2010

Second language proficiency: Self-report vs. objective measures and relationship with sentential priming in the processing of interlingual homographs.

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A Thesis
Submitted to the Faculty of Graduate Studies
through Psychology
in Partial Fulfillment of the Requirements for
the Degree of Master of Psychology at the
University of Windsor

Windsor, Ontario, Canada

2010

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ABSTRACT

Bilingual lexical access is apparently exhaustive: representations from both languages are activated when reading in either language. This study investigated the roles of proficiency and word frequency in bilingual processing using interlingual homographs – words with identical orthography across two languages but different meanings. Semantic representations from both languages should be activated, resulting in inhibition of the incorrect meaning. Participants read sentences ending with homographs in their second language, French, and a lexical decision followed. Some stimuli were translations of English homograph meanings to French; lingering semantic inhibition was expected to influence reaction time to these stimuli.

Lexical decisions were longer for homograph translations than control words, as expected, and the level of inhibition did not differ between proficiency groups. Low proficiency participants made more errors, and more errors were made on stimuli based on low frequency homographs. Results are discussed in relation to theory, neuroimaging studies, and neuropsychological research.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my advisor, Dr. Anne Baird, for her guidance and support in the completion of this thesis. Her detailed and insightful feedback through draft after draft helped shape and refine this document, as well as my research and writing skills. I also have to thank my committee members, Dr. Joe Casey and Dr. Tanja Collet-Najem for their valuable suggestions along the way. Their input during my proposal meeting and comments on earlier drafts of my thesis helped improve my research methodology, not to mention my grammar (in both English and French).

Thanks to my parents for supporting my extended and occasionally expensive forays into higher education, and to the rest of my family for their non-financial support. I would not be where I am today without my family, and I certainly would not have done research on bilingualism if they had not had the foresight to put me in a French Immersion school program at an early age. I also owe a debt of gratitude my fellow students in the University of Windsor Clinical Psychology program for being there when I needed academic guidance, statistical consultation, dinner company or just a sympathetic ear.

Finally, thank you to my cats for providing distraction and cuddles when I needed them, and to my lovely wife Ruth doing the same. I also appreciate that she stayed with me even when it seemed like I was spending more time with SPSS than with her. I am not sure I would have had the courage to move halfway across the country for grad school without her company, and without her comforting presence the past two years would have been far less pleasant.

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CHAPTER I

INTRODUCTION

General Introduction

Recent worldwide estimates suggest that the number of individuals who are fluent in multiple languages (bilinguals or multilinguals) greatly exceeds the number of individuals who speak and understand only one language (monolinguals) (Tucker, 1999). Research regarding the manner in which bilinguals process language is very important in that it contributes to the development of theories and models of language representation and it also may assist in improving methods of second language teaching and learning. For example, findings in past studies (e.g., Jiménez, García, & Pearson, 1995) have led some to suggest that bilingual children should be encouraged to draw on knowledge of their first language when they encounter an unknown word in their second language. Bilingual children have also been observed to display better cognitive flexibility and inhibitory control abilities than their monolingual peers (Bialystok & Viswanathan, 2009), and research in the area of bilingual language processing could contribute to greater understanding of this phenomenon.

Many studies have investigated monolingual processing of ambiguous words, both in isolation and in the context of sentences. Monolingual ambiguous words include homonyms, which have distinct semantic representations (meanings) that share the same orthography and phonology, (e.g., *bear* the animal vs. *bear* to carry), and homographs, which have semantic representations that share the same orthography but differ in both phonology and semantics (e.g., *dove* the bird vs. *dove* the past tense of dive). The processing of ambiguous words is generally studied through comparisons to the processing of control words (matched controls or simply controls) which have only one semantic representation and have a similar frequency of occurrence to the ambiguous words that are being studied. Control words are often also similar to the ambiguous words in terms of first letter and part of speech. A frequency of occurrence of a word (frequency) refers to an estimation of how often it is used in day-to-day speech. For instance, the word *the* has a far higher frequency of occurrence than the word *quincunx.* Word frequency estimations are usually based on analyses of books, films, and other media which involve the use of many words.

A number of studies have also been undertaken in order to determine how bilingual individuals process *interlingual homographs*, which are words with the same orthography but different semantic and phonological representations in two languages (e.g., *pain*, which in English means an unpleasant sensation resulting from physical harm and in French means bread). Other studies have investigated the processing of *cognates*, words that share the same orthography and meaning (and sometimes, but not always, phonology) across two languages (e.g., *danger*, which conveys a sense of hazard in both English and French). However, most of these studies have investigated the processing of words in isolation, and relatively little research has been conducted regarding the processing of interlingual homographs within sentences. This study will address the roles of second language proficiency and word frequency with regard to the processing of interlingual homographs in the context of sentences. In addition, the relationship between self-rated language proficiency and language proficiency as measured through objective means also will be investigated.

The background section of this proposal will provide a review of previous literature regarding the processing of ambiguous words, as well as information about self-report and objective measures of language proficiency. It will be structured in such a way that research regarding more basic language processing will be presented initially and then a discussion of studies involving more complex linguistic processing. First, a summary of research involving the processing of monolingual ambiguous words (e.g., homographs and homonyms) and bilingual ambiguous words (e.g., interlingual homographs) in isolation will be presented. Second, a sampling of studies investigating the processing of monolingual ambiguous words in sentences will follow. Theories addressing the processing of ambiguous words in the context of sentences will be reviewed. Third, the predominant theoretical model of bilingual language processing will be described and explained. Fourth, more recent work regarding the processing of interlingual homographs in the context of sentences will be presented. Fifth and lastly, some promising measures of self-reported and objectively measured language proficiency will be detailed.

A Note Regarding Terminology

In linguistics literature, the term *homonym* refers to any word which has two meanings (Collet-Najem, personal communication, January 29, 2010), and homonyms are subdivided into *homographs*, in which both meanings are spelled the same but not necessarily pronounced the same way (e.g., *bear/bear* or *dove/dove*), and *homophones*, in which both meanings are pronounced the same but not necessarily spelled the same way (e.g., *bear/bare* or *bear/bear*). In psychology literature, however, the term *homonym* refers specifically to words with two different meanings which are spelled and pronounced the same way (e.g., *bear/bear*), and this usage is the one that which has been adopted in this study. A glossary is provided in Appendix A of this document to assist in familiarizing the reader with other relevant terms.

CHAPTER II

REVIEW OF LITERATURE

Monolingual Processing of Ambiguous Words in Isolation

The processing of ambiguous words in isolation by monolinguals has been investigated in a number of studies. The main goal of these investigations has been to determine whether all of the semantic representations of a given word are exhaustively activated when it is viewed, or whether representations are selectively activated. Results predominantly agree with an exhaustive access model. For instance, Gottlob, Goldinger, Stone, and Van Orden (1999) elicited faster reaction times for homonyms with multiple distinct meanings than control words in naming (read each word out loud) and lexical decision (decide whether a given letter string is a word or a non-word) tasks, but found that reaction times were slower for homographs in those same tasks. The difference in reaction times between these two types of ambiguous stimuli was interpreted to mean that multiple semantic representations result in facilitation of processing, whereas multiple semantic and phonological representations cause inhibition as a result of increased competition. These phenomena were noted to be consistent with an exhaustive processing model in which all semantic representations of a given word are activated before the correct one is chosen.

Hino and Lupker (1996) examined the effect of frequency on the processing of homonyms which had either two distinct low-frequency meanings or two high-frequency meanings in both naming and lexical decision tasks. For instance, both meanings of *perch* (the type of fish and the act of standing on the edge of something) occur relatively rarely, whereas both meanings of *well* (a hole in the ground full of water and a synonym for good) are quite commonly used. The researchers found that low-frequency homonyms elicited faster reaction times than unambiguous control words on the naming task, but that the high-frequency homonyms did not. However, in the lexical decision task, both groups of homonyms produced faster responses than controls. As with the results of the Gottlob et al. (1999) study, this was thought to suggest a facilitation effect of multiple meanings on semantic activation.

Rodd, Gaskell, and Marslen-Wilson further explored the homonym facilitation effect in a 2002 study. These researchers divided homonym stimuli based on whether they had multiple unrelated semantic representations (e.g., *bass* the species of fish vs. *bass* low frequency tones) or multiple similar *senses* in that the meanings were related but conveyed slightly different information (e.g., *get an A* as in to receive a good mark vs. *get scared* as in to become frightened). Rodd et al. found that both lexical decision and naming times were faster to control words with one meaning compared to those with multiple meanings, but that words with more than one sense produced faster times than those with multiple, unrelated meanings or control words. Once again, this was interpreted to mean that competition between multiple distinct semantic representations of a word slows processing. In this case, however, it was demonstrated that multiple related semantic representations may actually result in faster processing.

A review conducted by Altarriba and Gianico (2003) cites results from a number of other lexical decision studies which have shown that both subordinate (less frequently occurring) and dominant (more frequently occurring) meanings of an ambiguous word produce priming of semantically related words (e.g., Yates, 1978; Swinney, 1979; Onifer & Swinney, 1981). Overall, the results of these and other studies with monolingual participants and stimuli suggest that multiple semantic representations of an ambiguous word are activated when it is viewed in isolation. When meanings are unrelated or multiple phonological representations are also activated, as in homographs, additional competition occurs and recognition of ambiguous stimuli is slowed.

Processing of Interlingual Homographs in Isolation

Studies similar to those undertaken with monolingual subjects also have been conducted with bilingual stimuli and participants. One area of research concerns the processing of interlingual homographs, otherwise known as *homographic non-cognates* or *false friends*. These are words which have the same orthography in two languages, but different distinct meanings in each language. As with the processing of ambiguous words in monolinguals, research in this area has largely focused on whether activation of these words is language-specific or exhaustive. The aforementioned review conducted by Altarriba and Gianico (2003) suggested that the majority of the literature is in favour of an exhaustive access model, but that the native-language (L1) representation of a homograph tends to be activated first, followed by the second-language (L2) representation. The researchers also noted that the frequency of word meanings across both languages plays a role in their processing.

In order to investigate the processing of interlingual homographs, Dijkstra, Van Jaarsveld, and Ten Brinke (1998) conducted a lexical decision task with native Dutch speakers in which words were only presented in their L2 (English). They discovered that response times to cognates were faster than those to controls, but did not observe a significant difference in reaction times between interlingual homographs and controls. Dijkstra and his colleagues suggested that this pattern of results was observed because the activation of semantic representations in both languages speeded responses to cognates, whereas the Dutch representations for interlingual homographs were inhibited and did not influence reaction times. They proposed that this may have occurred because participants thought they were engaging in an exclusively English task and thus suppressed Dutch representations. In a follow-up study, the researchers added Dutch filler words to the stimulus set in an attempt to increase the baseline activation of the L1 lexicon. English was still the target language, meaning that participants were only to respond *yes* to English words and not Dutch words. With this modification, slower lexical decision times were recorded to interlingual homographs than to control words.

In a third experiment, Dijkstra et al. (1998) had their participants respond *yes* to words that were either Dutch or English, and no to letter strings which were not a word in either language. In this case lexical decisions to interlingual homographs were faster than those made to control words. The three experiments undertaken by these researchers demonstrated that bilingual processing can be influenced by task demands, as well as demand expectancies or characteristics, as the different stimulus sets and instructions produced varying results. In the first lexical decision task, in which participants were under the impression that the stimulus set comprised only English words, Dutch representations of the interlingual homographs presented were thought to be inhibited because the subjects did not expect any of the words to be Dutch. Therefore, the Dutch representations did not compete with the English stimuli for activation and cause slower reaction times. In the second study, the Dutch fillers caused increased activation of the Dutch lexicon, and thus affected processing of these words by competing with the English representations and causing slower reaction time. Finally, in the study which required responses to both English and Dutch stimuli, since responses to either language were correct the interlingual homographs were identified more quickly as they were represented in both languages. The effects of task demands on bilingual language processing were later explored in further detail by others (e.g., de Groot, Delmar, & Lupker, 2000; Dijkstra, Timmermans, & Schriefers, 2000).

A novel study regarding the processing of interlingual homographs was conducted by de Groot, Delmaar, and Lupker in 2000. This study consisted of three experiments - a translation recognition task and two lexical decision tasks. In the translation recognition task subjects had to identify whether two words, one in Dutch and one in English, had equivalent meanings. Procedurally, the first of the two lexical decision experiments replicated Dijkstra et al.'s (1998) first lexical decision task, although in this case it was administered in two sections – once with L1 Dutch as the target language and once with L2 English as the target language. As in Dijkstra's first experiment, participants were told to respond *yes* only to words in the language in which they were being tested – not those in the other language. The second lexical decision experiment undertaken by de Groot et al. used the same procedures as their first but in this case some of the stimuli which required a *no* response were real words in the non-target language. This modification was thought to force the subjects to function in a language-specific mode in order to avoid false positives.

In the translation recognition task, responses were slower to interlingual homographs, especially when the homograph word in a pair of stimuli was less frequent than the non-homograph word. A small, frequency-dependent inhibitory effect for interlingual homographs was observed in the first lexical decision experiment performed by de Groot and colleagues (2000), but only in the first section when subjects were tested in Dutch. In the second lexical decision task a large, frequency-dependent inhibitory effect was demonstrated for homographs regardless of whether subjects were tested in Dutch or English. de Groot et al. suggested that the results of the first lexical decision task were somewhat counterintuitive, as they had predicted a greater level of homograph inhibition would occur when processing in L2 than in L1 due to the subjects' lower levels of English familiarity. They noted that the slowest reaction times across all experiments were observed when homographs with a low frequency in Dutch but a high frequency in English were presented. Based on the discrepancy in response patterns between the Dutch task and the English task in the first lexical decision task, the researchers suggested that the effect observed in this task was due to certain subjects choosing to perform in a "language neutral" (p. 412) manner on the Dutch portion of the stimulus set, although this was difficult to substantiate. Overall, they concluded that language access in bilinguals is non-selective.

Dijkstra, Timmermans, and Schriefers (2000) undertook a go/no-go task with L1 Dutch participants with English L2 in order to investigate the processing of interlingual homographs with varying levels of frequency. In one experiment, the subjects were to respond *yes* if the word presented was English, and in the other they were to respond *yes* to Dutch words. In both tasks, more false negative errors were committed on homographs than controls, and slower response latencies were observed for homographs as well. These effects were noted to be frequency-dependent, and the greatest number of false negative errors and the most inhibition was observed when a homograph was low-frequency in the target language but high-frequency in the non-target language.

In addition to studies regarding the semantic representations of interlingual homographs, some research has also been carried out on the activation of the phonological representations of interlingual homographs. Jared and Szucs (2002) performed one such study on native French speakers with L2 English and native English speakers with L2 French. The homograph stimuli used for both language groups in this study were low frequency words in L1and high frequency in L2, and the experiment required that participants first read aloud a block of English words, then a filler block of French words, and finally another block of English words. Error rates (mispronunciations) and response latencies (reading time) were the dependent variables in this study. In the first English block, French L2 and English L2 participants made more errors on homographs than non-ambiguous control words, but English L2 participants also demonstrated slower response latencies to homographs. During the second English block, both groups committed a greater number of errors and had slower response times to homograph stimuli – this was attributed to increased expectancy of French words induced by the filler task. Jared and Szucs interpreted their results to mean that, as with semantic activation, phonological activation in bilingual processing can be language specific or exhaustive, depending on task demands, the pattern of language acquisition of the individual being tested, and whether there is a high level of activation from L2. They also suggested that the phonological competition, which occurs in interlingual homographs in addition to the semantic competition, causes additional inhibition – similar to what was observed with homograph words in monolingual studies.

These studies, among others, demonstrate exhaustive activation of interlingual homographs in bilingual processing. However, the extent of activation appears to be influenced by task demands and homograph frequency in both languages.

The Bilingual Interactive Activation Model

Although both language-selective (e.g., Scarborough et al., 1984) and fully exhaustive (e.g., Beauvillain & Grainger, 1987) theories of bilingual language processing have been proposed, at present the Bilingual Interactive Activation (BIA) model (Dijkstra & Van Heuven, 1998; Van Heuven, Dijkstra, & Grainger, 1998) and its successor, the BIA+ (Dijkstra & Van Heuven, 2002) appear to be the predominant theories. The BIA+ is a model of bilingual word activation in which the activation of appropriate representations occurs chiefly through bottom-up processing with some top-down influences. This model involves a number of levels of processing and accounts for both selective and exhaustive effects.

According to the BIA+ model, when a letter string is presented to a bilingual, letters are recognized based on their prevalent features (a bottom-up process) and word candidates are subsequently activated at sublexical, lexical, orthographic, phonological, and semantic levels. There is interaction among these levels in that increasing activation of a word's representation at one level increases the activation at other levels, and decreasing activation at one level results in inhibition across other levels. As noted, the BIA+ model also takes into account top-down factors including word frequency, contextual effects, and language proficiency. L2 representations are held to have lower subjective frequencies due to the discrepancy between L1 and L2 familiarity among bilinguals, and this causes a delay in the activation of L2 representations relative to L1 representations. Overall, however, it is the similarity of a given letter string to the internal lexical representations that determines which word is activated, not language membership.

The BIA+ model also includes a task/decision system which explains the effects of task demand on bilingual processing. This system optimizes a bilingual person's language activation for the task at hand; for instance, if a task is being performed in only one language, processing occurs in a more selective manner and the non-target language is inhibited. However, if the task involves both of a bilingual's languages, they will both be activated during processing.

An example of how the BIA+ model would process an interlingual homograph follows. The example given is for a bilingual person for whom L1 is English and L2 is French. If this person sees the word *pain* while reading in French, it is first recognized at the sublexical and orthographic levels, and activation then spreads to the phonological and semantic levels. Since the orthography is consistent with representations in both English and French, phonological and semantic representations from both languages are activated and competition occurs. Frequency favours the more familiar L1 representation; however, the task/decision system recognizes that the context in which the word occurs is French. Thus, the overall level of activation for French representations increases, while English representations are inhibited. This allows for more language-selective processing, and the correct, French interpretation is selected.

Monolingual Processing of Ambiguous Words in Sentential Context

As mentioned previously, the research regarding monolingual processing of ambiguous words in isolation supports the idea that exhaustive activation of all representations occurs. However, words are rarely processed outside of sentences in real-life situations, and thus it is important to study how they are processed in context.

Some of the earliest research conducted with ambiguous words in context was undertaken by Swinney (1979) and Tanenhaus, Leiman, and Seidenberg (1979). Their studies investigated the processing of ambiguous words in sentential context by having subjects listen to sentences which contained a homonym and then engage in a lexical decision or naming task. The lexical decision or naming task occurred either immediately after they heard the homonym (Swinney, 1979) or after a 200ms delay (Tanenhaus et al., 1979). Although the frequencies of the homonym meanings in these studies were relatively balanced, the sentence contexts were biased toward one meaning. These studies demonstrated priming for multiple homonym meanings immediately after the homonym and after a brief delay, but found that following a longer delay only the appropriate meaning was facilitated.

Tambossi, Colombo, and Job (1987) presented subjects with sentences which were biased toward either the dominant meaning of a homonym or its subordinate meaning. In a subsequent lexical decision task they discovered that when dominant meanings were contextually primed, facilitation was observed on items which were semantically related to that meaning. However, when the sentence suggested the subordinate meaning, words related to either meaning were facilitated in the lexical decision. Another study by Tambossi (1988) compared the processing of homonyms in sentences which were either neutral or biased toward one meaning and found selective priming of the correct meaning when the sentence was biased, but activation of both meanings in the neutral condition. Taken together, these experiments demonstrate that the frequency of a particular representation of an ambiguous word and the context in which it is displayed can influence whether activation is exhaustive or selective for the given representation.

In an eye-tracking study conducted by Duffy, Morris, and Rayner (1988), participants read sentences containing homonyms that either had meanings with similar frequencies (balanced homonyms) or one dominant and one subordinate meaning (unbalanced homonyms). Sentences included contextual information which suggested one of the two meanings of the homonym, and this clarifying context or contextual prime occurred either before or after the homonym in the sentence. When the contextual prime occurred after a balanced homonym, longer fixation times were recorded for the homonym than for a control word. This was interpreted to mean that when context does not suggest a meaning, representations are exhaustively activated resulting in competition and slower processing. However, when the contextual prime occurred after an unbalanced homonym, fixation times were not significantly different for homonyms than controls. The experimenters suggested that this was because only the higher frequency representation was activated in this case and thus no competition occurred.

In conditions where the priming context occurred before a balanced homonym, fixation times were similar for homonyms and controls, potentially due to the fact that the context resulted in faster activation of the appropriate representation and eliminated competition from the other representation. Conversely, when context suggesting the subordinate meaning of an unbalanced homonym occurred before the target word, fixation times were longer than for controls. Duffy et al. (1988) interpreted these results to mean that when the sentence context increased activation for the subordinate meaning, it became available at the same time as the dominant meaning, which would have otherwise been activated earlier, and this resulted in competition. They concluded that both frequency of representations and sentence context are important in the processing of ambiguous stimuli.

A similar study was undertaken by Folk and Morris (1995). However, this study included homograph stimuli as well as homonyms. Their study replicated the findings of Duffy et al. (1988) with regard to homonyms, but a different pattern of results was observed when homographs were used. When the sentence context suggesting a meaning occurred after the homograph rather than before (e.g., a *bear* is an animal vs. my favourite animal is a *bear*), longer fixation times were recorded at the homograph than at a control word (e.g., *animal* in the previous two examples) in the same sentence. Folk and Morris suggested that this occurred because in addition to two different semantic representations (as with homonyms), homographs also have multiple distinct phonological representations and these phonological representations compete regardless of the relative frequencies of the corresponding semantic representations. When the disambiguating sentence context occurred before a homograph and suggested the subordinate meaning, longer fixation times were recorded for the homographs. However, fixation times were shorter with pre-homograph contextual suggestions relative to post-homograph suggestions. Folk and Morris concluded that both representations of a homograph are always activated, but that context has some mediating effect on this phenomenon.

Martin, Vu, Kellas, and Metcalf (1999) conducted a study that investigated the influence of high constraint vs. low constraint semantic contexts and frequency of meanings on the processing of homonyms. High constraint passages were designed to strongly suggest one meaning of a homonym (e.g., the butler got the jelly, then he prepared the *toast* – jelly is thought to be strongly associated with one meaning of toast), whereas weakly biased passages were less suggestive of the target meaning (e.g., he went to the kitchen to get some *toast* – kitchen is related to two different meanings of toast). Martin and colleagues' first experiment employed a moving window paradigm in which words were presented one at a time on a computer screen, with a new word appearing after the subject read the current word and pressed a button. When high constraint sentences were presented, no influence of frequency was observed: homonyms were processed at an equal rate regardless of whether the high or low frequency meaning had been suggested. This was thought to mean that when the context is strong enough, activation is selective and not frequency dependent. However, when sentences only gave a weak suggestion of meaning, reading times were faster when the dominant meaning was suggested than when the subordinate meaning was suggested. Martin et al. took this to mean that when a high frequency meaning was suggested by a weak context, only the appropriate representation was activated, whereas when a low-frequency meaning was suggested under the same conditions, activation was exhaustive as the weak context was not enough to overcome the frequency bias.

Martin and his colleagues (1999) did not feel that reading time and eye-gaze studies directly delved into which representations of ambiguous words are activated in sentence processing, and thus they conducted a second study. In this study, probe words associated with one of the meanings of a homonym were inserted immediately after the homonym in a sentence, and subjects had to name the probe words aloud. For example, when the sentences "The custodian fixed the problem. She inserted the *bulb* into the empty socket" were presented, either a related probe word (e.g., *light*) or an unrelated probe word (e.g., *tavern*) would immediately follow the homonym *bulb*. Despite the change in experimental design, similar results were obtained. When a highly constraining sentence was presented, responses to probe words related to the appropriate meaning were named more quickly than control probes which were not related to the meaning (facilitation). Response times for probes which were semantically related to the incorrect homonym meaning were no different from those to controls. As in their first study, Martin et al. interpreted this as an indication that, with strong context, activation is selective. When low constraint sentences suggesting subordinate homonym meanings were presented, probe words related to either homonym meaning elicited faster responses than control words (a facilitation effect). Conversely, when sentences weakly suggested the dominant meaning, only probes relating to the high frequency meaning were facilitated. Once again, Martin et al. demonstrated that homonym meanings were exhaustively activated when a low frequency meaning was suggested, but that only the high frequency meaning was activated when it was suggested by the sentence context.

In summary, the results of studies investigating the processing of ambiguous words in monolingual sentence contexts indicate that, in neutral sentences which do not provide a context that suggests a particular meaning, all semantic representations of the word are initially activated. However, when the sentence provides a highly constraining context or provides weak constraints suggesting a dominant meaning, activation appears to be more selective. There is also some evidence that homographs are processed more slowly than homonyms under all conditions due to competition at the phonological as well as at the semantic level.

Theories of Word Activation in Sentence Context

A number of theoretical models regarding word recognition in sentence context have been proposed. Onifer and Swinney (1981) suggested an *exhaustive theory*, in which lexical access is always exhaustive, regardless of sentence context or word frequency. Context only becomes relevant after all representations of an ambiguous word have been initially activated. The *ordered search theory* posited by Hogaboam and Perfitti (1975) stated that when an ambiguous word is encountered, its representations are activated one at a time, beginning with the most frequent, and this process continues until a context-appropriate representation is selected. As with the exhaustive theory, context only becomes involved after lexical representations are activated. However, these models are not compatible with the results of a number of studies, including those detailed above, which have demonstrated that frequency and context are involved in the selection of an appropriate word representation.

A number of experimenters have proposed a *reordered access model* in which all representations of a word begin to be activated at the same time, but the speed of activation is influenced by sentence context and the frequency of each meaning (e.g., Duffy, Morris, & Rayner, 1988; Rayner, Binder, & Duffy, 1999; Rayner & Duffy, 1986; Rayner & Frazier, 1989). As a result of this, dominant representations are activated more quickly than subordinate representations. This is similar to the delay in activation of L2 representations proposed by the BIA+ model of bilingual language processing. The reordered access model also states that context may facilitate the activation of appropriate representations, but that it does not inhibit inappropriate representations.

Duffy et al. (1988) suggested that competition between the representations of an ambiguous word can take place either at the point of initial access, or following initial access when context comes into play, and that this competition results in longer reading or reaction times to ambiguous words. In the event that context is neutral and all meanings are of balanced frequency, particularly high levels of competition will be observed. Rayner and his colleagues (1999) stated that the strength of a given context can influence processing, and described a situation akin to that observed in the Martin et al. (1999) study, detailed in the previous section. If context weakly suggests a subordinate meaning, the dominant meaning still is activated, resulting in competition. However, if the context is sufficiently constraining, only the appropriate meaning will activate regardless of frequency. Duffy et al. (1988) described the reordered access model in terms of frequency and context factors building up evidence for the varying representations of a word, and specified that the interpretation which had the strongest amount of evidence would be selected. When the evidence is equivalent across representations, competition occurs and selection is slowed.

A *context-sensitive model* of ambiguous word resolution proposed by other researchers (e.g., Martin, Vu, Kellas, & Metcalf, 1999; Paul, Kellas, Martin, & Clark, 1992; Vu & Kellas, 1999; Vu, Kellas, Petersen, & Clark, 2003) is fairly similar to the reordered access model. In the context-sensitive model, activation of a particular representation occurs due to a combination of frequency, whether the context in which the word is viewed biases a specific meaning, and the strength of the contextual bias (if present). Both frequency and strength of context are thought of as continuous variables, and it is posited that when context is weak, the influence of frequency becomes more important, whereas when context is strong, frequency plays less of a role. Although all semantic representations of an ambiguous word are activated to some extent, the level of activation is thought to be contingent on the aforementioned factors. The work of Martin et al. (1999) as described above can be explained by both the reordered access and context-sensitive models. When a dominant meaning is supported by weak context, only the dominant representation is activated. However, when a subordinate meaning is supported by weak context, both representations activate resulting in longer reading times for the ambiguous word and facilitation of probe words relating to both meanings. When the contextual suggestion is highly constraining, only the appropriate representation is selected, as evidenced by the lack of discrepancy between reading times for dominant and subordinate meanings, and facilitation of probes relating only to the appropriate meaning.

Bilingual Processing of Interlingual Homographs in Sentential Context

Compared to the body of research regarding monolingual processing of ambiguous words in sentential context, there is a relatively small amount of similar research with bilinguals. Altarriba and Gianico (2003) described one of the first studies of this nature, which was undertaken by Altarriba, Carlo, and Kroll in 1992. These researchers performed a study with native Spanish speakers with L2 English which investigated the processing of English and Spanish sentences ending with English/Spanish interlingual homographs which were semantically appropriate in the language in which the sentence was written or the other language. For instance, the homograph *fin* was presented in a sentence such as “The shark had a *fin*” where the

English meaning was appropriate and also a sentence such as “The play reached its *fin*” where the Spanish meaning was correct but the language context was not. In this study, subjects were required to read aloud a target word at the end of each sentence, and this word was either an interlingual homograph or a control word matched for frequency. Slower reading times were observed in conditions where the meaning was appropriate but the language was not (as in the second sentence above) relative to those where both the meaning and language were appropriate (as in the first sentence). The researchers discovered that, when language context was appropriate, the time taken to read an interlingual homograph in L1 was no greater than the time taken to read a control word; however, the time taken to read an interlingual homograph in L2 was greater even when the rest of the sentence was also in L2 English. This pattern of results was interpreted to mean that words may be processed in a language-selective manner when strong expectations are built up in a particular language, but in an exhaustive manner when the situation is ambiguous.

Altarriba, Kroll, Sholl, and Rayner (1996) further explored the influence of sentence context and word frequency in the bilingual processing of interlingual homographs. They employed a methodology similar to that used by Altaribba and her colleagues in 1992, in that native Spanish speakers with L2 English were presented with whole sentences which were either entirely written in English or ended with one Spanish word which was semantically appropriate in the sentence context. Sentence contexts provided either high constraint or low constraint in suggesting the final word, and participants’ eye movements were monitored in order to track the manner in which they scanned these sentences. Analysis of the eye tracking data revealed longer first fixation and total fixation times when the final word in a highly constraining sentence was presented in the non-target language, Spanish, than when it was presented in the target language, English. Altarriba et al. suggested that this occurred because the English sentence context built up an expectation for a specific English word. Even though the meaning of the Spanish word was appropriate, it was in the wrong language, and thus it was examined in more depth, as indicated by the longer fixation times. In contrast, when low constraint sentences were utilized, no difference in fixation times was noted when the final word was in English or Spanish, possibly because less expectation was induced. Altarriba et al. (1996) conducted a follow-up study with essentially the same procedures but presented the words in each sentence one-at-a-time in a rapid serial visual presentation (RSVP) format and asked participants to name a capitalized target word. A similar pattern of results was observed with these alterations.

Elston-Güttler, Paulmann, and Kotz (2005a) performed several experiments regarding bilinguals' processing of ambiguous words in sentences. Working with native German speakers in L2 English, they investigated how translations of German homonyms were processed. Two different types of homonyms were used in this study: half of them had two unambiguous English translations, and the other half had two English translations of which one was an ambiguous word in its own right. An example of the latter word type would be the German word *zoll*, which translates to *inch* and *duty* in English – *duty* also has two different meanings. The experimenters examined the processing of these two types of homonym translations in isolation and in the context of English sentences utilizing both event-related potential (ERP) data and a lexical decision task. ERP is a method of measuring brain activity through the use of electrodes attached to the scalp. In the single-word condition, participants engaged in a lexical decision task in which the target words were English translations of one meaning of a German homonym. These targets were preceded with either an unrelated control word, or a translation of the other meaning of the German homograph. For example, the German word *kiefer* has two meanings which can be translated to *jaw* and *pine* in English, so the target word *jaw* would be preceded by *pine* in the homonym translation pairs and by an unrelated word such as *boat* in the control pairs.

In the sentence condition, Elston-Güttler et al. (2005a) used the same homonyms and translations, but the prime was presented at the end of a contextually-appropriate sentence before the target word. For instance, in the stimulus pairings of interest, the sentence "The candy stuck together his jaw" would be followed by its homonym translation pair *pine*. The researchers posited that an inhibitory effect would be observed in the homonym translation pairs, as the two English meanings associated with the German homonym would complete with each other for activation. Such an effect would be observed in ERP data through the production of certain amplitudes (N200), which are associated with response inhibition, and through slower reaction time to homonym pairs than control pairs. These predictions were confirmed to some extent: increased N200 amplitudes and slower reaction times on the lexical decision task were observed in low-proficiency L2 learners when words were presented in isolation or in sentences. However, participants with high proficiency in English showed slower reaction times but no increase in N200 amplitudes when words were presented in isolation, and no effects on either measure were noted when the primes were presented in sentences. The researchers interpreted these results to mean that higher proficiency bilinguals are able to block out influences from L1 and suggested that efficient function of the BIA+ task/decision system may be one component of this ability.

Elston-Güttler, Gunter, and Koytz (2005b) conducted another study with native German speakers in which participants were presented with English (L2) sentences that were missing their final word. Once the participant pushed a key indicating that they had read the incomplete sentence, the final word appeared on the screen. The final words were either interlingual homographs which were contextually appropriate in the English sentences, or contextually-appropriate non-homograph words. These words served as primes for subsequent target words that were translations of the German meaning of the homograph into English. For example, in homograph translation items the incomplete sentence "The woman gave her friend a pretty…" would be followed by the interlingual homograph *gift* as a prime for the target word, which was the English translation of the German meaning of *gift*: *poison*. In the control version of the example sentence, *shell* would be presented as a prime for the same homograph translation. Elston-Güttler et al. also tested for priming effects by presenting the homograph and the target translation in a lexical decision task without the preceding sentence. In this task, participants were told that all of the words would be in English. When the homograph stimuli were presented in isolation, the homograph stimuli (e.g., *gift*) always primed translations of their L1 meanings (e.g., *poison*), which suggested exhaustive access to both languages. Before engaging in the sentence context task, subjects viewed a short film in either English or German; this was intended to raise the level of baseline activation for the language heard in the film. When the German film was presented first, priming of the homograph translations by the homographs was demonstrated in the lexical decision task, but, this effect was only observed during the first half of the task. Elston-Güttler and her colleagues theorized that as the task went on, participants eventually “zoomed in” (p. 68) to L2 and the influence of L1 was eliminated. Subjects who viewed the English film demonstrated no homograph priming at any point in the task. The researchers suggested that the combination of English sentence context and the increased baseline English activation resulting from the previously viewed film caused such strong L2 activation that the influence of L1 was essentially eliminated.

Although Elston-Güttler et al. (2005b) stated that their results support some degree of interaction between languages in the processing of interlingual homographs; they proposed that this phenomenon is sensitive to top-down influences. The top-down aspects of homograph processing were thought to be accounted for by the BIA+ task/decision system. In their study, the effects of this system were demonstrated through the fact that the language of the pre-task film affected lexical decision results early in the task and that response patterns changed over time as the subjects became accustomed to the lexical decision task. Elston-Güttler et al. suggested that although the task/decision and word identification components of the BIA+ are supposed to operate independently, they may work in unison during certain situations causing the language access system which is essentially exhaustive to become language-selective.

Schwartz and Kroll (2006) investigated the effects of sentential context on bilingual language processing in people who were bilingual in Spanish and English. For some participants L1 was Spanish while for others L1 was English. Additionally, some participants had high L2 proficiency while others had intermediate L2 skills. Their study examined the processing of cognates, interlingual homographs, and partial cognates –

words with the same orthography and one shared semantic representation between languages, but one or more other unshared representations (e.g., *band* meaning a group of people in English and *banda* meaning the same in Spanish). Schwartz also examined the role of phonological similarity or dissimilarity in cognates across the two languages. Sentences used in her experiments were either strongly biased toward one meaning of the target word or neutral, and were presented one word at a time in RSVP format. Subjects were instructed to read a capitalized target word out loud.

In one experiment conducted by Schwartz and Kroll (2006), native Spanish speakers with intermediate English skills demonstrated faster oral reading for phonologically similar cognates compared to control words in both neutral and constraining sentences. No difference was observed between interlingual homographs and control words in terms of reading time for the native Spanish speakers with intermediate English proficiency. However, more errors were committed by native Spanish speakers with high English proficiency in the oral reading of homographs relative to control words. When native English speakers were tested in Spanish in a second experiment, intermediate proficiency subjects demonstrated faster naming of words which were partial cognates, but only when the sentences were biased toward an unshared meaning. Although Schwartz and Kroll interpreted the findings of their experiments to mean that bilinguals activate all representations of ambiguous words regardless of context, the lack of further significant findings in both of these experiments challenges this interpretation.

Conklin (2005) performed a series of experiments with English/French bilinguals which examined the processing of interlingual homographs in sentential contexts. These experiments investigated the manner in which semantic representations of a homograph from one language impact processing in the other language while taking into account a number of factors. Her first and second studies concerned the effects of biased or unbiased sentence context on the processing of interlingual homographs in L1 and L2. In Experiment 1, native French speakers with high English proficiency read English sentences ending with interlingual homographs and subsequently performed a lexical decision on either a translation of the English meaning of the homograph into French or a control word matched for frequency, length, part of speech, and first letter. For instance, if the prime sentence ended with *lit*, which means *bed* in French, the homograph translation probe would be *allumé*, which conveys the same meaning as *lit* in English. The sentences were either biased to suggest the English meaning of the homograph (e.g., “The candles on the cake were lit”) or neutral.

The results of Conklin’s (2005) Experiment 1 revealed longer lexical decision times for homograph translation probe items than matched controls following neutral sentences, but no difference in lexical decision times was observed between probe types after biased sentences. This was interpreted to mean that the lack of contextual constraint in neutral sentences caused exhaustive activation of homograph representations across both languages, resulting in competition between the representations. Competition is thought to have occurred due to a greater familiarity with the L1 meaning but a greater contextual appropriateness for the L2 representation. When the English meaning was correctly selected, inhibition of the French representation occurred, and this resulted in slower reaction times to English homograph translations with the same meaning relative to control items in neutral sentences. Conversely, when biased sentences were presented, the strong suggestion of the English meaning prevented the French representation from becoming fully activated, and thus there was no competition from or resulting inhibition to the French semantic representation. Since the French representation was not inhibited, responses to the English homograph translations with the same meaning were performed at a similar rate to control words.

In Experiment 2, Conklin (2005) investigated whether representations of a bilingual's second language were activated when reading in their first language. Once again, she recruited native French speakers with high English proficiency for this study. The participants took part in two blocks of lexical decision tasks: the first block was composed of sentences and lexical decisions in their L2 (English), and the second the sentences and lexical decisions were presented in their L1 (French). In this study, all of the sentences were neutral. The English block was expected to replicate the results of Experiment 1, and the reasoning for placing it first was to raise the overall level of English activation in order to assess whether this would impact performance in the second, French block. Results of Experiment 2 indicated that, as expected based on the results of Experiment 1, longer lexical decision times were noted for homograph translations than control words in the English block. However, no difference in lexical decision time was observed between homograph translations and control words in the French block. This was thought to mean that the French sentence context suppressed English representations despite the neutral semantic context, and as a result English representations did not compete very strongly and were not inhibited. Conklin asserted that the results of her first two studies were consistent with an exhaustive model of bilingual language processing which takes into account contextual factors – biased sentences in Experiment 1, and language of study in Experiment 2. The BIA+ model of bilingual language processing is one such model.

Conklin's third and fourth experiments investigated the roles of word frequency and second language proficiency in the processing of interlingual homographs in a sentential context. Experiment 3 involved native French speakers with high English proficiency, whereas Experiment 4 was undertaken with native English speakers who had intermediate French proficiency. In Experiment 3, participants were subjected to a lexical decision task with identical procedures to those used in Experiments 1 and 2, and all sentences and stimuli were in their L2. Unbiased sentences were used in these two studies. In order to assess the effect of word frequency on processing, the 32 homographs were split into four groups: the 16 words with the highest rates of occurrence in English or French based on databases of language information were classed as high frequency, whereas the other 16 homographs in each language were defined as low frequency. The results of Experiment 3 suggested that words with high L1 frequency influenced processing in L2, resulting in slower reaction times, whereas low frequency L1 words did not have an effect on reaction time. When a second analysis of the same data was undertaken with L2 English frequency levels, it was revealed that lexical decisions were faster following homographs with high English frequency than following those with low English frequency. This result is congruent with the frequency effect demonstrated in monolingual studies of ambiguity resolution. Overall, the results of Experiment 3 were viewed as consistent with an exhaustive activation model in which selection is based on the weighting of evidence.

Experiment 4 (Conklin, 2005) was conducted with essentially the same methodology as Experiment 3, with the exception that, a French L2 stimulus set was employed. A higher proportion of false negative responses, in which words were incorrectly classified as non-words, were noted in this portion of the study relative to the other three experiments, and thus the error rates were subject to statistical analysis. Word frequency was observed to have a significant effect on error rate; more false negatives were committed on homographs that were low in L2 frequency than those rated as higher frequency. This effect was attributed to a relatively low level of French familiarity in the intermediate proficiency participants. Analysis of correct response times with relation to L1 (English) frequency showed that responses to French translations of homographs that were high frequency in English were slower than those to their matched controls, but no such effect was noted for low frequency homographs. Additional analyses were carried out with relation to L2 French frequency. In these analyses, a main effect of word type (homograph vs. control) was noted, but no effect of L2 frequency on reaction time was observed. These results were thought to suggest that interlingual homographs that are high frequency in L1 influence L2 processing in intermediate proficiency bilinguals, but interlingual homographs that are low frequency in L1 do not have such an effect. L2 frequency did not appear to have an impact on processing in individuals with intermediate L2 proficiency. Once again, these results were viewed as consistent with an exhaustive activation model of bilingual sentence processing, although the effect appeared to be contingent on an individual's level of language proficiency and the frequency of the words being processed. Conklin asserted that BIA+ model accounts for these factors.

The only notable difference between the findings of Experiments 3 and 4 was that L2 frequency affected lexical decision time in the higher proficiency group, as it does in monolinguals (Conklin, 2005), but not in the intermediate proficiency group, where it instead affected accuracy. Conklin suggested that this phenomenon occurred due to the fact that all L2 words have a relatively low frequency for intermediate proficiency bilinguals. A combination of the BIA+ model and the reordered access and/or context sensitive models was proposed to account for the pattern of results observed in these four experiments. Conklin also proposed that the top-down processes involved in sentence comprehension and the bottom-up processes of lexical activation may interact in determining which representation of an interlingual homograph is activated.

Processing of Cognate Words in Unilingual Sentences

Recent work regarding the processing of cognates in sentential context has been conducted by Duyck, Van Assche, Drieghe, and Hartsuiker (2007). These researchers argued that because Altarriba et al. (1996) employed mixed language sentences in their study, it was not possible to use their results to comment on how bilinguals process ambiguous words in a unilingual sentence context. As such, Duyck et al. (2007) designed a study intended to verify whether unilingual sentence context would eliminate activation in the non-target language during recognition of words within the sentence. They reasoned that if such an effect was observed, it would mean that bilingual lexical access in everyday reading may be essentially language specific. In the first part of their study, Duyck and colleagues had native Dutch speakers engage in a L2 English single-word lexical decision task which included English/Dutch cognates and near-cognates. Facilitation was observed for both cognates and near-cognates in this experiment.

In the second part of their study, Duyck and his colleagues (2007) presented English sentences ending with cognate or near-cognate words, and subjects were asked to perform a lexical decision on the sentence-ending target. The sentences were presented in RSVP format in order to prevent the subjects from translating them into their native language during the experiment. In another experiment, they used similar techniques and stimuli but placed the target words in the middle of modified sentences and utilized an eye-tracking paradigm to monitor how reading time was affected by cognates/near-cognates. Low-constraint sentences were used in this study in order to prevent subjects from having semantic expectations relating to the target words.

A cognate facilitation effect was observed on the lexical decision task, in that cognate words were recognized more quickly than controls. However, this effect was stronger for identical cognates than for near-cognates. Duyck et al. (2007) proposed that these results support an exhaustive model of bilingual processing. The results of the eye-tracking study indicated a cognate facilitation effect for identical cognates but not for near-cognates. It was suggested that sentence context eliminated the cognate facilitation effect which had previously been observed when near-cognates were presented in isolation because they did not induce as much cross-language activation due to their slightly differing orthography. Identical cognates, however, induced so much cross-language activation that the effect was not eliminated. Duyck et al. also noted that their eye-tracking study demonstrated that the facilitation effect for cognates occurred very early in visual word recognition, as it was observed in the first fixation time.

Research conducted by Van Hell and de Groot (2008) produced similar results. Dutch/English bilinguals were presented with either highly constraining or weakly constraining sentences in their L2 (English). One word was missing in each sentence, and a series of dashes was shown in its place. In one experimental condition, participants were required to perform a lexical decision task on either a cognate or control word either of which would have been appropriate in the blank space, or a non-word, whereas in another condition they were to perform a translation task with the target word or a control. When highly constrained sentences were presented, the cognate facilitation effect observed in other studies was eliminated in lexical decisions and decreased in the translation task. However, weakly constraining sentences did not influence cognate facilitation. Van Hell and de Groot's interpretation of their results was consistent with Conklin's (2005) suggestion that sentence comprehension processes (top-down) and lexical activation processes (bottom-up) interact, but they asserted that highly constraining sentence contexts result in selective activation of only one language.

A recent study by Libben and Titone (2009) investigated the activation of words in sentence context with an eye-movement-tracking paradigm. They also examined the effect of L2 proficiency. Native French speakers read sentences in their L2 (English) which contained either cognates, interlingual homographs, or matched controls. The sentences had either a high or a low level of constraint suggesting the correct English meaning of the target word. Libben and Titone discovered that both early-stage comprehension measures (defined as first fixation duration, gaze duration, and skipping) and late-stage comprehension measures (defined as go-past time and total reading time) showed a significant facilitation effect for cognates and significant inhibition effect for interlingual homographs in low constraint sentences. Conversely, in high constraint sentences these effects were only observed in early-stage access and no evidence of exhaustive access was found in late-stage measures. No effect of L2 proficiency was noted with regard to homograph interference, but less cognate facilitation was observed in individuals who had more developed L2 abilities.

Based on their results, Libben and Titone (2009) suggested that lexical activation in bilinguals is initially non-selective, but that highly constraining contexts cause a rapid shift toward the appropriate representation in later stages of comprehension. These researchers stated that although the BIA+ model is able to explain how highly constraining sentences eliminate homograph inhibition through semantic feedback to the orthographic level, the model cannot account for reduced cognate facilitation. They suggested that this effect may be due to the fact that the highly constraining sentences were so biased toward a particular word that no further facilitation was possible.

To summarize, although highly constraining semantic contexts in sentences appear to induce language-selective processing of ambiguous words in bilinguals, the mere act of reading in a given language is not sufficient to produce immediate selective processing of that language. In less constrained or neutral settings, however, activation and language processing seem to be more extensive in nature. The effects of L2 proficiency on the processing of ambiguous words have not been studied extensively. When the degree of proficiency in L2 has been evaluated, results have varied (e.g., Conklin, 2005; Schwartz & Kroll, 2006; Libben & Titone, 2009). Therefore the assessment of L2 proficiency and the relationship between L2 proficiency and interlingual homograph processing appears to warrant further investigation. The value of such an investigation hinges on accurate and thorough assessment of language proficiency.

Objective Assessment of Language Proficiency in Bilinguals

In monolingual studies regarding language processing, it is generally assumed that all participants have similar levels of proficiency, even though this is probably untrue. A similar and equally erroneous assumption is sometimes made with regard to bilinguals. Grosjean (1985) defined bilingualism as the regular use of two or more languages and notes that a bilingual's language proficiency is not equivalent to the combined proficiency of monolinguals in each language. Each bilingual person will have a slightly different language configuration depending on a number of factors. As a result of this, Grosjean argued that it is impossible to measure a bilingual person's language proficiency by simply testing them in one language, nor by adding together the results of tests in each language. He noted that overall language ability would be underestimated if only one language was tested, and that summing the results of tests in both languages could cause an overestimation, as there is likely some overlap between the two lexicons.

Many studies of bilingual language processing utilize unstandardized or researcher-generated instruments to measure language proficiency. These instruments typically take the form of vocabulary tests (e.g., Conklin, 2005) or picture naming tests (e.g., Magiste, 1992), and participants are generally only tested in their weaker language. The use of standardized instruments allows for greater uniformity across studies and in turn eliminates a potential source for error. The Bilingual Verbal Ability Test (BVAT; Muñoz-Sandoval, Cummins, Alvarado, & Ruef, 1998) is an example of a measure which was designed specifically to allow for the assessment of overall bilingual ability.

Self-Reported Language Proficiency in Bilinguals

Although many studies of bilingual language processing employ self-rating questionnaires to assess language proficiency, these vary from study to study and there is no accepted standard. Marian, Blumenfeld, and Kaushanskaya (2007) noted that although most prior studies regarding the self-assessment of language ability in bilinguals employed questionnaires which asked subjects about their language proficiency and their language history, the questionnaires differed in a number of ways. The distinction between language proficiency, language dominance, and language preference was not taken into account, behavioural tasks used to assess concurrent validity were limited or ignored entirely, and the questions and scales which were employed varied across studies. They attempted to remedy this problem by developing and validating a new language questionnaire, the Language Experience and Proficiency Questionnaire (LEAP-Q).

In their review of the existing literature, Marian et al. (2007) cited a number of past studies which indicated that self reported judgments of language proficiency are generally fairly accurate. However, they also described a study undertaken by Delgado, Guerrerro, Goggin, and Ellis in 1999 (cited by Marian et al., 2007) in which it was shown that self ratings of L1 proficiency correlated more closely with objective measures of proficiency than self ratings in L2, as well as another study by Bahrick, Hall, Goggin, Bahrick, and Berger in 1994 (as cited in Marian et al., 2007), which demonstrated that self ratings of language ability correlated highly with certain objective measures of proficiency (e.g., category fluency, vocabulary recognition), but not with other measures (e.g., oral comprehension). Overall, Marian et al. (2007) suggested that the relationship between self-report and objective measures of language proficiency tends to vary depending on the languages being assessed and the tasks which are used in the assessment.

Marian et al. (2007) discovered that exposure to friends speaking L2 and learning L2 from family were the best predictors of self-rated L2 proficiency. Predictors of self-rated proficiency levels were found to be more varied for L2 than for L1. For example, length of time spent in a country where people primarily speak the subject's L1 predicted L1 ratings of speaking, oral comprehension, and reading comprehension, whereas the age when the subject started to read in L2 predicted L2 reading comprehension ratings, but exposure to L2 from friends and family best predicted L2 speaking ratings. In a study investigating the criterion validity of the LEAP-Q, Marian et al. (2007) found that the best predictors of subjects' performance on objective measures of language ability such as language subtests of the Woodcock-Johnson battery and the Peabody Picture Vocabulary Test were the dimensions on which they had rated themselves as being least proficient. Reading proficiency was the most accurate predictor of L1 performance, whereas speaking ability was the best predictor of L2 performance. Correlations between self report data and objective measures tended to be stronger for L2 than L1; however, this was likely due to a limited range of ratings and test scores for L1.

In summary, Marian et al. stated that the combination of language history variables which best predict performance on objective measures may vary depending on the specific task and the languages involved. They suggested that in order to accurately predict performance on an objective measure, different combinations of variables would be necessary for each measure and language configuration. As such, the researchers indicated that collecting information regarding self-rated proficiency would be more efficient than obtaining large amounts of historical data. However, they added that certain historical information could increase the accuracy of predictions of language ability. Marian et al. recommended that the LEAP-Q be administered to a number of bilingual samples with different language backgrounds and configurations in order to validate the factor structure and utility as a measure of proficiency.

Conklin (2005) also investigated the relationship between self-reported proficiency and language ability as measured by objective means. Self-ratings of reading ability were significantly correlated with reading time on sentence stimuli presented in her lexical decision task, as well as performance on a reading comprehension test. Reading ability as measured by the questionnaire also correlated significantly with accuracy in the lexical decision task; those who rated themselves higher in reading skills made fewer false positive errors to non-word stimuli and fewer false negative responses to stimuli which were actual words than those who rated their reading skills lower. Self-rated speaking ability, writing ability, and oral comprehension ability also correlated significantly with reading times and lexical decision accuracy; conversely, there was no significant relationship between these ratings and performance on the reading comprehension task. Although Conklin stated that she administered a vocabulary test to participants in her studies as an additional measure of proficiency, correlations between this test and self-report measures of language ability were not reported.

In short, promising objective and self-report measures of language proficiency in bilingual individuals have been developed but not extensively studied. Use of these measures may enhance understanding of the processing of interlingual homographs.

CHAPTER III

DESIGN AND METHODOLOGY

The Present Study

A great deal of research has been undertaken regarding the processing of ambiguous words in monolingual and bilingual individuals. In some studies, the ambiguous stimuli have been presented in isolation, whereas in others they have been integrated into sentences in order to provide a context. The main goal of these experiments has been to determine whether all representations of a given ambiguous word are activated when it is viewed, or whether the activation is restricted to the most appropriate representation. The current dominant model of bilingual word processing (BIA+) posits that activation is generally extensive but that it is moderated by a number of factors, including sentence context, task demands, word frequency, and language proficiency. However, only a small number of experiments in the bilingual literature have investigated the roles of word frequency and proficiency in the processing of ambiguous words, and thus further investigation is warranted in order to determine whether the BIA+ model can adequately account for the effects of these variables or whether this model must be refined or replaced. Furthermore, proficiency has been inconsistently measured and poorly defined across experiments. As such, this study employed an empirically validated language proficiency questionnaire and a standardized test of bilingual language ability in order to ensure that these variables were accurately represented.

This study replicated Conklin's Experiment 4 (2005), which investigated the processing of interlingual homographs in French sentences by native English speakers. However, some refinements and modifications were made. Although Conklin justified the presentation of entire sentences to the participants in her study by correctly stating that having them view sentences one word at a time in a RSVP paradigm is not consistent with how people read naturally, this method has potential drawbacks. With a RSVP presentation, each participant sees each component of the sentence for a uniform length of time and the subsequent probe item is displayed at a set rate. When subjects are permitted to read a full sentence at their own pace, the rates at which they do so will vary, and this could result in varying levels of lexical activation. For instance, if someone takes a particularly long time to read a sentence or scans back to the beginning to re-read a given sentence, the semantic activation relating to the sentence-ending interlingual homograph could dissipate and this would influence the results of the forthcoming lexical decision. A similar problem could arise if there is a long pause between the moment that a participant finishes reading a sentence and the moment they choose to hit the space bar to continue. Furthermore, Conklin did not provide details regarding latency following the pressing of the space bar. If the probe stimulus appeared immediately thereafter, the act of having to move one's hand to the space bar and back to the yes/no response keys could have influenced that person's reaction time.

Another potential issue in Conklin's (2005) study was her comparison between proficiency levels of different types of bilinguals. The patterns of results observed in bilingual French natives may have differed from those of the English natives due to reasons other than their respective levels of L2 proficiency. There could be fundamental differences between language representations in people who learn French before English compared to those who learn English before French. For example, in a study by Fabbro (2001) bilinguals underwent neuroimaging as they engaged in language-related tasks.

Fabbro found that neural representation of grammar differed based on a participant's pattern of language acquisition. In addition, Conklin's choice to use bilinguals from different geographical regions and cultures is a potential source for error; the experience of learning English as a native French speaker in Canada is no doubt quite different from that of learning French as a second language in the U.S. Based on these factors, it would seem prudent to investigate the performance of bilinguals from one area who have the same L1 and L2 configuration but different levels of proficiency, as opposed to those with different patterns of L1 and L2 in addition to varying proficiency.

Hypotheses

First, it was predicted that lower proficiency participants would experience a greater level of interference from L1 representations of interlingual homograph meanings than higher proficiency participants, due to the relative lack of L2 representations in the neural networks of participants with less proficiency in L2. That is, a greater discrepancy in reaction time between homograph translations and control words was expected for the lower proficiency group than the higher proficiency group. Although such an effect was not observed in Conklin's (2005) study, this may have been due to methodological issues that will not influence the current experiment, such as her presentation of entire sentences at once and her use of bilingual subjects with different configurations of language acquisition.

A second prediction was that lower L2 proficiency would be associated with increased false negative errors in the lexical decision task; specifically, participants who were less familiar with French would be more likely to mistake homograph translations for non-words than those with a greater degree of familiarity due to their relative lack of experience with the language.

Third, with regard to the relationship between responses to the self-report LEAP-Q and objective measures of proficiency, based on the results of past research, it was expected that participants' self-ratings would correlate moderately with their psychometrically measured language abilities. However, a greater discrepancy between ratings and measured abilities was expected for lower proficiency participants, who may have been less aware of the limits of their French skills than more experienced and fluent French speakers.

Participants

The participants for this study were drawn from the University of Windsor psychology undergraduate participant pool. Refer to Appendix B for the recruitment ads posted on the participant pool website. Participants received research credits which could be applied toward their grades in undergraduate psychology courses as compensation for their time. Given that a relatively high percentage of Windsor residents (9%) reported fluency in both French and English (Statistics Canada, 2006), it was expected that finding an adequate sample would not be problematic. Ninety-four participants recruited based on having some degree of French fluency engaged in a screening session in which they completed the LEAP-Q so that their French language abilities could be estimated. Seventy-one participants whose average self-rated French proficiency exceeded 5/10 were contacted to return for a follow-up session (refer to following section for an explanation of average self-rated French proficiency) which entailed objective testing of language abilities and the completion of a computerized lexical decision task. Of those contacted, 52 participants returned to complete the testing session. Based on the procedures used in similar studies and power analyses conducted with G*Power version 3.0 for Windows Vista (Faul, Erdfeder, Lang, & Buchner, 2007), approximately 40 were required for the follow-up session – 20 per language proficiency group, and thus the sample obtained was adequate. Individuals who were fluent in languages other than French and English were not included in the sample due to potential interference from their other language(s).

Materials

To measure self-reported proficiency, participants were administered the LEAP-Q developed by Martin et al. (2007), available online at the Northwestern University School of Communication Bilingualism and Psycholinguistics Laboratory website. This questionnaire includes items regarding the subjects' language history, including when and how they learned their languages, in what situations and how frequently they use each language, and asks each respondent to rate their speaking, oral comprehension, and reading abilities in both languages. As such, it addresses not only language proficiency (one's overall language competence), but also language dominance (differing levels of fluency across languages), and language preference (choice of language across different tasks). Proficiency ratings are recorded on a ten-point scale ranging from *none* to *perfect*, and questions regarding language background and education require the subject to write in a response. Although no overall language proficiency self-rating is obtained from the LEAP-Q, the mean of participants' ratings in reading, writing, and oral comprehension was used as an average self-rated French proficiency score in this study. This variable was employed in creating high and low French proficiency groups and as a predictor in several regression analyses. Martin et al. stated that when a subject must provide information regarding two languages, the completion time for the LEAP-Q is approximately 15 minutes.

Martin et al. (2007) assessed the internal validity of the LEAP-Q through factor analysis and multiple regression analysis, and also investigated its criterion validity by correlating the results of their questionnaire with scores on a battery of objective measures of language proficiency. Factor analyses across two samples yielded similar factor structures, and most of the factors with higher eigenvalues were consistent in both studies. Marian et al. defined three of the most important factors as *L1 Competence* (included information regarding L1 proficiency, association with L1 culture, and preference for reading in L1), *L2 Competence* (included information relating to L2 immersion, L2 proficiency, length of exposure to L2, and preference for speaking L2), and *Late L2Learning* (included information regarding late age of acquisition and lack of comfort using L2). These factors accounted for large amounts of variance and had high internal consistency across samples. A fourth factor, defined as *L1 Maintenance* (included exposure to L1 in a variety of situations and lack of learning L2 from reading), accounted for a moderate amount of variance. The researchers suggested that the constructs are reliable based on a consistent clustering of questions in both studies.

The BVAT was used to obtain objective measures of language proficiency. This instrument consists of three subtests which measure different aspects of verbal ability: picture vocabulary, oral vocabulary (synonyms/antonyms), and verbal analogies (Muñoz-Sandoval et al., 1998). Although the BVAT tests vocabulary and lexical knowledge rather than overall language proficiency or fluency, few overall tests of language ability exist, and those which do are complex and time-consuming (e.g., evaluating individuals based on conversational performance). Furthermore, vocabulary scores have been found to correlate well with overall measures of proficiency (Jiménez, García, & Pearson, 1995). The BVAT is designed for use primarily with subjects whose second language is English and is available in 15 different languages (Muñoz-Sandoval et al., 1998). All three of the subtests are intended to be administered in English first, and items that were missed or not displayed due to cutoff are subsequently administered in the subject's native language to calculate a *gain* score. The administration of the BVAT was modified somewhat for the native English speaking sample, as it is generally intended for English L2 subjects. Subtests were administered in French first, and after the French subtests were completed the English subtests were administered. This allowed for measures of French ability and overall Bilingual ability. Muñoz-Sandoval et al. suggested that the BVAT should take between 20-30 minutes to administer. This test provides age and grade normed scores for both English and overall bilingual ability, which is the sum of the subject's English score and their native language *gain* score. Normative data are provided for ages 5-90 and are based on a subset of data from the Woodcock-Johnson-Revised Cognitive battery.

The BVAT manual (Muñoz-Sandoval et al., 1998) provides evidence of content validity through the discussion of the translation protocol employed, which allowed for variations in dialect and assured that untranslatable items were left out of the test. The manual cites inter-correlations between subtests ranging from r = .59 to .91 as support for construct validity. Concurrent validity was assessed through correlation with another language assessment instrument available in multiple languages, the Language

Assessment Scales (LAS), and a high correlation of r = .86 was obtained. The LAS was not considered for use in the present study as it does not allow for the assessment of overall bilingual ability, only ability in a single language. The BVAT correlated with school achievement scores at a rate of r = .65 to .85, which provided evidence of predictive validity, and the content validity was reportedly high. Alternate form reliability was evident with a correlation of r = .84 between different forms, and split-half reliability was reported to be r = .80.

A study by Alvarado (1999) revealed significant inter-correlation between the BVAT subtests, ranging from r = .60 to .64. These results were interpreted to mean that the subtests measure similar constructs, as the correlations between them are significant, but the individual subtests are not redundant, as the correlations do not approach r = 1.00, which would mean that they correlate perfectly and are measuring essentially the same construct. Alvarado found that native Spanish bilinguals generally obtained higher scores on the BVAT than on monolingual tests of language, which was thought to suggest that it provides a more accurate assessment of overall language ability than monolingual tests. The BVAT received two positive reviews in the 14th volume of the *Mental Measurements Yearbook* (Garfinkel, 2001; Stansfield, 2001) and has been described as a successful instrument to assess combined first and second language verbal ability (Jean & Genest, 2000). Overall, the BVAT appears to be a psychometrically sound instrument which is useful in the assessment of bilingual proficiency.

BVAT scores were calculated using the procedures described by Muñoz-Sandoval and colleagues (1998) in the BVAT manual. French subtest scores were summed to generate an overall French proficiency score, and an overall bilingual ability score was calculated by adding the French total to the English gain scores. Age and grade equivalent scores were calculated using the BVAT computer scoring program for descriptive purposes only.

As the BVAT does not gauge reading skills, an excerpt from a children's book (*Le Petit Prince*) was used to test reading speed in French (L2). Reading speed has been found to correlate well with overall reading abilities (Siegel, 1993). A relatively simple reading task was selected to ensure that most of the subjects would be able to read all of the words in the task, and thus speed would be more of a factor than comprehension. Reading speed and errors were recorded by the researcher with some leniency regarding variations in dialect and pronunciation. The form used can be found in Appendix B.

The lexical decision task employed in this experiment was based on the procedure employed by Conklin (2005) in her Experiment 4 and used the same sentence and word stimuli. The stimuli of interest were 32 interlingual homographs, French translations of the English meaning of the homograph, and French control words matched for frequency, length, part of speech, and first letter. Data regarding French word frequency were obtained by Conklin from Content, Mousty, and Radeau's 1990 Brulex database (as cited in Conklin, 2005), whereas English homograph frequencies were drawn from Francis and Kucera's 1982 database (as cited in Conklin, 2005). Priming sentences ending with the interlingual homographs were also drawn from Conklin's study. In addition to the stimuli of interest, 160 French filler sentences were generated by the researcher and reviewed by a French-speaking colleague to ensure that they were grammatically correct and comprehensible. Ninety-six of these sentences were paired with non-words generated by changing one letter of a French word, and none of these non-word stimuli were words in

English. Sixty-four of the sentences were paired with words chosen at random from a French dictionary. The discrepancy in number of non-words and filler words ensured an equal ratio of word and non-word stimuli; when combined with the homograph translations and control words, the total number of real French words in the stimulus set was 96. For an example of the stimuli presented in this experiment, refer to Table 1 below. For a complete list, see Tables 2 and 3. In keeping with Conklin's procedures, sentences ending with homographs were never followed by lexical decisions on non-word stimuli.

Table 1

Examples of Stimuli Used in Lexical Decision Task.

Priming sentence	Homograph translation	Control word
Demain, on doit acheter du *pain*.	Douleur*	Docteur
Filler sentence	Filler word	Non-word
Nous marchons sur la route.	Chien	
Nous conduisons une voiture dans la ville.		Charps

*French translation of English meaning of *pain*

Table 2

Stimuli of Interest Retained in Analysis

Homograph	English Frequency	French Frequency	French Prime Sentence	Homograph Translation	Control Word
chair	89	108.86	A travers la chemise de Marie, on apercevait sa chair.	chaise	chapeau
chose	177	1389.5	Il faut dire au moins une chose.	choisit	réussit
coin	18	129.41	La boulangerie se trouve zu coin.	monnaie	montre
court	286	114.65	Son discours est beaucoup trop court.	terrain	tendance
figure	389	169.53	Avant de se coucher, il regarde sa figure.	silhouette	simplicité
four	347	10.12	Michel veut acheter un nouveau four.	quatre	quotidien
lent	29	59.26	Ce camion rouge est beaucoup trop lent.	prêté	prévu
lit	72	204.16	Isabelle a acheté un nouveau lit.	allumé	attiré
ours	1233	10.12	Au parc, Clotilde a vu un ours.	nôtre	nonne
pain	102	86.87	Demain, on doit acheter du pain.	douleur	docteur
pays	325	282.23	Les jeunes, ça aime voir du pays.	payer	préférer
piece	129	225.69	Ce soir, on a vu une très bonne pièce.	morceau	mouton
pub	2	9.82	Luc aime bien cette pub.	bar	jupe
pull	145	1.1	Madeleine porte toujours le même pull.	tirer	tomber
sale	177	52.92	La maison de Jean est vraiment très sale.	vente	vague
singe	1	16.46	François veut avoir un singe.	roussir	rajouter
son	202	4377.23	Les enfants, plus aucun son.	fils	façon
sort	10	63.09	Phillipe a un mauvais sort.	classer	circuler
stage	174	2.3	En avril, Mirelle va faire un stage.	scène	salon
vent	10	191.91	A Buffalo, il fait souvent du vent.	ouverture	obéissance

* Frequencies listed as number of occurrences per million words.

Table 3

Stimuli of Interest Excluded from Analysis

Homograph	English Frequency	French Frequency	French Prime Sentence	Homograph Translation	Control Word
bride	40	9.01	Jacques avait toutes sortes de choses dans sa cave, y compris une bride.	mariée	maïs
chat	6	43.26	Patricia n'aime pas mon fils, mais elle aime mon chat.	bavarder	bousculer
dent	1	84.66	Le bébé a eu sa première dent.	bosse	bordel
fin	7	369.56	Pour comprendre le film, il faut attendre la fin.	nageoire	nettoyage
lame	2	15.35	Le vendeur nous conseilla d'examiner la lame.	boiteux	blaguer
mare	18	8.08	Au parc, il y a une mare.	jument	jumelle
mince	8	49.77	Cette femme-là est très mince.	hacher	héberger
net	24	73.89	Ce genre d'histoires, ce n'est pas très net.	filet	flèche
ride	21	17.35	Au milieu de sa main, Cécile avait une grande ride.	promener	partager
rude	6	31.82	L'année dernière, l'hiver a été très rude.	impoli	imprévu
sang	120	176.85	Là-bas, il y a du sang.	chanta	cacha
slip	47	0.34	L'enfant n'aime pas son slip.	glisser	gagner

* Frequencies listed as number of occurrences per million words.

Procedures

Informed consent was obtained before the screening and testing sessions. Consent forms can be found in Appendix C. In the screening session, the researcher administered the LEAP-Q to individual participants or groups of participants. Instructions for completing the questionnaire were explained by the researcher, and a sheet of instructions was also provided so that the participants could refer to it as needed. Participants were encouraged to ask questions if they did not understand a particular item. In the testing session, the BVAT was administered by the researcher to individual participants, and following the completion of the BVAT participants completed the computerized lexical decision task. Two lists of experimental stimuli were created so that each participant was exposed to each of the sentences ending in an interlingual homograph but only to one of the lexical decision response options – either the homograph translation, or the matched control. Furthermore, homographs were grouped into high frequency and low frequency groups based on their French and English frequencies, and each participant was presented with an equal number of high and low frequency homograph sentences. Thus, a total of four lists of stimuli were employed. An equal number of participants were assigned to each list, and the positions of all sentences were randomized throughout the task. Instructions were presented on the computer screen prior to the beginning of the lexical decision task, and these instructions were also explained by the researcher. Six practice trials were delivered prior to the commencement of the lexical decision task in order to ensure that participants fully understood the instructions.

In each trial, participants were first presented with a cross (+) in the center of the screen to induce fixation. Following this, a sentence was displayed on the screen one word at a time at a rate of 700ms per word, the rate at which Duyck et al. (2007) reported that their subjects were able to comfortably follow the sentence. Once the entire sentence was presented, the fixation cross was presented for 750ms, then a word or non-word appeared for 150ms before being replaced once again by the fixation cross. Subjects were required to hit the *Z* key on the keyboard if the letter string was a word, and the */* key if it was a non-word, and their reaction time was recorded.

Eight comprehension questions were presented at randomized points throughout the lexical decision task to ensure that the participants were paying attention to the sentences and not responding in a random fashion. The questions related to the sentence which was previously presented. For instance, the sentence "Steve n'aime pas les pommes" (Steve does not like apples) could be followed with a probe word, and after the subject made a word/non-word judgment the yes/no question "Est-ce que Steve aime les pommes?" (does Steve like apples?) would appear. The subject would be instructed to press the *Z* key to respond yes and the */* key to respond no. In addition, breaks were offered after the completion of 25%, 50%, and 75% of the lexical decision task in order to ensure that the participants did not experience visual fatigue or lose focus on the task.

Following the completion of the lexical decision task, subjects completed a post-experiment stimulus verification task developed by Conklin for her 2005 study. In this task, participants were presented with a list of the homograph-containing sentences, the homograph translations, and their matched controls (e.g., the sentence "La boulangerie se trouve vers le coin", the homograph translation *monnaie*, and the matched control *montre*). They were asked to circle all of the words which were unfamiliar to them, and if a large number of participants (>= 40%) was unfamiliar with a key component of any of the homograph/homograph translation/control pairings, the relevant test item was excluded from statistical analyses. The two pages of this form can be found in Appendix B, titled *Sentence Comprehension Form* and *Word Comprehension Form*.

Statistical Analyses

First, demographic information was explored in order to determine whether any trends existed in the overall sample or in the high and low language proficiency groups. Differences in demographics between the proficiency groups were quantified using independent samples *t*-tests. Error rate scores were calculated with all lexical decision items included, whereas the data set was screened to remove items which were not understood by an adequate number of subjects before mean reaction time scores and related analyses were calculated. In addition, the scores of participants who may not have adequately understood the stimuli presented in the lexical decision task or were suspected of suboptimal effort were removed and were not included in any analyses.

Pearson product-moment correlations were used to identify relationships between variables and to assist in selecting predictors in MRAs. In order to determine whether the order of presentation of items in the lexical decision task influenced speed or accuracy of responses, mean correct reaction time and the number of errors committed (error rate) were subjected to repeated measures ANOVAs by the quarter of the task in which they were presented. This was done principally to determine whether fatigue or boredom played a role in response speed or accuracy as the task progressed.

To test the hypothesis that individuals with low French proficiency would experience greater interference on homograph translation stimuli compared to control words than high proficiency French speakers (Hypothesis 1), and the hypothesis that low proficiency participants would commit more false negative errors on the lexical decision task (Hypothesis 2), 2x2 mixed model Analyses of Variance (ANOVAs) were conducted with stimulus type (homograph translation vs. control word) as the within-subjects factor and proficiency group (high vs. low) as the between-subjects factor. Mean correct reaction time and number of errors committed on each stimulus type (error rate) were used as dependent variables. If the first hypothesis was correct, then there should have been a greater difference between reaction times to homograph stimuli and control words for the low proficiency group; in other words there should have been an interaction between proficiency level and stimulus type. Furthermore, planned linear contrasts were carried out to compare the performance of high and low proficiency participants on each stimulus type.

Correlational data were used to investigate the extent to which self-rated French proficiency and proficiency as objectively measured by the BVAT were related (Hypothesis 3). The correlations between self-rated proficiency and total BVAT French score were calculated for each proficiency group and compared using Fisher's transformation, also known as Fisher's *r'* or Fisher's *z* (as per Clark-Carter, 1997). It was expected that a higher correlation between these measures would be observed in the high proficiency group, as these individuals were predicted to have a better awareness of their level of French understanding.

Except when specified, effects observed in the statistical procedures conducted in this study are reported as significant at $p < .05$. Effect sizes for ANOVAs are reported as Pearson's r, with $r = .10$ representing a small effect, $r = .30$ representing a medium effect, and $r = .50$ representing a large effect, as suggested by Field (2005). Effect sizes for multiple regression analyses (MRAs) were calculated with Cohen's f^2, and were interpreted according to Cohen's (1988) guidelines, with .02 representing a small effect, .15 representing a medium effect, and .35 signifying a large effect.

CHAPTER IV

ANALYSIS OF RESULTS

Sample Characteristics

The high and low proficiency groups did not differ in terms of age, self-reported high school GPA, or age at French acquisition. Differences were observed in years of education and French proficiency variables, as well as in overall bilingual proficiency as measured by the BVAT. Refer to Table 4 for additional information.

Table 4

Sample Characteristics with p-values for t-tests between High and Low Proficiency Groups

	High Proficiency	Low Proficiency	*p*-value	Total Sample
Number of Participants	20	20	n/a	46
Age	23.75 (7.97)	21.00 (4.39)	.19	21.93 (6.17)
Gender	18F, 2M	17F, 3M	n/a	41F, 5M
Handedness	18R, 2L	16R, 3L, 1M	n/a	40R, 5L, 1M
Years of Education	16.15 (2.58)	14.75 (1.65)	.05	15.22 (2.22)
High School GPA	82.90 (8.23)	81.30 (7.95)	.54	82.00 (8.18)
Age at French Acquisition	3.58 (2.35)	5.90 (2.83)	.07	4.86 (2.69)
Years of French Schooling	11.69 (2.85)	7.86 (4.95)	.05	9.79 (4.36)
Avg. Self-Rated French Proficiency	7.82 (1.03)	5.98 (1.11)	<.00	6.95 (1.39)
Total BVAT French Score (/135)	62.20 (11.08)	32.65 (7.80)	<.00	47.57 (16.49)
BVAT French Age Equivalent	9.54 (2.62)	5.21 (.79)	<.00	7.35 (2.71)
BVAT French Grade Equivalent	4.15 (2.46)	.48 (.46)	<.00	2.26 (2.38)
Total BVAT Bilingual Score (/135)	104.85 (9.61)	93.80 (14.29)	<.00	98.50 (12.76)
BVAT Bilingual Age Equivalent	21.26 (3.41)	18.69 (3.20)	.02	19.62 (3.51)
BVAT Bilingual Grade Equivalent	15.18 (3.07)	12.91 (2.99)	.02	13.71 (3.20)

With exception of Number of Participants, Gender, and Handedness, scores are represented as Mean (SD). Total *n* exceeds size of proficiency groups as six participants in the middle of the Total BVAT French Score distribution were removed to create more distinct language proficiency groups (see Data Screening section for details).

Data Screening

Based on the results of the stimulus verification task, 12 of the original 32 homograph translation/control pairs were removed from reaction time analyses as greater than 40% of subjects did not understand a key stimulus (the homograph, its translation, or the control word). These words were not removed from error rate analysis as semantic interference was expected to have less impact on accuracy and omitting words which were not understood may have caused a misrepresentation of total error rate differences between proficiency groups. For the reaction time analyses, more items based on low frequency than high frequency homographs were eliminated: eight homograph translation/control item pairs relating to low frequency French homographs were eliminated, whereas only four item pairs relating to high frequency homographs were retained. Similarly, 12 item pairs based on low frequency English homographs were retained, while only two item pairs generated from high frequency English homographs remained in the data set. This imbalance resulted in issues with the calculation of reaction times based on frequency. For instance, although the four stimulus sets were balanced initially for stimulus type and frequency, after these exclusions one set included only seven items based on high frequency French homographs and only three based on low frequency homographs.

Following the tabulation of mean reaction time and error scores, the scores of four participants of the initial 52 participants were removed from the data set because they had made more than 60 errors on the lexical decision task. This represented one third of the 180 items retained and such a high error rate was deemed unacceptable. In addition, a fifth participant's scores were excluded from analysis because the participant only answered four of the eight comprehension questions correctly. A high proportion of errors on the lexical decision task or chance-level responding on the comprehension questions was thought to suggest either poor understanding of the lexical decision items or poor motivation. Finally, a sixth participant's scores were removed from analysis because this individual indicated that they did not understand any of the words listed on the stimulus verification form. At this point, 46 cases remained in the data set, and these 46 cases were used for the MRAs.

An additional six cases were removed for use in most ANOVAs. Initial attempts to create high and low proficiency groups by dividing the sample in half based on BVAT total French scores were unsuccessful, as there was some overlap between the two groups; see Figure 1 for a visual representation. As such, the scores of the three participants whose BVAT total French scores fell at the bottom of the high proficiency group and the three participants whose scores fell at the top of the low proficiency group were removed to create more distinct groups; see Figure 2 for details. Thus, a total of 40 cases were retained for ANOVA analyses: 20 per proficiency group. Only six cases were removed in order to maintain an adequate sample size based on power analysis.

Figure 1

BVAT total French Score for Each Participant by Proficiency Group for Entire Sample

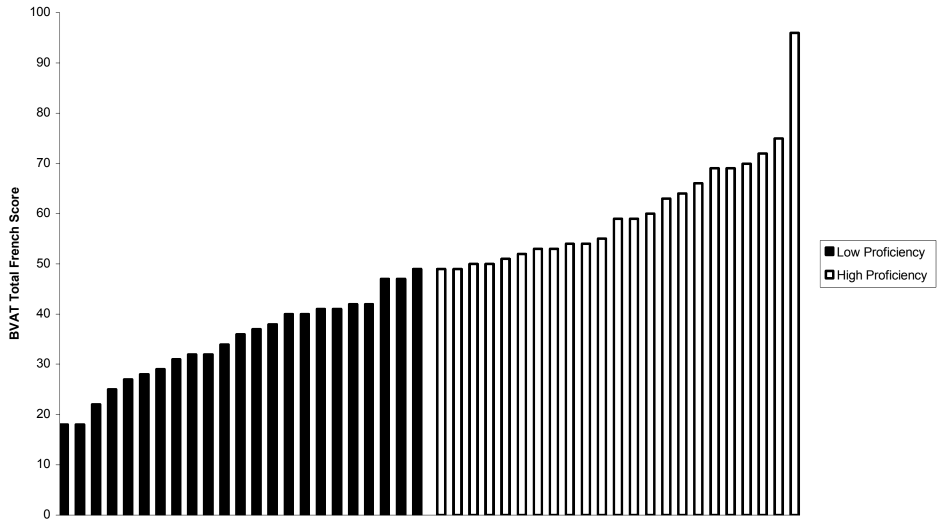
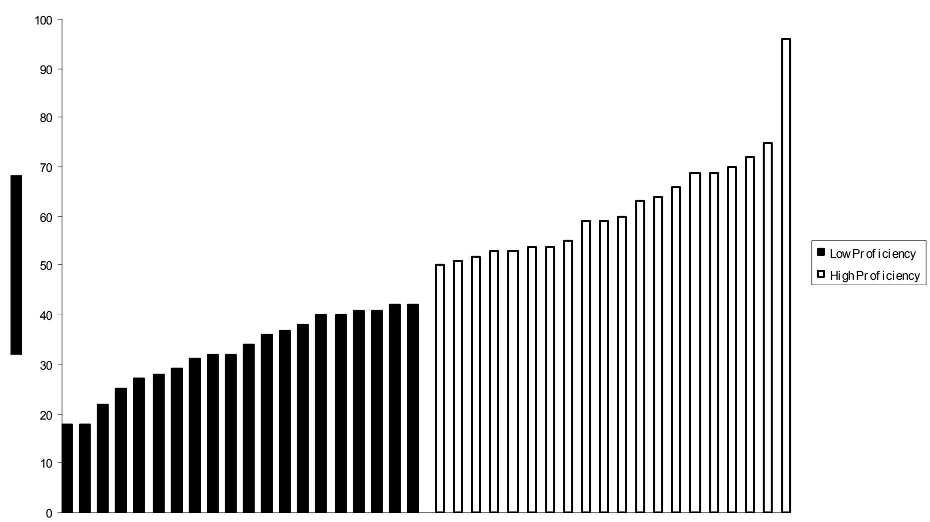


Figure 2

BVAT total French Score for Each Participant by Proficiency Group with Middle of Distribution Removed



Correlations

Statistically significant correlations were observed between a number of variables; see Table 5 for details. Due to the large number of correlations calculated, the Dunn-Šidák correction was employed to reduce the probability of Type 1 error. Measures related to proficiency, including average self-rated French proficiency, reading speed in French, reading errors in French, total BVAT French score, and understanding of stimulus words correlated well with each other. Data related to French learning (e.g., age at acquisition, number of years in school) also correlated well with proficiency measures. Reading speed was the only proficiency-related variable that had a significant relationship with overall reaction time, while a number of proficiency-related variables correlated strongly with total errors on the lexical decision task. Participant age did not correlate significantly with overall reaction time, $r = -.07$, $p = .65$; this suggested that age need not be included as a covariate in reaction time analyses.

Table 5

Correlations between Demographic, LEAP-Q, BVAT, Lexical Decision, and Stimulus Verification Task Variables (n = 46)

	Age at Fr. Acquisition	Years of School in Fr.	Avg. Self-Rated Fr. Proficiency	Reading Speed	Reading Errors	Tot. Fr. BVAT Score	Avg. RT for All Correct Responses	Total Err. on Lexical Decision Task	Comp. of Stimuli
Age at Fr. Acquisition	1	-.51***	-.59***	.45**	.39**	-.49***	.12	.26	-.28
Years of School in Fr.	-.51***	1	.53***	-.43**	-.56***	.48***	-.08	-.33*	.56***
Avg. Self-Rated Fr. Proficiency	-.59***	.53***	1	-.52***	-.58**	.70**	-.26	-.44**	.71**
Reading Speed	.45**	-.43**	-.52***	1	.60***	-.56***	.45**	.68***	-.42**
Reading Errors	.39**	-.56***	-.58***	.60***	1	-.72***	-.04	.75***	-.76***
Total French BVAT Score	-.49***	.48***	.70***	-.56***	-.72***	1	-.13	-.68***	.75***
Avg. RT for all Correct Responses	.12	-.08	-.26	.45**	-.04	-.13	1	.06	-.04
Total Err. on Lexical Decision	.26	-.33*	-.44**	.68***	.75***	-.68***	.06	1	-.61***
Comprehension of Stimuli	-.28	.56***	.71***	-.42**	-.76***	.75***	-.04	-.61***	1

* correlation significant at p < .010

** correlation significant at p < .005

*** correlation significant at p < .0008 (Dunn-Šidák correction)

Preliminary Analyses – Order of Lexical Decision Item Administration

To determine whether fatigue or boredom had an effect on speed or accuracy, the lexical decision task was divided into quarters by order of administration. Mean correct reaction time and mean error rate were calculated for each quarter and compared using repeated measures ANOVA.

Reaction time. The initial data set consisted of 184 observations; four for each of the 46 participants. Normality and homogeneity of variance of the dependent variable, logarithmically transformed reaction time, were assessed through the use of the SPSS Explore function. Mild problems with normality were observed, but these were resolved with the removal of one outlier. Mauchly's test indicated that the assumption of sphericity was violated, $\chi^2(5) = 12.65$, $p < .05$, and as such degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .83$).

There was a significant main effect of quarter of task, and Helmert contrasts revealed a difference in reaction time between the first quarter and the other three quarters, but no differences were observed between the second quarter and the remaining quarters, or between the third and fourth quarters. There was a general trend toward faster reaction times as the task progressed, suggesting a practice effect. However, this effect was controlled for by the randomization of stimuli throughout the task. Refer to Table 6 for ANOVA values and Figure 3 for a visual representation of the data.

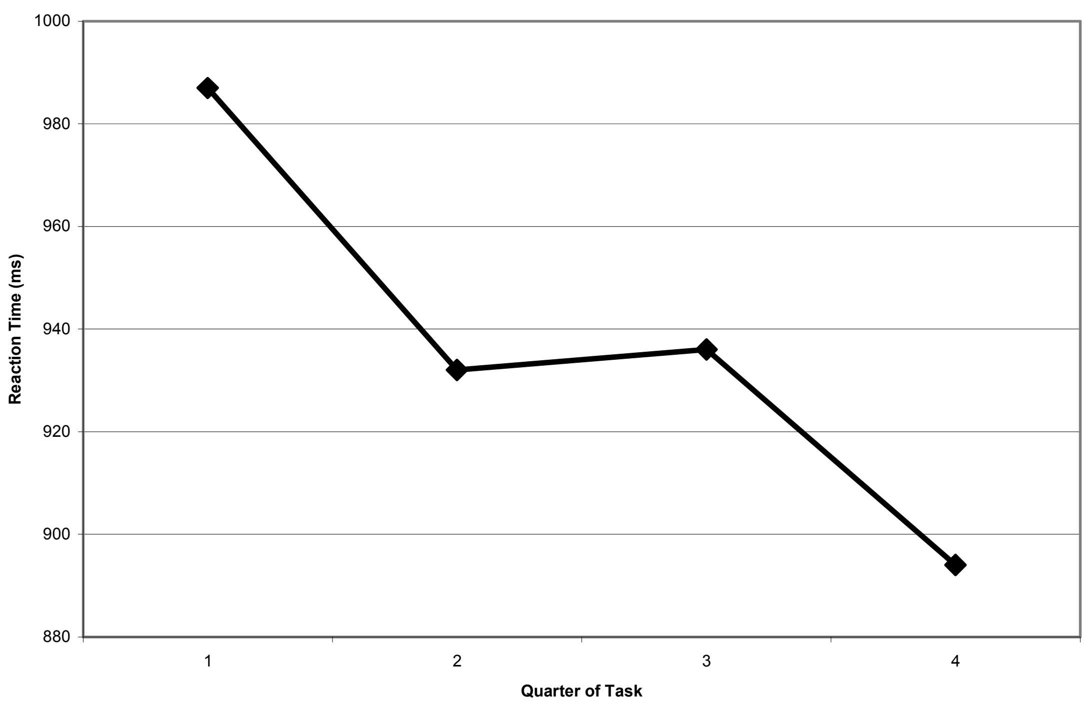
Table 6

ANOVA Results for Reaction Time by Quarter of Task (n = 46)

Effect	*F*	*df* model	*df* error	*p*-value	*r*
Quarter	6.50	2.49	109.43	< .00	.24
Quarter 1 vs. 2, 3, & 4	12.11	1	44	< .00	.46
Quarter 2 vs. 3 & 4	1.90	1	44	.18	.20
Quarter 3 vs. 4	1.30	1	44	.26	.17

Figure 3

Mean Raw Reaction Time by Quarter of Task



Error rate. The initial data set consisted of 184 observations; four for each of the 46 participants. Issues with normality were detected, but since cell sizes exceeded 20, these were not a great concern. The main effect of quarter of task on error rates was not significant, and Helmert contrasts showed no difference between the first quarter and the other three quarters, nor between the second quarter and the remaining quarters, or between the third and fourth quarters. Error rates did not change as the lexical decision task progressed, suggesting that boredom and fatigue did not influence accuracy. Refer to Table 7 for details regarding ANOVA results.

Table 7

ANOVA Results for Error Rate by Quarter of Task (n = 46)

Effect	*F*	*df* model	*df* error	*p*-value	*r*
Quarter	.82	3	135	.49	.08
Quarter 1 vs. 2, 3, & 4	1.82	1	45	.18	.20
Quarter 2 vs. 3 & 4	.57	1	45	.45	.11
Quarter 3 vs. 4	.11	1	45	.74	.05

Hypothesis 1: Reaction Time Effects

To determine whether the type of stimulus used in the lexical decision task influenced speed of processing and whether this effect differed by proficiency level, mean reaction time data for homograph translations and control words were compared using a mixed model ANOVA with stimulus type as a within-subjects factor and proficiency level (high or low) as a between-subjects factor.

Assumptions. The data set consisted of 80 observations; two for each of the 40 participants. No issues with normality were detected, but there were some problems with homogeneity of variance. ANOVA is robust to violations of homogeneity of variance and covariance when cell sizes are within a 1.5:1 ratio and variances for each level of the dependent variable are within a 4:1 ratio (Stevens, 2007), and since these conditions were fulfilled analyses continued.

There was a significant main effect of stimulus type; responses to homograph translations were slower than responses to control words. The effect of proficiency approached significance (p = .066), with a tendency for high proficiency participants to respond more quickly than low proficiency participants. Contrary to the hypothesis, there was no interaction between stimulus type and proficiency. However, planned contrasts revealed that high proficiency participants had faster reaction times than low proficiency participants on control words, but not on homograph translations. Refer to Table 8 for ANOVA values and Figure 4 for a visual representation of the data.

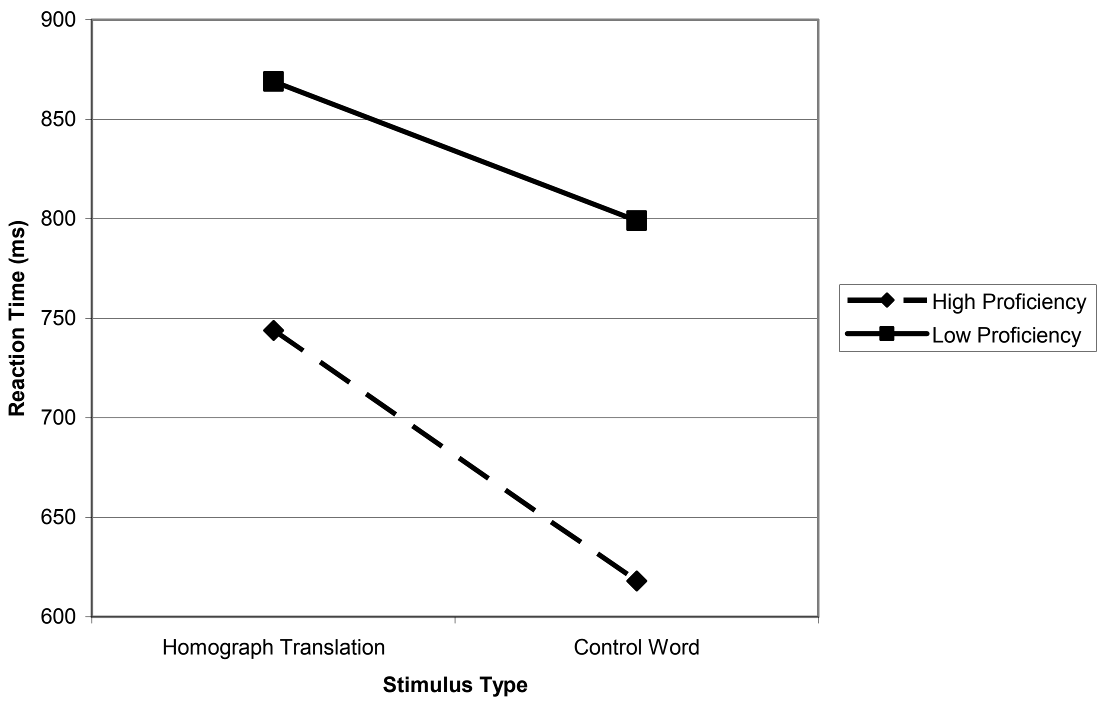
Table 8

ANOVA Results for Reaction Time by Stimulus Type and French (L2) Proficiency (n = 40)

Effect	*F*	*df* model	*df* error	*p*-value	*r*
Stimulus Type	27.40	1	38	< .00	.65
Proficiency	3.69	1	38	.06	.30
Stimulus Type*Proficiency	2.12	1	38	.15	.23
High vs. Low Proficiency at Homograph Translations	2.16	1	38	.15	.23
High vs. Low Proficiency at Controls	5.08	1	38	.03	.34

Figure 4

Mean Raw Reaction Time by Stimulus Type and French (L2) Proficiency



Hypothesis 1: Reaction Time Effects – Additional Analyses

The effect of homograph frequency on reaction time was investigated with 2x2x2 mixed model ANOVAs using homograph frequency (high vs. low) and stimulus type (homograph translation vs. control) as within-subjects measures, and proficiency level (high vs. low) as a between-subjects factor. These analyses were conducted twice – once evaluating the frequency of the French word represented by the homograph and once evaluating the English word represented by the homograph .

French homograph frequency. The data set consisted of 160 observations; four for each of the 40 participants. Minor issues with normality and homogeneity of variance were detected, but the removal of one outlier restored normality and homogeneity of variance. Since the sample size exceeded 20, issues with normality were not a great concern (Stevens, 2007), and, problems with homogeneity of variance were not severe as cell sizes were within a 1.5:1 ratio and variances for each level of the dependent variable were within a 4:1 ratio. As such, analyses continued. The main effect of stimulus type was significant, in that responses to control words were faster than responses to French homograph translations. French homograph frequency did not have a significant effect on reaction time, nor did proficiency. No two or three-way interactions were significant in this analysis. Refer to Table 9 for ANOVA values.

Table 9

ANOVA Results for Reaction Time by Stimulus Type, French (L2) Homograph Frequency, and French (L2) Proficiency (n = 39)

Effect	*F*	*df* model	*df* error	*p*-value	*r*
Stimulus Type	9.52	1	37	< .00	.45
Frequency	2.93	1	37	.10	.27
Proficiency	3.03	1	37	.09	.28
Stimulus Type*Proficiency	1.97	1	37	.17	.22
Frequency*Proficiency	.26	1	37	.61	.08
Stimulus Type*Frequency	.19	1	37	.66	.07
StimType*Freq*Prof	.02	1	37	.88	.02

English frequency. The initial data set consisted of 148 observations; 19 at each frequency and stimulus type combination for the high proficiency group, and 18 at each combination for the low proficiency group. Missing data points occurred because certain participants made errors on all occurrences of a given stimulus type/frequency combination during the lexical decision task and thus no reaction time for accurate responses could be calculated for one participant in the high proficiency group and two participants in the low proficiency group. Mild issues with normality and homogeneity of variance were detected, but since the sample size exceeded 20, cell sizes were within a 1.5:1 ratio and variances for each level of the dependent variable were within a 4:1 ratio, analyses continued.

Main effects of stimulus type and proficiency were similar to those observed in the main analysis. English homograph frequency had a significant effect: responses to stimuli based on homographs for which the English word represented by the homograph had a low frequency were slower than those to stimuli based on homographs for which the English word had a high frequency. The interaction between stimulus type and proficiency was not significant, nor was the interaction between frequency and proficiency, or the three-way interaction between all variables. The interaction between stimulus type and frequency was significant; reaction times to control words based on translations of high and low frequency homographs were similar, but responses to translations of low frequency homographs were slower than those to translations of high frequency homographs. This suggested that English homograph frequency played some role in reaction times to homograph translations, but not to control words. Refer to Table 10 for ANOVA values.

Table 10

ANOVA Results for Reaction Time by Stimulus Type, English (L1) Homograph Frequency, and French (L2) Proficiency (n = 37)

Effect	*F*	*df* model	*df* error	*p*-value	*r*
Stimulus Type	17.08	1	35	< .00	.57
Frequency	4.98	1	35	.03	.35
Proficiency	4.91	1	35	.03	.35
Stimulus Type*Proficiency	1.87	1	35	.18	.17
Frequency*Proficiency	.47	1	35	.50	.11
Stimulus Type*Frequency	13.33	1	35	< .00	.53
StimType*Freq*Prof	.55	1	35	.46	.12

Hypothesis 2: Error Rate Effects

To determine whether the type of stimulus used in the lexical decision task influenced accuracy of responses and whether this effect differed by proficiency level, mean error rata data for homograph translations and control words were compared using a mixed model ANOVA with stimulus type as a within-subjects factor and proficiency level (high or low) as a between-subjects factor.

Assumptions. The initial data set consisted of 80 observations; two for each of the 40 participants. Some minor issues with normality were detected, but analysis continued as ANOVA is robust to violations of normality with reasonably large sample sizes.

The main effect of stimulus type was not significant, but proficiency level was found to influence error rates; high proficiency participants made fewer errors than low proficiency participants. The interaction between stimulus type and proficiency approached significance, as the error rates of both proficiency groups were similar on homograph translations, but low proficiency participants made more errors on control words than high proficiency participants. Contrasts confirmed this, as no difference in the error rates by proficiency group was detected on homograph translations, but a significant difference was detected on control words. Low proficiency participants made more errors than high proficiency participants on control words. Although Hypothesis 2, which predicted a group difference in error rates on homograph translations relative to control words, was not supported, low proficiency participants did commit more errors overall. Refer to Table 11 for ANOVA results and to Figure 5 for a visual representation of the data.

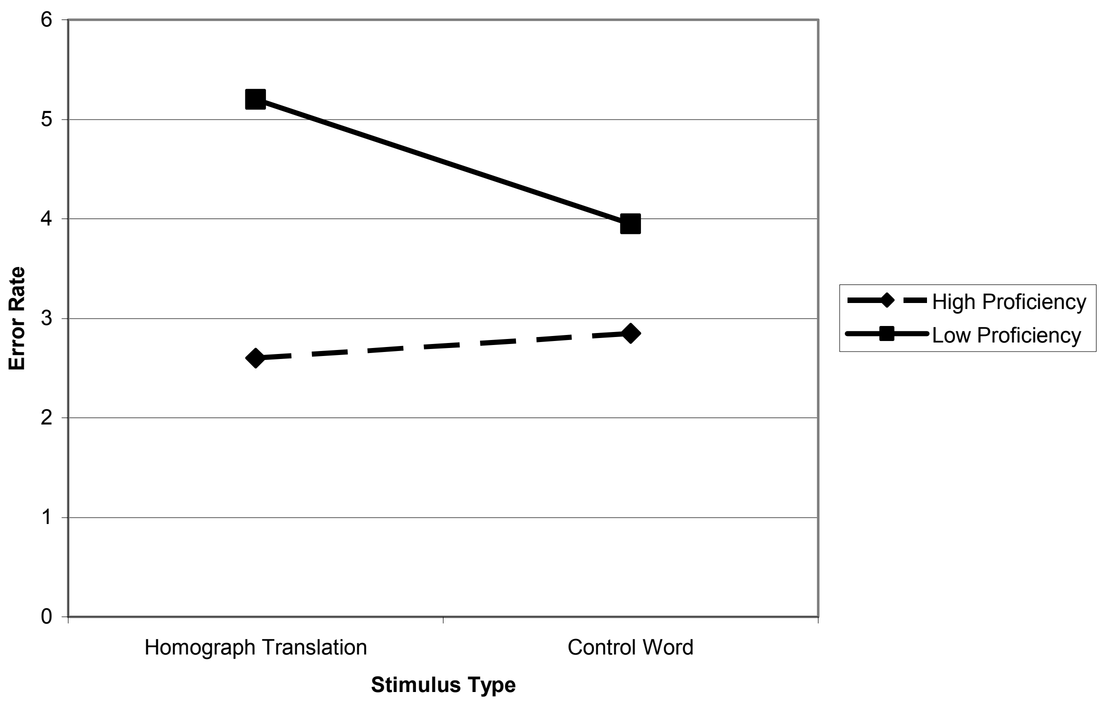
Table 11

ANOVA Results for Error Rate by Stimulus Type and French (L2) Proficiency (n = 46)

Effect	F	df model	df error	p-value	r
Stimulus Type	1.40	1	38	.24	.19
Proficiency	14.80	1	38	< .00	.53
Stimulus Type*Proficiency	3.15	1	38	.08	.28
High vs. Low Proficiency at Homograph Translations	2.75	1	38	.11	.26
High vs. Low Proficiency at Controls	17.84	1	38	< .00	.57

Figure 5

Mean Error Rate by Stimulus Type and French (L2) Proficiency



Hypothesis 2: Error Rate Effects – Additional Analyses

As with reaction time, the effect of homograph frequency on error rate was investigated with 2x2x2 mixed model ANOVAs using homograph frequency (high vs. low) and stimulus type (homograph translation vs. control) as within-subjects measures, and proficiency level (high vs. low) as a within-subjects factor. These analyses were conducted twice – once examining the effect of the frequency of the French word represented by the homograph and once examining the effect of the frequency of the English word represented by the homograph. No specific predictions were made regarding these analyses.

French homograph frequency. The initial data set consisted of 160 observations; four for each of the 40 participants. Issues with normality were detected and not resolved through the removal of outliers. Given that ANOVA is robust to violations of normality with reasonably large sample sizes, analysis continued.

The main effect of stimulus type on error rate was not significant. Frequency had a significant effect, in that more errors occurred on stimuli associated with low frequency homographs than those associated with high frequency homographs, and a significant main effect of proficiency was also observed. High proficiency participants made fewer errors overall than low proficiency participants. The interaction between stimulus type and proficiency approached significance; there was a small difference in error rates between proficiency groups on homograph translations, but a larger difference occurred on control words. The interaction between frequency and proficiency was not significant, nor was the interaction between stimulus type and frequency, or the three-way interaction between all independent variables. Refer to Table 12 for detailed ANOVA results.

Table 12

ANOVA Results for Error Rate by Stimulus Type, French (L2) Homograph Frequency, and French (L2) Proficiency (n = 40)

Effect	*F*	*df* model	*df* error	*p*-value	*r*
Stimulus Type	.84	1	38	.37	.15
Frequency	12.07	1	38	< .00	.49
Proficiency	15.84	1	38	< .00	.54
Stimulus Type*Proficiency	4.07	1	38	.05	.31
Frequency*Proficiency	1.89	1	38	.18	.22
Stimulus Type*Frequency	.94	1	38	.34	.16
StimType*Freq*Prof	.34	1	38	.56	.09

English homograph frequency. The initial data set consisted of 160 observations; four for each of the 40 participants. Issues with normality were detected and somewhat improved through the removal of outliers. Given that ANOVA is robust to violations of normality with reasonably large sample sizes, analyses continued.

The main effect of stimulus type on error rate was not significant. Frequency had a significant effect, in that more errors occurred on stimuli associated with low frequency homographs than those associated with high frequency homographs. The main effect of proficiency was also significant; low proficiency participants committed more errors than high proficiency participants. The interaction between stimulus type and proficiency was significant, in that error rates by proficiency group were similar on homograph translations, but low proficiency participants committed more errors on control words.

Furthermore, the interaction between frequency and proficiency was significant; error rates by proficiency group were relatively similar on homograph translations and control words associated with high frequency homographs, but there was a larger difference on stimuli associated with low frequency homographs. The interaction between stimulus type and frequency was not significant, nor was the three-way interaction between all independent variables. Refer to Table 13 for detailed ANOVA results.

Table 13

ANOVA Results for Error Rate by Stimulus Type, English (L1) Homograph Frequency, and French (L2) Proficiency (n = 36)

Effect	*F*	*df* model	*df* error	*p*-value	*r*
Stimulus Type	1.07	1	34	.31	.17
Frequency	71.43	1	34	< .00	.82
Proficiency	15.56	1	34	< .00	.56
Stimulus Type*Proficiency	5.82	1	34	.02	.38
Frequency*Proficiency	9.39	1	34	< .00	.47
Stimulus Type*Frequency	3.74	1	34	.06	.31
StimType*Freq*Prof	.01	1	34	.92	.06

<u>Hypothesis 3: Relationship Between Self-Reported and Objectively-Measured Proficiency – Main Analysis</u>

The hypothesis that high proficiency participants would rate their French ability more accurately than low proficiency participants was investigated by correlating average self-rated French proficiency and total BVAT French score for the participants in each proficiency group. For the high proficiency group, this correlation was $r = .42$, $p = .06$, whereas for the low proficiency group the variables correlated at $r = .47$, $p = .04$. The difference between these correlations was not significant, $r' = -.17$, $p = .43$.

Hypothesis 3: Relationship Between Self-Reported and Objectively-Measured Proficiency – Additional Analysis

Total BVAT French score multiple regression analysis. To determine which variables or combination of variables were best able to predict the total BVAT French score, a regression analysis was carried out using reading speed, average self-rated proficiency, and age at French acquisition as predictors. No issues with multicollinearity among the predictor variables were apparent, nor were there any issues with normality, heteroscedasticity of error variance, or independence of error.

A stepwise MRA was carried out and the final model retained average self-rated French proficiency and reading speed. This model had a regression coefficient of $R^2 = .54$, meaning that it accounted for approximately 54% of the variance in total BVAT French score. The model was significant in predicting control word errors, $F(2,45) = 25.15$, $f^2 = 1.17$. Adjusted R^2 for the model was .52, producing a shrinkage value of .02. If the model were derived from the population rather than this experimental sample, it would account for approximately 2% less variance. Thus, the model seems quite generalizable to the population. A backward regression analysis was performed to cross validate this model and the same predictors were retained. Refer to Table 14 for details regarding the stepwise regression analysis.

Self-rated French proficiency and reading speed were both significant predictors of total BVAT French score. Self-rated proficiency had a positive relationship with the dependent variable, in that higher self-rated proficiency was associated with higher objective proficiency as measured by the BVAT. Conversely, reading speed had an inverse relationship with total BVAT French score, in that longer reading times were associated with lower BVAT scores. Squared partial correlations indicated that self-rated proficiency accounted for 23% of the variance in total BVAT French score with reading speed removed from the model, whereas reading speed only accounted for 5% of the variance with self-rated proficiency removed from the model.

Table 14

Stepwise Regression Results for Total BVAT French Score Predicted by Average Self-Rated French (L2) Proficiency, Reading Speed, and Age at French Acquisition (n = 46)

	B	*SE B*	β	SR^2
Step 1				
Constant	21.01	17.35		
Average Fr. Proficiency	6.31	1.65	.53*	
Reading Speed	-.25	.122	-.26*	
Age at Fr. Acquisition	-.35	.81	-.06	
Step 2				
Constant	17.77	15.40		
Average Fr. Proficiency	6.64	1.44	.56*	.23
Reading Speed	-.26	.12	-.27*	.05

R^2 = .74 for Step 1; ΔR^2 = -.00 for Step 2 (p = .67). * p < .05

CHAPTER V

DISCUSSION

Summary

Hypothesis 1, which stated that reaction time would be slower when responding to homograph translations than control words, was supported by the results of this study: homograph translations elicited slower reaction times than control words across all analyses. Furthermore, reaction times of high proficiency participants were faster than those of low proficiency participants across most analyses. Reaction times to homograph translations were similar between proficiency groups, but there was a difference in reaction times to control words. Although French homograph frequency did not affect reaction time, stimuli associated with homographs that had low English frequency elicited slower reaction times than those associated with high frequency homographs. English homograph frequency influenced reaction time on homograph translation stimuli more so than control word stimuli.

Hypothesis 2, which stated that low proficiency participants would commit more false negative errors than high proficiency participants on homograph translation stimuli relative to control words, was not supported. Although low proficiency participants made more overall errors than high proficiency participants across all analyses, the discrepancy in error rate by proficiency group was significant for control words but not for homograph translations. Stimulus type was not found to influence error rate directly. Both French and English homograph frequencies influenced error rate, as more errors were committed on stimuli associated with low frequency homographs, regardless of language. Error rates by group differed more on stimuli associated with low frequency English homographs than high frequency English homographs.

Hypothesis 3, which stated that there would be a greater correlation between average self-rated French proficiency and total BVAT French score for high proficiency than low proficiency participants, was not supported.

The Influence of Stimulus Type and L2 Proficiency on Reaction Time

The BIA+ model (Dijkstra & Van Heuven, 2002) was used to make predictions regarding the results of the present experiment. Hypothesis 1 predicted that longer reaction times would be observed in response to homograph translations than control words. Restating the example used in the literature review, when one of the English L1 participants in the present study read the word *pain* (bread) at the end of a priming sentence in L2 French, the letter string *p-a-i-n* was first recognized at the sublexical and orthographic levels (bottom-up), then activation spread to phonological and semantic levels (bottom-up). Since orthographic information was consistent with words in both English and French, phonological and semantic representations were activated in both languages. As participants had L1 English and were more likely to encounter the English reading in their everyday communication, frequency provided support for the English representation (top-down); however, the task/demand system recognized that the context of the task was French and thus the baseline activation for French meanings increased while baseline English activation decreased (top-down). In the end, the correct French meaning was activated and the English meaning was inhibited. This inhibition carried over to the subsequent lexical decision task, so if the homograph translation *douleur*, which has the same semantic representation as the English *pain* was presented, a longer reaction time was elicited because the lingering semantic inhibition had to be overcome before the semantic representation was activated. When the unrelated control word *docteur* was presented, the semantic inhibition did not affect recognition, and hence participants responded more quickly. Participants in the current study responded more quickly to control words than to homograph translations, which is consistent with the predictions of the BIA+ model.

Based on the lack of a significant interaction between stimulus type and proficiency, both groups appeared to experience a similar level of inhibition on homograph translations, a finding which does not seem consistent with the BIA+ theory. This theory, which takes into account top-down effects such as language proficiency, would appear to predict that low proficiency participants should experience more interference from their L1 as words in their L2 have a lower subjective frequency than they would for a high L2 proficiency bilingual. That is, they occur less often in day-to-day life and thus have weaker mental representations. Thus, lower L2 French frequency should translate to greater initial support for the incorrect L1 English meaning of a given interlingual homograph, which would result in more inhibition when the correct L2 French meaning was activated. This should in turn translate to greater slowing in responses to semantically-related homograph translations. The lack of a significant interaction between proficiency and stimulus type is difficult to explain in the context of the BIA+ model. Perhaps the discrepancy in L2 proficiency between the two groups used in this study was not large enough to demonstrate a difference in the influence of L1 on processing in L2, or perhaps the BIA+ model should be modified to better account for proficiency effects. It may be that the language lexicons of a high proficiency bilingual are more closely integrated than those of a low proficiency bilingual and are thus more prone to interference. Another alternative explanation is that the discrepancy in overall bilingual proficiency between proficiency groups in this study, quantified by the total BVAT bilingual score, influenced the results of the L2 proficiency analysis.

The Influence of Stimulus Type and L2 Proficiency on Error Rate

Hypothesis 2, that low proficiency bilinguals compared to high proficiency bilinguals would commit more false negative errors on homograph translation stimuli relative to control words, was not supported by the results of this study. Stimulus type did not directly influence error rate, but interactions between stimulus type and proficiency were observed across analyses. Error rates tended to be similar for homograph translations, but different for control words. Perhaps high proficiency participants made more errors on homograph translations than control words due to semantic interference, though if this were the case greater error rates for both groups would be expected on homograph translations relative to control words. Once again, these results are difficult to interpret based on the BIA+ model.

The Role of L2 Proficiency in Bilingual Processing Across Studies

Overall, the results of the present study do not give a consistent picture of how L2 proficiency influences speed and accuracy in a lexical decision task involving interlingual homographs. The results of other studies taking into account L2 language proficiency have had mixed results. Elston-Güttler and her colleagues (2005a) found that bilinguals with high proficiency in L2 experienced less semantic inhibition than low proficiency bilinguals and suggested that this was the result of greater L2 ability assisting in the suppression of L1 influences. They noted that this could be one aspect of the BIA+

task/decision system. Oi and Saito (2009) obtained similar results in a translation judgment task. Participants were presented with words and an accompanying definition and had to decide whether or not the definition matched the word. Some of the words presented were interlingual homographs or cognates, and two blocks were administered: Japanese (L1) and Chinese (L2). The researchers found that low proficiency bilinguals made more errors than high proficiency bilinguals on interlingual homographs, and interpreted this to mean that high proficiency bilinguals were able to inhibit the influence of their L1 while processing L1. Conversely, Conklin (2005) found no difference in the level of semantic inhibition between two proficiency groups, and Schwartz and Kroll (2006) reported mixed results regarding the performance of the two proficiency groups in their study. Based on the lack of consistent findings regarding the role of L2 proficiency across studies, more work remains to be done in this area.

The Influence of L1 and L2 Homograph Frequency on Reaction Time and Error Rate

The BIA+ model states that top-down factors such as word frequency, task context, and language proficiency may affect processing of bilingual ambiguous words (Dijkstra & Van Heuven, 2002). Thus, it could be extrapolated that words with a higher frequency of occurrence should be processed more quickly, since they are more familiar. As such, if an interlingual homograph read in L2 context had a high frequency in L1, it should have been more difficult to reject and thus should have elicited greater inhibition than a homograph with low L1 frequency. The role of homograph frequency in the reaction time results obtained in this study was difficult to interpret. French homograph frequency did not influence reaction time, whereas English frequency had a significant effect, though this effect was the opposite of what would be expected based on the previously-mentioned interpretation of the BIA+ model, as reaction times were slower following the presentation of low English frequency homographs. The possibility that translations of low frequency English homographs had lower French frequency than translations of high English frequency homographs was considered as an explanation for this. If this were the case, the French frequency of the lexical decision stimuli, not the English frequency of the sentence-ending homographs, may have resulted in slower responses, as stimuli with lower L2 frequency would be less readily identifiable. Indeed, consultation of the Brulex database (Content & Mousty, 1982) showed that five of the six translations of low frequency English homographs retained in the analysis fell in the lower half of the French frequency distribution. Only five of the eight translations of homographs with low French frequency fell in the lower half of the French frequency distribution, which may explain why a similar pattern of results was not observed with French homograph frequencies. It is also possible that the two frequency levels in this stimulus set were not different enough to elicit differences in processing speed and therefore reaction time.

More errors were committed on words associated with translations of homographs which were low frequency in both languages. As with reaction time, this may reflect the fact that the translations and control words associated with low frequency homographs were low frequency themselves, and thus less familiar and more prone to be mistaken as non-words. Homograph frequency may not have been directly influencing response speed and accuracy; further research should be done regarding the role of L1 and L2 word frequency in bilingual processing, and the frequency of all experimental stimuli should be considered when analyzing and interpreting results.

Comparison with Conklin's (2005) Results

In spite of the fact that the lexical decision task used in this study was a modified replication of Conklin's (2005) Experiment 4 with the only alteration being a change in the way sentences were presented, it is difficult to compare the results of the two studies. Conklin did not conduct direct statistical comparisons between the performance of her proficiency groups, and thus her analyses differ from those employed in the present study. Instead, she conducted analyses for each proficiency group separately and compared the results of these analyses to form her conclusions. In addition, based on Conklin's description of her language proficiency groups (L1 French in Quebec with L2 English vs. L1 English in Buffalo with L2 French), it seems likely that the "high" proficiency group in this study has lower L2 proficiency than the one in her study. Unfortunately this cannot be verified, as measures of proficiency used in her study are not comparable to those employed in this study. This once again underscores the need for standardized measures. Briefly, Conklin suggested that both proficiency groups in her study experienced similar levels of inhibition, a finding which was replicated in the present study. She noted that slower reaction times were observed following the presentation of high L1 frequency homographs, whereas in the present study slower reaction times followed the presentation of low L1 frequency homographs.. As noted previously, the results regarding the effect of L1 homograph frequency on reaction time in the present study are at odds with the BIA+ model, as well as Conklin's findings.

Self-reported vs. Objectively-measured L2 Proficiency

As predicted, self-reported French proficiency was significantly correlated with proficiency as measured by total BVAT French score. Self-reported proficiency also significantly predicted objectively-measured proficiency in a regression analysis. These results are consistent with those described in a literature review by Marian and her colleagues (2007) and results obtained by Conklin (2005). However, the expectation that high proficiency participants would make more accurate estimates of their objectively-measured language proficiency than low proficiency participants was not supported. Based on these results, self-report may be an adequate measure of L2 language proficiency for studies involving bilinguals when L2 proficiency is not a key variable of interest, although a thorough language history and objective measures assist in providing additional descriptive information. Even though objective testing may not be necessary to quantify proficiency, it is still important to report detailed information regarding participants' language abilities to allow for comparison between studies with bilinguals of various proficiency levels.

Proficiency and Bilingual Language Processing

Based on the results of the present study, as well as others cited in the preceding literature review (e.g., Elston-Güttler et al., 2005a; Conklin, 2005, Schwartz & Kroll, 2006; Oi & Saito, 2009), it is clear that proficiency plays a role in the bilingual processing of ambiguous words. However, these studies do not directly address the precise nature of this role, nor the underlying mechanisms responsible. Other areas of bilingual research focus more on these questions. Recent work by Bialystok and Viswanathan (2009) addressed the executive functioning abilities of bilingual children as compared to monolingual children (aged 7-9) in a series of experiments using an anti-saccade task which did not draw directly on language abilities. This task provided measures of response suppression, inhibitory control, and cognitive flexibility. Bilingual participants were superior to monolinguals on measures of inhibitory control and cognitive flexibility, and the groups did not differ in terms of response suppression. The researchers interpreted their findings to mean that bilingualism fosters more effective executive functioning abilities. Bialystok and Viswanathan cited other evidence to this effect, noting that previous studies have shown that bilinguals develop executive functioning abilities earlier than monolinguals, have more efficient executive functions as young adults, and show greater maintenance of executive functioning in older age.

Kovács and Mehler (2009) conducted a study which demonstrated that even before verbal abilities are developed, children in bilingual environments have more flexible learning abilities than monolinguals. They attempted to teach 12-month-old infants associations between two types of trisyllabic speech sounds and the location of picture of a toy on a computer screen. If a sound with the syllabic structure ABA (where A and B represent two different syllables) was presented, the toy would appear on the right side, whereas if a sound with an AAB structure was presented, it would appear on the left. Bilingual children made more correct gaze responses than monolinguals after both types of speech sound, while monolinguals made more correct responses to AAB than ABA sounds. This was interpreted to mean that even at a very young age, bilingual children may be better than monolingual children at learning two speech structures simultaneously, or are better able to suppress interference from one structure while learning the other.

It appears that the differences between language processing abilities of high and low L2 proficiency bilinguals may be linked to executive functioning. In a review of relevant literature, Bialystok (2009) stated that bilinguals face a unique problem regarding attentional control, as they must constantly ensure that they are functioning in the correct language. It stands to reason, then, that the improved executive functioning abilities observed in the studies cited above may be the result of this process. If this is the case, differences in brain functioning while processing language should be observed in high and low L2 proficiency bilinguals.

Neural Correlates of Bilingualism

ERP studies provide one avenue of investigation into the neural underpinnings of bilingual language processing. In a recent study, Midgely, Holcomb, and Grainger (2008) found differences in ERP amplitudes when low proficiency bilinguals read words in L1 and L2, but when high proficiency bilinguals were tested, there was little difference between the ERP amplitudes elicited by L1 and L2 stimuli. Midgely and her colleagues suggested that the differences observed in low proficiency participants reflected difficulty processing in L2 relative to L1, whereas high proficiency participants experienced less difficulty and therefore less difference in ERP was observed.

Neuroimaging studies represent a very active area of bilingual research. In a review of literature regarding bilingual language processing, Bialystok (2009) noted that a number of studies have found increased grey matter density in the left inferior parietal lobe in bilinguals relative to monolinguals, and that this increase is larger in earlier and higher L2 proficiency bilinguals. In their review of existing literature, Martin, Dering, Thomas, and Thierry (2008) cited evidence that processing of L1 and L2 in late, lower L2 proficiency bilinguals occurs in non-overlapping areas, whereas in early, higher proficiency bilinguals the areas involved in processing both languages largely overlap.

Yokohama and colleagues (2009) cited evidence that when performing a lexical decision task in L2, low proficiency bilinguals show greater activation of certain brain areas on fMRI relative to high proficiency bilinguals. As with the findings of Liu and colleagues (2010), this finding is generally attributed to the fact that low proficiency bilinguals have to draw upon more cognitive resources to process the less familiar L2, whereas high proficiency individuals were able to process L2 with relative ease. Such findings correspond to slower responses and more errors on the lexical decision task for low proficiency participants. In a recent fMRI study, Yokohama and colleagues (2009) found that low proficiency bilinguals had less activation in the left middle temporal gyrus during lexical decision in L2 relative to high proficiency bilinguals and monolinguals participating in the same task with their L1. They attributed the difficulty experienced by low proficiency bilinguals in lexical decision tasks to this finding, as the left middle temporal gyrus has been associated with processing of words which are stored in the mental lexicon. Yokohama and colleagues concluded that the reduced activity in this region for low proficiency bilinguals reflected a poorly developed L2 lexicon.

A fMRI study by Liu, Hu, Guo, and Peng (2010) showed that, relative to picture naming in L1, picture naming in L2 was associated with increased left hemisphere activity in a number of areas, including the inferior frontal gyrus, cuneus, and precentral gyrus. The recruitment of additional brain areas was interpreted to mean that picture naming is less automatic in L2 than L1 and therefore more neural resources are required. It is of particular note that certain of the brain regions which were more active in low proficiency bilinguals, such as the inferior frontal gyrus, are thought to be associated with executive functioning. A review of bilingual neuroimaging literature conducted by van

Heuven and Dijkstra (2010) cited additional relevant findings. In their review, the authors noted that bilinguals operating in L2 show increased activity in areas associated with executive functions, such as the prefrontal cortex, compared to when they are operating in L1 A greater increase in activation has been observed in low L2 proficiency bilinguals than high L2 proficiency bilinguals. The role of executive functioning in bilingual language processing bears further investigation from neuroimaging, psycholinguistic, and neuropsychological perspectives.

<u>Limitations of the Present Study</u>

There were a number of limitations regarding the statistical procedures employed in this study. Firstly, over one third of the stimuli of interest were omitted from data analysis because a high percentage of participants did not understand them. Although an adequate number of items remained, it would have been preferable to include all of the items. Perhaps the construction and validation of a new, less difficult stimulus set could have prevented this problem. On a related note, the elimination of these items resulted in the inclusion of fewer stimuli based on low frequency homographs than those based on high frequency homographs. In some instances mean correct reaction time scores for low frequency stimuli had to be computed with only 2-3 observations, or could not be calculated at all, which is a less-than-ideal situation. Had more low frequency observations been available for analysis, perhaps the results would have been different. It may have been informative to include the French frequencies of the homograph translations and control words in statistical analyses, in addition to the French and English frequencies of the homographs they were based on. This may have made results for the frequency analyses more interpretable. Finally, as mentioned earlier, the discrepancy in overall verbal ability or verbal intelligence between the two proficiency groups may have had an impact on analyses which were intended to investigate only L2 proficiency.

Strengths of the Present Study

This study investigated language proficiency in greater depth than most others involving bilingual language processing, using standardized self-report and objective measures. A movement toward standardization in the field could allow for more valid comparisons between studies which would assist in elucidating the effects of proficiency level on bilingual language processing. In addition, the proficiency groups used in this study did not differ in terms of language acquisition pattern or geographical location. They all acquired English first and learned French later on, and they were all born and raised in Canada. This allowed for more controlled comparisons between the groups, as factors other than proficiency (e.g., culture) were less of an influence than they might be when groups with drastically differing language histories are compared (e.g., L1 English L2 French individuals in Canada vs. L1 Dutch L2 German individuals in the Netherlands).

Future Directions

The present study explored the processing of ambiguous words (interlingual homographs) in sentential context by bilinguals of varying proficiency levels. Given the mixed results that have been found in this research area regarding the roles of proficiency and word frequency in the processing of ambiguous words, more work remains to be done. Carefully controlled and standardized studies with well-constructed stimulus lists and well-differentiated proficiency groups would be useful in clarifying matters and improving existing models of bilingual language processing. It may also be prudent to investigate the roles of part of speech and word gender in bilingual processing. Certain of the interlingual homographs used in this and other studies are one part of speech in one language, and a different part of speech in another language (e.g., the word *lit* means bed in French and is therefore a noun, whereas it is the past tense of the verb light in English), and this could influence processing. Similarly, some languages assign a gender to nouns, whereas others do not, and differences in this respect across languages could also have an effect on how these words are processed. As the field moves forward, it will also be important to consider bilingual language processing in more naturalistic terms, for instance in paragraphs, larger blocks of text, or conversational context. Furthermore, the integration of behavioural findings with data from neuroimaging studies will be essential in forming fully realized models of bilingual language processing. More work in this area may assist in the development of better strategies for teaching and learning a second language. For example, the use of cognates may be encouraged with early L2 learners, as the facilitation effect would allow these words to be acquired more easily, whereas it may be prudent to avoid interlingual homographs, which could cause confusion.

APPENDICES

APPENDIX A

Glossary of Terms

Ambiguous word: a word with more than one meaning.

Balanced frequency: words which occur at roughly the same rate in a lexicon.

Bilingual: able to speak and understand two languages; or, information concerning two languages (e.g., bilingual ambiguous words are ambiguous across two languages).

Cognates: words which have the same orthography and meaning across two or more languages (e.g., *danger* connotes a sense of hazard in both English and French).

Evoked potential: a method of quantifying brain activity following the presentation of a stimulus by measuring electrical discharges with electrodes placed on the scalp. Varying degrees of nervous system activity have different interpretive values.

Eye-tracking: method of studying reading in which eye movements are tracked to determine how quickly each word is read, how many words are read at a time, and whether readers re-read words or sentences.

Facilitation: a decrease in reaction time as a result of exposure to a certain stimulus.

Frequency: how often a word occurs in a given lexicon (e.g., *the* has a high frequency in English, whereas *onomatopoeia* has a low frequency. This is usually determined through analysis of books, movies, or other media involving the use of many words.

Homographs: words which are spelled the same but have different meanings. They may or may not have the same pronunciation (e.g., *dive* to leap in the water vs. *dive* a run down building, or *dove* the bird vs. *dove* to have previously leapt in the water).

Homonyms: words which have either the same spelling or sound, but different meanings. A given homonym can be a homograph, a homophone or both. In the psychology literature, homonyms refer to words which are spelled and pronounced the same, but have two distinct meanings.

Homophones: words which sound the same but have different meanings. They may or may not be spelled the same (e.g., *bear* the animal vs. *bear* to carry, or *bear* the animal vs. *bare* to expose).

Inhibition: an increase in reaction time as a result of exposure to a certain stimulus; or, the suppression of one of a word's meanings when the other correct meaning is selected.

Interlingual homographs: words which have the same spelling across two languages, but different meanings (e.g., *pain* meaning an unpleasant sensation in English vs. *pain* meaning bread in French).

Lexical decision: a task in which letter strings are presented on computer and participants must decide whether they are words or non-words.

Matched control word: a word that is similar to the stimulus of interest (cognate, homograph, etc.) in a number of aspects (e.g., first letter, length, frequency, part of speech, phonology) but is different in the key aspect of investigation (i.e., is not a cognate or homograph).

Monolingual: able to speak and understand only one language; or, information concerning only one language (e.g., monolingual ambiguous words are ambiguous only in one language).

Orthography: the spelling of words.

Partial cognates: words which have the same meaning and a similar orthography across two languages (e.g., *band* meaning a group of people in English and *banda* meaning the same in Spanish).

Phonology: the way a word sounds or the manner in which it is pronounced.

Proficiency: an individual's overall level of expertise in a given language.

Semantic: refers to a word's meaning.

Translation recognition: a task in which words from two different languages are presented and the participant must decide whether these words have the same meaning.

Word representation: a mental construct explaining how words are stored and accessed in the human brain. Words are thought to have orthographic, phonological, and semantic representations in the brains of individuals who are proficient in reading and understanding speech in a given language.

APPENDIX B

Online Recruitment Ads

Study Name: Second Language Sentence Processing - Screener

Description

The purpose of this screen is to determine your eligibility for inclusion in the study entitled, "Second Language Sentence Processing". This screening is completely non-invasive. If you volunteer to participate, you will be asked to come into the laboratory for approximately 30 minutes in order to complete a screening questionnaire with the examiner. In this questionnaire, you will be asked to provide information about your language history, current language use, and your language proficiency, as well as some demographic information (e.g., age, gender, handedness). The screen is worth 0.5 credits. If you are deemed eligible to continue, and you wish to do so, a separate appointment will be set up for you to come in and take part in the testing session. The testing session takes approximately 1.5 hours and is worth 1.5 credits. The screening will take place in the Centre for Cognition and Function, Room 288, Second Floor Chrysler Hall South at the University of Windsor.

Eligibility Requirements

Participants must have English as a first language and have some French fluency. In addition, participants must not be fluent in any languages other than French or English.

Duration: 30 minutes

Points: 0.5 points

Researchers

Anne Baird
Phone: (519) 253-3000 Ext. 2234
Email: abaird@uwindsor.ca

Jordan Urlacher
Phone: (519) 566-3986
Email: urlache@uwindsor.ca

Participant Sign-Up Deadline

24 hours before the study is to occur

Study Name: Second Language Sentence Processing – Testing Session

Description

This study investigates the relationship between second language proficiency and the ability to process sentences in the second language. If you volunteer to participate in this study you will be given a language proficiency test which covers both French and English abilities. You will then read French sentences on a computer and be asked to judge whether a letter string presented after each sentence is a real word or a non-word. The session will take approximately 90 minutes to complete.

Sign-Up Restrictions

Must have completed ALL of these studies:

- Second Language Sentence Processing – Testing Session

Eligibility Requirements

Participants must have English as a first language and have some French fluency. In addition, participants must not be fluent in any languages other than French or English.

Duration: 90 minutes

Points: 1.5 points

Researchers

Anne Baird
Phone: (519) 253-3000 Ext. 2234
Email: abaird@uwindsor.ca

Jordan Urlacher
Phone: (519) 566-3986
Email: urlache@uwindsor.ca

Participant Sign-Up Deadline

24 hours before the study is to occur

APPENDIX C

Consent Forms

CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: Second Language Sentence Processing – Screening Questionnaire

You are asked to participate in a research study conducted by Jordan Urlacher (graduate student), and Dr. Anne Baird (faculty supervisor) , members of the Psychology Department at the University of Windsor. The results of this study will contribute to the student investigator's Masters thesis.

If you have any questions or concerns about this research, please feel to contact Jordan Urlacher at (519)566-3986, or via email at urlache@uwindsor.ca, or Dr. Anne Baird at (519) 253-3000 Ext. 2234 or via email at: abaird@uwindsor.ca

PURPOSE OF THE STUDY

The purpose of this study is to investigate the manner in which people with different levels of French proficiency process sentences in French. This screening component is intended to assist us in finding appropriate participants for further involvement in the study.

PROCEDURES

If you volunteer to participate in this study, we would ask you to:

- Complete a two-page questionnaire regarding your language use, proficiency, and background.

You may also be contacted to engage in two follow-up tasks at a later date:

- Engage in a language ability test which will assess your French and English proficiency.
- Perform a computerized reaction time test in which you will read sentences in French on the computer screen and identify whether letter strings following each sentence or words or non-words.

Completion of the screening questionnaire is anticipated to take 30 minutes. The follow-up appointment would take 90 minutes. All components of the study will be completed in the Centre for Cognition and Function, Room 288, Second Floor Chrysler Hall South at the University of Windsor.

POTENTIAL RISKS AND DISCOMFORTS

We do not expect that you will experience physical or psychological discomfort or harm in completing the questionnaire. The risks associated with the procedures used in the follow-up portion of the study are no greater than those associated with using a computer or participating in a conversation. However, it is possible that some participants may be embarrassed if they feel their performance on the language ability test is poor. Be aware that participants with a variety of language abilities must be included in this study, and that everyone has their individual strengths and weaknesses. Even if you feel that your performance is poor, you are still contributing to the study.

In addition, there is the possibility of visual fatigue from looking at the computer screen or finger fatigue from pressing keys repeatedly during the computerized portion of the study. Breaks will be provided throughout the computer task in order to alleviate fatigue.

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

Participation in the follow-up component of this study will provide you with exposure to language testing instruments and procedures used in a cognitive research lab. This may contribute to your understanding of psychological assessment and research. No other individual benefits are expected. The results of this study may contribute to theoretical models of bilingual language processing and may have implications for second language teaching and learning. They will also assist in the development of language proficiency questionnaires and test instruments.

PAYMENT FOR PARTICIPATION

Participants will receive 0.5 bonus points for 30 minutes of participation towards the psychology participant pool, if registered in the pool and enrolled in one or more eligible courses.. Credits can be applied toward your grades in psychology courses at the end of the term for bonus marks.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. In order to ensure your confidentiality, you will be assigned a random identification number when you begin the study. No documentation aside from the Consent Form and the list of identification numbers will include your name, and these documents will be stored separately from the rest of the forms used in this study (questionnaires, test protocols) to ensure that your name is not associated with your identification number. If you are selected for follow-up testing, you will be contacted via the email address associated with your Participant Pool account. All paper documentation regarding this study will be kept behind locked doors in the Centre for Cognition and Function. All electronic documentation will only refer to you by your identification number, and electronic documentation will be stored on password-protected computers in the Centre for Cognition and Function. Within five years of the last publication from this study, paper documentation will be destroyed through the University of Windsor's confidential shredding service, and all relevant electronic files will be deleted.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time, and you will receive credit for the time which you have spent engaging in the study. You may also refuse to answer any questions you do not want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so. You will be able to ask that the data regarding your participation be withdrawn up to the point that the data is entered into a computer database (approximately one month afterward).

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE SUBJECTS

A summary of the results of this study will be made available at the following internet address in approximately August of 2010.

Web address: www.uwindsor.ca/reb

SUBSEQUENT USE OF DATA

The data obtained in this study may be used in subsequent studies.

RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. If you have questions regarding your rights as a research subject, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF RESEARCH SUBJECT/LEGAL REPRESENTATIVE

I understand the information provided for the study *Second Language Sentence Processing* as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

____
Name of Subject

_____________________________________ ____________________
Signature of Subject Date

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____________________________________ ____________________
Signature of Investigator Date

University of Windsor

CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: Second Language Sentence Processing – Testing Session

You are asked to participate in a research study conducted by Jordan Urlacher (graduate student), and Dr. Anne Baird (faculty supervisor) , members of the Psychology Department at the University of Windsor. The results of this study will contribute to the student investigator's Masters thesis.

If you have any questions or concerns about this research, please feel to contact Jordan Urlacher at (519)566-3986, or via email at urlache@uwindsor.ca, or Dr. Anne Baird at (519) 253-3000 Ext. 2234 or via email at: abaird@uwindsor.ca

PURPOSE OF THE STUDY

The purpose of this study is to investigate the manner in which people with different levels of French proficiency process sentences in French.

PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following two things, one at a time, during one session:

(1) Engage in a language ability test which will assess your French and English proficiency.
(2) Perform a computerized reaction time test in which you will read sentences in French on the computer screen and identify whether letter strings following each sentence or words or non-words.

The total time of participation in this study is anticipated to be 1.5 hours. All components of the study will be conducted in the Centre for Cognition and Function, Room 288, Second Floor Chrysler Hall South at the University of Windsor.

POTENTIAL RISKS AND DISCOMFORTS

We do not expect that you will experience physical or psychological discomfort or harm – the risks associated with the procedures used in this study are no greater than those associated with using a computer or participating in a conversation. However, it is possible that some participants may be embarrassed if they feel their performance on the language ability test is poor. Be aware that participants with a variety of language abilities must be included in this study, and that everyone has their individual strengths and weaknesses. Even if you feel that your performance is poor, you are still contributing to the study.

In addition, there is the possibility of visual fatigue from looking at the computer screen or finger fatigue from pressing keys repeatedly during the computerized portion of the study. Breaks will be provided throughout the computer task in order to alleviate fatigue.

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

Participation in this study will provide you with exposure to language testing instruments and procedures used in a cognitive research lab. This may contribute to your understanding of psychological assessment and research. No other individual benefits are expected. The results of this study may contribute to theoretical models of bilingual language processing and may have implications for second language teaching and learning. They will also assist in the development of language proficiency questionnaires and test instruments.

PAYMENT FOR PARTICIPATION

Participants will receive 1.5 bonus points for 90 minutes of participation towards the psychology participant pool, if registered in the pool and enrolled in one or more eligible courses. Credits can be applied toward your grades in psychology courses at the end of the term for bonus marks.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. In order to ensure your confidentiality, you will be assigned a random identification number when you begin the study. No documentation aside from the Consent Form and the list of identification numbers will include your name, and these documents will be stored separately from the rest of the forms used in this study (questionnaires, test protocols) to ensure that your name is not associated with your identification number. All paper documentation regarding this study will be kept behind locked doors in the Centre for Cognition and Function. All electronic documentation will only refer to you by your identification number, and electronic documentation will be stored on password-protected computers in the Centre for Cognition and Function. Within five years of the last publication from this study, paper documentation will be destroyed through the University of Windsor's confidential shredding service, and all relevant electronic files will be deleted.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time, and you will receive credit for the time which you have spent engaging in the study. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so. You will be able to ask that the data regarding your participation be withdrawn up to the point that the data is entered into a computer database (approximately one month afterward).

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE SUBJECTS

A summary of the results of this study will be made available at the following internet address in approximately August of 2010.

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SUBSEQUENT USE OF DATA

The data obtained in this study may be used in subsequent studies.

RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. If you have questions regarding your rights as a research subject, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF RESEARCH SUBJECT/LEGAL REPRESENTATIVE

I understand the information provided for the study *Second Language Sentence Processing* as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

____
Name of Subject

______________________________________ ____________________
Signature of Subject Date

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____________________________________ ____________________
Signature of Investigator Date

APPENDIX D

Selected Materials Used in Study

Participant ID# _____

Reading Speed Form

J'ai ainsi vécu seul, sans personne avec qui parler véritablement, jusqu'à une panne dans le désert du Sahara, il y a six ans. Quelque chose s'était cassé dans mon moteur. Et comme je n'avais avec moi ni mécanicien, ni passagers, je me préparai à essayer de réussir, tout seul, une réparation difficile. C'était pour moi une question de vie ou de mort. J'avais à peine de l'eau à boire pour huit jours.

Le premier soir je me suis donc endormi sur le sable à mille milles de toute terre habitée. J'étais bien plus isolé qu'un naufragé sur un radeau au milieu de l'océan. Alors vous imaginez ma surprise, au lever du jour, quand une drôle de petite voix m'a réveillé. Elle disait: "S'il vous plaît... dessine-moi un mouton!"

Time to complete: _________

Number of errors: _________

Participant ID# _____

Sentence Comprehension Form

Instructions: circle any words you do not understand in the context of each sentence.

Jacques avait toutes sortes de choses dans sa cave, y compris une bride.
A travers la chemise de Marie, on apercevait sa chair.
Patricia n'aime pas mon fils, mais elle aime mon chat.
Il faut dire au moins une chose.
La boulangerie se trouve au coin.
Son discours est beaucoup trop court.
Le bébé a eu sa première dent.
Avant de se coucher, il regarde sa figure.
Pour comprendre le film, il faut attendre la fin.
Michel veut acheter un nouveau four.
Le vendeur nous conseilla d'examiner la lame.
Ce camion rouge est beaucoup trop lent.
Isabelle a acheté un nouveau lit.
Au parc, il y a une mare.
Cette femme-là est très mince.
Ce genre d'histoires, ce n'est pas très net.
Au parc, Clotilde a vu un ours.
Demain, on doit acheter du pain.
Les jeunes, ça aime voir du pays.
Ce soir, on a vu une très bonne pièce.
Luc aime bien cette pub.
Madeleine porte toujours le même pull.
Au milieu de sa main, Cécile avait une grande ride.
L'année dernière, l'hiver a été très rude.
La maison de Jean est vraiment très sale.
Là-bas, il y a du sang.
François veut avoir un singe.
L'enfant n'aime pas son slip.
Les enfants, plus aucun son.
Phillipe a un mauvais sort.
En avril, Mirelle va faire un stage.
A Buffalo, il fait souvent du vent.

SEE REVERSE SIDE FOR SECOND PART OF TASK

Participant ID# _____

Word Comprehension Form

Instructions: circle any words you do not understand.

mariée	maïs
chaise	chapeau
bavarder	bousculer
choisit	réussit
monnaie	montre
terrain	tendance
bosse	bordel
silhouette	simplicité
nageoire	nettoyage
quatre	quotidien
boiteux	blaguer
prêté	prévu
allumé	attiré
jument	jumelle
hacher	héberger
filet	flèche
nôtre	nonne
douleur	docteur
payer	préférer
morceau	mouton
bar	jupe
tirer	tomber
promener	partager
impoli	imprévu
vente	vague
chanta	cacha
roussir	rajouter
glisser	gagner
fils	façon
classer	circuler
scène	salon
ouverture	obéissance

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