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The goal of the present study was to examine whether cross-language activation of a bilingual's native language influences the processing of lexical ambiguity within a second language. Highly proficient Spanish-English bilinguals performed a semantic verification task in which sentence frames were followed by the presentation of the final word of the sentence (the prime word). Participants then decided whether a follow-up target word was related to the meaning of the sentence. On critical trials the sentences ended in a semantically ambiguous word that was either a cognate with Spanish (e.g., *novel*), or a noncognate control matched on frequency and length (e.g., *fast*). The preceding sentence context biased the subordinate meaning (e.g., *new*; *refrain from eating*) and targets were related to the irrelevant, dominant meaning (e.g., *BOOK*; *SPEED*). Mean reaction times and error rates were greater when the prime words were ambiguous cognates than when they were ambiguous noncognates. This suggests that the semantic representations from the native language were coactivated and increased the lexical competition from the shared, dominant meaning. Implications for second language vocabulary acquisition and current models of reading are discussed.

Keywords: cross-language activation, lexical ambiguity, semantic representation, cognates

An important outcome of vocabulary acquisition is the ability to quickly comprehend and produce words across a variety of communicative contexts. This ability depends critically on the formation of an accurate and robust cognitive representation of the word that can be accessed quickly across multiple modes of communication (e.g., Perfetti & Hart, 2001). However, the cognitive access of words is complicated by the fact that the richness and dynamics of language do not often allow

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for simple one-to-one mappings between a word and its corresponding meaning. Rather, words often have multiple meanings (e.g., *habit* can mean *frequent behavior* or *nun's apparel*) and meanings can be expressed through multiple words (e.g., *huge*, *large*, *gigantic*). Complicating the picture even more is the fact that most of the world's population is multilingual and words that are seemingly similar across languages, such as cognates, often take on different senses and uses. Indeed, ask any bilingual and she or he can tell of at least one embarrassing moment in which they used a word inappropriately, often in the second language.

What are the cognitive consequences of learning the different uses of words across languages? Are the cognitive representations of a word's meaning fundamentally different between bilinguals and monolinguals? Take the English-Spanish cognate *novel/novela* as an example. For both an English monolingual and an English-Spanish bilingual this word most often refers to a book or story. There is, however, another less frequent meaning in English that refers to something that is "new" and this meaning is *not* shared in Spanish. We know from previous research with monolinguals that, when a sentence context biases the subordinate meaning of an ambiguous word, access of that meaning requires competition with the dominant meaning, which delays processing. This is known as the "subordinate bias effect" (e.g., Duffy, Kambe, & Rayner, 2001; Duffy, Morris, & Rayner, 1988; Sereno, O'Donnell, & Rayner, 2006). Thus, a monolingual is likely to take longer to select the "new" meaning of "novel".

But, what about a Spanish-English bilingual? Is the competition from the more dominant meaning greater by virtue of being shared across both languages? That is, would the word recognition performance of a bilingual demonstrate an even greater subordinate bias effect for words whose ambiguity is across multiple languages? If so, this would suggest that, in terms of their cognitive representations, shared meanings across languages are weighted differently for bilinguals relative to monolinguals. This further implies that the cognitive representations that underlie bilinguals' vocabulary may be fundamentally different than those of monolinguals and more prone to lexical competition.

In the present study we compared bilingual readers' processing of ambiguous L2 words that were either cognates (e.g., *novel*) with the L1 or noncognate controls (e.g., *fast*) which were inserted in a sentence context biasing the subordinate meaning. Performance measures reflected greater competition from the dominant meaning when the ambiguous words were cognates relative to noncognate controls. These findings are critical, first because they suggest that, for bilinguals, proficiency in multiple languages can alter the weightings of the multiple meanings of ambiguous words. This in turn, has an influence on the efficiency with which less frequent meanings can be retrieved for comprehension and/or production. Second, they demonstrate that when bilinguals are reading sentences in their L2,

semantic representations from their native language (L1) are co-activated and influence processing. This implies that, even when there is contextual support for a particular meaning, bilinguals must negotiate cross-language lexical competition. Together these findings underscore the importance of developing robust lexical representations that allow the bilingual to effectively override the cognitive cost associated with lexical competition. Before describing the present study we first review monolingual and bilingual investigations of the representation and processing of lexical ambiguity.

Lexical ambiguity representation: The quality of the lexical code

A fundamental aspect of vocabulary acquisition is the construction of a high quality lexical representation that can be accessed efficiently and reliably. According to the "lexical quality hypothesis" proposed by Perfetti and Hart (2001), words with high quality lexical codes have representations that are specific, redundant and facilitate reliable retrieval. For homonyms lexical quality is at risk (e.g., *spade*, *port*). This is because there is not a direct one-to-one mapping between lexical form (be it orthographic or phonological) and meaning which compromises specificity and redundancy. Furthermore, infrequent meanings of ambiguous words (e.g., the "wine" meaning of *port*) are at added risk because their low frequency makes them less easily accessible.

However, it should be noted that according to this perspective, lexical quality is just one factor that contributes to how readily a word can be identified (i.e., its "functional identifiability"). How identifiable a word is in a given situation will depend on factors related to the reader, the context and, of course, the word itself. So for example, the word *novel* may have a high baseline level of identifiability for a highly skilled reader especially since one of its meanings is of high frequency. However, that same word for a less skilled reader, and particularly if the context calls for access of the subordinate meaning, can have a much lower identifiability (Perfetti & Hart, 2001). Thus, in order to successfully use the words that make up our vocabularies and their different meanings, we must build cognitive representations robust enough to override the effects of ambiguity, low frequency, lack of context, and other factors that detract from a word's "identifiability".

Lexical ambiguity representation: The role of context

In what specific ways does context contribute to the identifiability of ambiguous words? While there is general agreement that context aids in the identification of

ambiguous words, there is still debate concerning the time-course of this influence, particularly how early on in the process of lexical access context can exert its effect. According to the re-ordered access model (Duffy et al., 1988), the extent to which the multiple meanings of an ambiguous word compete is dependent on the relative time-course of their activation. The time-course of activation, in turn, depends on the relative frequency of the alternative meanings and the contextual support provided by the sentence. In the absence of a biasing context, the relative frequency of the alternative meanings determines the order (or relative speed) of their activation. However, a strong biasing context can reorder this activation.

Thus, according to this model, initial word access is affected by both lexical and contextual factors. To fully understand this model, consider two types of ambiguous words: balanced and biased. Balanced ambiguous words are words for which the multiple meanings have a similar likelihood or frequency of use (e.g., *fan*). Biased words, on the other hand, contain one meaning that is far more frequent or likely (e.g., *novel*). In a neutral context, balanced ambiguous words take longer to process than biased words or unambiguous controls. This is because the two, equally likely meanings compete for selection. For the biased words, this competition does not occur because the subordinate meaning is not activated early enough.

In a biasing context this pattern is reversed. Balanced words take less time than biased or unambiguous controls because the target meaning is activated early enough to bypass competition with the alternative. Biased words however, take longer to process if the context biases the subordinate meaning. This is because the preceding context boosts the activation of the subordinate meaning, allowing it to compete with the dominant meanings. This effect has been referred to as the "subordinate bias effect" (SBE) (Rayner, Pacht, & Duffy, 1994).

Lexical ambiguity representation: The bilingual case

In the present study we apply and extend the reordered access model to L2 reading. We were particularly interested in examining whether the nature and magnitude of the SBE would differ for words that have a high degree of lexical form overlap across languages (e.g., the Spanish-English cognate, *novel/novela*). We reasoned that, if the dominant meaning of ambiguous cognates (e.g., *novel: BOOK*) are co-activated across the L1 and L2, this would increase the magnitude of competition and incur a cost on processing.

Previous research has clearly demonstrated that bilingual lexical access is language non-selective in nature (e.g., Beauvillain & Grainger, 1987; Brysbaert, Van Dyck, & Van de Poel, 1999; de Groot, Borgwaldt, Bos, & Van Den Eijnden, 2002;

de Groot, Delmaar, & Lupker, 2000; Dijkstra, De Bruijn, Schriefers, & Brinke, 2000; Dijkstra, Grainger, & Van Heuven, 1999; Hermans, Bongaerts, De Bot, & Schreuder, 1998; Schwartz, Kroll, & Diaz, 2007; Spivey & Marian, 1999; Van Heuven, Dijkstra, & Grainger, 1998; Von Studnitz & Green, 2002). Thus, as bilinguals identify words in one language, they simultaneously co-activate words in the other language. This non-selectivity has been observed irrespective of task instructions or participant's expectations or knowledge that they will be presented with words from multiple languages (e.g., Dijkstra, Timmermans, & Schriefers, 2000; Dijkstra & Van Hell, 2003). It is important to note that much of the research demonstrating bilingual language non-selective access has been based on single-word recognition tasks. This is problematic since information from context may facilitate selective access of the appropriate meanings of words (Simpson & Kreuger, 1991; Tabossi & Zardon, 1993).

Recently investigators have examined the role that sentence context might play in modulating cross-language lexical activation (Altarriba, Kroll, Sholl, & Rayner, 1996; Duyck, Assche, Drieghe, & Hartsuiker, 2007; Elston-Güttler, Gunter, & Kotz, 2005; Elston-Güttler, Paulmann, & Kotz, 2005; Schwartz & Kroll, 2006; Van Hell & de Groot, in press). Overall these studies have demonstrated that, although a sentential context in and of itself is not sufficient to eliminate cross-language activation, language-selective activation is possible when there is high language proficiency and the context sufficiently biases the target word's meaning. For example, Kotz and Elston-Güttler (2004) found that low-proficiency German-English bilinguals activated non-target representations of German homonyms in L2 sentence contexts whereas language selective activation was observed for highly proficient bilinguals. Furthermore, Schwartz and Kroll (2006) observed persistent cognate facilitation, even for highly proficient Spanish-English bilinguals, when these were presented in low-constraint sentences in which the context did not bias the target word. Language-selective patterns of performance have been observed for highly-proficient bilinguals when either the sentence context has been sufficiently constraining (Schwartz & Kroll, 2006) or the overall linguistic context of the experiment was language exclusive (Elston-Güttler, Gunter, & Kotz, 2005). Finally, researchers have found that, in addition to modulating the overall magnitude of cross-language activation, sentence context can also influence the nature of this activation, that is, the type of lexical competitors that become active. More specifically, it appears that cross-language competitors that share semantic representations (e.g., cognates) are more resilient to the attenuating effects of context than those that only share form (e.g., Elston-Güttler, 2000; Schwartz & Fontes, 2008).

The goal of the present study was to examine whether co-activation of the L1 during sentence processing would influence bilingual readers' ability to efficiently resolve L2 lexical ambiguity. To address this issue we compared the SBE for two

types of biased ambiguous words: English-Spanish cognates (e.g., *novel*/*novela*) and non-cognates (*fast*/*rápido*) within a semantic-verification task. The biased, ambiguous cognates were selected such that the dominant meaning was shared with the L1 (e.g., *novela* in Spanish means *story* or *book*). These critical items were presented at the end of sentences that biased the subordinate meaning of the word (e.g., *Creative thinkers often generate ideas that are novel*). The sentences were then followed by target words in all capital letters that, on critical trials, were related to the dominant and contextually irrelevant meaning (e.g., *BOOK*). The participants' task was to indicate whether this word was related in meaning to the previous sentence. Accurate performance on this task required maintained activation of the relevant, subordinate meaning of the ambiguous word despite strong competition from the more dominant meaning. More critically, we hypothesized that, if there is non-selective activation of the L1, there would be added competition for the ambiguous cognates from the dominant meaning shared with the L1 relative to the ambiguous non-cognates.

In addition to the ambiguous words, we included an equal number of unambiguous cognates (e.g., *poet*) and matched noncognates (e.g., *happy*). This produced a fully crossed design and allowed us to independently manipulate both ambiguity and cognate status. For the unambiguous words we expected trials with cognates to be faster and/or less error prone than trials with noncognates. This prediction was based on the assumption that, for the cognates, both representations across languages converged on the same meaning whereas for the noncognate controls there would be only one representation. In the ambiguous cases, on the other hand, cognate status should inhibit performance due to the converging activation of a dominant meaning and increased competition.

The pattern of performance observed in the present study supported our major predictions. This suggests that the relative weights of the different meanings of ambiguous words are altered by knowledge of another language. This implies that, for bilinguals, there is an added layer of complexity that can hinder lexical quality and further decrease a word's functional identifiability.

Method

Participants

Twenty-nine highly proficient Spanish-English bilingual undergraduate students from the University of Texas at El Paso participated in the study. All participants earned course credit for their participation. Three participants' data were excluded from the analyses due to high error rates (greater than 40% across all trials) and

one participant was excluded due to low proficiency in Spanish, with a self-rating of less than 2 on a scale of 1 to 10. These exclusions produced a final sample size of 25 participants.

Materials and Design

The present study was based on a 2 X 2 within-participants design. The two independent variables were cognate status (cognate vs. noncognate) and ambiguity (ambiguous versus unambiguous) of the critical prime words. The dependent variables were reaction time (RT) in millisecond measures and percent error rates on the semantic verification task.

The critical stimuli list consisted of 80 English prime-target word pairs. For half of these pairs (40) the prime word was an ambiguous word for which there was one highly-frequent meaning and one low-frequency meaning (e.g., *novel*/*fast*). Half of these ambiguous primes (20) were English-Spanish cognates (e.g., *novel*/*novela*) and half were non-cognates (e.g., *fast*/*rápido*). The remaining 40 unambiguous prime words were similarly divided into cognates (e.g., *piano*/*piano*) and non-cognates (e.g., *pencil*/*lápiz*).

Within each of the two ambiguity conditions (ambiguous versus unambiguous) cognates and noncognates were matched on lexical frequency and length (see Table 1). For each ambiguous prime word the target word was related to its dominant meaning (e.g., *novel–BOOK*, *fast–SPEED*) while for each unambiguous prime word the target was completely unrelated to its meaning (e.g., *piano–GRASS*, *pencil–HAPPY*).

An additional 80 prime-target word pairs were included for filler, "yes" trials.

To ensure that the presence of a cognate or ambiguous word would not cue the participant to a "no" response, the filler primes included 30 cognates and 30 ambiguous words. Target words for these filler, "yes" primes were selected so that they were highly related to the prime word (e.g., *theater-STAGE*).

All prime words were preceded by a sentence frame which strongly biased its meaning (subordinate meaning for ambiguous words). This sentence frame

Table 1. Critical Prime Words and Their Lexical Characteristics

Condition	Primed words	Frequency[a]	Word length[b]
Cognate/ambiguous	novel	106.9	5.1
Noncognate/ambiguous	fast	104.6	5.0
Cognate/unambiguous	poet	80.7	5.9
Noncognate/unambiguous	happy	78.8	6.0

[a] Kucera & Francis, 1967

[b] Number of letters

Table 2. Example Sentences, Prime and Target Words

Condition	Sentences	Prime	Target
Cognate / Ambiguous	There were many fish in the river and they set up their poles along the	bank	money
Non-cognate / Ambiguous	The scuba diver admired all of the fish in the	school	teacher
Cognate / Unambiguous	Though he sometimes wrote prose, he was also a	poet	build
Non-cognate / Unambiguous	No one would help me, so I decided to do it all by	myself	wood

consisted of the complete sentence minus the last word. The frames were written to be as concise as possible (15 words or less) with simple syntactic structure (we avoided using embedded clauses) (see Table 2).

Procedure

All interactions with participants were carried out in English (L2). After informed consent procedures participants were tested in individual rooms and seated in front of a computer screen. They were instructed that they would be reading sentence frames presented on the computer screen. When they had read each frame they were to press a key on a button-box and the last word of the sentence would appear. Finally, a target word would be presented in all capital letters. They were asked to decide, as quickly and accurately as possible, whether the target word was related in meaning to the previously presented sentence. Participants were given 20 practice trials before starting the experimental trials.

Each trial was initiated by the presentation of a fixation point (+) in the center of the screen. This fixation remained on the screen until the participant pressed a key on the response box. The sentence frame was presented until the participant made another button press. After the button press the last word of each sentence (i.e., the prime word) was presented for 250 ms. After a one-second delay the target word was presented in all capital letters until the participant made a response or four seconds had elapsed. RT's were measured starting at the onset of the target word. Participants completed 160 trials (80 "no" trials and 80 "yes" trials). The study implemented a full within-subjects design and all participants saw all stimuli from the four conditions. Trials were randomly selected from each condition. After completing the computer task, participants completed a language history questionnaire in which they were asked to self-assess their proficiency in reading, writing, speaking and listening in English and Spanish on a ten-point scale. The entire experimental procedure was completed in approximately one hour.

Results and Discussion

Language history questionnaire data

The data from the language history questionnaires are summarized in Table 3. Participants reported acquiring Spanish earlier (2.0 years of age) than English (7.7 years of age), $t_1(24) = 3.98$, $p < .05$. On average, the participants assessed high proficiency in both Spanish (8.4) and English (8.9) (on a scale of 1 to 10) and the difference between these ratings was not significant, $t_1(24) = .97$, $p > .05$. Indeed, in bilingual communities such as El Paso it is not always clear which language should be designated as "L1" or "L2". Within the context of this study we use the labels "L1" and "L2" according to the relative timing of acquisition. Thus, the language acquired earlier is designated as L1 and L2 refers to the language acquired later on in life. Since participants in the present experiment acquired English somewhat later in life, around seven years of age, it is considered to be the L2.

Although the overall language ratings for Spanish and English were equivalent, there were differences among ratings of the individual skills. Participants rated their proficiency in Spanish lower than in English on reading, Spanish: 7.9, English: 9.1, $t_1(24) = 1.96$, $p = .06$, and writing, Spanish: 7.6, English: 9.0, $t_1(24) = 1.95$, $p = .06$. However, the ratings did not differ for either speaking, Spanish: 8.8, English: 8.7, $t_1(24) = -.21$, $p > .05$, or listening, Spanish: 9.0, English: 8.9, $t_1(24) = -.24$, $p > .05$. This pattern reflects the different contexts in which participants used their two languages. English was most often used in an academic setting while Spanish was primarily used with family and friends.

Table 3. Age of Acquisition and Self-Assessed Proficiency Ratings of the Spanish-English Bilingual Participants (n = 25)

	Spanish (L1)	**English (L2)**
Age of Acquisition (years)	2.0	7.7
Frequency of communication[b]	7.5	7.3
Self-Reported Ratings[b]		
Skill	**Spanish (L1)**	**English (L2)**
Reading	7.9	9.1
Writing	7.6	9.0
Speaking	8.8	8.7
Listening	9.0	8.9
Mean rating	**8.4**	**8.9**

[a] Based on a scale from 1 to 8

[b] Based on a scale from 1 to 10

Data treatment

Mean RTs for each participant for correct trials were calculated. RTs that were faster than 200 ms were counted as outliers and excluded from the analyses. This produced an exclusion rate of 3.0%. Any participant who had a greater than 40% error rate on either the completely unrelated trials or related trials was excluded. As mentioned above, this led to the exclusion of 4 participants. Statements of significance in this paper are based on F_1 (or t_1) analyses, treating participants as a random factor since critical and control items were matched for word frequency and length, on an item-by-item basis, and thus not selected randomly (see Raaijmakers, 2003; Raaijmakers, Schrijnemakers, & Gremmen, 1999).

Mean decision latency data

Overall, the average RT for "yes" trials was significantly faster (1272 ms) than "no" trials (1413 ms), $t_1(24) = 2.45$, $p < .05$. A two-way (ambiguity x cognate status) repeated measures ANOVA was performed on the participants' latency means across the four critical conditions. Neither the main effect of ambiguity of the prime word, $F_1(1, 24) = 0.2$ $MSE = 23{,}969.5$, $p > .05$, nor cognate status was significant, $F_1(1, 24) = 00.5$ $MSE = 19{,}081.3$, $p > .05$. However, the interaction between these two factors was significant, $F_1(1, 24) = 7.51$ $MSE = 46{,}748.1$, $p < .05$. As is evident in Figure 1, within the ambiguous prime word conditions participants were slower at rejecting target words when the primes were cognates relative to when they were noncognates. Conversely, within the unambiguous prime word conditions,

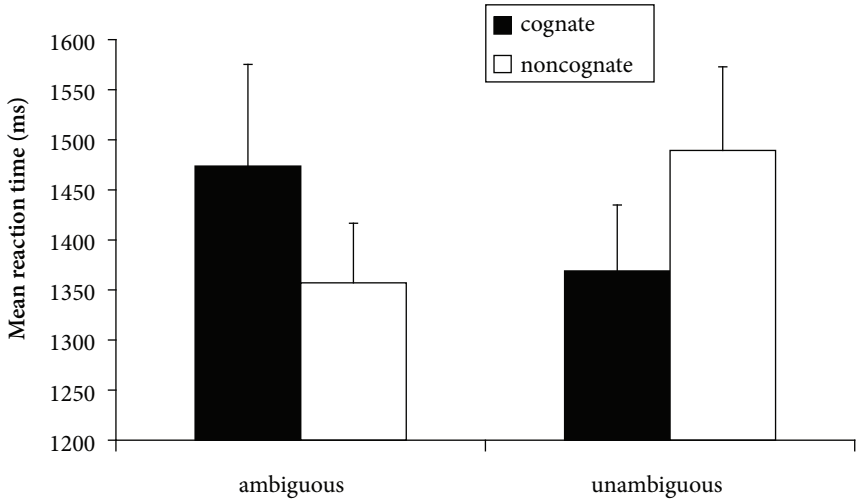

Figure 1. Mean RT by cognate and ambiguity status of prime word.

participants were faster in correctly rejecting targets when the prime word was a cognate. Follow-up paired *t*-tests performed with a Bonferroni correction indicated that, the cognate inhibition in the ambiguous conditions was not statistically reliable, $t_1(24) = 1.9$, $p > .05$, while the cognate facilitation within the unambiguous conditions was significant, $t_1(24) = 3.1$, $p < .05$. Overall the pattern of RT performance suggests that, when the dominant meaning was shared with the L1 there was greater competition than when this meaning existed only in the L2.

Mean percent error rate data

The mean percent error rates across the "yes" and "no" trials were quite similar (22.0% and 24.0% respectively) and did not differ significantly, $t(24) = 0.67$, $p > .05$. A two-way (ambiguity x cognate status) repeated measures ANOVA was performed on the participants' mean percent error rates for the critical "no" trials. The main effect of ambiguity was significant, $F_1(1, 24) = 17.1$ $MSE = 580.3$, $p < .05$, indicative of the higher error rates for trials in which the prime was ambiguous. The main effect of cognate status, on the other hand, was not statistically reliable, $F_1(1, 24) = 0.23$ $MSE = 79.4$, $p > .05$. These two factors were qualified by a significant, two-way interaction, $F_1(1, 24) = 7.5$ $MSE = 77.0$, $p < .05$. The nature of this interaction was similar to that observed in the RT analyses. As is evident in Figure 2, within the ambiguous prime word conditions, error rates were higher when the prime words were cognates relative to when they were noncognates. Conversely, within the unambiguous prime word conditions, cognate status was associated with a lower error rate. This pattern provides further evidence that when the contextually-irrelevant dominant meaning of an ambiguous word was shared with

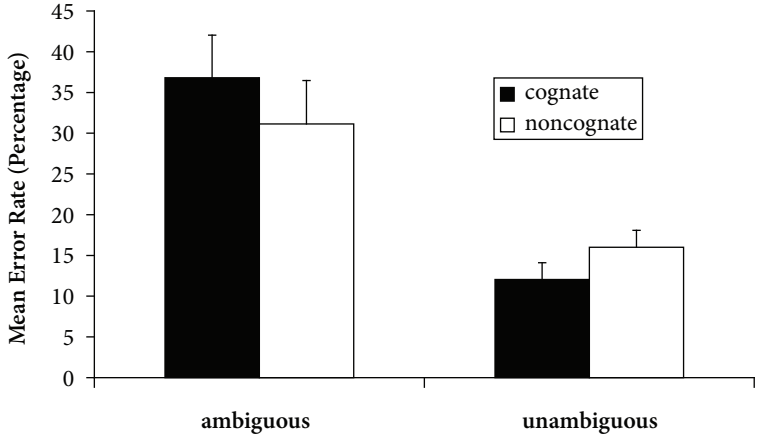

Figure 2. Mean percent error rate by cognate and ambiguity status of prime word.

the L1, the resulting lexical competition was greater relative to when that meaning was not shared with the L1. Follow-up paired *t*-tests performed with a Bonferroni correction indicated that the cognate inhibition in the ambiguous conditions was statistically reliable, $t_1(24) = 2.1$, $p < .05$, while the cognate facilitation within the unambiguous conditions was marginal, $t_1(24) = 1.7$ $p = .10$.

Overall, the findings support the hypothesis that the lexical representations of ambiguous words in an L2 are modified by lexical information from the L1. More specifically, when a specific meaning is shared across languages the relative weight or strength of its representation is increased.[1]

General Discussion

The goal of the present study was to examine whether cross-language activation of the native language would influence lexical disambiguation within the second language. We found that when bilinguals read sentences that biased the subordinate meanings of ambiguous L2 words (e.g., *novel*, *fast*), competition from the dominant meaning interfered with processing. More critically, this interference was greatest when the ambiguous word was a cognate and the dominant meaning was shared with the L1. This suggests that semantic representations from the L1 were coactivated during this exclusively L2 sentence processing task. The major implication from this study is that for bilinguals, the functional identifiability of words is influenced by cross-language lexical activation. Indeed, this added layer of competition might be partially responsible for the decreased L2 reading rates typically observed across levels of bilingual proficiency. Consequently bilinguals must develop robust lexical representations that can override the deleterious effects of both within- and across-language ambiguity.

The present findings add to the literature on lexical processing by extending existing theories of reading to bilinguals. For example, we observed a cross-language subordinate bias effect for cognates, thus extending the predictions of the re-ordered access model to bilingualism. Furthermore, the magnitude of the SBE was greater across languages than within languages. This is of particular importance since previous attempts to modulate the magnitude of the SBE have been largely unsuccessful (see Morris, 2006 for a review). These prior attempts have centered on decreasing the magnitude of the SBE by bolstering context, whereas in the present investigation we demonstrated that one can actually bolster the degree of competition, in spite of a rich sentential context. Future extensions of this work should more closely examine the time-line in which the semantic competition unfolds. More specifically, researchers should examine how the time-course varies depending on whether the competition is between or within languages.

The present study also extends the lexical quality hypothesis to L2 reading. In addition to observing a strong effect of lexical ambiguity in participant error rates, we also observed cognate facilitation when primes were unambiguous. It is likely that the underlying lexical representations of semantically-unambiguous cognates are of high quality due to the coherence of the lexical mappings across languages. When this coherence is at all compromised, however, the lexical quality of the underlying representation is affected. This in turn reduces the efficiency with which the lexical entry will be accessed.

In the present investigation lexical quality was reduced due to a lack of coherence at the semantic level specifically. However, lexical quality can be similarly affected by a lack of coherence at the orthographic of phonological level. For example, previous research on bilingual lexical access has demonstrated that recognition of cognates is delayed by a lack of coherence at the phonological level, due to differing and competing cross-language phonological representations of the cognate pair (Dijkstra et al., 1999; Schwartz et al., 2007). These phonological effects have been observed out of context and it is possible that when the lack of coherence is strictly at the form level (i.e., orthography and/or phonology) that the strong contextual support provided by a sentence in combination with coherence at the semantic level can override the potential deleterious effects of phonological and/or orthographic competition.

In conclusion, bilingual reading efficiency is affected at least in part by the functional identifiability of individual words. This identifiability is dynamic, and depends not only on the cross-language characteristics of a word (e.g., how closely representations cohere across languages) but also on the surrounding context. In order to capitalize on context and to avoid potential comprehension pitfalls, bilingual readers need robust lexical representations that can be quickly and efficiently accessed. A primary way to achieve such representations is through exposure to words in a variety of contexts, particularly contexts that instantiate less-frequently used meanings. In other words, there is no substitute for the single-best way to build vocabulary: rich and varied reading experiences. Ideally bilinguals should be exposed to cognates and all their different uses across a variety of contexts, and their attention should be drawn to the instances in which a cognate is being used in a less-typical fashion. Such exposure should be coupled with multiple opportunities with using the differing meanings of the cognate.

Of course, it is simply impossible to avoid activating contextually-irrelevant meanings of words. Indeed, the ability to access multiple meanings is one of the hallmarks of skilled reading and is necessary in order to eventually select the appropriate meaning. What all readers need to develop is efficiency in suppressing activated meanings that are not contextually-appropriate. Monolingual research has demonstrated that skilled readers are able to both quickly activate multiple,

potential meanings of words, and then efficiently suppress those meanings that are not relevant (Gernsbacher, 1997; Gernsbacher & Faust, 1991, 1995). Future studies should examine how bilingual readers develop their ability to suppress meanings and the pedagogical activities that can enhance suppression skill. One hypothesis is that any activity that forces the bilingual or language learner to alternately engage the different meanings of ambiguous words can reinforce suppression skill. Future studies should also examine whether suppression skill development is language dependent or independent. In other words, does the ability to efficiently suppress irrelevant meanings in one language necessarily translate into a similar ability in the other language? To what extent can highly proficient bilinguals continue to develop this skill? To what extent are individual differences in overall L2 reading speed attributable to the efficiency of accessing appropriate meanings of ambiguous words? Addressing such questions will allow the field to further our understanding of language representation while drawing direct implications for learning and teaching.

Note

1. This effect has recently been replicated in an on-going, follow-up study in our laboratory with a separate group of similar bilingual participants.

References

Altarriba, J., Kroll, J. F., Sholl, A., & Rayner, K. (1996). The influence of lexical and conceptual constraints on reading mixed-language sentences: Evidence from eye fixations and naming times. *Memory and Cognition, 24*(4), 477–492.

Beauvillain, C., & Grainger, J. (1987). Accessing interlexical homographs: Some limitations of a language-selective access. *Journal of Memory & Language, 26*(6), 658–672.

Brysbaert, M., Van Dyck, G., & Van de Poel, M. (1999). Visual word recognition in bilinguals: Evidence from masked phonological priming. *Journal of Experimental Psychology: Human Perception and Performance, 25*, 137–148.

de Groot, A. M. B., Borgwaldt, S., Bos, M., & van den Eijnden, E. (2002). Lexical decision and word naming in bilinguals: Language effects and task effects. *Journal of Memory and Language, 47*(1), 91–124.

de Groot, A. M. B., Delmaar, P., & Lupker, S. J. (2000). The processing of interlexical homographs in translation recognition and lexical decision: Support for non-selective access to bilingual memory. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 53A*(2), 397–428.

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., Timmermans, M., & Schriefers, H. (2000). On being blinded by your other language: Effects of task demands on interlingual homograph recognition. *Journal of Memory and Language, 42*(4), 445–464.

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., Kambe, G., & Rayner, K. (2001). The effect of prior disambiguating context on the comprehension of ambiguous words: Evidence from eye movements. In D. S. Gorfein (Ed.), *On the consequences of meaning selection: Perspectives on resolving lexical ambiguity. decade of behavior* (pp. 27–43). Washington, DC: American Psychological Association.

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.

Duyck, W., Assche, E. V., Drieghe, D., & Hartsuiker, R. J. (2007). Visual word recognition by bilinguals in a sentence context: Evidence for nonselective lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(4), 663–679.

Elston-Güttler, K. (2000). An enquiry into cross-language differences in lexical-conceptual relationships and their effect on L2 lexical processing. Unpublished dissertation, University of Cambridge, UK.

Elston-Güttler, K. E., Gunter, T. C., & Kotz, S. A. (2005). Zooming into L2: Global language context and adjustment affect processing of interlingual homographs in sentences. *Cognitive Brain Research, 25*(1), 57–70.

Elston-Güttler, K. E., Paulmann, S., & Kotz, S. A. (2005). Who's in control? proficiency and L1 influence on L2 processing. *Journal of Cognitive Neuroscience, 17*(10), 1593–1610.

Gernsbacher, M. A. (1997). Attenuating interference during comprehension: The role of suppression. In D. L. Medin (Ed.), *The psychology of learning and motivation: Advances in research and theory, vol. 37* (pp. 85–104). San Diego, CA: Academic Press.

Gernsbacher, M. A., & Faust, M. (1991). The role of suppression in sentence comprehension. In G. B. Simpson (Ed.), *Understanding word and sentence. advances in psychology, no. 77* (pp. 97–128). Oxford, England: North-Holland.

Gernsbacher, M. A., & Faust, M. (1995). Skilled suppression. In F. N. Dempster (Ed.), *Interference and inhibition in cognition* (pp. 295–327). San Diego, CA: Academic Press, Inc.

Hermans, D., Bongaerts, T., De Bot, K., & Schreuder, R. (1998). Producing words in a foreign language: Can speakers prevent interference from their first language? *Bilingualism: Language & Cognition, 1*(3), 213–229.

Kotz, S. A., & Elston-Güttler, K. (2004). The role of proficiency on processing categorical and associative information in the L2 as revealed by reaction times and event-related brain potentials. *Journal of Neurolinguistics*, *17*, 215–235.

Kucera, H., & Francis, W. H. (1967). *Computational analysis of present-day American English*. Providence, RI: Brown University.

Morris, R. K. (2006). Lexical processing and sentence context effects. In M. J. Traxler & M. A. Gernsbacher (Eds.), *Handbook of Psycholinguistics (2nd edition)* (pp 377–402). Amsterdam, The Netherlands: Elselevier.

Perfetti, C. A., & Hart, L. (2001). The lexical basis of comprehension skill. In D. S. Gorfein (Ed.), *On the consequences of meaning selection: Perspectives on resolving lexical ambiguity. decade of behavior* (pp. 67–86). Washington, DC: American Psychological Association.

Raaijmakers, J. G. W. (2003). A further look at the language-as-fixed-effect fallacy. *Canadian Journal of Experimental Psychology, 57*, 141–151.

Raaijmakers, J. G. W., Schrijnemakers, J. M. C & Gremmen, F. (1999). How to deal with "The language-as-fixed-effect fallacy": Common misconceptions and alternative solutions. *Journal of Memory and Language, 41*, 416–426.

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 & Language, 33*(4), 527–544.

Schwartz, A. I., & Fontes, A. 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., Kroll, J. F., & Diaz, M. (2007). Reading words in Spanish and English: Mapping orthography to phonology in two languages. *Language and Cognitive Processes, 22*, 106–129.

Sereno, S. C., O'Donnell, P. J., & Rayner, K. (2006). Eye movements and lexical ambiguity resolution: Investigating the subordinate-bias effect. *Journal of Experimental Psychology: Human Perception and Performance, 32*(2), 335–350.

Simpson, G. B., & Kreuger, M. A. (1991). Selective access of homograph meanings in sentence context. *Journal of Memory and Language, 30*(6), 627–643.

Spivey, M. J., & Marian, V. (1999). Cross talk between native and second languages: Partial activation of an irrelevant lexicon. *Psychological Science, 10*(3), 281–284.

Tabossi, P., & Zardon, F. (1993). Processing ambiguous words in context. *Journal of Memory and Language, 32*(3), 359–372.

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.

Van Hell, J. G., & de Groot, A. M. B. (in press). Sentence context modulates visual word recognition and translation in bilinguals. *Acta Psychologica.*

Von Studnitz, R. E., & Green, D. (2002). Interlingual homograph interference in german-english bilinguals: Its modulation and locus of control. *Bilingualism: Language and Cognition, 5*(1), 1–23.

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