest that access to subordinate meanings of L1 homonyms is the strongest predictor of error rates associated with access to subordinate meanings of L2 cognate homonyms as well ($\beta = .39$ for L1 lexical disambiguation versus $\beta = -.29$ for cross-language activation).

Reaction time data. Degree of cross-language activation, access to subordinate meanings of L1 homonyms and working memory span significantly accounted for about 32% of variance in speed of access to subordinate meanings of L2 cognate homonyms, [$R^2 = .32$, $F(3,66) = 10.5$, $MSE = 30004.7$, $p < .01$] (See Table 6). Only access to subordinate meanings of L1 homonyms was a significant individual predictor [$\beta = .57$, $t(66) = 5.5$, $p < .01$], suggesting that for every one standard deviation increase in access to subordinate meanings of L1 homonyms there is a .57 increase in speed of access to subordinate meanings of L2 cognate homonyms, while holding all other variables constant.

In summary, results from Experiment 1 supported my hypothesis: access to subordinate meanings of L1 homonyms was a significant predictor of access to subordinate meanings of both

noncognate and cognate L2 homonyms in both reaction time and error rate data. The degree of cross-language activation was a significant predictor of access to subordinate meanings of both noncognate and L2 cognate homonyms in the error rate data only, which was also hypothesized. Finally, working memory capacity only approached significance in predicting access to subordinate meanings of L2 cognate homonyms in the error rates. This finding might be spurious and needs to be replicated. In addition, the error rate data showed that access to subordinate meanings of cognate homonyms, which were shared across languages, was facilitated, compared to access to subordinate meanings of noncgnate homonyms. This finding also supported my hypothesis.

To conclude, access to subordinate meanings of L1 homonyms was the strongest, most reliable factor in predicting access to subordinate meanings of L2 homonyms. Thus, it seems that even specific, or subskills of reading can be transferred across languages. In Experiment 2, I tested whether this advantage would persist in a sentence reading task. On sentence processing, I expected both access to subordinate meanings of L1 homonyms and working memory capacity to be significant predictors of access to subordinate meanings of L2 homonyms. Working memory is expected to account for variance in a sentence context because previous research has shown that working memory span influences ambiguity resolution. Degree of cross-language activation is not expected to be a significant predictor in sentence processing because previous research has shown that effects of cross-language activation are attenuated in a sentence context.

Experiment 2

Experiment 2 addressed the same questions as Experiment 1, but in a sentential context. More specifically, I investigated the effects of (1) working memory capacity, (2) degree of cross-

language activation and (3) access to subordinate meanings of L1 homonyms on access to subordinate meanings of L2 homonyms. An additional goal of Experiment 2 was to examine the effect of cross-language activation on the time-course of activation of homonyms' meanings. In particular, I tested whether the co-activation of a subordinate across languages would allow it to be activated sufficiently earlier to bypass competition from a dominant meaning.

Methods

Initial Norming Procedures

Two graduate students from the Department of Linguistics at UTEP were asked to evaluate the set of sentences containing homonyms to ensure that: (1) biased sentences had similar biasing contexts across the cognate and noncognate conditions; (2) neutral sentences contained an equally non-biasing context prior to the target word across cognates and noncognates and (3) all sentences clearly disambiguated to the subordinate meaning of the target word. The students worked independently and both gave qualitative feedback to the experimenter, helping in the editing and improvement of the sentences to meet to above criteria.

Participants

Participants were 125 Spanish-English bilinguals recruited from Introduction to Psychology courses at UTEP (who had not participated in Experiment 1) and through flyers posted on different buildings at UTEP. The same bilingualism inclusion criteria used in Experiment 1 was used in Experiment 2 because we wanted to keep our samples as similar as possible across the two studies. After applying the bilingualism criteria, data from 37 participants were excluded from the sample, a rate of 30%. Therefore, the final group of Spanish-

English bilingual students consisted of 88 participants who, similarly to Experiment 1, were still very proficient in Spanish. Participants either received monetary compensation or course credit for their participation.

Proficiency measures.

The same subjective proficiency measure and inclusion criteria from Experiment 1 were used in Experiment 2. As a measure of objective proficiency, I compared participants' English and Spanish eye-movement data for the measure of total reading times in the non-homonym, non-cognates (control) trials. Total reading times were averaged across neutral and biased sentences in non-homonym, noncognate condition in both English and Spanish. Shorter reading times in one of the languages indicated higher proficiency in that language.

Proficiency data.

Data from the LEAP-Q is summarized in Table 7. Participants reported acquiring English (M = 7.8) later than Spanish (M = 2.1), $t(87) = -7.74$, $p < .01$. Participants also rated their proficiency (averaging across reading, speaking and comprehending) higher in Spanish (M = 8.9) than English (M = 7.5), $t(87) = 7.9$, $p < .01$. Additionally, participants reported being more exposed to Spanish (M = 58%) than English (M = 42%), $t(87) = 4.04$, $p < . 01$, and speaking more in Spanish (M = 64%), $t(84) = 5.98$, $p < .01$. Participants' total reading times across neutral and biased sentences on control conditions (i.e. noncognate non-homonym) did not differ between Spanish (M = 362.7) and English (M = 389.3), t(87) = 1.6, p > .05. Taken together, these results suggest that although bilinguals reported being more proficient in Spanish than English, in terms of lexical access they were similar across languages. This may be due to the fact that these bilinguals attend college in an English-speaking country and therefore are

currently to read more frequently in English than Spanish. In fact, bilinguals reported reading in English (M = 53%) just as frequently as in Spanish (M = 47%), t(85) = 1.34, p > .05.

Table 7. Self-rated proficiency, objective proficiency and language background of the Spanish-English bilinguals in Experiment 2.

Self-rated proficiency measures from LEAP-Q		
	Mean (SD)	*Mean (SD)*
	Spanish	English
Speaking	9.0 (1.0)	7.3 (1.9)
Reading	8.5 (1.6)	7.4 (1.7)
Comprehending	9.0 (1.1)	7.8 (1.6)
Percentage of time reported exposed to each language		
	Mean (SD)	*Mean (SD)*
	Spanish	English
Total exposure	57.5(18.3)	42.5 (17.8)
Reading	53 (21.2)	47 (21.4)
Speaking	63.8 (22.3)	35.2 (22.1)
Age of acquisition of each language		
	Mean (SD)	*Mean (SD)*
	Spanish	English
	2.1 (3.8)	7.8 (5.3)
Total reading times on control targets across neutral and biased contexts		
	Mean (SD)	*Mean (SD)*
	Spanish	English

	362.7 (108.2)	389.3 (149.7)

Design

The design was Experiment 2 also included two parts: a sentence manipulation and a manipulation of the individual differences measures. For the sentence manipulation, English homonyms that were either cognates with Spanish (e.g. cabinet/*gabinete*) or noncognates (e.g. chest/*cofre*) were presented in two types of sentence contexts. In one context, the sentence frame preceding the homonym was neutral and did not bias either meaning of the homonym. In the other context, the preceding frame biased the subordinate meaning of the homonym. This produced a 2 (type of context) X 2 (ambiguity status) X 2 (cognate status) within-subjects design. The dependent variables in both parts of the design were first fixation duration, gaze duration and total reading time. In the next section, I describe the materials used in the English sentence manipulation, followed by a description of how the individual differences measures were obtained for Experiment 2.

Table 8. Means and standard deviations of target frequencies and length, as well as sentence length and target position of the English sentences used in Experiment 2.

	Neutral context			
	Non-homonym		Homonym	
	Noncognate	Cognate	Noncognate	Cognate
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Target word frequency	65.9 (45.3)	75.5 (63.5)	79.7 (69.8)	62.7 (55.1)
Target word length	5.9 (1.5)	5.9 (1.6)	4.6 (.91)	4.9 (1.8)

Sentence length	15.8 (2.2)	15.7 (2.7)	16.0 (2.6)	16.1 (2.7)
Words before target	9.5 (2.1)	9.6 (2.1)	8.7 (1.9)	10.8 (2.0)
		Biased context		
	Non-homonym		Homonym	
	Noncognate	Cognate	Noncognate	Cognate
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Target word frequency	65.9 (45.3)	75.5 (63.5)	79.7 (69.8)	62.7 (55.1)
Target word length	5.9 (1.5)	5.9 (1.6)	4.6 (.91)	4.9 (1.8)
Sentence length	14.9 (3.1)	16.3 (1.8)	17.1 (3.3)	16.7 (3.2)
Words before target	9.6 (2.1)	10.1 (2.3)	8.5 (1.8)	10.7 (2.7)

Part 1: English stimulus sentences.

Noncognate homonyms and cognate homonyms from Experiment 1 were used in the critical sentences created for Experiment 2. Thus, critical target words were English homonyms (n=30), which in half of the trials were also cognates with Spanish (n=15). The context preceding the targets was also manipulated. For each homonym I created two sentences, one with a neutral preceding context and one with a biasing context, which biases the subordinate meaning of the homonym. Therefore, sixty sentences were created, half with neutral contexts and half with biasing contexts. See Table 8 for an example of the critical stimuli used in Experiment 2. Control sentences were created using non-homonyms (n=30), half of which were pure English-Spanish cognates. These non-homonyms were also preceded by both neutral and biasing contexts. Critical and control sentences were matched in length and in the number of words that preceded the target word. Homonyms were matched with cognate homonyms in length and frequency to

allow for direct comparisons between the two conditions. In one third of the trials comprehension questions followed the presentation of the sentence to ensure that participants were reading for comprehension. See Table 9 for a summary of the data from the sentence stimuli used in Experiment 2 and Appendices D and E for a complete list of sentences from Experiment 2.

Table 9. Examples of English sentence stimuli used in Experiment 2.

Type of context	Homonym	Cognate homonym
Neutral	In excited anticipation she placed her hands on the **chest** and thought of all the gold inside.	It was not easy and it took several years to get the **cabinet** to be composed of members from both parties.
Subordinate biased	The pirates stole the gold that was inside the **chest** hidden in the sunken ship.	The president was not happy with how the members of his **cabinet** carried out their business.

Part 2: Individual differences measures.

Degree of cross-language activation. In order to obtain a measure of degree of cross-language activation, a set of cognate and noncognate *non-homonyms* were included in the English design. This allowed for the creation of a difference score [(cognate) – (noncognate)], which indicated the degree of cross-language activation observed for each participant. The degree of cross-language activation score was created by subtracting FFDs on cognate non-homonym targets from FFDs on noncognate non-homonym targets [(cognate non-homonym) –

(noncogante non-homonym)]. Negative scores indicated cognate facilitation while positive scores indicated cognate interference.

Working memory measure and data.

As in Experiment 1, the measure of working memory capacity was obtained from the Reading Span task, which was performed in Spanish, participants'L1. Participants' span ranged from 1.5 to 4, and the average was 2.3. Thus, participants in Experiment 2 also fell under the mid-span category.

Spanish stimulus sentences.

In order to obtain a measure of access to subordinate meanings of L1 homonyms, participants also completed an eye-tracking reading task in Spanish. Thus, for a separate set of Spanish homonyms I manipulated whether the critical, target word was a homonym or non-homonym and whether it was preceded by neutral or biasing context. This manipulation generated a 2 (type of target) X 2 (type of context), within-subjects design. For this measure, I simply used FFDs on Spanish homonym targets on neutral and biased contexts to predict their respective FFDs on English homonym targets.

These Spanish sentences (n=35) were created using the pure Spanish homonyms from Experiment 1. For each homonym two sentences were created: one that biased the subordinate meaning of the homonym and one that is neutral (n=70). Control sentences containing non-homonyms were also created (n=70). Half of the control sentences biased the subordinate meaning of the non-homonym and half were neutral. Comprehension questions followed the sentences in one third of all trials. See Table 10 for complete examples.

Table 10. Examples of Spanish sentence stimuli used in Experiment 2.

Type of context	Homonym	Non-homonym control
Neutral	Mi prima Hilda siempre pone un tipo de **guarnición** en sus arreglos.	Tomás dice que se va a vestir de **murciélago** para la fiesta de disfraces.
Subordinate biased	A la estilista no le gusta usar ninguna **guarnición** grande para los peinados de novia.	Porque es un animal nocturno, el **murciélago** solamente sale de noche.

Apparatus

An eye-tracking system (SR Research Ltd. Eyelink 1000) was used to monitor participants' eye-movements as they read the sentences. This system is used with a chin and forehead rest, and is a video-based tracker consisting of one desktop mounted camera. The spatial resolution is 0.01° in pupil-only mode and the sampling rate is 1000 Hz. Data was collected in monocular mode, from the participants' dominant eye. The sentences were presented on the 17-inch Dell PC monitor. The camera set up includes three steps which are the camera adjustment, calibration, and validation. Camera adjustment ensures that participants' pupils can be captured by the cameras even when they look at the corners of the screen. In order to know precisely what subjects are looking at, a 9-point calibration and validation procedure was conducted to record the value that corresponds to each gaze position.

Procedures

When participants arrived at the laboratory, they signed an informed consent form. Participants were greeted in English and all interactions were carried out in English throughout the experimental session. Participants then went to an individual testing room where they sat in front of a computer to complete the English version of the eye-tracking sentence processing task. All participants wore an eye-tracking headband which was fitted and adjusted by the experimenter to ensure comfort to participants. Participants read practice sentences to get used to reading with the eye-tracker band on. Each test trial started with a fixation point presented in the left side of the screen. The participant was instructed to fixate at the dot and then press the space bar on the computer keyboard to see the sentence. The sentence was presented left-flushed, in the middle of the screen. After the participant read the sentence, he or she pressed the space bar again to go to the next sentence. The task was self-paced and participants were instructed to read each sentence thoroughly and attentively because after some sentences a comprehension question would be presented. Next, participants completed the sentence comprehension task in Spanish, which followed the same procedure as the English version of the task.

After completing the sentence comprehension task, participants completed the Reading Span task in Spanish. The same reading span from Experiment 1 was used in Experiment 2; therefore, procedure was identical to Experiment 1.

Last, participants completed the LEAP-Q, which was filled out online on a computer located outside the individual testing room. After that was completed, participants were debriefed about the study and thanked for their participation. The entire experimental session lasted about 90 minutes.

Data Analysis Procedures

The eye-tracking procedure allows for the analysis of different eye-movement records that have been associated with different stages of reading comprehension. Different dependent variables derived from the same participants and task can be used to evaluate the time course of reading processes.

In order to capture the early, pre-lexical stages of access, I analyzed two aspects of the eye-movement record: first fixation duration, gaze duration. To capture a post-lexical stage of access, I also analyzed measures of total reading time. The first fixation duration is the length, in milliseconds (ms) of the first fixation made on the target word the first time the eye lands on it. The gaze duration is the sum of all fixations made on a target word from the first time the eyes land on the word until the moment they move forward in the text. Total reading time is the total time of all fixations made on a target word, including regressive fixations made after proceeding forward in the text.

One third of the sentences were followed by comprehension questions, which allowed us to tell whether participants were reading for comprehension. Overall accuracy on the comprehension questions was measured and participants whose accuracy was lower than 80% were excluded from data analyses. This led to an exclusion of 9 participants (10.3%). Thus, further analyses were conducted on data from 79 participants.

Results

The description of results for Experiment 2 is also divided into two sections. In the first section I describe analyses on general effects of the independent variables (type of sentence context, homonym status of target word, cognate status of target word), irrespective of individual differences. In the second section I describe analyses on individual differences (working memory span, degree of cross-language activation effects, and efficiency of access to subordinate meanings in the L1) in terms of their predictive power of the efficiency of access to subordinate meanings (in terms of eye-movement data) in the L2 in a sentence context.

Analyses on General Effects of Sentence Context, Homonym Status and Cognate Status

Analyses of general effects: First fixation durations (FFD).

In the following section I report eye-movement data from the English reading task. Relevant data from the Spanish manipulation are reported later, in the section for analyses on individual differences. First fixation durations were submitted to a 2 X 2 X 2 repeated measures ANOVA with type of context (neutral or biased), ambiguity status of the target word (non-homonym or homonym) and cognate status of the target word (noncognate or cognate) as the within-subjects variables. The main effect of ambiguity was significant, [$F(1,78) = 8.0$, $MSE = 1041.7$, $p < 01$], reflecting participants' longer FFDs on homonyms ($M = 226.9$) than on non-homonyms ($M = 219.6$). The main effect of cognate status was also significant, [$F(1,78) = 3.7$, $MSE = 941.8$, $p = .05$], reflecting participants' longer FFDs on cognates ($M = 225.6$) than on noncognates ($M = 220.9$).

The interaction between type of context and cognate status was significant, [$F(1,78) = 4.9$, $MSE = 1049.1$, $p < .05$]. Follow-up paired t-tests showed that when the context biased the

meaning of the target word, first fixations durations on noncognates and cognates were about the same (*M* = 221.8 and *M* = 220.9, respectively). When the context was neutral, on the other hand, first fixation durations were longer on cognates (*M* = 230.7) than on noncognates. (*M* = 220), $t(78) = 2.7$, $p < .01$. The three-way interaction between type of context, ambiguity and cognate status was also significant, [$F(1,78) = 6.5$, $MSE = 879.0$, $p < .05$]. I next conducted follow-up 2 X 2 repeated measure ANOVAs with ambiguity and cognate status as the within-subjects variables, analyzing biased and neutral contexts separately. See Figures 5 and 6 for these two ANOVAs. These analyzes revealed an interaction between ambiguity and cognate status in the neutral context, [$F(1,78) = 4.9$, $MSE= 854.5$, $p < .05$]. Follow-up paired t-tests further revealed comparable first fixation durations on noncognate non-homonyms (*M* = 222.9) and cognate non-homonyms (*M* = 225.5). Conversely, when the target was a homonym, first fixations were longer on cognate homonyms (*M* = 238.0) than on noncognate homonyms (*M* = 218.0), $t(87) = -3.8$, $p < .01$. The interaction between ambiguity and cognate status was not significant in the biased context, [$F(1,78) = 2.1$, $MSE= 832.7$, $p > .05$]. A look at the pattern of means in the biased context suggests that, as in the neutral context, there was no cognate effect on non-homonyms for the biased context. In the biased context, although not significant, a change of directions in the pattern of means for the homonyms was observed. This trend suggests that cognate homonyms (*M* = 222.9) were fixated slightly less than noncognate homonyms (*M* = 228.7). It may be the case that when a subordinate meaning is shared across languages it can be lexically accessed earlier and faster than non shared meanings. These results provide some evidence of the role of cross-language activation on the process of bilingual lexical disambiguation; it interacts with context to alter the time-course of activation of multiple meanings of a homonym.

Furthermore, these results supported the initial hypothesis regarding the replication of previous studies from the laboratory, and suggest that the subordinate bias effect has been eliminated.

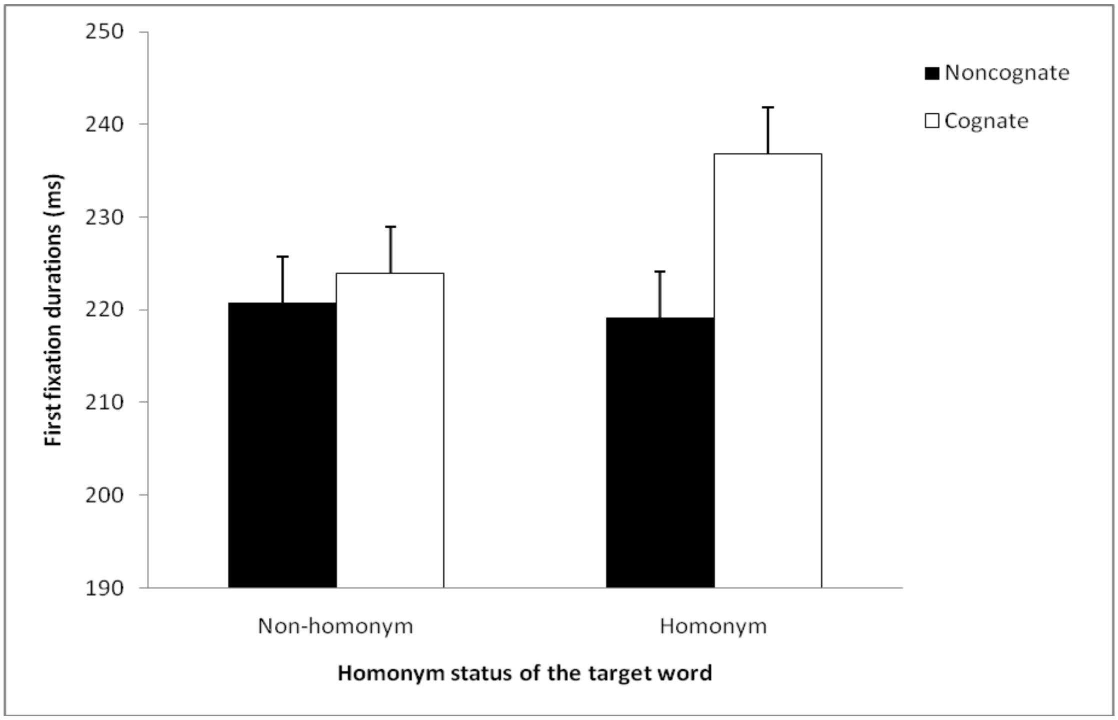

Figure 5. First fixation durations on both cognate and noncognate targets across homonym status in the neutral sentence context in Experiment 2. Standard errors are represented in each figure by the error bars attached to each column.

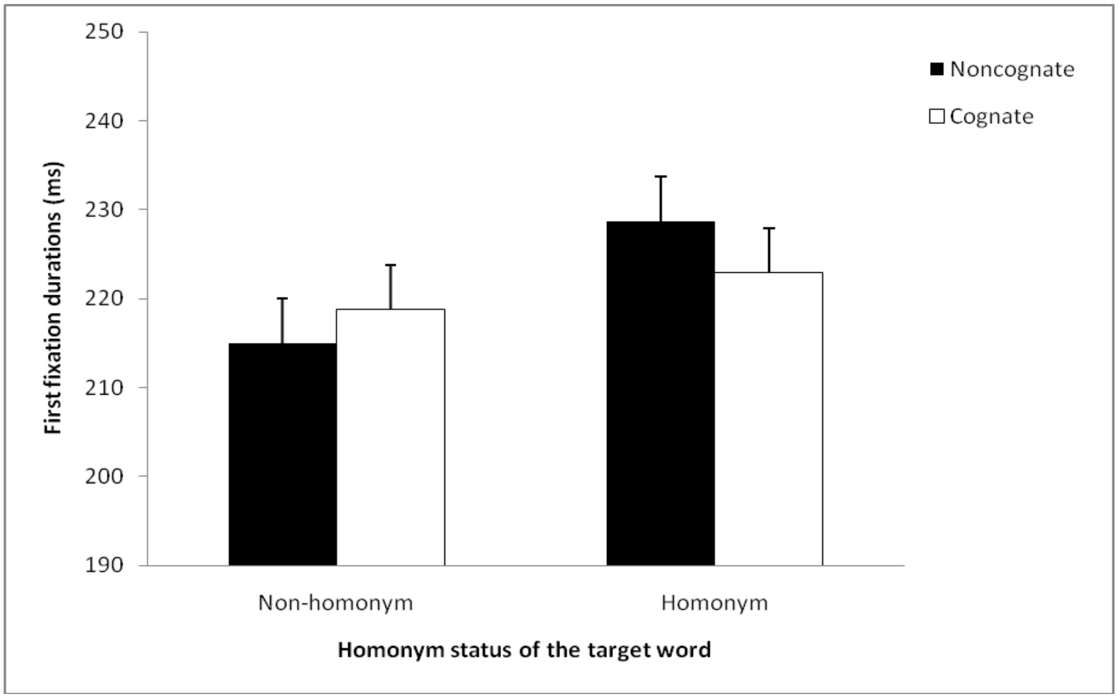

Figure 6. First fixation durations on both cognate and noncognate targets across homonym status in the biased sentence context in Experiment 2. Standard errors are represented in each figure by the error bars attached to each column.

Analyses of general effects: Gaze durations (GD).

Gaze durations were submitted to a 2 X 2 X 2 repeated measures ANOVA with type of context, ambiguity and cognate status of the target as the within-subjects variables. The main effect of type of context was significant, such that gaze durations on neutral sentences were longer (*M* = 282.1) than on biased sentences (*M* = 273.1), [$F(1,78) = 6.0$, $MSE = 2172.\ 7$, $p <$ .05]. There was also a main effect of cognate status [$F(1,78) = 12.3$, $MSE = 2187.1$, $p <$ 01], demonstrating longer gaze durations on cognates (*M* = 284.1) than on noncognates (*M* = 271.1).

The interaction between type of context and ambiguity was significant, [$F(1,78) = 6.8$, $MSE = 2672.5$, $p <$ 05]. Follow-up paired t-tests revealed that, as in the FFDs, when the context biased the target word there was no cognate effect such that gaze duration on noncognates (*M* = 271.9) were similar to gaze durations on cognates (*M* = 274.2). When the sentences were

neutral, once again, there was a pattern on cognate interference, such that gaze durations on cognates were longer (*M* = 294.1) than on noncognates (*M* = 270.3), $t(78) = 4.5$, $p < .01$. The interaction between type of context and ambiguity approached significance, [$F(1,78) = 2.9$, $MSE = 2660.6$, $p = .09$]. The pattern of means suggests that on neutral contexts, gaze durations on non-homonyms and homonyms are about the same (*M* = 282.9 and *M* = 281.3, respectively). On biased contexts, gaze durations are slightly longer on homonyms (*M* = 277.4) than on non-homonyms (*M* = 268.7).

The three way interaction between type of context, ambiguity and cognate status was also significant, [$F(1,78) = 5.9$, $MSE = 2885.8$, $p < .05$]. We next conducted follow-up 2 X 2 repeated measure ANOVAs with ambiguity and cognate status as the within-subjects variables, analyzing biased and neutral contexts separately. See Figures 7 and 8 for these analyses. On the neutral context there was an interaction between ambiguity and cognate status, [$F(1,78) = 8.0$, $MSE= 2984.6$, $p < .01$]. Follow-up paired t-tests revealed the same pattern of results observed in FFDs: no cognate effect on non-homonyms, such that gaze durations on noncognate non-homonyms (*M* = 284) were similar to cognate non-homonyms (*M* = 293.5), and a cognate effect on homonyms. When the target was a homonym, gaze durations were longer on cognate homonyms (*M* = 314) than on noncognate homonyms (*M* = 264.3), $t(87) = -4.4$, $p < .01$. On the biased context, on the other hand, the interaction between ambiguity and cognate status did not reach significance, [$F(1,78) = .37$, $MSE= 2561.7$, $p > .05$]. An examination of the means suggests a similar trend to that observed in the FFDs. Here again gaze durations were slightly longer on cognates (*M* = 271.6) than noncognates (*M* = 265.8) when the target was also a non-homonyms. However, this difference pretty much disappears when the target is also a homonym, for noncognates (*M* = 278), and for cognates (*M* = 276.8). Although much smaller in magnitude, there is still a trend of

change in direction of effects, such that gaze durations are becoming shorter on cognates homonyms. Once again, subordinate meanings that are shared across languages were accessed earlier and strongly enough to eliminate competition from the dominant meaning. This is further evidence supporting the initial hypothesis, and more importantly, supporting the elimination of the subordinate bias effect.

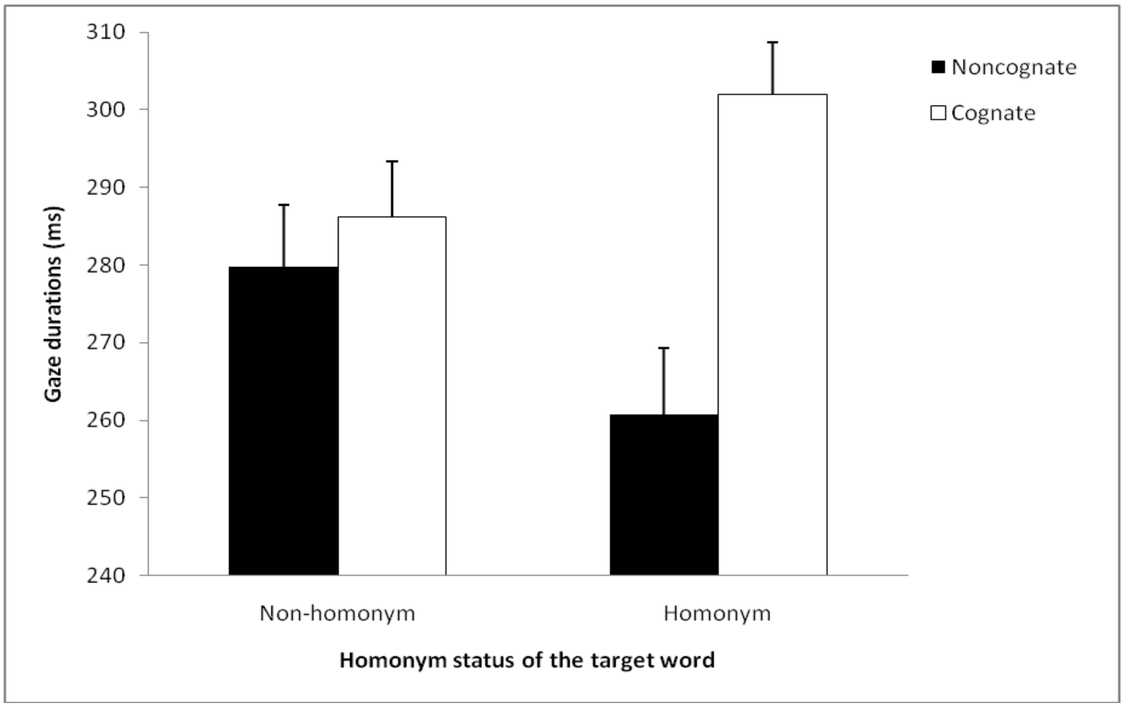

Figure 7. Gaze durations on both cognate and noncognate targets across homonym status in the neutral sentence context in Experiment 2. Standard errors are represented in each figure by the error bars attached to each column.

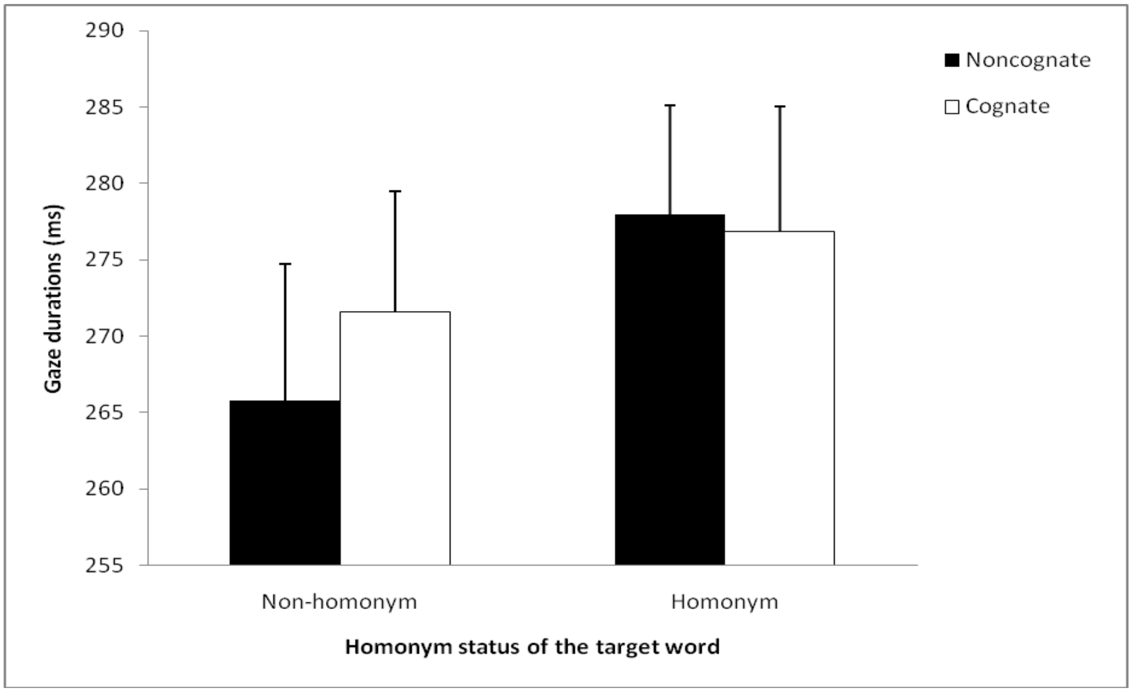

Figure 8. Gaze durations on both cognate and noncognate targets across homonym status in the biased sentence context in Experiment 2. Standard errors are represented in each figure by the error bars attached to each column.

Analyses of general effects: Total reading times (TRT).

Total reading times were submitted to a 2 X 2 X 2 repeated measures ANOVA with type of context, ambiguity and cognate status of the target as the within-subjects variables. There was a main effect of type of context, [$F(1,78) = 24.5$, $MSE = 12241.9$, $p < .01$], showing participants' longer TRTs on neutral sentences ($M = 411.7$) than biased sentences ($M = 368.1$). The main effect of ambiguity was also significant, with longer TRTs on homonyms ($M = 410.5$) than on non-homonyms ($M = 369.2$), [$F(1,78) = 21.4$, $MSE = 12595.9$, $p < .01$].

The interaction between type of context and cognate status was significant, [$F(1,78) = 3.9$, $MSE = 9479.7$, $p = .05$]. Follow up paired t-tests were not statistically significant. However, an examination of the means suggests a trend in the effects such that on neutral contexts, TRTs on cognate targets were slightly longer ($M = 419.4$) than on noncognate targets ($M = 403.9$).

This trend changed directions on the biased context such that cognates had shorter TRTs (*M* = 360.4) than noncognates (*M* = 375.8). The 3-way interaction between type of context, ambiguity and cognate status approached significance, [$F(1,78) = 3.7$, $MSE = 13123. 2$, $p = .06$] (See Figures 9 and 10). Although not a lot can be said about this approaching interaction, a quick look at the means suggests that in total reading times the pattern of effects observed in FFDs and GD changes direction such that that there is now cognate interference on the biased context, such that cognate homonyms (*M* = 376.6) have longer TRTs than noncognate homonyms (*M* = 344.7). Since TRTs reflect measures of post-lexical access, it may be the case that the cognate facilitation effect observed in FFDs and GDs disappears in later stages of processing because integration processes may already be in play. Thus, there is more competition in integrating a meaning that presents competition from within, as well as from across languages.

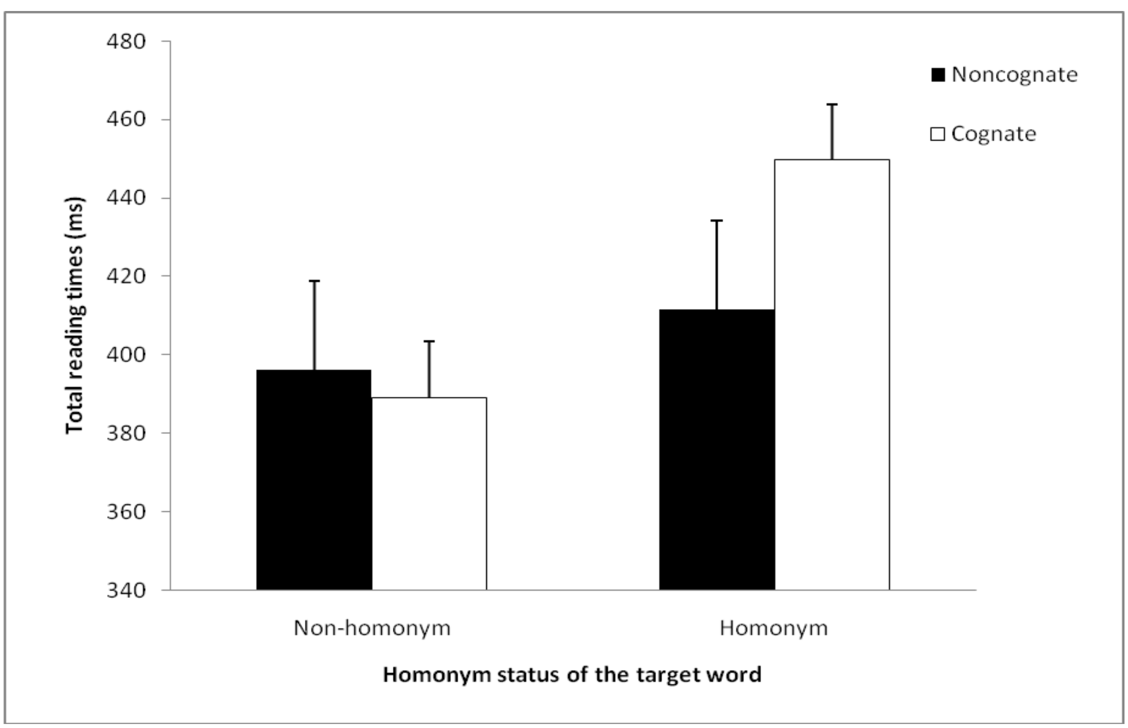

Figure 9. Total reading times on both cognate and noncognate targets across homonym status in the neutral sentence context in Experiment 2. Standard errors are represented in each figure by the error bars attached to each column.

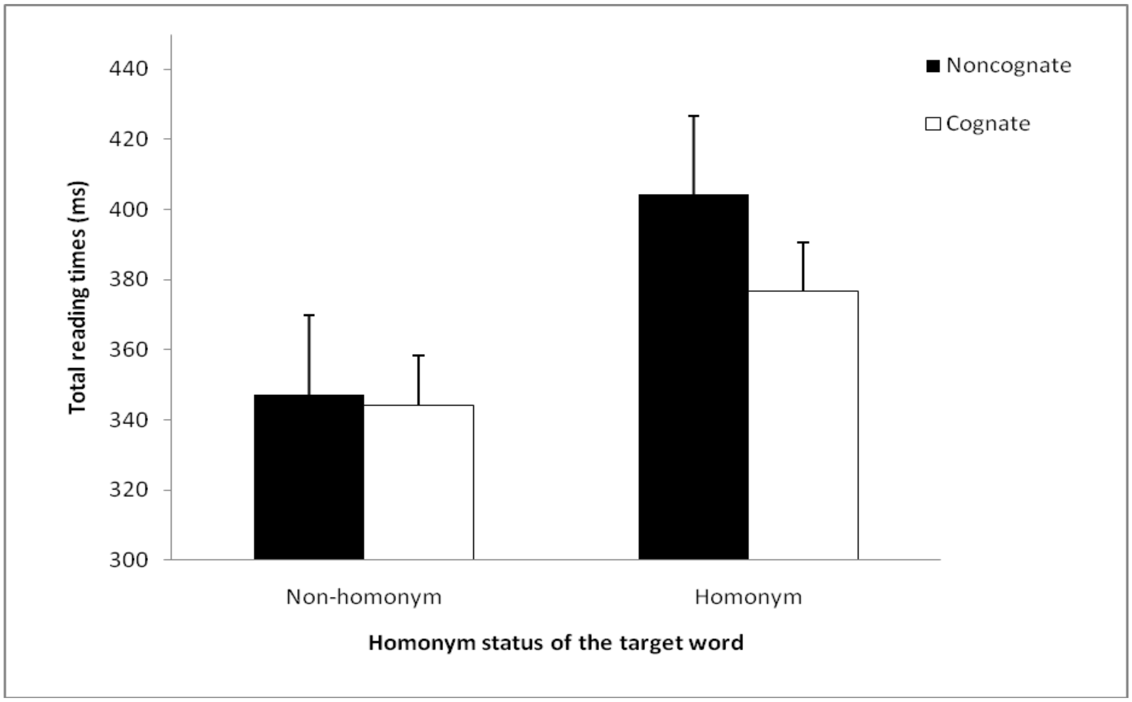

Figure 10. Total reading times on both cognate and noncognate targets across homonym status in the biased sentence context in Experiment 2. Standard errors are represented in each figure by the error bars attached to each column.

Analyses of Individual Differences Measures

In Experiment 2 I addressed the question of how working memory capacity, access to subordinate meanings of L1 homonyms and degree of cross-language activation would influence access to subordinate meanings of L2 homonyms in a sentence context. More specifically, I was interested if these three factors would predict lexical access to subordinate meanings of L2 homonyms and how it would differ depending on whether this meaning was shared with Spanish (i.e. cognate) or not (i.e. noncognate). Thus, I conducted four multiple regressions to predict the following dependent variables: FFDs on noncognate homonym targets in a neutral context, FFDs on noncognate homonym targets in a biased context, FFDs on cognate homonym targets in a

neutral context and FFDs on cognate homonym targets in a biased context. See Table 11 for a summary of the data from the regression analysis. Because the present study focused on lexical access to subordinate meanings of homonyms, I chose to focus on the earlier measure of lexical access (i.e. FFDs) and thus only reported regression analyses for this dependent variable. For all four regressions I entered all three variables simultaneously, in the first model.

The analysis of intercorrelations between the independent variables, on FFDs for each the noncognate and cognate homonyms, indicated that the predictors were not correlated, all *p* values > .05.

Table 11. Summary of multiple regression analysis performed in Experiment 2 predicting access to subordinate meanings of L2 homonyms from degree of cross-language activation, access to subordinate meanings of L1 homonyms and working memory capacity.

	Access to subordinate meanings of L2 homonyms			
	Noncognates		Cognates	
	Neutral context	Biased context	Neutral context	Biased context
R^2 with all three variables in the model	.27**	.08	.17**	.26**
Individual predictors	*β*	*β*	*β*	*β*
Degree of cross-language activation	.18†	-.01	-.05	.02
Access to subordinate meanings of L1 homonyms	.48**	.28*	.41**	.49**
Working memory capacity	.04	.12	.11	.26*

Note. *p < .05. **p < .01. †p < .10.

Access to subordinate meanings of noncognate homonyms.

Neutral context. Working memory span, first language lexical disambiguation scores and cross-language activation scores significantly accounted for about 27% of variance in access to subordinate meanings of noncognate homonyms in a neutral context, [R^2 = .27, F(3,75) = 9.4, MSE = 1110.4, p < .01] (See Table 11). With all three predictors in the model, only access to subordinate meanings of L1 homonyms was a significant predictor [β = .47, t(75) = 4.8, p < .01]. Thus, for every one standard deviation increase in FFDs on L1 homonyms in a neutral context there is a .47 increase in FFDs on L2 noncognate homonyms in a neutral context, while holding other variables constant. Although degree of cross-language activation scores only approached significance, the direction of the effect suggests that for every one standard deviation increase in the degree of cross-language activation, there is an increase of approximately .18 in FFDs on noncognate homonyms in the L2, holding all other variables constant, [β = .18, t(75) = 1.8, p = .08].

Biased context. Working memory span, access to subordinate meanings of L1 homonyms and degree of cross-language activation did not explain significant variance in access to subordinate meanings of L2 noncognate homonyms in a biased context, [R^2 = .08, F(3,75) = 2.2, MSE = 1512.1, p > .05] (See Table 11). When all three variables were included in the model, only access to subordinate meanings of L1 homonyms was a significant predictor, suggesting that for every one standard deviation increase in FFDs on L1 homonyms in a biased context there is a .28 increase in FFDs on L2 noncognate homonyms in a biased context, while holding other variables constant, [β = .28, t(75) = 2.4, p < .05].

Access to subordinate meanings cognate homonyms.

Neutral context. Working memory span, access to subordinate meanings of L1 homonyms and degree of cross-language activation significantly accounted for about 17% of variance in access to subordinate meanings of L2 cognate homonyms in a neutral context, [R^2 = .17, F(3,75) = 5.1, MSE = 1942.8, p < .01] (See Table 11). With all three variables in the model, only access to subordinate meanings of L1 homonyms was a significant predictor, suggesting that for every one standard deviation increase in FFDs on L1 homonyms in a neutral context there is a .41 increase in FFDs on L2 cognate homonyms in a neutral context, while holding other variables constant, [β = .41, t(75) = 3.8, p < .01].

Biased context. Working memory span, access to subordinate meanings of L1 homonyms and degree of cross-language activation significantly explained about 26% of the variance in access to subordinate meanings of cognate homonyms in a biased context, [R^2 = .26, F(3,75) = 8.9, MSE = 1194.2, p < .01] (See Table 11). With all three variables in the model, both working memory span and access to subordinate meanings of L1 homonyms were significant predictors. For every one standard deviation increase in working memory there is .26 increase in FFDs on L2 cognate homonyms in a biased context, [β = .26, t(75) = 2.6, p < .05]. Similarly, for every one standard deviation increase in FFDs on L1 homonyms in a biased context there is a .49 increase in FFDs on L2 cognate homonyms in a biased context, [β = .49, t(75) = 4.9, p < .01]. FFDs on L1 homonyms in a biased context was also the strongest factor in predicting FFDs on L2 cognate homonyms in a biased context, (β = .49 compared to β = .26 for working memory span).

The fact that working memory span was a significant predictor only in predicting FFDs on cognate homonyms in a biased context suggests that accessing subordinate meanings of cognate homonyms is more demanding on working memory than accessing any other type of subordinate meanings. However, the effect of working memory capacity was not very reliable and needs to be replicated in future research.

In summary, results from Experiment 2, regarding the analysis of individual differences, are in line with results from Experiment 1: access to subordinate meanings of L1 homonyms was the most reliable, strongest predictor of access to subordinate meanings of L2 homonyms. Thus, the hypothesis concerning transfer of a specific subskill of reading was supported. In addition, the hypothesis about degree of cross-language activation was also supported as this factor was not a significant predictor of access to subordinate meanings of L2 homonyms in a sentence context. Working memory capacity was not a significant predictor, which did not support the initial hypothesis. However, similar null results for the effects of working memory capacity on reading comprehension have been found (la Pointe & Engle, 1990). Further analysis of this null effect is presented in the discussion.

Discussion

The present experiments investigated the role of degree of cross-language activation, access to subordinate meanings of L1 homonyms and working memory capacity on efficiency of access to subordinate meanings of homonyms in a second language. Across the two experiments, access to subordinate meanings of L1 homonyms was a consistent and reliable predictor of access to subordinate meanings of L2 homonyms. Access to subordinate meanings of L1 homonyms was a significant predictor, and explained the most variance in access to *both*

noncognate and cognate subordinate meanings in *both* the single word and sentence processing tasks. Thus, results from the present studies suggest that bilingual lexical access is influenced by both languages not only through cross-language activation, but also through transfer of L1 reading skills.

One possible mechanism for this transfer is that second language learners who have a solid, strong linguistic background in the L1 are able to rely on linguistic skills in the L1 when processing in the L2. Recall that participants in both experiments reported being more proficient in Spanish (L1) than English (L2). Thus, it may be that the specific skill of lexical disambiguation is transferred across languages and bilinguals, or second language learners who have good lexical disambiguation skills in the L1 are at advantage for the same type of processing in the L2. They can more easily access subordinate meanings in the L2, regardless of whether the meaning is a cognate or not.

Another possible mechanism is that lexical disambiguation is seen more as a general cognitive process that requires readers to enhance and activate appropriate meanings, while inhibiting and deactivating inappropriate ones. Bilinguals, by virtue of having to constantly deal with two languages in their mind, might be very efficient at enhancing relevant meanings, while inhibiting irrelevant information. Thus, bilinguals may show an enhanced general cognitive ability for lexical disambiguation. In fact, there is support for a general cognitive mechanism in the process of lexical disambiguation, with monolingual readers. In the structure-building framework (e.g., Gernsbacher, 1990, 1996; Gernsbacher & Faust, 1991), individual differences in enhancement and suppression mechanisms are responsible for how much a sentence context aids in lexical selection. In this framework, enhancement helps in the construction of mental structures by activating the information necessary to create the initial foundation upon which a

new structure will be created. Suppression in turn reduces the activation of irrelevant information. Furthermore, less skilled readers show less efficient enhancement and suppression mechanisms, with the opposite pattern true for more skilled readers (Gernsbacher & Faust, 1991). In the case of the present study, the ability to access subordinate meanings (e.g. enhancement of appropriate meanings) would be irrelevant of the language of processing, and thus considered a more general mechanism, because it operates equally in both the L1 and the L2.

Additional evidence from working memory data supports the idea of a mechanism for transferring of a specific subskill of reading. The fact that working memory capacity was not a strong predictor of access to L2 subordinate meanings in either single-word recognition or sentence contexts suggests that the observed transfer of L1 linguistics skills was not simply a matter of enhanced verbal abilities. It supports the possibility of a mechanism for transfer of specific subskills of reading.

Results from Experiment 1 demonstrated that degree of cross-language activation is a significant predictor of access to subordinate meanings of non-cognate homonyms, as well as cognate homonyms. This predictive relationship with non-cognate homonyms was not expected and did not follow the initial hypothesis that degree of cross-language activation would be a significant predictor of access to subordinate meanings of cognate homonyms only. What this evidence suggests is that the individual degree of cross-language activation helps bilinguals to access subordinate meanings of L2 homonyms, irrespective of their cognate status. Together with the evidence demonstrating that access to subordinate meanings of L1 homonyms is also a significant predictor of access to subordinate meanings of both cognate and noncognate homonyms, it seems that cross-language activation acts as an additional process to activate and

select meanings of homonyms. It suggests there might be a single cognitive mechanism that feeds into both individual differences in degree of cross-language activation along with L1 lexical disambiguation skills, and that this mechanism is driving the ability to activate and access all possible meanings of a homonym for further processing.

Additional evidence from Experiment 1 suggested that working memory capacity is not an important factor for lexical disambiguation in a single word context. The effect of working memory capacity only approached significance in the ability to predict access to subordinate meanings of cognate homonyms in the error rates. This is not surprising since access to a subordinate meaning that is shared across languages activates multiple semantic candidates within and across languages and it thus takes up more working memory resources. In terms of access to subordinate meanings of L2 homonyms in a single-word context, the present study demonstrated that both access to subordinate meanings of L1 homonyms and degree of cross-language activation are important individual differences that must be taken into account when developing models of bilingual lexical disambiguation.

In the sentence-processing task of Experiment 2, degree of cross-language activation and working memory capacity were significant predictors of access to subordinate meanings of L2 homonyms under different conditions. Degree of cross-language activation was a significant predictor of access to subordinate meanings of L2 noncognate homonyms in a neutral context. A greater degree of cross-language activation predicted longer first fixation durations on noncognate homonyms. This result was unexpected, especially because this cross-language activation did not similarly predict the first fixations for cognate homonyms. However, it can be understood through the idea presented earlier, which suggests that bilinguals may have an enhanced ability to activate and select multiple meanings of words, whether they are shared

across languages or not. This may be due to the constant need to deal with two languages. This constant practice may strengthen semantic and orthographic connections within and across languages such that cross-language activation may be constantly at play and may sometimes delay processing of noncognate words. In other words, the idea is that semantic nodes from both of a bilingual's language are accessed exhaustively, but when the meaning to be selected is a noncognate, delay in processing is observed.

Working memory capacity was only a significant predictor of access to subordinate meanings of L2 cognate homonyms in a biased context (when all other variables were held constant), such that increased working memory capacity predicted longer FFDs on cognate homonyms. One possible explanation is that bilinguals with greater working memory capacity have enough cognitive resources available during early stages of lexical access to activate and consider multiple meanings. As a consequence, bilingual readers with greater working memory capacity show longer viewing latencies of homonyms early on, but in later integrative phase of processing they do not spend as much time on these words. The fact that working memory capacity was a predictor only when cognate homonyms were embedded in a biasing context condition suggests that this condition required the most cognitive resources to be processed. Nonetheless, this might have been a spurious finding, as working memory capacity was expected to predict variance in all conditions because of its documented effect on reading comprehension. One possibility for this unreliable effect might be that Daneman and Carpenter's reading span task does not tap into processes of ambiguity resolution involved in reading. The task requires participants to read aloud sentences and recall their last words. This might tap more onto rehearsal in the phonological loop, rather than executive control, which is more required for

ambiguity resolution. As a matter of fact, la Pointe and Engle (1990) argue that reading span does not measure a working memory specific to reading.

In summary, in a sentence context, individual differences in access to subordinate meanings of L1 homonyms was shown to have the largest contribution to access to subordinate meanings of L2 homonyms. This is a new finding in the literature that should be taken into account for models of bilingual lexical disambiguation.

The present results also speak to the additional goal of the present studies, which included extending a monolingual model of lexical disambiguation to bilinguals (RAM), by providing evidence to support cross-language activation as a factor that influences lexical disambiguation for bilinguals. Evidence from both experiments supports the important role of cross-language activation. In Experiment 1, when prime-target pairs were related semantically, I found that targets related to subordinate meanings of cognates generated error rates that were more than ten times less than error rates associated with subordinate meanings of noncognates ($M = .57$ versus $M = 6.52$). Evidence from Experiment 2 provides additional support for the role of cross-language activation in L2 lexical disambiguation. Specifically, the pattern of results from that experiment reflects a change in the nature of the subordinate bias effect. When a subordinate meaning of a homonym is both biased by the context and shared across languages, that meaning can be activated and accessed earlier, compared to a noncognate subordinate meaning, thus bypassing competition from the dominant meaning and eliminating the subordinate bias that is observed for non-cognate homonyms. Therefore, is seems that the cognate status of a meaning of a homonym, along with the type of context it is embedded in, alters the time course of activation of such meaning. In a biased context, subordinate meanings of cognate homonyms are accessed early enough because of additional cross-linguistic

activation, and can bypass the competition from dominant meanings. Other studies have attempted to eliminate the subordinate bias effect (Sereno, Patch & Rayner, 1992; Martin, Vu, Kellas & Metcalf, 1999). However, because these studies were either re-interpreted, or failed to be replicated, they were unsuccessful in eliminating the effect. Therefore, it is essential that the findings from this study are replicated in future research.

Another piece of evidence that amounts to the important role of cross-language activation on bilingual lexical disambiguation is the cognate interference finding in the neutral context on both first fixation and gaze durations. Recall that on neutral contexts, longer first fixation and gaze durations were observed for cognate homonyms, relative to noncognate homonyms. This suggests that competition from the dominant meaning of a cognate, which is always activated in a neutral context, was more difficult to resolve, compared to a noncognate. This finding replicates results from Schwartz, Yeh and Shaw (2008), in which bilinguals had more difficulty rejecting targets related to dominant meanings of cognate homonyms, relative to noncognate homonyms. Taken together, results from Experiments 1 and 2 provide compelling evidence for the inclusion of cross-language activation as a factor in a bilingual model of lexical disambiguation.

Finally, the present studies reveal that at least three individual difference factors may also play a role in bilingual lexical disambiguation. In particular, individual differences in access to subordinate meanings of L1 homonyms played a major role in L2 lexical disambiguation. It seems that the ability to select appropriate meanings of homonyms is one processing skill that can be transferred across languages. As far as degree of cross-language activation as an individual difference factor, it is a more important factor in single-word contexts. In sentence contexts, degree of cross-language activation was not sufficiently consistent (it was only

significant in one condition) to be considered a key factor in L2 lexical disambiguation. Working memory capacity was also not a very consistent factor, being a significant predictor in only one single-word condition and one sentence condition. This may be because the present study used measures of early lexical access (i.e. FFD) to subordinate meanings of homonyms. If the measures used were more integrative in nature, then perhaps working memory capacity would have played a more relevant role. Thus, I will not yet discard working memory as an important factor in l2 lexical disambiguation, it may be just a factor that acts later in processing

Applications

Results from the present study can be applied in two different settings: scientific and educational. Scientific because it speaks directly to a new model of bilingual lexical disambiguation in which cross-language is added as an additional factor that alters the time course of activation of meanings. In addition, a bilingual model of lexical disambiguation should account for individual differences in L1 lexical disambiguation (i.e. access to subordinate meanings of L1 homonyms) because it has been shown to predict performance in L2 lexical disambiguation.

Educational because, like many other bilingual studies, the present experiments show that bilinguals cannot turn off one of their languages, even when the task is performed in a single language. Thus, requiring that children do not use their native language in the classroom does not make a difference because that language is active unconsciously, and will influence processing. Furthermore, bilinguals rely on their L1 linguistic knowledge when performing tasks in the L2. This is additional evidence to support the claim that classrooms should allow for the use of the native language. In the present study, even a specific type of reading processing is transferred

across languages. Thus, given that a language cannot be turned off and skills are transferred across languages, the use of the L1 in ESL or bilingual education classes should be permitted as a resource for students with difficulty and as a way to foster L2 skills.

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Appendix A

Prime-TARGET pairs used in Experiment 1

Homonym primes

Prime	Target	List	Cognate status of the prime	Meaning instantiated by target	Relatedness status
arm	LEG	A	cognate	dominant	related
arm	WEAPON	B	cognate	subordinate	related
bill	PAYMENT	A	cognate	dominant	related
bill	MONEY	B	cognate	subordinate	related
box	SQUARE	A	cognate	dominant	related
box	FIGHT	B	cognate	subordinate	related
bulb	LIGHT	A	cognate	dominant	related
bulb	TULIP	B	cognate	subordinate	related
cabin	MOUNTAIN	A	cognate	dominant	related
cabin	SHIP	B	cognate	subordinate	related
cabinet	KITCHEN	A	cognate	dominant	related
cabinet	ADVISORS	B	cognate	subordinate	related
cane	CRUTCH	A	cognate	dominant	related
cane	SUGAR	B	cognate	subordinate	related
capital	CITY	A	cognate	dominant	related
capital	LETTERS	B	cognate	subordinate	related
compact	COMPRESSED	A	cognate	subordinate	related
compact	SMALL	B	cognate	dominant	related
culture	BACKGROUND	A	cognate	dominant	related
culture	GROW	B	cognate	subordinate	related
cycle	BICYCLE	A	cognate	subordinate	related
cycle	CIRCLE	B	cognate	dominant	related

digit	NUMBER	A	cognate	subordinate	related
digit	FINGER	B	cognate	dominant	related
fan	CLUB	A	cognate	subordinate	related
fan	COOL	B	cognate	dominant	related
fault	BLAME	A	cognate	dominant	related
fault	EARTHQUAKE	B	cognate	subordinate	related
form	CREATE	A	cognate	subordinate	related
form	PAPER	B	cognate	dominant	related
fortune	RICH	A	cognate	dominant	related
fortune	COOKIE	B	cognate	subordinate	related
grace	PRAYER	A	cognate	dominant	related
grace	BALLET	B	cognate	subordinate	related
grave	SERIOUS	A	cognate	subordinate	related
grave	CEMETERY	B	cognate	dominant	related
justice	FAIR	A	cognate	dominant	related
justice	JUDGE	B	cognate	subordinate	related
letter	WRITE	A	cognate	dominant	related
letter	ALPHABET	B	cognate	subordinate	related
mold	SHAPE	A	cognate	subordinate	related
mold	GREEN	B	cognate	dominant	related
net	WEIGHT	A	cognate	subordinate	related
net	FISH	B	cognate	dominant	related
novel	IDEA	A	cognate	subordinate	related
novel	BOOK	B	cognate	dominant	related

operation	MISSION	A	cognate	subordinate	related
operation	SURGERY	B	cognate	dominant	related
pass	FAIL	A	cognate	dominant	related
pass	TICKET	B	cognate	subordinate	related
patient	CALM	A	cognate	subordinate	related
patient	DOCTOR	B	cognate	dominant	related
plane	FLAT	A	cognate	subordinate	related
plane	FLY	B	cognate	dominant	related
plate	METAL	A	cognate	subordinate	related
plate	DISH	B	cognate	dominant	related
produce	BUILD	A	cognate	subordinate	related
produce	FRUIT	B	cognate	dominant	related
race	COLOR	A	cognate	subordinate	related
race	WIN	B	cognate	dominant	related
reservation	HOTEL	A	cognate	dominant	related
reservation	INDIAN	B	cognate	subordinate	related
rest	REMAINING	A	cognate	subordinate	related
rest	BREAK	B	cognate	dominant	related
roll	FALL	A	cognate	dominant	related
roll	BREAD	B	cognate	subordinate	related
scale	RATING	A	cognate	dominant	related
scale	WEIGH	B	cognate	subordinate	related
sentence	PARAGRAPH	A	cognate	dominant	related
sentence	PRISON	B	cognate	subordinate	related

stable	UNSTABLE	A	cognate	subordinate	related
stable	HORSE	B	cognate	dominant	related
table	CHART	A	cognate	subordinate	related
table	CHAIR	B	cognate	dominant	related
term	SEMESTER	A	cognate	dominant	related
term	WORD	B	cognate	subordinate	related
train	TEACH	A	cognate	subordinate	related
train	TRACK	B	cognate	dominant	related
trunk	ELEPHANT	A	cognate	subordinate	related
trunk	CAR	B	cognate	dominant	related
affair	LOVE	A	noncognate	dominant	related
affair	EVENT	B	noncognate	subordinate	related
ball	GAME	A	noncognate	dominant	related
ball	DANCE	B	noncognate	subordinate	related
blue	SKY	A	noncognate	dominant	related
blue	SAD	B	noncognate	subordinate	related
bridge	WATER	A	noncognate	dominant	related
bridge	CARD	B	noncognate	subordinate	related
bug	ANNOY	A	noncognate	subordinate	related
bug	INSECT	B	noncognate	dominant	related
cap	BOTTLE	A	noncognate	subordinate	related
cap	HAT	B	noncognate	dominant	related
chest	HAIR	A	noncognate	dominant	related
chest	TREASURE	B	noncognate	subordinate	related

cold	ICE	A	noncognate	dominant	related
cold	SICK	B	noncognate	subordinate	related
fire	HOT	A	noncognate	dominant	related
fire	GUN	B	noncognate	subordinate	related
foot	INCH	A	noncognate	subordinate	related
foot	WALK	B	noncognate	dominant	related
ground	DIRT	A	noncognate	dominant	related
ground	BEEF	B	noncognate	subordinate	related
hard	EASY	A	noncognate	subordinate	related
hard	SOFT	B	noncognate	dominant	related
horn	BULL	A	noncognate	subordinate	related
horn	NOISE	B	noncognate	dominant	related
jam	TRAFFIC	A	noncognate	subordinate	related
jam	SWEET	B	noncognate	dominant	related
joint	BONE	A	noncognate	dominant	related
joint	TOGETHER	B	noncognate	subordinate	related
key	CRUCIAL	A	noncognate	subordinate	related
key	CHAIN	B	noncognate	dominant	related
kind	NICE	A	noncognate	dominant	related
kind	TYPE	B	noncognate	subordinate	related
land	SEA	A	noncognate	dominant	related
land	AIRCRAFT	B	noncognate	subordinate	related
litter	KITTEN	A	noncognate	subordinate	related
litter	WASTE	B	noncognate	dominant	related

log	BOOK	A	noncognate	subordinate	related
log	WOOD	B	noncognate	dominant	related
match	FIRE	A	noncognate	dominant	related
match	TENNIS	B	noncognate	subordinate	related
mean	AVERAGE	A	noncognate	subordinate	related
mean	ANGRY	B	noncognate	dominant	related
pack	WOLF	A	noncognate	dominant	related
pack	CIGARETTE	B	noncognate	subordinate	related
pinch	SALT	A	noncognate	subordinate	related
pinch	HURT	B	noncognate	dominant	related
play	BALL	A	noncognate	dominant	related
play	THEATRE	B	noncognate	subordinate	related
pool	TABLE	A	noncognate	subordinate	related
pool	SWIM	B	noncognate	dominant	related
punch	DRINK	A	noncognate	subordinate	related
punch	HIT	B	noncognate	dominant	related
rash	CARELESS	A	noncognate	subordinate	related
rash	RED	B	noncognate	dominant	related
ruler	KING	A	noncognate	subordinate	related
ruler	MEASURE	B	noncognate	dominant	related
season	SUMMER	A	noncognate	dominant	related
season	FOOD	B	noncognate	subordinate	related
sharp	SMART	A	noncognate	subordinate	related
sharp	POINT	B	noncognate	dominant	related

shoot	KILL	A	noncognate	dominant	related
shoot	PICTURE	B	noncognate	subordinate	related
shot	DEAD	A	noncognate	dominant	related
shot	GLASS	B	noncognate	subordinate	related
square	ROOT	A	noncognate	subordinate	related
square	SHAPE	B	noncognate	dominant	related
star	MOVIE	A	noncognate	subordinate	related
star	MOON	B	noncognate	dominant	related
suit	OUTFIT	A	noncognate	dominant	related
suit	LAW	B	noncognate	subordinate	related
tire	WHEEL	A	noncognate	dominant	related
tire	SLEEP	B	noncognate	subordinate	related
toast	BREAD	A	noncognate	dominant	related
toast	DRINK	B	noncognate	subordinate	related
vessel	BLOOD	A	noncognate	subordinate	related
vessel	BOAT	B	noncognate	dominant	related
wave	GESTURE	A	noncognate	subordinate	related
wave	OCEAN	B	noncognate	dominant	related
act	SQUARE	B	cognate	na	unrelated
admit	WEAPON	A	cognate	na	unrelated
admit	CITY	B	cognate	na	unrelated
band	FIGHT	A	cognate	na	unrelated
bank	SHIP	A	cognate	na	unrelated
bank	MOUNTAIN	B	cognate	na	unrelated

cape	MONEY	A	cognate	na	unrelated
cape	PAYMENT	B	cognate	na	unrelated
case	BEACH	A	cognate	na	unrelated
case	FALL	B	cognate	na	unrelated
coast	GROW	A	cognate	na	unrelated
coast	BACKGROUND	B	cognate	na	unrelated
deposit	WEIGH	A	cognate	na	unrelated
deposit	RATING	B	cognate	na	unrelated
express	TICKET	A	cognate	na	unrelated
express	FAIL	B	cognate	na	unrelated
figure	JUDGE	A	cognate	na	unrelated
figure	FAIR	B	cognate	na	unrelated
float	ALPHABET	A	cognate	na	unrelated
float	WRITE	B	cognate	na	unrelated
habit	COOKIE	A	cognate	na	unrelated
habit	RICH	B	cognate	na	unrelated
mine	BALLET	A	cognate	na	unrelated
mine	PRAYER	B	cognate	na	unrelated
panel	ADVISORS	A	cognate	na	unrelated
panel	KITCHEN	B	cognate	na	unrelated
permit	PRISON	A	cognate	na	unrelated
permit	PARAGRAPH	B	cognate	na	unrelated
pupil	INDIAN	A	cognate	na	unrelated
pupil	HOTEL	B	cognate	na	unrelated

racket	TULIP	A	cognate	na	unrelated
racket	LIGHT	B	cognate	na	unrelated
rare	SUGAR	A	cognate	na	unrelated
rare	CRUTCH	B	cognate	na	unrelated
terminal	EARTHQUAKE	A	cognate	na	unrelated
terminal	BLAME	B	cognate	na	unrelated
union	LETTERS	A	cognate	na	unrelated
union	LEG	B	cognate	na	unrelated
volume	WORD	A	cognate	na	unrelated
volume	SEMESTER	B	cognate	na	unrelated
bitter	TYPE	A	noncognate	na	unrelated
bitter	NICE	B	noncognate	na	unrelated
change	TENNIS	A	noncognate	na	unrelated
change	FIRE	B	noncognate	na	unrelated
coat	CIGARETTE	A	noncognate	na	unrelated
coat	WOLF	B	noncognate	na	unrelated
drag	SAD	A	noncognate	na	unrelated
drag	SKY	B	noncognate	na	unrelated
draw	GUN	A	noncognate	na	unrelated
draw	HOT	B	noncognate	na	unrelated
duck	FOOD	A	noncognate	na	unrelated
duck	SUMMER	B	noncognate	na	unrelated
fare	LAW	A	noncognate	na	unrelated
fare	DRESS	B	noncognate	na	unrelated

fast	TOGETHER	A	noncognate	na	unrelated
fast	BONE	B	noncognate	na	unrelated
file	DANCE	A	noncognate	na	unrelated
file	GAME	B	noncognate	na	unrelated
glare	THEATRE	A	noncognate	na	unrelated
glare	BALL	B	noncognate	na	unrelated
gross	EVENT	A	noncognate	na	unrelated
gross	BEST	B	noncognate	na	unrelated
husky	TREASURE	A	noncognate	na	unrelated
husky	HAIR	B	noncognate	na	unrelated
kernel	CARD	A	noncognate	na	unrelated
kid	WATER	B	noncognate	na	unrelated
light	SICK	A	noncognate	na	unrelated
light	ICE	B	noncognate	na	unrelated
lobby	AIRCRAFT	A	noncognate	na	unrelated
lobby	SEA	B	noncognate	na	unrelated
mug	PICTURE	A	noncognate	na	unrelated
mug	KILL	B	noncognate	na	unrelated
pitch	DRINK	A	noncognate	na	unrelated
pitch	BOUND	B	noncognate	na	unrelated
resort	BEEF	A	noncognate	na	unrelated
resort	DIRT	B	noncognate	na	unrelated
room	GLASS	A	noncognate	na	unrelated
room	DEAD	B	noncognate	na	unrelated

speaker	SLEEP	A	noncognate	na	unrelated
speaker	WHEEL	B	noncognate	na	unrelated

Appendix B

Prime-TARGET pairs used in Experiment 1

<u>Non-Homonym primes</u>

Prime	Target	List	Cognate status of prime	Relatedness status
actor	STAGE	A	cognate	related
baby	CHILD	B	cognate	related
band	ROCK	B	cognate	related
benign	GOOD	A	cognate	related
button	SHIRT	B	cognate	related
calm	QUIET	B	cognate	related
capacity	FULL	B	cognate	related
captain	LEADER	B	cognate	related
cereal	BREAKFAST	A	cognate	related
correct	WRONG	B	cognate	related
director	MOVIE	B	cognate	related
error	MISTAKE	B	cognate	related
evasion	ESCAPE	B	cognate	related
example	SAMPLE	B	cognate	related
final	END	B	cognate	related
formal	DRESS	A	cognate	related
gradual	SLOW	B	cognate	related
guide	TOUR	B	cognate	related
guitar	STRING	B	cognate	related
helicopter	FLY	A	cognate	related
hospital	NURSE	B	cognate	related
hour	MINUTE	A	cognate	related
insect	BUG	B	cognate	related

inspector	OBSERVE	A	cognate	related
local	NEAR	A	cognate	related
metal	STEEL	A	cognate	related
mortal	HUMAN	A	cognate	related
music	SONG	A	cognate	related
perfect	GREAT	A	cognate	related
piano	PLAY	A	cognate	related
poet	WRITER	B	cognate	related
professor	TEACHER	B	cognate	related
romantic	LOVE	B	cognate	related
severe	BAD	A	cognate	related
superior	INFERIOR	A	cognate	related
terror	FEAR	A	cognate	related
theory	SCIENCE	A	cognate	related
tractor	TRAILER	A	cognate	related
triple	THREE	A	cognate	related
virus	FLU	A	cognate	related
airplane	FLIGHT	B	noncognate	related
ant	HILL	A	noncognate	related
begin	START	A	noncognate	related
boat	SEA	A	noncognate	related
body	MUSCLE	B	noncognate	related
breath	LUNG	B	noncognate	related
clock	ALARM	B	noncognate	related

close	FAR	B	noncognate	related
disease	CURE	B	noncognate	related
duty	JOB	A	noncognate	related
egg	CHICKEN	B	noncognate	related
empty	NOTHING	A	noncognate	related
evil	WICKED	B	noncognate	related
exit	ENTER	A	noncognate	related
fix	BROKEN	A	noncognate	related
four	FIVE	B	noncognate	related
fun	LAUGH	B	noncognate	related
hate	DISLIKE	A	noncognate	related
hitch	HIKE	B	noncognate	related
ill	FEVER	A	noncognate	related
iron	ELEMENT	B	noncognate	related
kid	BOY	A	noncognate	related
kite	WIND	A	noncognate	related
knowledge	WISDOM	B	noncognate	related
learn	ACQUIRE	A	noncognate	related
loud	NOISE	A	noncognate	related
lower	HIGHER	B	noncognate	related
notice	ATTENTION	B	noncognate	related
pants	JEANS	B	noncognate	related
popcorn	BUTTER	A	noncognate	related
reader	LISTENER	A	noncognate	related

scared	AFRAID	B	noncognate	related
sing	VOICE	B	noncognate	related
singer	DANCER	A	noncognate	related
stone	THROW	B	noncognate	related
taste	SMELL	A	noncognate	related
tie	NECK	A	noncognate	related
turn	AROUND	A	noncognate	related
turtle	SHELL	A	noncognate	related
wonderful	LIFE	B	noncognate	related
acre	MOUNT	A	cognate	unrelated
acre	OBSERVE	B	cognate	unrelated
cable	MISTAKE	A	cognate	unrelated
cable	NEAR	B	cognate	unrelated
canal	ROCK	A	cognate	unrelated
canal	SCIENCE	B	cognate	unrelated
casual	END	A	cognate	unrelated
casual	STEEL	B	cognate	unrelated
crystal	QUIET	A	cognate	unrelated
crystal	BREAKFAST	B	cognate	unrelated
debate	SAVE	A	cognate	unrelated
debate	HUMAN	B	cognate	unrelated
diagram	BUG	A	cognate	unrelated
diagram	GREAT	B	cognate	unrelated
diet	WRITER	A	cognate	unrelated

diet	PLAY	B	cognate	unrelated
eligible	TEACHER	A	cognate	unrelated
eligible	INFERIOR	B	cognate	unrelated
genuine	LEAST	A	cognate	unrelated
genuine	FEAR	B	cognate	unrelated
image	CHILD	A	cognate	unrelated
image	THREE	B	cognate	unrelated
judicial	SHIRT	A	cognate	unrelated
judicial	TRAILER	B	cognate	unrelated
motor	FULL	A	cognate	unrelated
motor	GOOD	B	cognate	unrelated
notable	SAKE	A	cognate	unrelated
notable	MINUTE	B	cognate	unrelated
radio	ESCAPE	A	cognate	unrelated
radio	RISE	B	cognate	unrelated
real	SAMPLE	A	cognate	unrelated
real	SONG	B	cognate	unrelated
reform	WRONG	A	cognate	unrelated
reform	DINNER	B	cognate	unrelated
tiger	TOUR	A	cognate	unrelated
tiger	BAD	B	cognate	unrelated
vacant	STRING	A	cognate	unrelated
vacant	FLU	B	cognate	unrelated
visible	SLOW	A	cognate	unrelated

visible	STAGE	B	cognate	unrelated
bath	THROW	A	noncognate	unrelated
bath	DANCER	B	noncognate	unrelated
bond	CHICKEN	A	noncognate	unrelated
bond	NARROW	B	noncognate	unrelated
cousin	JEANS	A	noncognate	unrelated
cousin	BUTTER	B	noncognate	unrelated
elbow	FAR	A	noncognate	unrelated
elbow	START	B	noncognate	unrelated
ending	ELEMENT	A	noncognate	unrelated
ending	FEVER	B	noncognate	unrelated
engagement	AFRAID	A	noncognate	unrelated
engagement	BOY	B	noncognate	unrelated
female	LIFE	A	noncognate	unrelated
female	LISTENER	B	noncognate	unrelated
fixed	MUSCLE	A	noncognate	unrelated
fixed	HILL	B	noncognate	unrelated
husband	LAUGH	A	noncognate	unrelated
husband	TEACH	B	noncognate	unrelated
illness	HIGHER	A	noncognate	unrelated
illness	DISLIKE	B	noncognate	unrelated
mildew	WICKED	A	noncognate	unrelated
mildew	NIGHT	B	noncognate	unrelated
murder	HIKE	A	noncognate	unrelated

murder	NOTHING	B	noncognate	unrelated
painting	LUNG	A	noncognate	unrelated
painting	WIND	B	noncognate	unrelated
pencil	FLIGHT	A	noncognate	unrelated
pencil	SMELL	B	noncognate	unrelated
plenty	ALARM	A	noncognate	unrelated
plenty	ENTER	B	noncognate	unrelated
recovery	CURE	A	noncognate	unrelated
recovery	SHELL	B	noncognate	unrelated
river	FIVE	A	noncognate	unrelated
river	NECK	B	noncognate	unrelated
saddle	WISDOM	A	noncognate	unrelated
saddle	AROUND	B	noncognate	unrelated
summer	VOICE	A	noncognate	unrelated
summer	JOB	B	noncognate	unrelated
teacher	ATTENTION	A	noncognate	unrelated
teacher	BROKEN	B	noncognate	unrelated

Appendix C

Prime-TARGET pairs used in Experiment 1

Non-word targets

Prime	Target	List	Homonym status of prime
admitted	GURN	AB	homonym
appendix	HIFE	AB	homonym
article	MAWN	AB	homonym
bark	BORK	AB	homonym
base	BISH	AB	homonym
bass	HICE	AB	homonym
beam	CHUNDER	AB	homonym
bend	TROVINCE	AB	homonym
boot	TEAP	AB	homonym
cast	BEON	AB	homonym
chance	WEEM	AB	homonym
check	DABITAT	AB	homonym
china	CRADE	AB	homonym
chop	COBIC	AB	homonym
console	CASSENGER	AB	homonym
contact	SOCITARY	AB	homonym
counter	BLARK	AB	homonym
court	PARDINAL	AB	homonym
crest	FAREMELL	AB	homonym
cricket	BRAME	AB	homonym
dash	POLLAGE	AB	homonym
deed	SWOCK	AB	homonym
digest	SLOOM	AB	homonym

drill	EXCLOSION	AB	homonym
expressed	SINDULAR	AB	homonym
fall	PRAG	AB	homonym
felt	FABLIC	AB	homonym
force	ESTERTAIN	AB	homonym
free	DELIATION	AB	homonym
gag	DEIGHBOR	AB	homonym
gear	TRADIENT	AB	homonym
invalid	FORBIGGEN	AB	homonym
jerk	SPELTRUM	AB	homonym
knit	SNOP	AB	homonym
lap	ANMIQUE	AB	homonym
limp	ROOP	AB	homonym
lounge	LONK	AB	homonym
mad	GASOFINE	AB	homonym
marble	BARAGRAPH	AB	homonym
march	USIBLE	AB	homonym
maroon	MABILITY	AB	homonym
mint	FLIMPSE	AB	homonym
model	CHOVER	AB	homonym
mouse	VOSTLY	AB	homonym
nail	SCORIOUS	AB	homonym
nut	IDJACENT	AB	homonym
odd	REDIANT	AB	homonym

order	MEEP	AB	homonym
organ	TASS	AB	homonym
pad	HULOROUS	AB	homonym
palm	TRAB	AB	homonym
paste	WILTH	AB	homonym
pawn	SOSS	AB	homonym
pelt	SOLUNTEER	AB	homonym
permitted	NEGRECT	AB	homonym
picket	SHURDY	AB	homonym
pipe	VERNICAL	AB	homonym
plot	EQUELITY	AB	homonym
poach	BRADUAL	AB	homonym
pot	TRAGE	AB	homonym
present	MICKET	AB	homonym
press	RESUDE	AB	homonym
ram	PIDER	AB	homonym
reflect	ONDURE	AB	homonym
register	INFASTRY	AB	homonym
right	CILL	AB	homonym
scallop	YORN	AB	homonym
screen	DASTY	AB	homonym
seal	REGIND	AB	homonym
semester	GLEEDING	AB	homonym
shed	BINEST	AB	homonym

shell	CORAVAN	AB	homonym
sink	MOTABLY	AB	homonym
sling	CUFFALO	AB	homonym
smack	TRUNS	AB	homonym
sow	ORIUM	AB	homonym
spade	FANDY	AB	homonym
spring	ANGIEN	AB	homonym
squash	IQUATE	AB	homonym
stall	TEMON	AB	homonym
steal	FRESHBAN	AB	homonym
steer	OSTIMUM	AB	homonym
straw	VOMINATE	AB	homonym
streak	ROTTERY	AB	homonym
stroke	ATHLETO	AB	homonym
subject	CLEMISTRY	AB	homonym
swear	GROUDLY	AB	homonym
tap	SKUN	AB	homonym
tart	AMULAR	AB	homonym
tear	DIANIST	AB	homonym
tend	TUNGLE	AB	homonym
tied	WHISPOR	AB	homonym
till	GRANSIT	AB	homonym
trace	SHUNG	AB	homonym
trial	IVERCAST	AB	homonym

trim	KASTE	AB	homonym
vain	CLEEP	AB	homonym
walker	COTATO	AB	homonym
well	BRANSLATE	AB	homonym
accuse	GUSTAIN	AB	non-homonym
advise	PEVALTY	AB	non-homonym
arrange	FACTASY	AB	non-homonym
awfully	DISPRESS	AB	non-homonym
bacon	NECREASE	AB	non-homonym
balloon	QUIM	AB	non-homonym
baton	FIGHTNING	AB	non-homonym
blessing	GRUM	AB	non-homonym
bolt	HEAK	AB	non-homonym
bound	SWIP	AB	non-homonym
chart	THILL	AB	non-homonym
cheerful	SLIENT	AB	non-homonym
cigar	RUZOR	AB	non-homonym
coffee	LORK	AB	non-homonym
conform	ILTER	AB	non-homonym
container	PEXTURE	AB	non-homonym
craft	REMUSAL	AB	non-homonym
decency	HEVISPHERE	AB	non-homonym
deck	APPRAVE	AB	non-homonym
dialect	PREEK	AB	non-homonym

disabled	BROVE	AB	non-homonym
disturb	DISNIKE	AB	non-homonym
ditch	SPOVE	AB	non-homonym
dreadful	GENSE	AB	non-homonym
elegance	MOCAL	AB	non-homonym
export	STENERY	AB	non-homonym
fake	DEVUTE	AB	non-homonym
feminine	TARENT	AB	non-homonym
fling	HESIUM	AB	non-homonym
flock	TISERY	AB	non-homonym
folly	TICNIC	AB	non-homonym
forecast	BLEEZE	AB	non-homonym
forum	NIZABLE	AB	non-homonym
fragile	LENNIS	AB	non-homonym
grief	ORGALIZE	AB	non-homonym
halt	DELINERATE	AB	non-homonym
harness	VITERAL	AB	non-homonym
hello	TROSPERITY	AB	non-homonym
hesitate	SPATURE	AB	non-homonym
honesty	WILEAGE	AB	non-homonym
hunt	QUEEDLE	AB	non-homonym
imagery	SPRUTINY	AB	non-homonym
imperative	MOLENTUM	AB	non-homonym
ingenious	CROFILE	AB	non-homonym

integrity	QUARIFY	AB	non-homonym
knee	DURSE	AB	non-homonym
lease	SLORE	AB	non-homonym
lifetime	JINIMIZE	AB	non-homonym
luggage	GLUM	AB	non-homonym
meek	FOOMISH	AB	non-homonym
mercury	RECIPROJAL	AB	non-homonym
merge	QUENT	AB	non-homonym
negotiate	TUSCULAR	AB	non-homonym
oily	STRIME	AB	non-homonym
part	CONFRENT	AB	non-homonym
perfume	EXPLIRE	AB	non-homonym
poison	HILLOW	AB	non-homonym
pony	REVEDATION	AB	non-homonym
prediction	FLOCKADE	AB	non-homonym
princess	KAGNETISM	AB	non-homonym
puzzle	STIBBORN	AB	non-homonym
ration	GATISFY	AB	non-homonym
recruit	COLTAGE	AB	non-homonym
refrain	RECAY	AB	non-homonym
reject	DIMP	AB	non-homonym
reservoir	DUSH	AB	non-homonym
restrain	WAPTED	AB	non-homonym
roast	ELIMIBLE	AB	non-homonym

robbery	ALITIOUS	AB	non-homonym
rocky	CHYSICIAN	AB	non-homonym
rust	MARADISE	AB	non-homonym
sandwich	PHANY	AB	non-homonym
scar	ASSIRM	AB	non-homonym
segment	SPETCH	AB	non-homonym
serene	NOLAR	AB	non-homonym
sewer	PRASPEROUS	AB	non-homonym
slate	HURIOUS	AB	non-homonym
slug	CARMING	AB	non-homonym
sole	DECSUE	AB	non-homonym
swallow	LISK	AB	non-homonym
tackle	IPISODE	AB	non-homonym
temple	OTLAS	AB	non-homonym
theft	NOTROGEN	AB	non-homonym
thermometer	ARDUNT	AB	non-homonym
thumb	IBNORANT	AB	non-homonym
tremble	BLEANED	AB	non-homonym
tune	INTERLERE	AB	non-homonym
tunnel	ASTIC	AB	non-homonym
typewriter	CLAG	AB	non-homonym
unite	ICCENT	AB	non-homonym
utilize	FLOSET	AB	non-homonym
vest	WOPE	AB	non-homonym

veto	GLAVOR	AB	non-homonym
void	FULFULL	AB	non-homonym
waiter	BLINDNASS	AB	non-homonym
weird	INLISIBLE	AB	non-homonym
wipe	NIST	AB	non-homonym
witty	PRANE	AB	non-homonym
wool	PESEMBLE	AB	non-homonym
wrist	INSPINCT	AB	non-homonym
zinc	CORNIVAL	AB	non-homonym

Appendix D

Sentences used in Experiment 2

Homonym targets

Target word	Cognate status	Biased sentence	Neutral sentence
arm	cognate	We saw the officer reach for the holster and pull out his **arm** and aim at the escaping robber.	From where we were standing we could see he had his **arm** tucked in the holster.
bill	cognate	To give the waitress a tip he put the **bill** in an envelope and left it on the table.	I was feeling very frustrated today because the **bill** was rejected by the vending machine.
bulb	cognate	The plant is about to bloom and the new **bulb** is big and ready to open up.	We waited for weeks to see that the new **bulb** was turning into a wonderful flower.
cabinet	cognate	The president was not happy with how the members of his **cabinet** carried out their business.	It was not easy and it took several years to get the **cabinet** to be composed of members from both parties.
cane	cognate	The refined sugar you taste is originally from **cane** harvested in Brazil.	That country is known to be the biggest exporter of **cane** and coffee.
digit	cognate	She could not call because the number he gave her was missing a **digit** so she looked through the yellow pages.	She realized it was only because of a missing **digit** in her calculation that she got the question wrong.
fan	cognate	The celebrity was stalked by an obsessive **fan** for nearly three years.	My cousin reminds me of the typical **fan** of a boy band, always screaming whenever she hears them play.
fault	cognate	There were frequent earthquakes along the **fault** so we moved far away.	Analyzing the situation, it is clear that it was not the **fault** that caused the earthquake.
letter	cognate	The class recited the alphabet as the teacher pointed to each **letter** on the blackboard.	Although the child tried very hard, she wrote each **letter** on the blackboard backwards.
net	cognate	Subtracting deductions from gross salary gives the **net** earnings for the fiscal year.	According to the latest report they had read the **net** earnings for this year had doubled.

operation	cognate	Because the previous strategy failed the army general devised a new **operation** that would require thousands of more troops.	The talented anchorman explained on the nightly news how the new **operation** would require thousands of more troops.
race	cognate	Some judge by the color of one's skin and form prejudices about members of a different **race**, often leading to conflict.	Some members of the society still refused to believe in the possibility of a different **race** of people living on an undiscovered island.
sentence	cognate	Once convicted, the judge will decide the length of the **sentence**, which can be up to forty years.	His friends were very surprised by the length of the **sentence** he got for possession of such a small amount of marijuana.
table	cognate	To clearly describe the data she referred to the **table** on her slides and to two graphs.	While talking to the group he referred to the **table** from the text and additional analyses.
term	cognate	Acquiring a good vocabulary requires learning each **term** in different contexts.	My youngest child was aware that each **term** his older brother taught her would come in handy.
ball	noncognate	We could already tell that the princess would attend the **ball** and fall in love with the prince.	We were all very excited to see that the **ball** was a success and there was dancing all night long.
pack	noncognate	You have to be over 18 to buy a **pack** of cigarettes in the state of Texas.	You should be aware that with a **pack** of cigarettes in your lungs every day you're in serious danger.
bridge	noncognate	They decided to change plans and play **bridge** instead of playing board games.	My good friend said that the **bridge** was not going well for him today.
pool	noncognate	We usually go to bars where we can play **pool** and drink beer all night long.	In order to get a good spot to play **pool** you have to be at the bar early.
joint	noncognate	The married couple opened a **joint** account even before they got married.	He was very excited about a **joint** account he was opening with his wife.

hard	noncognate	When your teacher tells you to study **hard** for an exam, you should prepare for it days in advance.	If you thought this one was **hard**, then you should study much more for the next exam.
slip	noncognate	The medical information was on the **slip** and was mailed to the patient.	The patient was relieved when she discovered that the **slip** contained all of the information.
chest	noncognate	The pirates stole the gold that was inside the **chest** hidden in the sunken ship.	In excited anticipation she placed her hands on the **chest** and thought of all the gold inside.
staff	noncognate	The old man started walking with the **staff** to alleviate the pain he felt in his legs.	He was still unhappy with the **staff** we had given him and decided to use a wheelchair instead.
kid	noncognate	The farmer did not shave wool off the **kid** but only from the adult goat.	Everyone in the group laughed at the **kid** as it bleated for the mother goat.
ground	noncognate	They ate tacos today, so the kitchen smelled like **ground** beef and different spices.	My neighbor told me he was very pleased with the **ground** beef that his girlfriend was cooking just for him.
foot	noncognate	She was considered short and needed to grow another **foot** if she ever wanted to be a model.	They were surprised to see that there was only one **foot** of tape left on the roll.
star	noncognate	George Clooney is that **star** that every girl wants a picture with.	When Maria saw the **star** she could barely breathe to get his autograph.
square	noncognate	For the next Math exam, you should know the **square** root of all the numbers on the handout.	We weren't really sure, but we thought that the **square** root of both quantities would help us solve the problem.
ruler	noncognate	Queen Elizabeth has been the **ruler** of England for many years.	Let me know if you see the **ruler** of France because I need to repair his costume.

Appendix E

Sentences used in Experiment 2

Non-Homonym targets

Target word	Cognate status	Biased sentence	Neutral sentence
actor	cognate	He did not win the Oscar because he is not a very good **actor** and there were more deserving candidates.	No one in the family really thought he would be a very good **actor** so he got very little support.
calm	cognate	Deep breathing exercises helped her be **calm** throughout the early stages of labor.	His lifelong mentor taught him to be **calm** when faced with a crisis.
cereal	cognate	The child poured the milk in the **cereal** and ate breakfast.	The child found a bug in the **cereal** but ate it anyway.
correct	cognate	Two points were deducted because what I wrote was not **correct** and I needed to study more.	The group told me what I wrote was not **correct** and we all lost points.
director	cognate	A movie will not be great without the guidance of a good **director** and the talent of great actors.	His favorite uncle gave him the name of a good **director** who could help with the movie.
final	cognate	After much haggling, the vendor said the offer was **final** and to take it or leave it.	Before leaving, I asked if the plan was **final** and ready to print out.
formal	cognate	He rented a tuxedo because the party was a **formal** event and very high class.	She had informed us that it was a **formal** party and we would have to dress up.
hospital	cognate	His fever was high so we drove him to the **hospital** in the strange town.	He was relieved and glad to know that the **hospital** was only a few blocks away.
hour	cognate	We were too early and waited another **hour** before more guests arrived.	We sat and watched patiently as another **hour** passed and no one was called into the office.
inspector	cognate	The restaurant was so dirty that the health department sent an **inspector** and it was forced to	The owners hoped that soon they would be sent an **inspector** to

		close.	come and test the water.
local	cognate	There is a charge for long distance but if you make a **local** call it will be completely free.	She could not figure out why she could not make a **local** call with the new telephone.
perfect	cognate	The diamond had no flaws and was therefore a **perfect** stone and very expensive.	When they returned they told us that it was a **perfect** trip for the holidays.
piano	cognate	She went to music school to study **piano** and she was now part of a famous orchestra.	She had always wanted to study **piano** but her parents were against it.
poet	cognate	After writing a few sonnets he decided to become a **poet** and we enjoyed his work very much.	An old friend of mine from college was a **poet** and was enjoying her work very much.
theory	cognate	The scientist relied on her **theory** to explain her newest results.	She did not think her **theory** could explain their latest data set.
beginning	noncognate	She read the entire book, from the **beginning** to the end without putting it down once.	They were present only for the **beginning** of the lecture and missed the quiz given at the end of class.
clock	noncognate	He could not be late, so he checked the **clock** every five minutes and arrived at school on time.	She did not know why, but she realized that the **clock** in the kitchen had stopped working.
fixed	noncognate	After the accident I took my bike to get it **fixed** and ready to ride again.	We felt better knowing that things had been **fixed** by a professional that we trusted.
fun	noncognate	We did not stop the boys from playing because they were having lots of **fun** with the new toys.	I decided not to complain this time because they did have lots of **fun** visiting their father's home over the weekend.
husband	noncognate	They were recently married and	My friend was annoyed that the

		the **husband** was already thinking of kids.	**husband** did not allow the wife to go out.
illness	noncognate	The body aches and high fever indicated that she had an **illness** that would not go away soon.	It seemed to me that this time he had an **illness** that would only get worse.
loud	noncognate	The music from the house next door was **loud** and I called the police because I could not sleep.	She did not care if they were **loud** because she also enjoyed having parties at her house.
painting	noncognate	At the art gallery I admired the **painting** that had come from France.	They made a space for the **painting** being shipped in from France.
pants	noncognate	To match her new shirt she bought **pants** that fit her well and made her look professional.	We both went to the store and bought **pants** to match our new shirts.
pencil	noncognate	The student was looking for some paper and a sharp **pencil** to write his essay with.	When I was not looking, he kept trying to take the sharp **pencil** away from me.
plenty	noncognate	She told us to eat more because there was **plenty** of food left over.	After our long reunion they told us there was **plenty** more to discuss.
reader	noncognate	Because he enjoyed books, he was an advanced **reader** for his age and impressed the teachers.	The young boy was considered an advanced **reader** because he recognized words quickly and accurately.
river	noncognate	The beautiful steamboat floated slowly down the **river** as the sun set in the distance.	We read on the newspaper this morning about the **river** overflowing into the town.
summer	noncognate	The weather gets really hot in the **summer**, months before school starts.	I wrote my friend a letter about the **summer** I spent in Australia.
teacher	noncognate	The students learned to follow the instructions of their **teacher**	They always listened to the advice of the **teacher** who was

	before being allowed to play with the blocks.	well known for his wisdom.

Curriculum Vitae

Ana Beatriz Arêas da Luz Fontes moved from Brazil to El Paso in 2001 with an athletic scholarship to play volleyball at The University of Texas at El Paso. At UTEP, she received the Outstanding Academic Achievement in Print Media Award when she graduated with a bachelor degree in Communication. In 2005 she began to pursue a Ph.D. in Psychology and study the cognitive aspects of bilingualism and reading, with the goal of understanding the dynamics of multiple language representations in the brain. In 2008, she earned a Master's degree in Experimental Psychology for her thesis entitled: "The development of lexical ambiguity resolution skills through reading experience," for which she received the Outstanding Graduate Thesis in Experimental Psychology Award.

Dr. Arêas da Luz Fontes has research publications in *Bilingualism: Language and Cognition*, *Language and Cognitive Processes*, and *Letrônica*. She has presented her research at professional meetings, including meetings for the American Association of Applied Linguistics, the Mental Lexicon conference, the International Symposium of Bilingualism, the ARMADILLO conference and the First International ANPOLL meeting. She also served as a research consultant to the Center for Research on Educational Reform and for the Teachers for a New Era Program.

In 2010, Dr. Arêas da Luz Fontes defended her doctoral thesis entitled "An examination of the cognitive factors that contribute to lexical disambiguation," under the supervision of Dr. Ana I. Schwartz. Dr. Arêas da Luz Fontes is currently searching for postdoctoral research positions as well as jobs in academia. She intends to pursue a career in academia and continue with her line of research in bilingualism and reading.