BILINGUAL ACCESS TO INTERLINGUAL HOMOGRAPHS: AN EXAMINATION OF EFFECTS OF SENTENTIAL CONTEXT, WORD FREQUENCY, AND PROFICIENCY

by

Kathryn Colleen Conklin

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ABSTRACT

Support for the exhaustive activation of multiple meanings of interlingual homographs like *coin* (meaning money in English and corner in French) comes primarily from studies presenting homographs in isolation (e.g., Beauvillain & Grainger, 1987; Dijkstra & Van Heuven, 1998; De Groot et al., 2000). I investigated whether exhaustive activation occurs when interlingual homographs are presented in sentential contexts. My studies examine the influence of word frequency and sentence context, which have been shown to influence the activation of multiple meanings of lexically ambiguous words in monolingual studies (e.g., Tabossi, 1988; Duffy et al. 1988; Martin et al. 1999).

I investigated the role of sentence context (Experiment 1), language of processing (Experiment 2), word frequency (Experiments 3-4), and proficiency (Experiments 3-4) on exhaustive activation of interlingual homographs. French-English bilinguals made lexical decisions to homograph translations (e.g., "corner" for *coin*) or control words following sentences ending in interlingual homographs. Experiment 1 showed slower lexical decisions to homograph translations relative to control words following neutral sentences but not following sentences strongly supporting only one homograph meaning, when processing was in L2 English. Experiment 2 revealed slower lexical decisions to homograph translations relative to control words following sentences in a second language (L2), but not a first language (L1). In Experiments 3-4, lexical decisions to L2 homograph translations were slower following homographs having a high L1 frequency (e.g., French *coin* 129 occurrences in a million) than following homographs having a low L1 frequency (e.g., French *four* 10 occurrences in a million).

These results show that lexical access is exhaustive, but that it is constrained by sentential context and influenced by L1 word frequency. Asymmetrical inhibition effects are hypothesized to be due to weaker representation of L2 words which permits more strongly represented L1 meanings to be activated more quickly and influence processing. These results parallel those in the monolingual literature and indicate that processing in L2 is subject to the same mechanisms as L1. These findings can be explained in terms of the Bilingual Interactive Activation+ Model (Dijkstra & Van Heuven, 2002) and the Context Sensitive Model (e.g., Martin et al. 1999).

CHAPTER 1

1 Introduction

1.1 General Introduction

Because over half of the world's population speaks more than one language, research on bilingual word (lexical) representation and processing is essential.[1] An important issue in bilingual research is the extent to which one language influences processing in the other language. A central question is whether lexical representations from the two languages of a bilingual are processed independently from each other or concomitantly. For example, when English-French bilinguals are reading in their second language (L2) French, are only French language representations activated? Or is it the case that when reading in their L2, both French and English word representations activated? If language representations from both languages are activated when processing in one language, a further question is to what degree these representations interact. To illustrate, consider the situation in which a native English speaker reads the French newspaper headline *On a encore trouvé deux bras 'Two arms were found again'* and encounters the letter string <bras> which corresponds to words in both French and English. Is only the language-appropriate interpretation 'arm' activated, or is the English interpretation 'women's undergarments' also activated? Does the English interpretation of the letter string <bras> influence processing in French? Does an English-French bilingual consider the possibility that the story described by the French headline is about finding women's undergarments, as illustrated by Figure 1? Or instead, is it the case that

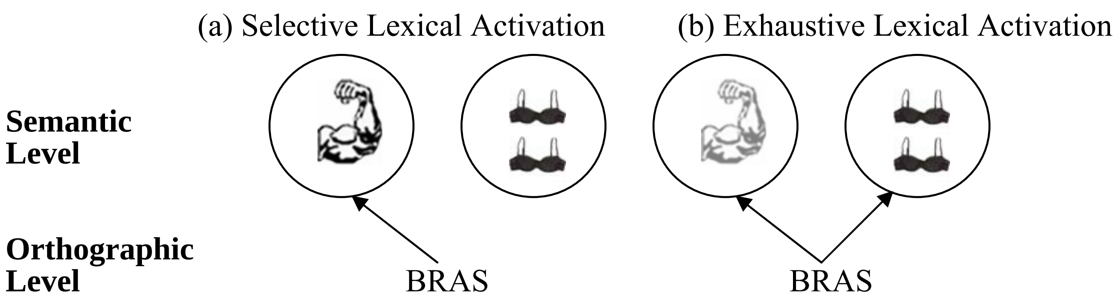
[1] In the bilingualism literature, the term *bilingual* is used by researchers to refer to very different populations. In this dissertation the term *bilingual* will be used to refer to people who speak two languages and use both of them on a regular basis (for a discussion of classifying bilinguals and use of the term see, Grosjean, 1982; Wölck, 1988). When discussing particular groups of bilingual participants, more specific details of their language background and proficiency will be provided.

because the bilingual is reading in French, that only the French meaning of the string <bras> is activated? Activation of the English interpretation of the letter string <bras> while reading in French, as illustrated in Figure 1, should have serious processing repercussions for bilinguals. Therefore, understanding the conditions under which lexical representations from one language influence processing in another is important.

Figure 1. A representation of the activation of English lexical-semantic information 'woman's undergarments' associated with the letter string <bras> while reading the L2 French headline *"On a encore trouvé deux bras" 'Two arms were found again'*.

Investigations of whether bilingual lexical activation is influenced by both the language of current processing and the language not being processed in, have made use of interlingual homographs. Interlingual homographs are words like *bras* that share the same orthography in two languages, in this case English and French, but which differ in both meaning (e.g., *bras* means 'arm' in French and 'woman's undergarments' in English) and in pronunciation (e.g., *bras* is pronounced /bra/ in French and /braz/ in English). Because interlingual homographs have identical orthography but differing semantics and phonology, they provide a unique opportunity for investigating whether lexical-semantic activation is influenced by both the language of processing and the other language.[2] If only information associated with the language of processing is activated upon encountering an interlingual homograph like *bras*, then only the meaning associated with the language currently in use will be activated. This possibility is illustrated in Figure 2(a), in which the orthographic string <bras> is read while processing in French and the meaning ‘arm’ is selectively activated (henceforth referred to as language selective activation). In contrast, if information associated with both the language of processing and the other language is activated upon encountering an interlingual homograph like *bras*, then both meanings will be activated. This possibility is illustrated in Figure 2(b), in which the orthographic string <bras> is read while processing in French and both the ‘arm’ and ‘women’s undergarment’ meanings associated with the letter string are exhaustively activated (henceforth referred to as exhaustive activation).

Figure 2. A representation of (a) selective and (b) exhaustive lexical-semantic activation of information associated with the interlingual homograph *bras* while reading in French. Arrows indicate the flow of activation.



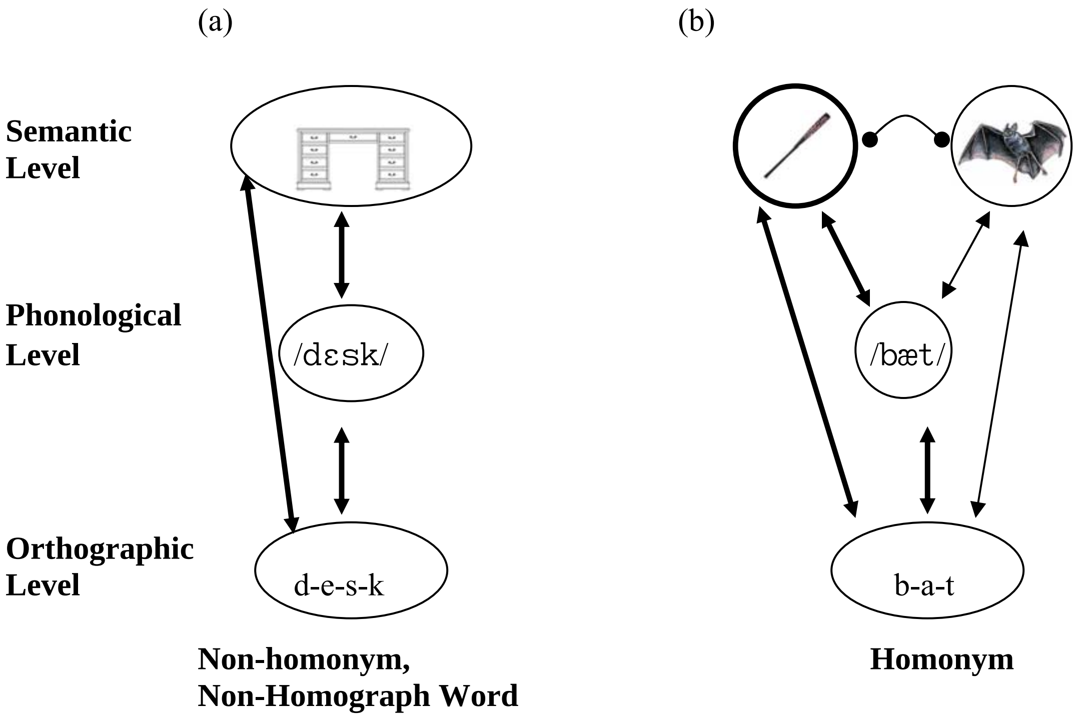
[2] For some English-French interlingual homographs there is not complete overlap in orthography due to the presence of accent marks in French. In the current studies there is only one interlingual homograph in which there is a difference in orthography due to an accent mark in French. (i.e., *pièce* ‘play’ in French and *piece* ‘part’ in English).

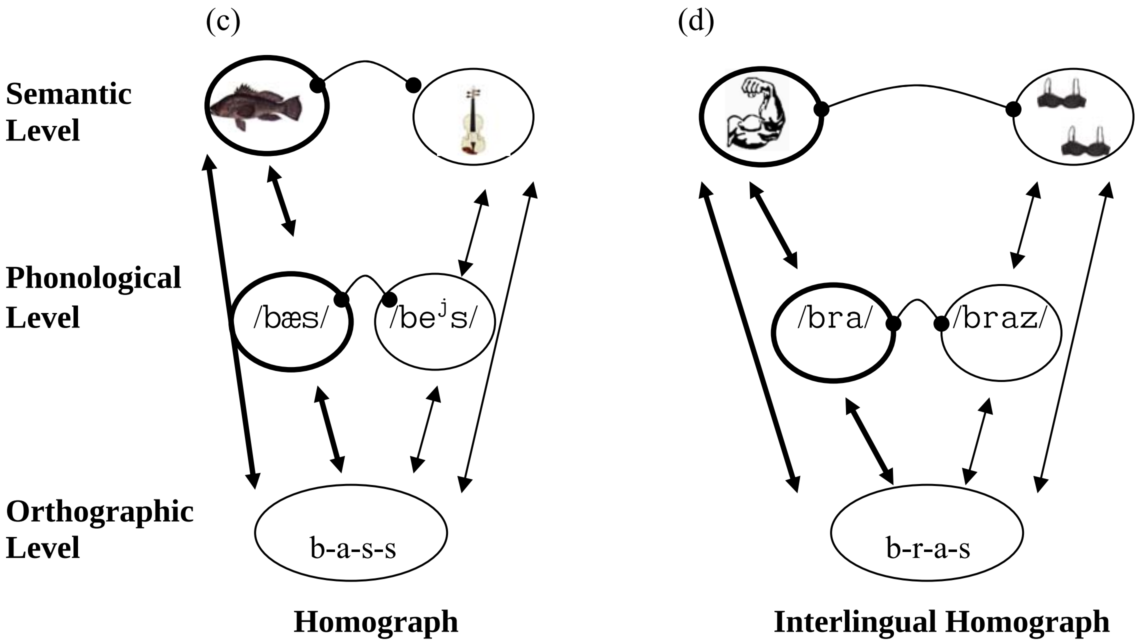
As is illustrated by Figure 2, interlingual homographs like *bras* have at least two distinct meaning representations associated with them. Such words allow researchers to examine whether all lexical-semantic information associated with letter strings is exhaustively activated upon encountering them, or whether readers selectively activate only the appropriate semantic representations. Monolingual investigations of patterns of lexical-semantic activation have examined the processing of homographs and homonyms. Homographs share the same orthography but differ in pronunciation and meaning (e.g., bass /bæs/ 'fish' or /be^{j}s/ 'stringed instrument'), while homonyms are words that share the same orthography and pronunciation but differ in meaning (e.g., bat /bæt/ meaning 'heavy wooden stick' or 'flying mammal').

Monolingual studies have examined whether readers activate all phonological and semantic information associated with a letter string like <bat>. Crucially many of these investigations have studied how sentence context and the frequency of the two meanings of homographs and homonyms influences patterns of activation. Investigators have examined whether readers initially selectively activate only the contextually appropriate meaning, or exhaustively activate all meanings associated with a homograph or homonym regardless of context and the frequency of occurrence of the two meanings (e.g., Duffy, Kambe, & Rayner, 2001; Duffy, Morris, & Rayner, 1988; Folk & Morris; 1995; Gottlob, Goldinger, Stone, & Van Orden, 1999; Martin, Vu, Kellas, & Metcalf, 1999; Onifer, & Swinney, 1981; Paul, Kellas, Martin, Clark, 1992; Rayner, Binder, & Duffy, 1999; Rayner & Frazier, 1989; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Swinney, 1979; Tabossi, 1988a; Tabossi, Colombo, & Job, 1987; Tabossi & Zardon, 1993; Tanenhaus, Leiman, & Seidenberg, 1979). Monolingual findings on the influence of sentence context and the frequency of occurrence of the two meanings of homographs will be discussed in greater detail in section 1.3.

As stated above, researchers have investigated the activation of lexical-semantic information associated with homonyms and homographs to determine whether readers and listeners exhaustively activate all meanings associated with an ambiguous word. As with bilinguals, if monolinguals activate all meanings associated with a homograph while reading a sentence, processing will be affected. For example, when reading a sentence like *"The fisherman caught a big green bass"*, if both the 'type of fish' and 'stringed instrument' meanings of the string <bass> are activated, then processing will be influenced. Figure 3 illustrates patterns of activation for (a) non-homonym, non-homograph words with a single pronunciation and meaning, (b) homonyms with a single pronunciation and two competing meanings, (c) homographs with competing pronunciations and meanings, and (d) interlingual homographs with competing pronunciations and meanings.

Figure 3. Schematic networks for four types of words: (a) non-homonym, non-homograph words with a single pronunciation and meaning, (b) homonyms with a single pronunciation but two competing meanings, (c) homographs with two competing pronunciations and two competing meanings, and (d) interlingual homographs with two competing pronunciations and two competing meanings. Positive connections are indicated by arrows, and inhibitory connections are indicated by filled circles. Dark lines indicate more frequent representations. The figure is based on Gottlob et al. (1999) and McClelland & Rumelhart (1981).





As is illustrated in Figure 3, words have an orthographic representation at the orthographic level, a phonological representation at the phonological level, and a meaning representation at the semantic level. These representations are linked via facilitory connections. Specifically, representations at the orthographic level are linked to representations at the phonological level, representations at the phonological level are linked to representations at the semantic level, and representations at the orthographic level are connected to representations at the semantic level. For example the letter string <desk> at the orthographic level is linked to the phonological representation /dɛsk/ at the phonological level, and both are linked to the meaning representation 'table used for paperwork' at the semantic level.

As illustrated by Figure 3b, homonyms like *bat* share orthographic and phonological representations. They also share connections between the orthographic and phonological levels. Homonyms have multiple meanings associated with them, and therefore have separate semantic representations at the semantic level. A single representation at the orthographic and phonological levels is linked to two representations at the semantic level. Most homonyms and homographs have one meaning that is more frequent than the other.[3] For example the 'heavy wooden stick' meaning of *bat* occurs more frequently than the 'flying mammal' meaning in corpora of written English. More frequent meanings are illustrated by darker connections between representations at the different levels. Because the 'heavy wooden stick' meaning of *bat* is more frequent than

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[3] The frequency of the two meanings of a homograph or homonym can be established using corpora which are assumed to reflect the frequency of usage. Frequency can be estimated by eliciting responses from participants (see; Nelson, McEvoy, Walling, & Wheeler, 1980; Wollen, Cox, Coahran, Shea, & Kirby, 1980).

Research shows that word frequency affects word recognition (e.g., Rayner & Balota, 1989). In general, findings indicate that high frequency words are processed more quickly than low frequency words. Despite the general agreement that frequency plays an important role in processing, coming up with a good metric for assessing word frequency that is accurate for all speakers of a language is impossible. Experimenters use databases like Francis and Kučera (1982), a written word frequency corpus, to approximate actual frequency. However, it must be recognized that corpora data provides an estimate of average word frequency for a population. The actual frequency of a word for a participant will be based on their personal experience with the language.

Gernsbacher (1984) demonstrated that familiarity ratings for experimental stimuli may be a better predictor of response times than written frequency norms, especially for low frequency words. Her studies indicated that familiarity is highly correlated with frequency (r=.81), and that overall the relation between familiarity and frequency is highly linear. However, for low frequency words the relationship is less linear. Based on Gernsbacher's results it appears that for low frequency words, familiarity may be a better predictor of response time than frequency.

Establishing word frequency is more complicated when studying bilingual participants. For bilinguals, word frequency will be highly correlated with their experience with the language, certain semantic domains, registers, etc. Therefore, it is difficult to accurately establish word frequency for bilingual participants. As with monolinguals, experimenters testing bilinguals use corpora like Francis and Kučera (1982) to establish the frequency of experimental materials. Importantly, experimental results indicate that when native speakers and bilinguals are asked to give frequency judgments for near synonyms in English, bilinguals' judgments are better than native speakers with only a high school education, and less good than well educated native speakers (Schmitt & Dunham, 1999). These results indicate that bilinguals have, at a minimum, frequency intuitions in English that approach those of a native speaker.

the ‘flying mammal’ meaning, the lines illustrating connections between the phonological level and semantic level and the orthographic and semantic level are darker than those for the ‘flying mammal’ meaning. As will be discussed later, the frequency of a word plays an important role in lexical-semantic activation. In general, more frequent words or meanings are activated more quickly than less frequent words or meanings.

Figure 3b illustrates that when a letter string is read or a word is heard, activation at the orthographic or phonological levels is spread to representations at the semantic level. Because homonyms like *bat* have two meaning representations, activation is spread to both the semantic representations ‘heavy wooden stick’ and ‘flying mammal’. However when reading a sentence, only one meaning can be selected for integration into the context. Therefore, representations at the semantic level are mutually inhibitory, as is illustrated by inhibitory connections at the semantic level. Figure 3b illustrates that homonyms have competing meaning representations that vie for selection at the semantic level. Because non-homonym, non-homograph words like *desk* do not have competing representations vying for selection, all else being equal, performing tasks (e.g., lexical decision) on words like *desk* should be faster than for homonyms like *bat*.

As illustrated in Figure 3c, homographs (e.g., *bass*) only share a representation at the orthographic level. The letter string <bass> at the orthographic level is linked to two distinct representations at the phonological level. The two phonological representations (e.g., /bæs/ and /be^{j}s/) at the phonologic level are in turn connected to separate meaning representations at the semantic level (e.g., ‘fish’ and ‘musical instrument playing low pitches’). Similar to homonyms, one meaning associated with a homograph is more frequent than the other, as illustrated by darker connections between the orthographic level and the other levels linked to the meaning ‘fish’, and lighter connections between the orthographic level and the other levels linked to the meaning ‘musical instrument playing low pitches’. Once a letter string like <bass> is encountered, activation is spread to the phonological and semantic levels. Because homographs like *bass* have two phonological and two semantic representations, activation is spread from the orthographic representation to both phonological representations and both semantic representations. However, when processing, only one pronunciation and one meaning can be selected. Therefore, representations within the phonological level and within the semantic level are mutually inhibitory, as is illustrated by inhibitory connections within these two levels. Both the pronunciations /bæs/ and /be^{j}s/ compete for selection as do the meanings ‘fish’ and ‘stringed instrument’. Competition results in increased processing time on tasks like lexical decision. Therefore, processing the word *bass* takes longer than processing a word like *desk*, where there is no competition for selection at any level.

As shown in Figure 3d, interlingual homographs (e.g., *bras*), like monolingual homographs, only share a representation at the orthographic level. The letter string <bras> at the orthographic level is linked to two distinct representations at the phonological level. The two phonological representations (e.g., /bra/ and /braz/) at the phonological level are in turn connected to separate meaning representations at the semantic level (e.g., ‘arm’ and ‘women’s undergarments’). Again frequency differences are depicted by darker connections between levels. As with homographs, once a letter string like <bras> is encountered, activation is spread to both phonological and semantic levels. Both the pronunciations /bra/ and /braz/ compete for selection as do the meanings ‘arm’ and ‘women’s undergarments’. Competition results in increased processing time. Therefore, all else being equal, processing the word *bras* should take longer than processing a word like *desk*, where there is no competition.

1.2 Homograph Processing in Bilinguals

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

One apparent exception to this general finding that the activation of meanings of interlingual homographs is exhaustive, is a study conducted by Gerard and Scarborough (1989) using a lexical decision task.[4] Gerard and Scarborough examined lexical decisions to Spanish-English homographs (e.g., *fin* meaning ‘part of a fish’ in English and ‘end’ in Spanish), cognates (words that have similar phonology and meaning across languages (e.g., *hospital* in Spanish and English), and non-homographic non-cognate words (translations having <u>no</u> overlapping phonology or orthography but similar meanings (e.g.,

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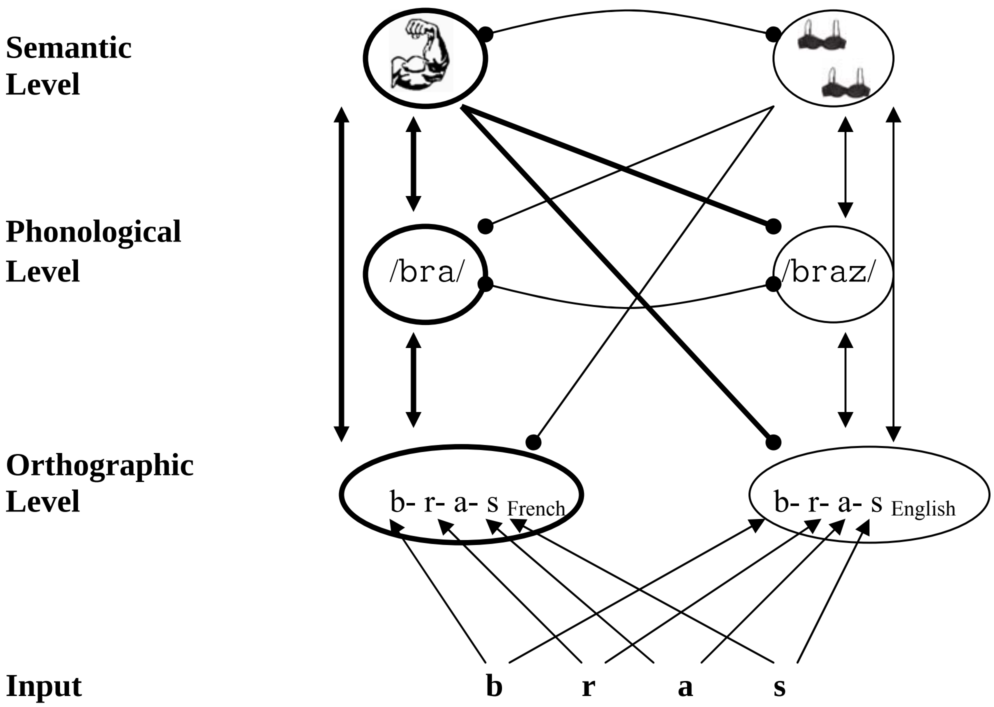
[4] In a lexical decision task a string of letters is presented on screen and participants are asked to indicate via a button press if the string is a word or not. When participants see a string like *desk*, they should response “YES” because *desk* is a word. When participants see a string like *guck*, they should respond “NO” because *guck* is not a word.

chair in English is *silla* in Spanish). 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. For example, *fin* meaning 'part of a fish' in English is low frequency, while *fin* meaning 'end' in Spanish is high frequency. 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 non-homographs. This result was interpreted as evidence for selective activation under the assumption that if bilinguals had accessed both lexical-semantic representations 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 non-target language. However, their result is completely compatible with exhaustive activation.

An exhaustive activation explanation can be couched either in representational or performance criterial terms. Both can be explained in terms of Figure 4. In representational terms, inhibition could arise from incompatible meanings inhibiting each other, thereby slowing the activation necessary to make a word decision. This is illustrated by inhibitory connections at the semantic level between the 'arm' and 'women's undergarments' meanings. 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. This is demonstrated by inhibitory connections between the 'arm' meaning at the semantic level and the representation <bras>$_{\text{English}}$ at the orthographic level, and inhibitory connections between the ‘women’s undergarments’ meaning at the semantic level and the representation <bras>$_{\text{English}}$ at the orthographic level.

Figure 4. Complete schematic network of homographs with two competing pronunciations and two competing meanings with facilitory and inhibitory connections within and between levels. Thick lines indicate higher frequency representations.



In performance terms, activation of both the semantic representations ‘arm’ and ‘women’s undergarments’ in the context of making a word decision in French leads to a response conflict, resulting 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 non-target language competitor representation to which they are supposed to respond to as a non-word. Resolving this conflict results in longer response times, higher error rates, or both. Greater conflict is expected when the target language meaning of a homograph is of a lower frequency (represented by the thin connection arrows) than the non-target language competitor. When the target meaning has a higher frequency (represented by thick lines) than the non-target language competitor, little or no effect of the non-target meaning is expected. Effects of frequency will be discussed at greater length in section 1.6.

Interestingly, Dijkstra, Van Jaarsveld and Ten Brinke's (1998) Experiment 1 with L1 Dutch speakers processing in L2 English, failed to replicate Gerard and Scarborough's (1989) finding of longer decision times for low frequency homographs with high frequency non-target homograph competitors compared to low frequency controls, or to low frequency homographs with low frequency non-target 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. Dijkstra et al. suggested that the activation of homograph competitors was rapidly suppressed when participants only had to make responses to words in the target language. Therefore, their Experiment 1 did not show effects of exhaustive activation of all meanings of Dutch and English meanings of a homograph while processing in L2 English.

In a second study, the same list of Dutch-English homographs, fillers, and control words was augmented with Dutch filler words and participants were told that they were to make a non-word 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 causing responses to homographs to be slower. And indeed, slower responses 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 non-homograph controls. In contrast to Experiment 1, Experiments 2 & 3 demonstrated exhaustive activation of all meanings associated with interlingual homographs.

The results of these latter two studies demonstrate that with the right task demands, exhaustive lexical access can be observed in the processing of interlingual homographs either as inhibition or facilitation of lexical decisions relative to non-homograph controls. However, these results still leave open the question of why Gerard and Scarborough observed slow response times to homographs when none were observed in Dijkstra et al.'s Experiment 1. This issue will be taken up in detail shortly, but for now, note that if low or suppressed activation of the non-target language were the explanation for the null result in Dijkstra et al.'s Experiment 1, then Gerard and Scarborough should **not** have observed slow responses 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 L1 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. Participants were supposed to judge letter strings as words only in the target language. De Groot et al. suggest that 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 non-target language. For those adopting the stricter criterion, slower response times would be expected if lexical activation is exhaustive, as Dijkstra et al. observed in their second study. For those adopting a more lax criterion, facilitation would be expected if lexical activation is exhaustive, just as Gerard and Scarbourough originally conjectured. According to De Groot et al. null differences may arise when a significant number of participants do not adopt the same decision criterion and as a consequence, fast and slow response times 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. After finding a null result, De Groot et al. examined decision times for each of their experimental items. 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 (L1). 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 (L1) target condition, and suggested that this supported their contention that null results may be due to differences in decision criteria across participants.

However, 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 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 De Groot et al. suggest, participants differed in their task compliance, this has yet to be clearly demonstrated. Moreover, there may be a simpler explanation for the pattern of results observed in the three studies I have reviewed 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 L2 in these experiments, and in Spanish or Dutch, which corresponds to the L1.[5] The cells in the English (L_2) target language condition represent the conditions that were similar across Gerard and Scarborough, Dijkstra et al., and De Groot et al.'s studies. I 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. An 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 non-target (L1) 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 slower response times to interlingual homographs because the frequencies of their low frequency readings were much lower and the frequencies of their high frequency readings were much higher than their counterparts in the other studies.

[5] The log frequencies in Table 1 are as given in Gerard and Scarborough (1989), Dijkstra et al. (1998), and De Groot et al. (2000).

Table 1. Mean log frequencies per million for L1 and L2 homograph readings when the L1 or L2 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 De Groot et al. (2000). An asterisk (*) indicates a significant reaction time finding at $p < .05$, while NS indicates a non-significant reaction time finding at $p > .05$.

Condition		Experiment		
		Gerard & Scarbourough	Dijkstra et al. Exp. 1	De Groot et al. Exp. 1 & 2
Target Lang.	Homograph Freq.	Frequency	Frequency	Frequency
L2/ English	HF-S/D	2.28	1.87	.82
	LF-E	.08	1.10	.13
	H-L Diff	2.2*	.77 NS	.69 NS
	HF-E	2.61	2.05	1.71
	LF-S/D	.62	.64	.11
	H-L Diff	1.99 NS	1.41 NS	1.60 NS
L1/ Dutch	HF-D	--	--	.82
	LF-E	--	--	.13
	H-L Diff	--	--	.69 NS
	HF-E	--	--	1.71
	LF-D	--	--	.11
	H-L Diff	--	--	1.60 *

De Groot et al.'s pattern of results can be explained by differences in the relative frequencies of the Dutch and English readings of the homographs. When homographs had a high frequency in English and a low frequency in Dutch and the language of processing was Dutch, inhibition was observed. In the other conditions, inhibition was not observed. The only condition in which the non-target language competitor reading had a very high mean log frequency, one approaching the high log frequency values used by Gerard and Scarborough, was the one in which processing was in Dutch and homographs had a high frequency in English and a low frequency in Dutch. That is, this was the only condition in which activation of a non-target language competitor was high enough to slow word decisions to a low frequency probe in the target language, which was also the L1 for participants. From this, the conclusion can be drawn that the relative frequency of the meanings of an interlingual homograph may play an important role in interactive activation. Specifically, when a non-target language competitor has a high frequency, it receives activation and competes for selection with the target language meaning of an interlingual homograph. Therefore, when participants read the letter string <bras> in English, because the French meaning of the homograph has a higher frequency than the English meaning, it quickly becomes activated and competes for selection with the English meaning.

To summarize, all the studies reviewed thus far examining the processing of interlingual homographs, even those that have yielded apparent language-selective activation, are compatible with exhaustive activation, given certain assumptions about differences in the frequencies of the two readings of an interlingual homograph. Specifically, when a non-target language competitor has a frequency that is sufficiently higher than the frequency of the target language reading, inhibition results. 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 exhaustive activation 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 non-target 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 exhaustive activation may depend on participant variables, while very interesting, awaits further statistical verification.

Other evidence for the role of frequency on the activation of multiple meanings of homographs comes from the use of the lexical decision task when primes and targets are presented as pairs instead of in isolation. Beauvillain and Grainger's (1987) Experiment 2 examined lexical decisions made to target words that were related to either the French or English meaning of a homograph prime, or to a target word that was unrelated to either meaning. The frequencies of the two meanings 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 exhaustive activation reviewed above, providing evidence that exhaustive activation 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 non-target language meaning 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 will be discussed shortly, this accords well with homograph priming findings in the monolingual literature.

Convergent evidence for the role of frequency on exhaustive activation of the multiple meanings of interlingual homographs comes from the use of a go/no-go task. In a go/no-go task participants are asked to react only when a word belongs to a particular language. In Experiment 2, Dijkstra, Timmermans, and Schriefers (2000) asked Dutch-English bilingual participants to react (go) only if a stimulus was a word in English. If the stimulus was not a word in English they would not react (no go). In Experiment 3, a new set of Dutch-English bilingual participants were asked to react (go) only if a stimulus was a word in Dutch, and not to react (no-go) if a stimulus was not a word in Dutch. In both Experiments 2 and 3 there were higher miss rates and slower response times to homographs than controls. Miss rates and slower response times to homographs were dependent on the frequency ratio of words in the target and non-target languages. The strongest inhibition occurred when the frequency of the homograph in the target language was low but high in the non-target language. Participants did not respond (no-go) to about 34% of the homographs while processing in L2 when the frequency was low in L2 but high in L1, and to about 22% of the homographs while processing in L1 when the frequency was low in L1 but high in L2. These results are a further indication that the relative frequencies of homographs in L1 and L2 plays an important role in exhaustive language activation.

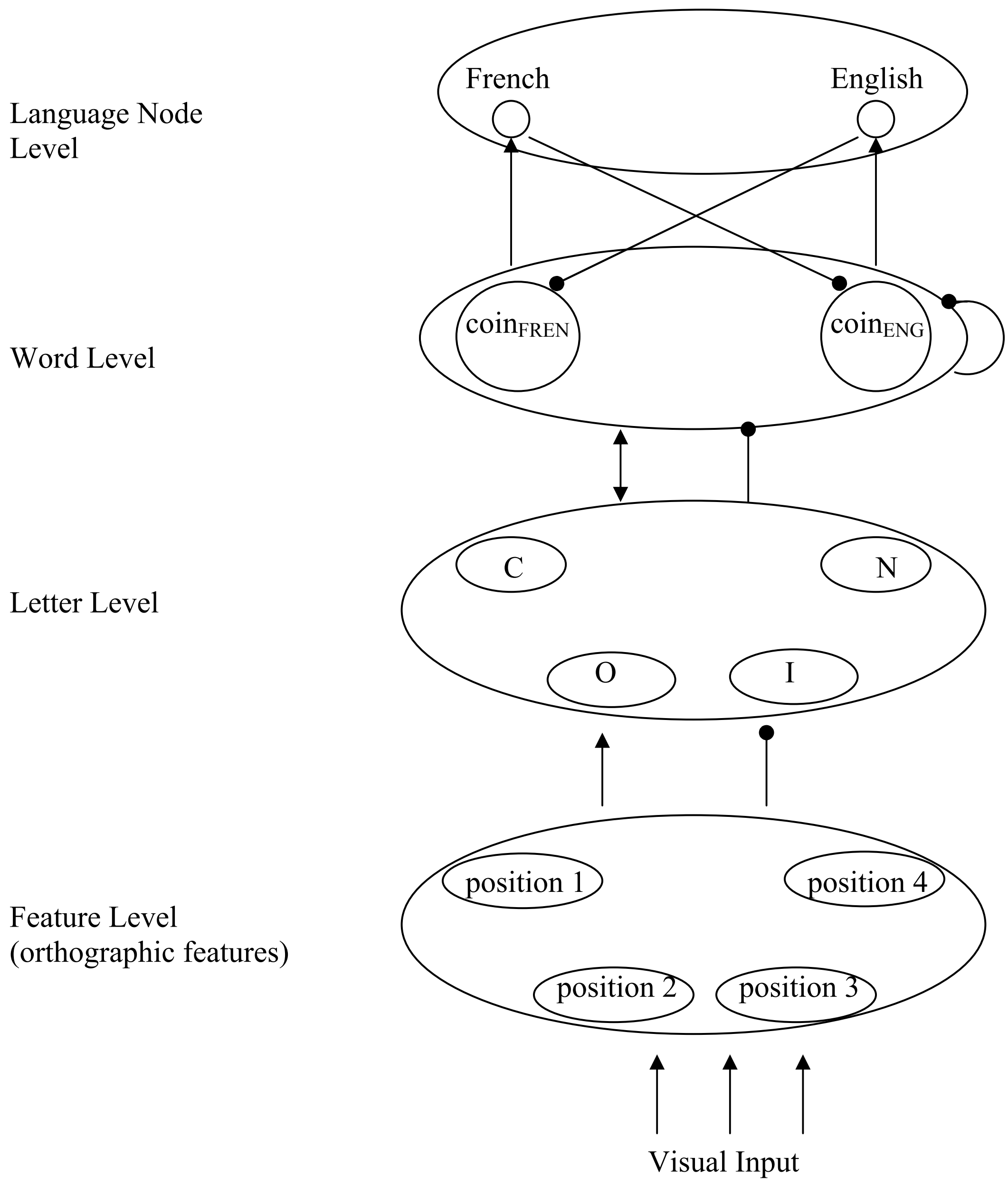
To summarize, most if not all of the research to date on bilingual processing of interlingual homographs supports the view that bilingual lexical access is exhaustive. However, these findings depend on a number of variables which have been found to be important in lexical decision tasks. Among these variables, the frequency of interlingual homographs in each language has emerged as an important determinant of whether lexical activation appears to be selective or exhaustive. 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 outcome of studies involving the processing of interlingual homographs, most likely by shifting decision criteria and/or biasing processing to a language selective or exhaustive 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 is inhibited or before they decay. Participant variables are also important. Participants in all of the studies reviewed here involved relatively balanced bilinguals. When language proficiency is more disparate, it is likely that evidence for exhaustive activation 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. Two processing models have been proposed to explain the pattern of results described above. These models will be taken up in the next section.

1.3 Modeling Bilingual Word Recognition in Isolation

Patterns of activation of the multiple meanings of interlingual homographs have been accounted for by the Bilingual Interactive Activation Model (BIA) (Dijkstra and Van Heuven, 1998; Dijkstra et al., 1998; Van Heuven, Dijkstra, & Grainger, 1998), and the BIA+ Model (Dijkstra & Van Heuven, 2002). These models will be taken up below and will be used to account for the findings of the current studies.

Early results in the bilingual word recognition literature were accounted for by the BIA (Dijkstra and Van Heuven, 1998; Dijkstra et al., 1998; Van Heuven, Dijkstra, & Grainger, 1998). This model, illustrated in Figure 5, extends the monolingual Interactive Activation (IA) model of McClelland and Rumelhart (1981) to bilingual language processing by adding a Language Node Level containing two language nodes. In the BIA model, a written word activates (through orthographic features and letter level) word representations from both languages. A Language Node receives activation from activated word representations from the corresponding language, and via feedback to word representations in the other language inhibits them. For example, when processing in French the Language Node inhibits word representations that are not French. In an experimental setting, when the language of the stimulus word is different from that of a previous trial, the language node for the non-target language is in a state of higher activation at the beginning of the trial than the language node for the target language. This should inhibit the processing of the new target compared to the processing of a new target in a trial where there is no change in language. Similar results would be predicted when words appear in sentential contexts.

Figure 5. An illustration of the Bilingual Interactive Activation model (Dijkstra & Van Heuven, 1998), where excitatory connections are indicated by arrows and inhibitory connections by filled circles.



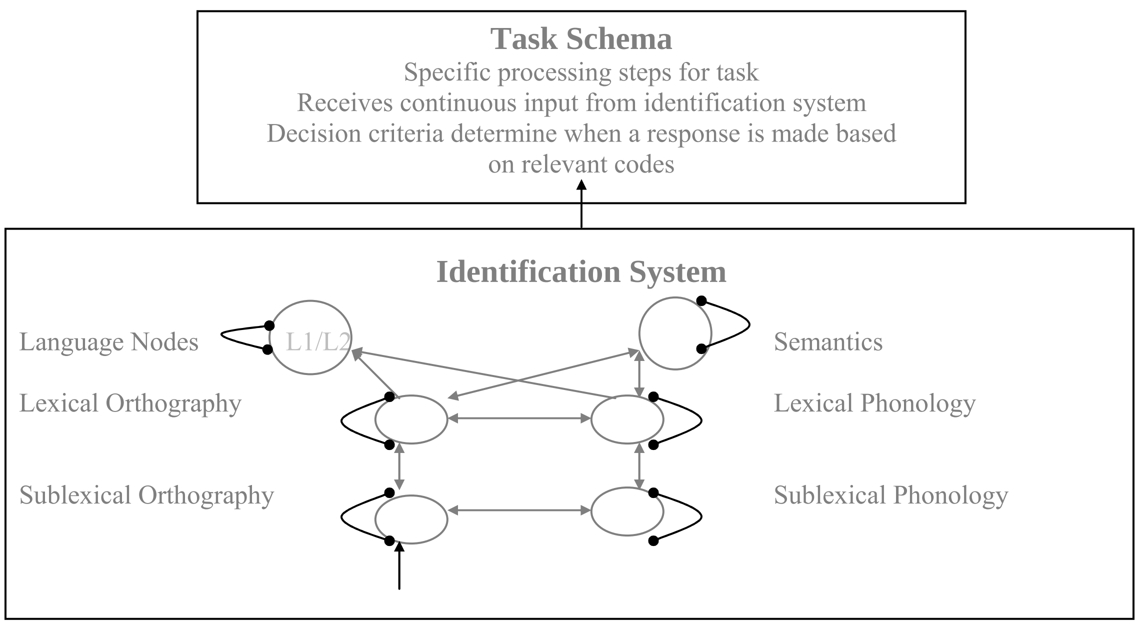
According to the BIA model, when a French-English bilingual participant reads a word like *coin*, the letter string <coin> is recognized at the Feature Level and then at the Letter Level and finally at the Word Level. However, at the Word Level the string <coin>

is compatible with a word both in French and English. This means that both the representations $coin_{English}$ and $coin_{French}$ should receive activation. When participants are taking part in an English experiment, primarily word form representations from English are activated. Therefore, the English Language Node should be active and send inhibitory excitation to word representations in French. More specifically, when the string <coin> is read, both $coin_{English}$ and $coin_{French}$ should receive activation. The English Language Node sends inhibitory feedback to the French lexical representations $coin_{French}$ thereby delaying recognition of the string <coin>. It is important to note that because there is mutual inhibition at the word level, activation of $coin_{English}$ should result in inhibitory feedback being sent to $coin_{French}$ even without the presence of inhibitory feedback from the Language Node.

The BIA model is a fairly simple word recognition model. As has been demonstrated by the review of the monolingual and bilingual processing literatures, word frequency plays an important role in lexical-semantic activation. The role of frequency in word recognition is not accounted for by the BIA model. In addition, the subsequent review of the monolingual literature will highlight the role of sentence context on the activation of multiple meanings of homographs. The role of semantics and sentence context on word activation is not specified by the BIA model. Therefore, a more comprehensive model is needed to account for findings in the monolingual and bilingual literatures. And because the Language Node Level has no real psychological validity, a model is needed to explain experimental findings that does not make use of such nodes.

The BIA+ model (Dijkstra & Van Heuven, 2002), illustrated in Figure 6, addresses some of the shortcomings of the BIA through the addition of nodes for sublexical orthography, lexical orthography, sublexical phonology, lexical phonology, and semantics, and a task schema. Each will be discussed in turn, as will the diminished role of the Language Nodes. At the sublexical orthographic level, features of individual letters are represented, which allows letters like “c”, “o”, “i”, “n” to be recognized at the orthographic level. Similarly, features of different phonemes, (e.g., aspiration) are represented at the sublexical phonological level, which allows sounds to be recognized at the lexical phonological level. Importantly, the BIA+ adds a semantic node where meanings associated with orthographic and phonological representations are stored.

Figure 6. BIA+ model of bilingual word recognition (Dijkstra & Van Heuven, 2002).



Crucial to the current work, the role of the language nodes has been changed in the BIA+ model. According to the BIA+, language nodes simply serve as language membership representations or language tags. They do not function as language filters. In addition, the BIA+ model makes a distinction between a word identification system and a task/decision system. The word identification system accounts for effects arising from the linguistic context available in sentences (e.g., lexical, syntactic, semantic, and language of processing information), while the task/decision system accounts for effects arising from the non-linguistic context (e.g., instructions, task demands, and participant expectations). Word activation is not modulated by non-linguistic context. Non-linguistic context only affects the task decision system and serves to optimize performance.

According to the BIA+, exhaustive activation, frequency-dependent results, and facilitation or inhibition of response times are all explained by the word identification system. Crucially, activation of semantic representations depends on word frequency. In the BIA+, Dijkstra and Van Heuven introduce the "temporal delay assumption". On the temporal delay assumption, there is a delay in the activation of L2 semantic representations relative to those in L1 due to the lower frequency of L2 words. In addition, the BIA+ allows linguistic context to directly affect access to lexical representations. Dijkstra and Van Heuven characterize word recognition as being sensitive to syntactic and semantic context information from different languages in the same way monolingual word recognition is sensitive to sentential context. However, they do not specify how and when context plays a role.

The BIA+ can account for findings in the literature in the following way. When an English-dominant participant reads a word like *coin* while reading in French, the string <coin> is recognized at the sublexical orthographic level and at the orthographic level, which spreads activation to the semantic level. Because the input is consistent with both $coin_{English}$ and $coin_{French}$, both the 'money' and 'corner' meanings should be accessed at the semantic level. However, this access is mediated by the frequencies of $coin_{English}$ and *coin*$_{French}$. Activation of the meanings of low frequency words is slower because the representation of low frequency words is weaker at the lexical level. Therefore, in the condition where the French homograph has a significantly lower frequency than its English competitor (based on monolingual corpora data); the English counterpart provides strong competition for the French interpretation which results in slow response times. In the condition where the French homograph has a significantly higher frequency than its English counterpart, the English counterpart should not be a strong competitor. However, as stated before the issue of establishing word frequency is complicated when studying bilingual participants. For bilinguals, word frequency will reflect their experience with the language, certain semantic domains, registers, etc. Therefore, it is difficult to accurately establish word frequency for bilingual participants. In addition, L2 will have weaker representation than L1 (imperfect or incomplete representation of syntax, morphology, the lexicon, etc.). One consequence of the weaker representation of L2 will be overall depressed word frequencies. In other words, *a* and *un* are high frequency words in English and French respectively. For a native speaker of English, French *un* will have a "high" frequency in the French linguistic system, but this will be less than the frequency of the equivalent *a* in the English system. Therefore, in the case discussed above an English competitor like *coin*$_{English}$ has a stronger representation for a native English speaking bilingual than *coin*$_{French}$. As a consequence of the stronger representation of L1 words, *coin*$_{English}$ may provide competition for selection with the more weakly represented *coin*$_{French}$. This competition would lead to longer response times relative to frequency matched control words.

The BIA+ highlights the importance of frequency and semantics on word recognition. As discussed previously (section 1.2), research to date strongly favors an exhaustive view of bilingual lexical activation; however, 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 is not yet known. For example, little work has been done on the processing of sentences for comprehension by bilinguals, where the language of use and the semantic context might be expected to exert a particularly strong influence. Dijkstra and Van Heuven characterize bilingual word recognition as being sensitive to semantic context information and frequency in much the same way as monolingual word recognition is. However, they do not specify when and how semantic context plays a role in word recognition. Monolingual studies have investigated the role of sentence context on the exhaustive activation of all meanings associated with a homograph (e.g., *bass*). Therefore, before turning to the current studies, in which the role of sentence context on the activation of interlingual homographs is investigated, it is important to review the relevant findings from the monolingual literature. The following two sections will examine how context and frequency influence the on-line processing of lexically ambiguous words and a set of models that have been proposed to explain the results.

1.4 Homograph and Homonym Processing in Monolinguals

Many monolingual studies have examined whether all meanings associated with homonyms (e.g., *bat*) and homographs (e.g., *bass*) are activated upon encountering them. Similar to bilingual studies, monolingual studies of lexically ambiguous words presented in isolation have demonstrated exhaustive activation of the multiple meanings of such words (e.g., Gottlob, Goldinger, Stone, & Van Orden, 1999; Hino & Lupker, 1996; Pexman & Lupker, 1999; Rodd, Gaskell, & Marslen-Wilson, 2002). Gottlob et al. (1999) showed that responses to homonyms presented in isolation were faster than to control words in naming and lexical decision tasks.[6] However, responses to homographs presented in isolation were slower than to controls in both naming and lexical decision tasks. These findings provide evidence for the exhaustive activation of multiple meanings of lexically ambiguous words when presented in isolation. These results suggest that exhaustive activation leads to faster recognition (facilitation) when lexically ambiguous words have overlapping orthography and phonology but multiple semantic representations. When words have overlapping orthography but have both semantic and phonological representations that compete for selection, recognition is slowed (inhibited).

A study by Hino and Lupker (1996) examined the role of frequency on the

[6] In a naming task a word is presented on a screen and participants are asked to say (name) the word aloud. As stated previously, in a lexical decision task a string of letters is presented on a screen and participants are asked to indicate via a button press if the string is a word or not.

activation of multiple meanings of homonyms presented in isolation using both naming and lexical decision tasks.[7] The homonyms used by Hino and Lupker had meanings that were either both high frequency (e.g., *well*) or both low frequency (e.g., *perch*). In the naming task, only the low frequency homonyms were named faster than frequency matched control words. Low frequency homonyms were named 21 ms faster than frequency matched control words, while there was no difference in response times to high frequency homonyms and frequency matched control words. In the lexical decision task, both high and low frequency homonyms were responded to more quickly than frequency matched control words. There was no interaction between word type (homonym vs. non-homonym) and frequency. The lack of an interaction was attributed to a similar facilitation effect relative to control words for both high and low frequency homonyms. Both high and low frequency homonyms were responded to 13 ms faster than their control words. In contrast to the studies that will be reviewed below, the frequency of the meanings of the homonyms used by Hino and Lupker were either both low or both high. Other studies investigating the role of frequency on the processing of homonyms presented in isolation and sentential contexts examined processing when the frequency of one homonym was high and the other was low. The findings of such studies will be discussed below.

In a study by Rodd, Gaskell, and Marslen-Wilson (2002), a distinction was made between homonyms having multiple unrelated meanings (e.g., *bark*) and those having

[7] Hino and Lupker (1996) used the term polysemeous to describe their experimental stimuli. However, an examination of their stimuli reveals that all 15 of their low frequency polysemeous words were homonyms. Fourteen of their high frequency polysemeous words were homonyms while only one was a homograph. Therefore, these studies can most accurately be described as studying effects of frequency on the processing of homonyms.

multiple related word senses (e.g., *twist*).[8] Using both lexical decision and naming tasks for words presented in isolation, Rodd et al. (2002) found that words with one meaning were responded to significantly faster than words with two meanings. Words with multiple related senses were responded to more quickly than words with multiple unrelated meanings. These results indicate that competition between the multiple unrelated meanings of ambiguous words slows their recognition. In cases where there are rich semantic representations associated with a word, recognition is speeded.

Taken together, the results discussed above indicate that when a lexically ambiguous word is encountered in isolation, the multiple meanings of this word are activated. Crucial to my dissertation experiments, when the meanings of the lexically ambiguous words are unrelated and when there are multiple phonological representations competing for selection, recognition is slowed. In the monolingual experiments discussed thus far, words were presented in isolation. However, in "real-world" processing contexts, words are hardly ever encountered in isolation. Therefore, it is important to review findings examining the processing of lexically ambiguous words presented in sentential contexts.

In seminal studies by Swinney (1979) and Tanenhaus, Leiman, & Seidenberg, (1979), participants listened to context sentences containing a monolingual homonym like *bug*, and made a lexical decision or named visually presented letter strings at two

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[8] Rodd et al. (2002) used the term ambiguous to describe their experimental stimuli. An examination of their stimuli reveals that in Experiment 1, 123 of their ambiguous words had senses with overlapping phonology, while only 1 had differing phonologies. In Experiment 2, 45 of the ambiguous words had senses with overlapping phonology, and 1 had differening phonologies. In Experiment 3, all 46 ambiguous words had senses with overlapping phonology.

different probe positions either directly following the homonym or a few word positions later (Swinney, 1979), or at 0 or 200 ms after a homonym (Tanenhaus et al., 1979). The frequency of occurrence of the two meanings of the homonyms was relatively balanced, while the context sentences were biased toward just one of the homonym's meanings, as illustrated by the example in Table 2 from Swinney's study.

Table 2. Contextually biased context 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 homonyms was 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 homonym like *bug*, decision times to 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 homonym, responses to only the contextually relevant meaning were facilitated.

Since these original findings, a large literature on the immediate, automatic, semantic activation of multiple meanings of homonyms and homographs in a sentential context has developed (e.g., Duffy, Kambe, & Rayner, 2001; Duffy, Morris, & Rayner, 1988; Folk & Morris; 1995; Martin, Vu, Kellas, & Metcalf, 1999; Onifer, & Swinney, 1981; Paul, Kellas, Martin, Clark, 1992; Rayner, Binder, & Duffy, 1999; Rayner & Duffy, 1986; Rayner & Frazier, 1989; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Tabossi, 1988a; Tabossi, Colombo, & Job, 1987; Tabossi & Zardon, 1993). Tabossi and her colleagues (Tabossi, 1988a; Tabossi, Colombo, & Job, 1987; Tabossi & Zardon, 1993) showed that both the relative frequency with which the meanings of a homonym occur and sentence context affect the activation of multiple meanings of homonyms. Tabossi (1988a) compared the processing of homonyms when sentential contexts either primed a semantic feature of the more frequent meaning of the homonym, as in (1), or did not, as in (2).[9]

> (1) The violent hurricane did not damage the ships which were in the *port*, one of the best equipped along the coast.
> (2) The man had to be at 5 o'clock at the *port*, for a very important meeting.

In sentence (1) the word *ship* appeared, which is a semantic feature of the more frequent meaning of *port*. In sentence (2) it is clear that the interpretation of the word *port* was 'a place where ships dock' and not 'a type of wine'. Even though the interpretation of the word *port* was clear in (2), a feature of the word was not present in the context sentence. Results showed that there was selective activation of the more frequent meaning of a homonym when the context primed one of its features, as in (1). In contexts as in (2), where a feature of the more frequent interpretation was <u>not</u> present, targets related to both the more and less frequent meanings were responded to faster than control words.

In a similar cross-modal study, Tabossi et al. (1987) presented participants with sentences that rendered salient either the more or less frequent meaning of a homonym. As with her other study, only targets related to the more frequent meaning were facilitated when the context rendered salient the more frequent interpretation. However,

[9] The sentences in (1) and (2), given in English, were presented in Italian to Italian native speakers. See Tabossi (1988a) for the full set of materials in Italian.

targets related to both meanings were facilitated relative to control words when the context rendered salient the less frequent interpretation of a homonym. Taken together the set of studies by Tabossi and her colleagues indicate that activation of multiple meanings of homonyms is mediated by both sentential context and the frequency with which each meaning of a homonym occurs.[10]

In a series of eye-tracking studies, Duffy, Rayner and their colleagues investigated the effects of frequency and sentential context on the exhaustive activation of multiple meanings of lexically ambiguous words (Duffy, Kambe, & Rayner, 2001; Duffy, Morris, & Rayner, 1988; Rayner, Binder, & Duffy, 1999; Rayner & Duffy, 1986; Rayner & Frazier, 1989). Duffy et al. (1988) had participants read sentences containing lexically ambiguous words like *pitcher* whose interpretations were equivalently frequent (equibiased), or like *port* whose interpretations had different frequencies (non-equibiased), as illustrated in Table 3. For non-equibiased homonyms like *port*, the sentence context supported the less frequent meaning. Therefore, the sentence context supported the 'type of wine' meaning of *port* instead of the 'harbor' meaning. A disambiguating region, indicating the appropriate interpretation of the homonym, either preceded or followed it.

[10] The studies by Tabossi and her colleagues demonstrate the role of semantic features in the activation of meanings of target words. Other studies on word activation in sentential context indicate that the predictiveness of a sentence context constrains activation (e.g., Fischler, 1985; Fischler & Bloom, 1980; Schwanenflugel, & LaCount, 1988; Schwanenflugel & Shoben, 1985). Such studies have shown that in contexts where a target word is highly predictive, there is only facilitation for the predicted word and not for other congruous words. In sentences that are not highly predictive, there is facilitation for any words that are congruous with the context. It may be the case that the features used by Tabossi and her colleagues make a target word predictable, thereby activating only one meaning of a homonym. It is likely that feature overlap and predictiveness are correlated.

Table 3. Contextually biased contexts with disambiguating region either before or after a homonym (indicated in italics, and control word in parentheses) from Duffy et al. (1988).

Disambiguating Region	
	Sentences with equibiased homonyms
before	Because it was kept on the back of a high shelf, the *pitcher* (whiskey) was often forgotten.
after	Of course the *pitcher* (whiskey) was often forgotten Because it was kept on the back of a high shelf.
	Sentences with less frequent meaning of non-equibiased homonym
before	When she finally served it to her guests, the *port* (soup) was a great success.
after	Last night the *port* (soup) was a great success when she finally served it to her guests.

Results showed that when a disambiguating region followed an equibiased homonym, fixation durations on equibiased homonyms were longer than for control words. Duffy et al. believe when the context preceding an equibiased homonym does not constrain its interpretation, multiple meanings are activated. These meanings compete for selection, thereby slowing processing at the homonym. When the context preceding a less frequent meaning of a homonym does not constrain its interpretation, fixations durations on the homonym were not significantly different from control words. This is attributed to only the more frequent meaning of the homonym being activated. Because only the more frequent meaning is activated, there is not competition for selection. Duffy et al. suggest that under such conditions a homonym is processed as though it had only one meaning.

In contrast, when the disambiguating region preceded an equibiased homograph, fixations durations were not different for homonyms and control words. In this case, a preceding disambiguating context increased the availability of the appropriate meaning, allowing it to become available first. An examination of fixation times for the region following the equibiased homonym revealed no difference between sentences containing a homonym and those with a control word. Duffy et al. believe that such results indicate that context allows the appropriate meaning to become available first. Therefore, there is no competition for selection of multiple meanings of a homonym. However, when the disambiguating region preceded the less frequent meaning of a non-equibiased homograph, fixation durations were longer than for control words. Duffy et al. argued that when a preceding disambiguating context increased the availability of the low frequency meaning, both meanings became available at the same time. This resulted in competition for selection, as evidenced by longer fixation durations at the homonym.

Taken together, the results of eye-tracking studies discussed above highlight the importance of frequency and context on the activation of multiple meanings of homonyms. Duffy and colleagues believe that frequency and context play a role in the speed of activation of the multiple meanings of homographs. When a preceding context does not indicate the appropriate interpretation of a homonym, and one meaning is more frequent than the other, the more frequent meaning is activated more quickly. Because the more frequent meaning is highly activated, there is no competition for selection. When a preceding context indicates the appropriate interpretation of a homonym and the meanings are equally frequent, the contextually appropriate meaning is activated more quickly. Again there is no competition for selection. When context indicates that the appropriate interpretation of a homonym is the more frequent one, it becomes available more quickly and there is no competition for selection. However, when context indicates the appropriate interpretation of a homonym is the less frequent one, both meanings quickly become activated. This leads to competition for selection as evidenced by longer fixation times.

In a similar set of eye-tracking studies by Folk and Morris (1995), the effect of context on the processing of the less frequent meaning of non-equibiased homonyms (e.g., *calf*) and homographs (e.g., *tear*) was examined. Materials are illustrated in Table 4. Folk and Morris replicated the basic findings of Duffy, Rayner and colleagues in which both frequency and context influence the availability of the meanings homonyms. In Experiment 1, the disambiguating region followed homonyms and homographs (Table 4, b & d). Folk and Morris found no processing differences for homonyms and control words at the homonym. This is consistent with the explanation that the most frequent interpretation of a homonym is activated more quickly, and that there is little competition from the less frequent meaning. When the disambiguating context indicated that the appropriate interpretation of the homonym was the less frequent one (as in b), there were longer fixation times in this region. This indicates that readers initially selected the most frequent meaning of a homonym. When the context was consistent with the less frequent interpretation, readers had to revise their selection.

Table 4. Contextually biased contexts with disambiguating region either before or after the less frequent meaning of a homonym or homograph (indicated in italics and control words in parentheses) from Folk and Morris (1995).

Disambiguating Region	
	Sentence with less frequent meaning of homonym
before	a) Because Jon was limping, his mother examined Jon's *calf* (shin) for a bruise.
after	b) His mother examined Jon's *calf* (shin) for a bruise, because Jon was limping.
	Sentence with less frequent meaning of homograph
before	c) After he caught his sleeve on a thorn, there was a *tear* (hole) in Jim's shirt.
after	d) There was a *tear* (hole) in Jim's shirt, after he caught his sleeve on a thorn.

Interestingly, a different pattern of results was observed for the processing of the less frequent meaning of homographs. When the context followed the homograph (e.g., d), Folk and Morris found increased reading times at the homograph (e.g., *tear*) compared to control words (e.g., *hole*). This was interpreted as an indication that both meanings of a homograph are initially accessed, regardless of frequency differences associated with the two meanings. In addition, in the subsequent disambiguating region participants made more regressions to the homograph than to the control word in the control condition. In contrast, there was no difference in the number of regressions to homonyms and control words. Folk and Morris interpret their pattern of results as an indication that orthography activates a single phonological representation for homonyms, which in turn has two meanings associated with it. The availability of the two meanings is frequency ordered. In contrast, homographs activate two phonological representations, each of which is linked to a distinct meaning representation. Readers must choose between phonological representations as well as meaning representations. The finding of initial processing difficulty for homographs suggests that the availability of the phonological codes is not frequency ordered. Both phonological and meaning representations become active close in time, resulting in a competition between meanings that cannot be resolved on the basis of orthography. Folk and Morris suggest that the pattern of data indicates that phonological codes are active when a homograph is encountered, and are used as a route to meaning.

In Folk and Morris's Experiment 2, the disambiguating region preceded homonyms and homographs and supported the less frequent meaning (e.g., a & c). As with previous studies, when reading a context that supported a lower frequency meaning of a homonym, there were longer fixation times at the homonym than control word. Similarly, longer fixation times were found at the homograph than at the control word. Even though fixation times were longer for homographs than for control words, there was a reduction in the amount of time spent looking at homographs when the disambiguating context preceded the homograph (40 ms in Experiment 2) than when it followed the homograph (80 ms in Experiment 1). Folk and Morris interpret this as an indication that representations associated with both meanings of a homograph are always exhaustively activated, no matter the frequency. They argue that contextual information can mediate the competition for selection of multiple meanings of homographs to some extent.

A set of studies by Kellas and colleagues also investigated the role of context and frequency on the activation of multiple meanings of homonyms (Martin, Vu, Kellas, & Metcalf, 1999; Paul, Kellas, Martin, & Clark, 1992; Vu & Kellas, 1999; Vu, Kellas, Petersen, & Metcalf, 2003). In two experiments Martin et al. (1999) presented participants with short passages containing homonyms. The passages either provided a strong context for the interpretation of a homonym, as shown in Table 5 (a) and (b), or provided a weak context, as illustrated in (c) and (d). The contexts were either consistent with the more frequent meaning of the homonym (e.g., a & c), or were consistent with the less frequent one (e.g., b & d). In Experiment 1, contexts were presented using a moving window paradigm. Words were presented on a computer screen one at a time. When participants had read a word they pressed the mouse and the next word of the sentence appeared. In Experiment 1 the dependent measure was the reading time for the homonym.

Table 5. Homonyms (in italics) and the context sentences in Kellas et al. (1999). Contexts were either strong or weak and were either consistent with high or low frequency interpretation of the homonym. In Experiment 2, participants were presented with probes immediately following the homonym (probe point indicated by #) that were related or unrelated to the meanings of the homonym.

Context Strength	**Homonym Frequency**	**Context**	**Probe Word**	
			Related	**Unrelated**
strong	high	a) The custodian fixed the problem. She inserted the *bulb* # into the empty socket.	light	tavern
	low	b) The gardener dug a hole. She inserted the *bulb* # carefully into the soil.	flower	metal
weak	high	c) The farmer saw the entrance. He reported the *mine* # to the survey crew.	coal	vault
	low	d) The scout patrolled the area. He reported the *mine* # to the commanding officer.	explosive	river

Martin et al. found no difference in reading times for high and low frequency homonyms in strong contexts (e.g., a & b). Martin et al. interpret these results as an indication that when context is strongly biased, only the appropriate meaning is activated, regardless of frequency. In weak contexts the high frequency homonym (e.g., c), was read faster than the low frequency one (e.g., d). This indicates that both meanings were activated when the low frequency homonym was encountered. However, when the high frequency homonym was encountered, only the more frequent meaning was activated. Martin et al. argue that these results demonstrate that the strength of context directly influences the subordinate bias effect. In other words, the more frequent meaning of a homonym is not activated when reading the less frequent homonym if the context is sufficiently strong.

Martin et al. contend that neither their reading time results nor the fixation duration results of Rayner, Duffy, and colleagues directly assess what meanings are activated when a homonym is encountered. In order to investigate this question Martin et al. conducted a second study in which probe words associated with the multiple meanings of a homonym were presented directly following the homonym. In Experiment 2, participants were asked to name aloud probe words (see Table 5). The pattern of reading time results in Experiment 1 was replicated in Experiment 2 with naming times. A summary of naming latency results is shown in Table 6. In strong contexts, probe words related to the appropriate meaning of the homonym were named more quickly than control words. Crucially, naming of probe words related to the inappropriate meaning of the homonym was not significantly different from control words, regardless of the frequency. Similar to the reading time results, this indicates that when context is strongly biased, only the appropriate meaning is activated, regardless of frequency. In weak contexts, when the less frequent homonym was encountered, probe words related to both the low and high frequency meanings were named faster than control words. When the more frequent homonym was encountered, only probe words related to that meaning were named faster than control words. Naming latencies for probe words related to the less frequent meaning were not significantly different from control words. Again, as with the reading time results, these results indicate that both meanings were activated when the low frequency homonym was encountered. When the high frequency homonym was encountered, only the more frequent meaning was activated. These results provide further evidence that strength of context and frequency directly influence the activation multiple meanings of lexically ambiguous words.

Table 6. Naming latency results from Martin et al. (1999), where significantly faster naming times to probe words related to the homonym relative to unrelated words are indicated by an asterisk (*) and non-significant results by n.s.

Context Strength	**Homonym**	**Homonym Frequency**	**Probe Word** (in italics)	**Result**
strong	BULB	high	high frequency meaning, *flower*	*
			low frequency meaning, *light*	n.s.
		low	high frequency meaning, *flower*	n.s.
			low frequency meaning, *light*	*
weak	MINE	high	high frequency meaning, *coal*	*
			low frequency meaning, *explosive*	n.s.
		low	high frequency meaning, *coal*	*
			low frequency meaning, *explosive*	*

Results from both monolingual and bilingual studies with homographs and homonyms suggest that regardless of whether an orthographic string is associated with multiple meanings within a language or across languages, all meanings associated with the string may initially be activated. However, as the results discussed above illustrate, speed or level of activation of multiple meanings depends on their relative frequencies and strength of context. Crucial to the current work, in studies involving homographs (in contrast to homonyms) where there are multiple representations at both the phonological and semantic levels, naming times, lexical decision response times, and fixation times are all significantly slower compared to control words.

Very little research has been done on the effect of sentence context on lexical-semantic processing by bilinguals. But before turning to the current studies, in which the role of sentence context on the activation of interlingual homographs is investigated, a limited set of studies on the role of sentence context on bilingual lexical-semantic activation will be reviewed.

1.5 Bilingual Sentence Processing

As discussed above, there is a great deal of evidence indicating that bilinguals exhaustively activate multiple meanings of homographs when ambiguous words are presented in isolation or in prime-probe contexts. However, because words are almost never processed in isolation, it is important to examine the effect of sentence context on bilingual language processing.

Altarriba, Kroll, Sholl, and Rayner (1996) examined whether sentence context and word frequency played a role in exhaustive activation in bilingual language processing. Spanish-English bilingual participants were presented with sentences that were either all in English (e.g., *The wedding cake had a bride and groom figurine on the top layer*) or in English with a target word in Spanish (e.g., *The wedding cake had a bride and novio figurine on the top layer*). The sentences constrained the interpretation of the target word (shown underlined) either before (e.g., 3) or after (e.g., 4) it. The target word was either in the same language as the sentence or a translation of that word (e.g., *novio* is the Spanish translation of the English *groom*). Eye-movements of Spanish-English bilingual participants were monitored while reading these sentences.

(3) The wedding cake had a bride and a <u>groom/novio</u> figurine on the top layer.
(4) He wanted his shirt to look like the one the <u>groom/novio</u> was wearing at the wedding.

An analysis of first fixations revealed that participants had significantly longer fixation times on high frequency Spanish words when the constraining context came before the target words than after it. In contrast, participants had significantly longer first fixation times on low frequency Spanish words when the constraining context came after the target word than when it appeared before it. In Experiment 2, Altarriba et al.

presented the same set of stimuli using rapid serial visual presentation (RSVP). In this RSVP task each word in a sentence was presented on a computer screen one word at a time for 250 ms. Participants were asked to say aloud the capitalized target word in each sentence (either *groom* or *novio*) when it appeared on the screen. The pattern of naming latencies was similar to that of first fixations times in Experiment 1. Altarriba et al. concluded that when bilinguals read a strong context, they build up an expectancy for a specific word. Therefore, when participants read a context like, *"The wedding cake had a bride and a"*, an expectancy for the word *groom* is set up. When a specific word like *groom* is expected, but the word that appears is a high frequency word in the non-target language (e.g., *novio*), processing is slowed. This results in longer fixation times for the high frequency non-target language competitor. However, when the context does not set up expectancy for a specific word, presentation of a non-target language competitor does not disrupt processing.

Schwartz (2003) examined effects of sentence context on bilingual language processing by both high and low proficiency participants. In Experiments 3 and 4 Schwartz studied effects of sentence context on the processing of cognates (words having the same orthography and meaning e.g., *piano*), homographs (words having the same orthography but different meanings e.g., *pan* meaning 'something you cook things in' in English and 'bread' in Spanish), and partial cognates (words that share orthography and have overlapping meaning as well as distinct meanings e.g., *grave* meaning 'serious' in both Spanish and English but having the additional meaning in English of 'where bodies are buried'). The group of cognates was further divided into those that were more (e.g., *piano* /pjano/ in English and /piæno/ in Spanish) or less (e.g., *base* /be^{j}s/ in English and /base/ in Spanish) phonologically similar. Sentences either highly constrained the interpretation of the critical word or did not, as illustrated in Table 7. Sentences were presented using an RSVP task in which each word in a sentence was presented for 250 ms in the center of the screen. Participants said the target word (uppercase) aloud. In Experiment 3 Schwartz examined the naming latency and errors of L1 Spanish speakers in L2 English, while in Experiment 4 she examined L1 English speakers in L2 Spanish.

Table 7. Sentences that highly constrained the interpretation of the target (in uppercase) or did not in a RSVP task from Schwartz (2003).

Constraint	Experimental Sentence	Control Sentence
High	The composer sat at the bench and began to play the PIANO as the lights dimmed.	The student looked around for some paper and a sharp PENCIL as the test session began.
Low	As we walked through the room we noticed there was a large PIANO by the window.	The drawers were so messy that I could not find my favorite PENCIL to write with.

Schwartz predicted an effect of sentence context. In other words, in sentences that highly constrained the interpretation of target word, no effect of the other language was expected. More specifically no naming latency or error differences were expected for target and control words in highly constraining sentences. In sentences that did not constrain the interpretation of the target word, faster latencies to target words than to control words were predicted for cognates that had an overlapping phonology (e.g., *band*), and slower latencies and/or increased errors were predicted for homographs (e.g., *pan*). Slower naming latencies and/or increased error responses were also predicted for partial cognates when the appropriate interpretation corresponded to the meaning not shared by the two languages (e.g., when the appropriate interpretation was the ‘cemetery’ meaning of *grave* and not 'serious'). The analysis of the naming latency and error results are summarized in Table 8.

Table 8. Summary of the naming latency and error (in parenthesis) results from Schwartz's Experiment 3 with native Spanish speakers in English, and Experiment 4 with native English speakers in Spanish. An asterisk (*) indicates significantly different naming latencies or errors to target words than control words at a level of $p < .05$ and n.s. indicates a non-significant result.

Experiment 3	**Proficiency of Native Spanish Speakers**			
	high		**low**	
	Sentence Constraint			
	high	**low**	**high**	**low**
cognates overlapping phonology (e.g., *band*)	n.s. (n.s.)	* (n.s.)	* (n.s.)	* (n.s.)
cognates non-overlapping phonology (e.g., *acre*)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)
homographs (e.g., *pan*)	n.s. (n.s.)	n.s. (*)	n.s. (n.s.)	n.s. (n.s.)
shared meaning of homograph (e.g., 'serious' for *grave*)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)
not shared meaning of homograph (e.g., 'cemetery' for *grave*)	n.s. (n.s.)	n.s. (*)	n.s. (n.s.)	* (*)
Experiment 4	**Proficiency of Native English Speakers**			
	high		**low**	
	Sentence Constraint			
	high	**low**	**high**	**low**
cognates overlapping phonology (e.g., *band*)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)
cognates non-overlapping phonology (e.g., *acre*)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)
homographs (e.g., *pan*)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)
shared meaning of homograph (e.g., 'serious' for *grave*)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)	n.s. (n.s.)
not shared meaning of homograph (e.g., 'cemetery' for *grave*)	n.s. (n.s.)	n.s. (n.s.)	* (n.s.)	n.s. (n.s.)

In Experiment 3, with native Spanish speakers with low English proficiency, Schwartz found faster naming latencies for cognates with overlapping phonology (e.g., *band*) in both high and low constraint sentences relative to control words. High performing participants only had a shorter naming latency for cognates relative to controls in low constraint sentences. For cognates where phonology did not completely overlap (e.g., *acre*), there were no significant differences in naming latencies or errors for the cognates and controls in either the high constraint or low constraint sentences. Homographs only no naming latency differences, but a significant increase in errors among high performing participants in low constraint sentences relative to controls. For partial cognates there was no significant influence of sentence constraint or comprehension skill. In Experiment 4 there was only one significant finding. Native English speakers had faster naming latencies relative to control words when the target word was a partial cognate and the sentence was highly constraining and biased towards the meaning that was not shared across English and Spanish. This finding was only significant when low proficiency participants were performing the task.

Because of the finding of faster naming latencies for cognates with overlapping phonology and increased error rates for homographs in low constraint sentences in Experiment 3, Schwartz suggests that her findings indicate that all representations associated with either phonologically or semantically ambiguous words are exhaustively activated. She explains that exhaustive activation is manifested by naming latency differences in one condition and error rates in another, which is a hallmark of a speed accuracy trade-off. However, Schwartz offers no principled reason for a pattern of results in which exhaustive activation is manifested by naming latency differences in 4 out of 20 conditions in Experiment 3 and 1 out of 20 conditions in Experiment 4, and by error rate differences in 3 out of 20 conditions in Experiment 3 and not at all in Experiment 4.

Schwarz's findings, while interesting, do not provide conclusive evidence that sentence language is not sufficient to constrain exhaustive activation, while sentence context is. In addition, an RSVP task, in which words are presented individually for 250 ms, does not simulate the conditions in which most bilinguals read.

1.6 Modeling Word Recognition in Sentential Contexts

Findings in the monolingual literature have been used to support different theories of the role of context and frequency in the activation of multiple meanings of lexically ambiguous words. I will now examine several of these theories. According to an *exhaustive theory* (Onifer & Swinney, 1981; Swinney, 1979), lexical access is an autonomous and exhaustive process that is not influenced by word frequency or sentence context. In other words, all of the meanings of an ambiguous word are accessed regardless of their relative frequency and the sentence context. Context only plays a role after the initial activation of all the meanings of an ambiguous word. On an *ordered search theory* (Higoboam & Perfetti, 1975), the meanings of an ambiguous word are serially searched, beginning with the most frequent. The most frequent meaning is retrieved and examined to see if it matches the context. If it matches, the search is completed. If it does not match, the next most frequent meaning is retrieved and matched against the context. This is done until a meaning is retrieved that matches the context. On this theory context only plays a role after lexical representations have been accessed.

Overall, experimental findings indicate that both frequency and context play a role in the activation of lexically ambiguous words. The *reordered access model* (Duffy, Morris, & Rayner, 1988; Rayner, Binder, & Duffy, 1999; Rayner & Duffy, 1986; Rayner

& Frazier, 1989) was proposed to account for these findings. Under such a model, the meanings of a lexically ambiguous word are exhaustively activated in parallel. However, the speed of activation is influenced by frequency and context. Higher frequency meanings of an ambiguous word are activated more quickly than lower frequency ones. This is very similar to the "temporal delay assumption" built into the BIA+. According to the temporal delay assumption, low frequency lexical representations are activated more slowly than high frequency ones.

On the *reordered access model*, context also speeds activation of a contextually appropriate meaning, but does not influence activation of the inappropriate meaning. According to Duffy et al. (1988), when two meanings of a lexically ambiguous word become available simultaneously, there can be competition at either the access stage or the post-access stage when the word is integrated into the context. Competition leads to longer response times for ambiguous words than for unambiguous control words. When a sentential context is neutral and both meanings of a lexically ambiguous word are of a similar frequency, and therefore, become available simultaneously, there is competition. When a sentential context supports a less frequent meaning, thereby speeding its activation, the two meanings become available simultaneously, resulting in competition. Rayner et al. (1999) point out that context can vary along a strength continuum, thereby affecting activation along a continuum. Consequently, in weak contexts a more frequent meaning becomes available first. In contexts supporting a less frequent meaning, both meanings become available simultaneously. And in contexts <u>strongly</u> supporting the less frequent meaning, it may become available first.

Duffy et al. (1988) indicate that the *reordered access model* can be thought of in terms of an interactive activation model in which frequency and context both affect the amount of evidence accruing for each meaning of an ambiguous word. Each meaning is weighted according to the amount of evidence available to support it. Selection is relatively fast when evidence clearly supports one meaning. Selection is slow when the evidence supports both meanings equally. In other words when both meanings of an ambiguous word have an equivalent frequency and context does not support either meaning, response times are long because there is an equal amount of evidence supporting both interpretations. Response times are also slow when evidence based on frequency supports one meaning and evidence based on context supports the other meaning.

According to a *context-sensitive model* (Martin, Vu, Kellas, & Metcalf, 1999; Kellas, Martin, & Clark, 1992; Paul, Kellas, Martin, & Clark, 1992; Vu & Kellas, 1999; Vu, Kellas, Petersen, & Clark, 2003), activation is the result of an interaction between frequency, whether the context supports the more or less frequent meaning, and the strength of context. Kellas and his colleagues believe that context strength and frequency are both continuous variables that together affect patterns of activation. When context is on the weak end of the continuum, word frequency drives activation. When context is on the strong end of the continuum it drives activation. On the *context-sensitive model*, when contextual information is sufficiently constraining, only the contextually appropriate meaning receives a significant amount of activation, even if this corresponds to the less frequent meaning. Activation is not exhaustive when only one interpretation of an ambiguous word is strongly supported by a given context.

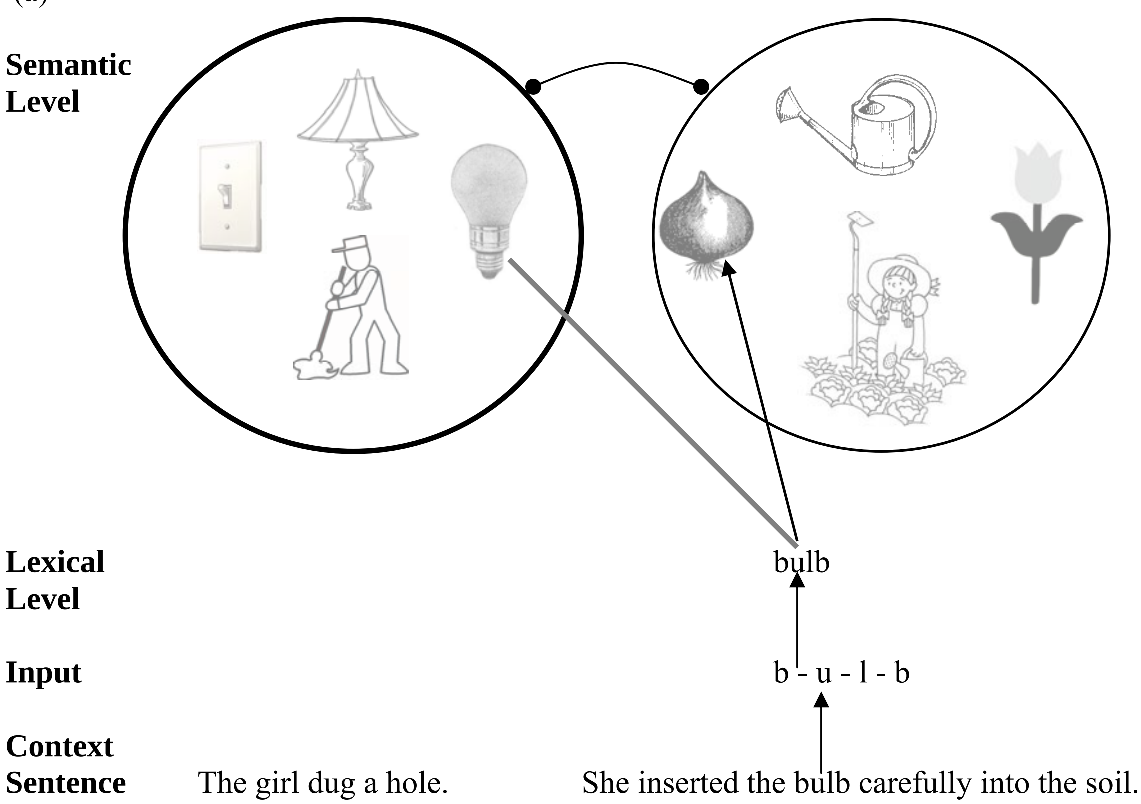
The current form of the *reordered access model* is very similar to the *context-sensitive model*. In early versions of the *reordered access model*, context served to speed activation of the less frequent meaning of a lexically ambiguous word. When sentential context supported a low frequency meaning, both the high and low frequency meanings became available simultaneously, resulting in competition. In early versions, context did not allow a low frequency meaning to be activated without a high frequency meaning also being activated. However, as mentioned above, Rayner et al. (1999) have conceded that context varies along a strength continuum. In the revised model, when context strongly supports a low frequency meaning, it may become available first and does not compete with a high frequency meaning for selection. Both the *context-sensitive model* and the newer version of the *reordered access model* make the same predictions about patterns of activation.

The previously discussed findings of Martin et al. can be explained in terms of both the *context-sensitive* and *reordered access* models. When readers encounter a lexically ambiguous word like *mine* in (5) and (6), frequency supports the ‘coal’ meaning and not the ‘explosive’ meaning. When context is weak, and supports the high frequency meaning, as in (5), only the ‘coal’ meaning is activated. When context is weak, and supports the low frequency meaning, as in (6), both the ‘coal’ and ‘explosive’ meanings are activated. This is supported by significantly longer reading times at *mine* in sentence (6) than (5), and by faster naming latencies for probes related to both meanings relative to control words in sentence (6) but only to probes related to the ‘coal’ meaning in sentence (5). In contrast, when context is strong, as in (7) and (8), only the contextually appropriate meaning is activated. This is supported by the finding of no differences in reading times at *bulb* in sentences (7) and (8). Faster naming latencies for probes related to the appropriate meaning relative to control words were found in sentences (7) and (8), but no difference in latencies for probes related to the inappropriate meaning and control words were found. The pattern of results accounted for by the *context-sensitive* and *reordered access models* can be demonstrated by Figure 7.

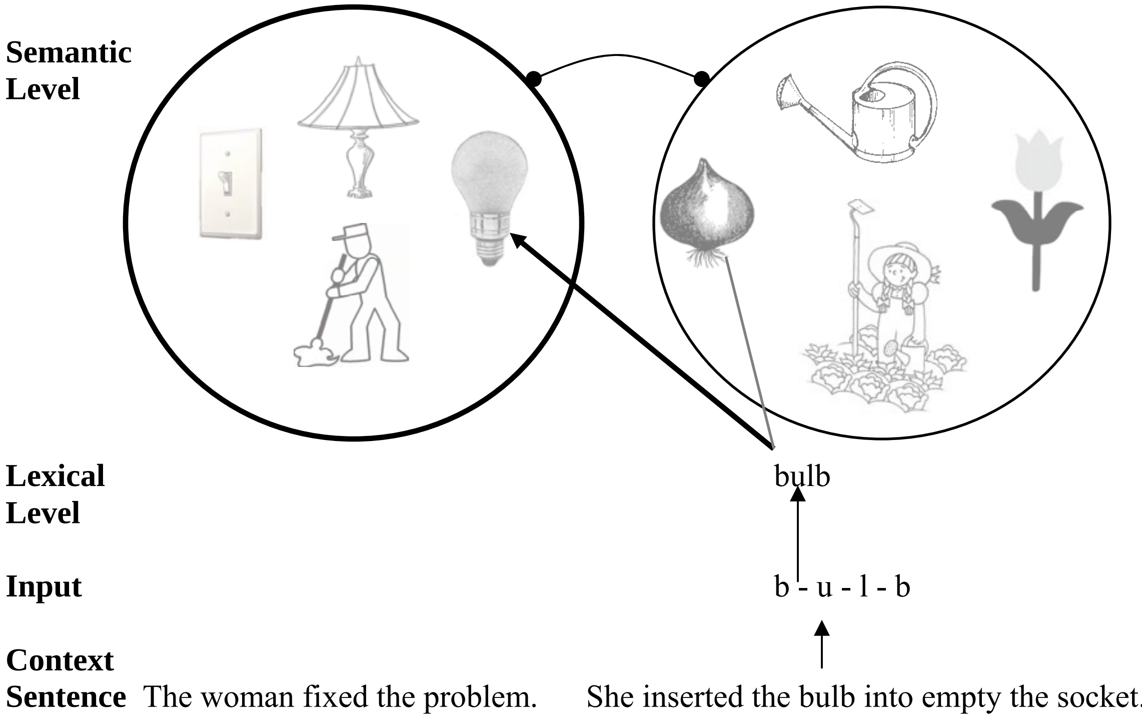
(5) The farmer saw the entrance. He reported the *mine* to the survey crew.
(6) The scout patrolled the area. He reported the *mine* to the commanding officer.
(7) The custodian fixed the problem. She inserted the *bulb* into the empty socket.
(8) The gardener dug a hole. She inserted the *bulb* carefully into the soil.

Figure 7. A depiction of the activation of the 'flower' (a & d) and 'light' (b & c) meanings associated with the homonym *bulb*, where thick lines represent high frequency and thin lines represent low frequency meanings. In (a) and (b) the context is weak while in (c) and (d) it is strong.

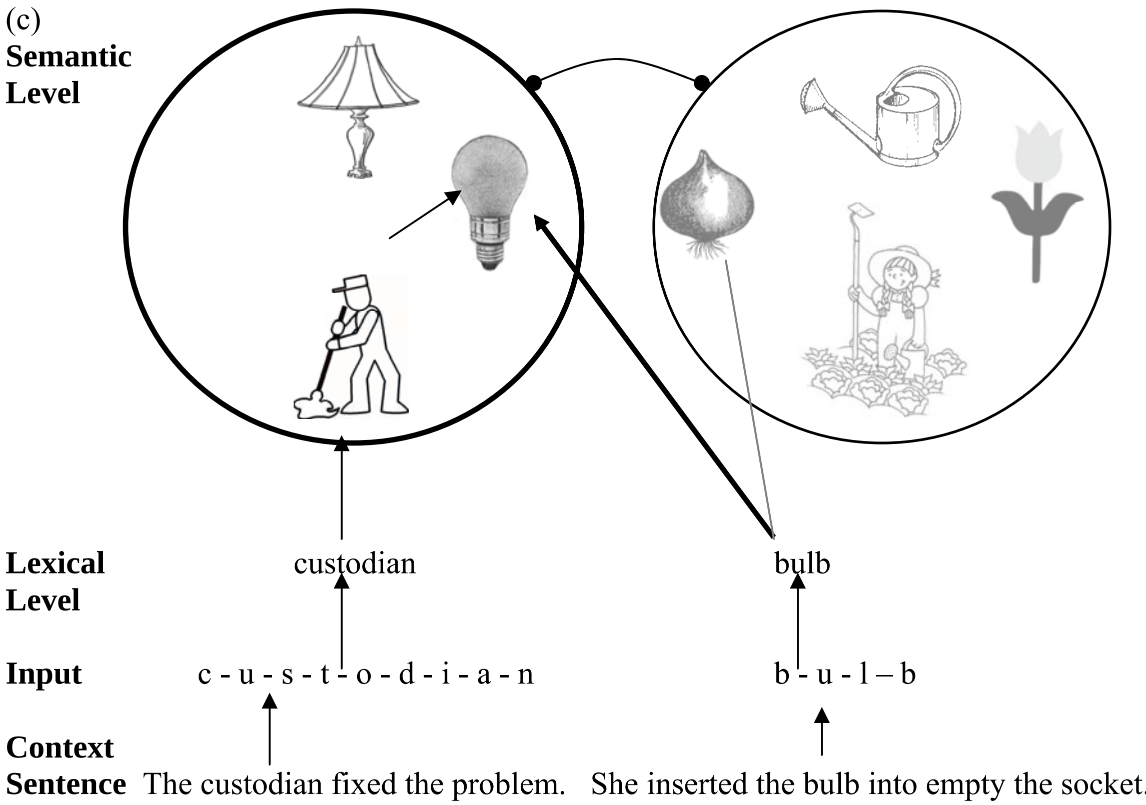
(a)



(b)


Semantic Level
Lexical Level
bulb
Input
b - u - l - b
Context Sentence
The woman fixed the problem.
She inserted the bulb into empty the socket.

(c)


Semantic Level
Lexical Level
custodian
bulb
Input
c - u - s - t - o - d - i - a - n
b - u - l – b
Context Sentence
The custodian fixed the problem.
She inserted the bulb into empty the socket.

(d)

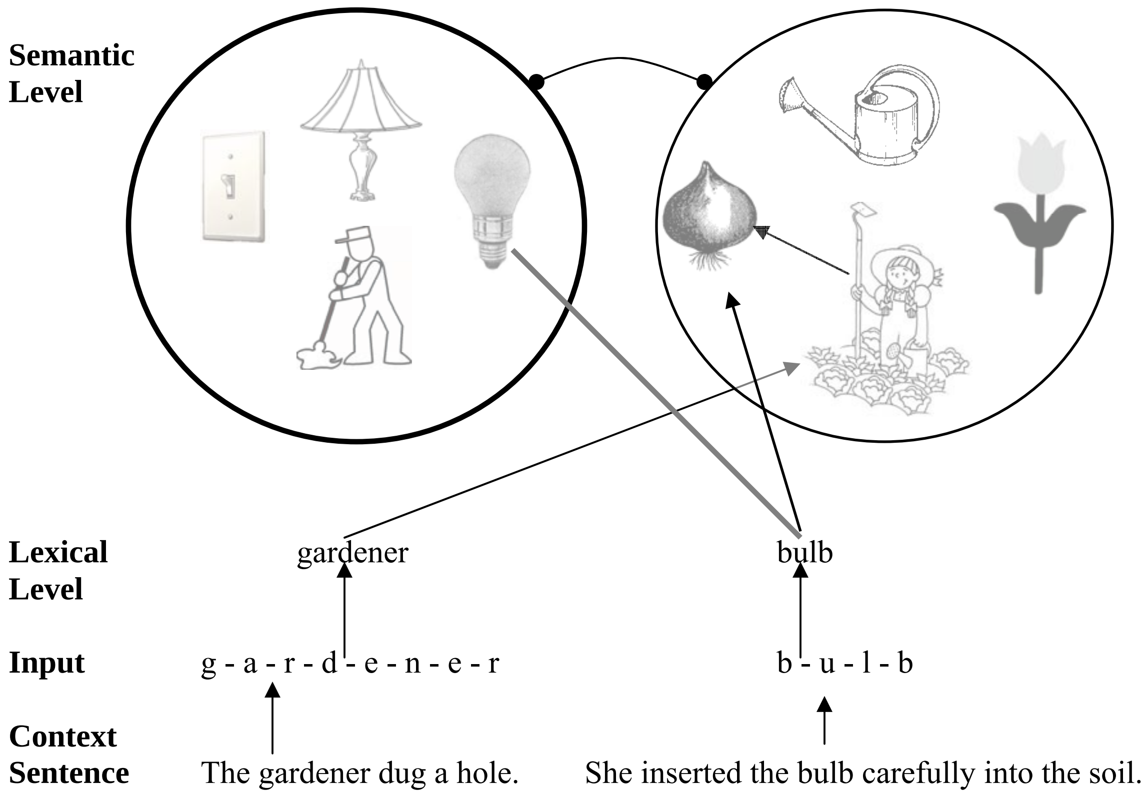


Figure 7 highlights the roles of both frequency and context on the activation of multiple meanings of lexically ambiguous words. As will be discussed in the following section, this dissertation will examine the role of frequency and sentence context in the activation of interlingual homographs.

1.7 Current Investigation

My dissertation experiments capitalize on the findings and experimental paradigms in the bilingual and monolingual lexical processing literatures by examining lexical access to interlingual homographs presented in sentential contexts. These experiments were undertaken to gain a greater understanding of the conditions under which lexical representations from one language influence processing in another.

Specifically these experiments investigated the role of sentence context (Experiment 1), the language of processing (Experiment 2), frequency (Experiments 3 & 4), and proficiency (Experiments 3 & 4) on exhaustive activation. Table 9 provides examples of the experimental stimuli used in four on-line processing experiments. All of the sentences ended in interlingual homographs, while contexts were either biased or neutral. In biased contexts a word or words in a sentence provide a semantic feature of the sentence-final interlingual homograph. In other words, 'monetary value' is a feature of the English word *coin*. In the biased French sentence, a feature of a *carré* 'square' is that it has a *coin* 'corner'. In neutral contexts there was no relationship between the sentence and the meaning of the sentence-final interlingual homograph. Sentences were followed by lexical decisions (i.e., word/non-word judgments) to probe words that were either a translation of the sentence-final interlingual homograph from the non-target language (e.g., the translation of $coin_{French}$ is 'corner' and is $coin_{English}$ 'monnaie'), or control words matched for frequency, length, part of speech and where possible phonology, with the homograph translation. Probe words were always in the same language as the preceding context sentences.

Table 9. Example sentence stimuli and following probe in English and French in both biased and neutral contexts used in four on-line processing experiments.

Biased Sentence English	**Probe Word**	**Probe Type**
The thing with the lowest monetary value is a coin.	a) corner	homograph translation Fr. meaning of *coin*
	b) friend	control for *corner*
Neutral Sentence English		
While walking, the little boy found a coin.	c) corner	homograph translation Fr. meaning of *coin*
	d) friend	control for *corner*
Biased Sentence French		
Alex, mon petit, en haut et à gauche d'un carré, il y a un coin.	e) monnaie	homograph translation Eng. meaning of *coin*
'Alex, my little one, up and to the left of a square is a corner.'	f) montre *'watch'*	control for *monnaie*
Neutral Sentence French		
La boulangerie se trouve vers le coin. *'The bakery is near the corner.'*	g) monnaie	homograph translation Eng. meaning of *coin*
	h) montre *'watch'*	control for *monnaie*

The primary goal of these studies is to assess whether bilingual lexical activation is selective or exhaustive in the context of reading sentences that either indicate the appropriate interpretation of the homograph or do not. If bilingual lexical access is truly exhaustive while reading sentences, lexical decision times to probe words that are translations of sentence-final homographs should be significantly longer than lexical decision times to control words. Specifically, a "YES", or word, response to *corner* following a sentence like (a) should be significantly different from the response to *friend* following the same sentence, illustrated in (b). Exhaustive activation could lead to either faster response times to homograph translations than controls or slower response times. Because Gottlob et al. showed that within a single language there are longer response times to homographs relative to control words in both naming and lexical decision tasks, longer responses times are predicted for the current experiments to homograph translations compared to their control words. In addition, research on interlingual homographs presented in isolation has demonstrated that when participants are engaged in a language-specific task, there are longer response times to non-target language semantic competitors. Because reading in one language is a putatively language-specific task, this leads to a prediction of longer response times to homograph translations than to control words. In contrast, if lexical activation is selective, then lexical decision times to *corner* and *friend* should not differ.

Experiments 1a & b were carried out to determine whether word activation is exhaustive while reading in L2. If word activation was found to be exhaustive while processing in L2, a further goal was to determine whether context could effectively constrain exhaustive activation. Experiment 1a investigated whether native French speakers activated the meaning 'corner' associated with $coin_{French}$ while reading the neutral sentence *"While walking, the little boy found a coin"* in English. This was tested by probing with the word *corner* immediately after participants read the sentence. If word activation is language selective, when reading sentences in a specific language, there should be no significant difference in response times to homograph translations (e.g., *corner*) and control words (e.g., *friend*). But, if word activation is exhaustive under these conditions, there should be significantly longer response times to homograph translations than to control words.

Beyond assessing whether L1 lexical-semantic representations are activated while processing in L2, Experiment 1a investigated whether sentence context constrained interactive activation. If sentence context does not constrain interactive activation, there should be no difference in response times to homograph translations and control words following biased and neutral sentences. However, if context does constrain interactive activation, there should be a significant difference in response times to *corner* and *friend* following biased and neutral sentences. Previous research has shown that when a sentence context contains a feature or a property of an ambiguous word or significantly constrains its interpretation, only the contextually appropriate word is activated to a significant level. Therefore, it was predicted that there would be no significant differences in response times to *corner* and *friend* following sentences that contained a feature of the ambiguous word as in the sentence, *"The thing with the lowest monetary value is a coin"*.

Experiment 1b was carried out to ensure that the results of Experiment 1a were due to participants being bilingual, and were not an artifact of the experimental materials. Experiment 1b replicated Experiment 1a with monolingual English participants. If the results of Experiment 1a were due to the activation of multiple meanings of interlingual homographs by bilingual participants, the pattern of results in Experiment 1a should <u>not</u> be replicated in Experiment 1b.

Experiment 2 investigated whether bilinguals have exhaustive lexical activation while processing sentences in their L1. More specifically, Experiment 2 examined whether native French speakers who are highly fluent in English activated the L2 'money' meaning associated with the homograph *coin* while reading the neutral L1 French sentence, *"La boulangerie se trouve vers le coin"*. If activation is exhaustive while processing in French there should be longer responses to homograph translations (e.g., *monnaie*) than to control words (e.g., *montre*). However, if when processing in L1 there is not a significant level of activation for L2 words, L2 words will not compete with

L1 words for selection. Then there will be no significant difference in response times to *monnaie* and *montre*.

Experiments 3 and 4 investigated the role of frequency and proficiency on exhaustive activation. Experiment 3 tested native French speakers highly fluent in English while reading in English. Experiment 4 tested native English speakers who had an intermediate French proficiency while reading in French. If exhaustive activation while processing in L2 is due to the strength of L2 representations, there should be a significant influence of “strong” L1 representations while processing in L2. In particular, if frequency (used as a proxy for strength of representation) plays a role in exhaustive lexical activation, there should be significant differences in response times to homograph translations when the homograph is high or low frequency in L1. Specifically, slower response times are expected when homograph translations correspond to high frequency L1 interlingual homographs than when they correspond to low frequency ones.

Further, Experiments 3 and 4 investigated the role of proficiency on the exhaustive activation of multiple meanings of interlingual homographs. Because the participants in Experiment 4 had an intermediate level of proficiency in L2 French, a larger influence of “strong” L1 representations was expected. In contrast, in Experiment 3 where participants had a high L2 English proficiency, less of an influence of “strong” L1 representations was expected. In other words, because representations of L2 words will be “stronger” for high proficiency participants, L1 representations should have less influence on lexical activation in L2. The effect of proficiency will be assessed by comparing the pattern of results across Experiments 3 and 4.

Taken together, the set of dissertation experiments investigated whether processing in one language is influenced by lexical-semantic representations in another language. Specifically, they examined whether the influence one language exerts while processing in the other is mediated by sentence context and the strength (frequency) of lexical-semantic representations. Before turning to these investigations, the next two chapters discuss the assessment of the language proficiency of my bilingual participants, and the norming studies that were done to create the stimuli used in the on-line processing experiments.

CHAPTER 2

2 Language Proficiency

2.1 Assessing Language Proficiency

Although it is likely erroneous, there is typically an assumption of homogeneity of proficiency among monolingual participants. Consequently, monolingual participants are not usually asked to give information about their linguistic background. However, in studies involving bilinguals, such homogeneity cannot be assumed in L2. Therefore, bilingual participants are usually asked to provide an assessment of their proficiency and to describe patterns of use for each of their two languages. Also, performance on certain tasks is sometimes used to assess bilinguals' proficiency in their L2. Both self-assessment and performance on tasks used to assess proficiency will be discussed in this chapter.

Because experimental results can be influenced by the proficiency level of participants in their two languages, the proficiency of all bilingual participants in their L1 and L2 was assessed. This was done to ensure that all bilingual participants within an experiment had roughly similar levels of proficiency in both L1 and L2. Proficiency was assessed using a language background questionnaire and by evaluating participants' performance on a vocabulary test or a stimuli verification test. Each of these will be discussed in turn.

Research has demonstrated that results from language background questionnaires, in which participants are asked to assess their own proficiency, correlate with independent measures of proficiency (see Grosjean 1982; Metz, Caccamise, & Gustafson, 1997). To assess the proficiency of the bilingual participants in the current experiments, English-French translation equivalent language background questionnaires were prepared (see Appendix A).[11] The language background questionnaire assessed proficiency by evaluating the following three factors:

1. language history – when and how English and French were acquired
2. the function of English and French – when each language is used with whom and for what purpose
3. language ability in English and French

First, in order to assess the participants' language history, each participant was asked at what age they were first exposed to English and French, whether their parents spoke either or both languages with them, whether they learned either language or both languages at school or at home, and whether either language or both languages were used in elementary school, middle school, high school, university and graduate school. Participants were asked whether they spoke other languages in addition to English and French and their proficiency in each. Any participants who rated themselves as having a proficiency of "ok" or better in a third language were excluded from further study, as their knowledge of a third language might influence the results of the studies.

Second, the functions of English and French were assessed by asking participants to rate whether they always speak English, speak English more than French, speak English and French equally, speak French more than English, always speak French, or did not apply to the following people: their parents; their brothers and sisters; their friends; and their co-workers. Similarly the participants were asked to rate the language use of the same people when speaking to them. Participants were also asked to assess the relative frequency with which they read, write, speak, and hear English and French.

[11] The language background questionnaire is modeled after the one used by Fernández (2000) in her study on relative clause attachment by Spanish-English bilinguals.

Participants also specified how many hours a week they speak, read, and listen to English and French.

Third, to assess language ability, participants were asked to rate their abilities as excellent, good, ok, weak, or very poor in speaking, reading, writing, and comprehension in both English and French. Participants were asked if they could always, almost always, sometimes, almost never, or never pass as a monolingual speaker in English and French when talking with someone who doesn't know them. Finally, participants were asked what language they feel most comfortable speaking, what language they use to do simple arithmetic, and if they had any other information they thought was important to assess their language background.

As stated above, previous research has demonstrated that participants' assessment of their own proficiency correlates with independent measures of proficiency. Therefore, the language background questionnaire was used as a metric of proficiency. An additional measure was a vocabulary test. Vocabulary size, usually assessed by testing participants' knowledge of vocabulary at different frequency levels, has been demonstrated to be correlated with general language proficiency (e.g., Schmitt & Mera, 1997). Knowledge of vocabulary is also correlated with performance on reading comprehension tasks (e.g., Alderson, 2000). Crucial to the current research, if participants did not have a sufficient vocabulary in their second language, it would be impossible for them to successfully read experimental sentences and probe words in their L2.

Vocabulary tests are used in studies where an estimate of lexical size at a relevant frequency level is considered informative (e.g., Schmitt & Mera, 1997). Because some of the interlingual homographs used in the current studies were low frequency in English and/or French, it was important to assess participants' knowledge of low frequency words in English and French. If participants were unfamiliar with the low frequency words on the vocabulary test, it is unlikely that they would know the low frequency homographs.

Vocabulary tests (see Appendix B) were created and given to participants who were considered, *a priori*, to have high L2 proficiency.[12] The vocabulary tests were given in both L1 and L2. Participants were asked to provide a definition or translation for five high, five mid, and five low frequency words in both English and French. English word frequencies were established using Francis & Kučera (1982), a corpus of 1 million words of written English. French frequencies were established using Brulex (Content, Mousty, & Radeau, 2000), a corpus of 100 million words of written French. If participants were unfamiliar with a word, they were asked to indicate that they did not know it. The vocabulary verification test was administered to ensure, in conjunction with the language background questionnaire, that all of the bilingual participants within an experiment had a similar level of proficiency in their L2. In addition, the test could be used as an indication that participants would be able to read successfully for comprehension, and that they would be familiar with the low frequency interlingual homographs and control words. All of the bilingual participants from the University of Toronto and l'Université du Québec à Montréal were able to provide a definition or translation for all high- and

[12] English-French bilingual participants at the University of Toronto (Norming Study 1) and French-English bilingual participants at l'Université du Québec à Montréal (Exp. 1a, Experiment 2, & Experiment 4) were considered, *a priori*, to have high proficiency in both languages and were given a post experiment vocabulary test. Third and forth semester French students at the University of Buffalo (Experiment 3) were considered, *a priori*, to have an intermediate proficiency and were given a test verifying their knowledge of the homographs and the words used in the lexical decision task.

mid-frequency words. No participant gave an incorrect response or indicated *"don't know"* for more than one of the low-frequency words. This was taken as an indication that all of the participants assigned to the high proficiency group had a similar level of proficiency, that they would be able to read for comprehension successfully, and that they would be familiar with the low frequency homographs and control words.

Third and forth semester French students at the University at Buffalo (Experiment 3) were considered, *a priori*, to have an intermediate L2 proficiency. It was assumed that they would be unfamiliar with many of the low and mid frequency words on the in the on-line processing experiment and on the vocabulary test. Therefore, instead of the vocabulary test, they were given a post-experiment stimulus verification task (see Appendix C). The verification task was done to discern which of the homographs, homograph translations, and control words in the on-line processing experiment the participants were unfamiliar with. Participants were asked to indicate, by circling, which if any of the words in the sentences or probe words that they felt they were unfamiliar with. If participants indicated that they were unfamiliar with any of the interlingual homographs or probe words used in the lexical decision task, these items would be excluded from analysis.

In the on-line processing experiment, intermediate proficiency participants were assigned to different experimental lists, such that when a homograph was presented, it was followed either by a homograph translation or a control word. A participant never saw a homograph followed by both its translation and the translation's control word. Specifically, participants assigned to list 1 saw the homograph *coin* followed by the translation equivalent *'monnaie'*, but not the control word *montre*. Participants assigned to list 2 saw the homograph *coin* followed by the control word *montre*, and <u>not</u> the translation equivalent *monnaie*. In the verification task, participants assigned to list 1 saw the word *monnaie*, and those assigned to list 2 saw the word *montre*. In the verification task, participants were asked to indicate any words from the experimental sentences and their subsequent lexical decision tasks that they did not know. Participants assigned to both lists 1 and 2 saw the sentence *"La boulangerie se trouve vers le coin"* on the verification task and were asked to circle any words in the sentence they were not familiar with. Similarly participants were asked to circle any words from the lexical decision task that they were unfamiliar with. Sentences containing interlingual homographs and/or items with homograph translations and control words that were unfamiliar to 40% or more of the participants were excluded from analysis. This resulted in the loss of 12 of 32 items. This will be discussed further in section 4.5 when the analysis and results of Experiment 4 are taken up.

2.2 Analysis of the Results from the Language Background Questionnaire

As stated previously, a language background questionnaire was given to all bilingual participants. A potential problem is that results from the questionnaire might be affected by the language it was completed in. Completing the language background questionnaire in L2 may be more difficult than in L1. Therefore, participants may be more likely to rate their proficiency as being 'less good' when completing the questionnaire in their L2. In contrast, when participants complete a language background questionnaire in their L1 they have not been asked to do anything that they might find difficult in their L2. Therefore, they may be more likely to rate their L2 proficiency as being “good”. To investigate whether self-assessment is influenced by the language of the questionnaire, 24 English-French bilingual participants from the University of Toronto were given the language background questionnaire in either L1 English or L2 French. Participants were asked to rate themselves on speaking, reading, writing, and comprehension along the following five point scale: 1. excellent/excellent, 2. good/bon, 3. ok/ok, 4. weak/faible, 5. very weak/très faible. Results from the questionnaire on the mean number of years exposed to both L1 and L2 and self-ratings in L2 can be seen in Table 10. Results from the self-rating were analyzed using the Mann-Whitney U test.[13] There were no significant differences in self-rating on speaking ($p>.05$), reading ($p>.05$), writing ($p>.05$), or comprehension ($p>.05$) when participants were given the questionnaire in L1 English or L2 French. These results indicate that with high proficiency participants, self-assessment is not entirely influenced by the language of the questionnaire.

[13] The Mann-Whitney test is a nonparametric test which compares two independent groups when variables are ordinal (e.g., Likert scales using measures like Strongly Disagree, Moderately Disagree, Slightly Disagree, Neutral, etc.) instead of continuous. Crucial to the current analysis of self-assessed proficiency, the Mann-Whitney U test does not make assumptions about normal distribution.

Table 10. Self ratings with Standard Error in parenthesis from language background questionnaire when completed in either L1 English or L2 French by bilingual participants at the University of Toronto. Ratings were on a 5 point scale where 1 indicated an excellent and 5 a very poor proficiency.

	Language of Questionnaire	
	L1 English n=12	**L2 French** n=12
Mean years exposed to L1	24.7	21.5
Mean years exposed to L2	21.6	20.6
Average self-rating on 5 point scale:		
speaking L2 French	2.0 (0.2)	1.8 (0.2)
reading L2 French	1.5 (0.2)	1.8 (0.2)
writing L2 French	2.1 (0.1)	2.1 (0.2)
comprehension in L2 French	1.8 (0.2)	1.6 (0.2)

Results on the language background questionnaire may also have been influenced by the context in which it was administered. For example, after completing the on-line processing experiments in L2, participants may be more likely to rate their proficiency as ‘less good’. In contrast, when participants have not yet been asked to do anything in their L2, they may be more likely to rate their proficiency as ‘good’. Forty French-English bilingual participants from l’Université du Québec à Montréal were given the language background questionnaire in L1 French either before or after completing the on-line processing experiment in English. As before, participants were asked to rate themselves on speaking, reading, writing, and comprehension along a five point scale. Results from the questionnaire can be seen in Table 11. These results were analyzed using a Mann-Whitney U test. There were no significant differences in self-rating on speaking ($p>.05$), reading ($p>.05$), writing ($p>.05$), or comprehension ($p>.05$) when participants were given the questionnaire in L1 either before or after completing the on-line processing experiment. These results indicate that for high proficiency participants, self-assessment is not completely driven by whether or not participants have just completed a processing task in their L2.

Table 11. Self ratings with Standard Error in parenthesis from language background questionnaire when completed by bilingual participants at l'Université du Québec à Montréal in L1 French either before or after a reading comprehension task. Ratings were on a 5 point scale where 1 indicated an excellent and 5 a very poor proficiency.

	Questionnaire Given	
	before n=20	**after** n=20
Mean years exposed to L1	33.0	33.8
Mean years exposed to L2	24.7	27.8
Average self-rating on 5 point scale:		
speaking L2 English	1.9 (0.2)	1.9 (0.2)
reading L2 English	1.8 (0.2)	1.5 (0.2)
writing L2 English	2.0 (0.2)	1.9 (0.2)
comprehension in L2 English	1.8 (0.3)	1.7 (0.2)

To further examine if results on a self-assessment of proficiency are driven by whether the questionnaire is administered before or after completing the on-line processing experiment in L2, 18 English speakers with an intermediate French proficiency at the University of Buffalo rated themselves on speaking, reading, writing, and comprehension before and after a reading comprehension task. The participants were all L1 English speakers and currently taking a third or forth semester French course. The questionnaire was always administered in L1 English. The full questionnaire was given before participating Experiment 4. After completing Experiment 4 and the stimulus verification task, participants were asked to rerate themselves on the five point scale for their speaking, reading, writing, and comprehension abilities in L2 French. Because these participants only had an intermediate proficiency in French, they might be more likely to give their abilities a 'less good' rating (e.g., rating closer to 5 on the scale) after participating in the on-line experiment and the stimulus verification task. Results from the questionnaire when administered before and after can be seen in Table 12. There were no significant differences in self-rating on speaking ($p>.05$), reading ($p>.05$), writing ($p>.05$), or comprehension ($p>.05$) in L2 before and after participating in the on-line processing experiment. These results indicate that even for intermediate proficiency participants, self-assessment is not driven by whether or not participants have just completed a processing task in their L2.

Table 12. Self ratings with Standard Error in parenthesis from language background questionnaire when administered in L1 English both before and after on-line experiment to third and forth semester French participants at the University of Buffalo. Ratings were on a 5 point scale where 1 indicated an excellent and 5 a very poor proficiency.

Mean years exposed to L1	20.0	
Mean years exposed to L2	8.7	
	Questionnaire Given	
	before n=9	**after** n=9
Average self-rating on 5 point scale:		
speaking L2 French	3.1 (0.2)	2.9 (0.2)
reading L2 French	2.6 (0.2)	2.6 (0.2)
writing L2 French	2.9 (0.2)	2.8 (0.2)
comprehension in L2 French	2.7 (0.2)	2.6 (0.2)

Taken together, these results indicate that neither the language of the questionnaire nor the point at which it is administered significantly affect how participants rate themselves. Further, intermediate proficiency participants' self-ratings do not change after having completed the on-line experiment and the stimuli verification task.

If the language background questionnaire is a good measure of proficiency, results from the questionnaire should correlate with other measures such as performance on the vocabulary test, reading times in experiments, performance on comprehension questions in the experiments, and performance on the word/non-word decision during the experiment. As stated before, all of the bilingual participants from the University of Toronto and l'Université du Québec à Montréal were able to provide a definition or translation for all high- and mid-frequency words. Further, no participant gave an incorrect response or indicated *"don't know"* for more than one of the low-frequency words. Because the participants were performing at ceiling on the vocabulary test, there was not enough variability in performance to conduct a further statistical analysis correlating performance and self-assessment. However, results from sentence reading times and performance on comprehension questions and the word/non-word decision during the on-line experiments can be used as independent measures of proficiency and correlated with self-assessment on the language background questionnaire.

Because the on-line processing experiment involved reading in a second language and making decisions about what was read, I looked at whether participants' self-evaluation of their reading skills correlated with their performance. All of the following analyses examined the correlation between self-assessment on the language background questionnaire and performance by the 18 intermediate proficiency participants from the University of Buffalo in Experiment 4 and the 18 high proficiency participants from l'Université du Québec à Montréal in Experiment 3.

Self-assessment of reading skill in a second language correlated with reading times in Experiments 3 and 4, $\rho=.56$, $p<.05$.[14] In other words, participants who rated themselves as better readers (e.g., values closer to 1) read the sentences more quickly. This is demonstrated in Figure 8 which shows that overall faster reading times are associated with "better" judgments of reading skill in a second language. Self-assessment of reading skill in a second language also correlated with the percent of incorrect responses to comprehension questions about the sentences that the bilinguals had read, $\rho=.36$, $p<.05$. As is illustrated by Figure 9, participants who rated themselves as having better reading proficiency missed fewer questions than those rating themselves as having weak reading skills. Self-assessed reading skill correlated with incorrect responses on the non-word, $\rho=.53$, $p<.05$, and word decisions, $\rho=.55$, $p<.05$. As illustrated by Figures 10 and 11 respectively, participants who rated themselves as having better reading proficiency incorrectly identified fewer non-words as words, and fewer words as non-words than participants who rated themselves as having weaker reading proficiency. Taken together these results indicate that self-assessment of reading skill in a second language serves as a good indicator of performance on reading and reading comprehension tasks.

[14] Spearman's rank correlation coefficient, denoted by ρ (rho), was used to assess the relationship between self-assessment and performance. Spearman's rank correlation coefficient is a non-parametric measure that assesses how well an arbitrary monotonic function describes the relationship between two variables, without making any assumptions about the frequency distribution of the variables. Unlike the Pearson product moment correlation coefficient, Spearman's rank correlation coefficient does not require that the relationship between the variables be linear, nor that the variables be measured on interval scales. Crucially, Spearman's rank correlation coefficient is used for variables measured at the ordinal level, as is the case with the self-assessment measure.

Figure 8. Reading time per letter in (ms) vs. self-assessment of reading skill in a second language, where 1 indicates excellent and 5 indicates very poor.

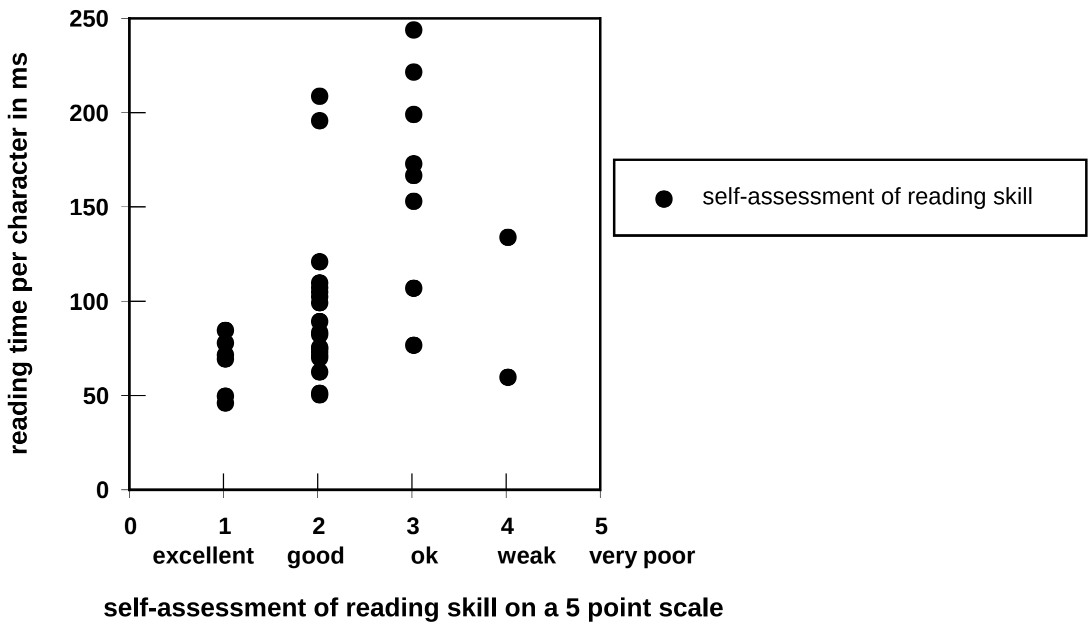


Figure 9. Percentage of incorrectly answered comprehension questions vs. self-assessment of reading skill in a second language, where 1 indicates excellent and 5 indicates very poor.

Figure 10. Percentage of non-words incorrectly identified as words vs. self-assessment of reading skill in a second language, where 1 indicates excellent and 5 indicates very poor.

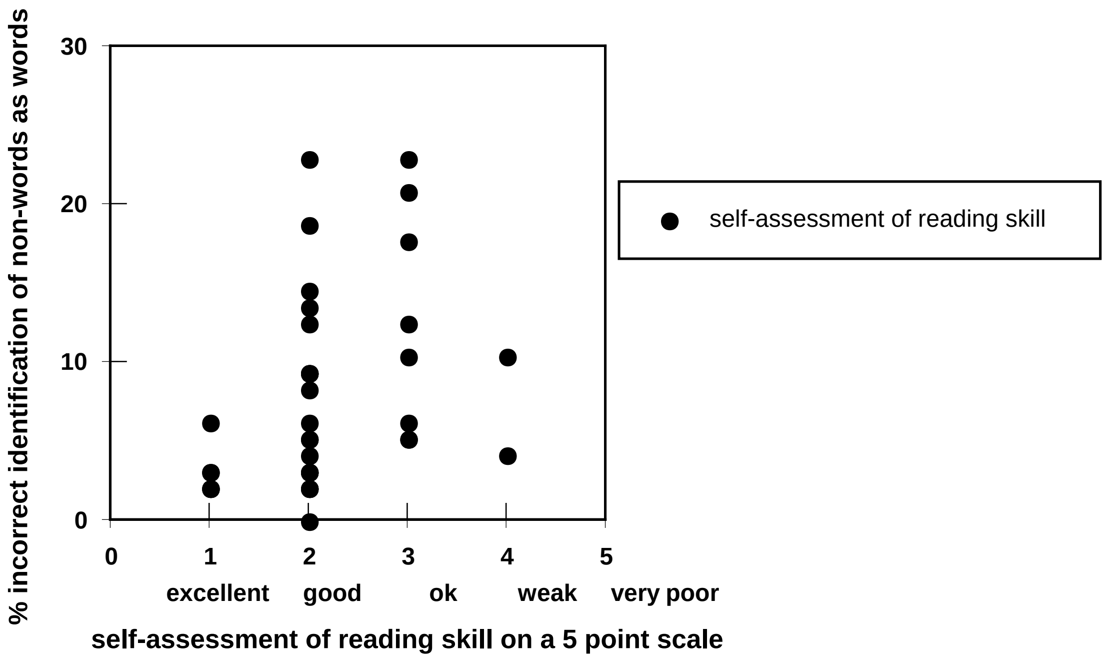
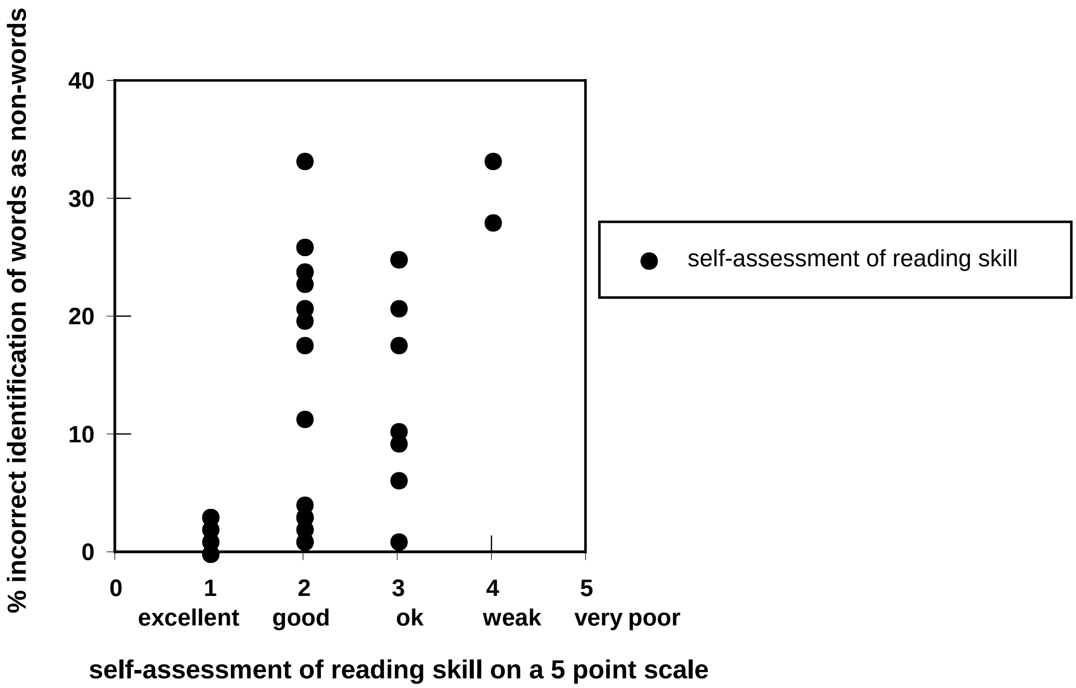


Figure 11. Percentage of words incorrectly identified as non-words vs. self-assessment of reading skill in a second language, where 1 indicates excellent and 5 indicates very poor.



Self-assessment of speaking ability in a second language also correlated with reading times, $\rho=.56$, $p<.05$. Participants who rated themselves as having better speaking abilities read the sentences more quickly. However, self-assessment of speaking abilities did not correlate with the number of comprehension questions that bilinguals answered incorrectly, $\rho=.24$, $p>.05$. But self-assessed speaking ability correlated with incorrect responses on the non-word, $\rho=.59$, $p<.05$, and word decisions, $\rho=.67$, $p<.05$. In other words, participants who rated themselves as having better speaking abilities incorrectly identified fewer non-words as words and fewer words as non-words than participants who rated themselves as having weak speaking abilities. The same pattern of results was found for self-assessment of writing and comprehension skills. Both self-assessed writing and comprehensions skills correlated with reading times and ability to identify words and non-words. There was no correlation between self-assessed writing and comprehension skills and performance on comprehension questions. Taken together these results indicate that self-assessment of reading skill in a second language is the best indicator of performance on reading, reading comprehension, and word/non-word identification tasks. Self-assessment of speaking, writing, and comprehension skills are also good indicators of performance on reading, and word/non-word identification tasks. Because the current self-assessment correlated with performance, results from the language background questionnaire will be taken to serve as a metric for evaluating language proficiency.

CHAPTER 3

3 Stimulus Norming

As discussed previously, experimental findings indicate that both frequency and context play a role in the activation of lexically ambiguous words. The *reordered access model* (Duffy, Morris, & Rayner, 1988; Rayner, Binder, & Duffy, 1999; Rayner & Duffy, 1986; Rayner & Frazier, 1989) and the *context sensitive model* (Martin, Vu, Kellas, & Metcalf, 1999; Paul, Kellas, Martin, & Clark, 1992; Vu & Kellas, 1999; Vu, Kellas, Petersen, & Metcalf, 2003) account for experimental findings that implicate word frequency and context in lexical activation. According to these models, speed of activation is influenced by frequency and context. Context varies along a strength continuum, thereby affecting activation in a graded fashion. In weak contexts, a more frequent meaning becomes available first. In contexts supporting an infrequent meaning, both meanings become available. In contexts that <u>strongly</u> support an infrequent meaning, only the infrequent meaning becomes available.

In order to test whether sentential context and frequency mediate activation of interlingual homographs, biased sentences which make salient one meaning of a homograph, and neutral sentences which do not make salient the meaning of the homograph, were created. Following Tabossi's (1988a; 1988b) procedures, strongly biased sentences were created by first eliciting the salient features of the homographs. These features were then used to construct biased sentences for the subsequent on-line processing experiments.

3.1 Norming Study 1

3.1.1 Method

Materials. Ninety words were selected for norming in this study. Half of them were English interlingual homographs, like *coin*, and the other half were translations of the meaning of the homographs from French (e.g., *corner* is the translation of *coin*). Two bilinguals, one a French and the other an English native speaker, agreed upon the best English translation for each homograph (e.g. the best English translation for French *coin* is English *corner*).

Participants and Procedure. Twenty monolingual English speakers from the University at Buffalo participated for partial course credit. Participants were asked to give the three most important properties or features of words that were English interlingual homographs (e.g., *coin*) and of words that were English translations of French interlingual homographs (e.g., *corner*). Two examples (e.g., 9a & b) were provided to illustrate what was meant by important properties and features (see Appendix D for Norming Exp. 1). Because all of the participants were monolingual English speakers, there was no relation between the homographs and their translations. Participants were not given any indication that the words presented in the experiment were interlingual homographs and their translations until they were debriefed.

9. a) What are the most important properties or features of TREE.

    ____
    ____
    ____

    You might list *LEAVES, BRANCHES, TRUNK.*

   b) What are the most important properties or features of RICE.

    ____
    ____
    ____

    You might list *WHITE, FOOD, GRAIN.*

3.1.2 Results and Discussion

The most frequently elicited response to concrete nouns were features or properties of the noun. For example, the most frequent response to *coin* was *'monetary value'*. However, many of the interlingual homographs were not concrete nouns in both English and French. For example, the homograph *lit* is a noun meaning *'bed'* in French, but is the past tense of the verb *light* in English. When the experimental items were not concrete nouns, as in the case of *lit*, responses were words that had the experimental item as a salient property. In the case of *lit*, the most frequently elicited response was *'candle'*, which has as a salient property something that is *lit*.

The first or second most frequently elicited responses for each of the words presented in Norming Study 1 were used to create sentences that biased a language-specific interpretation of an interlingual homograph.[15] Because *'monetary value'* was the most frequently elicited response to the word *coin*, it was used to create a sentence in

[15] For two homographs, *lame* and *laid*, the most frequently elicited responses were for the slang meaning of these words. The most frequently elicited response to *lame* was *'stupid'* and to *laid* *'sex'*. For *lame* the most frequently elicited response that was not related to the slang meaning was *'limp'* and to *laid* was *'table'*. Responses that were not related to the slang meaning of these homographs were used in sentence construction.

which the context was biased towards the English interpretation, given in (10a). The most frequently elicited response to *corner* (translation into English of French *coin*) was *'square'*. This response was used to create a sentential context biased towards the French interpretation of the word *coin*, given in (10c). In all biased sentences there was always at least one and never more than five words between the word evoking a salient feature and the interlingual homograph. Neutral sentences, which were designed so as to not bias readers toward a language specific interpretation of interlingual homographs, were created jointly by a native speaker of English and a native speaker of French. In these sentences the most frequently elicited responses from Norming Study 1 were not used, and an attempt was made to make the sentences neutral with respect to the meaning of the sentence final homograph (e.g., 10b and 10d).

(10)a. The thing with the lowest monetary value is a coin.
b. While walking, the little boy found a coin.
c. Alex, mon petit, en haut et à gauche d'un carré, il y a un coin
(*'Alex, my little one, to the top and to the left of a square is a corner.'*)
d. La boulangerie se trouve vers le coin.
(*'The bakery can be found by the corner.'*)

For seven of the 45 interlingual homographs, sentences were not constructed because when these interlingual homographs occurred sentence finally, the sentences were either ungrammatical or unnatural in English and/or French. For example, the homograph *pour* meaning "for" is unnatural sentence finally in French. Similarly, the homograph *main* sounds awkward sentence finally in English.

3.2 Norming Study 2

A second norming study was conducted to ensure that the property elicited in Norming Study 1 actually served to render salient the meaning of a homograph in its sentential context. Again following Tabossi's (1988a; 1988b) procedures, participants were asked which if any words in a sentence made them think of a particular feature of the homograph. In biasing sentences, participants should agree upon which word or words evoked the meaning of a homograph. In neutral sentences, there should not be any words in the sentence that rendered salient the meaning of a homograph.

3.2.1 Method

Materials. Thirty-eight sentence quadruples, like those in (10), were constructed. The sentences differed in whether they were in English (10a) and (10b) or in French (10c) and (10d), and whether they were biasing (10a) and (10c), or neutral (10b) and (10d).

Participants and Procedure. 24 monolingual English speakers from the University at Buffalo participated for partial course credit. These participants were given the English version of the task, in which they saw sentences like those in (10a) and (10b) (see Appendix E). 24 French-English bilinguals from the University of Toronto were paid to participate in the French version of the task. The bilinguals saw sentences like those in (10c) and (10d) (see Appendix E).

Participants were asked to indicate by circling whether any word or words in a sentence made them think of the homograph or evoked a feature or aspect of the homograph. If there were not any words in the sentence that made them think of the homograph they were asked to indicate this by circling none. They were given three example sentences to illustrate the task. In both the English and the French tasks the items were counterbalanced across two lists such that participants saw an interlingual homograph in only one condition (e.g., in either a biased or neutral sentence) and saw an equal number of homographs in each condition. For example, a participant only saw *coin* in the biased or neutral sentence. Participants were not given any indication that the words presented in the norming study contained interlingual homographs until they were debriefed.

3.2.2 Results and Discussion

Tabossi (1988a; 1988b) had a panel of 10 participants indicate, for all experimental sentences, whether there were words in a sentence that evoked features or properties of the critical word. She found 84% agreement on the words that evoked features or properties of the critical word. Similar to Tabossi's studies, for the 32 sentence quadruples (e.g., 10) chosen to be used in the on-line processing experiments there was a high level of agreement on the word, words, or no words that evoked a feature or property of the interlingual homographs. In Norming Study 2 for neutral sentences there was between 73% and 100% agreement across sentences, with an average agreement of 86%, that no words in the sentence evoked a property or feature of the interlingual homograph. In biased sentences there was between 65% and 100% agreement across sentences, with an average of 82% agreement, on the word or words from the sentence that evoked a feature or property of an interlingual homograph. There was less overall agreement on the biased sentences than the neutral ones. Previous research has shown that when a sentence context contains a feature or a property of an ambiguous word, only the contextually appropriate meaning is activated to a significant level. If some of the biased sentences, like those in which there was only 65% agreement, did not clearly evoke a feature or property of the interlingual homograph, an effect of sentence context may not be found. However, because overall there was a high level of agreement, an effect of sentence context is predicted for the biased sentences.

CHAPTER 4

4 On-line Processing Experiments

The following experiments investigated the conditions under which lexical representations from one language influence processing in another. Specifically, these experiments investigated the role of sentence context (Experiment 1), the language of processing (Experiment 2), frequency (Experiments 3 & 4), and proficiency (Experiments 3 & 4) on exhaustive activation. Table 9 in section 1.7 provides examples of the experimental stimuli used in these four on-line processing experiments. All of the sentences ended in interlingual homographs, while contexts were either biased or neutral. Sentences were followed by lexical decisions (i.e., word/non-word judgments) to probe words that were either a translation of the sentence-final interlingual homograph from the non-target language or control words matched for frequency, length, and part of speech to the homograph translation. Probe words were always in the same language as the preceding context sentences.

The primary goal of the following studies was to test whether bilingual lexical activation is selective or exhaustive in the context of reading sentences that either indicate the appropriate interpretation of the homograph or do not. If bilingual lexical access is truly exhaustive, lexical decision times to probe words that are homograph translations of the preceding interlingual homographs should be significantly different from lexical decision times to control words.

Experiments 1a & b were carried out to assess whether word activation is exhaustive while reading in L2. If word activation is exhaustive while processing in L2, a further goal was to test whether context could effectively constrain exhaustive activation.

More specifically, Experiment 1a investigated whether native French speakers activated the meaning 'corner' associated with *coin*$_{French}$ while reading the neutral sentence *"While walking, the little boy found a coin"*. This was tested by probing with the word *corner* immediately after participants read the sentence. If word activation is language selective, there should be no significant difference in lexical decision times to homograph translations (e.g., *corner*) and control words (e.g., *friend*). If all meanings corresponding to a letter string are exhaustively activated no matter the language of processing, there should be significantly longer lexical decision times to homograph translations than to control words.

Beyond assessing whether L1 lexical-semantic representations are activated while processing in L2, Experiment 1a investigated whether sentence context constrains exhaustive activation. If sentence context does not constrain interactive activation, there should be no difference in lexical decision times to homograph translations and control words following biased and neutral sentences. However, if context does constrain interactive activation, there should be a significant difference in lexical decision times to *corner* and *friend* following biased and neutral sentences. As discussed above, previous research has shown that context affects the activation of multiple meanings of homographs and homonyms. Therefore, the prediction was that that there would be no significant difference in lexical decision times to *corner* and *friend* following sentences that contained a feature of the ambiguous word as in the sentence, *"The thing with the lowest monetary value is a coin"*.

Experiment 1b was a control experiment that was conducted to assess whether the materials used in Experiment 1a were driving its results (homograph translations and control words, and biased and neutral sentences). Experiment 1b replicated Experiment 1a with monolingual English speakers. If the activation of multiple meanings associated with a homograph were responsible for the pattern of results in Experiment 1a, there should be no significant findings in Experiment 1b. However, if the materials were responsible for the pattern of results in Experiment 1a, these results should be replicated in Experiment 1b.

Experiment 2 investigated whether bilinguals exhaustively activate L2 lexical representations while processing in L1. Specifically, Experiment 2 examined whether native French speakers who are highly fluent in English have a significant level of activation of the L2 'money' meaning associated with the homograph *coin* while reading the neutral L1 French sentence, *"La boulangerie se trouve vers le coin"*. If activation is exhaustive while processing in French, there should be longer lexical decision times to homograph translations (e.g., *monnaie*) than control words (e.g., *montre*). However, if when processing in L1, L2 words do not receive a significant level of activation and compete for selection with stronger L1 representations there should be no significant difference in lexical decision times to *monnaie* and *montre*.

Experiments 3 and 4 investigated the role of frequency and proficiency on exhaustive activation. Experiment 3 tested native French speakers who were highly fluent in English while processing in English. Experiment 4 tested native English speakers who had an intermediate French proficiency while reading in French. If exhaustive activation while processing in L2 is due to word frequency, there should be a significant influence of high frequency L1 representations while processing in L2. Slower lexical decision times are expected to homograph translations corresponding to high frequency L1 interlingual homographs than to low frequency ones.

Experiments 3 and 4 also investigated the role of proficiency on the exhaustive activation of multiple meanings of interlingual homographs. Because the participants in Experiment 4 had an intermediate proficiency in L2 French, a larger influence of L1 representations was expected. In contrast, in Experiment 3 where participants had a high L2 English proficiency, less of an influence of L1 representations was expected. In other words, the strength of L2 representations will be higher for high proficiency participants. Therefore, the influence of L1 representations should be less.

4.1 Experiment 1a

As stated above, if word activation is language selective, there should be no significant difference in lexical decision times to homograph translations (e.g., *coin*) and control words (e.g., *friend*) while processing in L2 English. If word activation is exhaustive, there should be a significant difference in lexical decision times to homograph translations and control words. Because interlingual homographs, like homographs, have multiple representations at both the phonological and semantic levels, longer lexical decision times to homographs relative to control words are expected due to competition for selection at these levels. Additionally, research on interlingual homographs presented in isolation demonstrated that when participants are engaged in a language-specific task there are longer lexical decision times to non-target language semantic competitors. Because reading in one language is a putatively language-specific task, lexical decision times to homograph translations are expected to be significantly longer than to control words.[16]

If sentence context does not constrain interactive activation, there should be no difference in lexical decision times to homograph translations and control words following biased and neutral sentences. However, if context constrains interactive activation or causes the contextually appropriate meaning to become activated more quickly, there should be a significant difference between biased and neutral sentence contexts. As discussed previously, research with lexically ambiguous words has demonstrated that when context is *strongly* biased, only the contextually appropriate meaning receives a significant amount of activation. Because the biased sentences in Experiment 1 were constructed to evoke a feature or property of the homograph, the sentences should strongly constrain interpretation of the homograph. Consequently, only the contextually appropriate meaning of the homograph should receive a significant amount of activation upon reading a biased sentence. In contrast, when reading a sentence that does not evoke a feature or property of a homograph, both meanings of the homograph should become activated. Therefore, it is predicted that there will be a significant difference in lexical decision times to homograph translations and control words in neutral sentences, but not in biased ones.

[16] Even though reading in one language is a putatively language-specific task, I cannot discount the possibility that participants were engaged in language general processing. Participants may have engaged in language-general processing instead of language-specific processing because they knew that they had been recruited because they were bilingual. If participants were engaged in language-general processing both languages would be highly activated, instead of only the language of processing being highly activated.

4.11 Method

Participants. 40 French dominant bilinguals from l'Université du Québec à Montréal, who rated themselves as highly proficient in L2 English, were paid $10 CND for their participation. Self-assessment of proficiency can be seen in Table 13.

Table 13. Language background of French dominant bilingual participants at l'Université du Québec à Montréal in Experiment 1a in each of the four lists. Self-assessed ratings were on a 5 point scale, where 1 indicated an excellent and 5 a very poor proficiency. Standard Error is given in parentheses.

	list 1 n=10	**list 2 n=10**	**list 3 n=10**	**list 4 n=10**
Mean years exposed to L1	34.7	31.3	31.1	36.3
Mean years exposed to L2	26.5	22.9	25.6	31.8
Average self-rating on 5 point scale:				
speaking L2 English	2.0 (0.3)	1.8 (0.3)	2.1 (0.3)	1.6 (0.3)
reading L2 English	2.0 (0.3)	1.6 (0.3)	1.8 (0.2)	1.8 (0.2)
writing L2 English	2.4 (0.3)	1.6 (0.3)	2.0 (0.2)	1.8 (0.4)
comprehension in L2 English	2.0 (0.3)	1.6 (0.3)	1.9 (0.1)	1.5 (0.3)

Materials. Thirty-two pairs of biased and neutral English sentences, like those in Table 14, were constructed such that every sentence ended in an interlingual homograph (e.g., *coin*). Biased sentences, shown in (a) and (b), included words that were related to the English meaning of the sentence-final interlingual homograph. For example *'monetary value'* is related to the word *coin*. In neutral sentences, shown in (c) and (d), there was no relationship between the words in the sentence and the meaning of the sentence-final interlingual homograph. Probe words were presented for a lexical decision after each sentence. Probe words were either translations of the sentence final homograph (e.g., *corner*) or control words (e.g., *friend*). The control words were matched for frequency, length, part of speech, and when possible for phonology with homograph translations.

Table 14. Stimuli for Experiments 1a & 1b, investigating effect of sentence bias.

Biased Sentence	**Probe Word**	**Probe Word Type**
a) The thing with the lowest monetary value is a coin.	corner	homograph translation of French *coin*
b) The thing with the lowest monetary value is a coin.	friend	control for *corner*
Neutral Sentence		
c) While walking, the little boy found a coin.	corner	homograph translation of French *coin*
d) While walking, the little boy found a coin.	friend	control for *corner*

In Experiment 1a, all sentences and words used in the lexical decision task were in English. Sentences and probe words were counterbalanced across four presentation lists such that each participant saw only one member of a quadruple, like those in Table 14. Participants saw an equal number of biased and neutral sentences and an equal number of homograph translations and control words. A participant saw eight biased sentences followed by a homograph translation, eight biased sentences followed by a control word, eight neutral sentences followed by a homograph translation, and eight neutral sentences followed by a control word. In addition participants saw 160 filler sentences followed by words and non-words. Thus participants saw a total of 192 probe words following the experimental and filler sentences. Of these probes, half were real words and half were non-words.[17] Non-words were formed by replacing a letter in a real word with another letter. For, example the non-word *guck* was formed by replacing the letter ‘d’ of *duck*. A complete set of experimental sentences and the following probe

[17] In all of the experiments all of the non-words were non-words in both English and French.

words is provided in Appendix F. Following 48 (25%) of the sentence and probe word pairs, a comprehension question was presented to ensure that participants were reading attentively. For example participants saw the sentence, *"We need to get up early every day"* followed by the non-word *"waim"*, which was in turn followed by the comprehension question *"Can we sleep in on Saturday?"*.

Procedure. Sentences like those in Table 14 were presented on a computer screen. Participants were asked to read each sentence for comprehension as quickly as possible. When participants finished reading a sentence, they pressed the spacebar. Upon pressing the spacebar, a string of letters appeared on the screen. Participants were asked to indicate, by either pressing a "YES" or "NO" key on the keyboard, as quickly and accurately as possible if the string of letters was a word or not. As indicated above, after 25 percent of sentence and lexical decisions, participants were asked a question about the sentence they read. Again the "YES" and "NO" keys were used to indicate a response. For the remaining 75 percent of trials, participants were simply asked if they were ready to proceed to the next trial. Participants pressed "YES" when they were ready to continue. Participants were given 8 practice trials before beginning the actual experiment. The participants were not made aware that their knowledge of French played any role in the experiment. They were not given any indication that the experiment contained interlingual homographs and their translations until they were debriefed (see Appendix J for the debriefing).

4.1.2 Results

With a lexical decision task in which participants are asked to decide if a string of letters is a word or not, there are two dependent variables, judgments and lexical decision times. Because both homograph translations (e.g., *coin*) and their controls (e.g., *friend*) are all actual words in English, few incorrect “NO” responses were expected. Further, because the control words were matched for frequency, length, and part of speech with homograph translations, no differences in incorrect “NO” responses were expected across conditions.

Judgments. Mean percentages of incorrect "NO" (non-word) responses for homograph translations and controls following both biased and neutral sentences are shown in italics in Table 15. There were fewer than 7.5% incorrect “NO” responses to homograph translations and control words. Due to the low number of incorrect responses reliable statistical analysis was not possible.

Table 15. Mean correct lexical decision times (ms) with standard error in parentheses for L2 English homograph translations (e.g., *corner*) and control words (e.g., *friend*) following biased and neutral sentences by high proficiency French dominant participants. Percent incorrect (“NO”) responses to homograph translations and control words in italics.

	Sentence Type			
	Biased		**Neutral**	
Word Type	**RTs**	**% Error**	**RTs**	**% Error**
homograph translation, e.g. *corner*	1149 (59)	*7.5%*	1257 (67)	*7.2%*
control, e.g. *friend*	1203 (78)	*6.3%*	1162 (52)	*6.3%*

Lexical Decision Times. Mean correct “YES” lexical decision times to homograph translations and control words in both biased and neutral sentences are shown in Table 15. Mean correct lexical decision times for each participant and item were submitted to separate 2(word type) x 2(sentence type) analyses of variance (ANOVA). The effect of word type was not significant in analyses by either participants or items,

$F_1(1,36) = 2.2$, $p > .05$, $F_2(1,28) = .70$, $p > .05$. However, the effect of sentence type was significant, but only by participants $F_1(1,36) = 4.3$, $p < .05$, $F_2(1,28) = .57$, $p > .05$. Crucially there was a significant interaction between word type and sentence type, by both participants and items, $F_1(1,36) = 5.5$, $p < .05$, $F_2(1,28) = 3.9$, $p < .05$. This interaction was characterized by significantly longer lexical decision times to homograph translations (e.g., *corner*) than to control words (e.g., *friend*) following neutral sentences by both participants and items, $F_1(1,36) = 4.4$, $p < .05$, $F_2(1,28) = 4.1$, $p < .05$. As predicted, when context strongly constrained the interpretation of the homograph, there was no significant difference in lexical decision times to homograph translations and control word by either participants or items, $F_1(1,36) = 1.5$, $p > .05$, $F_2(1,28) = 1.5$, $p > .05$.

Comprehension Questions. After 25% of the trials comprehension questions were included to ensure that participants were reading attentively. Participants made between 6.25%-33% incorrect responses to the comprehension questions with an average miss rate of 17.7%. An average miss rate of 17.7%, with some participants missing as many as 33% of the comprehension questions, may seem high. However, the comprehension questions were deliberately difficult to encourage participants to read carefully. Further, the average miss rate of 17.7% of bilinguals in this experiment was very similar to the 15.3% miss rate of monolinguals in Experiment 1b (see section 4.2.2). This indicates that the bilingual participants' understanding of the sentences was similar to that of the monolinguals'. Finally, if performance on the comprehension questions is an accurate measure of how carefully participants were reading, including the results of participants who had a high miss rate only makes it more difficult to find a significant finding, as the results of participants who were not reading the stimuli carefully are included in the analyses.

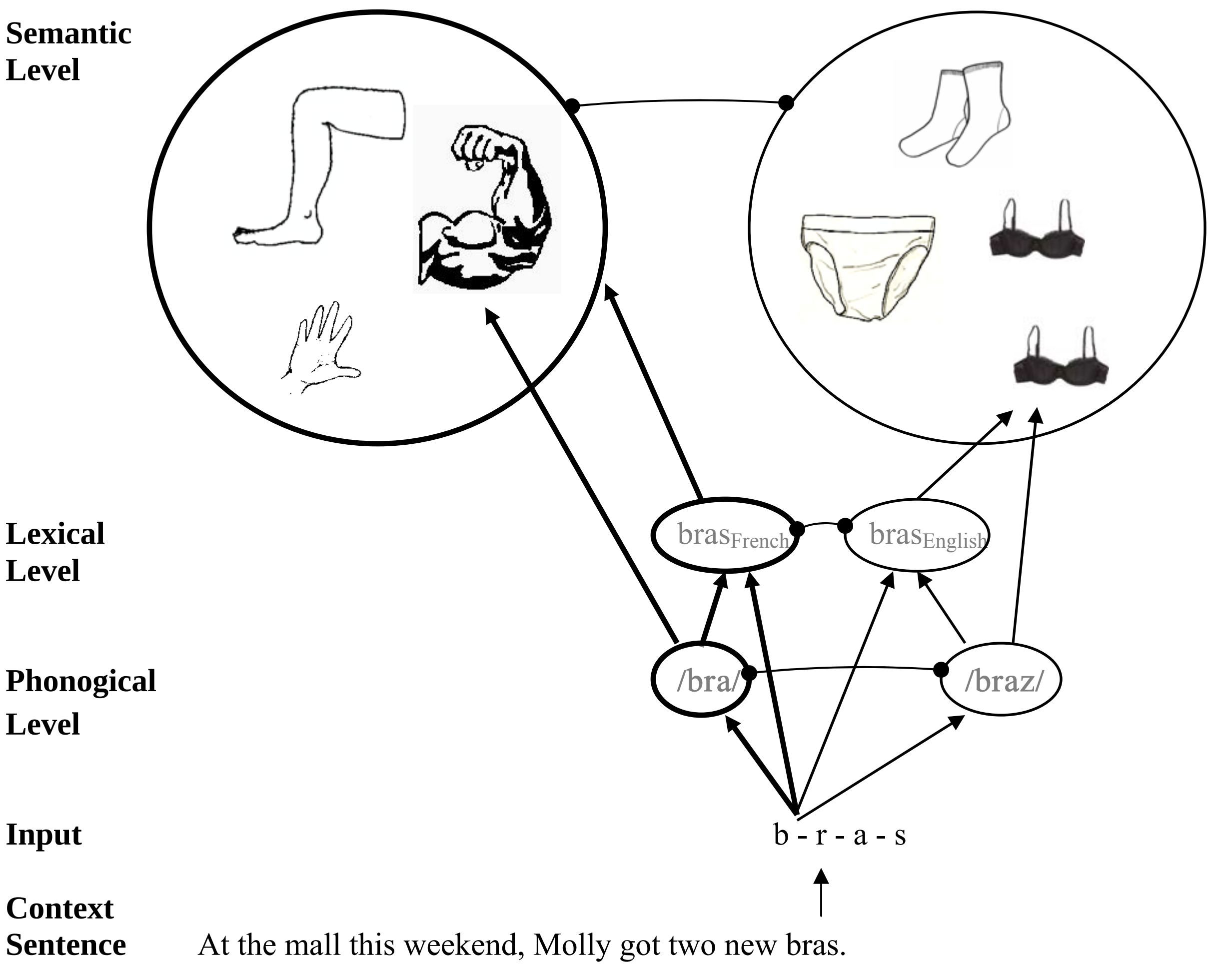
4.13 Discussion

As stated before, Experiment 1a was carried out to determine whether word activation is exhaustive while reading in L2. If word activation is exhaustive while processing in L2, a further goal was to determine whether context could effectively constrain exhaustive activation. The current results show that when the sentence context is neutral, lexical decision times to homograph translations like *corner* were slower than to control words. However, when the context strongly biased the interpretation of the interlingual homograph there was no significant difference in lexical decision time homograph translations and control words. This finding is consistent with a model of exhaustive bilingual lexical activation in which sentence context plays a role in exhaustive activation. In neutral sentences, as depicted in Figure 12(a), the input is consistent with both $bras_{English}$ and $bras_{French}$ which are, in turn, associated with the 'underwear' and 'arm' meanings. Both meanings become available and are weighed according to the amount of evidence available to support them. Because French is the L1 of the participants, $bras_{French}$ 'arm' should have an overall stronger representation than $bras_{English}$ 'underwear'. This is indicated by thick lines. While evidence based on strength of representation does not support the L2 'underwear' interpretation, the language of the sentence (English) does. Evidence supporting the English interpretation comes from the lexical or orthographic levels in which more sublexical patterns conforming to English than French have been activated. Competition for selection of a meaning of the homograph causes recognition to be slow in this case. Because the language of the sentence is English, the ‘underwear’ meaning is ultimately selected and the ‘body part’ meaning is rejected. Rejection of $bras_{French}$ results in inhibitory feedback being sent to the ‘arm’ meaning. When the word *arm* appears immediately after selection of the ‘underwear’ meaning, recognition of the word *arm* is slow. This is depicted in Figure 12(a).

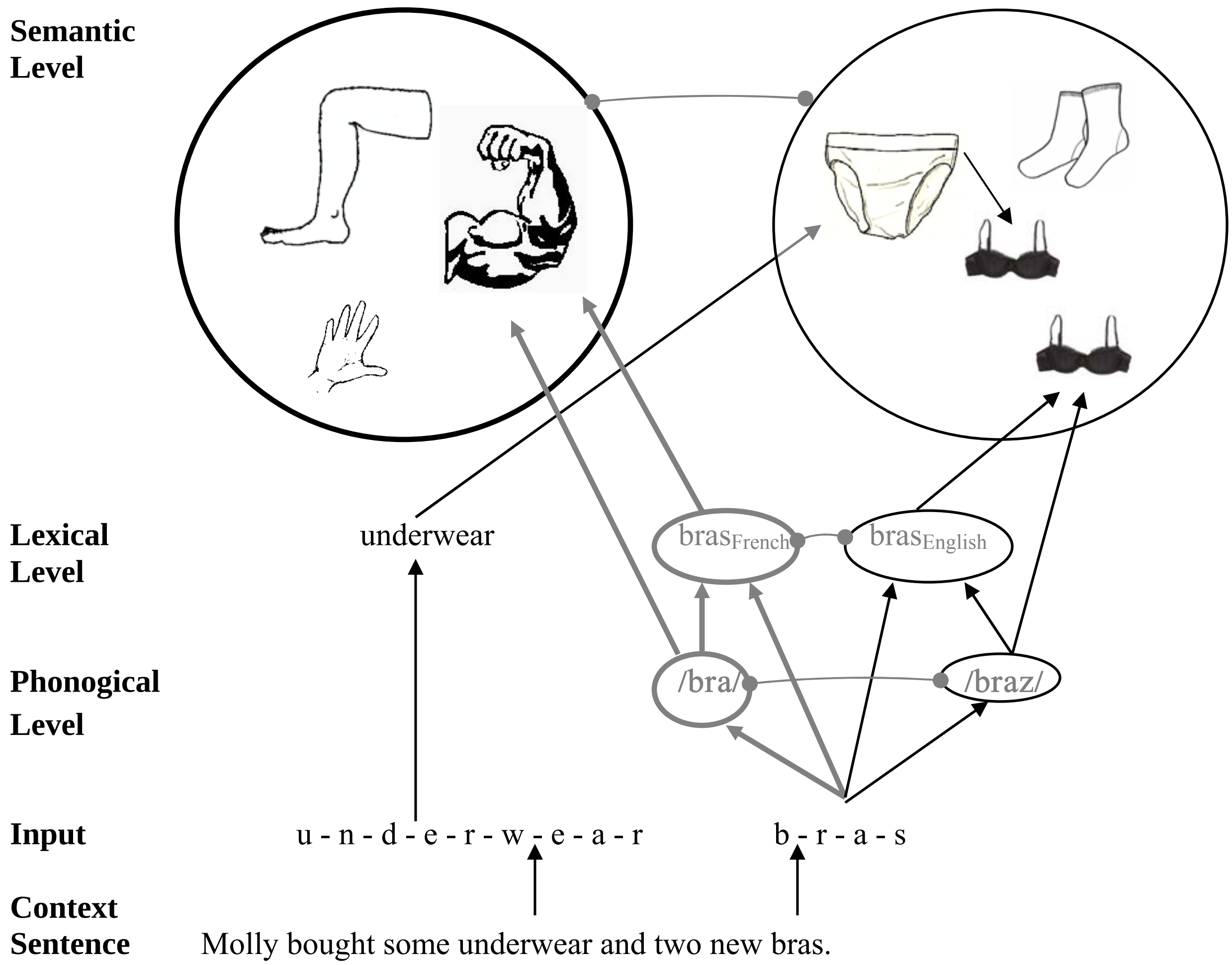
In cases where the sentence context is sufficiently constraining, as shown in Figure 12(b), enough evidence accrues early to support the L2 ‘underwear’ interpretation of the homograph, despite the stronger representation of the L1 word representation. In particular, reading the word *underwear* boosts the resting level of activation of $bras_{English}$, which in turn suppresses the activation of $bras_{French}$. When the string <bras> is encountered, $bras_{English}$ already has a high level of activation, and $bras_{French}$ cannot compete with it for selection. Therefore, when the word *arm* is seen immediately after *bras*, it is recognized just as quickly as a control word.

Figure 12. A depiction of the activation of the ‘arm’ and ‘underwear’ meanings associated with the homonym *bras*, where thick lines represent high frequency and thin lines represent low frequency connections. Connections that do not appear to influence processing are in gray. In (a) the context is weak while in (b) it is strong.

(a)



(b)



Before concluding that context influenced the processing of interlingual homographs, an alternative must be considered. The significant differences in lexical decision times to probe words in Experiment 1a could be attributed to systematic differences between biased and neutral sentence contexts, or to homograph translations and control words not being well matched. Even though control words were matched for frequency, length, and part of speech with homograph translations, they may not actually have been equivalent. To ensure that the pattern of significance in Experiment 1a was due to the bilingualism of the participants, and was <u>not</u> due to systematic differences in sentences or probe words, Experiment 1b was conducted with monolingual English participants.

4.2 Experiment 1b

Experiment 1b is a replication of Experiment 1a with monolingual speakers of English. Unless systematic differences across sentence type (biased and neutral) and word type (homograph translations and control words) were driving the results in Experiment 1a, there should be no significant findings for monolingual control participants in any condition. For participants with no knowledge of French there should be no relation between the word final homograph and the probe word in the lexical decision task. Therefore, no difference in lexical decision times are expected for homograph translations and control words following either biased or neutral sentences.

4.2.1 Method

Participants. 40 monolingual English speaking participants from the University at Buffalo participated for partial course credit. None of the participants had any knowledge of French.

Materials and Procedure. The materials, experimental design, and procedure were the same as for Experiment 1a. However, participants were not asked to assess their proficiency or to do the vocabulary verification task.

4.2.2 Results

As with Experiment 1a, because both homograph translations (e.g., *corner*) and their controls (e.g., *friend*) were actual words in English, few incorrect "NO" responses were expected. Further, because the control words were matched for frequency, length, and part of speech with homograph translations, no differences in incorrect "NO" responses were expected across conditions. If the control words were well equated with homograph translations, there should be no significant difference in lexical decision times to *corner* and *friend*. Unless systematic differences in biased and neutral sentences played a role in a subsequent lexical decision task, there should be no significant difference across sentence type. Because the participants were processing in L1, overall faster lexical decision times were expected in Experiment 1b than in Experiment 1a.

Judgments. Mean percentages of incorrect "NO" (non-word) responses for homograph translations and controls following both biased and neutral sentences are shown in italics in Table 16. There were fewer than 6% incorrect "NO" responses in any condition. Due to the low number of "NO" responses, no statistical analysis was possible.

Table 16. Mean lexical decision times (ms) with Standard Error (in parentheses) for English homograph translation (e.g., *corner*) and control words (e.g., *friend*) following biased and neutral sentences by monolingual English participants. Percent incorrect ("NO) responses to homograph translation and control words in italics.

	Sentence Type			
	Biased		**Neutral**	
Word Type	**RTs**	**% Error**	**RTs**	**% Error**
homograph translation, e.g. *corner*	963 (35)	*4.1%*	965 (40)	*5.9%*
control, e.g. *friend*	1109 (41)	*4.7%*	1103 (34)	*5.9%*

Lexical Decision Times. Mean correct participant lexical decision times to homograph translations and control words in both biased and neutral sentences are shown in Table 16. Participant and item lexical decision times were submitted to separate 2(word type) x 2(sentence type) analyses of variance (ANOVA). There was no main effect of word type by participants or items, $F_1(1,36) = 3.0$, $p > .05$, $F_2(1,28) = 0.2$, $p > .05$. There was no main effect of sentence type by participants or items $F_1(1,36) = 0.005$, $p > .05$, $F_2(1,28) = 0.1$, $p > .05$. There was also no significant interaction between word type and sentence type in analyses by either participants or items, $F_1(1,36) = 0.02$, $p > .05$, or $F_2(1,28) = 0.2$, $p > .05$. In order to compare the results of Experiment 1b to those of 1a planned comparisons were carried out, even though the interaction was not sigificant. Unlike with bilingual participants, planned comparisons of monolingual results yielded no difference in lexical decision times to homograph translations and control words in neutral sentences by either participants or items, $F_1(1,36) = 0.9$, $p > .05$, $F_2(1,28) = 0.5$, $p > .05$. As with bilingual participants, there was no significant difference in lexical decision times to homograph translations in biased sentences by either participants or items, $F_1(1,36) = 1.5$, $p > .05$ and $F_2(1,28) = 0.002$, $p > .05$.

Comprehension Questions. Participants gave between 4.2%-29.2% incorrect responses to the comprehension questions with an average miss rate of 15.3%. As indicated above, range and average of the miss rate is very similar to the miss rate of the bilingual subjects in Experiment 1a.

4.2.3 Discussion

Because in Experiment 1b there were no significant differences in lexical decision times to homograph translations like *corner* and controls like *friend*, in biased and neutral sentences, the significant pattern of results from Experiment 1a cannot be attributed to systematic differences in biased and neutral sentences or in homograph translations and control words. If systematic differences in sentences and differences in homograph translations and control words were responsible for the pattern of results in Experiment

1a, the same pattern of results should have been observed in Experiment 1b with monolingual participants.

4.3 Experiment 2

The results of Experiment 1a indicate that both meanings of an interlingual homograph are exhaustively activated when highly fluent bilinguals are reading sentences in their L2 that do not constrain the interpretation of a homograph. Experiment 2 investigated whether bilinguals have exhaustive activation of L2 representations while processing in L1. In other words, Experiment 2 examined whether highly fluent French dominant bilinguals activate the L2 ‘money’ meaning associated with the homograph *coin* to a significant level when reading in L1, or whether only the L1 ‘corner’ meaning has a significant level of activation to influence processing.

4.3.1 Method

Participants. 20 French dominant bilinguals from l’Université du Québec à Montréal, who rated themselves as highly proficient in L2 English, were paid $10 CND for their participation. Self-assessment of proficiency can be seen in Table 17. None of the participants in Experiment 2 had taken part in Experiment 1a.

Table 17. Language background of French dominant bilingual participants at l'Université du Québec à Montréal in Experiment 2 in each of the four lists. Self-assessed ratings were on a 5 point scale, where 1 indicated an excellent and 5 a very poor proficiency. Standard Error is given in parentheses.

	list 1 n=10	list 2 n=10	list 3 n=10	list 4 n=10
Mean years exposed to L1	22.5	23.2	23.0	23.8
Mean years exposed to L2	17.8	15	14.4	16.2
Average self-rating on 5 point scale:				
speaking L2 English	2.2 (0.2)	2.6 (0.4)	2.6 (0.2)	2.2 (0.4)
reading L2 English	1.4 (0.2)	3.0 (0.3)	2.4 (0.5)	2.4 (0.5)
writing L2 English	1.8 (0.2)	3.0 (0.5)	2.6 (0.5)	3.0 (0.4)
comprehension in L2 English	2.2 (0.2)	2.6 (0.3)	2.2 (0.4)	1.8 (0.4)

Materials. Thirty-two pairs of French and English sentences, like those in Table 18, were constructed such that an interlingual homograph ended every sentence (e.g., *coin*). All of the sentences were neutral with respect to the sentence-final homograph (i.e., there was no relationship between the words in the sentence and the meaning of the sentence-final interlingual homograph). Presentation of French sentences, illustrated in (a) and (b) and English sentences, illustrated in (c) and (d), was followed by a probe word. Probe words were either translations of the sentence final homograph (e.g., *corner* or *monnaie*) or control words (e.g., *friend* or *montre*). Control words were matched for frequency, length, part of speech, and when possible for phonology with homograph translations. Probe words were always in the same language as that of the preceding sentence.

Table 18. Stimuli for Experiment 2 which investigated the effect of language of processing (L2 English and L1 French) on exhaustive activation.

Neutral Sentence in L1 (French)	**Probe Word**	**Probe Word Type**
La boulangerie se trouve vers le coin. *'The bakery is near the corner.'*	a) monnaie	English meaning of *coin*
	b) montre *'watch'*	control for *monnaie*
Neutral Sentence in L2 (English)		
While walking, the little boy found a coin.	c) corner	French meaning of *coin*
	d) friend	control for *corner*

Sentences and probe words were counterbalanced across four presentation lists such that each participant saw only one member of a quadruple, like those in Table 19. Participants saw an equal number of French and English sentences and an equal number of homograph translations and control words. A complete set of experimental materials is provided in Appendix G. Specifically, participants saw eight French sentences followed by a homograph translation, eight French sentences followed by a control word, eight English sentences followed by a homograph translation, and eight English sentences followed by a control word. In addition, participants saw 80 filler sentences in French followed by a probe word and 80 in English followed by a probe word. Of the probe words, half were real words and half were non-words. As in Experiment 1, non-words were formed by replacing a letter in a real word with another letter. For, example the French non-word *sableau* was formed by replacing the 't' of *tableau*. Following 48 (25%) of the sentence and probe word pairs, a comprehension question was presented. For example, in French, participants saw the sentence, *"Frédéric a un chien, un chat et un cochon" 'Frédéric has a dog, a cat and a pig'* followed by the word *"jambon" 'ham'* which in turn was followed by the comprehension question, *"Frédéric a-t-il quatre animaux?" 'Does Frédéric have four animals?'*.

In Experiment 2 stimuli were blocked by language. Participants completed the English block first. They were not told that there would be a French block until they had completed the English one. Because participants were unaware of the upcoming component of the experiment that involved the use of their L1, they should have been processing in a language-specific mode when completing the L2 English block.[18] Because the English block was presented first, and participants were unaware of the French component of the experiment, the conditions of Experiment 1a were duplicated. Therefore, it was expected that there would be a significant difference in lexical decision times to homograph translations (e.g., *corner*) and control words (e.g., *friend*) while processing in L2. Because the French block was presented after the English one, L2 representations should have had a relatively high level of activation. Therefore, it may be possible to see an influence of L2 lexical-semantic representations while processing in L1. If L2 representations are activated to a significant level and influence processing in L1, there should be significantly longer lexical decision times to homograph translations (e.g., *monnaie*) than to control words (e.g., *montre*).

Procedure. The basic procedure was the same as for Experiments 1a & 1b. The only difference was that the stimuli were blocked by language in Experiment 2. The English block was always first. Before beginning the English block, participants were given instructions in English and completed 8 practice trials. At the end of the English block, participants were informed that there was also a French block. Participants were

[18] As with Experiment 1a, I cannot completely discount the possibility that participants were engaged in language-general processing. Participants may have engaged in language-general processing instead of language-specific processing because they knew that they had been recruited because they were bilingual.

given instructions and completed 8 practice trials in French. As in the previous experiments, participants were not given any indication that the experiment contained interlingual homographs and their translations until the debriefing.

4.3.2 Results

As with the previous experiments, few incorrect “NO” responses were expected because both homograph translations and control words were real words. Because the control words were matched for frequency, length, and part of speech with homograph competitors, no differences in incorrect “NO” responses were expected to homograph translations and control words.

The results of Experiment 1a indicated that word activation is exhaustive while processing in L2. In the English block, a replication of Experiment 1a is expected in which responses to homographs translations, like *corner*, are slower than to control words, like *friend*, in L2 English. If L2 English words are activated to a significant level while processing in L1, there should be a significant difference in lexical decision times to homograph translations and control words in the French block. Specifically, there should be longer lexical decision times associated with making a “YES” response to homograph translations (e.g., *monnaie*) than to control words (e.g., *montre*). However, if L2 words do not have a significant level of activation while processing in L1, there would be no significant difference in lexical decision times to homograph translations (e.g., *monnaie*) and control words (e.g., *montre*). Additionally, overall faster lexical decision times are expected in L1 French than in L2 English.

Judgments. Mean percentages of incorrect "NO" (non-word) responses for homograph translations and controls following both French and English sentences are shown in italics in Table 19. There were fewer than 7.5% incorrect "NO" responses in any condition with minimally more incorrect responses in L1 than L2. Due to the low number of "NO" responses no statistical analysis was possible.

Table 19. Mean correct lexical decision times in ms with Standard Error in parentheses to homograph translation (e.g., *corner/monnaie*) and controls (e.g., *friend/montre*) following L1 French and L2 English sentences by highly fluent French dominant participants. Percent incorrect ("NO") responses to homograph translations and control words in italics.

	Language			
	L1 French		**L2 English**	
Word Type	**RTs**	**% Errors**	**RTs**	**% Errors**
homograph translation, e.g. *coin/monnaie*	1141 (59)	*2.5%*	1387 (79)	*7.5%*
control, e.g. *friend/montre*	1108 (59)	*3.1%*	1208 (50)	*6.9%*

Lexical Decision Times. Mean correct participant lexical decision times to homograph translations and control words in both L1 English and L2 French sentences are shown in Table 19. Participant and item lexical decision times were submitted to two separate 2(language) x 2(word type) analyses of variance (ANOVA). There was a main effect of language by participants and items, $F_1(1,16) = 15.2$, $p < .05$, $F_2(1,28) = 7.5$, $p < .05$ with responses to words in L1 eliciting significantly faster responses. There was also a main effect of word type by both participants and items, $F_1(1,16) = 16.9$, $p < .05$, $F_2(1,28) = 5.0$, $p < .05$ with faster responses to control words than homograph translations. However, the interaction between language and word type was not significant by either the analysis by participants or items, $F_1(1,16) = 2.3$, $p > .05$, or $F_2(1,28) = 1.9$, $p > .05$.

Even though the interaction was not significant, planned comparisons were carried out in order to see if the pattern of results from Experiment 1a were replicated by the L2 English block of Experiment 2. Planned comparisons revealed, as with Experiment 1a, there were significantly longer lexical decision times associated with making a word response to homograph translations than to control words in L2 English in analyses by both participants and items, $F_1(1,16) = 7.0$, $p < .05$, $F_2(1,28) = 7.0$, $p < .05$. However, there was not a significant difference between lexical decision times to homograph translations and control words in L2 French by either participants or items, $F_1(1,16) = 0.3$, $p > .05$, or $F_2(1,28) = 0.5$, $p > .05$.

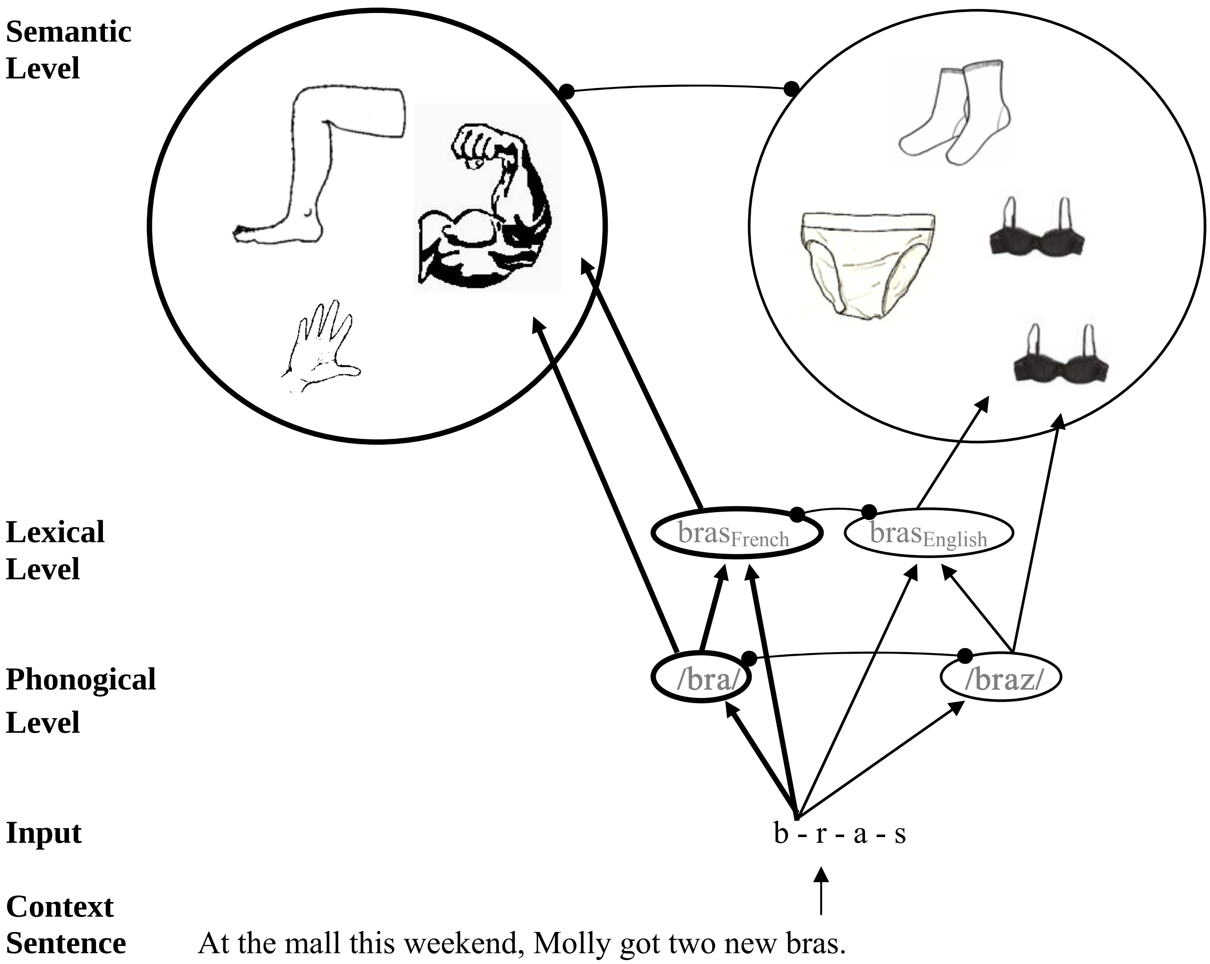
Comprehension Questions. In the English block, participants gave between 8.3%-29.2% incorrect responses to the comprehension questions with an average miss rate of 17.0% in. In the French block, participants gave between 0%-20.8% incorrect responses to the comprehension questions with an average miss rate of 7.9%. The miss rate in the English block is very similar to the miss rate of the bilingual participants in Experiment 1a and the monolingual participants in Experiment 1b. Interestingly, the performance of the participants in the French block, their native language, was considerably better. Although questions were constructed to be difficult in both English and French, it is possible that the French questions were easier. However, even in the French block, some participants had up to 20% errors. And as with the previous experiments, if performance on the comprehension questions is an accurate measure of how carefully participants were reading, including the results of participants who had a high miss rate only makes it more difficult to find a significant finding.

4.3.3 Discussion

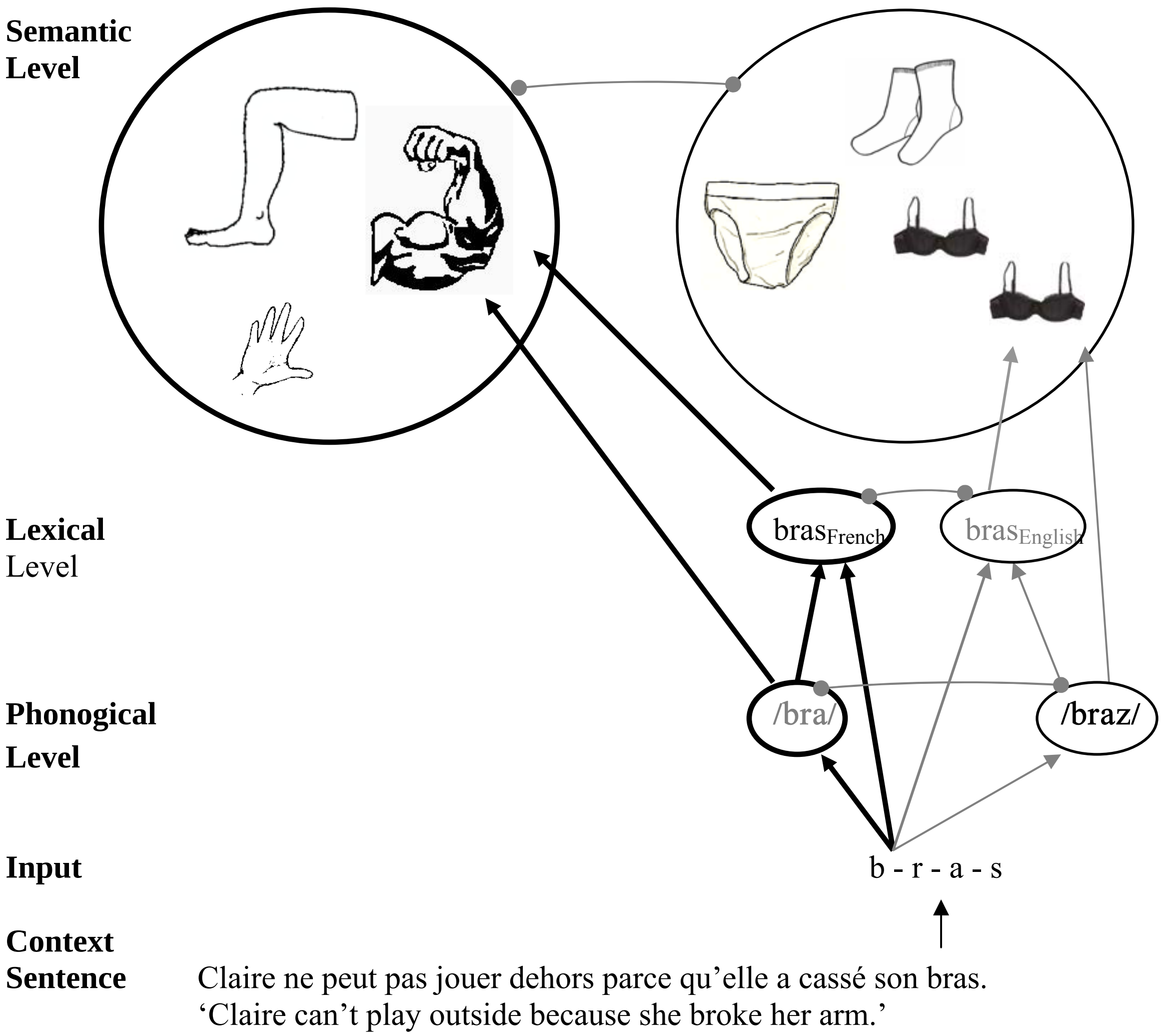
Results in the English block of Experiment 2 replicate those of Experiment 1a. There were longer lexical decision times to *corner* than *friend*. However, while processing in L1 French there were no significant differences in lexical decision times to homograph translations (e.g., *monnaie*) and control words (e.g., *montre*) after reading the interlingual homograph *coin*. The pattern of results can be described in terms of Figure 13. In (a), the context sentence is in L2 English and supports the $bras_{English}$ 'undergarment' interpretation. The stronger L1 representation supports the $bras_{French}$ 'arm' interpretation. When processing in L2 both $bras_{English}$ and $bras_{French}$ receive a significant amount of activation. Because processing is in English, ultimately $bras_{English}$ is selected. Selection of $bras_{English}$ 'undergarment' sends inhibitory feedback to $bras_{French}$ 'arm'. When the word *arm* is subsequently presented, recognition is delayed because 'arm' has just been inhibited. In (b) the context sentence is in L1 French and supports the $bras_{French}$ interpretation. The stronger L1 representation also supports the $bras_{French}$ interpretation. $Bras_{English}$ does not receive a significant amount of activation and therefore does not provide strong competition for selection. Because $bras_{English}$ does not serve as a competitor it is not inhibited. Consequently recognition of *soutif* 'bras' is not slowed. However, it is important to note that when processing in L1, homograph translations like *soutif* were recognized 100 ms more slowly than control words. While this finding was not significant, it suggests the possibility that $bras_{English}$ may exert some influence on processing.

Figure 13. A depiction of the activation of the ‘arm’ and ‘underwear’ meanings associated with the homonym *bras*, where thick lines represent high frequency and thin lines represent low frequency connections. Connections that do not appear to influence processing are in gray. In (a), the context sentence is in L2 English, and in (b), it is in L1 French.

(a)



(b)



4.4 *Experiment 3*

As stated above, establishing word frequency in a second language is difficult. Word frequency should be highly correlated with a bilingual's experience with a language, certain semantic domains, registers, etc. On the assumption that L2 lexical representations have a weaker representation due to lower exposure rates, there is an expectation that L1 word representations will be activated more quickly and influence processing, even when processing in L2. In particular, L1 representations with a high frequency will be activated quickly and are expected to influence processing in L2. This prediction was tested in Experiment 3.

4.4.1 Method

Participants. In Experiment 3, 18 French dominant bilinguals from l'Université du Québec à Montréal, who rated themselves as highly proficient in L2 English, were paid $10 CND for their participation. Self-assessment of proficiency can be seen in Table 20. None of the participants in Experiment 3 had taken part in Experiments 1a or 2.

Table 20. Language background of French dominant bilingual participants at l'Université du Québec à Montréal in Experiment 3 in each of the two lists. Self-assessed ratings were on a 5 point scale, where 1 indicated an excellent and 5 a very poor proficiency. Standard Error is given in parentheses.

	list 1 n=9	**list 2 n=9**
Mean years exposed to L1	27.1	29.2
Mean years exposed to L2	19.0	23.1
Average self-rating on 5 point scale:		
speaking L2 English	2.3 (0.2)	2.3 (0.2)
reading L2 English	1.8 (0.2)	2.1 (0.2)
writing L2 English	2.7 (0.3)	2.8 (0.3)
comprehension in L2 English	1.8 (0.2)	1.9 (0.2)

Materials. Thirty-two sentences, like those in Table 21, were constructed such that every sentence ended in an interlingual homograph. Probe words that were either translations of the homograph or control words were presented for a lexical decision after each sentence. A complete set of experimental materials is provided in Appendix H. In addition, participants saw 160 filler sentences followed by probes. Half of the probes were real words and half were non-words. As with the previous experiments, comprehension questions followed 48 (25%) of the sentence and probe word pairs.

Table 21. Stimuli for Experiment 3, investigating effect of frequency in L2 English by high proficiency bilinguals.

Homograph with High French Frequency	**Probe Word**	**Probe Type**
While walking, the little boy found a coin.	a) corner	homograph translation of French *coin*
	b) friend	control for *corner*
Homograph with Low French Frequency		
Jan wanted enough china for four.	c) oven	homograph translation of French *four*
	d) olive	control for *oven*
Homograph with High English Frequency		
Jan wanted enough china for four.	e) oven	homograph translation of French *four*
	f) olive	control for *oven*
Homograph with Low English Frequency		
Mary watch the veterinarian doing surgery on a fin.	g) end	homograph translation of French fin
	h) city	control for city

In order to assess the role of frequency on exhaustive activation, interlingual homographs were divided into two groups based on their frequency. To assess the role of English frequency, the sixteen homographs with the highest English frequency were categorized as high frequency, while the sixteen homographs with the lowest frequency were categorized as low frequency. English word frequencies were established using Francis & Kučera (1982). Homographs in the high frequency group ranged in log frequency from 47-1233 words per million and had a mean of 251 (S.E. = 70.2), while ones in the low frequency group ranged in log frequency from 1-40 words per million and a mean of 13 (S.E. = 2.8) (see appendix K for frequencies of interlingual homographs).[19]

[19] The frequencies used here represent lemma frequency. For example, the frequency of the interlingual homograph *lit* is that of the lemma *light*.

The role of French word frequencies on exhaustive activation was also investigated. Interlingual homographs were re-categorized as high and low frequency based on their French word frequency. The sixteen homographs with the highest frequency in French were categorized as high frequency, and the sixteen with the lowest frequency were categorized as low frequency. French frequencies were established using Brulex (Content et al., 2000), a word frequency database for written French based on a corpus of 100 million words. Homographs in the high frequency group ranged in log frequency from 63-4377 words per million[20] and had a mean log frequency of 503 (S.E. = 270.1), while ones in the low frequency group ranged in log frequency from 0.3-59 words per million and had a mean frequency of 21 (S.E. = 4.9).

In Experiment 3, sentences and probe words were counterbalanced across two presentation lists such that each participant saw only one member of a pair, like the one in Table 21a & b. Participants saw an equal number of sentences followed by homograph translations and control words. In addition, participants saw an equal number of homographs that had a "high" frequency in L1 (e.g., *coin 'corner')* and a "low" frequency in L1 (e.g., *four 'oven'*).

Procedure. Procedure is the same as for Experiment 1a.

4.4.2 Results

Because both homograph translations and their control words were actual words in English, few incorrect "NO" responses were expected. Results from Experiment 1a

[20] Brulex (Content et al., 2000) is a corpus of 100 million words, while Francis & Kučera (1982) is a corpus of 1 million words. Due to the differences in the size of the corpora, French word frequencies are divided by 100 to facilitate comparison to English word frequencies.

indicated that word activation is exhaustive while processing in L2. If frequency plays a role in whether lexical activation is exhaustive, a difference in lexical decision times to homograph translations having high and low frequencies in French is expected. The prediction is that when a bilingual encounters the interlingual homograph *coin* (e.g., Table 22a), the language of the sentence supports the English interpretation. However, its frequency in French is high. Therefore, evidence does not clearly support one interpretation over the other, which would result in competition for selection. Ultimately the 'money' meaning is selected because processing is in English. Selection of the 'money' meaning sends inhibitory feedback to 'corner'. When *corner* is subsequently encountered, recognition is slow. In contrast, when a bilingual encounters the interlingual homograph *four* (see Table 22c), the language of the sentence supports the English interpretation. Because the frequency of *four* in French is low, evidence more clearly supports the English interpretation of the interlingual homograph *four*. Because neither the language of processing nor the frequency of $four_{French}$ support the 'oven' interpretation of the homograph, $four_{French}$ does not receive a significant amount of activation. Therefore the 'oven' interpretation is not a strong competitor with the '4' interpretation for selection. Because $four_{French}$ does <u>not</u> compete for selection it is <u>not</u> inhibited. Therefore, subsequent presentation of the word *oven* is not affected by having just encountered the string <four>. As a result, shorter lexical decision times to homograph translations in the low frequency condition are expected than in the high frequency one.

<u>Judgments</u>. Mean percentages of incorrect "NO" (non-word) responses for homograph translations and controls following L2 English sentences are shown in italics

in Table 22. There were fewer than 8.5% incorrect “NO” responses to homograph translations and control words in any condition. Due to the low number of incorrect responses reliable statistical analysis was not possible.

Table 22. Mean correct lexical decision times (ms) with Standard Error in parentheses by highly fluent French dominant bilingual participants to homograph translations and control words when the L1 French frequency of the homograph is either high or low and when the L2 English frequency of the homograph is either high or low. Percent incorrect (“NO”) responses to homograph translations and control words in italics.

	L1 French Frequency			
	High		**Low**	
Word Type	**RTs**	**% Errors**	**RTs**	**% Errors**
homograph translation	1164 (70)	*7.6%*	1242 (95)	*7.6%*
control word	949 (40)	*2.1%*	1248 (91)	*6.9%*
	L2 English Frequeny			
	High		**Low**	
	RTs	**% Errors**	**RTs**	**% Errors**
homograph translation	1059 (57)	*4.2%*	1247 (44)	*8.3%*
control word	1018 (65)	*2.8%*	1180 (79)	*7.6%*

Lexical Decision Times. Mean correct participant lexical decision times to homograph translations and control words when a homograph had a high or low frequency in L1 French and L2 English are shown in Table 22. Participant and item means were submitted to two separate 2(word type) x 2(frequency type) ANOVA. The first ANOVA examined the effect of L1 French interlingual homograph frequency while processing in L2 English by high proficiency participants. The analysis of the role of L1 French word frequency revealed a significant main effect of word frequency by participants and items, $F_1(1,16) = 19.9$, $p < .05$, $F_2(1,14) = 6.3$, $p < .05$. The main effect of word type was only significant by participants, $F_1(1,16) = 4.8$, $p < .05$, $F_2(1,14) = 2.5$, $p > .05$. The interaction between frequency and word type was also only significant by participants, $F_1(1,16) = 5.7$, $p < .05$, $F_2(1,14) = 1.7$, $p > .05$. Although the interaction was not substantiated by the items analysis, I explored it further. The interaction was characterized by significantly longer decision times to homograph translations than to control words in the high frequency condition by participants and items, $F_1(1,16) = 10.9$, $p < .05$, $F_2(1,14) = 6.6$, $p < .05$. There was not a significant difference in decision times to homograph translations and control words in the low frequency condition in analyses by either participants or items, $F_1(1,16) = 0.008$, $p > .05$, $F_2(1,14) = 0.6$, $p > .05$, indicating that low frequency L1 representations did not influence processing in L2.

The second ANOVA examined the effect of L2 English frequency while processing in English by high proficiency participants. The analysis of the role of L2 English word frequency revealed a significant main effect of word frequency in which responses to high frequency words were faster than low frequency words by both participants and items, $F_1(1,16) = 16.3$, $p < .05$, $F_2(1,14) = 10.4$, $p < .05$. There was no main effect of word type in either analysis, $F_1(1,16) = 0.5$, $p > .05$, $F_2(1,14) = 1.6$, $p >.05$. And there was no interaction between frequency and word type by either participants or items, $F_1(1,16) = 0.3$, $p > .05$, $F_2(1,14) = 1.1$, $p >.05$. Because the interaction was not significant, planned comparisons were not conducted. However, these results indicate, much like with monolinguals, an effect of word frequency when processing in L2.

Comprehension Questions. Participants gave 2.1%-33.3% incorrect responses to the comprehension questions with an average miss rate of 11.8%. Again the inclusion of results from participants who had a high miss rate only makes it more difficult to find a significant finding.

4.4.3 Discussion

The pattern of results from Experiment 3 indicates that when high proficiency participants are reading in L2, high frequency L1 words influence processing. Lexical decision times to the homograph translation *corner* were slower than to the control word *friend* following interlingual homographs having a high L1 French frequency (e.g., *coin* with a frequency of 129 per million words). This pattern of results shows that high frequency French words like *coin* influence reading in English. In contrast, low frequency L1 French words like *four* 'oven' (with a frequency of 10 per million words) did not influence reading in English. In other words, there was no significant difference in lexical decision times to homograph translations (e.g., *oven*) and control words (e.g., *olive*) following interlingual homographs having a low L1 French frequency (e.g., *four*). Taken together these results indicate that high frequency L1 words influence reading in L2, but that low frequency L1 words do not.

Importantly, there was an effect of L2 word frequency for high proficiency bilinguals when processing in their L2. High frequency words were responded to more quickly than low frequency ones. High proficiency participants show frequency effects in L2 much like those of monolingual participants.

These findings are consistent with a model of exhaustive activation. When a bilingual reader encounters the letter string <four>, which is associated with '4' in English and 'oven' in French, both meanings are weighed according to the amount of evidence available to support them. Because $four_{French}$ occurs with a low frequency, there is not a lot of evidence to support the 'oven' interpretation. Moreover, the language of the context sentence supports the ‘4’ interpretation. Thus, when reading in English low frequency French homographs do <u>not</u> offer much competition for selection.

When a bilingual reader encounters the letter string <coin> both meanings are weighed according to the amount of evidence available to support them. Because the French word *coin* occurs with high frequency, the ‘corner’ interpretation of the homograph has more evidence to support selection of this interpretation. However, the language of processing supports the English ‘money’ interpretation. The French meaning of a high frequency interlingual homograph like *coin* therefore, competes for selection with the English meaning, but ultimately the ‘money’ meaning is chosen over the ‘corner’ meaning because the language of processing is English. Selection of $coin_{English}$ ‘money’ results in inhibitory feedback being sent to $coin_{French}$ ‘corner’. When the word *corner* is encountered directly after selection, it is recognized more slowly than the control word *friend* because ‘corner’ has just been inhibited.

4.5 Experiment 4

As stated before, results thus far indicate that the L1 French meaning of an interlingual homograph is exhaustively activated while processing in L2 English, but that the L2 English meaning of an interlingual homograph is not necessarily exhaustively activated while processing in L1 French. In other words, results show that fluent French dominant bilinguals activate the ‘corner’ meaning associated with the interlingual homograph *coin* while reading in L2 English, but that the ‘money’ meaning is not significantly activated while reading in L1 French. The lack of evidence for exhaustive activation while processing in L1 may be due to the overall lower strength of representation of L2 words. Experiment 3 showed the influence of high frequency interlingual homographs while reading in L2 English by high proficiency bilinguals. Experiment 4 assesses the role of frequency on exhaustive activation while processing in L2 French by intermediate proficiency participants.

4.5.1 Method

Participants. 18 English-dominant bilinguals from the University at Buffalo, who had an intermediate proficiency in L2 French, were paid $6 USD for their participation. Self-assessment of proficiency can be seen in Table 23. None of the participants had taken part in Experiment 1b.

Table 23. Language background of English dominant participants with an intermediate proficiency in French at the University at Buffalo in Experiment 4 on the two lists. Self-assessed ratings were on a 5 point scale, where 1 indicated an excellent and 5 a very poor proficiency. Standard Error is given in parentheses.

	list 1 n=9	**list 2 n=9**
Mean years exposed to L1	20.6	19.5
Mean years exposed to L2	7.5	9.0
Average self-rating on 5 point scale:		
speaking L2 French	2.9 (0.2)	3.3 (0.2)
reading L2 French	2.3 (0.2)	2.8 (0.2)
writing L2 French	2.8 (0.2)	3.0 (0.3)
comprehension in L2 French	2.5 (0.2)	3.0 (0.3)

Materials. Thirty-two sentences, like those in Table 24, were constructed such that an interlingual homograph ended every sentence. Probe words followed every sentence and were either translations of the homograph from English (e.g., *allumé ‘lit’*) or control words (e.g., *attiré ‘pulled’*). In Experiment 4, all sentences and words used in the lexical decision task were in French. A complete set of experimental materials is provided in Appendix I. In addition to the experimental stimuli, participants saw 160 filler sentences followed by probes. Half of the probes were real words and half were non-words. Following 48 (25%) of the sentence and probe word pairs a comprehension question was presented.

As in Experiment 3, in order to assess the role of frequency on exhaustive activation, interlingual homographs were divided into two groups based on their frequency. Sentences and probe words were counterbalanced across two presentation lists such that each participant saw a sentence followed either by a homograph translation or control word, and saw an equal number of each. In addition, participants saw an equal number of homographs that had a high frequency in L1 (e.g., *lit 'bed')* and a low frequency in L1 (e.g., *bride 'bridle'*).

Table 24. Stimuli for Experiment 4, investigating effect of frequency in L2 French by intermediate proficiency bilinguals.

Homograph with High L2 Frequency	**Probe Word**	**Probe Type**
a) Isabelle a acheté un nouveau lit. *'Isabelle bought a new bed.'*	a) allumé	homograph translation of English *lit*
	b) attiré	control for *allumé*
Homograph with Low L2 Frequency		
c) Jacques avait toutes sortes de chose dans sa cave, y compris une bride. 'Jacques has a lot of things in his basement, including a bridle.'	c) mariée	homograph translation of English *bride*
	d) maïs	control for *mariée*

Procedure. The procedure was the same as for Exp. 1a, except instructions were given in both English and French to ensure that participants understood the task. Eight practice trials were completed in French.

4.5.2 Results

Because homograph translations (e.g., *allumé ‘lit’* & *mariée ‘bride*) and their controls (e.g., *attiré ‘pulled’* & *maïs ‘corn’*) were actual words in French, few incorrect “NO” responses were expected. However, as these participants only had an intermediate proficiency in French more incorrect responses to both homograph translations and control words were expected than in previous experiments.

If frequency plays a role in exhaustive activation for intermediate proficiency participants, longer lexical decision times to homograph translations in the high than low frequency condition are expected. For example, when the language context of a sentence supports the French interpretation of the word *lit* ‘bed’ (e.g., Table 24a), but its frequency in English is high, there is evidence to support both interpretations. Competition for selection of the ‘bed’ and ‘started burning’ meanings should ensue. Because the sentence is in French, ultimately the ‘bed’ meaning is selected. Selection of lit_{French} sends inhibitory feedback to $lit_{English}$ ‘started burning’. When *allumé* ‘started burning’ is subsequently presented, longer lexical decision times ensue because ‘started burning’ has just been inhibited. In contrast, when the context supports the French interpretation of a word like *bride* ‘bridle’ (see Table 24d), and its frequency in English is low, available evidence most strongly supports the French interpretation. In other words, $bride_{English}$ does not compete for selection with $bride_{French}$. Because $bride_{English}$ does not serve as a competitor, selection of $bride_{French}$ does not result in the inhibition of $bride_{English}$. As a result there should be shorter lexical decision times to homograph translations in the low frequency condition than in the high frequency one.

Data Trimming. Twelve of the homograph translations and/or their controls received 50 percent or more incorrect “NO” responses. Additionally, these words were judged as unfamiliar to 40 percent or more of the participants on the stimuli verification task.[21] Due to the unfamiliarity of these 12 words and/or their controls they were excluded from any further analysis. The remaining 20 homographs were divided into high and low frequency groups based on their English and French frequencies. The ten homographs with the lowest English frequency were assigned to the low frequency group and had a mean log frequency of 31.7 per million (S.E. = (.5). Ten homographs with the highest frequency in English were assigned to the high frequency group and had a mean frequency of log 235.0 per million (S.E. = 29.4). The homographs were also divided into high and low frequency groups based on their French frequencies. Ten homographs were assigned to the low frequency group and had a mean log frequency of 21.5 per million (S.E. = 7.7). The ten homographs were assigned to the high frequency group and had a mean log frequency of 743.3 per million (S.E. = 421.2).

Judgments. Mean percentages of incorrect "NO" (non-word) responses for homograph translations and control words that have a high or low frequency in L2 French are shown in Table 25. There were 10.4% incorrect “NO” responses for homograph translations and 12.3% for their controls. Further, high frequency homograph translations lead to 4.2% incorrect “NO” responses, while their controls had 5.6% incorrect “NO” responses. Low frequency homograph translations resulted in 16.7% incorrect responses, while their controls resulted in 18.9% incorrect responses. Incorrect “NO” responses were submitted to two separate 2(word type) x 2(frequency type) analyses of variance

[21] The stimuli verification task is described in detail in 2.1 and can be seen in Appendix C.

(ANOVA). Analyses revealed no significant effect of word type by participants or items, $F_1(1,16) = 0.2$, $p > .05$, $F_2(1,10) = 0.3$, $p > .05$. In other words, there was no overall difference in incorrect "NO" responses to homograph translations and control words. There was significant main effect of word frequency in analyses by participants and items, $F_1(1,16) = 11.7$, $p < .05$, $F_2(1,10) = 19.5$, $p < .05$. Participants made more incorrect "NO" responses to low frequency words than to high frequency ones. However, there was no interaction between word type and word frequency in analyses by either participants or items, $F_1(1,16) = 0.2$, $p > .05$, or items $F_2(1,10) = 0.1$, $p > .05$.

Planned comparisons revealed that high frequency homograph translations and controls elicited fewer incorrect "NO" responses than low frequency homograph translations and controls, $F_1(1,16) = 22.0$, $p < .05$, $F_2(1,10) = 5.6$, $p < .05$. However, there was no difference in incorrect "NO" responses to high frequency homograph translations and control words by either participants or items, $F_1(1,16) = 0.7$, $p > .05$, $F_2(1,10) = 0.04$, $p > .05$. And, there was no difference in incorrect "NO" responses to low frequency homograph translations and control words by either participants or items, $F_1(1,16) = 0.3$, $p > .05$, $F_2(1,10) = 0.1$, $p > .05$.

Table 25. Percent incorrect ("NO") responses to homograph translations and control words that have either a high or low L2 French frequency with Standard Error in parentheses.

	L2 French Frequency	
	High	**Low**
homograph translation	4.2 (2.0)	16.7 (4.9)
control word	5.6 (2.3)	18.9 (4.1)

Taken together, these results indicate, unsurprisingly, that intermediate proficiency participants have more incorrect "NO" responses to low frequency L2 words than high frequency ones. This difference can probably be attributed to the fact that intermediate proficiency students are unfamiliar with many low frequency words in their L2 and do not recognize them as actual words.

Lexical Decision Times. Mean correct participant lexical decision times to homograph translations and controls when the homographs had high and low frequencies in L1 English and L2 French are shown in Table 26. Participant and item means were submitted to two separate 2(word type) x 2(frequency type) ANOVA with participant and items as random variables. The first ANOVA examined the effect of L1 English frequency while processing in L2 French by intermediate proficiency participants. There was a main effect of word type by participants $F_1(1,16) = 7.9$, $p < .05$, but not by items $F_2(1,10) = 3.1$, $p = .1$. There was a main effect of English word frequency by participants and items, $F_1(1,16) = 7.3$, $p < .05$, $F_2(1,10) = 8.5$, $p < .02$. There was not a significant interaction between word type and word frequency in analyses by either participants or items, $F_1(1,16) = 0.6$, $p > .05$, $F_2(1,10) = 0.3$, $p > .05$.

Table 26. Mean correct lexical decision times (ms) by intermediate proficiency English dominant bilingual participants to homograph translations and control words when the L1 English frequency of the homograph is either high or low and when the L2 French frequency of the homograph is either high or low. Standard Error is in parentheses.

	L1 English Frequency	
	High (e.g., *lit*)	**Low** (e.g., *bride*)
homograph translation, e.g. *allumé/mariée*	1418 (110)	1583 (118)
control, e.g. *attiré/maïs*	1262 (70)	1500 (106)
	L2 French Frequency	
	High (e.g., *fin*)	**Low** (e.g., *stage*)
homograph translation, e.g. *nageoire/scène*	1475 (124)	1567 (113)
control, e.g. *nettoyage/salon*	1336 (67)	1400 (111)

Because 12 out of the 32 items had been excluded from further analyses because participants had been unfamiliar with the interlingual homograph, homograph translation, and/or control word, I was left with a small set of items for analysis. The lack of an interaction may be due to the limited set of items. And although the interaction was not significant, planned comparisons were carried out to further explore the results. Analyses revealed that high frequency homograph translations (e.g., *allumé*) were responded to significantly more slowly than to their control words (e.g., *attiré*) by both participants and items, $F_1(1,16) = 6.0$, $p < .05$, $F_2(1,10) = 5.0$, $p < .05$. In other words, participants responded "YES" more slowly to homograph translations than control words following an interlingual homograph that had a high frequency in L1 English. There was no significant differences in lexical decision times to low frequency homograph translations (e.g., *mariée*) and their control words (e.g., *maïs*) by either participants or items, $F_1(1,16) = 1.9$, $p > .05$, $F_2(1,10) = 2.1$, $p > .05$.

A second ANOVA was done to determine whether French word frequency played a role in lexical decision times while processing in L2 French by intermediate proficiency participants. Analyses showed a significant main effect of word type by participants and a marginal effect by items, $F_1(1,16) = 9.9$, $p < .0061$, $F_2(1,10) = 4.2$, $p < .07$. There was <u>no</u> main effect of French word frequency by participants or items, $F_1(1,16) = 0.7$, $p > .05$, $F_2(1,10) = 0.3$, $p > .05$. In other words there was no difference in lexical decision times following homographs that had high and low frequency in French. There was also no interaction between word type and word frequency by either participants or items, $F_1(1,16) = 0.02$, $p > .05$, $F_2(1,10) = 0.10$, $p > .05$.

As before, even though there was no interaction, planned comparisons were conducted to further examine the findings. Planned comparisons showed no difference in lexical decision times to homograph translations (e.g., *nageoire 'fin'*) and control words (e.g., *nettoyage 'wash'*) following homographs that had a high L2 French frequency (e.g., *fin*) by either participants or items, $F_1(1,16) = 2.7$, $p > .05$, $F_2(1,10) = 3.3$, $p > .05$. There was no significant difference in lexical decision times to homograph translations (e.g., *scène 'stage'*) and control words (e.g., *salon 'living room'*) following homographs that had a low L2 French frequency (e.g., *stage*) by either participants or items, $F_1(1,16) = 3.6$, $p > .05$, $F_2(1,10) = 0.2$, $p > .05$. These results indicated that for intermediate proficiency participants, there was no effect of L2 word frequency on correct "YES" lexical decision times.

Comprehension Questions. Participants gave 12.5%-33.3% incorrect responses to the comprehension questions with an average miss rate of 18.5%. An average miss rate of 18.5%, with some participants missing as many as 33% of the comprehension questions, may seem high. Like with the previous experiments, including the results from participants who had a high miss rate only makes it more difficult to find a significant finding. And because there was a high level of incorrect responses, results should be taken with caution.

4.5.3 Discussion

Results in Experiment 4 indicate that when intermediate proficiency participants are reading in L2, high frequency L1 words influence processing. Lexical decision times to the homograph translation *allumé* were slower than to the control *attiré* following interlingual homographs having a high L1 English (e.g., *lit*). This pattern of results shows that high frequency English words like *lit* influence processing in French. In contrast, low frequency L1 words like *bride* did not influence processing in French. There was no significant difference in lexical decision times to homograph translations (e.g., *mariée*) and control words (e.g., *maïs*) following the interlingual homograph *bride* which has a low L1 English frequency. There was also no effect of French word frequency on lexical decision times for intermediate proficiency participants while processing in L2 French. In other words, lexical decision times to homograph translations (e.g., *nageoire/scène*) and control words (e.g., *nettoyage/salon*) following homographs having either a high or low frequency in L2 French (e.g., *fin/stage*) did not differ. However, there was a significant effect on errors for intermediate proficiency participants. Intermediate proficiency participants made more incorrect "NO" responses to interlingual homographs and control words in the low frequency condition than in the high frequency condition. As stated above, this was probably due to the participants' unfamiliarity with many low frequency words in French.

These findings are consistent with a model of exhaustive activation. When a bilingual reader encounters the letter string <bride>, which is associated with 'woman getting married' in English and 'bridle' in French, both meanings are weighed according to the amount of evidence available to support them. Because $bride_{English}$ occurs with a low frequency, there is not a lot of evidence to support the 'woman getting married' interpretation. The language of the context sentence supports the 'bridle' interpretation. Therefore, when reading in French, low frequency English homographs do <u>not</u> offer much competition for selection. When a bilingual reader encounters the letter string <lit>, associated with ‘started burning’ in English and ‘bed’ in French, because the English word *lit* occurs with high frequency the ‘started burning’ interpretation of the homograph has evidence to support this interpretation. However, the language of processing supports the French ‘bed’ interpretation. This leads to competition for selection and ultimately, $lit_{English}$ is inhibited, which slows the response to *allumé*.

A further goal of Experiments 3 and 4 was to investigate the role of proficiency on the exhaustive activation of multiple meanings of interlingual homographs. It had been hypothesized that because the participants in Experiment 4 only had an intermediate proficiency in L2 French, a larger influence of L1 representations would be found. In contrast, in Experiment 3 where participants had a high L2 English proficiency less of an influence of L1 representations was expected. Specifically, it was expected that the relative strength of L2 representations would be greater for high proficiency participants, and therefore, the influence of L1 representations would be less. However, both experiments showed a similar pattern of results. Both high and intermediate proficiency participants showed an influence of frequent L1 representations when reading in L2. There was a significant difference in lexical decision times for homograph translations and control words following high frequency interlingual homographs for both participant groups. This indicates that the L1 meaning of an interlingual homograph is activated when reading in L2, if the homograph has a sufficiently high frequency in L1, regardless of the proficiency of the participants in L2. In addition, it had been hypothesized that even low frequency L1 representations would influence processing by intermediate proficiency participants. However, for both the high and intermediate proficiency groups there was no influence of interlingual homographs that had a low L1 frequency when reading in L2. The lack of evidence for the influence of low frequency L1 words on processing by intermediate proficiency participants may be due to the small set of items that were actually familiar to low proficiency participants. If a larger set of items, which were familiar to low proficiency participants, could be studied, an effect of low frequency L1 words would be predicted.

The only difference in the pattern of results from Experiments 3 and 4 was the role of L2 word frequency when processing in L2. Intermediate proficiency participants did not show an effect of L2 word frequency on lexical decision times. In other words, lexical decision times to words having a high and low frequency in L2 were not significantly different. Intermediate proficiency participants only showed an effect of frequency in their pattern of errors. They made more incorrect “NO” responses to low frequency words than high ones. In contrast, results from high proficiency participants indicate that the L2 frequency of words plays a role in the on-line processing of words. More specifically, high proficiency participants responded more quickly to words having a high frequency in L2 than those having a low frequency. This is similar to monolingual findings that show that word frequency affects the speed of word recognition (e.g., Rayner & Balota, 1989). In general, findings indicated that high frequency words are processed more quickly than low frequency ones. Taken together, the results from Experiments 3 and 4 indicate that word frequency influences processing for high proficiency participants in much the same way as it does for monolinguals. And it appears that for intermediate proficiency participants word frequency of known words in L2 plays does not influence correct “YES” lexical decision times. This is probably because for intermediate proficiency participants all words have a relatively low frequency.

CHAPTER 5

5 General Discussion and Conclusions

My dissertation experiments were undertaken to gain a greater understanding of the conditions under which lexical representations from one language influence processing in another. Such an understanding has implications for linguistic and psycholinguistic models of language representation. Additionally, an understanding of the conditions that lead to language-exhaustive or selective processing has practical applications for second language learning and teaching. Ultimately, discovering the factors that allow for selective language processing without the influence from another language will lead to new and better ways of learning and teaching a second language.

5.1 Summary of Major Findings

The dissertation experiments investigated whether processing in one language is influenced by lexical-semantic representations in another language. Specifically these experiments investigated the role of sentence context (Experiment 1), the language of processing (Experiment 2), word frequency (Experiments 3 & 4), and proficiency (Experiments 3 & 4) on exhaustive activation.

Experiment 1a was carried out to determine whether bilingual lexical activation was exhaustive while reading in L2. If bilingual lexical activation was found to be exhaustive while processing in L2, a further goal was to determine whether context could effectively constrain exhaustive activation. More specifically, Experiment 1a investigated whether native French speakers activated the meaning ‘corner’ associated with *coin*$_{French}$ while reading the sentence *“While walking, the little boy found a coin”*. This was tested by probing with the word *corner* immediately after participants read the sentence. The logic of this study was as follows: if bilingual lexical activation is language selective, there should be no significant difference in lexical decision times to homograph translations (e.g., *corner*) and control words (e.g., *friend*). In contrast, if bilingual lexical activation is exhaustive (i.e., all meanings corresponding to a letter string are exhaustively activated no matter the language being processed in), there should be significantly longer lexical decision times to homograph translations than to control words. I found that participants had significantly longer lexical decision times to homograph translations like *corner* than to the control words like *friend*. Thus, I conclude that bilingual lexical activation is exhaustive when reading in L2.

Beyond investigating whether L1 lexical-semantic representations are activated while processing in L2, Experiment 1a examined whether sentence context constrained exhaustive lexical activation. The logic underlying this investigation was as follows: if sentence context does not constrain interactive activation, there should be no difference in lexical decision times to homograph translations and control words following biased and neutral sentences. However, if context does constrain interactive activation, there should be a significant difference in lexical decision times to *corner* and *friend* following biased and neutral sentences. Previous research has shown that when a sentence context contains a feature or a property of an ambiguous word or constrains the interpretation of it, only the contextually appropriate meaning is activated (e.g., Duffy, Kambe, & Rayner, 2001; Duffy, Morris, & Rayner, 1988; Folk & Morris; 1995; Martin, Vu, Kellas, & Metcalf, 1999; Morris, 1994; Onifer, & Swinney, 1981; Paul, Kellas, Martin, Clark, 1992; Rayner, Binder, & Duffy, 1999; Rayner & Frazier, 1989; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Tabossi, 1988; Tabossi, Colombo, & Job, 1987; Tabossi & Zardon, 1993). Therefore, the prediction was for no significant difference in lexical decision times to *corner* and *friend* following sentences that contained a feature of the ambiguous word, as in the sentence, *"The thing with the lowest monetary value is a coin"*. Results indicated that only the contextually appropriate meaning of the homograph was activated to a significant level when reading a biased sentence. Evidence for this came from the null difference in lexical decision times to homograph translations and control words following homographs in biased sentences.

Experiment 1b was conducted to ensure that the results of Experiment 1a were not due to systematic differences in neutral and biased sentences, or homograph translations and control words. Experiment 1b used the same set of experimental materials as Experiment 1a, and tested monolingual English speakers. If the materials were <u>not</u> driving the results in Experiment 1a, there should be <u>no</u> significant differences for monolingual control participants in any condition because there was no relation between the word final homograph and the word in the lexical decision task for participants who did not speak French. The prediction was confirmed. Therefore, the pattern of results from Experiment 1a cannot be attributed to systematic differences in sentences or probe words.

The results of Experiment 1a indicated that both meanings of an interlingual homograph were exhaustively activated when highly fluent bilinguals read sentences in their L2 that did not constrain the interpretation of the homograph. Experiment 2 investigated whether bilingual lexical activation is exhaustive when processing is in L1. More specifically, Experiment 2 examined whether native French speakers who are highly fluent in English activated the L2 'money' meaning associated with the homograph *coin* while reading the L1 French sentence, *"La boulangerie se trouve vers le coin"*. If activation is exhaustive while processing in French, there should be longer responses to homograph translations (e.g., *monnaie*) than control words (e.g., *montre*). However, if when processing in L1, the L2 'money' meaning associated the interlingual homograph *coin* does not receive a significant level of activation, it will <u>not</u> influence processing. Then the prediction is that there will <u>not</u> be a significant difference in lexical decision times to *monnaie* and *montre*. And as in Experiment 1a, there should be longer lexical decision times to *corner* than *friend* after reading the interlingual homograph *coin* in L2 English. The results of Experiment 2 replicated those of Experiment 1. There were longer lexical decision times to *corner* than *friend* after reading *coin* in L2 English. However, while processing in L1 French there was no significant difference in lexical decision times to *monnaie* and *montre* after reading the interlingual homograph *coin*. This indicates that the language of processing influences whether or not all meanings associated with an interlingual homograph will be activated. Specifically, when a bilingual encounters an interlingual homograph while processing in L1, the likelihood that an L2 meaning will receive a significant level of activation and influence processing is low.

The lack of evidence for the influence of L2 lexical representations while processing in L1 may be due to the relative frequencies of L1 and L2 words in a bilingual's mental lexicon. In order to assess the role of frequency on exhaustive activation, Experiments 3 and 4 were carried out. Experiments 3 and 4 assessed the role of frequency on exhaustive activation. In these two experiments, participants read sentences in their L2 and performed lexical decisions on homograph translations and control words following interlingual homographs that were either high or low frequency in their L1.

Furthermore, Experiments 3 and 4 assessed the role of L1 word frequency on exhaustive activation by high proficiency bilinguals (Experiment 3) and intermediate proficiency bilinguals (Experiment 4) when reading in L2. If frequency plays a role in the activation of multiple meanings of interlingual homographs, a difference in lexical decision times to homograph translations in the high and low frequency conditions was expected. For example, if the language context of a sentence supports an English interpretation of the homograph *coin* and its frequency in French is high, evidence does not clearly support either interpretation and competition for selection results. Ultimately the ‘money’ meaning is selected because processing is in English. Selection of the ‘money’ meaning sends inhibitory feedback to ‘corner’. When *corner* is subsequently encountered, recognition is slow. In contrast, when the context supports an English interpretation of a word like *four* and its frequency in French is low, evidence more strongly supports an English interpretation of the interlingual homograph *four*. Because neither the language of processing nor the frequency of $four_{French}$ support the ‘oven’ interpretation of the homograph, $four_{French}$ does not receive a significant amount of activation. Therefore the ‘oven’ interpretation does not compete with ‘4’ for selection. Because $four_{French}$ does <u>not</u> compete for selection, it is <u>not</u> inhibited. Therefore, subsequent presentation of the word *oven* is not affected by having just encountered the string <four>. As a result, shorter lexical decision times to homograph translations in the low frequency condition were found than in the high frequency one.

Slower lexical decision times were expected and found to high frequency L1 interlingual homographs and their controls but not to low frequency L1 interlingual homographs and their controls. These results suggest that when both high and intermediate proficiency participants are reading in L2, high frequency L1 words influence processing, but not low frequency ones.

In addition, Experiments 3 and 4 investigated the role of proficiency on the exhaustive activation of multiple meanings of interlingual homographs. It had been hypothesized that a larger influence of L1 representations would be found with intermediate proficiency participants. It was expected that strength of L2 representations would be greater for high proficiency participants, and therefore, the influence of L1 representations would be less. However, both high and intermediate proficiency participants had significantly longer lexical decision times for homograph translations and control words following high frequency L1 interlingual homographs. This indicates that the L1 meaning of an interlingual homograph is activated when reading in L2, if the homograph has a sufficiently high frequency, regardless of the proficiency of the participants. In addition, it had been hypothesized that even low frequency L1 representations would influence processing by intermediate proficiency participants. However, for both the high and intermediate proficiency groups there was no influence on lexical decision times following interlingual homographs that had a low L1 frequency when reading in L2.

The only difference in the pattern of results from Experiments 3 and 4 was the role of L2 word frequency when processing in L2. Intermediate proficiency participants did not show an effect of L2 word frequency on lexical decision times while high proficiency participants did. High frequency L2 words were processed more quickly than low frequency ones by high, but not by intermediate proficiency participants. However, intermediate proficiency participants showed an effect of frequency in their pattern of errors. Thy made more incorrect “NO” responses to low frequency words than high frequency ones. Collectively the results from Experiments 3 and 4 indicate that word frequency influences speed of processing for high proficiency participants in much the same way as it does for monolinguals, but for intermediate proficiency participants in affects accuracy on the lexical decision task.

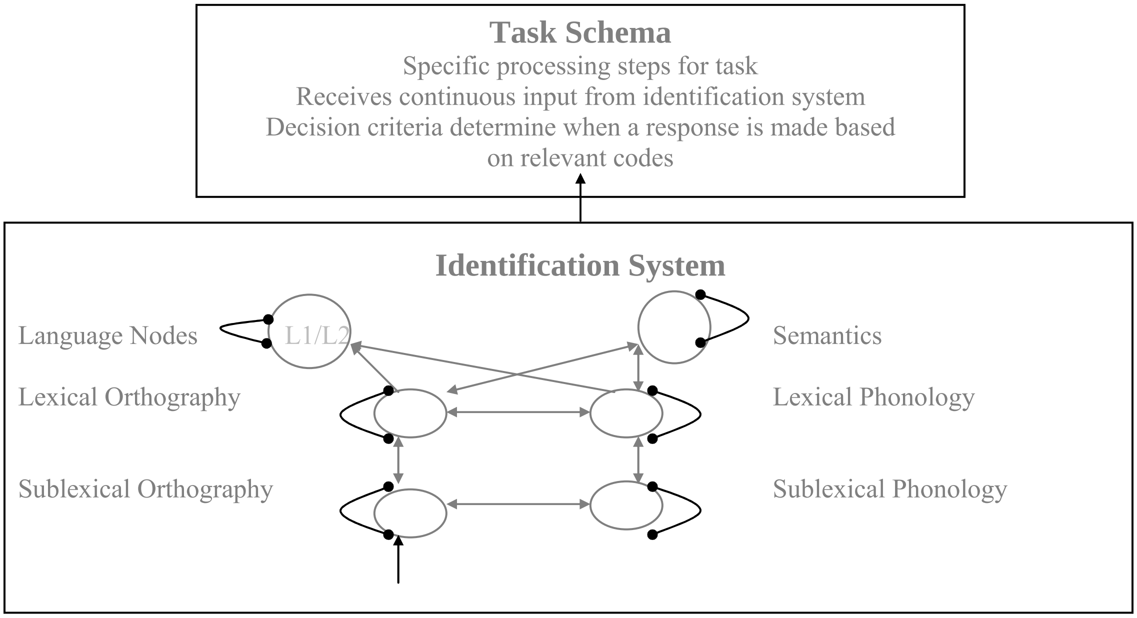
Taken together the set of results from the dissertation experiments indicate that processing in an L2 is influenced by lexical-semantic representations in L1. Crucially, the influence of L1 is mediated by sentence context and the frequency of L1 representations.

5.2 An Account of the Findings in Terms of Processing Models

The findings reviewed above can partially be explained in terms of several different models. As discussed previously (see section 1.3), many results in the bilingual word recognition literature can be accounted for by the BIA model (Dijkstra and Van Heuven, 1998; Dijkstra et al., 1998; Van Heuven, Dijkstra, & Grainger, 1998). However, the BIA model is a fairly simple word recognition model and does not account for the role of word frequency or context in word activation. Because the current results show an influence of both context and frequency, the BIA will not be able to adequately account for the pattern of findings. Instead, the BIA+ model (Dijkstra & Van Heuven, 2002) will be used to explain the current findings.

The BIA+ model addresses some of the limitations of the BIA model through the addition of nodes for sublexical orthography, lexical orthography, sublexical phonology, lexical phonology, and semantics (see Figure 14). At the sublexical orthographic level features of individual letters are represented. Activation of features at this level leads to the activation and recognition of letters like, “b”, “r”, “a”, “s”. Similarly, features of different phonemes, (e.g., aspiration) are represented at the sublexical phonological level. Activation of these features leads to activation and recognition of phonemes. Importantly, the BIA+ adds a semantic node where meanings associated with orthographic and phonological representations are stored. Activation of semantics directly influences the activation of lexical representation. In other words, activation of the semantic representation ‘underwear’ can influence activation of the lexical representation ‘bras’. Therefore, when a participant reads a sentence like, *“Molly bought some underwear and two new bras”* and encounters the word *underwear*, the semantics associated with this word will be activated. Activation of the semantics associated with ‘underwear’ leads to the activation of related semantic representations like, ‘bras’. Because the semantics of ‘bras’ already has a heightened level of activation, when the string <bras> is subsequently encountered, recognition of $bras_{English}$ is speeded and an influence of $bras_{French}$ is not seen.

Figure 14. BIA+ model of bilingual word recognition (Dijkstra & Van Heuven, 2002).



In addition, the BIA+ model makes a distinction between a word identification system and a task/decision system. The word identification system accounts for effects arising from the linguistic context available in sentences (e.g., lexical, syntactic, semantic, and language of processing information), while the task/decision system accounts for effects arising from the non-linguistic context (e.g., instructions, task demands, and participant expectations). Word activation is not modulated by non-linguistic context. Non-linguistic context only affects the task decision system and serves to optimize performance. In the dissertation experiments, the task/decision system may have played a role if participants used the information that they had been recruited because they were bilingual to optimize their performance. However, if this were the case, a similar pattern of results would be expected when processing in L1 and L2. If participants were using the knowledge that their understanding of both languages was being tested even though they were reading in only one, a difference in lexical decision times to homograph translations and controls should have been found when reading in L1.

According to the BIA+, exhaustive activation, frequency-dependent results, and facilitation or inhibition of lexical decision times are all explained by aspects of the word identification system. Crucially, activation of semantic representations depends on word frequency. Frequency effects are accounted for by the "temporal delay assumption", which says that there is a delay in the activation of L2 semantic representations relative to those in L1 due to the lower frequency of L2 words. An alternative way to conceptualize this is that L2 and lower frequency representations take more time to reach the threshold for recognition.

The BIA+ can account for the current findings in the following way. When a French dominant participant reads the string <bras> in an English task, activation is sent from the sublexical orthographic level to the orthographic level, where *bras* is recognized. Recognition of *bras* at the orthographic level sends activation to the phonological sand semantic levels. Because the input is consistent with both $bras_{English}$ and $bras_{French}$, both the 'money' and 'corner' meanings should be accessed at the semantic level. However, this access is mediated by the relative frequencies of $bras_{English}$ and $bras_{French}$. $Bras_{French}$ has a relatively high frequency while $bras_{English}$ has a relatively low one (based on monolingual corpora data). Therefore, evidence based on frequency supports the selection of $bras_{French}$. However, the language of processing supports selection of $bras_{English}$. The French interlingual homograph provides strong competition for selection which leads to longer lexical decision times. When an English homograph has a significantly higher frequency than the French one, the French homograph should not be a strong competitor.

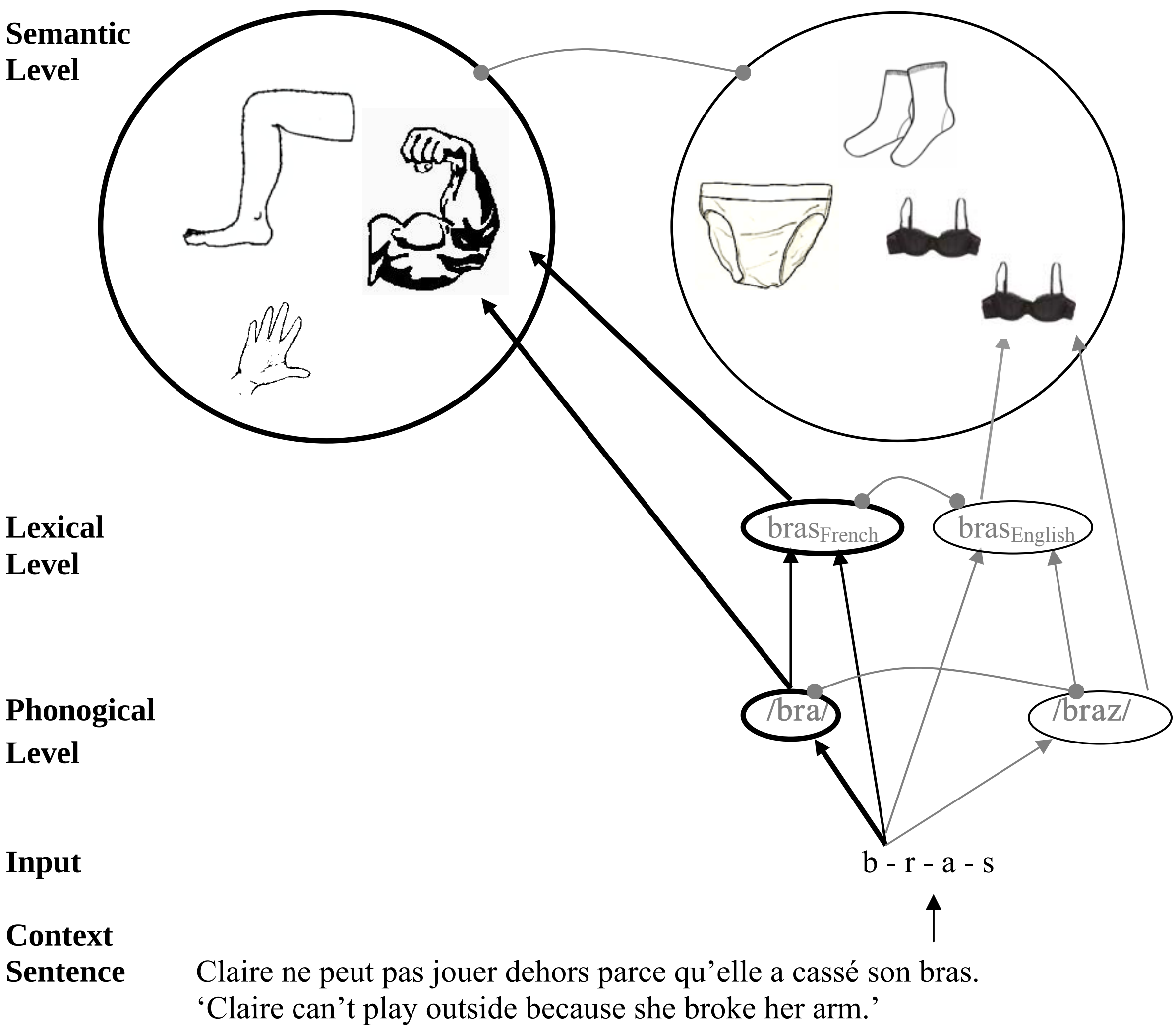
The BIA+ highlights the importance of frequency on word recognition. Dijkstra and Van Heuven also characterize bilingual lexical activation as being sensitive to semantic context information in much the same way as monolingual word recognition is. However, the BIA+ does not specify how and when context plays a role in activation. To account for how frequency and context interact to affect activation, I will turn to monolingual models of word activation in sentential contexts.

Neither the *exhaustive* nor the *ordered search theories* provide an adequate account for the current findings because they do not account for the role of frequency and context respectively on lexical activation (see section 1.6 for a discussion of models of word recognition in sentential contexts). The revised version of the *reordered access model* (Duffy, Morris, & Rayner, 1988; Rayner, Binder, & Duffy, 1999; Rayner & Duffy, 1986; Rayner & Frazier, 1989) and the *context-sensitive model* (Martin, Vu, Kellas, & Metcalf, 1999; Kellas, Martin, & Clark, 1992; Paul, Kellas, Martin, & Clark, 1992; Vu & Kellas, 1999; Vu, Kellas, Petersen, & Clark, 2003) make similar predictions about the role of frequency and context on the activation of the meanings of lexically ambiguous words. On the *context selective model*, activation is the result of an interaction between frequency and strength of context. Both context strength and frequency are considered to be continuous variables that together affect patterns of activation. However, neither the *reordered access* nor the *context-sensitive models* explain lexical activation at the sublexical level. Taken separately the BIA+, the *reordered access model*, and the *context-sensitive model* cannot explain the obtained pattern of results. The BIA+ will be used to account for bottom-up effects and the *reordered access* and the *context-sensitive models* will be to explain top-down effects.

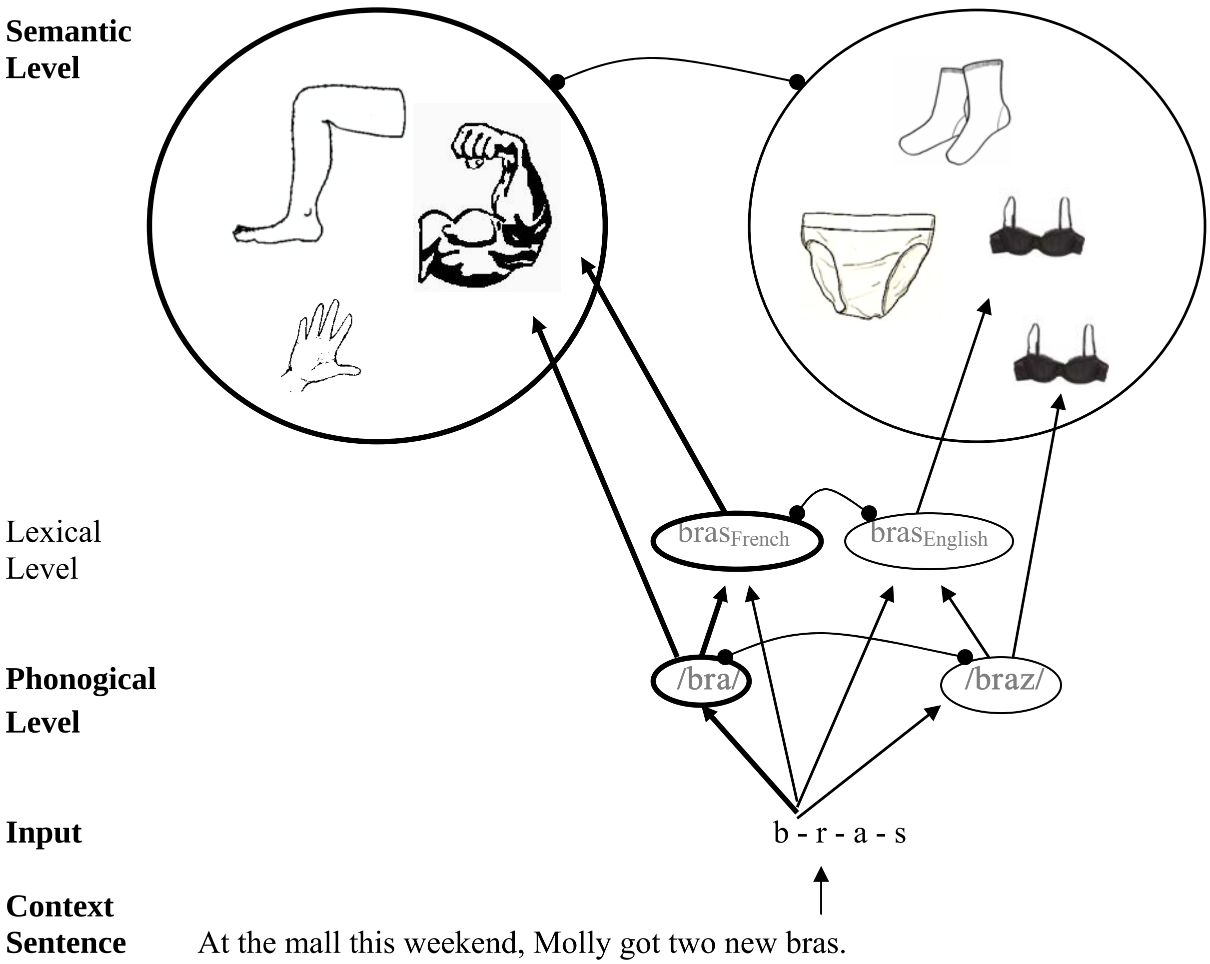
According to the BIA+, when a French dominant participant reads a word like *bras*, it is recognized at the sublexical orthographic level and then at the orthographic level. At the orthographic level the input is consistent with both *bras*$_{English}$ and *bras*$_{French}$, corresponding to the meanings 'underwear' and 'arm' respectively. Upon encountering the letter string <bras>, both the English and French phonological codes, /braz/ and /bra/ receive activation. The two phonological codes compete for selection. Activation of the phonological representations /braz/ and /bra/ contributes to the activation of the lexical representation 'bras' and the semantic representations 'underwear' and 'arm'. The phonological representations compete for selection as do the semantic representations. Each meaning is weighted according to the amount of evidence available to support it. Because *bras*$_{French}$ has a higher frequency than *bras*$_{English}$, evidence based on frequency supports selection of the 'arm' meaning. When reading in French, more sublexical patterns conforming to French patterns will have been activated. This will lead to stronger activation of the lexical representation *bras*$_{French}$ and the phonological representation /braz/. When reading sentences in L1 French, evidence based on frequency and the language of the sentence support the L1 interpretation of the interlingual homograph. Because there is little evidence to support the 'women's undergarment' interpretation, it does not compete for selection with the 'arm' meaning, and therefore is not inhibited. If the 'women's undergarment' meaning had been inhibited, the subsequent presentation of the word *slip* 'underwear' would elicit slow lexical decision times. The lack of difference in lexical decision times to homograph translations and control words following interlingual homographs when processing in L1 provides evidence that the L2 meaning does not have a significant level of activation to compete for selection with the L1 meaning. This is illustrated in Figure 15a.

Figure 15. A depiction of the activation of the ‘arm’ and ‘underwear’ meanings associated with the homonym *bras*, where thick lines represent high frequency and thin lines represent low frequency connections. Connections that do not appear to influence processing are in gray. In (a) and (b) the context sentence is neutral, while in (c) and (d) it is biased. In (a) and (c) the context sentence is in L1 French, while in (b) and (d) it is in L2 English.

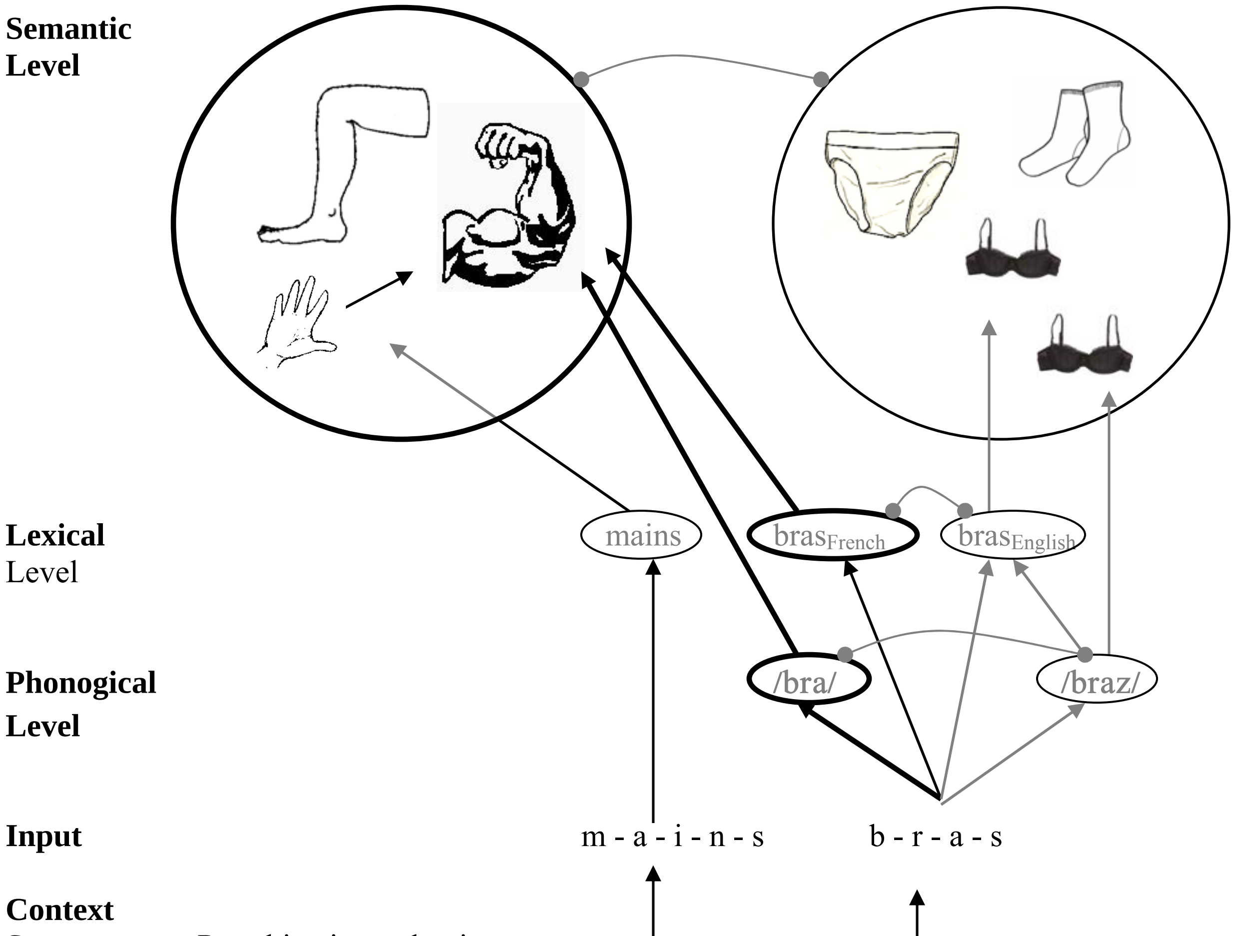
(a)



(b)

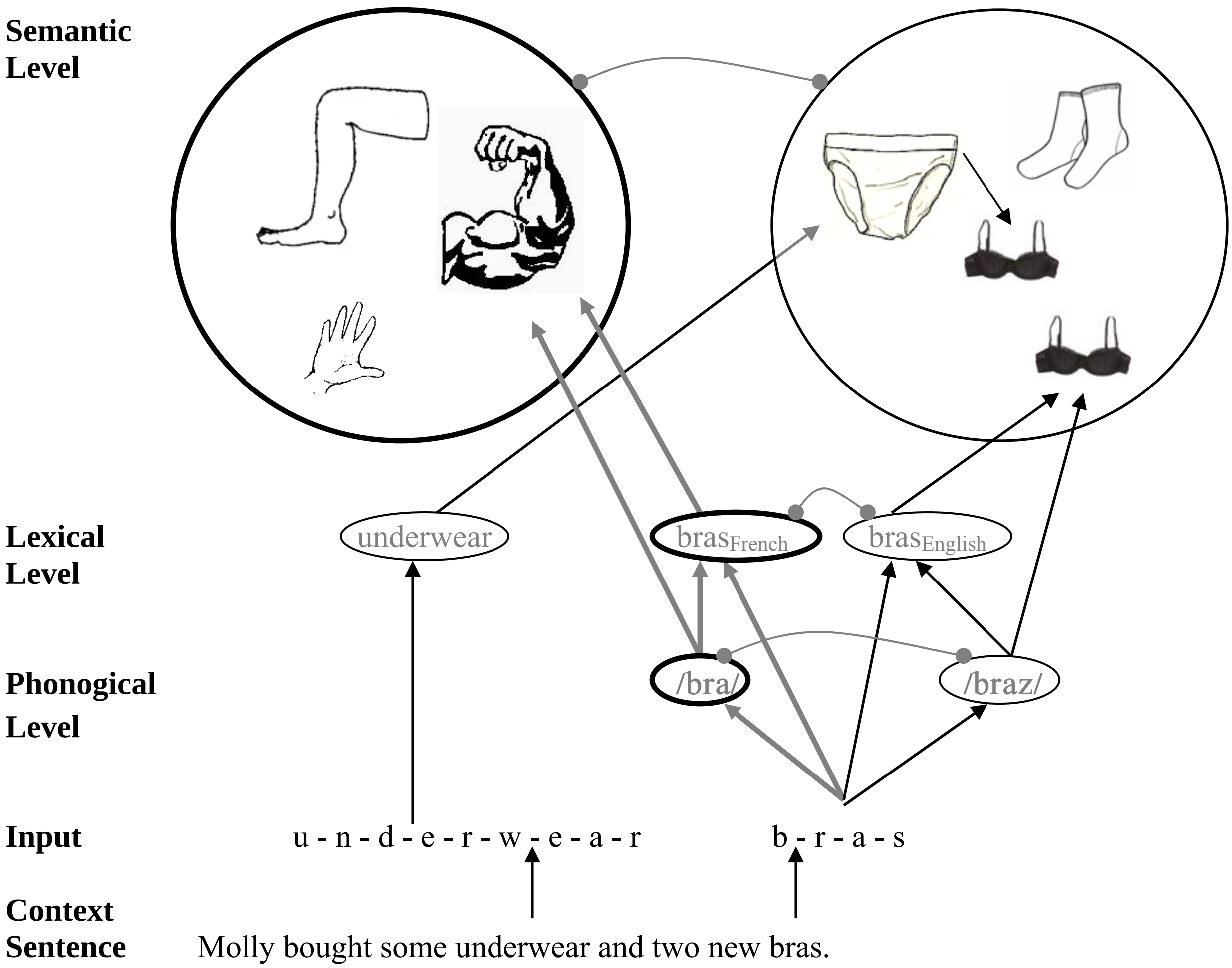

Semantic Level
Lexical Level
bras French
bras English
Phonogical Level
/bra/
/braz/
Input
b - r - a - s
Context Sentence
At the mall this weekend, Molly got two new bras.

(c)



Pour bien jouer du piano,
il faut pas seulement utiliser les mains mais aussi les bras.
'To play the piano well,
it is necessary to use your hands as well as your arms.'

(d)



When French-dominant participants encounter the string <bras> in an English sentence it is recognized at the sublexical orthographic level and then at the orthographic level. At the orthographic level the input is consistent with both $bras_{English}$ and $bras_{French}$, therefore, both the English and French phonological codes, /braz/ and /bra/ receive activation. The two phonological codes compete for selection. Activation of the phonological representations /braz/ and /bra/ contributes to the activation of the lexical representation 'bras' and the semantic representations 'underwear' and 'arm'. The phonological representations compete for selection as do the semantic representations. Each is weighted according to the amount of evidence available to support it. When reading in English, more sublexical and subphonological patterns conforming to English patterns will have been activated. This leads to stronger activation of the lexical representation $bras_{English}$ and the phonological representation /bra/. Thus, the language of processing supports the 'underwear' meaning of *bras*. The evidence based on frequency also supports more strongly represented L1 'underwear' meaning. This situation is illustrated in Figure 15b. Because evidence supports both the 'underwear' and 'arm' meanings, there is competition for selection. Because the bilingual is reading in English, ultimately the 'underwear' meaning is selected and the arm meaning is inhibited. When the word *arm* is subsequently presented, lexical decision times are slow because it has just been inhibited.

However, when reading in L2 English, if the sentence context is sufficiently constraining (e.g., *"Molly bought some new underwear and two new bras"*) enough evidence accrues early to support the L2 interpretation of the homograph, and the 'arm' meaning does not compete for selection. More specifically, reading the word *underwear* boosts the resting level of activation of $bras_{English}$. When the string <bras> is encountered, $bras_{English}$ already has a high level of activation, and $bras_{French}$ does not compete with it for selection. Since $bras_{French}$ does not compete for selection it does not need to be inhibited. The lack of difference in lexical decision times to homograph translations and control words following interlingual homographs when reading biased context sentences in L2 provides evidence that in this context the L1 meaning does not compete for selection with the L2 meaning. This is illustrated in Figure 15d. Similarly, when reading a context that evokes a feature or property of *bras* in L1 French, there is no influence of English. This is illustrated in Figure 15c.

The pattern of activation in the current experiments is very similar to those in the monolingual literature. These results indicate that processing in a L2 is subject to the same processing mechanisms as L1 and can be explained in terms of the same models. Crucially, the findings highlight the capacity of context, much like in the monolingual literature, to prevent more frequent representations from influencing the processing of lexically ambiguous words.

5.3 Future Directions

My dissertation results indicate that both context and frequency affect the activation of multiple meanings of lexically ambiguous interlingual homographs like *coin* and *bras*. The findings indicate that L1 representations influence processing while reading in L2. However, there is no evidence that the reverse is true. The lack of evidence for L2 representations influencing processing in L1 may be due to the overall weaker representation of words in L2. If it were possible to find a large enough set of interlingual homographs that have a high L2 frequency and a low L1 frequency, an influence of L2 representations while processing in L1 may be found. While it was not possible to find a large enough set of words in English and French that were high frequency in one language and low frequency in the other, it may be possible in other languages.

Rayner and colleagues suggest that context and frequency play a role after lexical access. On the *reordered access model* all meanings associated with a lexically ambiguous word are activated in parallel. The activated lexical representations are then weighted according to accumulating evidence based on frequency and context. More specifically, on this model context and frequency only play a role in a post-lexical access selection process. On the *context sensitive model* the strength of activation for multiple meanings of ambiguous words is driven by frequency, whether the context supports the more or less frequent meaning, and how strong the context is. On this model context and frequency play a direct role in lexical activation. The current results do not distinguish between a process affecting lexical activation and a post lexical access process, since a lexical decision task does not distinguish between these two possibilities. A methodology like eye-tracking, and in particular first pass reading times, might provide clear evidence that context and frequency play a role in lexical activation in bilingual processing and is not simply a post-lexical process. If the current pattern of results were replicated using the eye-tracking methodology, this would provide strong evidence for the role of context and frequency in the activation process. However, is important to point out that in the monolingual literature, eye-tracking, self-paced reading, lexical decision, and naming provide converging evidence for the activation of lexically ambiguous words like *bat*. It may be the case that lexical decision, similar to eye-tracking, is tapping into the lexical activation process and not simply post-lexical activation.

As discussed above, previous studies in the monolingual literature highlight the role of phonology and semantics in the activation of multiple meanings of homographs. Results indicate that faster response times are associated with words having overlapping orthography and phonology, but competing semantics (e.g., the homonym *bat*) (e.g., Gotlob et al., 1999; Hino & Lupker, 1996; Rodd et al., 2002; Swinney, 1979; Tanenhaus et al., 1979). Slower lexical decision times are associated with encountering words having overlapping orthography, but competing phonology and semantics (e.g., the homograph *base*) (e.g., Gotlob et al., 1999). It appears that only differing phonology slows response times. However, Rodd et al. (2002) criticize this conclusion and point out that previous studies did not vary how disparate the semantics of homonyms were. Rodd et al. compare response times of words with one meaning to homonyms having multiple unrelated meanings (e.g., *bark*) and those having multiple related word senses (e.g., *twist*). They showed that words with one meaning were responded to significantly faster than words with two meanings. Words with multiple related senses were responded to more quickly than words with multiple unrelated meanings. Their results indicate that competition between the multiple unrelated meanings of ambiguous words slows their recognition. In cases where there are rich semantic representations associated with a word, recognition is speeded.

Taken together these results indicate that both competing phonology and semantics affect word recognition. However, exactly when and how each plays a role is not clear. In order to gain a greater understanding of when and how competing phonological and semantic representations interact, future investigations should look at the processing of interlingual homographs that have more or less phonological and semantic overlap.

In the bilingual literature a lot of work has been done on the processing of interlingual homographs. Because interlingual homographs have a shared orthography that maps onto distinct phonological and semantic representations in two languages, they allow researchers to study how conflict between two potentially competing languages is resolved. In the future it may be informative to look at other cases where there is overlap between the two languages but also potential conflict. For example, the word *piano* has a shared orthography and semantics, and similar phonologies in English and French, but differs in grammatical gender across the two languages. In English inanimate nouns like *piano* do not typically have a gender, while in French *piano* is masculine. When a French-English bilingual reads or hears a word like *piano* while processing in English, the orthographic, phonological, and semantic overlap may cause the masculine gender to become activated. The activation of the masculine gender may influence processing in English. In particular when hearing a sentences like, *"The piano will be played by Bob. He is on the other side of the room"*, the pronoun *he* may be ambiguous if *piano* activates the male gender. Examples like the one outlined above will allow researchers to investigate whether other instances of overlap result in conflict for the language processing system of bilinguals, and the cues bilinguals use to resolve this potential conflict. It is important that researchers continue to study the conditions under which lexical representations from one language influence processing in another. Such research has important implications for linguistic and psycholinguistic models of language representation, and has practical applications for second language learning and teaching.

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Appendix A: Language Background Questionnaires

Language Background Questionnaire
English

Age: _____ Sex: ☐ male ☐ female

Age you were first exposed to English: _____ Age you were first exposed to French: _____

Where did you learn English? ☐ at home ☐ at school

Where did you learn French? ☐ at home ☐ at school

What language(s) does/do your mother speak **with you**? ☐ English ☐ French ☐ other ________

What language(s) does/do your father speak **with you**? ☐ English ☐ French ☐ other ________

Indicate other languages you speak in addition to English and French and your proficiency in each.
__________ ☐ excellent ☐ good ☐ ok ☐ weak ☐ very poor
Indicate other languages you speak in addition to English and French and your proficiency in each.
__________ ☐ excellent ☐ good ☐ ok ☐ weak ☐ very poor
Indicate other languages you speak in addition to English and French and your proficiency in each.
__________ ☐ excellent ☐ good ☐ ok ☐ weak ☐ very poor

Educational Background (check **all** that apply):

elementary school	☐ in English	☐ in French	☐ other _________
middle school	☐ in English	☐ in French	☐ other _________
high school	☐ in English	☐ in French	☐ other _________
college	☐ in English	☐ in French	☐ other _________
graduate school	☐ in English	☐ in French	☐ other _________

Rate your language use with the following people:

At home to your parents
☐ always English ☐ English more than French ☐ English and French equally ☐ French more than English ☐ always French ☐ does not apply

At home with your brothers or sisters
☐ always English ☐ English more than French ☐ English and French equally ☐ French more than English ☐ always French ☐ does not apply

with your friends
☐ always English ☐ English more than French ☐ English and French equally ☐ French more than English ☐ always French ☐ does not apply

with your co-workers
☐ always English ☐ English more than French ☐ English and French equally ☐ French more than English ☐ always French ☐ does not apply

Rate the language use of the following people when speaking to you:

your parents
☐ always English ☐ English more than French ☐ English and French equally ☐ French more than English ☐ always French ☐ does not apply

your brothers or sisters
☐ always English ☐ English more than French ☐ English and French equally ☐ French more than English ☐ always French ☐ does not apply

your friends
☐ always English ☐ English more than French ☐ English and French equally ☐ French more than English ☐ always French ☐ does not apply

your co-workers

☐ always English	☐ English more than French	☐ English and French equally	☐ French more than English	☐ always French	☐ does not apply

Rate the relative frequency with which you do the following in English and French:

read	☐ always English	☐ English more than French	☐ English and French equally	☐ French more than English	☐ always French	☐ does not apply
write	☐ always English	☐ English more than French	☐ English and French equally	☐ French more than English	☐ always French	☐ does not apply
speak	☐ always English	☐ English more than French	☐ English and French equally	☐ French more than English	☐ always French	☐ does not apply
hear (TV, radio, teachers, parents, etc)	☐ always English	☐ English more than French	☐ English and French equally	☐ French more than English	☐ always French	☐ does not apply

Rate your abilities in **English** for the following categories:

speaking	☐ excellent	☐ good	☐ ok	☐ weak	☐ very poor
reading	☐ excellent	☐ good	☐ ok	☐ weak	☐ very poor
writing	☐ excellent	☐ good	☐ ok	☐ weak	☐ very poor
comprehension	☐ excellent	☐ good	☐ ok	☐ weak	☐ very poor

Rate your abilities in **French** for the following categories:

speaking	☐ excellent	☐ good	☐ ok	☐ weak	☐ very poor
reading	☐ excellent	☐ good	☐ ok	☐ weak	☐ very poor
writing ability	☐ excellent	☐ good	☐ ok	☐ weak	☐ very poor
comprehension	☐ excellent	☐ good	☐ ok	☐ weak	☐ very poor

How many hours a week do you do the following activities in English and French:

speak	_____ English	_____ French
read	_____ English	_____ French
write	_____ English	_____ French
listen	_____ English	_____ French

Could you pass as a monolingual speaker when talking with someone who doesn't know you?

In English:	☐ always	☐ almost always	☐ sometimes	☐ almost never	☐ never
In French:	☐ always	☐ almost always	☐ sometimes	☐ almost never	☐ never

Which language do you feel most comfortable speaking?

☐ English ☐ French ☐ other _________

Which language do you use to do simple arithmetic (counting, adding, etc)?

☐ English ☐ French ☐ other _________

Do you have any other comments on your language use/background that you think are important, but which you were not asked about in the questionnaire?

____

____

____

Questionnaire linguistique
Version française

Age: _____ Sexe: ☐ masculin ☐ féminin

Age de votre premier contact avec l'anglais: _____
Age de votre premier contact avec le français: _____

Où avez-vous appris l'anglais? ☐ à la maison ☐ à l'école
Où avez-vous appris le français? ☐ à la maison ☐ à l'école

En quelle(s) langue(s) est-ce que votre mère **vous** parle? ☐ français ☐ anglais ☐ autre langue ____________

En quelle(s) langue(s) est-ce que votre père **vous** parle? ☐ français ☐ anglais ☐ autre langue ____________

Indiquez quelle langues vous parlez en dehors du français et de l'anglais et votre degré de compétence en chacune?
__________ ☐ excellente ☐ bonne ☐ ok ☐ faible ☐ très faible
Indiquez quelle langues vous parlez en dehors du Français et de l'Anglais et votre degré de compétence en chacune?
__________ ☐ excellente ☐ bonne ☐ ok ☐ faible ☐ très faible
Indiquez quelle langues vous parlez en dehors du Français et de l'Anglais et votre degré de compétence en chacune?
__________ ☐ excellente ☐ bonne ☐ ok ☐ faible ☐ très faible

Education (mettez une croix pour **chaque** niveau pertinent):

Ecole primaire	☐ en français	☐ en anglais	☐ autre langue _________
Ecole secondaire	☐ en français	☐ en anglais	☐ autre langue _________
Lycée	☐ en français	☐ en anglais	☐ autre langue _________
Université	☐ en français	☐ en anglais	☐ autre langue _________
Thèse	☐ en français	☐ en anglais	☐ autre langue _________

Evaluez votre usage relatif du français et de l'anglais avec les personnes suivantes:

A la maison avec vos parents
☐ toujours français ☐ français plus que anglais ☐ français et anglais à égalité ☐ anglais plus que français ☐ toujours anglais ☐ N/A apply

A la maison avec vos frères et soeurs
☐ toujours français ☐ français plus que anglais ☐ français et anglais à égalité ☐ anglais plus que français ☐ toujours anglais ☐ N/A apply

Avec vos amis
☐ toujours français ☐ français plus que anglais ☐ français et anglais à égalité ☐ anglais plus que français ☐ toujours anglais ☐ N/A apply

Au travail
☐ toujours français ☐ français plus que anglais ☐ français et anglais à égalité ☐ anglais plus que français ☐ toujours anglais ☐ N/A apply

Evaluez l'usage relatif du Français et de l'Anglais de vos interlocuteurs:

Vos parents
☐ toujours français ☐ français plus que anglais ☐ français et anglais à égalité ☐ anglais plus que français ☐ toujours anglais ☐ N/A apply

Vos frères et soeurs
☐ toujours français ☐ français plus que anglais ☐ français et anglais à égalité ☐ anglais plus que français ☐ toujours anglais ☐ N/A apply

Vos amis

☐ toujours français	☐ français plus que anglais	☐ français et anglais à égalité	☐ anglais plus que français	☐ toujours anglais	☐ N/A apply

Vos compagnons de travail

☐ toujours français	☐ français plus que anglais	☐ français et anglais à égalité	☐ anglais plus que français	☐ toujours anglais	☐ N/A apply

Evaluez votre usage relatif du Français et de l'Anglais pour les occupations suivantes:

Lire

☐ toujours français	☐ français plus que anglais	☐ français et anglais à égalité	☐ anglais plus que français	☐ toujours anglais	☐ N/A apply

Ecrire

☐ toujours français	☐ français plus que anglais	☐ français et anglais à égalité	☐ anglais plus que français	☐ toujours anglais	☐ N/A apply

Parler

☐ toujours français	☐ français plus que anglais	☐ français et anglais à égalité	☐ anglais plus que français	☐ toujours anglais	☐ N/A apply

Ecouter (télé, radio, profs, parents, etc)

☐ toujours français	☐ français plus que anglais	☐ français et anglais à égalité	☐ anglais plus que français	☐ toujours anglais	☐ N/A apply

Evaluez vos capacités en **français** pour les catégories suivantes:

Parler	☐ Excellent	☐ Bon	☐ ok	☐ faible	☐ très faible
Lire	☐ Excellent	☐ Bon	☐ ok	☐ faible	☐ très faible
Ecrire	☐ Excellent	☐ Bon	☐ ok	☐ faible	☐ très faible
Comprendre	☐ Excellent	☐ Bon	☐ ok	☐ faible	☐ très faible

Evaluez vos capacités en **anglais** pour les catégories suivantes:

Parler	☐ Excellent	☐ Bon	☐ ok	☐ faible	☐ très faible
Lire	☐ Excellent	☐ Bon	☐ ok	☐ faible	☐ très faible
Ecrire	☐ Excellent	☐ Bon	☐ ok	☐ faible	☐ très faible
Comprendre	☐ Excellent	☐ Bon	☐ ok	☐ faible	☐ très faible

Indiquez combien d'heures par semaine vous faites les chose suivantes en français et en anglais:

Parler	_____ en français	_____ en anglais
Lire	_____ en français	_____ en anglais
Ecrire	_____ en français	_____ en anglais
Ecouter	_____ en français	_____ en anglais

Passeriez-vous pour un locuteur monolingue pour quelqu'un qui vous ne connaîtrait pas?

En français:	☐ toujours	☐ presque toujours	☐ parfois	☐ presque jamais	☐ jamais
En anglais:	☐ toujours	☐ presque toujours	☐ parfois	☐ presque jamais	☐ jamais

Dans quelle langue vous est-il plus facile de parler?

☐ français ☐ anglais ☐ autre langue _________

Dans quelle langue comptez-vous (addition, substraction, etc)?

☐ français ☐ anglais ☐ autre langue _________

Avez-vous des commentaires sur votre comportement linguistique que vous considérez importants, mais sur lesquels le questionnaire ne vous a pas interrogé?

____

____

____

Appendix B: Vocabulary Assessment for High Proficiency Participants

English Version

For the following words give <u>either</u> *a definition in English* <u>OR</u> *a translation into French*, whichever is easier for you.
If you cannot come up with a definition or translation fairly quickly, check the box *don't know*.

For example:

a. What is the definition or translation for *dog*?
four-legged, house pet that barks OR *chien*____________________ ☐ don't know

b. What is the definition or translation for *ontogenesis*?
____ ☒ don't know

1. What is the definition or translation for *door*?
____ ☐ don't know

2. What is the definition or translation for *band*?
____ ☐ don't know

3. What is the definition or translation for *enough*?
____ ☐ don't know

4. What is the definition or translation for *abode*?
____ ☐ don't know

5. What is the definition or translation for *mail*?
____ ☐ don't know

6. What is the definition or translation for *school*?
____ ☐ don't know

7. What is the definition or translation for *canter*?
____ ☐ don't know

8. What is the definition or translation for *bay*?
____ ☐ don't know

9. What is the definition or translation for *ditty*?
____ ☐ don't know

10. What is the definition or translation for *less*?
____ ☐ don't know

11. What is the definition or translation for *depict*?
____ ☐ don't know

12. What is the definition or translation for *bud*?
____ ☐ don't know

13. What is the definition or translation for *catch*?
____ ☐ don’t know

14. What is the definition or translation for *need*?
____ ☐ don’t know

15. What is the definition or translation for *trust*?
____ ☐ don’t know

French Version

Pour les mots suivants on vous demande de donner *la definition en français* <u>OU</u> *la traduction en anglais,* suivant ce qui vous est plus facile.
Si vous ne parvenez pas à une definition ou traduction assez rapidement, cochez la case *ne sais pas.*

Voici quelques exemples:

a. Donnez la définition ou la traduction du mot suivant: *poche*
un petit sac de toile à l'intérieur d'un vêtement OU *pocket*_________ ☐ ne sais pas

b. Donnez la définition ou la traduction du mot suivant: *ontogenesis*?
______________________________ x ne sais pas

1. Donnez la définition ou la traduction du mot suivant: *rue*.
______________________________ ☐ ne sais pas

2. Donnez la définition ou la traduction du mot suivant: *coller*.
______________________________ ☐ ne sais pas

3. Donnez la définition ou la traduction du mot suivant: *grisant*.
______________________________ ☐ ne sais pas

4. Donnez la définition ou la traduction du mot suivant: *revenir*.
______________________________ ☐ ne sais pas

5. Donnez la définition ou la traduction du mot suivant: *écouler*.
______________________________ ☐ ne sais pas

6. Donnez la définition ou la traduction du mot suivant: *âme*.
______________________________ ☐ ne sais pas

7. Donnez la définition ou la traduction du mot suivant: *linge*.
______________________________ ☐ ne sais pas

8. Donnez la définition ou la traduction du mot suivant: *loutre*.
______________________________ ☐ ne sais pas

9. Donnez la définition ou la traduction du mot suivant: *pendant*.
______________________________ ☐ ne sais pas

10. Donnez la définition ou la traduction du mot suivant: *coteau*.
______________________________ ☐ ne sais pas

11. Donnez la définition ou la traduction du mot suivant: *souvent*.
______________________________ ☐ ne sais pas

12. Donnez la définition ou la traduction du mot suivant: *épée*.
______________________________ ☐ ne sais pas

13. Donnez la définition ou la traduction du mot suivant: *pavaner*.
____ ☐ ne sais pas

14. Donnez la définition ou la traduction du mot suivant: *racine*.
____ ☐ ne sais pas

15. Donnez la définition ou la traduction du mot suivant: *klaxon*.
____ ☐ ne sais pas

Appendix C: Stimuli Verification Task for Intermediate Proficiency Participants

List 1

Circle any words in the following sentences that you are unfamiliar with.

1. Madeleine porte toujours le même pull.
2. Avant de se coucher, il regarde sa figure.
3. La boulangerie se trouve vers le coin.
4. Patricia n’aime pas mon fils, mais elle aime mon chat.
5. Pour comprendre le film, il faut attendre la fin.
6. A Buffalo, il fait souvent du vent.
7. L’enfant n'aime pas son slip.
8. Le bébé a eu sa première dent.
9. Ce camion rouge est beaucoup trop lent.
10. Ce genre d'histoires, ce n’est pas très net.
11. Au parc il y a une mare.
12. Ce soir on a vu une très bonne pièce.
13. L’année dernière, l’été a été très rude.
14. Les jeunes, ça aime voir du pays.
15. La maison de Jean est vraiment très sale.
16. Les enfants, plus aucun son.
17. Le vendeur nous conseilla d’examiner la lame.
18. Cette femme là est très mince.
19. Jacques avait toutes sortes de choses dans sa cave, y compris une bride.
20. A travers la chemise de Marie, on apercevait sa chair.
21. Il faut dire aux moins une chose.

22. Michel veut acheter un nouveau four.

23. Isabelle a acheté un nouveau lit.

24. Son discours est beaucoup trop court.

25. Au parc, Clotilde a vu un ours.

26. Luc aime bien cette pub.

27. Là-bas, il y a du sang.

28. Philippe a un mauvais sort.

29. Demain, on doit acheter du pain.

30. Au milieu de sa main, Cécile avait une grande ride.

31. François veut avoir un singe.

32. En avril, Mireille va faire un stage.

Circle any of the following words that you are unfamiliar with.

1. tomber	12. mouton	23. allumé
2. simplicité	13. imprévu	24. terrain
3. montre	14. préférer	25. nôtre
4. bousculer	15. vague	26. bar
5. nettoyage	16. façon	27. chanta
6. obéissance	17. boiteux	28. classer
7. gagner	18. hacher	29. douleur
8. bordel	19. mariée	30. promener
9. prévu	20. chaise	31. roussir
10. fleche	21. choisit	32. scène
11. jumelle	22. quatre	

List 2

Circle any words in the following sentences that you are unfamiliar with.

1. Madeleine porte toujours le même pull.
2. Avant de se coucher, il regarde sa figure.
3. La boulangerie se trouve vers le coin.
4. Patricia n'aime pas mon fils, mais elle aime mon chat.
5. Pour comprendre le film, il faut attendre la fin.
6. A Buffalo, il fait souvent du vent.
7. L'enfant n'aime pas son slip.
8. Le bébé a eu sa première dent.
9. Ce camion rouge est beaucoup trop lent.
10. Ce genre d'histoires, ce n'est pas très net.
11. Au parc il y a une mare.
12. Ce soir on a vu une très bonne pièce.
13. L'année dernière, l'été a été très rude.
14. Les jeunes, ça aime voir du pays.
15. La maison de Jean est vraiment très sale.
16. Les enfants, plus aucun son.
17. Le vendeur nous conseilla d'examiner la lame.
18. Cette femme là est très mince.
19. Jacques avait toutes sortes de choses dans sa cave, y compris une bride.
20. A travers la chemise de Marie, on apercevait sa chair.
21. Il faut dire aux moins une chose.
22. Michel veut acheter un nouveau four.

23. Isabelle a acheté un nouveau lit.

24. Son discours est beaucoup trop court.

25. Au parc, Clotilde a vu un ours.

26. Luc aime bien cette pub.

27. Là-bas, il y a du sang.

28. Philippe a un mauvais sort.

29. Demain, on doit acheter du pain.

30. Au milieu de sa main, Cécile avait une grande ride.

31. François veut avoir un singe.

32. En avril, Mireille va faire un stage.

Circle any of the following words that you are unfamiliar with.

1. tirer
2. silhouette
3. monnaie
4. bavarder
5. nageoire
6. ouverture
7. glisser
8. bosse
9. prêté
10. filet
11. jument
12. morceau
13. impoli
14. payer
15. vente
16. fils
17. blagueur
18. héberger
19. maïs
20. chapeau
21. réussit
22. quotidien
23. attiré
24. tendance
25. nonne
26. jupe
27. cacha
28. circuler
29. docteur
30. partager
31. rajouter
32. salon

Appendix D: Norming Study 1

In the following you will be asked to give the three most important properties or features of a word.

For example:
What are the most important properties or features of TREE.

____
____
____

You might list *LEAVES, BRANCHES, TRUNK*.

Additional example:
What are the most important properties or features of RICE.

____
____
____

You might list *WHITE, FOOD, GRAIN*.

1. What are the most important properties or features of WIND:
   ____
   ____
   ____

2. What are the most important properties or features of BRIDE:
   ____
   ____
   ____

3. What are the most important properties or features of CAR:
   ____
   ____
   ____

4. What are the most important properties or features of CHOSE:
   ____
   ____
   ____

5. What are the most important properties or features of COIN:
   ____
   ____
   ____

6. What are the most important properties: or features of COMMENT:
   ____
   ____
   ____

7. What are the most important properties or features of CHAIR:
   ____
   ____
   ____

8. What are the most important properties or features of CHAT:
   ____
   ____
   ____

9. What are the most important properties or features of COURT:
____
____
____

10. What are the most important properties or features of DENT:
____
____
____

11. What are the most important properties or features of DIRE:
____
____
____

12. What are the most important properties or features of DOT:
____
____
____

13. What are the most important properties or features of FIGURE:
____
____
____

14. What are the most important properties or features of FILE:
____
____
____

15. What are the most important properties or features of FIN:
____
____
____

16. What are the most important properties or features of FOUR:
____
____
____

17. What are the most important properties or features of LAID:
____
____
____

18. What are the most important properties or features of LAME:
____
____
____

19. What are the most important properties or features of LENT:
____
____
____

20. What are the most important properties or features of LIT:
____
____
____

21. What are the most important properties or features of MAIN:
____
____
____

22. What are the most important properties or features of MARE:
____
____
____

23. What are the most important properties or features of MINCE:
____
____
____

24. What are the most important properties or features of NET:
____
____
____

25. What are the most important properties or features of OURS:
____
____
____

26. What are the most important properties or features of PAIN:
____
____
____

27. What are the most important properties or features of PAYS:
____
____
____

28. What are the most important properties or features of PIECE:
____
____
____

29. What are the most important properties or features of POUR:
____
____
____

30. What are the most important properties or features of PUB:
____
____
____

31. What are the most important properties or features of PULL:
____
____
____

32. What are the most important properties or features of RANG:
____
____
____

33. What are the most important properties or features of RIDE:
____
____
____

34. What are the most important properties or features of RUDE:
____
____
____

35. What are the most important properties or features of SALE:
____
____
____

36. What are the most important properties or features of SANG:
____
____
____

37. What are the most important properties or features of SEIZE:
____
____
____

38. What are the most important properties or features of SINGE:
____
____
____

39. What are the most important properties or features of SLIP:
____
____
____

40. What are the most important properties or features of SON:
____
____
____

41. What are the most important properties or features of SORT:
____
____
____

42. What are the most important properties or features of STAGE:
____
____
____

43. What are the most important properties or features of TAPE:
____
____
____

44. What are the most important properties or features of TENANT:
____
____
____

45. What are the most important properties or features of VENT:
____
____
____

46. What are the most important properties or features of ARM:
____
____
____

47. What are the most important properties or features of BRIDLE:
____
____
____

48. What are the most important properties or features of BUS:
____
____
____

49. What are the most important properties or features of FLESH:
____
____
____

50. What are the most important properties or features of CAT:
____
____
____

51. What are the most important properties or features of THING:
____
____
____

52. What are the most important properties or features of CORNER:
____
____
____

53. What are the most important properties or features of HOW:
____
____
____

54. What are the most important properties or features of SHORT:
____
____
____

55. What are the most important properties or features of TOOTH:
____
____
____

56. What are the most important properties or features of SAY:
____
____
____

57. What are the most important properties or features of DOWRY:
____
____
____

58. What are the most important properties or features of FACE:
____
____
____

59. What are the most important properties or features of LINE:
____
____
____

60. What are the most important properties or features of END:
____
____
____

61. What are the most important properties or features of OVEN:
____
____
____

62. What are the most important properties or features of UGLY:
____
____
____

63. What are the most important properties or features of BLADE:
____
____
____

64. What are the most important properties or features of SLOW:
____
____
____

65. What are the most important properties or features of BED:
____
____
____

66. What are the most important properties or features of HAND:
____
____
____

67. What are the most important properties or features of POND:
____
____
____

68. What are the most important properties or features of THIN:
____
____
____

69. What are the most important properties or features of HONEST:
____
____
____

70. What are the most important properties or features of BEAR:
____
____
____

71. What are the most important properties or features of BREAD:
____
____
____

72. What are the most important properties or features of COUNTRY:
____
____
____

73. What are the most important properties or features of PLAY:
____
____
____

74. What are the most important properties or features of FOR:
____
____
____

75. What are the most important properties or features of AD:
____
____
____

76. What are the most important properties or features of SWEATER:
____
____
____

77. What are the most important properties or features of ROW:
____
____
____

78. What are the most important properties or features of WRINCLE:
____
____
____

79. What are the most important properties or features of ROUGH:
____
____
____

80. What are the most important properties or features of DIRTY:
____
____
____

81. What are the most important properties or features of BLOOD:
____
____
____

82. What are the most important properties or features of SIXTEEN:
____
____
____

83. What are the most important properties or features of MONKEY:
____
____
____

84. What are the most important properties or features of UNDERWEAR:
____
____
____

85. What are the most important properties or features of SOUND:
____
____
____

86. What are the most important properties or features of FATE:
____
____
____

87. What are the most important properties or features of TRAINING:
____
____
____

88. What are the most important properties or features of HIT:
____
____
____

89. What are the most important properties or features of HOLD:
____
____
____

90. What are the most important properties or features of BRAS:
____
____
____

Appendix E: Norming Study 2

English Version

INSTRUCTIONS AND PRACTICE

In the following you will be asked to CIRCLE any word or words in a sentence (1) which evoke a feature or aspect of the underlined word or (2) which make you think of the underlined word. If there are NOT any words that make you think of the underlined word or evoke a feature or aspect of the underlined word you should CIRCLE the word NONE. The following give some examples.

a. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Susan got a new tire for her bike. NONE

In the above sentence you should circle "tire" because a tire is a property or an aspect of a *bike*.

b. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Jimmy really wants to get a second dog. NONE

In the above sentence you should circle NONE because there is nothing in the sentence that should make you think of *dog* or that evokes a property or aspect of a *dog*.

c. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Carrots are usually orange. NONE

In the above sentence you should circle the word "carrots" because carrots should make you think of the color orange.

ENGLISH LIST ONE ITEMS

1. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Molly bought some new underwear and two new bras. NONE

2. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

For Halloween, the secretary dressed up as a bride. NONE

3. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The man couldn't fix the engine of the antique car. NONE

4. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

One of the four legs broke on the old chair. NONE

5. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The old ladies love to sit on the porch and chat. NONE

6. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

That is the car that Eve chose. NONE

7. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Usually the thing with the lowest monetary value is a coin. NONE

8. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

All last week Amanda was in court. NONE

9. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Mom didn't buy the can of soup that had a dent. NONE

10. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

On the piece of paper there was a single dot. NONE

11. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

A woman who is a model usually has a good figure. NONE

12. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The important papers were neatly organized in a big file. NONE

13. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Mary watched a veterinarian doing surgery on a fin. NONE

14. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The even number after two is four. NONE

15. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The farmer has a dog that is lame. NONE

16. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The president was shocked when he found out how much money the bank had lent. NONE

17. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Before singing Happy Birthday all of the candles on the cake were lit. NONE

18. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Yesterday, Sam saw a brown mare. NONE

19. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Gary thought the apples were easy to mince. NONE

20. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The sportsman caught a lot of fish in his net. NONE

21. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

After making the final payment, we felt like we owned it and it was ours. NONE

22. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Henry's elbow caused him a lot of pain. NONE

23. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Daniel thinks that being in real-estate pays. NONE

24. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Jennifer couldn't finish because the puzzle was missing a piece. NONE

25. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Near the corner, there is a very popular pub. NONE

26. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

To open a heavy door, forcefully move it towards you when you pull. NONE

27. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The assistant came running whenever the old woman rang. NONE

28. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

John always likes to take his family for a ride. NONE

29. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The obnoxious customer said something very rude. NONE

30. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Susan realized that there was a big sale. NONE

31. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

In the morning, after getting up, Matt always sang. NONE

32. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

If your face gets too close to the fire, your hair might singe. NONE

33. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

When walking, Wendy is always careful so that she doesn't slip. NONE

34. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Bob really wanted to have a son. NONE

35. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The new employee found the documents difficult to sort. NONE

36. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

After the play, the actors took a bow on stage. NONE

37. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

To fix the ripped page, Jeremy used some really sticky but old tape. NONE

38. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

On the wall, bellow the window there was a big vent. NONE

ENGLISH LIST TWO ITMES

1. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

At the mall this weekend Molly got two new bras. NONE

2. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The wedding gown looked beautiful on the bride. NONE

3. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

On the front lawn, there was an old car. NONE

4. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

At the garage sale last weekend, Sally bought an old chair. NONE

5. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The talkative salesclerk loves to chat. NONE

6. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Eve was supposed to decide, but instead I chose. NONE

7. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

When he was walking to school yesterday, John found a coin. NONE

8. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

All last week the lawyer was in court. NONE

9. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

After the accident, Mike noticed his car had a dent. NONE

10. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

When writing the letter 'i', Mark always forgets the small, round dot. NONE

11. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The champion gymnast has a very nice figure. NONE

12. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Charles was having trouble locating the important file. NONE

13. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Many fish have a distinctive fin. NONE

14. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Jan wanted enough china for four. NONE

15. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The dog limps because it is lame. NONE

16. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Bob never gave back the book Gail had lent. NONE

17. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Dan is a chain smoker and always keeps his pipe lit. NONE

18. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The horse breeder bought a new mare. NONE

19. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Onions are easy to chop, but hard to mince. NONE

20. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

On the ground there was a net. NONE

21. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

After looking at the beautiful house, we wanted to make it ours. NONE

22. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Because of his serous injuries, Henry was in constant pain. NONE

23. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

If you want to have a lot of money, being a stock-broker really pays. NONE

24. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

No matter what, Jennifer always wants the biggest piece. NONE

25. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

In England, people like to have beer at a local pub. NONE

26. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The movie return bin had a sign on it that said pull. NONE

27. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

When I was a kid, as soon as we sat down for dinner the phone always rang. NONE

28. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

After John fixed his bike he went for a ride. NONE

29. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The customer in front of me in line was very rude. NONE

30. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

We only go shopping when there is a sale. NONE

31. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

Amazing Grace is the song that girl always sang. NONE

32. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

When curling your hair, you should be careful not to let it singe. NONE

33. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

When walking on the ice, be careful not to fall and slip. NONE

34. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

During the championship game the father was proud of his son. NONE

35. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

The new secretary found the files difficult to organize and sort. NONE

36. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

In the front of the room there was a little stage. NONE

37. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

On Jeremy's floor there was some tape. NONE

38. Are there any word or words in the following sentence that make you think of a particular aspect of the underlined word?

After leaving the furnace, heated air passes through a big vent. NONE

French Instructions and Practice

On vous demande d'ENCERCLER ci-dessous les mots dans une phrase (1) qui évoquent une propriété ou un aspect du mot souligné, ou (2) qui vous font penser au mot souligné. S'il n'y a AUCUN mot qui vous fasse penser au mot souligné ou qui évoque pour vous une propriété ou un aspect du mot souligné, ENCERCLEZ le mot AUCUN. Voici quelques exemples.

a. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Susanne a acheté un nouveau pneu pour son <u>vélo</u>. AUCUN

Dans la phrase ci-dessus vous devez encercler *pneu* parce qu'un pneu est une propriété ou un aspect d'un vélo.

b. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Jean veut vraiment acquérir un deuxième <u>chien</u>. AUCUN

Dans la phrase ci-dessus vous devez encercler *AUCUN* parce que rien dans la phrase ne fait penser à un chien ou évoque une propriété ou un aspect d'un chien.

c. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Les carottes sont généralement <u>orange</u>s. AUCUN

Dans la phrase ci-dessus vous devez encercler *carottes* parce qu'une carotte fait penser à la couleur orange.

FRENCH LIST ONE ITEMS

1. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

   Pour bien jouer du piano, il faut pas seulement utiliser ses mains mais aussi le <u>bras</u>. AUCUN

2. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

   Jacques voulait faire une ballade en forêt, mais il ne pouvait pas parce que le cheval avait cassé sa <u>bride</u>

   AUCUN

3. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

   Pour aller au marché, Sophie prend le <u>car</u>. AUCUN

4. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

   A travers sa chemise de nuit transparente on apercevait sa peau ambrée et sa chair. AUCUN

5. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

   Mon chéri, il faut faire attention aux griffes de ce chat. AUCUN

6. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

   Il faut dire aux moins une chose. AUCUN

7. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

   Alex, mon petit, en haut et à gauche d'un carré, il y a un coin. AUCUN

8. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

   Une table de 50cm de long, c'est très court. AUCUN

9. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

   Le bébé a eu sa première dent. AUCUN

10. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

    La femme avait une dot. AUCUN

11. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

    Malheureusement pour lui, David n'avait ni le nez ni les yeux au milieu de la figure AUCUN

12. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

    Dans cette boulangerie, pour acheter son pain, il faut attendre à la file. AUCUN

13. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Pour comprendre le film, il faut attendre la fin. AUCUN

14. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Michel veut acheter un nouveau four. AUCUN

15. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Quand on achète un bon couteau, c'est pour sa lame. AUCUN

16. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Ce vieux camion est beaucoup trop lent. AUCUN

17. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Isabelle avait envie de dormir sur un bon lit. AUCUN

18. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

L'été avait été sec, alors il n'y avait plus beaucoup d'eau dans la mare. AUCUN

19. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Pierre avait essayé tous les régimes pour devenir svelte et mince. AUCUN

20. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Jean n'est pas très intègre, en bref pas net. AUCUN

21. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Dans la fôret, Clotilde a vu un ours. AUCUN

22. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Au supermarché on peut acheter du pain. AUCUN

23. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

La France, c'est ma terre, c'est mon pays. AUCUN

24. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Ce soir on a vu une très bonne pièce. AUCUN

25. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Pour augmenter ses ventes, il faut plus de pub. AUCUN

26. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Si Madeleine veut avoir chaud, Jeanne lui tricotera un pull. AUCUN

27. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Je veux que vous formiez une seule file et soyez en rang. AUCUN

28. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Au milieu de sa main, Cécile avait une grande ride. AUCUN

29. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

L'année dernière, l'hiver a été très dur et rude. AUCUN

30. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

La maison de Jean est vraiment très sale. AUCUN

31. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Là-bas, il y a du sang. AUCUN

32. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Tarzan aime autant les bananes qu'un singe. AUCUN

33. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

L'enfant ne veut pas porter son slip. AUCUN

34. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Les enfants, plus de bruit, plus aucun son. AUCUN

35. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Philippe a un mauvais sort. AUCUN

36. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

En Avril, Mireille va faire un stage. AUCUN

37. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Marc ne veut pas que son grand frère le tape. AUCUN

38. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Au dessus du palais, un drapeau flottait agité par le vent. AUCUN

FRENCH LIST TWO ITEMS

1. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?
   Clarie ne peut pas jouer dehors, parce qu'elle a cassé son <u>bras</u>. AUCUN

2. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?
   Jacques avait toutes sortes de choses dans sa cave, y compris une <u>bride</u>. AUCUN

3. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?
   Pour les touristes, le meilleur moyen de transport, c'est le <u>car</u>. AUCUN

4. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?
   A travers la chemise de Marie, on apercevait sa <u>chair</u>. AUCUN

5. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?
   Patricia n'aime pas mon fils, mais elle aime mon <u>chat</u>. AUCUN

6. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?
   Marcel est ignoble: Il traite sa femme comme sa propriété, sa <u>chose</u>. AUCUN

7. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?
   La boulangerie se trouve vers le <u>coin</u>. AUCUN

8. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?
   Son discours est beaucoup trop <u>court</u>. AUCUN

9. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?
   Monsieur, vous avez en effet une carie sur cette <u>dent</u>. AUCUN

10. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Le vicomte ne pouvait imaginer que sa fille se marie sans une dot. AUCUN

11. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Avant de se coucher, il faut se laver la figure. AUCUN

12. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Quand il y a un embouteillage, Marc ne peut pas aller tout droit, il change toujours de file. AUCUN

13. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Nous avons terminé, c'est la fin. AUCUN

14. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Le plat est encore à peine chaud, quel mauvais four. AUCUN

15. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Le vendeur nous conseilla d'examiner la lame. AUCUN

16. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Les lions, c'est très rapide, mais les escargots, c'est très lent. AUCUN

17. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Isabelle a acheté un nouveau lit. AUCUN

18. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Au milieu du chemin, il y a une mare. AUCUN

19. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Si l'on veut être une actrice, il faut être <u>mince</u>. AUCUN

20. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Ce genre d'histoires, ce n'est pas très <u>net</u>. AUCUN

21. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Henri aime les animaux qui ont des belles fourrures et surtout les <u>ours</u>. AUCUN

22. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

En ce temps-la, pour toute nourriture on n'avait que du <u>pain</u>. AUCUN

23. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Les jeunes, ça aime voir du <u>pays</u>. AUCUN

24. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Les acteurs montèrent sur scène pour jouer la <u>pièce</u>. AUCUN

25. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Luc aime bien cette <u>pub</u>. AUCUN

26. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Madeleine porte toujours le même <u>pull</u>. AUCUN

27. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Anne ne voit pas bien, alors elle se met au premier <u>rang</u>. AUCUN

28. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Avant le concours de beauté, Mlle Canada regarda attentivement sa peau et découvrit une ride AUCUN

29. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

L'année dernière, l'été a été très rude. AUCUN

30. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Jean avait enfin décidé de nettoyer sa voiture qui était pleine de boue et particulièrement sale. AUCUN

31. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Quand les détectives arrivèrent, le mur était couvert de trainées rouges, probablement du sang. AUCUN

32. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

François veut avoir un singe. AUCUN

33. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Avant d'enfiler ses vêtements, il faut mettre son slip. AUCUN

34. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Les enfants, plus aucun son. AUCUN

35. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Philippe ne rejettait pas sa destinée et acceptait son sort. AUCUN

36. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Mireille qui était au chômage avait decidé de compléter sa formation grace à un stage. AUCUN

37. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

Marc est une brute donc il fait mal aux chats et les tape. AUCUN

38. Y a-t-il un mot ou des mots dans la phrase suivante qui vous fassent penser à un aspect particulier du mot souligné?

A Buffalo, il fait souvent du vent. AUCUN

Appendix F: Experiment 1a and 1b Stimuli

Sentences that participants read in Experiments 1a & b in L2 English, and the subsequent word used in the lexical decision task. Sentences were either biased towards the language specific interpretation (a) or neutral (b). Lexical decisions were on either a homograph translation (c) or a control word (d).

a)	Many fish have a distinctive fin.
b)	Mary watched a veterinarian doing surgery on a fin.
c)	end
d)	city
a)	The wedding gown looked beautiful on the bride.
b)	For Halloween, the secretary dressed up as a bride.
c)	bridle
d)	bribe
a)	Usually the thing with the lowest monetary value is a coin.
b)	When he was walking to school yesterday, John found a coin.
c)	corner
d)	friend
a)	To open a heavy door, forcefully move it towards you when you pull.
b)	The movie return bin had a sign on it that said pull.
c)	sweater
d)	sunset
a)	Eve was supposed to decide, but instead I chose.
b)	That is the car that Eve chose.
c)	thing
d)	area
a)	A woman who is a model usually has a good figure.
b)	That person over there has a nice figure.
c)	face
d)	room
a)	The talkative salesclerk likes to chat.
b)	The old ladies love to sit on the porch and chat.
c)	cat
d)	clock
a)	One of the four legs broke on the old chair.
b)	At the garage sale last weekend, Sally bought an old chair.
c)	flesh
d)	grass
a)	The horse breeder bought a new mare.
b)	Yesterday, Sam saw a brown mare.
c)	pond
d)	plate
a)	After the accident, Mike noticed his car had a dent.
b)	Mom didn’t buy the microwave that had a dent.

c)	tooth
d)	tail
a)	All last week the lawyer was in court.
b)	All last week Amanda was in court.
c)	short
d)	soon
a)	The even number after two is four.
b)	Jan wanted enough china for four.
c)	oven
d)	olive
a)	The president was shocked when he found out how much money the bank lent.
b)	That's the book that Gail lent.
c)	slow
d)	soft
a)	Before singing Happy Birthday, all of the candles on the cake were lit.
b)	Dan always keeps the lamp lit.
c)	bed
d)	ball
a)	Because of his serious injuries, Henry was in a lot of pain.
b)	Henry's elbow caused him a lot of pain.
c)	bread
d)	brush
a)	After making the final payment, we felt like we owned it and it was ours.
b)	The beautiful house over there is ours.
c)	bear
d)	band
a)	The dog limps because it is lame.
b)	The farmer has a dog that is lame.
c)	blade
d)	blank
a)	The sportsman caught a lot of fish in his net.
b)	On the ground there was a net.
c)	honest
d)	angry
a)	Onions are easy to chop, but hard to mince.
b)	Gary thought the apples were easy to mince.
c)	thin
d)	equal
a)	Jennifer couldn't finish because the puzzle was missing a piece.
b)	No matter what, Jennifer always wants the biggest piece.
c)	play
d)	party
a)	After John fixed his bike, he went for a ride.
b)	John always likes to take his family for a ride.
c)	wrinkle
d)	wreckage

a)	We only go shopping when there is a big sale.
b)	Susan realized that there was a big sale.
c)	dirty
d)	crazy
a)	If you want to have a lot of money, being a stock-broker really pays.
b)	Daniel thinks that being in real-estate pays.
c)	country
d)	church
a)	During the championship game, the father was proud of his son.
b)	Bob really wanted to have a son.
c)	sound
d)	heart
a)	The obnoxious customer said something very rude.
b)	The customer in front of me in line was very rude.
c)	tough
d)	tail
a)	In England, people like to have beer at a local pub.
b)	Near the corner, there is a very popular pub.
c)	ad
d)	ash
a)	When walking on the ice, be careful not to fall and slip.
b)	During the colder months, Wendy is careful so that she doesn’t slip.
c)	underwear
d)	ultimatum
a)	After leaving the furnace, heated air passes through a big vent.
b)	On the floor, bellow the window there was a big vent.
c)	wind
d)	moon
a)	If your face gets too close to the fire, your hair might singe.
b)	When curling your hair, you should be careful not to let it singe.
c)	monkey
d)	mouse
a)	Amazing Grace is the song that the girl always sang.
b)	In the morning, after getting up, Matt always sang.
c)	blood
d)	truth
a)	After the play, the actors took a bow on stage.
b)	In the back of the room there was a little stage.
c)	training
d)	evening
a)	The new secretary found the new files difficult to organize and sort.
b)	The new employee found the pictures difficult to sort.
c)	fate
d)	fence

Appendix G: Experiment 2 Stimuli

Sentences that participants read in Experiment 2 in L2 English (a) and L1 French (b), and the subsequent word used in the lexical decision task. Lexical decisions following an English sentence (a) were on either a homograph translation in English (c) or its control word (d). Lexical decisions following a French sentence (b) were on either a homograph translation in French (e) or its control word (f).

a)	Mary watched a veterinarian doing surgery on a fin.	c)	end
		d)	city
b)	Pour comprendre le film, il faut attendre la fin.	e)	nageoire
		f)	nettoyage
a)	For Halloween, the secretary dressed up as a bride.	c)	bridle
		d)	bribe
b)	Jacques avait toutes sortes de choses dans sa cave, y compris une bride.	e)	mariée
		f)	maïs
a)	When he was walking to school yesterday, John found a coin.	c)	corner
		d)	friend
b)	La boulangerie se trouve vers le coin.	e)	monnaie
		f)	montre
a)	The movie return bin had a sign on it that said pull.	c)	sweater
		d)	sunset
b)	Madeleine porte toujours le même pull.	e)	tirer
		f)	tomber
a)	That is the car that Eve chose.	c)	thing
		d)	area
b)	Il faut dire aux moins une chose.	e)	choisit
		f)	réussit
a)	That person over there has a nice figure.	c)	face
		d)	room
b)	Avant de se coucher, il regarde sa figure.	e)	silhouette
		f)	simplicité
a)	The old ladies love to sit on the porch and chat.	c)	cat
		d)	clock
b)	Patricia n'aime pas mon fils, mais elle aime mon chat.	e)	bavarder
		f)	bousculer
a)	At the garage sale last weekend, Sally bought an old chair.	c)	flesh
		d)	grass
b)	A travers la chemise de Marie, on apercevait sa chair.	e)	chaise
		f)	chapeau
a)	Yesterday, Sam saw a brown mare.	c)	pond
		d)	plate
b)	Au parc il y a une mare.	e)	jument
		f)	jumelle

a)	Mom didn’t buy the microwave that had a dent.	c)	tooth
		d)	tail
b)	Le bébé a eu sa première dent.	e)	bosse
		f)	bordel
a)	All last week Amanda was in court.	c)	short
		d)	soon
b)	Son discours est beaucoup trop court.	e)	terrain
		f)	tendance
a)	Jan wanted enough china for four.	c)	oven
		d)	olive
b)	Michel veut acheter un nouveau four.	e)	quatre
		f)	quotidien
a)	That's the book that Gail lent.	c)	slow
		d)	soft
b)	Ce camion rouge est beaucoup trop lent.	e)	prêté
		f)	prévu
a)	Dan always keeps the lamp lit.	c)	bed
		d)	ball
b)	Isabelle a acheté un nouveau lit.	e)	allumé
		f)	attiré
a)	Henry’s elbow caused him a lot of pain.	c)	bread
		d)	brush
b)	Demain, on doit acheter du pain.	e)	douleur
		f)	docteur
a)	The beautiful house over there is ours.	c)	bear
		d)	band
b)	Au parc, Clotilde a vu un ours.	e)	nôtre
		f)	nonne
a)	The farmer has a dog that is lame.	c)	blade
		d)	blank
b)	Le vendeur nous conseilla d'examiner la lame.	e)	boiteux
		f)	blagueur
a)	On the ground there was a net.	c)	honest
		d)	angry
b)	Ce genre d'histoires, ce n’est pas très net.	e)	filet
		f)	flèche
a)	Gary thought the apples were easy to mince.	c)	thin
		d)	equal
b)	Cette femme là est très mince.	e)	hacher
		f)	héberger
a)	No matter what, Jennifer always wants the biggest piece.	c)	play
		d)	party
b)	Ce soir on a vu une très bonne pièce.	e)	morceau
		f)	mouton
a)	John always likes to take his family for a ride.	c)	wrinkle
		d)	wreckage

b)	Au milieu de sa main, Cécile avait une grande ride.	e)	promener
		f)	partager
a)	Susan realized that there was a big sale.	c)	dirty
		d)	crazy
b)	La maison de Jean est vraiment très sale.	e)	vente
		f)	vague
a)	Daniel thinks that being in real-estate pays.	c)	country
		d)	church
b)	Les jeunes, ça aime voir du pays.	e)	payer
		f)	prérérer
a)	Bob really wanted to have a son.	c)	sound
		d)	heart
b)	Les enfants, plus aucun son.	e)	fils
		f)	façon
a)	The customer in front of me in line was very rude.	c)	tough
		d)	tail
b)	L'année dernière, l'été a été très rude.	e)	impoli
		f)	imprévu
a)	Near the corner, there is a very popular pub.	c)	ad
		d)	ash
b)	Luc aime bien cette pub.	e)	bar
		f)	jupe
a)	During the colder months, Wendy is careful so that she doesn't slip.	c)	underwear
		d)	ultimatum
b)	L'enfant n'aime pas son slip.	e)	glisser
		f)	gagner
a)	On the floor, bellow the window there was a big vent.	c)	wind
		d)	moon
b)	A Buffalo, il fait souvent du vent.	e)	ouverture
		f)	obéissance
a)	When curling your hair, you should be careful not to let it singe.	c)	monkey
		d)	mouse
b)	François veut avoir un singe.	e)	roussir
		f)	rajouter
a)	In the morning, after getting up, Matt always sang.	c)	blood
		d)	truth
b)	Là-bas, il y a du sang.	e)	chanta
		f)	cacha
a)	In the back of the room there was a little stage.	c)	training
		d)	evening
b)	En avril, Mireille va faire un stage.	e)	scène
		f)	salon

Appendix H: Experiment 3 Stimuli

Sentences that participants read in Experiment 3 in L2 English, and the subsequent word used in the lexical decision task. Lexical decisions were on either a homograph translation (a) or a control word (b) matched for frequency, length and part of speech.

Mary watched a veterinarian doing surgery on a fin.	a) end b) city
For Halloween, the secretary dressed up as a bride.	a) bridle b) bribe
When he was walking to school yesterday, John found a coin.	a) corner b) friend
The movie return bin had a sign on it that said pull.	a) sweater b) sunset
That is the car that Eve chose.	a) thing b) area
That person over there has a nice figure.	a) face b) room
The old ladies love to sit on the porch and chat.	a) cat b) clock
At the garage sale last weekend, Sally bought an old chair.	a) flesh b) grass
Yesterday, Sam saw a brown mare.	a) pond b) plate
Mom didn’t buy the microwave that had a dent.	a) tooth b) tail
All last week Amanda was in court.	a) short b) soon
Jan wanted enough china for four.	a) oven b) olive
That's the book that Gail lent.	a) slow b) soft
Dan always keeps the lamp lit.	a) bed b) ball
Henry’s elbow caused him a lot of pain.	a) bread b) brush
The beautiful house over there is ours.	a) bear b) band
The farmer has a dog that is lame.	a) blade b) blank
On the ground there was a net.	a) honest b) angry
Gary thought the apples were easy to mince.	a) thin b) equal
No matter what, Jennifer always wants the biggest piece.	a) play b) party

John always likes to take his family for a ride.	a)	wrinkle
	b)	wreckage
Susan realized that there was a big sale.	a)	dirty
	b)	crazy
Daniel thinks that being in real-estate pays.	a)	country
	b)	church
Bob really wanted to have a son.	a)	sound
	b)	heart
The customer in front of me in line was very rude.	a)	tough
	b)	tail
Near the corner, there is a very popular pub.	a)	ad
	b)	ash
During the colder months, Wendy is careful so that she doesn't slip.	a)	underwear
	b)	ultimatum
On the floor, bellow the window there was a big vent.	a)	wind
	b)	moon
When curling your hair, you should be careful not to let it singe.	a)	monkey
	b)	mouse
In the morning, after getting up, Matt always sang.	a)	blood
	b)	truth
In the back of the room there was a little stage.	a)	training
	b)	evening
The new employee found the pictures difficult to sort.	a)	fate
	b)	fence

Appendix I: Experiment 4 Stimuli

Sentences that participants read in Experiment 4 in L2 French, and the subsequent word used in the lexical decision task. Lexical decisions were on either a homograph translation (a) or a control word (b) matched for frequency, length and part of speech.

Le vendeur nous conseilla d'examiner la lame.	a) boiteux b) blagueur
Cette femme là est très mince.	a) hacher b) héberger
Jacques avait toutes sortes de choses dans sa cave, y compris une bride.	a) mariée b) maïs
A travers la chemise de Marie, on apercevait sa chair.	a) chaise b) chapeau
Il faut dire aux moins une chose.	a) choisit b) réussit
Michel veut acheter un nouveau four.	a) quatre b) quotidien
Isabelle a acheté un nouveau lit.	a) allumé b) attiré
Son discours est beaucoup trop court.	a) terrain b) tendance
Au parc, Clotilde a vu un ours.	a) nôtre b) nonne
Luc aime bien cette pub.	a) bar b) jupe
Là-bas, il y a du sang.	a) chanta b) cacha
Philippe a un mauvais sort.	a) classer b) circuler
Demain, on doit acheter du pain.	a) douleur b) docteur
Au milieu de sa main, Cécile avait une grande ride.	a) promener b) partager
François veut avoir un singe.	a) roussir b) rajouter
En avril, Mireille va faire un stage.	a) scène b) salon
Madeleine porte toujours le même pull.	a) tirer b) tomber
Avant de se coucher, il regarde sa figure.	a) silhouette b) simplicité
La boulangerie se trouve vers le coin.	a) monnaie b) montre
Patricia n'aime pas mon fils, mais elle aime mon chat.	a) bavarder b) bousculer

Pour comprendre le film, il faut attendre la fin.	a)	nageoire
	b)	nettoyage
A Buffalo, il fait souvent du vent.	a)	ouverture
	b)	obéissance
L’enfant n'aime pas son slip.	a)	glisser
	b)	gagner
Le bébé a eu sa première dent.	a)	bosse
	b)	bordel
Ce camion rouge est beaucoup trop lent.	a)	prêté
	b)	prévu
Ce genre d'histoires, ce n’est pas très net.	a)	filet
	b)	flèche
Au parc il y a une mare.	a)	jument
	b)	jumelle
Ce soir on a vu une très bonne pièce.	a)	morceau
	b)	mouton
L’année dernière, l’été a été très rude.	a)	impoli
	b)	imprévu
Les jeunes, ça aime voir du pays.	a)	payer
	b)	préférer
La maison de Jean est vraiment très sale.	a)	vente
	b)	vague
Les enfants, plus aucun son.	a)	fils
	b)	façon

Appendix J: Debriefing Given to Participants after Experiments

We are examining the nature of the connections between words of the two languages of a bilingual. We are testing whether bilinguals when reading a word which has the same or nearly the same spelling in both languages, but different meanings in the two languages, access both meanings while reading a sentence. For example:

English: *After the surgery the girl was in a lot of **pain**.*

French: *Chaque matin on va à la boulangerie pour acheter du **pain**.*

Previous research with monolinguals suggests that both meanings of homographs like **bug** (meaning *'beetle'* and *'microphone'*) are accessed when they are read in sentence contexts. In this experiment we are testing whether both meanings of cross language homographs like **pain** (meaning *'bread'* in French and *'douleur*' in English) are accessed when reading in one language. The results of this experiment will demonstrate whether or not bilinguals can selectively activated one of their languages, or whether they non-selectively activate both of their languages when reading homographs in sentences.

References:

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Appendix K: Homograph Frequencies in English and French

English log word frequencies are as given by Francis & Kucera (1982), a corpus of 1 million words for written English. French log frequencies are as given by Brulex (Content, Mousty, & Radeau, 2000), a corpus of 100 million words for written French. Due to the difference in the size of the corpora, French word frequencies are divided by 100 to make them more easily comparable to English.

Homograph	English Frequency	French Frequency
bride	40	9.01
chair	89	108.86
chat	6	43.26
chose	177	1389.5
coin	18	129.41
court	286	114.65
dent	1	84.66
figure	389	169.53
fin	7	369.56
four	347	10.12
lame	2	15.35
lent	29	59.26
lit	72	204.16
mare	18	8.08
mince	8	49.77
net	24	73.89
ours	1233	10.12
pain	102	86.87
pays	325	282.23
piece	129	225.69
pub	2	9.82
pull	145	1.1
ride	21	17.35
rude	6	31.82
sale	177	52.92
sang	120	176.85
singe	1	16.46
slip	47	0.34
son	202	4377.23
sort	10	63.09
stage	174	2.3

vent	10	191.91