

2011-01-01

Bilingual Homonym Disambiguation At The Discourse Level

Yvette Aguilar Baca

University of Texas at El Paso, yaguilar99@yahoo.com

Follow this and additional works at: https://digitalcommons.utep.edu/open_etd



Part of the [Cognitive Psychology Commons](#), and the [Other Psychology Commons](#)

Recommended Citation

Baca, Yvette Aguilar, "Bilingual Homonym Disambiguation At The Discourse Level" (2011). *Open Access Theses & Dissertations*. 2235.
https://digitalcommons.utep.edu/open_etd/2235

This is brought to you for free and open access by DigitalCommons@UTEP. It has been accepted for inclusion in Open Access Theses & Dissertations by an authorized administrator of DigitalCommons@UTEP. For more information, please contact lweber@utep.edu.

BILINGUAL HOMONYM DISAMBIGUATION AT THE DISCOURSE LEVEL

YVETTE AGUILAR BACA

Department of Psychology

APPROVED:

Ana I. Schwartz, Ph.D., Chair

Wendy Francis, Ph.D.

Michael Zarate, Ph.D.

Arturo Pacheco, Ph.D.

Benjamin C. Flores, Ph.D.
Acting Dean of Graduate School

Copyright ©

By

Yvette Aguilar Baca

2011

BILINGUAL HOMONYM DISAMBIGUATION AT THE DISCOURSE LEVEL

by

YVETTE AGUILAR BACA, B.S., M.A.

THESIS

Presented to the Faculty of the Graduate School of

The University of Texas at El Paso

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF ARTS

Department of Psychology

THE UNIVERSITY OF TEXAS AT EL PASO

December 2011

Abstract

The objective of this study was to investigate the effects of global context and local context on the time course of activation of cognate homonyms for bilingual readers. Of interest was whether meaning frequency, context, and cross-language activation modulated the time course of activation of the subordinate meaning of cognate homonyms. Also, whether the subordinate bias effect would be altered or even eliminated by the combined influence of such contextual factors and cross-language activation. Eye movements of Spanish-English bilinguals were measured using an eye-tracking device while they read English paragraphs. The paragraphs contained cognate homonyms (e.g. novel/*novela*), cognate non-homonyms (e.g. plastic/*plástico*), non-cognate homonyms (e.g. slip), or non-cognate non-homonyms (e.g. hook) all in English. The topic of the paragraph (global context) was either biasing the subordinate meaning of the homonym or was neutral. The sentence where the target word was embedded (local context) had a preceding region that was either biasing the subordinate meaning or was neutral. Analyses revealed that the combination of strong, contextual support and cross-language activation of the subordinate meaning resulted in the reduction of processing costs of cognate homonyms.

Table of Contents

	Page
Abstract.....	iv
Table of Contents.....	v
List of Tables.....	vii
List of Figures.....	viii
Chapter	
1. Introduction.....	1
2. Methods.....	9
2.1. Participants.....	9
2.2. Materials.....	9
2.2.1. Word stimuli.....	9
2.2.2. Paragraph stimuli.....	9
2.2.3. Reading Speed Measures.....	10
2.2.4. Language History Questionnaire.....	10
2.3. Procedure.....	11
3. Analyses.....	12
3.1. Inclusion Criteria.....	12
3.1.1.1. Accuracy Data.....	12
3.1.1.2. Proficiency Measures.....	12
3.1.1.3. Reading Speed Measures.....	12
3.2. Critical Analyses.....	13
4. Results.....	14

4.1.1. Cognates.....	14
4.1.1.1. Global neutral conditions.....	14
4.1.1.2. Global biasing conditions.....	14
4.1.2. Non-cognates.....	16
5. Discussion.....	19
6. References.....	29
7. Curriculum vitae.....	32

List of Tables

Table 1.....	23
Examples of word stimuli.	
Table 2.....	23
Examples of paragraph stimuli for the cognate homonym <i>bulb</i> .	
Table 3.....	24
Self-Assessed English and Spanish Proficiency Ratings (N = 46).	

List of Figures

Figure 1	26
Histogram of English reading speed distribution.	
Figure 2.....	26
Gaze duration of the global neutral conditions in the three-way interaction of global context, local context, and homonym status of cognate targets.	
Figure 3.....	27
Gaze duration of the global biasing conditions in the three-way interaction of global context, local context, and homonym status of cognate targets.	
Figure 4.....	27
Gaze duration of the global neutral conditions in the three-way interaction of global context, local context, and homonym status of non-cognate targets.	
Figure 5.....	28
Gaze duration of the global biasing conditions in the three-way interaction of global context, local context, and homonym status of non-cognate targets.	

Introduction

A challenge that individuals face while reading is the inherent ambiguity of written language. Most words in a language have more than one meaning (referred to as homonyms). For example, the homonym *ball* means both a round object used in many sports as well as a formal dance. Most of the time skilled readers are unaware of the ambiguity of words because they can efficiently select the appropriate meanings- however when reading is more effortful the cognitive demands of integrating target meanings of ambiguous words can risk comprehension. Furthermore, the cognitive demands of integrating meanings are greater due to the added competition that exists when there is more than one language system. For a bilingual reader the challenge becomes even stronger because of the many meanings that are active in both languages (Areas Da Luz Fontes & Schwartz, 2010).

Research on monolingual reading provides a strong foundation for understanding bilingual reading. There are two general classes of models of how readers select meanings of ambiguous words. Selective-access models assume that the selection of the meaning of a homonym is influenced by the context in which it is encountered. For this model, bottom-up processes of word identification can be directly affected by the top-down processes of sentence comprehension, which allows for a single meaning to be selected, previous to the completion of lexical access, when it is biased by context (e.g., Simpson, 1981). Exhaustive-access models, on the other hand, assume that all of the meanings of an ambiguous word are initially activated, irrespective of context. These theories assume that bottom-up processes of meaning selection are encapsulated; not directly affected by processes of context comprehension. Information from context is used in the selection of the appropriate meaning; however, context only aids in the decision process of meaning selection, which occurs after initial lexical access (Swinney, 1979).

It is still debated which class accounts for meaning selection; however there is one model that does a good job of accounting for available data, the Reordered Access Model (Duffy et. al, 1988), which assumes there is exhaustive activation of all meanings of an ambiguous word, irrespective of context.

According to the Reordered Access Model, how readily a meaning is activated will depend on two factors: the relative frequency of the meaning and the disambiguating context in which the word is presented. These two factors produce different predictions regarding the processing time of balanced homonyms versus biased homonyms in and out of context. When balanced homonyms (words with equally frequent meanings) are in a neutral context, the meanings will be activated in the same time frame competing with each other for selection and delaying processing. When the preceding context of the balanced homonym biases one of the meanings, that meaning will become available faster than the contextually-irrelevant meaning, allowing it to be more readily integrated into context. When biased homonyms (words with a dominant and subordinate meaning) are in neutral context, on the other hand, the dominant meaning will be activated early on because of its higher, bypassing competition for integration with the lower frequency meanings. When the context biases the weaker, or subordinate meaning, competition between the subordinate meaning and the dominant meaning will occur because both of the meanings are activated in the same time frame, this in turn leading to what Rayner et. al, (1994) labeled the *subordinate bias effect*.

The subordinate bias effect has been observed across various studies (e.g. Binder, 2003; Kambe, Rayner, & Duffy, 2001; Binder & Morris, 1995; Duffy, Morris, & Rayner, 1988) suggesting that even when information from the sentence context clearly biases the weaker meaning of a word, the dominant meaning is nonetheless activated. One possibility is that

selective access of a homonym meaning can occur if it is biased at a higher level than just sentential- for example at the level of discourse. A few investigators have tested this possibility by examining homonym processing in larger contexts, such as a paragraph (Binder, 2003; Binder & Morris, 1995; Kambe et. al, 2001).

Binder and Morris (1995) investigated whether global contextual information (topic sentence of a paragraph) has a direct impact on availability of homonym meanings by causing active inhibition of the meaning not supported by the global context. For this purpose, readers were presented with short paragraphs that contained two instances of a homonym that had two equally frequent meanings (e.g. club). The first instance of the homonym was always consistent with the global context. Critically, on some trials the second instance required access to the other meaning, inconsistent with the global context. If having to initially select one meaning of a balanced homonym leads to active inhibition of the other, unselected meaning, then there should be a cost when the reader at the second presentation of the homonym is forced to select that other meaning. They observed no such cost- suggesting that the activation level of unselected meanings is unaffected by information either at the sentence or topic levels. Global context only affected the availability of a previously selected meaning. When the target meaning of the balanced homonym remained the same across both presentations, access on the second presentation was facilitated.

Kambe and colleagues (2001) also examined the influence of global context on meaning availability with a particular emphasis on whether information from a topic can facilitate meaning selection. Participants read short paragraphs that contained one instance of a homonym that had a dominant and a subordinate meaning (i.e., biased homonyms) such as *duck*. The biased homonym was always embedded in a sentence that supported the subordinate meaning, either

prior to the homonym in the sentence or after. The critical manipulation was whether the global context of the paragraph was consistent with the subordinate meaning or the dominant meaning of the target homonym. Findings were similar to Binder (2003) in that the subordinate bias effect remained unchanged in the presence of topic subordinate biasing information. They found the presence of the subordinate bias effect in the three conditions that supported the subordinate meaning (global dominant-local before, global subordinate-local after, and global subordinate-local before). If topic-level information influences the availability of a homonym meaning, then one would expect a smaller subordinate bias effect when both the global and local sentence context bias the subordinate meaning, relative to when only the local sentence biases that meaning. A cost was observed when both the global context and preceding local context of the homonym biased the subordinate meaning of the word. A cost was also found when the global context was inconsistent with the subordinate meaning of the target word. This suggests that a single source of biasing information (whether it is global or local) is needed for the subordinate meaning to compete with the dominant meaning. They also found that the magnitude of support for the subordinate meaning did not differ if there was one source of support (global dominant-local prior or global subordinate-local after) or two sources of support (global subordinate-local before).

The selection of the intended meaning of a homonym is influenced by the frequency of the meaning and the context in which it is embedded. For bilinguals, the selection of the meaning is also influenced by cross-language activation. Research from the past decade has shown that language is non-selective for bilinguals (e.g. de Bruijn et al., 2001; Dijkstra et al., 2000; Dijkstra & Van Hell, 2003; Gollan, Forster, & Frost, 1997; Jared & Kroll, 2001; Van Heuven, et al., 1998). This means that, for a bilingual, both languages are activated in parallel. For a while, most

evidence for language non-selectivity came from experiments using single word recognition paradigms. This is problematic in that in everyday life words are usually encountered in a context such as a sentence. Therefore, it is important to investigate the effect of context in cross-language activation. Schwartz and Kroll (2006) looked at cross language activation through the use of English-Spanish cognates and inter-lingual homograph embedded in sentences that biased the meaning of the cognate or interlingual homograph (high constraint sentences) or were neutral (low constraint sentences). Evidence for non-selectivity was observed through facilitated processing of cognates relative to non-cognate controls when cognates were embedded in low-constraint sentences; however, this effect was eliminated when the same word was presented in a high-constraint sentence. This finding suggests that semantic information provided by a sentence context can attenuate cross-language activation.

Findings from a more recent eye-movement monitoring study by Libben and Titone (2009) produced convergent findings regarding an attenuated effect of context on language non-selectivity. It was found that inter-lingual homographs were read more slowly than their matched controls when embedded in both high- and low-constraining context. Thus, convergent with Schwartz and Kroll (2006) effects of cross-language activation were observed even in sentence context. However these effects were only observed in eye-movement measures that tap into early stages of lexical access (i.e., first fixation duration) but were eliminated in later measures (i.e., total gaze duration). Thus there is converging evidence that semantic information from a sentence context constrains the magnitude of the effect of cross-language activation.

On the contrary, an eye movement study by Van Assche and colleagues (2009) failed to find any attenuation of cross language activation from sentence context. This study investigated cross-language activation in native-language reading of Dutch-English bilinguals. Cognates were

presented within Dutch (native language) sentences in order to observe whether knowledge of the second language (English) would influence lexical access while reading in the native language, even if the sentence context provided a highly efficient lexical cue. They found that early reading times (i.e. first fixation duration and gaze duration) were shorter for cognates than their controls when read in the native-language. This suggests a cognate effect on native-language sentence processing. It shows that representations of non-native language are strongly activated irrespective of context comprehension, which in turn affects word recognition. These results show that sentence context does not modulate lexical access in bilinguals.

Currently there is no published model that addresses the specific issue of bilingual homonym processing. However, the Reordered-access Model from the monolingual domain offers a starting point. In order for the model to extend to bilingual homonym processing, it must address the influence of cross-language activation. A Bilingual Reordered-Access Model has been proposed (Areas Da Luz Fontes, Yeh & Schwartz, 2010; Schwartz & Areas Da Luz Fontes, 2008) which assumes that bilingual access of meanings is influenced by cross-language lexical activation in addition to meaning frequency and context. This assumption has been supported by a combination of reaction time and eye-movement data. For example, bilingual readers take longer to reject contextually-irrelevant meanings of homonyms that are cognates (e.g., rejecting the “book” meaning of the word *novel* which is a cognate with Spanish, *novela*) relative to homonyms that are not cognates (Schwartz, Yeh, & Shaw, 2008). This means that there is greater interference of selection from not only the meanings within one language but also the meanings shared across both languages. Also, studies on eye movement measures have shown that the relative time-course with which different meanings of a homonym become activated is fundamentally shifted for cognate homonyms relative to non-cognate homonyms. For example,

unlike the typical subordinate bias effect observed for non-cognate homonyms, when the homonym is also a cognate the shared, subordinate meaning is activated early enough to cause competition with the dominant meaning, even in a neutral context. When this same type of cognate homonym is placed in a context biasing the subordinate meaning, there is no evidence of competition from the dominant meaning. Thus, the subordinate bias effect is completely eliminated due to cross-language lexical activation (Schwartz & Areas Da Luz Fontes, 2010; in preparation).

Monolingual research on lexical disambiguation at a discourse level has shown three factors- global context, local context, and the frequency of the meanings-as possible contributors to selective access of meanings. However, evidence shows that global context has no influence on selective access of the intended meaning. On the contrary, local context seems to play a role in meaning selection, which it is observed through the *subordinate bias effect*.

The present study examined the effects of global context (topic level information) and local context (prior or post disambiguating region where the homonym is embedded) of paragraphs on the time course of activation of cognate and non-cognate homonyms for bilingual readers. As with the monolingual research, global context, local context, and meaning frequency are factors that are thought to contribute to the selective meaning access; however, in the case of bilinguals, another factor will play a major role: cross-language activation. Current bilingual research on lexical ambiguity has come up with clear evidence that when a cognate is presented within a biasing context, both cross-language activation and local context influence the timing of activation, strong enough to eliminate the subordinate bias effect (Schwartz & Areas Da Luz Fontes, in press). Cross-language activation has enough potential for selective access when

combined with context. In monolingual research, prior context is enough to activate meanings to compete but selective access is never observed.

It was hypothesized that cross-language activation will alter the time course of meaning activation and that this alteration would result in selective access of the subordinate meaning of cognate homonyms when these were supported by the surrounding context. It was predicted that eye-movements would reflect a different pattern of meaning selection at a discourse level, compared to what is seen with monolingual research. Also, as Schwartz & Areas Da Luz Fontes (2011, in press) has shown, cross-language activation along with local context would allow for selective access in conditions where local context biases the subordinate meaning. In addition, global context and cross-language activation would also result in selective access, a condition not observed with monolinguals. If the results were convergent with the hypotheses, these would support the proposed Bilingual-Reordered Access model, which assumes that context, meaning frequency and cross-language activation will alter the time course of activation of meaning selection for bilinguals.

Methods

Participants

Fifty-eight undergraduate students from psychology courses at the University of Texas at El Paso participated in the study for course credit. The criterion for participation was that individuals must be Spanish-English bilinguals. Participants were both males and females over the age of 18 years. Data for 46 participants was used for the final analysis due to omissions involving proficiency measures, accuracy, and reading times that were out of range. Details of these measures are discussed in the “Analyses” section.

Materials

Word Stimuli. A total of 22 English homonyms (semantically-ambiguous words) were selected from a published corpus (Twilley et al, 1994). Of the 22 homonyms, 11 were cognates that share the subordinate meaning with Spanish (e.g. arms-armas,) and the remaining 11 were noncognates (e.g. wing, slip) that served as controls. The noncognate homonyms were matched with relative frequency and length on an item-by-item basis with each cognate (see Table 1).

Paragraph Stimuli. Four paragraphs for each word across the four critical word conditions (cognate and noncognate homonyms, cognate and noncognate nonhomonyms) were created conforming to the 4 possible context conditions [Global (neutral, biasing), Local (neutral biasing)]. The content of the paragraphs were based on the paragraph construction of previous similar studies (Kambe et al, 2001) and were edited by trained linguists. The first sentence of the paragraph instantiated the global context with a topic sentence that was either related to the meaning of the upcoming critical word or neutral. The second sentence instantiated the local context and contained the critical word. In cases in which the critical word was a homonym, this sentence always biased the subordinate meaning, the disambiguating regions of the sentence

occurred either before (*local biasing context*) or after the critical word (*local neutral context*).

The last sentence of the text was a concluding sentence that was neutral throughout conditions.

All paragraphs were pseudo-randomly assigned to one of four different experimental running lists, such that no participant would see the same critical word.

Each participant was presented with a total of 44 paragraphs. The paragraphs included all homonym cognates and their matched control homonym non-cognates. Comprehension questions were created and asked after some of the paragraphs to ensure that participants were processing the text (see Table 2).

Reading Speed Measures. To obtain an objective measure of reading speed in English and Spanish a set of 10 sentences for each language presented after the critical paragraphs while eye-movements continued to be recorded. None of the words in these sentences shared any orthographical characteristics with the other language. Eye-movements were measured in milliseconds for each word of the sentence. Comprehension questions followed some of the single sentence in order to observe whether the participant understood the context.

Language History Questionnaire. A language history questionnaire (LHQ) was administered as a subjective measure of participant's language proficiency in English and in Spanish. The LHQ is designed to assess the experience and understanding of the individual's languages. Individuals were asked to give self-assessments of their English and Spanish reading proficiency, writing proficiency, speaking ability, and speech comprehension with a Likert-type scale (1=equals not literate/not fluent/not able to understand; 10=very literate/very fluent/perfectly able to understand).

Procedure

Informed consents were gathered prior to the study. The participant was asked to sit on a chair in front of a computer monitor. Eye movement monitoring was measured using EyeLink 1000 software (SR-Research, Ontario, Canada). Eye movements were recorded binocularly at a sampling rate of 500 Hz. Eye movements were recorded using the dominant eye of the participant. Once the eye tracker was calibrated, the screen displayed instructions, which were read to them out-loud by the experimenter. Participants were instructed to read a series of paragraphs to themselves. They were told to pay close attention to what the paragraphs were saying because on half of the trials the text was followed by a series of comprehension questions. They were instructed that after reading the paragraphs, they would be reading single sentences in English and in Spanish and that these sentences also had follow-up questions. Each participant sat through a number of practice trials before beginning the experimental trials to make sure that each understood the task and to allow them to ask questions if there were any. Each trial was first presented with a blank screen that had a fixation point in place where the first word of the paragraph would appear. In order for the paragraph to be seen, the participant had to fixate on the dot, a procedure done for each trial to ensure that the pupil was positioned on the right spot of the screen to avoid drift. The experimenter sat in the room with the participant throughout the entire experiment. Once the experiment was over, the participant filled out the language history questionnaire, was debriefed, and issued course credit.

Analyses

Inclusion Criteria

Data included in critical analysis was based on two types of criteria: accuracy and language proficiency.

Accuracy Data. Comprehension questions were constructed to follow-up some of the critical paragraphs. These questions were to ensure that the participants were processing the content. Data for participants with a percentage error over 40 was omitted from the analysis. This resulted in the exclusion of 5 participants' data.

Proficiency Measures. Analysis for the LHQ revealed that participants reported that their first language was Spanish, acquired at an age of 1.7 years on average. Their second language, English, was acquired at a later age of about 7.5 years. Their self-ratings of reading, writing, speaking, and listening skills across the two languages indicated that the participants means of Spanish equal to those of English, self-ratings that makes them balanced bilinguals in Spanish and English (English, $M=8.8$; Spanish, $M= 8.8$) (see Table 3).

Reading Speed Measures. The measure of reading speed of both languages was conducted as an objective measure of proficiency. It was calculated by dividing the total reading time for each sentence by the number of words that made up the sentence. An average was calculated for the set of sentences in English and Spanish; therefore, each participant had two reading time measures: one for English and another for Spanish. Data with an average that was out of range from the mean plus/minus 2 times the standard deviation was removed from the analysis. This resulted in the exclusion of 4 participants' data. Also, after reviewing the English reading speed distribution on a histogram, data for 3 participants was excluded because it was outside of the bell curve (see Figure 1). Their reading speed was above 600 ms per word.

Critical Analyses

To test the hypothesis that the combination of global and local contextual information would allow for an elimination of the subordinate bias effect for cognates, a series of 2 (global context) X 2 (local context) X 2 (homonym status) repeated measures analyses of variance (ANCOVAs) were conducted for cognates and non-cognates separately, using English reading speed from the reading speed measure described above as a covariate. Fixations that were less than 100 ms were omitted from the analysis because they were attributed to an eye movement drift.

The dependent variables submitted to the analyses were first fixation duration, gaze duration, and total gaze duration for each cognate and non-cognate on critical sentences. First fixation duration is the first fixation of the target word. Gaze duration will measure the fixations on the target word before reading on to the following word. These two measures are assumed to tap into initial processing of words, when a word is first being accessed. Total gaze duration measures the total fixations of the target word that includes the fixations after regressing to the word. This measure is a later stage of processing that observes when a word has already been accessed and its meaning is now being integrated into the entire sentence (Rayner, 1988). As discussed earlier, a critical assumption of the Reordered Access Model relates to the meaning activation of a word before it is identified and retrieved from long-term memory. The subordinate bias effect is then observed during initial stages of lexical access. If the subordinate bias effect is eliminated, this would be observed within first fixation duration and gaze duration, when the meanings of the homonym are first being accessed.

Results

Cognates

Analyses on the first fixation duration data for cognates revealed no significant main effects or interactions. The three-way interaction between global and local bias and homonyms status in first fixation duration was not significant ($F(1,36)^1 = 2.723, p = .108, MSE = 4339.491$). In the analysis on gaze duration this three-way interaction reached statistical significance ($F(1,36) = 5.837, p = .021, MSE = 5504.569$). To examine the nature of this interaction, two follow-up 2 (local context) X 2 (homonyms status) ANCOVA's were performed separately across global contexts.

Global neutral conditions. The two way interaction of local context and homonym status was not significant ($F(1,41) = 0.818, p = 0.371, MSE = 7518.721$). However, there was a main effect of local context ($F(1,41) = 5.213, p = .028, MSE = 9513.872$). A cost is observed in a biasing context perhaps because boosted top-down activation from semantics to orthography slowed processing of cognates because they were not orthographically identical. Thus, the added semantics provided in biasing global contexts, boosted the activation of the orthographic representation in Spanish- causing some competition. This is observed with cognates because they are so similar across languages that both representations are activated in parallel; therefore, when there is a lack of convergence in form, there is a cost (Schwartz, Diaz, & Kroll, 2007).

Global biasing conditions. The two way interaction of local context and homonym status was not significant ($F(1,39) = 1.296, p = 0.262, MSE = 8070.828$). There were no significant main effects of local context or homonym status.

¹ Degrees of freedom differ amongst analyses due to missing data.

A follow-up analysis for the comparison of the means revealed that neither homonym cost in local neutral context ($F(1,40) = .148, p = .702, MSE = 9680.363$) nor homonym cost in local biasing context ($F(1,42) = 1.389, p = .245, MSE = 7147.341$) was statistically reliable.

When comparing Figure 2 and Figure 3, which represent the three-way interaction, the pattern of means in global neutral conditions shows longer processing times of cognate homonyms in global neutral conditions than global biasing conditions. A follow-up paired-sample t-test performed on the average gaze duration for cognate homonyms in Global Neutral contexts (averaging across both local neutral and local biasing) and average gaze duration for cognate homonyms in Global Biasing contexts (averaging across both local neutral and local biasing contexts) revealed a statistically significant difference between the average duration in neutral contexts ($M = 303$) relative to biasing contexts ($M = 232$), $t(49) = 4.78, p = .000$. These results demonstrate that the cost of processing of cognate homonyms is eliminated with the addition of topic level information. When there is no support of the subordinate meaning from global context in global neutral conditions, a cost is observed because local context and cross-language activation only activate the subordinate meaning earlier enough to be able to compete with the dominant meaning. However, when there is topic level support for the subordinate meaning in global biasing conditions, the subordinate meaning is activated early enough to bypass the competition with the dominant meaning- in turn, eliminating the cost of processing.

This is unlike previous monolingual studies, in which at least one source of contextual support is required for the subordinate meaning to compete. This suggests that cross-language co-activation of the subordinate meaning of these cognate homonyms allowed the weaker meaning to be sufficiently activated to compete, even in the absence of contextual support.

To assess whether this cost was truly due to the activation of the subordinate meaning of the cognate homonyms and not a result of a spurious characteristic of the composition of the global biasing versus global neutral paragraphs, a follow-up t-test was performed on the average gaze duration for cognate non-homonyms across Global Neutral and Global Biasing conditions. This t-test revealed no significant difference in processing time, $t(49) = 0.349$, $p = .728$.

The analyses performed on total reading time measures for cognates revealed no significant main effects. The 3-way interaction also was not significant ($F(1,36) = .111$, $p = .741$, $MSE = 32610.973$). These results suggest that in post-lexical access ambiguity has already been resolved.

Non-cognates

Analyses on the first fixation duration data for non-cognates revealed non-significant interaction of homonym status and local context ($F(1,34) = 2.473$, $p = .125$, $MSE = 1871.044$). A follow-up analysis 2(local context) X 2(homonym status) ANCOVA was conducted to look at the interaction of homonym status and local status across the two global conditions (neutral/biasing).

No significant main effects or interactions of local context and homonym status for global neutral conditions were observed. The interaction of local context and homonym status was not significant in global biasing either. However, there was a marginal main effect of homonym status in global biasing conditions ($F(1,36) = 3.595$, $p = .066$, $MSE = 3912.019$), where fixations were longer on homonyms ($M = 234$) than non-homonyms ($M = 217$). Here we observe the expected monolingual pattern for the non-cognates. When there is support for the subordinate meaning from topic, it allows that meaning to be activated earlier enough to compete with the dominant meaning. A cost is observed because the subordinate meaning has some support.

There were no significant main effects or interactions in the analyses performed on gaze duration. The three-way interaction of global context, local context, and homonym status was not significant, ($F(1,34)=.003$, $p=.960$, $MSE=11318.073$). This was an unexpected result because in monolingual research, the subordinate bias effect is observed within this measure. In monolingual data, a greater cost of homonym processing compared to non-homonyms is found when the context biases the subordinate meaning, which allows that subordinate meaning to be activated at an earlier time course and competes with the dominant meaning.

Even though the three-way interaction was not significant, there were some interesting patterns. As Figure 4 illustrates, there is no subordinate bias effect present in global neutral conditions in gaze duration. There is no cost of homonym status observed. However, as seen in Figure 5, it is interesting that gaze duration for non-cognate homonyms in global biasing-local neutral conditions is highly inflated. This suggests that the subordinate meaning was activated only when there was global support for it. However, a follow-up analysis revealed that the comparison between the means in this condition did not differ from each other ($F(1,43)=1.178$, $p=.284$, $MSE=10066.565$). In the global biasing-local biasing condition, the combination of global and local support for the subordinate meaning eliminated that cost. A comparison of these means was also not significant ($F(1,37)=.264$, $p=.611$, $MSE=15540.033$). Participants for this study were not proficient enough in English to even show an expected subordinate bias effect. More specifically, these findings suggest that readers that are more proficient in Spanish lack lexical speed and fluency to activate the subordinate meaning.

The analyses performed on total reading time measures for non-cognates revealed no significant main effects. The 3-way interaction also was not significant ($F(1,36)=1.117$, $p=.298$,

$MSE= 38556.672$). These results suggest that in post-lexical access ambiguity has already been resolved.

Discussion

The present study examined the effects of global context and local context on the time course of activation of cognate homonyms for bilingual readers. Of interest was whether the time course of activation of the subordinate meaning of cognate homonyms was modulated by meaning frequency, context, and cross-language activation. Also, whether the subordinate bias effect would be altered or even eliminated by the combined influence of such contextual factors and cross-language activation.

The major finding of the present study is that the combination of strong, contextual support and cross-language activation of the subordinate meaning resulted in the reduction of processing costs of cognate homonyms. A greater cost of processing was observed for cognate homonyms in global neutral conditions compared to global biasing conditions. Global neutral conditions only had two sources of support for the subordinate meaning- local context and cross-language activation. For these conditions, the topic level information did not provide any support for the subordinate meaning. When the cognate homonyms were embedded in global neutral conditions with a local context that biased the subordinate meaning, a cost in processing time was observed. In this case, the combination of the local support and cross-language activation allowed for the subordinate meaning to be activated earlier on, competing with the dominant meaning.

In global-biasing conditions, however, the cost of processing times of cognate homonyms was significantly reduced. This suggests that the competition between dominant and subordinate meanings was reduced or even eliminated. The elimination of this competition was predicted for local-biasing conditions, in which three, separate sources of support for the subordinate meaning would allow it to bypass competition with the dominant meaning. These findings suggest that

topic level information along with local context and cross-language activation provided enough support for the subordinate meaning to be activated at an earlier time course, which in turn allowed that activation to bypass competition with the dominant meaning.

Although the subordinate bias effect was not directly observed within cognate target conditions, the reduction of cost of processing of cognate homonyms has demonstrated that for bilinguals, having three sources of support for the subordinate meaning- global context, local context, and cross-language activation is enough to allow for a reduction of competition with the dominant meaning. These findings are supportive of the selective access models. There might be something special about cognates and the differential effect that cross-language activation can have on meaning selection that helps context activate the correct meaning at an earlier stage of processing.

These findings further support the proposed Bilingual-Reordered Access Model (Arêas Da Luz Fontes, Yeh & Schwartz, 2010; Schwartz & Arêas Da Luz Fontes, 2008), as well as with those of Schwartz & Arêas (in prep) who found that context and cross-language activation was strong enough to selectively access the correct meaning of the target word.

The observed reduction of processing of cognate homonyms across global conditions suggests that global context may play a more direct role in meaning selection of cognates relative to non-cognates for bilingual readers. This accentuated effect for cognate processing may be due to co-activation of the two representations of the cognate across languages. Another possibility is that the facilitated access of cognate representations allows for bilingual readers to capitalize more on global sources of information in ways that they cannot for non-cognates.

It is also important to note that the major finding of the present study for cognates was observed during the same time frame as typically observed with monolinguals. For

monolinguals, cost in processing due to the competition between subordinate and dominant meanings has been observed in gaze duration; as it has been observed for bilinguals. Gaze duration is an initial stage of processing, when the word is first being accessed.

Not observing a clear subordinate bias effect in cognate conditions where there was a source of support for the subordinate meaning (global neutral –local biasing, global biasing-local neutral, global biasing-local biasing) was unexpected. However, observing a cost of processing in global neutral conditions, which is then reduced in global biasing conditions, is convergent with monolingual data. Monolingual data has found a cost of processing of homonyms in conditions where there is a source of support for the subordinate meaning (Kambe et al 2001; Binder 2003). They found that as long as there is one source of support for the subordinate meaning, a cost of processing was observed.

The pattern of processing times for non-cognate homonyms in global-biasing conditions provides convergent evidence that the reduction of processing costs of cognate homonyms in the present study critically depended on cross-language activation. In these conditions a simple main effect of homonyms status was observed. Thus, having at least one source of contextual support for the subordinate meaning allowed it to compete with the dominant meaning. Furthermore, it is unclear to why there was no observable cost of processing of non-cognate homonyms in conditions that provided a source of support for the subordinate meaning. The participants for this study were second language readers; as you might recall, their native language is Spanish and these critical items were read in their second language, English. These findings might be a reflection of a lack of lexical ability that is not sufficient enough to show a typical subordinate bias effect. It is interesting that the patterns of non-cognates for bilinguals are unusual. The patterns suggest that in the absence of cross-language overlap- there is not sufficient activation of

the subordinate meaning. Another possible implication is that our non-cognate items could have been less than ideal, something that needs to be considered in future studies.

There are some possible individual differences that played a critical role in the findings of the present study. As mentioned above, our sample consisted of bilinguals who were more proficient in Spanish; therefore, our analyses were conducted with a covariate of English proficiency. The typical subordinate bias effect was not observed in global neutral conditions for cognates and non-cognates perhaps due to lack of English proficiency. However, the reduction of cost of processing for cognate homonyms of these bilinguals was observed because they were highly proficient, native speakers of Spanish. For cognates, reading the sentences in English allowed for a strong presence of that language, and being more proficient in Spanish allowed for more representations of the cognates for support of earlier activation of the subordinate meaning once read in global biasing conditions where the topic level information supported the subordinate meaning. Another individual difference for our bilingual sample is that they might be more efficient at suppressing the unintended meanings of cognates. As you can recall, language is non-selective for bilinguals, meaning that both languages are always activated in parallel. In this case bilinguals are always struggling with two competing languages, which might allow them to be more efficient at selecting the appropriate language.

Findings from the present study have important implications for bilingual and second language reading. Because language is ambiguous, it is important to understand the cognitive processes that take place during disambiguation of language in reading. Currently research is beginning to examine ambiguity in bilinguals; however, there are no systematic studies that explain the influence of discourse context on the way that bilinguals disambiguate language in

reading. The development of bilingual lexical disambiguation is essential to pedagogy that contributes to bilingual and second language reading.

It is critical to attend to the issues of bilingualism because of the increasing size of the population for whom English is not the first or only language. Immigrants are learning English as their second language; therefore, it is critical to understand language acquisition and how the bilingual mind operates, not only for educational purposes but also for a smoother transition into the American culture. It is also critical to understand bilingual language processing so that processing differences that are in fact due to the unique aspects of bilingualism will not be attributed to a lack of knowledge. For example, standardized tests might not be assessing bilinguals to their full potential because they are constructed for monolinguals.

Table 1. Examples of word stimuli.

Critical Word	Cognate Status	Homonym Status	Celex F	Word Length
arms	cognate	homonym	106.03	4
adult (control)	cognate	nonhomonym	90.19	5
ruler	noncognate	homonym	7.65	5
tents (control)	noncognate	nonhomonym	7.15	5

Table 2.

Examples of paragraph stimuli for the cognate homonym *bulb*.

	Local Neutral	Local Biasing
Global Inconsistent	My nose itched. As I grabbed the <i>bulb</i> , the pollen touched my nose. It was going to be a bad day.	My nose itched. The flower's pollen from the <i>bulb</i> had touched my nose when I smelled it. It was going to be a bad day.
Global Consistent	I walked through the garden and picked a daisy. As I grabbed the <i>bulb</i> , the pollen touched my nose. I was going to have allergies the rest of the day.	I walked through the garden and picked a daisy. The flower's pollen from the <i>bulb</i> had touched my nose when I smelled it. I was going to have allergies the rest of the day.

Table 3.

Self-Assessed English and Spanish Proficiency Ratings (N = 46).

	English	Spanish
Age of Acquisition (years of age)	7.5	1.7
Self- assessed ratings ¹		
Reading	8.7	8.7
Writing	8.6	8.0
Speaking	8.7	9.0
Listening	9.1	9.3
Mean rating	8.8	8.8

¹Self-assessed ratings based on a scale 1-10.

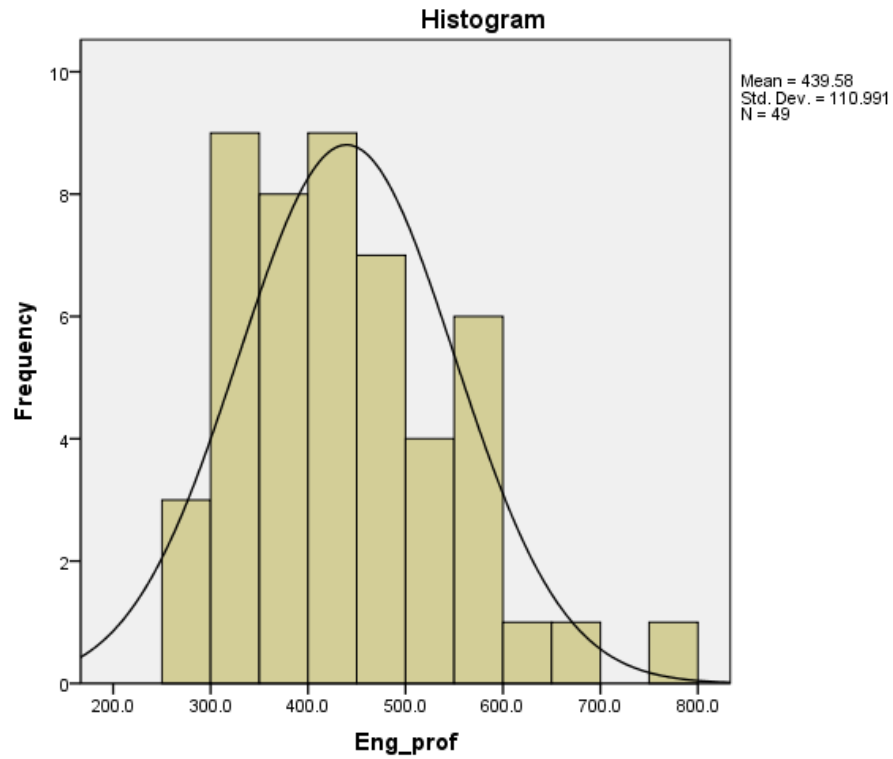


Figure 1. Histogram of English reading speed distribution.

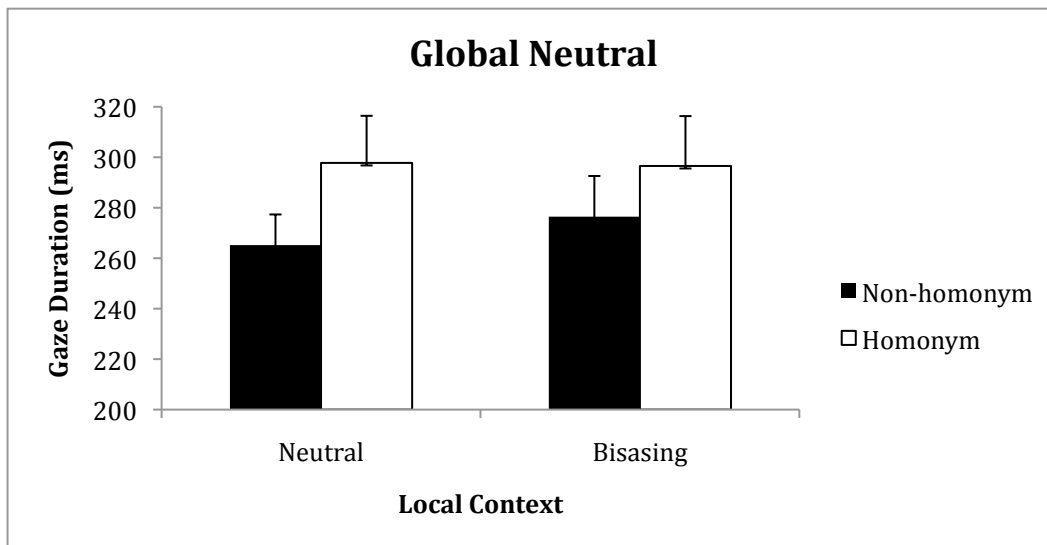


Figure 2. Gaze duration of the global neutral conditions in the three-way interaction of global context, local context, and homonym status of cognate targets.

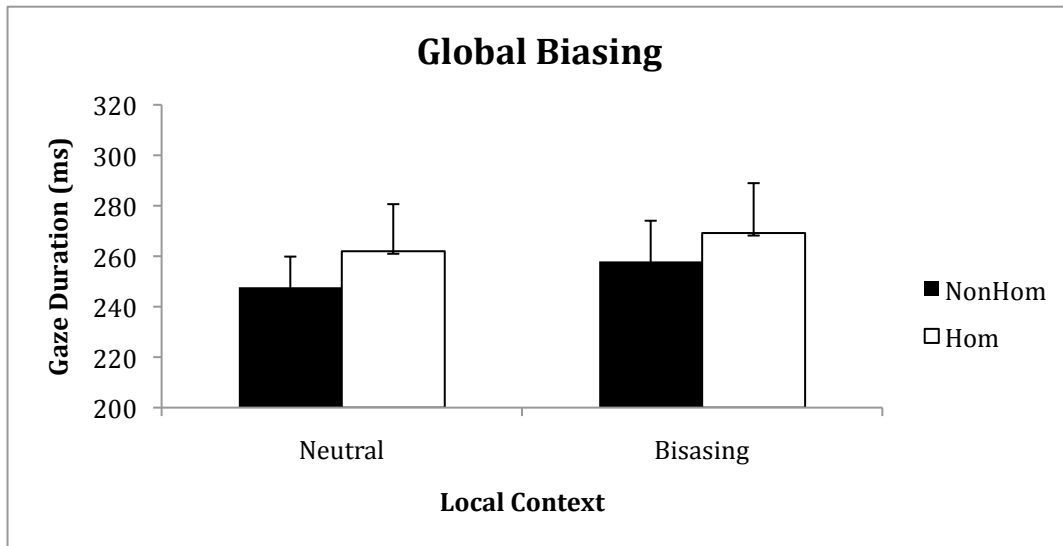


Figure 3. Gaze duration of the global biasing conditions in the three-way interaction of global context, local context, and homonym status of cognate targets.

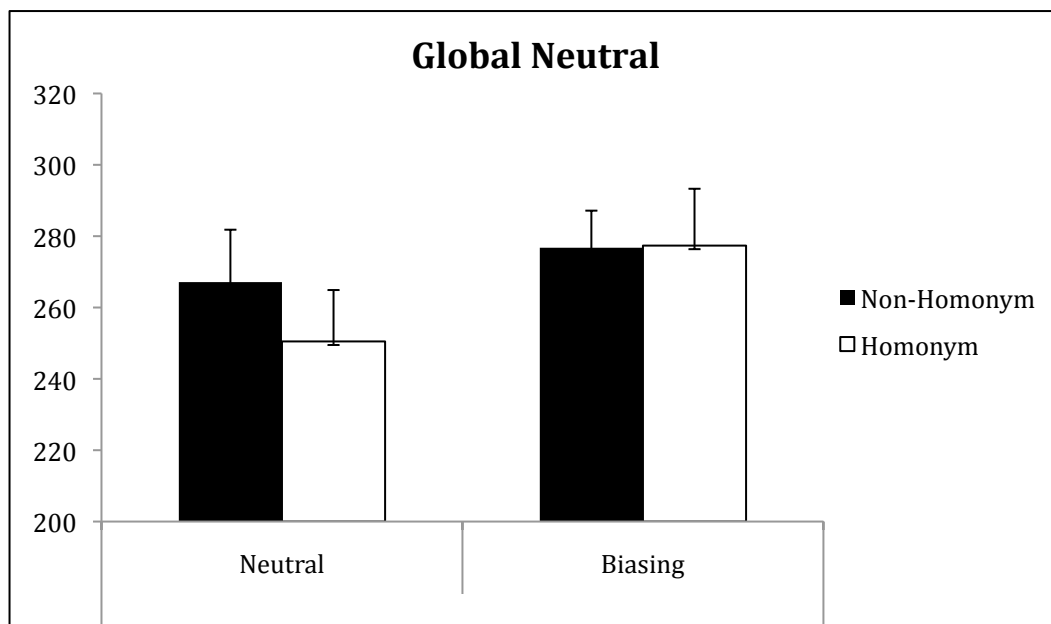


Figure 4. Gaze duration of the global neutral conditions in the three-way interaction of global context, local context, and homonym status of non-cognate targets.

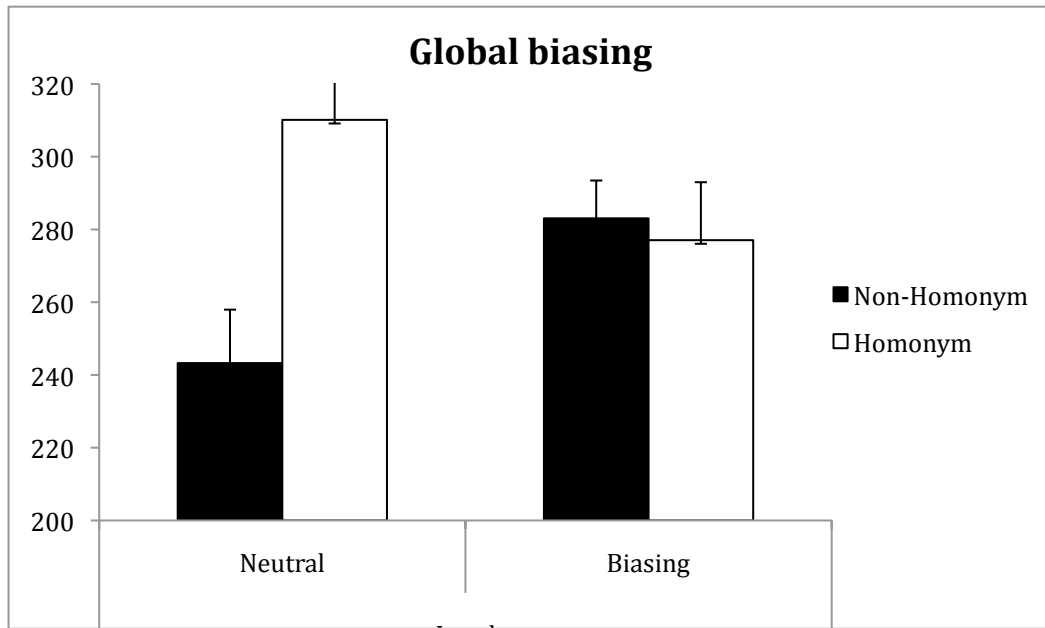


Figure 5. Gaze duration of the global biasing conditions in the three-way interaction of global context, local context, and homonym status of non-cognate targets.

References

- Arêas da Luz Fontes, A.B & Schwartz, A.I. (2010). On a different *plane*: Cross-language effects on the conceptual representations of within-language homonyms. *Language and Cognitive Processes* 25(4), 508-532.
- Arêas da Luz Fontes, A. B. & Schwartz, A. I. (2010). Working memory influences on cross-language activation during bilingual lexical disambiguation. *Bilingualism: Language and Cognition*. Retrieved from <http://journals.cambridge.org>
- Arêas da Luz Fontes, A. B., Yeh, L., Schwartz, A. I. (2010). Bilingual lexical disambiguation: The nature of cross-language activation effects. *Letrônica*, 3(1), 107-127.
- Binder, K. S. (2003). Sentential and discourse topic effects on lexical ambiguity processing: An eye movement examination. *Memory & Cognition*, 31(5), 690-702.
- Binder, K. S. & Morris, R. K. (1995). Eye movements and lexical ambiguity resolution: effects of prior encounter and discourse topic. *Journal of Experimental Psychology*, 21 (5), 1-11.
- Buchner, A., Erdfelder, E., & Faul, F. (1997). How to Use G*Power. Retrieved from http://www.psych.uni-duesseldorf.de/aap/projects/gpower/how_to_use_gpower.html
- de Groot, A. M. B., & Keijzer, R. (2000). What is hard to learn is easy to forget: The roles of word concreteness, cognate status, and word frequency in foreign-language vocabulary learning and forgetting. *Language Learning*, 50(1), 1-56.
- de Bruijn, E. R. A., Dijkstra, T., Chwilla, D. J., & Schriefers, H. J. (2001). Language context effects on interlingual homograph recognition: Evidence from event-related potentials and response times in semantic priming. *Bilingualism: Language and Cognition*, 4(2), 155-168.

- Dijkstra, T., De Bruijn, E., Schriefers, H., & Brinke, S. T. (2000). More on interlingual homograph recognition: Language intermixing versus explicitness of instruction. *Bilingualism: Language and Cognition*, 3(1), 69-78.
- Dijkstra, T., Grainger, J., & van Heuven, W. J. B. (1999). Recognition of cognates and interlingual homographs: The neglected role of phonology. *Journal of Memory and Language*, 41(4), 496-518.
- Dijkstra, T., & van Hell, J. G. (2003). Testing the language mode hypothesis using trilinguals. *International Journal of Bilingual Education and Bilingualism*, 6(1), 2-16.
- Duffy, S. A., Morris, R. K., & Rayner, K. (1988). Lexical ambiguity and fixation times in reading. *Journal of Memory and Language*, 27(4), 429-446.
- Gollan, T. H., Forster, K. I., & Frost, R. (1997). Translation priming with different scripts: Masked priming with cognates and noncognates in hebrew-english bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 23, 1122-1139.
- Jared, D., & Kroll, J. F. (2001). Do bilinguals activate phonological representations in one or both of their languages when naming words? *Journal of Memory and Language*, 44(1), 2-31.
- Kambe, G., Rayner, K., & Duffy, S. A. (2001). Global context effects on processing lexically ambiguous words: Evidence from eye fixations. *Memory & Cognition*, 29(2), 363-372.
- Leinenger, M. & Rayner, K. (2011, November). *When lexical access for ambiguous words can be reordered*. Poster session presented at the Annual Meeting of the Psychonomic Society, Seattle WA.

- Libben, M. R., & Titone, D. A. (2009). Bilingual lexical access in context: Evidence from eye movements during reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 35(2), 381-390.
- Rayner, K., Pacht, J. M., & Duffy, S. A. (1994). Effects of prior encounter and global discourse bias on the processing of lexically ambiguous words: evidence from eye fixations. *Journal of Memory and Language*, 33(4), 527-544.
- Schwartz, A., & Arêas Da Luz Fontes, Ana B. (2008). Cross-language mediated priming: Effects of context and lexical relationship. *Bilingualism: Language and Cognition*, 11(1), 95-110.
- Schwartz, A. I., & Kroll, J. F. (2006). Bilingual lexical activation in sentence context. *Journal of Memory and Language*, 55, 197-212.
- Schwartz, A. I., Yeh, L., & Shaw, M. P. (2008). Lexical representation of second language words: Implications for second language vocabulary acquisition and use. *The Mental Lexicon*, 3(3), 309-324.
- Simpson, G. B. (1981). Meaning dominance and semantic context in the processing of lexical ambiguity. *Journal of Verbal Learning & Verbal Behavior*, 20(1), 120-136.
- Swinney, D. A. (1979). Lexical access during sentence comprehension: (Re)consideration of context effects. *Journal of Verbal Learning & Verbal Behavior*, 18(6), 645-659.
- Van Assche, E., Dyuck W., Hartsuiker, R. J., & Diependaele, K. (2009). Does bilingualism change native-language reading? Cognate effects in a sentence context. *Psychological Science*, 20(8), 923-927.
- van Heuven, W. J. B., Dijkstra, T., & Grainger, J. (1998). Orthographic neighborhood effects in bilingual word recognition. *Journal of Memory and Language*, 39(3), 458-483.

Curriculum Vitae

Yvette Aguilar Baca was born in El Paso, Texas. The only child of Hector and Guadalupe Aguilar, she graduated from Del Valle High School, El Paso, Texas, in the spring of 2001 and entered The University of Texas at El Paso in the fall of 2001. After obtaining her bachelor's degree in psychology, she worked for Communities in Schools as a program coordinator. This non-profit organization works with public school children in providing them with social and academic services that will benefit their academic future. She also worked as a research associate for the Center for Research on Education Reform, which conducts broad-based and multidisciplinary research on educational reform in elementary, secondary, and post-secondary education.

She has presented her research at professional meetings, including meetings for the American Association of Applied Linguistics and the Annual Psychonomic Meeting.

In 2011, Yvette Aguilar Baca defended her master's thesis entitled "Bilingual homonym disambiguation at the discourse level," under the supervision of Dr. Ana I. Schwartz.