Conklin, Kathy and Mauner, Gail (2005) Investigating bilingual lexical access: processing French-English homographs in sentential contexts. In: 4th International Symposium on Bilingualism (ISB4), 30 April-3 May 2003, Arizona State University, Tempe, Arizona, USA.

Investigating Bilingual Lexical Access: Processing French-English Homographs in Sentential Contexts

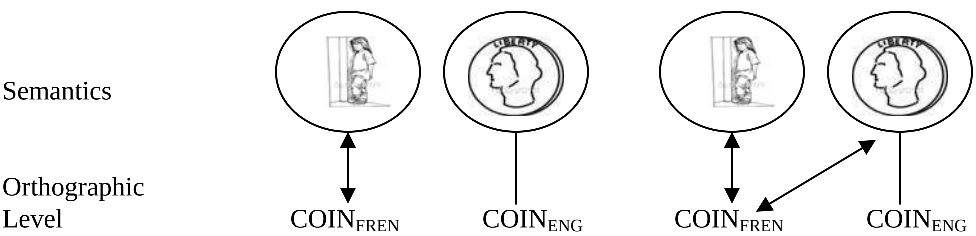
Kathy Conklin and Gail Mauner
The University at Buffalo, State University of New York

1. Introduction

1.1 General introduction

One controversy in bilingual language processing research is whether individuals who speak more than one language selectively activate or access lexical representations in a target language, that is the language they are currently using, or whether instead, they nonselectively activate lexical representations in both languages, regardless of the language currently in use. Much of the research focused on the issue of selective vs. nonselective lexical access has made use of interlingual homographs, words like *coin* that share the same spelling in two languages, in this case English and French, but differ in meaning. In English *coin* means "piece of money" while in French it means "corner". Language selective lexical access would entail activating only the meaning associated with the target language upon encountering an interlingual homograph like *coin* (e.g., Gerard & Scarborough, 1989; Macnamara & Kushnir, 1971). This possibility is illustrated in Figure 1(a), in which the orthographic string "coin" is read in French and activates only the "corner" meaning. In contrast, lexical access that is language nonselective would entail activating both the "corner" meaning associated with the word *coin* in French, and the "money" meaning associated with the English word *coin* (e.g., Altenberg & Cairns, 1983; Beauvillain & Grainger, 1987; Dijkstra & Van Heuven, 1998). This is illustrated in Figure 1(b).

Figure 1: Selective and nonselective lexical access of the homograph *coin* while reading in French
(a) Selective Lexical Access (b) Nonselective Lexical Access



The processing of homographs has also played an important role in investigating lexical access in monolingual speakers. The focus of these studies has been on whether readers and hearers initially access one or both meanings of a homograph when the homograph appears in a sentential context that is strongly biased toward one meaning. On the assumption that two meanings are accessed, a further issue has been to determine when the contextually appropriate meaning is selected (e.g., Onifer, & Swinney, 1981; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Swinney, 1979; Tabossi & Zardon, 1993; Tanenhaus, Leiman, & Seidenberg, 1979). Thus, instead of the language of use forming a processing context that might constrain access to the meanings of a homograph, the monolingual studies employ semantically biased sentential contexts to selectively constrain access to the meanings of intralingual homographs.

In this paper we present two studies that capitalize on the findings and experimental paradigms in the bilingual and monolingual lexical processing literatures by examining lexical access to interlingual homographs presented in biasing sentential contexts. In two experiments, English and French dominant bilinguals read French and English sentences that ended in an interlingual homograph, such as those illustrated in examples (1a) and (1b). Participants then made lexical decisions (i.e., word-nonword judgments) to a probe word that was semantically related to the meaning of the sentence-final interlingual homograph in the nontarget language. Probe words were always in the same language as the preceding context sentences. Lexical decision responses were compared to a baseline measure of responses made to probe words that were semantically unrelated to their context sentences, as illustrated in example (1c).

(1) a. In her wallet, Kim had a dollar bill and a coin. CORNER
b. Anne a garé sa grande voiture près du coin. MONNAIE
(translation: Anne parked her big car next to the corner. COIN)
c. Harold loves to eat a lot of cheese. FOLDER

The primary goal of these studies was to determine whether bilingual lexical access is language selective or nonselective in the context of reading sentences that strongly bias both language processing and meaning selection against nonselective access. If bilingual lexical access is truly nonselective, lexical decision times to target words following homograph sentences should be significantly different than lexical decision times to probe words that were semantically unrelated to their sentential contexts. In other words, a "yes" or word decision to *CORNER* following a sentence like (1a) should be significantly different than to *FOLDER* following a sentence like (1c). In contrast, if lexical access in language selective, than lexical decision times to *CORNER* and *FOLDER* should not differ.

1.2 Homograph processing in bilinguals

Investigations into whether individuals who speak more than one language selectively access meanings of interlingual homographs in just the language they are currently using or instead nonselectively access both meanings have yielded apparent mixed results. However, on balance, most of the research on bilingual activation of interlingual homographs favors non-selective access (e.g., Altenberg & Cairns, 1983; Beauvillain & Grainger, 1987; Dijkstra, De Bruijn, Schriefers, & Ten Brinke, 2000; Dijkstra & Van Heuven, 1998). In what follows we will review and reinterpret a select but representative sample of the findings that have been argued to support selective or nonselective lexical access in the processing of interlingual homographs.

Most studies investigating the processing of interlingual homographs have supported the hypothesis that bilingual lexical access is language nonselective. One apparent exception to this general trend is a study conducted by Gerard and Scarborough (1989), which examined lexical decisions to Spanish-English homographs, cognates, and nonhomographic noncognate control words. All three target word categories included both low and high frequency words in both English and Spanish. A crucial design feature in this study was that homograph frequency differed across languages. Thus, homographs that occurred with a low frequency in one language (e.g., Spanish) occurred with a high frequency in the other (e.g., English). Gerard and Scarborough found that lexical decision times to interlingual homographs were slower for low frequency homographs than for low frequency nonhomographs. This result was interpreted as evidence for selective activation under the assumption that if bilinguals had accessed both lexicons during homograph processing, then lexical decisions to low frequency homographs in a target language should have been aided by the concomitant activation of a high frequency counterpart in the nontarget language. However, their result is completely compatible with nonselective access.

A nonselective access explanation can be couched either in representational or performance criterial terms. In representational terms, inhibition could arise from incompatible meanings inhibiting each other, thereby slowing the activation necessary to make a word decision. Alternatively, incompatible meanings could send feedback to separate English and Spanish orthographic representations, which would, in turn, inhibit each other, thereby slowing lexical decision times. In performance terms, the activation of a nontarget meaning of an interlingual homograph in the context of making word decisions in a target language could only lead to a response conflict that would result in longer decision times. Specifically, readers have two activated representations, a target language lexical representation to which they are supposed to respond to as a word, and a nontarget language competitor representation to which they are supposed to respond to as a nonword. Resolving this conflict should result in longer response times, higher error rates or both. Greater conflict would be expected when the activation of the target language reading of the homograph is weaker than the activation of its nontarget language competitor. Little or no inhibition would be expected in single language task conditions when the activation of the target reading of a homograph is high relative to that of the competitor in the nontarget language.

Interestingly, Dijkstra, Van Jaarsveld and Ten Brinke's (1998) Experiment 1 failed to replicate Gerard and Scarborough's (1989) finding of longer decision times for low frequency homographs with high frequency nontarget homograph competitors compared to low frequency controls, or to low frequency homographs with low frequency nontarget competitors. This replication failure was attributed to the fact that participants were explicitly instructed to respond only to English words and were told that no exclusively Dutch words would be presented. More specifically, it was suggested that the activation of homograph competitors was rapidly suppressed when participants only had to make responses to words in the target language.

In a second study, the same list of Dutch-English homographs, fillers, and controls was augmented with Dutch filler words and participants were told that they were to make a nonword response to them. Dijkstra, et al. hypothesized that the inclusion of Dutch fillers would maintain the Dutch lexicon at a much higher level than in Experiment 1, thereby inducing inhibition effects for homographs. And indeed, inhibition effects were observed for both low and high frequency English homograph targets with high frequency Dutch homograph competitors. In a third experiment, participants were told to make a "word" response to strings that were words in either English or Dutch. In this study, word decisions to homographs were faster than decisions made to nonhomograph controls.

The results of these latter two studies by Dijkstra, et al. demonstrate that with the right task demands, nonselective lexical access can be observed in the processing of interlingual homographs either as inhibition or facilitation of lexical decisions relative to nonhomograph controls. But, these results still leave open the question of why Gerard and Scarborough observed inhibitory effects when none were observed in Dijkstra, et al.'s Experiment 1. We will take up this issue in detail shortly, but for now note that if low or suppressed activation of the nontarget language were the explanation for the null result in Experiment 1, then Gerard and Scarborough should also **not** have observed any inhibitory effects in their study.

De Groot, Delmar, and Lupker's (2000) Experiment 2 was a replication of Dijkstra, et al.'s first study, except that they also examined lexical decision times when L_1 was the target language. They hypothesized that Dijkstra, et al.'s null finding may have been due to some participants adopting a processing mode that was different from that of other participants. Although participants were supposed to judge letter strings as words only in the target language, some participants may have adopted a looser criterion in which they made a "word" decision if a string was a word in either the target or the nontarget language. For those adopting the stricter criterion, inhibition would be expected if lexical access is nonselective, as Dijkstra, et al. observed in their second study. For those adopting the laxer criterion, facilitation would be expected if lexical access is nonselective, just as Gerard and Scarbourough originally conjectured. According to DeGroot, et al., null differences may arise when a significant number of participants do not adopt the same decision criterion and as a consequence, facilitory and inhibitory responses cancel each other out.

De Groot, et al. found no differences in decision times for interlingual homographs relative to control words when responses were made to English targets (L_2), replicating Dijkstra, et al.'s first study. But, surprisingly, they found that decision times were significantly slower to low frequency Dutch homographs with high frequency English homograph competitors compared to frequency matched Dutch control words when responses were made to Dutch targets (L_1). De Groot, et al. noted that only 40% of the participants in the English (L_2) target condition appeared to have adopted the stricter criterion in comparison to 70% of the participants in the Dutch (L_1) target condition, and suggested that this supported their contention that null results may be due to differences in decision criteria across participants. But it is hard to know what to make of these reported differences since it is not known whether, for each participant, the classification into a lax or strict criterion categories was based on whether homograph decision times were just numerically greater or smaller than control word decision times, which could be due to the vagaries of chance, or instead, on whether, for each participant, homograph decision times were always significantly greater or smaller than control word decision times. While it is possible that, as DeGroot, et al. suggest, participants differed in their task compliance, this has yet to be clearly demonstrated. Moreover, we think that there may be a simpler explanation for the pattern of results observed in the three studies we have reviewed in detail, that does not appeal to differences in either task or participant characteristics.

Table 1 presents the log frequencies for high and low frequency readings of interlingual homographs in English, which always corresponds to the nondominant language in these experiments, and in Spanish or Dutch, which corresponds to the dominant language. The cells in the English (L_2) target language condition represent the conditions that were similar across Gerard and Scarborough, Dijkistra, et al., and De Groot, et al.'s studies. We will focus on these first. Recall that, when English was the target language in these three studies, only Gerard and Scarborough observed significantly longer decision times for interlingual homographs relative to frequency-matched controls. Moreover, this difference was observed only when the low frequency reading was English and the high frequency reading was Spanish. Our alternative explanation for the failures to replicate Gerard and Scarborough lies in the differences in the relative frequencies of homographs in the target (L_2) language, which was always English, and the nontarget (L_1) languages which were either Spanish or Dutch. An inspection of the high minus low differences in log frequencies in Table 1 reveals a much larger difference for the homographs used by Gerard and Scarborough than either Dijkstra, et al. or De Groot, et al. It is likely that Gerard and Scarborough observed interference effects in interlingual homographs because the log frequencies of their low frequency readings were much lower and the log frequencies of their high frequency readings were much higher than their counterparts in the other studies.

An explanation for the significant inhibition De Groot, et al. observed for homographs with low frequency Dutch and high frequency English readings when Dutch was the target language and the L_1 but no inhibition for these same homographs when English was the target language can also easily be explained by differences in the relative frequencies of these readings. Inhibition was observed here, but not in the other conditions in De Groot, et al.'s study because it was the only condition in which the nontarget language competitor reading had a very high mean log frequency, one approaching the high log frequency values used by Gerard and Scarborough. That is, this was the only condition in which activation of a nontarget language competitor was high enough to slow word decisions to a low frequency probe in the target language, which was also the L_1 for participants.

To summarize thus far, all the studies we have reviewed that have examined the processing interlingual homographs, even those that have yielded apparent selective language results, are compatible with nonselective lexical access, given certain assumptions about differences in the log frequencies of the two readings of an interlingual homograph. Specifically, when a nontarget language competitor has a log frequency that is sufficiently higher than the log frequency of the target language reading, inhibition should result. Note that this conclusion in no way diminishes Dijkstra et al.'s demonstrations from Experiments 2 and 3 that task and materials variables can have a significant impact on whether evidence for nonselective access is observed in the processing of interlingual homographs. They have clearly demonstrated that it is possible to increase the sensitivity of the lexical decision task to lexical representations in a nontarget language by altering task and materials variables so that word decisions become either more or less discriminating. De Groot, et al.'s conjecture that obtaining evidence for nonselective access may depend on participant variables, while very interesting, awaits further statistical verification.

Beauvillain and Grainger's (1987) Experiment 2 examined lexical decisions made to target words that were related to either the French or English reading of a homograph prime, or to a target word that was unrelated to either meaning. The frequencies of the two readings of homographs were always unbalanced. That is, a high frequency reading in one language always had a low frequency counterpart in the other language. Prime and target words could either be in the same or different languages. Beauvillain and Grainger found that interlingual homographs primed semantically related targets in both languages, but only when the semantically related probe word was of high frequency. This result is consonant with the findings favoring nonselective access that we have reviewed above, showing that evidence for nonselective access can be obtained in both straight lexical decision tasks and in priming paradigms. In addition, in their first study, Beauvillain and Grainger found, that the nontarget language reading of an interlingual homograph primed a semantically related probe word, but only when the stimulus onset asynchrony (SOA) between prime and probe was less than 750 ms. As we will discuss shortly, this accords well with homograph priming findings in the monolingual literature.

Table 1. Mean log frequencies for L_1 and L_2 homograph readings when the L_1 or L_2 targets were Spanish-English or Dutch-English homographs. Also shown are differences in high-frequency and low-frequency readings of homographs used in Gerard & Scarborough (1989), Dijkstra, et al. (1998), and DeGroot, et al. (2000).[1] An asterisk (*) indicates $p < .05$, while NS indicates $p > .05$.

Condition		Experiment: Gerard & Scarbourough	Experiment: Dijkstra, et al. Experiment 1	Experiment: DeGroot, et al. Experiment 2
Target Lang.	Homograph Freq.	Log Freq.	Log Freq.	Log Freq.
L2/ English	HF-S/D	2.28	1.75	1.91
	LF-E	.08	1.0	1.11
	H-L Diff	2.2*	.69 NS	.80 NS
	HF-E	2.61	1.98	2.23
	LF-S/D	.62	.71	1.04
	H-L Diff	1.99 NS	1.27 NS	1.19 NS
L1/ Dutch	HF-D	--	--	1.91
	LF-E	--	--	1.11
	H-L Diff	--	--	.80 NS
	HF-E	--	--	2.23
	LF-D	--	--	1.04
	H-L Diff	--	--	1.19*

To summarize, most if not all of the research to date on bilingual processing of interlingual homographs supports the view that bilingual lexical access is language nonselective. However, these findings depend on a number a variables which have been found to be important in lexical decision tasks. Among these variables, the relative frequencies of the two meanings of interlingual homographs has emerged as an important determinant of whether lexical access appears to be selective or nonselective. Materials variables, such as whether words are presented in just one or both of a bilingual's languages, and task variables, such as whether or not participants are to ignore words in one of their languages, have also been shown to influence the outcomes of studies involving the processing of interlingual homographs, most likely by shifting decision criteria and/or biasing processing to a language selective or language nonselective mode. Time course, as measured by SOA, is also an important determinant of whether evidence for language nonselectivity will be observed. It is important to observe language processing before the activation of contextually irrelevant meanings are inhibited or before they decay. Participant variables are also important. Participants in all of the studies we have reviewed were relatively balanced bilinguals. When language proficiency is more disparate, it is likely that evidence for nonselective access will be more difficult to observe unless the difference in the relative frequencies of a homograph's readings is quite large and decision criteria are strongly biased. It is also possible that differences in participant variables may influence experimental outcomes if some participants tend to adopt strict decision criteria while others tend to adopt lax decision criteria.

While the research to date strongly favors a language nonselective view of bilingual lexical access, all of the reviewed findings have been obtained by examining the processing of single words or word pairs. Whether this presents an accurate picture of bilingual lexical access under more natural language processing situations, for instance, while processing sentences for comprehension, where the language of use and the semantic context might be expected to exert a particularly strong influence is not yet known. This is the question we address in our studies. But before turning to these studies, we

[1] The values for Dijkstra, et al. homographs were estimated by averaging the sample log frequencies in their Appendix provided for a subset of homographs in each condition (6/14 items).

will briefly discuss some findings on the processing of monolingual homographs on which our studies are partially based.

1.3 Homograph processing in monolinguals

In seminal studies by Swinney (1979) and Tanenhaus, Leiman, & Seidenberg, (1979), participants listened to context sentences containing a monolingual homograph like *bug* and made a lexical decision or named visually presented letter strings at two different probe positions either directly following the homograph or a few syllables later (Swinney, 1979), or at 0 or 200 msec after a sentence-final homograph (Tanenhaus, et al., 1979). Crucially, the frequency of occurrence of the two meanings of the homographs was relatively balanced, while the context sentences were strongly biased toward just one of the homograph's meanings, as illustrated by the example in Table 2 from Swinney's study.

Table 2. Contextually biased contexts with early and late probe positions (indicated with underscoring) and contextually appropriate, inappropriate and unrelated probe words from Swinney (1979).

Auditory Context Sentence	Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other bugs __ in the corner ___ of his room.		
Type of Probe Word	Contextually Appropriate	Contextually Inappropriate	Contextually Unrelated
	ANT	SPY	SEW

In both studies, priming for both meanings of intralingual homographs were observed at the early probe position or shorter SOA. But, at the later probe position or longer SOA, only the contextually appropriate meaning was facilitated. That is, when the probe word was encountered shortly after a homograph like *bug*, both the "espionage" and "insect" meanings were facilitated relative to decision times to an unrelated probe like *sew*. But when the probe word was encountered as little as 200 ms after the homograph, responses to only the contextually relevant meaning were facilitated. Since this original finding, a large literature on the immediate automatic semantic activation of multiple meanings of homographs in a sentential context has developed (e.g., Onifer, & Swinney, 1981; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982).

More recently, these findings were qualified by Tabossi and her colleagues (Tabossi, 1988; Tabossi, Colombo, & Job, 1987; Tabossi & Zardon, 1993). Tabossi and Zardon showed that both dominance (the relative frequency with which the meanings of a homograph occur) and context affect the activation of multiple meanings of homographs. In sentential contexts that were biased to the subordinate meaning of a homograph, lexical decisions to both words related to the dominant and subordinate meanings of the homograph were facilitated relative to unrelated controls. However, when the sentential context was biased toward the dominant meaning, only lexical decisions for words associated with the dominant meaning were facilitated. This finding suggests that activation is mediated by both sentential context and the frequency with which each meaning of a homograph occurs.

The results from intralingual homograph studies by Swinney, and by Tanenhaus, et al., taken together with the findings on the processing of interlingual homographs, suggest that regardless of whether a word is a homograph within a language or across languages, both meanings are initially accessed. When the results of the bilingual homograph studies we have reviewed are considered in light of Tabossi and her colleagues' findings, it appears that whether context exerts an influence on access to the two meanings of interlingual homographs may depend on their relative frequencies or dominance and strength of context. The current experiments on the processing of interlingual homographs are modeled, in part, on these intralingual homograph studies.

2. Experiment 1

Although most research to date on interlingual homographs supports the view that lexical access is language non-selective, this support has come from studies involving the processing of single words or word pairs. Whether bilingual lexical access appears nonselective under more natural language processing conditions such as when bilinguals are reading sentences containing homographs for comprehension is as yet unknown. In this experiment we examined whether French-English homographs appearing at the end of French and English semantically biasing sentences would activate both homograph meanings, even though only the reading that was consonant with the target language (i.e., the language the sentence was written in) was appropriate given the meaning of the sentence.

We presented French and English dominant bilinguals with French and English sentences containing sentence-final homographs, such as sentences (a) and (b) in Table 3 or non-homographs, such as sentences (c) and (d), also in Table 3. Each sentence was followed by a target word to which participants made a lexical decision. Target words following homograph sentences were always a translation of the homograph reading in the nontarget language. Thus, for the English sentence in (a) which ended in the interlingual homograph *coin*, meaning "type of money" in English, the target word was the translation of the French reading of *coin*, namely *corner.* If lexical access is language selective, then lexical decision times for target words corresponding to the meanings of interlingual homographs in a nontarget language should not significantly differ from that of control probe words following nonhomographs. Predictions for language nonselectivity are more complex, since either facilitation or inhibition of decision times to homograph probes relative to control probes is possible. If bilingual lexical access of homographs exactly parallels monolingual access of intralingual homographs, then decision times to probes following homographs should be facilitated. However, we have also seen that forcing bilinguals to make lexical decisions to words in mixed language lists leads to increased inhibition of decision times to interlingual homographs. Although participants do not make decisions on homographs in this study, bilingual language processing may be more generally characterized by a constant suppression of the language not currently in use. This, may in part, account for observations of processing costs in language switching (e.g. Macnamara & Kushnir, 1971; Soares & Grosjean, 1984). Thus, on the hypothesis that bilinguals have to suppress language irrelevant meanings when speaking or comprehending one of their languages, it is also possible that responses to probe words that are related to the language irrelevant meaning of a homograph would be suppressed, resulting in slower lexical decision times.

Table 3. English and French context sentences with sentence-homograph prime words (underlined), and corresponding English and French target words. Targets on homograph trails correspond to homograph meaning in non-target language.

English and French Context Sentences	Target Type
Homograph Trials	**Nontarget Meaning**
a. In her wallet, Kim had a dollar bill and a <u>coin</u>.	corner
b. Anne a garé sa grande voiture près du <u>coin</u>.	monnaie
(Anne parked her big car next to the corner.)	(coin)
Non-Homograph Unrelated Control Trials	**Unrelated**
c. Harold loves to eat a lot of <u>cheese</u>.	folder
d. Allez cherchez nos affaires dans la <u>cuisine</u>.	malade
(Go get our things from the kitchen.)	(sick)

2.1 Methods
2.1.1 Participants

Ten English dominant and one French dominant graduate student at the University at Buffalo participated in this study. The English dominant participants were students in M.A. or Ph.D. programs in French. The native French speaker obtained her B.A., and was pursuing an M.A. in Spanish at the University at Buffalo. Thus, while L_2 proficiency was not evaluated for any of the participants the fact that all were doing post-graduate work on theirr L_2 or in their L_2 suggests a reasonably high level of fluency in their second language. All of the participants volunteered to take part in the experiment without remuneration.

2.1.2 Design and materials

The materials included 36 interlingual homographs or near homographs[2], which were used to construct pairs of sentences in English and French. Each sentence pair contained the same homograph in sentence-final position, as is illustrated by the sentences (a) and (b) in Table 3. The sentences were not controlled for length. Each participant saw 18 homograph sentences in English and French, but only one sentence from each pair. Twenty English and 20 French sentences like those in (c) and (d) in Table 3 respectively, were constructed as nonhomograph controls. An additional 40 English and 40 French sentences were constructed to be followed by nonword control words.

Each of the 36 interlingual homographs was paired with two target words, one in English and one in French. These target words corresponded to the translation of the homograph in French and English (i.e.. French - *coin* was translated into English *corner*, and English *coin* was translated into French *monnaie*). The translations in each language were provided by the Larousse *Dictionnaire Moderne Français-Anglais* (DuBois, 1960). None of the 40 nonhomograph control words had any relation to their preceding context sentences. Crucially, target words were always in the same language as their context sentences. Eighty nonwords were created by replacing one letter of a common French or English word (i.e. *mark* to *marb*, or *lampe* to *lamse*). All nonwords were formed from words in the language of the preceding context sentence and were very word-like in that language.

The primary concern when selecting target words for lexical decision following a sentence-final homograph was that the word be a good translation of the meaning of the homograph in the other language. Because frequency has been shown to play a role in accessing the meanings of homographs, homograph frequency was taken into account by using the Francis and Kucera corpus (1982) for English and the *Frequency Dictionary for French* (Juilland, Brodin, Davidovitch, 1970).[3] Interlingual homographs with too low a frequency of occurrence in French were not used because they might not be known by some of our participants. Additionally, because the length of words and nonwords influences lexical decision times, target words and nonwords were matched for length. All ranged in length from 3 to 10 letters and there was no significant difference in mean lengths of targets in either English or French, p's > .05.

Although we did not select our interlingual homographs on the basis of the frequency of their two readings, we provide this data to facilitate comparisons with previous studies. High frequency readings are defined as those whose log frequencies were above the median log frequency for English or French, while low frequency readings were those that fell below the median for English or French. These high and low log frequencies for the French and English readings of our homographs are shown in Table 4. The difference between a homograph reading in one language and its competitor reading in the other language was always significant except in the case of a low frequency English homographs. Low frequency English homographs did not have strong high frequency French competitors.

The homograph sentences pairs were counterbalanced across two presentation lists such that each participant saw only one pair member. In this way every homograph was tested in both languages, although by different participants. Sentences containing interlingual homographs were pseudo-randomly mixed with sentences containing unrelated words and nonwords such that no two

---

[2] Several of the stimuli were near homographs for example, *cart* in English and *carte* in French "map". A study by Lukatela and Turvey (1991) indicated that pseudo-words like *tabyle*, which were homophones of real words, could serve as primes for words like *chair*. These results indicate that a French word like *carte* can serve as a prime for *map*, and that an English word like *cart* can serve as a prime for *caddie* (in French “shopping cart”).
[3] The log frequency was calculated using the following formula: $\log_{10}$(raw frequency). In addition, because raw frequencies in the *Frequency Dictionary for French* were based on a corpus of 500,000 words while in the Francis and Kucera corpus they were based on 1,000,000 words, the raw frequencies of words in the *Frequency Dictionary for French* were multiplied by 2 before calculating the log frequency so that comparisons would be on equivalent scales.

experimental items appeared successively. Each presentation list contained an equal number of English and French sentences.

Table 4. Mean log frequencies for homographs and their competitors when homographs are high and low frequency in French and English. Also indicated are differences between targets and competitors' frequency readings. An asterisk (*) indicates $p < .05$, while NS indicates $p > .05$.

Homograph Freq.	Log Freq.
HF-F	2.1
English Competitor	1.7
Difference and Significance	.4*
LF-F	.9
English Competitor	1.4
Difference and Significance	.5*
HF-E	2.1
French Competitor	1.8
Difference and Significance	.3*
LF-E	.9
French Competitor	1.3
Difference and Significance	$.4^{NS}$

2.1.3 Procedure

Each trial was presented on a black and white Macintosh computer screen. A Macintosh Hypercard program was written to present sentences and their following targets for lexical decision, and to record responses and response times in centiseconds.[4] Participants were first presented with a sentence and used a mouse to click on a "continue" button, which appeared on the screen, when they had completed reading the sentence. After clicking "continue", a word or non-word appeared on the screen along with "yes" and "no" buttons. The "yes" and "no" buttons were always in English (even for the French participant) and always appeared in the same position on the screen. The participants used the mouse to click on the "yes" button if the target was a word and on the "no" it was not. After making the lexical decision, a screen appeared with a "continue" button, which the participants clicked when they were ready to continue to the next trial. Participants were asked to center the mouse at this time, so that the mouse would be equidistant from the “yes” and “no” buttons during the next lexical decision task.

Participants were instructed to read each sentence as quickly as possible without sacrificing comprehension, because they would be tested on their understanding of the sentences during the course of the experiment. Participants were told that after reading a sentence and clicking the “continue” button a string of letters would appear on the screen with "yes" and "no" buttons. They were told to click on the "yes" button if the string of letters was a word and on the “no” button if it was not. They were instructed to make the word/non-word decision as quickly as possible without sacrificing accuracy. Participants were not told that there was any relation between the sentences and the words that would follow them, nor were they told anything about the language sentences would be in.

Before the experiment began, participants were given 12 practice trials to familiarize them with the experimental procedure and apparatus. In the practice trial, six of the lexical decision tasks were on words and six were on nonwords. None of the practice trials involved a homograph. At the midpoint of the experimental session, participants were given a sentence recognition test containing 10 sentences. This test was constructed to ensure that participants were reading the on-line sentences attentively. Participants were asked to indicate whether any of the 10 sentences had appeared in the on-line

[4] Due to the nature of the Hypercard program the interstimulus interval (ISI) between the context sentence and probe word could not be manipulated or recorded. It varied randomly from 20 – 200 msec for any given trial.

experiment. If participants thought a sentence had appeared during the experiment, they were asked to indicate whether it had appeared in the same language or in translation. Five sentences in the test had appeared in the experiment. Of the five that had not appeared, two contained the other member of the homograph sentence pair, which was semantically very different from the sentence that had appeared in the on-line experiment. The other three sentences that had not appeared had no semantic relation to the sentences that appeared during the on-line experiment. Following the experimental session, participants were given a questionnaire to determine if they had noticed any relationship between the context sentences and target words.

2.2 Results

We first report on the results of the sentence recognition test and questionnaire. On the recognition test all of the participants responded that at least one of the two sentences containing a homograph had appeared or that its translation had appeared in the on-line experiment, when in fact they had not. Recall that the sentences containing a homograph in the reading verification had no semantic relation to the sentence that had been read in the on-line task nor were they translations of what had appeared. Participants falsely believed that they had read the sentences or translations of the sentences containing a homograph. This is interesting in light of Potter and Lombardi's (1990) finding that readers may not actually remember sentences verbatim, but instead reconstruct them on the basis of conceptual information associated with lexical items. For the remaining eight sentences in the recognition task, the error rate was 4.2%. This indicates that the participants had read the on-line sentences attentively.

The questionnaire, which was given following the experiment, assessed whether participants had noticed any relationship between the sentences they read and the words which followed in the lexical decision task. Of the 10 participants tested, 7 thought that the purpose of the target words was to deflect their attention from the sentences read on the computer. They stated that the lexical decision task interfered with their ability to decide whether they had read the sentences or their translations in the on-line study. Two participants said that they noticed that some of the words in the experiment were words in both French and English. Further questioning revealed that these participants did not think that these words were the focus of the experiment. Their data for homograph trials did not differ from that of other participants.

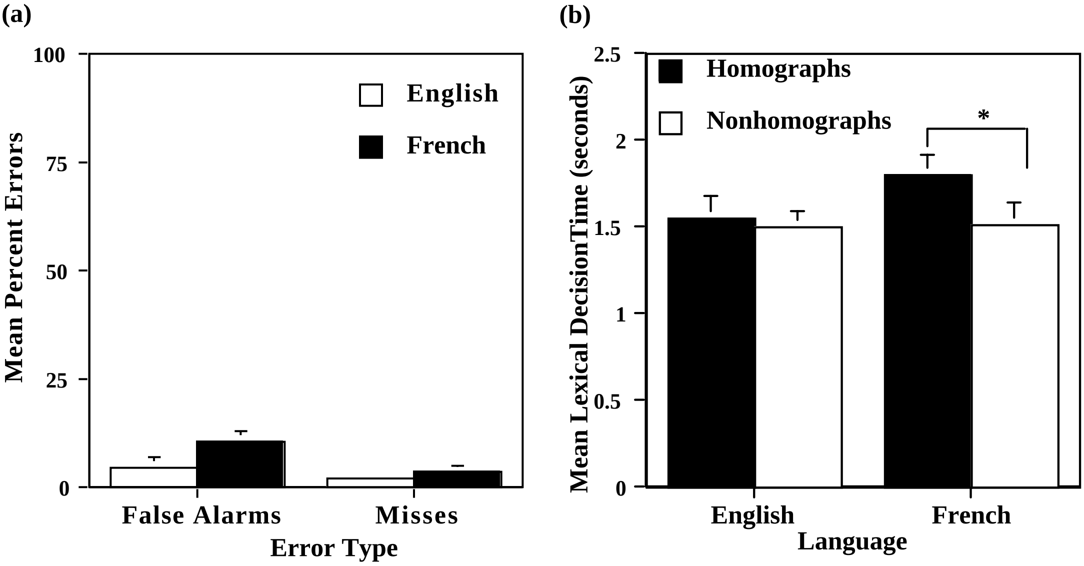
Error rates were computed separately for each of the nine English dominant participants in English and French for words and nonwords.[5] Overall, there were very few errors. On average, participants made word responses to nonwords and nonword responses to words on 5.4% of trials. We also separately examined errors in terms of false alarms (making a word response to a nonword) and misses (making a nonword response to a word) for both English and French trials. Percentages of misses and false alarms for French and English trials are presented in Figure 2(a). Participants produced misses on 2.4 and 3.6 percent of English and French trials respectively. Participants produced false alarms on 4.7 and 10.8 percent of the trials in English and French, respectively. The generally low rate of misses in both French and English suggests that our target words were part of both the French and English vocabularies of our participants.

Error data were submitted to a 2(language) x 2(error type: false alarm vs. miss) Analysis of Variance (ANOVA) with just participants as a random factor.[6] There were more errors when French was the target language, $F_1(1, 8) = 7.2$, $p < .05$, and summing across language, there were more false alarms than misses $F_1(1, 8) = 5.5$, $p < .05$. These main effects are qualified by a significant Language type Error type interaction, $F_1(1, 8) = 11.5$, $p < .05$. To further explore this interaction, we conducted a series of planned comparisons. There were significantly more false alarms than misses in both French, $F_1(1, 8) = 49.6$, $p < .05$, and English, $F_1(1, 8) = 5.1$, $p < .05$, indicating that participants were more likely to falsely recognize nonwords as words than reject words as nonwords regardless of language. Moreover, this tendency was more pronounced in French as participants were more likely to make a

[5] The data from our one French dominant participant was not analyzed statistically. We report descriptive data for this participant only.
[6] These are fairly low error rates, so one must be cautious when interpreting their statistical significance. Because error rates were so low, nothing meaningful could be gained by an items analysis.

word response to a French nonword than to an English nonword, $F_1(1, 8) = 35.9$, $p < .05$. The greater occurrence of false alarms in French indicates that participants were more willing to say unfamiliar targets were words when they were orthographically legal strings in French than in English.

Figure 2. (a) Mean percent of false alarms and misses following French and English trials; (b) Mean lexical decision time in seconds with significant differences indicated by an asterisk (*).



Before computing mean decision times for each participant, we excluded decision times for trials with errors. We also excluded data for three stimulus sentence pairs and their yoked nonhomograph word and nonword control sentences due to spelling errors. Finally, any response greater than 7 seconds was excluded, after which, for each participant outliers beyond 2.5 standard deviations of the mean were replaced by a boundary value of the mean plus or minus 2.5 standard deviations (this outlier procedure affected less than 1% of the data). After outlier exclusion, we computed the mean decision times for each participant in each of the six conditions. Mean decision times for the crucial comparisons between French and English homograph and nonhomograph trials are illustrated in Figure 2(b).

We submitted these mean lexical decision times to a series of ANOVAs with either participants or items as random variables. In all analyses, list was a between participants or between items dummy factor (see Pollatsek & Well, 1995) while language and word type were within participant and within items variables. We first submitted these data to a 2(list) x 2(language) x 2(word type: word vs. nonword) ANOVA to examine whether responses to words and nonwords differed from each other or differed across languages. Not surprisingly, regardless of language, word decisions were faster than nonword decisions by participants, $F_1(1,8) = 12.6$, $p < .05$, and by items, $F_2(1,33) = 27.7$, $p < .05$. Planned comparisons showed that this overall pattern was significant when responses were made only in English, $F_1(1,8) = 31.5$, $p < .05$; $F_2(1, 33) = 3.8$, $p < .05$, or only in French, $F_1(1,8) = 32.1$, $p < .05$; $F_2(1, 33) = 21.4$, $p < .05$. Participants were also faster in making both word and nonword decisions in English in analyses by participants, L1, $F_1(1,8) = 7.2$, $p < .05$, and by items, $F_2(1, 33) = 10.4$, $p < .05$. However, the interaction between language and word type was not significant by participants, $F<1$, and only trended in the analysis by items, $F_2(1,33) = 3.5$, $p < .07$.

Data for French and English homograph and nonhomograph trials were also submitted to two 2(list) x 2(language) x 2(word type: homograph vs. nonhomograph) ANOVAs, again with either participants or items as random variables. Again, responses to words following homographs and nonhomographs in English were faster than responses made in French, but only in the analysis by participants, $F_1(1,8) = 18.8$, $p < .05$; $F_2(1, 33) < 1$. Regardless of response language, decision times to words following homographs were slower than decision times to words following nonhomographs, $F_1(1,8) = 44.2$, $p < .05$; $F_2(1, 33) = 5.2$, $p < .05$, when either participants or items were random.

However, the interpretation of these main effects is modulated by a significant Language by Word type interaction, $F_1(1,8) = 5.0$, $p < .05$; $F_2(1, 33) = 10.5$, $p < .05$, in both analyses.

To explore this interaction further, we conducted a series of planned comparison. On trials in which responses were made to English targets, decision times to targets following homographs and nonhomographs did not differ, $F_{1\&2} <1$. In contrast, decision times to targets following homographs in French sentences were significantly longer than decision times to targets following nonhomographs by participants, $F_1(1, 16) = 15.9$, $p < .05$, and by items, $F_2(1, 33) = 18.4$, $p < .05$. Finally, decision times to words following homographs in French sentences were longer than words following the same homographs in English sentences, $F_1(1, 8) = 11.3$, $p < .05$, $F_2(1, 33) = 8.4$, $p < .05$. This latter difference cannot be attributed to faster response times for English words overall given that responses to words following French and English sentences ending in nonhomographs did not differ from each other, $F_1< 1$; $F_2(1, 33) = 2.9$, $p = .1$.

2.3 Discussion

Experiment 1 examined whether bilingual lexical access is nonselective when reading sentences, which arguably constitutes a more natural language processing situation than reading words or pairs of words in isolation. We hypothesized that sentential contexts might serve to strongly constrain the interpretation of homographs to only their contextually and language appropriate meaning because that is what must be accessed for each sentence to be understood. However, the results of our study indicate that semantically constraining sentential contexts do not restrict the interpretation of interlingual homographs. Responses to targets following sentence-final homographs in French but not English sentences were longer than to targets following nonhomograph control sentences. Although we could not statistically analyze the data obtained from our one French dominant participant, numerically, she produced longer decision times to targets on homograph trials than nonhomograph trials when homographs appeared in English sentences, the reverse of pattern observed in our English dominant participants. The finding of longer decision times on homograph than nonhomograph trials clearly supports the hypothesis that bilingual lexical access is language nonselective. Note that it is unlikely that the language asymmetry is due to more target words being unknown in French than English for English dominant participants for two reasons. First, this would not explain the difference between homograph and nonhomograph trials. Second, error rates for target words in both languages were quite low, less than 5%. We defer providing a detailed explanation of the asymmetry in responses to targets following homographs in English and French, which were the dominant and nondominant languages of our participants respectively.

Although these results confirm the hypothesis of nonselective bilingual lexical access, they must be viewed with caution. This is because participants used a mouse to make lexical decision responses. This may have contributed to the somewhat longer than usual lexical decision times in this study. This is a concern because longer responses make it more likely that these results could have been due to post-lexical rather than lexical processes. For this reason we conducted a second study in which responses were collected from the keyboard rather a mouse click. A second goal of this study was to follow-up on the interesting finding in the sentence recognition task. It revealed that all participants falsely believed that at least one and often both of the sentences containing a homograph or its translation had appeared in the on-line experiment. This result is potentially interesting given Potter and Lombardi's (1990) finding that so-called verbatim memory for sentences may instead be reconstructive and based on conceptual level information activated by lexical items. It suggests the possibility that false recognition of sentences containing an interlingual homograph is not constrained by the language in which a sentence was encountered and may be based on conceptual level information. However, there were only two homograph sentences in the recognition test—too few to draw strong conclusions from. Thus, in our second experiment we increased the number of homograph sentences in the sentence recognition task.

3. Experiment 2

This study is a replication of Experiment 1. Thus its primary goal is to determine whether bilingual lexical access is nonselective when bilinguals read sentences containing interlingual homographs. This experiment differs from Experiment 1 in two ways. First, responses were collected from a keyboard rather than a mouse. This should reduce lexical decision times, thereby decreasing the likelihood that any differences in homograph processing can be attributed to post-lexical rather than lexical processes. Our second goal was to further explore whether previously encountered interlingual homographs in a target language sentence are likely to lead to false recognition of nontarget language sentences in which the homograph takes on a different meaning by increasing the number of unseen homograph sentences with interlingual homographs in the sentence recognition test.

3.1 Methods

3.1.1 Participants

Eleven students, none of whom had participated before, from the University at Buffalo took part in this study. Ten were English dominant. Four of these participants were undergraduates completing their last year of a French major. All four had spent at least one month in France. Five English dominant participants were pursuing graduate degrees in French and one other was pursuing a graduate degree in linguistics and had spent a year in France. Our one French dominant participant was pursuing a Ph.D. in French. In comparison to the participants from Experiment 1, the French proficiency of these participants was more variable because some were undergraduates who had had less training in and exposure to French. No testing was done to evaluate the level of proficiency in either of the participants' languages. However, the low number of errors in the on-line experiment indicates that most, if not all of our target words in both languages were known by all participants. All of the participants volunteered to take part in the experiment without remuneration.

3.1.2 Design and materials

The materials were the same as those from Experiment 1, except the three experimental items with spelling errors in Experiment 1 were corrected. An expanded sentence recognition test was created to further explore whether participants, when presented sentences containing a homograph in a sentence they had not seen, would falsely believe that they had read these sentences or their translations. It was composed of 20 sentences, ten of which had appeared in the experiment. Of the ten sentences that had not been encountered in the first half of the experiment, six were sentences containing a homograph that had appeared, but in a sentence in the other language and with a very different meaning. The other four sentences that had not appeared had no semantic relation to previously read sentences.

3.1.3 Procedure

With the exception of collecting responses from a keyboard rather than a mouse and a longer sentence recognition test, the procedure was identical to that of Experiment 1. Participants used the option key for "yes" and the apple key for "no", to respond whether or not the string of letters was a word or nonword. They used their left and right index fingers to press the keys. The option key was covered with tape marked "yes" and the apple key covered with tape marked "no". A press of the "shift" key when participants had completed reading a sentence caused the context sentence to disappear and the target word or nonword to appear on the screen. After completing the lexical decision task the next sentence appeared on the screen.

3.2 Results

As before, the results from the reading verification task were taken as an indication that participants had engaged in reading the on-line sentences. The reading verification task was comprised of 20 sentences. Ten of these had occurred in the experiment and ten had not. Of the ten which had not appeared, six of those were the other member of a homograph sentence pair. These sentences had no semantic relationship to the sentences which were seen during the on-line experiment. The only similarity between the two was the presence of an interlingual homograph in sentence final position. For 67% of the sentences containing a homograph, participants erroneously said that they had seen it or its translation during the on-line experiment. For the other sentences on the verification task the error rate was 3.5%. The low error rate on the other sentences was taken as an indication that participants had been reading the sentences attentively.

The questionnaire, given after the completion of the on-line experiment showed that none of the participants noticed that any of the experimental items contained homographs. All 11 of the participants thought a relationship existed between the sentences they had read and the sentences which appeared on the reading verification task. Most participants believed the experiment was designed to test their ability to remember sentences in French and English.

Error rates were computed separately for each of the ten English dominant participants in English and French for words and nonwords.[7] Overall, there were very few errors. On average, participants made word responses to nonwords and nonword responses to words on 5.1% of trials. More specifically, participants missed on .3 and 6.5 percent of English and French trials respectively, and false alarmed on 1.9 and 11.5 percent of the trials in English and French, respectively. Percentages of misses and false alarms for French and English trials are presented in Figure 3(a). The generally low rate of misses in both French and English suggests that our probe words were part of both French and English vocabularies of our participants.

Error data were submitted to a 2(language) x 2(error type: false alarm vs. miss) ANOVA with just participants as a random factor.[8] There were more errors when French was the target language, $F_1(1, 9) = 21.3$, $p < .05$. False alarms did not differ from misses $F_1(1, 9) = 1.6$, $p = .2$. Language and error type did not interact, $F_1(1, 9) =.7$, $p = .4$. Although, we did not find an interaction between language and error type we conducted a series of planned comparisons in order to compare the results of Experiments 2 with those of Experiment1. There were not significantly more false alarms than misses in either French, $F_1(1, 9) = 3.1$, $p = .1$, or English $F_1(1, 9) = .3$, $p = .6$. Participants were more likely to make a word response to nonwords in French than English $F_1(1, 9) = 11.2$, $p < .05$, but were only marginally more likely to make a nonword response to a word in French than in English, $F_1(1, 9) = 4.6$, $p = .06$ and were. The greater occurrence of false alarms in French suggests that participants were more willing to say unfamiliar nonwords were words when they were orthographically legal strings in French than in English.

Before computing mean decision times for each participant, we excluded decision times for trials with errors. Any response greater than 7 seconds was excluded, after which, for each participant decision times beyond 2.5 standard deviations of the mean were replaced by a boundary value of the mean plus or minus 2.5 standard deviations (this represented less than 1% of the data). After outlier exclusion, we computed the mean decision times for each participant in each of the six conditions. Mean decision times for the crucial comparisons between French and English homograph and nonhomograph trials are illustrated in Figure 3(b).

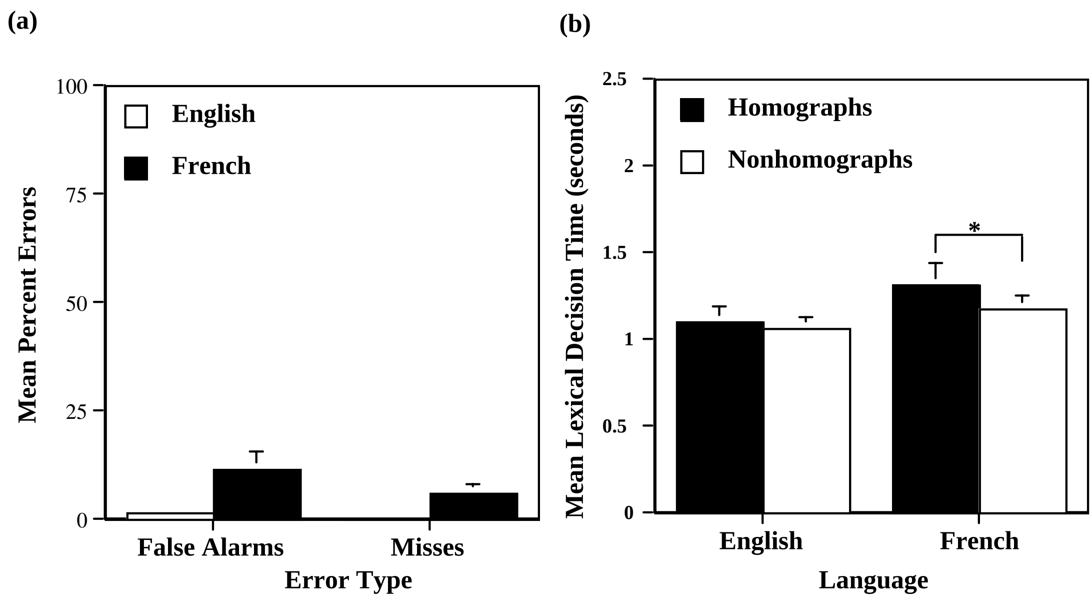
We submitted the mean lexical decision times to a series of ANOVAs in which either participants or items were random variables. In all analyses, list was a between participants or between items dummy factor while language and word type were within participant and within items variables. We first submitted these data to a 2(list) x 2(language) x 2(word type: word vs. nonword) ANOVA to examine whether responses to words and nonwords differed from each other or differed across languages. Not surprisingly, regardless of language, word decisions were faster than nonword decisions by participants, $F_1(1, 9) = 17.8$, $p < .05$, and by items $F_2(1, 34) = 17.1$, $p < .05$. Planned comparisons showed that this overall pattern was significant when responses were made only in English, $F_1(1, 9) = 13.8$, $p < .05$; $F_2(1, 34) = 13.6$, $p < .05$, or only in French, $F_1(1, 9) = 36.6$, $p < .05$;

[7] The data from the one French dominant participant was not used in any of the analyses not analyzed statistically. We report descriptive data for this participant only.

[8] These are fairly low error rates, so one must be cautious when interpreting their statistical significance. Because error rates were so low, nothing meaningful could be gained by an items analysis.

$F_2(1, 34) = 7.1$, $p < .05$. Participants were also faster in making both word and nonword decisions in English by participants, $F_1(1, 9) = 24.9$, $p < .05$, and by items $F_2(1, 34) = 26.4$, $p < .05$. However, the interaction between language and word type was not significant by participants or items, $F_1(1, 9) = 2.7$, $p = .1$; $F_2(1, 34) = .5$, $p < .5$.

Figure 3. (a) Mean percent of false alarms and misses following French and English trials; (b) Mean reaction time in seconds with significant differences indicated by an asterisk (*).



Data for French and English homograph and nonhomograph trials were also submitted to two 2(list) x 2(language) x 2(word type: homograph vs. nonhomograph) ANOVAs, again with either participants or items as random variables. Responses to words following homographs and nonhomographs in English were faster than responses made in French by participants, $F_1(1, 9) = 14.1$, $p < .05$, and by items $F_2(1, 34) = 16.4$, $p < .05$. Regardless of response language, decision times to words following homographs were marginally slower than decision times to words following nonhomographs by participants, $F_1(1, 9) = 3.6$, $p = .09$, but significantly slower by items $F_2(1, 34) = 4.2$, $p < .05$. The interaction between language and word type was not significant, $F_{1\&2} = .3$, in either analysis.

Although, the interaction was not significant we conducted a series of planned comparison so that the results of Experiment 2 could be compared with those of Experiment 1. On trials in which responses were made to English targets, decision times to targets following homographs and nonhomographs did not differ, $F_{1\&2} <1$. In contrast, decision times to targets following homographs in French sentences were significantly longer than decision times to targets following nonhomographs by participants, $F_1(1, 9) = 4.6$, $p = .06$, and by items $F_2(1, 34) = 5.4$, $p < .05$. Finally, decision times to words following homographs in French sentences were longer than words following the same homographs in English sentences, $F_1(1, 9) = 10.0$, $p < .05$; $F_2(1, 34) = 14.2$, $p < .05$. This latter difference cannot be attributed to faster response times for English words overall given that responses to words following French and English sentences ending in nonhomographs did not differ from each other, $F_{1\&2} > .05$.

3.3 Discussion

The goal of Experiment 2 was to replicate the results of Experiment 1 with a different group of participants when responses were collected from a keyboard rather than a mouse click. We expected this change to result in faster overall lexical decision times, which would lessen the likelihood that differences in decision times on homograph and nonhomograph trials could be due to post-lexical processes. As the mean lexical decision times to targets following sentence-final homographs and nonhomographs in Figure 3(b) illustrate, word decision times were on average about a half a second faster than word responses in Experiment 1. Nonword decision times were also faster. Mean nonword decision times were 1.90 and 1.30 secs in Experiments 1 and 2 respectively.

The results of this study replicate those of Experiment 1. Lexical decision times for target words are longer following sentence-final interlingual homographs than following sentence-final nonhomographs, but only when the interlingual homograph is processed in the are bilingual reader's nondominant language. A similar numeric difference was observed in for English target words for our French dominant participant. Importantly, differences were observed even when overall response times were half a second faster, making it somewhat less likely that our original result was due to processing occurring after lexical access[9]. As in Experiment 1, the low error rates in this experiment suggest that these results cannot be attributed to target words in the nondominant language not being in the vocabularies of our participants.

Our second goal was to determine whether, on a sentence recognition test with a greater number of sentences with interlingual homographs, bilinguals would continue to falsely recognize sentences with interlingual homographs at high rates. With a larger (but admittedly still relatively small number of homograph sentences), on average bilingual participants falsely recognized sentences they had not encountered when they contained a previously encountered interlingual homograph 67% of the time.

4. General discussion

We began this set of studies with the goal of finding out whether lexical access in bilinguals would look language selective or nonselective under processing circumstances that were both more naturalistic and more semantically constraining than which is typically the case in bilingual lexical access studies. In both of our studies, we found evidence for nonselective access. Decision times were longer to target words expressing the meaning of a homograph in the nontarget language when they followed sentences ending in an interlingual homograph, than when they followed sentences that did not end in a homograph and bore no semantic relationship to the words in the context sentence. However, this inhibition effect was only observed when English-dominant bilingual participants were reading sentences and making lexical decisions in their nondominant language. This pattern of results was echoed in the numeric differences found in the data for our two French dominant participants.

Our data present us with two interesting asymmetries that require explanation. First, why were inhibition effects observed only when participants were processing in their nondominant language? Second, why did we observe inhibition effects while in very similar studies involving intralingual homographs, facilitation effects have been repeatedly observed? We will take up these issues in turn.

Drawing from the literature on the processing of interlingual homographs, and on current models of bilingual lexical access, we can speculate as to why inhibition was found only when our participants were reading sentences and making word decisions about words in their nondominant language. As we observed in our discussion of the literature on interlingual homographs, inhibition effects, when they are observed, tend to be language asymmetric. But we further noted that this language asymmetry may be due to differences in the relative frequencies of the L_1 and L_2 readings of an interlingual homograph. Inhibition has been observed when the homograph reading in the target language is of much lower log frequency than the homograph reading in the nontarget language. Of course, comparisons of log frequencies may either over or underestimate the differences in the strength of the two readings of an interlingual homograph for individual participants, because it does not take into account degree of language proficiency in L_2. Presumably, if the differences in the strengths of the two readings of an interlingual homograph could be equated across L_1 and L_2, one would find evidence for nonselective access when bilinguals are processing in either L_1 or L_2. We did not select our intralingual homographs with the intention of creating strong cross-language competitors with respect to the log frequencies of the French and English readings. Note that our interlingual homographs were selected so that the average log frequencies of the French and English readings would be equivalent. Thus if, as we suspect, our results were driven by differences in the relative strengths of the French and

[9] The lexical decision task in known to be sensitive to both lexical and post-lexical processes.

English readings of our interlingual homographs, these differences are most likely best stated in terms of subjective frequencies (as Gerard and Scarborough also measure) rather than actual log frequencies. In the future, we will be examining this possibility.

Our studies were very closely modeled on homograph studies from the monolingual word recognition literature. In this light, it is interesting to speculate about why we observed inhibition effects with interlingual homographs when studies involving lexical decisions to target words following sentences with intralingual homographs have repeatedly observed that both meanings of a homograph are initially facilitated relative to an unrelated control word. We suspect that this difference may arise out of the necessity for bilinguals to suppress activation of lexical representations in one of their languages to efficiently process in their other. In fact, inhibition of the kind we have observed has been predicted by bilingual versions of interactive activation models of lexical access, where the primary addition to the monlingual versions of these models is some way of suppressing the activation of the lexical representations of one language when activating lexical representations in the other, fore example by language nodes (Dijkstra & van Heuven, 1998). To account for the language asymmetries in the processing of interlingual homographs that we and others have observed, it may be necessary to modify these models so that subjective rather than actual log frequencies are used as metrics of activation strength as was suggested by Dijkstra and Van Heuven (2002).

We conclude by noting some limitations in the current studies, and how they are being addressed in ongoing and planned research and some implications of the current work. Some clear limitations of the current studies were that decision times were collected in centiseconds rather than milliseconds, making our decision times were more variable than they would have been if responses had been collected from input devices with millisecond accuracy, our timing was not synchronized with the raster display, and our ISI was not equal across trials. While our decision times are clearly blurred by these factors, these factors in no way diminish our basic finding since they served only to add variability to all of the responses we collected. Thus, the fact that we observed and replicated an inhibition effect with relatively few participants in our two studies speaks to the robustness of our findings. A second potential limitation in the current studies is that our interlingual homographs were balanced in terms of the log frequencies of the two readings. It is clear that various relationships in the log frequency, and possibly subjective frequency, of the two readings of interlingual homographs need to be more fully explored. We are pursuing this in ongoing research. A third factor that may have influenced our results, especially in Expeirment 2, is that the proficiency of our bilingual participants in their L_2 varied quite a bit. When circumstances make it difficult to find balanced bilinguals, it may be that experimental designs that use degree of language proficiency as a predictor may be more appropriate for examining bilingual lexical access. Although we failed to find an effect of context on the processing of our homographs, it may be that our sentence contexts were not as constraining as those used by Tabossi and her colleagues. If such constraining contexts can be constructed and context effects obtained for high frequency readings of interlingual homographs, then one interesting possibility to be explored is that bilingual lexical access might not be either selective or nonselective. Rather, it might best be characterized in terms of the nature of the lexical items that are being processed and the contexts they occur in, and the conditions under which they are being processed. In other words, it may be that the utility of the selective-nonselective access dichotomy, while important for the research it has stimulated, may have run its course and may be replaced by a view of bilingual lexical access in which lexical, contextual, and criterial factors flexibly interact to either facilitate or inhibit access to lexical representations in both of a bilingual's languages. Finally, the results of our sentence recognition test, especially in Experiment 2 points the way to some interesting explorations of bilingual sentence memory which we will also be following up on.

References

Altenberg, Evelyn, & Cairns, Helen. (1983). The effects of phonotactic constraints on lexical processing in bilingual and monolingual participants. *Journal of Verbal Learning and Verbal Behavior, 22*, 174-188.

Beauvillain, Cécile, & Grainger, Jonathan. (1987). Accessing interlexical homographs: Some limitations of a language-selective access. *Journal of Memory and Language, 26*, 658-672.

De Groot, Annette, Delmaar, Philip, & Lupker, Stephen. (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*, *53,* 397-428.

Dijkstra, Ton, De Bruin, Ellen, Schriefers, Herbert, & Ten Brinke, Sjoerd. (2000). More on interlingual homograph recognition: Language intermixing versus explicitness of instruction. *Bilingualism: Language and Cognition, 3,* 69-78.

Dijkstra, Ton, & Van Heuven, Walter. (1998). The BIA model and bilingual word recognition. In J. Grainger and A. Jacobs (Eds). *Localist connectionist approaches to human cognition*. Hilsdale, NJ: Lawrence Erlbaum Associates. 189-225.

Dijkstra, Ton, & Van Heuven, Walter. (2002). The architecture of the bilingual word recognition system: From identification to decision. *Bilingualism: Language and Cognition, 5*, 175-197.

Dijkstra, Ton, Van Jaarsveld, Henk, & Ten Brinke, Sjoerd. (1998). Interlingual homograph recognition: Effects of task demands and language intermixing. *Bilingualism: Language and Cognition, 1*, 51-66.

Dubois, Marguerite-Marie. (1960). *Dictionnaire Moderne: Français-Anglais*. Paris: Librairie Larousse.

Francis, W., & Kucera, Henry. (1982). *Frequency Analysis of English Usage: Lexicon and Grammar*. Boston: Houghton Mifflin Company

Gerard, Linda, & Scarborough, Don. (1989). Language-specific lexical access of homographs by bilinguals. *Journal of Experimental Psychology: Learning, Memory and Cognition, 15*, 305-313.

Juilland, Alphonse, Brodin, Dorothy, & Davidovitch, Catherine. (1970). *Frequency Dictionary of French Words*. Paris: Mouton.

Lukatela, Georgije, & Turvey, M.T. (1991). Phonological access of the lexicon: Evidence from associative priming with pseudohomophones. *Journal of Experimental Psychology: Human Perception and Performance, 17*, 951-956.

Macnamara, John, & Kushnir, Seymor. (1971). Linguistic independence in bilinguals: The input switch. *Journal of Verbal Learning and Behavior, 10*, 480-487.

Onifer, William, & Swinney, David. (1981). Acxessing lexical ambiguity durign sentence comprehension: Effects of frequency of meaning and contextual bias*. Memory and Cognition, 9,* 225-236.

Pollatsek, Alexander & Well, Arnold D. (1995). On the use of counterbalanced designs in cognitive research: A suggestion for a better and more powerful analysis. *Journal of Experimental Psychology: Learning, Memory, & Cognition. 21, 785-794.*

Potter, Mary, & Lombardi, Linda. (1990). Regeneration in the short-term recall of sentences. *Journal of Memory and Language, 29*, 633-654.

Seidenberg, Mark, Tanenhaus, Michael, Leiman, James, & Bienkowski, M. (1982). Automatic access of the meanings of ambiguous words in context: Some limitations of knowledge-based processing. *Cognitive Psychology, 14*, 489-537.

Soares, Carlos, & Grosjean, François. (1984). Bilinguals in a monolingual and bilingual speech mode: The effect on lexical access. *Memory and Cognition, 12*, 380-386.

Swinney, David. (1979). Lexical access during sentence comprehension: (Re)consideration of context effects. *Journal of Verbal Learning and Behavior, 18*, 645-659.

Tabossi, Patrizia. (1988). Accessing lexical ambiguity in different types of sentential context. *Journal of Memory and Language, 27*, 324-340.

Tabossi, Patrizia, Colombo, L., & Job, R. (1987). Accessing lexical ambiguity: Effects of context and dominance. *Psychological Research, 49*, 161-167.

Tabossi, Patrizia, & Zardon, Francesco. (1993). Processing ambiguous words in context. *Journal of Memory and Langauge, 32*, 359-372.

Tanenhaus, Michael, Leiman, James, & Seidenberg, Mark. (1979). Evidence for multiple stages in the processing of ambiguous words in syntactic contexts*. Journal of Verbal Learning and Verbal Behavior, 18*, 427-440.

ISB4: Proceedings of the 4th International Symposium on Bilingualism

edited by James Cohen, Kara T. McAlister, Kellie Rolstad, and Jeff MacSwan

Cascadilla Press Somerville, MA 2005

Copyright information

ISBN 978-1-57473-210-8 CD-ROM
ISBN 978-1-57473-107-1 library binding (5-volume set)

Ordering information

To order a copy of the proceedings, contact:

Cascadilla Press
P.O. Box 440355
Somerville, MA 02144, USA

phone: 1-617-776-2370
fax: 1-617-776-2271
sales@cascadilla.com
www.cascadilla.com

Web access and citation information

This paper is available from www.cascadilla.com/isb4.html and is identical
to the version published by Cascadilla Press on CD-ROM and in library binding.