Individual Differences in Second-Language Reading Skill: Understanding the Role of Cross-Linguistic Interactions

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Abstract

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Despite substantial evidence demonstrating the existence of cross-linguistic interactions during second-language (L2) use, current models of L2 reading still lack an emphasis on the role of this unique predictor. The goal of this dissertation was to address this gap in the literature by testing a novel model of L2 reading in which individual differences in cross-linguistic interactions, and the predictors of such interactions, were investigated using structural equation modeling. In particular, it was hypothesized that increased first-language (L1) to L2 cross-linguistic interactions creates additional demands on the reader, and therefore results in poorer L2 reading skill. In support of this hypothesis, the findings revealed that L1 to L2 interactions negatively contributed to L2 reading skill. In addition, both variability in relative L1 to L2 proficiency and non-linguistic conflict management skills were shown to contribute to individual differences in L1 to L2 interactions. These results are important as they fill a critical gap in the current L2 reading literature, and provide a foundation on which both future work exploring the unique predictors of L2 reading skill and targeted L2 reading interventions can be built upon.

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Chapter 1. Introduction

Reading is a highly complex, learned skill that is critical to functioning in modern society. Its complexity is driven by the fact that reading requires successful integration between many disparate systems (e.g., visual, linguistic, memory, and executive systems). As a consequence, large individual differences have been observed in reading skill, even among highly practiced adults (e.g., Bell & Perfetti, 1994; Daneman & Carpenter, 1980; Just & Carpenter, 1992; Long, Prat, Johns, Morris, & Jonathan, 2008). Importantly, a significant amount of research has shown that these individual differences predict critical academic (e.g., Jackson, 1955; Robertson & Harrison, 1960; Vineyard & Bailey, 1960), economic (e.g., Raudenbush & Kasim, 1998), and health (e.g., DeWalt, Berkman, Sheridan, Lohr, & Pignone, 2004) outcomes. This line of work has fueled a complementary line of research aimed at understanding the source, or sources, of individual differences in reading skill.

Much of this research has focused on variability in native language (L1) reading, particularly among English monolingual readers. However, according to the U.S. Census Bureau, the number of second-language (L2) English speakers, as indexed by the number of individuals for whom a language other than English is spoken at home, has risen steadily over the last few decades (1990: 13.82%, 2000: 17.89%, 2013: 20.71% of the U.S. population; U.S. Census Bureau, 1992; 2003; 2015). Thus, it is becoming increasingly important to improve our understanding of the factors that contribute to variability in bilingual reading skill, and in particular, L2 reading skill.

Thus far, investigators have tried to leverage what is known about individual differences in L1 reading skill to understand variability in L2 reading skill. In fact, in a recent meta-analysis, Jeon and Yamashita (2014) found that three primary factors have been explored in the L2 reading literature: (1) language proficiency (L2 vocabulary knowledge, L2 grammar knowledge, L2 morphological knowledge, and L2 listening comprehension), (2) reading sub-component processes (L2 phonological awareness, L2 orthographic knowledge, L2 decoding skill, and L1 reading comprehension skill) and (3) non-linguistic cognitive support processes (working memory and metacognitive skill); each of which has also been shown to be a predictor of L1 reading skill (e.g., Bell & Perfetti, 1994; Just & Carpenter, 1992; Stanovich, 1982). While this approach has been highly informative, it lacks an emphasis on the factors that may be *unique* to L2 reading. In particular, previous work has demonstrated that L2 readers not only co-activate both L1 and L2 representations while reading in their L2, but also that these co-activated L1 representations interact with L2 representations and influence L2 processing (e.g., Bijeljac-Babic, Biardeau, & Grainger, 1997; Chen & Ho, 1986; Fang, Tzeng, & Alva, 1981; Preston & Lambert, 1969; van Heuven, Dijkstra, & Grainger, 1998). Thus, I hypothesized that L2 readers experience additional demands associated with managing these cross-linguistic interactions during reading, which consequently contribute to individual differences in L2 reading skill. Consistent with this view, in a comprehensive review of L2 reading research, Koda (2007) emphasized the need to consider the *dual-language* experiences of bilingual readers in future models of L2 reading. The current study accomplishes this goal through the development and testing of a novel model of L2 reading, which focuses on the role of cross-linguistic interactions.

1.1. The Bilingual Mental Lexicon

The concept of cross-linguistic interactions is inherently constrained by assumptions about the structure and function of the bilingual mental lexicon. The empirical literature has primarily focused on two dimensions of the bilingual lexicon: 1) the structure of the lexicon, and 2) the nature of access within the lexicon. In particular, researchers have either argued for separate language-specific lexicons, with language selective access (i.e., the selective hypothesis) or an integrated lexicon, with language non-selective access (i.e., the non-selective hypothesis). According to the selective hypothesis, lexical entities are stored within separate bilingual mental lexicons established for each language. Under this model, word recognition and lexical access occur only within a particular language, limiting the potential for cross-linguistic interactions. Alternatively, according to the non-selective hypothesis, the mental lexicons associated with each of a bilingual's languages are integrated, and access within them occurs in parallel across both languages. This co-activation of languages is what creates the potential for cross-linguistic interactions. Two of the most prominent models characterizing the bilingual lexicon, the Revised Hierarchical Model (RHM; Kroll & Stewart, 1994) and the Bilingual Interactive Activation Model (BIA; Dijkstra & van Heuven, 1998; Grainger & Dijkstra, 1992), vary in their hypotheses regarding the selective vs. non-selective debate.

1.1.1. The Revised Hierarchical Model. According to the RHM (Kroll & Stewart, 1994; based on previous hierarchical models, Potter, So, Von Eckardt, & Feldman, 1984), the bilingual lexicon is hierarchically composed of independent lexical, or word form, representations for each language and an integrated conceptual, or meaning, system. The core feature of the RHM (Kroll & Stewart, 1994) is the proposed dynamic development of the connections between the lexical and conceptual systems as a learner becomes more proficient in their L2. The RHM (Kroll & Stewart, 1994) starts with the assumption that there are strong established connections between L1 word form representations and the conceptual system. Early in L2 development, before established connections are developed between L2 word form representations and their associated meanings in the conceptual system, the RHM (Kroll & Stewart, 1994) proposes that access to L2 meanings are acquired through direct word form links from L2 to L1. More specifically, the RHM (Kroll & Stewart, 1994) argues that L2 word form inputs activate translation equivalents in the L1 lexical system, which are then used to access associated meanings in the conceptual system. As proficiency in an L2 develops, the strength of the connections between the L2 lexical system and the conceptual system increases, eventually leading to a decrease in the reliance on the L2-to-L1 lexically mediated process and an increase in the use of direct L2 word-to-meaning connections (see Figure 1). Thus, the RHM (Kroll & Stewart, 1994) proposes language-specific lexicons and, at least for proficient bilinguals, relatively selective access between word forms and meanings in a particular language (i.e., consistent with the selective hypothesis).

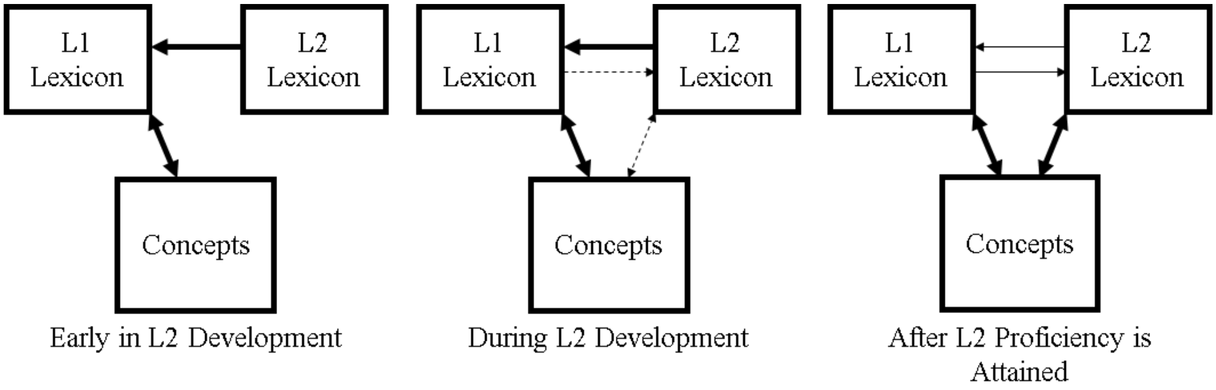


Figure 1. Revised Hierarchical Model (adapted from Kroll and Stewart, 1994).

The majority of evidence in favor of the RHM (Kroll & Stewart, 1994) has focused on the transition stage between early L2 development and later attainment of L2 proficiency. During this stage, the RHM (Kroll & Stewart, 1994) proposes an asymmetry between the word form and meaning connections within the bilingual lexicon. Specifically, the RHM (Kroll & Stewart, 1994) hypothesizes that the lexical link from L2 to L1 is much stronger than the lexical link from L1 to L2, mirroring the direction of transfer during L2 acquisition. Similarly, the RHM (Kroll & Stewart, 1994) hypothesizes that the conceptual link between L1 word forms and their associated meanings within the conceptual system is much stronger than the corresponding link between L2 word forms and the conceptual system, mirroring the established proficiency in L1 versus the developing proficiency in L2. This hypothesized asymmetry results in a series of predictions regarding the particular "path" accessed during L1 versus L2 word processing.

A central tenet behind the predictions generated from the RHM (Kroll & Stewart, 1994) is that interference at the conceptual level (e.g., semantic interference) will only occur when sustained access to the conceptual system leads to the activation of multiple conceptual representations, and associated lexical alternatives, which compete for selection. Thus, the potential for this interference to occur differs based on the particular linguistic task being completed, in so much as the task demands differ in their reliance on accessing conceptual representations. For example, the RHM (Kroll & Stewart, 1994) predicts that word naming, regardless of the language, relies on word form representations and thus is not susceptible to semantic interference. Driven by the strong lexical link from L2 to L1 representations, the RHM (Kroll & Stewart, 1994) similarly predicts that translating from L2 to L1 will utilizes access to word form representations and thus will not activate conceptual representations or be affected by semantic interference. Alternatively, the RHM (Kroll & Stewart, 1994) predicts that translating from L1 to L2 is driven by the strong connection between L1 word form representations and the conceptual system. Thus, forward translation (from L1 to L2) is predicted to be "conceptually mediated," meaning that it relies on access to the conceptual system, and is thus susceptible to semantic interference. To test this prediction, Kroll and Stewart (1994) had Dutch-English bilinguals name or translate lists of words in blocks of English naming, Dutch naming, L1 to L2 forward translating, or L2 to L1 backward translating. Critically, the lists were composed of either items from the same semantic category or a random set of items. If sustained access to the conceptual system leads to semantic interference, then a list type effect, with longer reaction times for semantically categorized lists versus random lists, would be expected in the forward translation condition only. This pattern of results is exactly what Kroll and Stewart (1994) observed, supporting both their predictions and the RHM.

1.1.2. The Bilingual Interactive Activation Model. The Bilingual Interactive Activation (BIA) model (Dijkstra & van Heuven, 1998; Grainger & Dijkstra, 1992) proposes an integrated lexicon, with parallel access across both languages (consistent with the non-selective hypothesis). Similar to the RHM (Kroll & Stewart, 1994), the BIA model (Dijkstra & van Heuven, 1998; Grainger & Dijkstra, 1992) hypothesizes a hierarchical structure within the bilingual lexicon. According to the BIA model (which extended the Monolingual Interactive Activation model, McClelland & Rumelhart, 1981), the bilingual lexicon is organized into layers that correspond to different representational units: visual features, letters, or words. These layers are neutral to the language in use. The representational codes within each layer are assumed to have a particular level of resting activation, based on features like frequency, recency of use, and language proficiency. When a visual input string is presented to the system, the activation levels for features that match that input string are increased, this process continues up the hierarchy until a set of lexical candidates are activated and compete for selection. Within and between each layer, activation of particular codes suppresses activation of competing codes, ultimately allowing for one lexical candidate to surpass an activation threshold, be selected, and facilitate the processing of the word.

With the exception of the integrated dual-language lexicon, the major extension of the BIA model (Dijkstra & van Heuven, 1998; Grainger & Dijkstra, 1992) from the previously proposed monolingual version (McClelland & Rumelhart, 1981), was the addition of the two "language nodes." In the BIA model, the language nodes play several roles that ultimately facilitate accurate word processing. For example, according to the BIA model, activated words from a particular language send activation up to their corresponding language node. This activity then initiates inhibition of all linguistic codes from the other language. In this way, the activation level of a language node represents the global amount of activation within each language. In addition to these linguistic functions (serving as a language tag, "collecting" global activity in a lexicon, and using inhibition to function as a language filter), Dijkstra and van Heuven (1998) propose that the language nodes play an additional non-linguistic function. Specifically, the authors argue that the language nodes not only collect linguistic activation, but also non-linguistic context activation that allows for the top-down influence of factors like task design and participant expectations.

While simulations derived from the BIA model have been able to accurately capture patterns of performance observed on bilingual lexico-semantic tasks (to be described below), several limitations were identified with this original model. Among the limitations, the two most prominent were a lack of phonological or semantic representations in the simulated bilingual lexicon (the BIA focused on the processing of orthographic features only) and an under-specified account regarding how linguistic and non-linguistic contexts affect bilingual language processing (the BIA model assumed both types of contextual cues influence activation in the language nodes). To address these limitations, the authors of the BIA model (Dijkstra & van Heuven, 1998; Grainger & Dijkstra, 1992) developed the BIA+ model (Dijkstra & van Heuven, 2002; see Figure 2). In addition to expanding the linguistic features represented within the bilingual lexicon (e.g., orthographic, phonological, and semantic codes), the BIA+ model also outlined a distinction between a word identification system and a task schema/decision system. Under the BIA+ model, the functioning of the word identification system is essentially identical to the functioning of the previously specified BIA lexicon (with the exception of the additional phonological and semantic codes in the BIA+ model). Specifically, within the identification system, there is a proposed hierarchy of layers for specific linguistic features through which activation spreads and is suppressed based on correspondence between the lexical input and the particular linguistic code. The critical difference between the BIA and BIA+ model, is the addition of the task decision system. The task decision system, which was heavily influenced by the Inhibitory Control model (Green, 1998), proposes an inhibitory mechanism through which bilingual individuals exert control over their lexico-semantic system. Under the original BIA model (Dijkstra & van Heuven, 1998; Grainger & Dijkstra, 1992), activation in the language nodes was proposed to be influenced by both bottom-up linguistic information and top-down contextual information regarding the task design, task goals, and participant expectations. In the BIA+ model, the language nodes still function to specify language membership and activation within the nodes still represent global activation in the lexicon. However, the nodes no longer play a language filtering role or take into account non-linguistic contextual information. Instead, information from the word identification system and non-linguistic contextual information is fed into the task decision system which affects the output of the word identification system before a response is made.

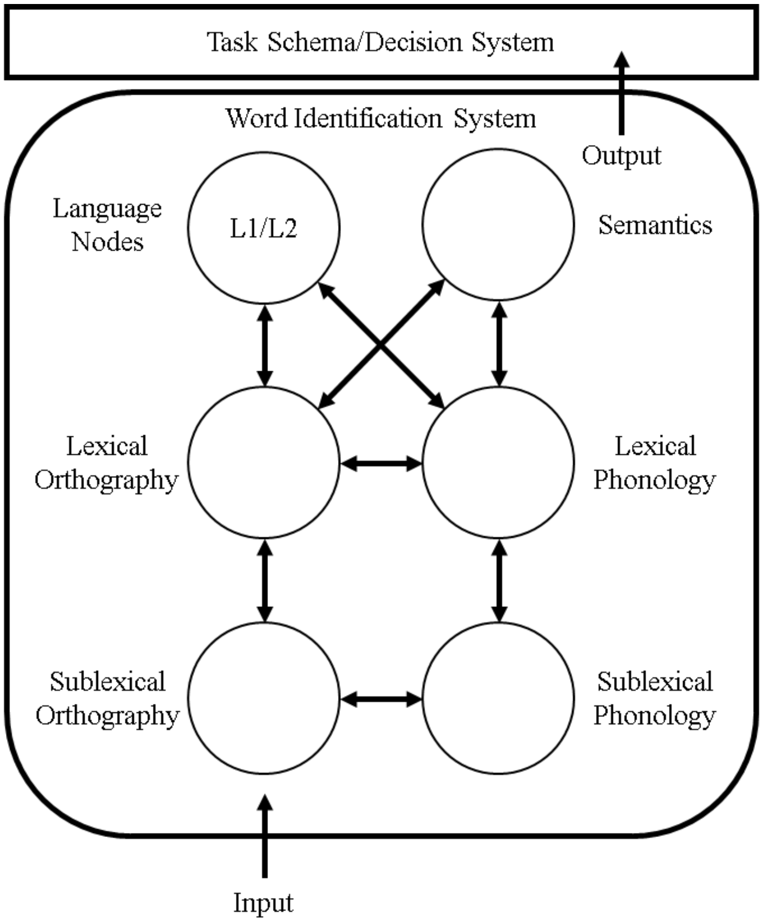


Figure 2. Bilingual Interactive Activation+ Model (adapted from Dijkstra and van Heuven, 2002).

Support for the BIA/BIA+ models (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992) has primarily come from simulation studies in which the models have been able to accurately account for empirical findings within the bilingual literature (e.g., Dijkstra & van Heuven, 1998; Dijkstra, Van Jaarsveld, & Ten Brinke, 1998; van Heuven, Dijkstra, & Grainger, 1998). In an effort to both highlight these studies, as well as to demonstrate more global evidence for the non-selective hypothesis, the following section will outline two lines of research: (1) evidence for language non-selective access and (2) evidence for an integrated bilingual lexicon.

1.1.3. Empirical evidence for language non-selective access. Language non-selective access assumes activation of all relevant lexical candidates, within a bilingual's lexicon(s), regardless of the language in use. According to the BIA/BIA+ models (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992), a lexical candidate would be relevant if any feature of that code matches any feature of the input or other activated lexical codes (e.g., orthographic, phonological, or semantic similarity). This is in contrast to language selective access, which assumes only relevant lexical candidates of the language in use will be activated by an input of a particular language.

From the monolingual literature, it is well established that multiple lexical alternatives can be activated in response to a particular linguistic input and furthermore, that the activation of alternatives can influence the processing of subsequent inputs (e.g., Collins & Loftus, 1975). For example, if a target word (e.g., DOG) is preceded by a semantically related prime word (e.g., CAT), the processing of that target will be facilitated. The assumption behind this priming effect is that the processing of the prime activates lexical alternatives that are related to the prime (including the target word). When the processing of the target word begins, there is already pre-activation above its resting activation level which decreases the time necessary to reach the activation threshold for response selection. Within the bilingual domain, if access is selective then a prime should only impact a related target in the same language. However, if access is non-selective then the processing of a prime in one language could influence the processing of a related target in another language. Using a masked orthographic priming design, Bijeljac-Babic, Biardeau, and Grainger (1997) investigated these hypotheses directly. Across two experiments, participants were asked to complete a lexical decision task. Unbeknownst to the participants, a subconsciously processed prime was presented before each target word. Critically, the prime was either an orthographically unrelated word in the target language (e.g., English; rich - HELM) or the non-target language (e.g., French; acte - JOIN) or an orthographically related word in the target language (e.g., English; help - HELM) or the non-target language (e.g., French; joie - JOIN). The authors found that target words preceded by orthographically related primes, regardless of the language the prime was presented in, were responded to more slowly than those preceded by an unrelated prime. The fact that the non-target language was irrelevant to the task (participants were unaware that any stimuli was presented in the non-target language) and yet effects of the non-target language prime were observed, provides strong evidence for the language non-selective hypothesis. Importantly for the BIA/BIA+ models, this pattern of an inhibitory priming effect for orthographically similar primes has been accurately simulated using the parameters of the BIA/BIA+ models (Dijkstra, Van Jaarsveld, & Ten Brinke, 1998).

1.1.4. Empirical evidence for an integrated lexicon. The effects observed in cross-linguistic prime-target studies, such as the one previously described, provide strong evidence for non-selective access. However, given that competition between lexical candidates can occur outside of the lexicon, at the level of response selection, these studies cannot provide insight into the question of separate versus integrated bilingual lexicons. Specifically, it is possible that parallel activation of lexical alternatives within two separate lexicons could produce multiple potential lexical candidates which then compete for selection in an external task decision system. This competition could result in the observation of cross-linguistic effects. For example, if the alternative produced by the non-target lexicon was very similar to the correct alternative produced by the target lexicon this may cause interference which would potentially manifest as slower reaction times or decreased accuracy (e.g., target word = ROPE, non-target co-activated alternative = ROPA, meaning clothes in Spanish). In an effort to circumvent this problem, investigators have explored cross-linguistic effects in linguistic processes that are assumed to occur within the lexicon. For example, researchers have investigated cross-linguistic neighborhood density effects in bilingual word processing, as the influence of neighborhood density is assumed to arise early in word identification. Neighborhood density reflects the number of words that vary from a target word by one feature. For instance, a word with a high orthographic neighborhood density has many more words that vary by one letter (respecting word length and letter position) than a word with a low orthographic neighborhood density. Research within the monolingual domain has demonstrated that variability in orthographic neighborhood size influences word processing (e.g., Andrews, 1989; Grainger, O'regan, Jacobs, & Segui, 1989; Grainger, & Segui, 1990). However, whether increasing orthographic neighborhood size facilitates or inhibits word processing depends on the particular task design, goals, and demands (e.g., Snodgrass & Mintzer, 1993). Within the bilingual domain, if bilingual individuals possess two independent, language-specific lexicons, then the estimation and influence of neighborhood size should be isolated to each particular language. Alternatively, if bilingual individuals possess an integrated lexicon then neighborhood size should be estimated across languages and cross-linguistic influences of neighborhood size should be observable. van Heuven, Dijkstra, and Grainger (1998) explored theses hypotheses using progressive demasking and lexical decision tasks. In progressive demasking tasks, a word is initially presented for a short duration followed by a mask. Over the course of the trial, the presentation of the word and mask continue to alternate until the participant indicates that they have identified the word (usually with a button press). Each time the word and mask are presented, the presentation time for the word is increased and the presentation time for the mask is decreased. Thus, over the course of a trial, the presentation duration of the word increases making it easier for identification. Across four experiments, Dutch-English bilinguals were asked to identify or perform a lexical decision on English and Dutch words (and nonwords for the lexical decision tasks). As would be predicted based on findings within the monolingual literature, the authors found evidence for a within-language effect of neighborhood size, such that across all experiments Dutch words with higher Dutch neighborhood densities were responded to much slower than Dutch words with lower Dutch neighborhood densities and English words with higher English neighborhood densities were responded to much faster than English words with lower English neighborhood densities. More importantly for the current study, van Heuven, Dijkstra, and Grainger (1998) also observed cross-linguistic neighborhood effects. Again consistently across all four experiments, the authors found that Dutch words with higher English neighborhood densities were responded to much slower than Dutch words with lower English neighborhood densities and English words with higher Dutch neighborhood densities were responded to much slower than English words with lower Dutch neighborhood densities. Given that the effects of neighborhood density are thought to arise within the lexicon, during early word identification, these results provide critical support for the integrated lexicon hypothesis. It is also important to note that these results additionally provide evidence for non-selective access. Notably for the BIA/BIA+ models, simulations using the parameters of the BIA/BIA+ models have been able to replicate the observed facilitatory and inhibitory effects of within- and between-language neighborhood density size (van Heuven, Dijkstra, & Grainger, 1998).

For the purposes of the current study, there are two aspect of the previously outlined literature that are critical for the hypotheses tested. First, empirical evidence suggests that the bilingual mental lexicon is organized in a language independent manner, with non-selective access. This structure provides the foundation on which cross-linguistic interactions can occur. In the following sections, I will describe the nature of these cross-linguistic interactions, including a discussion of the factors that contribute to variability in the amount of interaction experienced and the mechanisms through which L2 readers control these interaction. Second, both the RHM (Kroll & Stewart, 1994) and BIA/BIA+ models (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992) propose asymmetrical interactions between L1 and L2 representations (particularly for those with unbalanced proficiency or language dominance). For example, the BIA/BIA+ models propose that cross-linguistic effects will be stronger from L1 to L2 because L2 representations generally have lower subjective frequencies (due to decreased exposure to the L2) and thus are activated somewhat more slowly than L1 representations (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992). This hypothesis provides the foundation for the central prediction in the current study. In particular, the model tested herein will investigate the prediction that managing cross-linguistic interactions from L1 to L2 will be particularly important during L2 reading.

1.2. The Nature of Cross-Linguistic Interactions

Within the monolingual literature, it is well established that factors related to frequency of occurrence and linguistic context (e.g., semantic or syntactic constraint) affect the activation patterns of lexical alternatives during instances of within-language ambiguity (e.g., He went to the *bank*; Simpson, 1981; Simpson & Burgess, 1985; Tabossi, 1988; Tabossi & Zardon, 1993). Degani and Tokowicz (2010) review and extend these lines of research by exploring these factors within the domain of cross-linguistic ambiguity. According to the three-factor model that Degani and Tokowicz (2010) propose in their review, the nature of cross-linguistic interactions is primarily governed by three factors: frequency, linguistic context, and language context. The role that each of these factors, as well as two additional factors (task demands and language similarity), play in influencing the activation patterns of cross-linguistic lexical alternatives are reviewed in the sections that follow.

1.2.1. The role of frequency. Higher frequency words have consistently been shown to be processed (and presumably accessed) more quickly than lower frequency words (e.g., Forster & Chambers, 1973; Howes & Solomon, 1951; McGinnies, Comer, & Lacey, 1952; Preston, 1935; Whaley, 1978). Furthermore, in instances of ambiguity, when a word may have multiple meanings with different associated frequencies, the higher frequency meaning is often given priority over the lower frequency meaning (particularly in the absence of contextual bias). For bilingual individuals, frequency effects such as these manifest at two levels: (1) word frequency effects within a language and (2) language frequency effects across languages. Specifically, in line with the monolingual experience, particular words or meanings within a language develop higher frequencies than others due to factors like patterns of exposure and usage. In addition, driven by similar factors, lexical candidates in a bilingual's more proficient or dominant language are assumed to have a greater overall frequency than lexical alternatives in a bilingual's less proficient or non-dominant language.

For models like the BIA/BIA+ (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992), differences in frequency are represented in the bilingual lexicon as differences in resting levels of activation, with higher frequencies being associated with higher resting levels of activation. Given some threshold for access, it is assumed that lexical candidates with a higher resting level of activation will more quickly reach that threshold than candidates with a lower level of resting activation, assuming that activation for both candidates is facilitated by the particular input (e.g., translation equivalents that share semantic features with the input).

Within the context of cross-linguistic interactions, models like the BIA/BIA+ (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992) predict that, for balanced bilinguals, cross-linguistic interactions will be experienced relatively consistently from both L1 and L2. However, for unbalanced bilinguals, stronger cross-linguistic influence is predicted to be experienced from the dominant language, due to the higher levels of resting activation (and thus quicker access) for the dominant language. In line with this prediction, asymmetry in cross-linguistic interactions has been repeatedly observed with the bilingual literature (e.g., Meuter & Allport, 1999; Peeters, Runnqvist, Bertrand, & Grainger, 2014). Preston and Lambert (1969) were among the first to experimentally demonstrate the language dominance effect. The authors showed that balanced English-French (Experiment 1), English-Hungarian (Experiment 1), and English-German (Experiment 2) bilinguals showed no difference in the magnitude of cross-linguistic interference from their L1 vs. L2 on a bilingual Stroop task. Alternatively, Preston and Lambert (1969) found that English-French bilinguals (Experiment 3) early in their French development showed greater cross-linguistic interference from L1 during L2 processing vs. from L2 during L1 processing on a bilingual Stroop task.

While the work of Preston and Lambert (1969) and others (e.g., Beauvillain & Grainger, 1987; Bijeljac-Babic, Biardeau, & Grainger, 1997; Chen & Ho, 1986; Mägiste, 1984; Tzelgov, Henik, & Leiser, 1990; van Heuven, Dijkstra, & Grainger, 1998) have demonstrated that global language frequency influences the degree of cross-linguistic interaction experienced, when relative word frequency and global language frequency effects are examined simultaneously, it appears that word frequency has a stronger impact on cross-linguistic lexical activation (e.g., Beauvillain & Grainger, 1987). For example, Beauvillain and Grainger (1987) examined word frequency effects on a lexical decision task for two groups of English-French bilinguals that differed in their language dominance (e.g., participants were either English or French dominant). On each trial, participants read a “context word” (prime) and then subsequently made a lexical decision on a “test word” (target). In the critical condition, all primes consisted of English-French interlingual homographs (e.g., words that share orthographic features, i.e., are printed in the same way, but have different meaning across languages). All homographs were unbalanced, such that either the English or French meaning was more frequent. In addition, target words (which were presented in either French or English), were related to either the higher or lower frequency meaning of the homograph. Under these conditions, if language frequency (dominance) has a stronger influence on cross-linguistic interactions then participants should show the greatest cross-linguistic priming effects from their dominant language (regardless of word frequency). Alternatively, if word frequency is more influential, then both groups should display greater priming from the high frequency meaning as compared to the low frequency meaning (regardless of the language associated with the higher frequency meaning). The results demonstrated that for both groups, English and French targets associated with the higher frequency meaning of the homograph prime (introspective of whether or not the higher frequency meaning was in French or English) showed greater priming as compared to targets associated with the lower frequency meaning of the homograph prime (Beauvillain & Grainger, 1987, Experiment 2). Taken together, these results suggest that while both relative and global frequency influence activation levels, resting level activation appear to be more sensitive to relative word frequencies.

1.2.2. The role of context. Empirical work has demonstrated that readers can use linguistic context to facilitate comprehension (e.g., Kellas, Paul, Martin, & Simpson, 1991; Schwanenflugel, 1991; Simpson, 1981; Tabossi, 1988). For example, when a reader encounters ambiguity, linguistic context can help to facilitate comprehension by constraining potential alternative interpretations (e.g., Simpson, 1981; Tabossi, 1988). Investigators have primarily focused on the role of two types of linguistic context, semantic and syntactic context. However, research has demonstrated (within the monolingual literature) that semantic context is generally more influential than syntactic context (Kawamoto, 1993). This is likely because semantic context usually biased far fewer potential alternatives than syntactic context (e.g., a set of specific lexical alternatives vs. all nouns). Consistent with this finding, research investigating the role of linguistic context within the domain of bilingual reading has primarily focused on the role of semantic context.

Using a paradigm in which Spanish-English bilinguals named interlingual homographs embedded in sentences that were either semantically constrained towards the English or the Spanish meaning of the homograph, Altarriba, Carlo, and Kroll (1992) demonstrated that semantic context can influence the activation of cross-linguistic lexical alternatives, but only under certain circumstances (as described in Altarriba & Gianico, 2003). Specifically, the authors found that cross-linguistic interference (e.g., slower naming times for the homographs as compared to control words) was observed when the sentence was written in participant's L2 (English), regardless of the semantic context. However, when the sentence was written in participant's L1 (Spanish), cross-linguistic interference was only observed when the semantic context biased the L2 meaning of the homograph (i.e., no interference was observed when participants read sentences in their L1 (Spanish) that biased the L1 meaning of the homograph).

In addition to semantic context, bilingual readers also encounter a language context during reading (i.e., the language of the input). Consistent with research on the influence of semantic context, language context appears to constrain cross-linguistic activation, but only when the stimulus context is in the readers' L1 (presumably their dominant language). For example, Marian and Spivey (2003) tracked eye movements while Russian-English bilinguals located particular objects within an array of objects that included phonological distractors. In Experiment 1, participants completed the task entirely in English (their L2). On the critical cross-linguistic trials, participants looked longer at distractor objects, whose Russian name overlapped phonologically with the English target name, than at control items. However, this cross-linguistic interference was not observed in Experiment 2, when the task was completed in Russian (their L1). In particular, participants' looking times were not significantly different between distractor objects, whose English name overlapped phonologically with the Russian target name, and control items.

On the whole, these results suggest that context can constrain cross-linguistic co-activation. More specifically, cross-linguistic interactions appear to occur in the L2 context but are ameliorated within the L1 context. Assuming that a bilingual's L1 is their dominant language, this asymmetry can be explained by models like the BIA/BIA+ (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992) through an interaction between context facilitation and resting levels of activation. As previously described, under the BIA/BIA+ models (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992), it is assumed that a bilingual's dominant language has higher resting levels of activation than a bilingual's non-dominant language. According to the BIA/BIA+ model (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992), the presentation of a linguistic input starts a process through which activation spreads within the bilingual lexicon to linguistic codes that are related to the input or other activated codes. Thus, any feature, such as contextual features of the input, that strengthens the association between an input and particular linguistic codes will accelerate the accumulation of activation for those particular codes. Given that L1 codes start at higher resting levels of activation, this facilitation boost from context effects may results in L1 lexical candidates reaching activation thresholds well before L2 lexical candidates can reach the same thresholds. This results in a reduction or elimination of cross-linguistic interactions from L2 to L1 when L1 inputs are processed within L1 contexts. However, while L2 contextual effects likely also lead to a facilitation of activation accumulation for L2 codes, since L2 linguistic codes begin at a lower resting level of activation it takes L2 codes longer to reach activation thresholds thus giving time for activation to accumulate for L1 codes as well. One caveat to this interpretation is that the BIA/BIA+ models (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992) are traditionally conceptualized as models of word recognition and thus it is not clear exactly how one would instantiate the impact of factors beyond the word level (e.g., semantic context) on levels of activation within the bilingual lexicon under these models.

1.2.3. The role of task demands. While not explicitly outlined in their three-factor model, Degani and Tokowicz (2010) acknowledge in their review that factors related to task demands can interact with the elements of their three-factor model to influence the degree of cross-linguistic activation. In one of the clearest demonstrations on how task demands can impact cross-linguistic interactions, Dijkstra, Van Jaarveld, and Brinke (1998) examined how performance changed as Dutch-English bilinguals completed three different versions of a lexical decision task. In Experiment 1, Dutch-English bilinguals completed an English lexical decision task. The task included interlingual homographs (similarity in form but not meanings across languages), interlingual cognates (similarity in form and meaning across languages), and English words and nonwords (no similarity to Dutch words). Critically, participants were told that they were to judge English words and nonwords (e.g., there was no mention of the inclusion of interlingual words). Under this task design, participants showed facilitation effects for cognates (faster reaction times to cognates as compared to control words), but no cross-linguistic effects for homographs. The authors interpreted this finding to suggest that because the task stimulus, instructions, and goals all focused entirely on English, the Dutch lexicon was globally inhibited. This inhibition suppressed the potential cross-linguistic effects of the homographs (which only share lexical feature across languages). However, because cognates share semantic representations across languages (which would not be suppressed by the inhibition of Dutch lexical codes), cross-linguistic facilitation effects emerged. In Experiment 2, participants were again instructed to make lexicality judgments on English letter strings. Critically, however, in addition to the interlingual homographs, English words, and English nonwords, Dutch words, to which participants had to respond "nonword," were also included. In contrast to the findings of Experiment 1, the authors found that the inclusion of irrelevant Dutch stimuli, produced inhibitory effects for homographs as compared to control words. Under the same logic that was used to interpret the findings of Experiment 1, the authors concluded that the bottom-up activation produced by the Dutch words prevented the successful top-down inhibition of Dutch that had eliminated the effects of interlingual homographs in Experiment 1. Finally, in Experiment 3, participants completed a generalized lexical decision task in which interlingual homographs, English words, Dutch words, English nonwords, and Dutch nonwords were included. Participants were instructed to respond to any word (regardless of language) as a "word" and any nonword (regardless of language) as a "nonword." Under these task demands, participants displayed facilitation effects for homographs (as compared to English control words). The results of this study clearly demonstrate that task demands can interact with the features described in Degani and Tokowicz (2010)'s three-factor model, such as language context, to modulate cross-linguistic interactions.

1.2.4. The role of language similarity. Degani and Tokowicz (2010)'s review focused on the processing of interlingual homographs, which share orthographic, and often phonological, similarity across languages. Thus, the impact of language similarity on the nature of cross-linguistic interactions was not critical to their discussion. Nonetheless, previous research has demonstrated that language similarity can modulate the degree of cross-linguistic interactions observed on bilingual tasks (e.g., Dyer, 1971; Fang, Tzeng, & Alva, 1981; van Heuven, Conklin, Coderre, Guo, & Dijkstra, 2011). Under the BIA/BIA+ model (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992), the spread of activation within the bilingual lexicon is determined by similarity between the input and linguistic codes. Therefore, the less overlap two languages have in their orthographic, phonological, or semantic representations the less cross-linguistic activation is predicted by the BIA/BIA+ model (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992). Support for this prediction has been found using versions of the bilingual Stroop task. In the traditional Stroop task, participants name the font color of visually presented letter strings. On critical trials, the letter strings form color words that are incongruent with the font color (e.g., BLUE written in a to-be-named red font). Generally speaking, interference, as indexed by increased naming times, is observed on these critical trials as compared to neutral trials (e.g., XXXX written in a to-be-named red font). In the bilingual Stroop task, critical cross-linguistic trials consist of trials in which the incongruent color word is written in one of the bilingual's language and the font color is to be named in the bilingual's other language (e.g., Preston & Lambert, 1969). By examining the performance of trilinguals on versions of the bilingual Stroop task, van Heuven, Conklin, Coderre, Guo, and Dijkstra (2011) were able investigate changes in the magnitude of cross-linguistic interference for languages with the same vs. different orthographies both within and across individuals. In particular, three experiments were conducted in which Stroop effects within and between languages were examined in German-English-Dutch trilinguals (color words shared orthography across all three languages), Chinese-English-Malay trilinguals (color words shared orthography across two language, English and Malay), and Uyghur-Chinese-English trilinguals (color words did not share orthography across languages). In line with the predictions generated by the BIA/BIA+ models (Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992), their results demonstrated greater cross-linguistic interference for pairs of languages that shared an orthography vs. pairs of languages that differed in orthography (van Heuven, Conklin, Coderre, Guo, & Dijkstra, 2011).

1.3. Selecting Between Cross-Linguistic Lexical Alternatives

In the previous section I discussed how language related factors (i.e., frequency and language similarity) and task related factors (i.e., context and task demands) affect the automatic spread of activation across languages, and thus influence the nature of cross-linguistic interactions. In the following section, I will describe the role of non-linguistic cognitive factors in selecting among the co-activated lexical alternatives across languages.

1.3.1. Inhibition or enhancement? According to interactive activation models (e.g., MIA: McClelland & Rumelhart, 1981; BIA/BIA+: Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992), a lexical candidate must reach an activation threshold in order to be “accessed.” Further, when multiple lexical candidates reach the threshold and compete for selection, the alternative with the highest level of activation is the one that is ultimately selected. Thus, successful selection of the *relevant* lexical alternative can be accomplished either through enhancement of the activation level of the context-appropriate candidate or by inhibition of the activation level of the context-inappropriate candidate(s).

Relatively few studies have investigated the mechanism by which bilingual individuals resolve cross-linguistic competition between lexical candidates (e.g., Fox, 1996; Neumann, McCloskey, & Felio, 1999). However, according to the Inhibitory Control Model (Green, 1998), bilingual individuals manage cross-linguistic co-activation through inhibitory mechanisms that actively suppress non-target language alternatives. Some of the most compelling evidence in support of the Inhibitory Control Model (Green, 1998) has come from negative priming studies. In negative priming paradigms, participants are first required to select between competing lexical alternatives. Then, the ease of subsequent processing for the unselected item is examined in order to understand the strategy used for selection. Under an inhibition model, selection of the relevant item is accomplished by inhibiting the activation of the irrelevant item. Thus, given the active suppression of the unselected item, it is predicted that subsequent processing of that previously unselected item will be slower and more effortful (e.g., negative priming). Only a handful of studies have used this type of paradigm to investigate the mechanisms by which bilingual readers select between co-activated cross-linguistic alternatives (e.g., Fox, 1996; Neumann, McCloskey, & Felio, 1999). The results from this line of work has demonstrated that bilingual individuals likely utilize an inhibition-based mechanism to resolve cross-linguistic competition. For example, Neumann, McCloskey, and Felio (1999) conducted two experiments in which participants completed a monolingual negative priming task and a bilingual negative priming task. For the purposes of the current study, only the bilingual negative priming experiment (Experiment 2) will be discussed herein, however it should be noted that the monolingual experiment also showed evidence of negative priming. In the bilingual task, participants were first presented with a “prime display” that consisted of a lowercase English target word and an uppercase English distractor word. On prime trials, participants were instructed to name the target word. Following each prime trial, a probe trial was presented which consisted of a lowercase Spanish word or nonword and an uppercase English distractor word. On probe trials, participants were instructed to make a lexical decision on the lowercase Spanish letter string. There were three critical conditions in this experiment: (1) Attended, in which the prime and probe targets were translation equivalents (e.g., Prime = dog FIRE; Probe = perro CHAIR; perro means “dog” in Spanish), (2) Unrelated, in which the prime target and distractor were semantically unrelated to the probe target (e.g., Prime = dog FIRE; Probe = tarro CHAIR; tarro means “jar” in Spanish), and (3) Ignored, in which the prime distractor and the probe target were translation equivalents (e.g., Prime = dog FIRE; Probe = fuego CHAIR; fuego means “fire” in Spanish). Under an enhancement model, selection of the target word on the prime trial would be accomplished by increasing the activation level for the target word (e.g., dog). This would result in a facilitation for processing of the probe target on Attended trials (e.g., perro; positive priming) and no effect on processing of the probe target on Ignored trials (e.g., fuego). Alternatively, under an inhibition model, selection of the target word on the prime trial would be accomplished by decreasing the activation level for the distractor word (e.g., FIRE). This suppression of the distractor word would not affect subsequent processing of the probe target on Attended trials (e.g., perro), but would be expected to disrupt processing of the probe target on Ignored trials (e.g., fuego; negative priming). Neumann, McCloskey, and Felio (1999) observed that English-Spanish bilinguals performing this task showed no evidence of positive priming (i.e., no significant difference in probe target processing time between the Attended and Unrelated conditions), but reliable evidence of negative priming (e.g., a significant difference in probe target processing time between the Ignored and Unrelated conditions). This pattern of results, as well as similar patterns observed in other bilingual negative priming studies (e.g., Fox, 1996), provides clear evidence for inhibition based theories, like the Inhibitory Control Model (Green, 1998).

1.4. Summary

The goal of this dissertation is to explore the role of cross-linguistic interactions in L2 reading. In particular, I aim to test the hypothesis that variability in L1 interactions with L2 reading processes contributes to individual differences in L2 reading skill. Specifically, I propose that the greater the L1 to L2 interactions are, the more interference an L2 reader will experience, and hence the poorer their reading skill will be. Additionally, I predict that variability in L1 to L2 interactions will be driven by both linguistic and cognitive factors. The previous literature described herein provides support for the foundational assumptions behind the primary hypothesis. Specifically, in order for individual differences in cross-linguistic interactions to contribute to variability in L2 reading skill:

1. The bilingual lexicon must be set up such that there is a potential for co-activation across languages. In support of this proposition, previous research has established that the bilingual lexicon is integrated across languages and lexical access occurs non-selectively (within and across languages; see section 1.1).
2. Co-activation must result, at least part of the time, in cross-linguistic interactions. In support of this proposition, studies over the last few decades have shown that bilingual individuals do indeed experience cross-linguistic interactions on a large variety of linguistic tasks including priming, naming, lexical decision, Stroop, and sentence processing tasks (see section 1.2).
3. Individuals must vary in the amount of cross-linguistic interaction they experience. In support for this proposition, empirical work has demonstrated that language, task, and

cognitive factors all contribute to individual differences in the amount of cross-linguistic interaction experienced during linguistic processing (see section 1.2 and 1.3).

The model proposed herein will extend this previous work by directly testing two novel components: (1) whether or not, and to what degree, variability in cross-linguistic interactions contribute to individual differences in L2 reading skill and (2) the relative contributions of language- and cognitive-related factors on individual differences in cross-linguistic interactions.

1.5. Preliminary Study

I provided initial support linking variability in linguistic interactions to individual differences in L2 reading skill in a preliminary investigation of the association between conflict management and individual differences in reading skill in English monolinguals and L1 and L2 English bilinguals (Yamasaki & Prat, 2014). Based on both models of bilingual lexical access (e.g., RHM: Kroll & Stewart, 1994; BIA/BIA+: Dijkstra & van Heuven, 1998; Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992) and prior empirical work demonstrating an asymmetry between the amount of cross-linguistic interaction experienced (e.g., Meuter & Allport, 1999; Peeters, Runnqvist, Bertrand, & Grainger, 2014), I predicted that conflict management would contribute uniquely to variability in L2 reading skill. That is, given that L2 readers experience ***more*** linguistic interactions (due to strong L1 to L2 interactions) during reading than monolinguals or L1 readers, I predicted that the ability to manage conflict would be particularly important for bilingual individual reading in their L2. To test this prediction, an English Stroop task, in which participants named the font color of visually presented letter strings, was used to measure individual differences in conflict management. Specifically, the difference in performance on conflict trials (i.e., an English color word presented in a to-be-named-in-English incongruent font color) versus neutral trials (i.e., a series of XXXX presented in a to-be-named-in-English font color) was used as the index of conflict management (with a bigger difference reflecting more interference on conflict trials, and thus poorer conflict management). According to the traditional automaticity view of Stroop performance, interference experienced from the color words should increase as reading proficiency increases. Therefore, under this model, one would expect a positive correlation between Stroop conflict scores and reading skill across all groups. Alternatively, performance on the Stroop task may reflect individual differences in the ability to manage conflict (experienced from the written color word during font color naming). If conflict management is particularly important during L2 reading (due to strong L1 to L2 interactions), then under this alternative model, one would predict a negative correlation between Stroop conflict effects and reading skill for L2 readers specifically. In line with this prediction, the results of the preliminary study demonstrated a negative correlation between interference experienced on the Stroop task and reading skill, but only for L2 readers as opposed to L1 and monolingual readers (Yamasaki & Prat, 2014).

While this preliminary study established a relation between variability in conflict management and individual differences in L2 reading skill, there are two major limitations that constrain our ability to address the primary hypothesis. First, the hypothesis motivating the current study is that variability in *cross-linguistic interactions* contributes to individual differences in L2 reading skill. However, in the preliminary study interference was only measured within English, not cross-linguistically. Second, previous research has demonstrated that there are several different factors that contribute to individual differences in the amount of cross-linguistic interaction experienced. These factors were not considered in the preliminary study, and thus a more comprehensive model of the relation between cross-linguistic interactions and L2 reading skill should include these factors.

1.6. Current Study

The aim of the current study was to address the limitations of the preliminary study and more thoroughly investigate the primary hypothesis. This was accomplished by testing a novel model of L2 reading skill that investigated the hypothesis that individual differences in L1 to L2 cross-linguistic interactions would relate to L2 reading skill, with more interactions resulting in decreased reading skill. Additionally, it is predicted that both linguistic and cognitive factors will contribute to variability in L1 to L2 cross-linguistic interactions.

1.6.1. Predictions.

1.6.1.1. Individual differences in L2 reading skill. It is predicted that individuals who experience more L1 to L2 interactions will demonstrate poorer L2 reading skills. Results from the preliminary study illustrated that efficiency in managing conflict contributes to individual differences in L2 reading skill (Yamasaki & Prat, 2014). However, this relation was demonstrated through an investigation of the role of managing interference from a single task in English only. It was hypothesized that the fact that conflict management was only correlated with reading in an L2 reflects the additional demands of L1 to L2 interactions experienced by L2 readers. Therefore, the present study will extend these preliminary findings by directly testing the relation between variability in L1 to L2 interactions and L2 reading skill.

1.6.1.2. Individual differences in L1 to L2 interactions. One of the primary linguistic factors Degani and Tokowicz (2010) describe as contributing to individual differences in cross-linguistic co-activation is word frequency. As previously discussed, frequency effects are thought to manifest as variability in characteristics associated with linguistic representations, and in particular as differences in resting levels of activation. Higher frequency words have been shown to be easier and less effortful to access (e.g., Forster & Chambers, 1973; Howes &

Solomon, 1951; McGinnies, Comer, & Lacey, 1952; Preston, 1935; Whaley, 1978), presumably due to the higher resting levels of activation. Frequency is known to be an experience-driven linguistic factor, such that the more exposure and usage to a lexical item an individual has, the higher the perceived frequency for that lexical item will be. Therefore, in the current study variability in linguistic representations will be indexed by measures of L1 and L2 proficiency and usage. It is predicted that higher relative L1 proficiency as compared to L2 proficiency will result in more L1 interactions with L2. This relation would be driven by the fact that higher L1 proficiency should result in higher resting levels of activation for L1 lexical alternatives, and therefore a higher likelihood of co-activation of those L1 lexical alternatives during L2 reading.

In addition, in line with the Inhibitory Control Model (Green, 1998), previous research has established that bilingual individuals likely resolve conflict between cross-linguistic lexical alternatives through inhibitory mechanisms (e.g., Fox, 1996; Neumann, McCloskey, & Felio, 1999). Thus, individual differences in this conflict management skill likely contribute to variability in the degree to which one experiences cross-linguistic interactions. Therefore, variability in conflict management will be measured through three non-linguistic executive attention tasks in the current study. It is predicted that poorer executive attention (indexed by larger conflict effects) will result in more L1 to L2 interactions, as individuals poorer in this skill would be less efficient at managing interactions between co-activated lexical items.

Chapter 2. Methods

Three-hundred and twelve individuals (mean age = 19.69 years, female = 62.45%) received course credit for participation in this study. All participants completed informed consent procedures, as outlined by the University of Washington Institutional Review Board. Participation consisted of two 1.5 hour sessions that occurred one day apart (e.g., Monday and

Wednesday). Of the 312 total participants, 272 (87.18%) completed both sessions. Over the course of the two sessions, participants completed twelve tasks as well as demographic questionnaires.

2.1. Participant Eligibility

Study inclusion criteria were evaluated against participants' self-reported L1 and L2 history. To be included in the analysis, participants' L1 had to be Mandarin, Korean, Spanish, or Japanese and their L2 had to be English. The Language Experience and Proficiency Questionnaire (LEAP-Q; Marian, Blumenfeld, & Kaushanskaya, 2007) was used to index each participants' language history and to ensure that all participants met the inclusion criteria. Of the total 312 participants, 32 (10.26%) were removed due to a missing or incomplete LEAP-Q, 16 (5.13%) were removed due to an invalid L1, 2 (0.64%) were removed due to simultaneous acquisition of their L1 and L2, and 1 (0.32%) was removed due to an experimenter error which resulted in the behavioral tasks not being conducted in the participant's L1. Therefore, a total of 261 participants were included in the final analysis. Demographic information for the final study sample is displayed in Table 1.

Table 1

Demographic Information For Study Sample (N = 261)

	N	Mean (SE)	Minimum	Maximum
Female	163			
Age	261	19.96 (0.09)	18.00	26.00
L1 Average Use	261	42.48 (0.98)	2.00	78.33
L1 Speaking Proficiency	261	9.05 (0.07)	4.00	10.00
L1 Understanding Proficiency	260	9.22 (0.07)	0.00	10.00
L2 Age-of-Acquisition	261	6.92 (0.17)	2.00	19.00
L2 Speaking Proficiency	260	7.22 (0.09)	4.00	10.00
L2 Understanding Proficiency	261	7.60 (0.09)	4.00	10.00

2.2. Materials and Procedures

2.2.1. L2 reading tasks.

2.2.1.1. Nelson Denny Reading Test. The Nelson Denny Reading Test (NDRT; Brown, 1960) is a timed two-part test with subtests that index English vocabulary knowledge and English discourse comprehension skill. The vocabulary subtest is composed of 80 multiple choice questions, each containing a test word embedded in an opening statement (e.g., "A vivid description is: ") and five potential response options. Participants are given 15 minutes to complete the vocabulary subtest by selecting the word that best completes the statement for each question (e.g., "lively"). For the comprehension subtest, participants are given 20 minutes to answer 38 comprehension questions distributed across five passages. After reading each passage, participants work through the associated questions, referencing the passage as needed. Two standardized versions of the NDRT were administered across participants, each consisting of an independent set of questions for both the vocabulary and comprehension subtests. The number of correct answers was calculated independently for each subtest. These scores were then used to determine percentile scores based on normed percentiles for college readers.

2.2.1.2. Homograph Sentence task. The Homograph Sentence task was modified from Gernsbacher, Varner, & Faust, 1990. In this task, participants read English sentences, 3-6 words in length (mean length = 4.24 words), and then made relatedness judgments to probe words presented after a short (100ms, 50% of trials) or long (850ms; 50% of trials) delay following the sentence. Participants completed 160 trials, of which 80 had related probe words and 80 had unrelated probe words. Of the 80 unrelated trials, 40 comprised the critical condition in which the sentence final word consisted of an ambiguous homograph. All homographs were balanced (with equally frequent meanings), however the sentence context biased a particular meaning (e.g., He dug with the spade.). In the critical condition, the probe word always corresponded to the alternative, context-inappropriate meaning of the homograph (e.g., ACE). The remaining 40 unrelated trials comprised the control condition, in which the sentence final word was unambiguous (e.g., He dug with a shovel). On each trial, a fixation was presented for 850ms, followed by each word of the sentence presented one word at a time. Each word was presented at a rate of 300ms + 16.7ms multiplied by the number of letters in the word and a 150ms ISI. After a delay (100ms or 850ms), the probe word was presented for 2000ms (or until a response was made). Participants received accuracy feedback (presented for 1500ms) following each response. Two versions of the task were created such that the condition the probe word was associated with (e.g., critical or control) varied across versions. Average accuracy to probe words was computed. An effect size was calculated the by taking the difference between accuracies on control trials (unambiguous trials) and critical trials (inappropriate homograph trials) at the long delay (where individual differences have been shown to be greater; Gernsbacher, Varner, & Faust, 1990).

2.2.2. Executive attention tasks.

2.2.2.1. Simon task. In the Simon task (Simon & Rudell, 1967), participants respond to visually presented shapes according to a specific task rule (e.g., if circle, then press right). On each trial, one shape is presented on either the left (50% of trials) or right (50% of trials) side of the screen. On 75% of the trials, the location of the response indicated by the task rule corresponded to the presentation side of the stimulus (e.g., circle presented on the right-hand side of the screen; congruent trials). On the remaining 25% of trials, the response side was opposite of the presentation side (e.g., circle presented on the left-hand side of the screen; incongruent trials). After 8 practice trials, participants completed 60 experimental trials (45 congruent, 15 incongruent). Each trial began with a fixation for 800ms and a blank preparation screen for

250ms, followed by the stimulus for 3000ms (or until a response was made). Two versions of the Simon task were created by randomizing the trials between versions. Average reaction time was calculated separately for the congruent and incongruent trials. Effect sizes were calculated by subtracting incongruent and congruent reaction times.

2.2.2.2. Flanker task. The structure, trial composition, and dependent variable calculation on the Flanker task (Eriksen & Eriksen, 1974) was consistent with the Simon task. The only differences between the tasks were the stimuli used and the task rules that participants responded to. In the Flanker task, participants were presented with a series of five arrow symbols (e.g., < or >). On congruent trials, all five stimuli faced the same direction (e.g., < < < < <), whereas on incongruent trials, all five stimuli excluding the center symbol faced the same direction (e.g., < < > < <). On all trials, participants were instructed to respond with a right or left button press corresponding to the direction of the center symbol.

2.2.2.3. Spatial Stroop task. The Spatial Stroop task (Shor, 1970) mirrored the Simon (and Flanker) task in structure, trial composition, and dependent variable calculation. In the Spatial Stroop task, participants respond to arrows presented laterally on the screen. Participants were instructed to press the button that corresponds to the side of the screen the arrow is presented on (e.g., arrow on right, press right button). On congruent trials, the arrow is presented such that the orientation of the arrow corresponds to the correct response (e.g., right facing arrow presented on the right-hand side of the screen). On incongruent trials, the arrow is presented such that the orientation is opposite of the correct response (e.g., right facing arrow presented on the left-hand side of the screen).

2.2.3. Linguistic stimuli selection. Linguistic stimuli for all of the cross-linguistic interaction tasks were sampled from the University of South Florida Word Association, Rhythm, and Word Fragment Norm Database (Nelson, McEvoy, & Schreiber, 1998). Two-thousand three-hundred and sixty-seven pairs of cue and target words, with forward strengths between 0.3 and 1.0, were taken from the database. From those, 325 pairs were randomly sampled. A four step process was used to acquire the L1 cue for each pair. First, all cues were translated using Google Translate (into Mandarin, Japanese, Korean, or Spanish). Second, a native speaker of each L1 ensured that the translations were correct and removed items that either did not have a translation in the L1 or were pronounced like their English translation (e.g., cognates or false friends). Third, a native speaker of each L1 evaluated the relatedness between the L1 cue and English target pair and categorized each pair into one of 7 categories: (1) cue and target words are related in the L1, (2) cue and target words are not related in the L1, (3) cue and target words were related in the L1 but only in particular contexts, (4) cue and target words have the same translation in the L1 (e.g., YELL - SCREAM, YELL and SCREAM are the same word in Mandarin), (5) target word contains the cue word (e.g., HAND - FINGER, FINGER in Mandarin is “hand point”), (7) other problem with the cue and target pair (e.g., MAN - WOMAN, WOMAN in Mandarin also means “human”). Word pairs that were categorized under condition 1 were distributed among prime-target related conditions in the linguistic interaction tasks (excluding the Color-Word task, which used only four color words and their L1 translations). Word pairs that were categorized under conditions 2 or 3 were distributed among filler conditions in the linguistic interaction tasks (excluding Color-Word). Word pairs that were categorized under conditions 4-6 were not included in any tasks. Across all linguistic interaction tasks (excluding Color-Word), target words in the related and associated unrelated pairs were balanced for word length and frequency. In addition, degree of prime-target relatedness was balanced across task versions within each task.

2.2.4. L1 to L2 interaction tasks.

2.2.4.1. Lexical Decision task. In the Lexical Decision task, participants were presented with L1 and L2 letter strings. Participants were instructed to press a button according to whether the presented letter string was a word or a nonword (25% English words, 25% L1 words, 25% English nonwords, and 25% L1 nonwords). Letter strings were presented in one of six conditions: (1) L1 nonword (25% of trials), (2) L2 nonword (25% of trials), (3) L1 filler (18% of trials), (4) English filler (5% of trials), (5) English prime, related English target (13.5% of trials), or (6) L1 prime, related English target (13.5% of trials). On each trial, a fixation cross was presented for 750ms before the letter string was presented until a button response was detected. Two versions of the task were created in which the language of the related prime (L1 or English) was switched across versions. Average reaction time was calculated separately for each stimulus type. Effect sizes were calculated by subtracting reaction times to English targets preceded by a related L1 prime from English targets preceded by an unrelated L1 prime (e.g., English filler or prime words preceded by an unrelated L1 filler or L1 nonword).

2.2.4.2. Word Naming task. In the Word Naming task, participants were instructed to verbally name each English (50%) and L1 (50%) word presented on the screen. Words were presented in one of four conditions: (1) L1 filler (36.4% of trials), (2) English filler (9% of trials), (3) English prime, related English target (27.3% of trials), or (4) L1 prime, related English target (27.3% of trials). Each trial consisted of the presentation of the word until a verbal response was detected. The language of the related prime (L1 or English) was switched across two task versions. Average reaction time was calculated for each stimulus type and effect sizes were calculated by subtracting reaction times to English targets preceded by a related L1 prime from English targets preceded by an unrelated L1 prime (e.g., English filler or prime words preceded by an unrelated L1 filler).

2.2.4.3. Word Identification task. In the Word Identification task (van Heuven, Dijkstra, & Grainger, 1998), participants were presented with word pairs, one word at a time. Participants were instructed to press a spacebar when they identified each English (50%) or L1 (50%) word. After a 1000ms fixation, the first word in the pair (e.g., the prime) was presented for 2000ms (or until a button response was made). Immediately following a button press, participants were prompted to verbally name the prime word. The second word in the pair (e.g., the target) was presented in an alternating pattern with a mask (######) for 300ms. The word was initially presented for 15ms followed by a 285ms mask. On each successive presentation of the word and mask, the duration of the word increased (in 15ms increments) and the duration of the mask decreased (in 15ms increments). This alternating pattern continued until the word was presented for 300ms or a button response was made. Following the target word, a 500ms mask was presented before participants were prompted to verbally identify the previous target word. Prime-target pairs were presented in one of four conditions: (1) L1 prime, L1 unrelated target (36.4% of trials), (2) English prime, English unrelated target (9% of trials), (3) English prime, related English target (27.3% of trials), or (4) L1 prime, related English target (27.3% of trials). The language of the related prime (L1 or English) was switched across two versions of the task. Average reaction time was calculated separately for each condition. Effect sizes were calculated by subtracting reaction times to English targets preceded by a related L1 prime from English target preceded by an unrelated English prime.

2.2.4.4. Color-Word task. In the Color-Word task (Preston & Lambert, 1969), participants verbally respond (in English) to visually presented letter strings in accordance with their font color. On 20% of the trials, the letter strings consisted of a series of X's (e.g., neutral trials). On 40% of the trials, the letter strings consisted of English color words that were incongruent with the to-be-named font color. On the remaining 40% of the trials, the letter strings consisted of L1 color words that were incongruent with the to-be-named font color. On each trial, the letter string was presented until a verbal response was detected. Two versions of the task were created in which the trials were randomized across versions. Average reaction time was calculated for each condition and effect sizes were calculated by subtracting reaction times to neutral trials from incongruent trials with an L1 color word.

2.2.4.5. Word-Word task. In the Word-Word task, participants were presented with pairs of letter strings and were instructed to name aloud the lowercase English word (regardless of the language or composition of the other letter string presented). On 33% of the trials, the lowercase English target word was presented with a letter string that consisted of a series of X's (e.g., neutral trials). On 33% of the trials, the lowercase English target word was presented with a semantically related uppercase English word. On the final 33% of trials, the lowercase English target word was presented with a semantically related L1 word. The lowercase English target word was presented equally often on the left and right side of the letter string pairs. Each trial consisted of the presentation of the letter string pairs, and was not terminated until a verbal response was detected. The language of the semantically related distractor (L1 or English) was switched across two task versions. Average reaction time was calculated for each condition and effect sizes were calculated by subtracting reaction times to neutral trials from trials with a semantically related L1 distractor word.

2.2.4.6. Picture-Word task. In the Picture-Word task (Hentschel, 1973), participants were presented with black-and-white line drawn pictures with red letter strings printed adjacent to them (in the upper right-hand corner of the image). Participants were instructed to verbally name the item depicted in the line drawn picture. On 50% of the trials, the line drawn picture was presented with a letter string that consisted of a series of X’s (e.g., neutral trials). On 25% of the trials, the line drawn picture was presented with a semantically related English word. On the remaining 25% of trials, the line drawn picture was presented with a semantically related L1 word. Each picture-word pair was presented until a verbal response was detected. Two task versions were created in which the language of the semantically related distractor (L1 or English) was switched across versions. Average reaction time was calculated separately for each condition. Effect sizes were calculated by subtracting reaction times to neutral trials from trials with a semantically related L1 distractor word.

2.2.5. Language Experience and Proficiency Questionnaire (LEAP-Q).

In addition to being used to determine study eligibility, responses on the LEAP-Q (Marian, Blumenfeld, & Kaushanskaya, 2007) were also used to index three language experience variables. A participant’s self-reported speaking and understanding proficiency in their L1 and L2 were used to calculate two proficiency ratios. More specifically, relative speaking proficiency was measured by subtracting self-reported L2 speaking proficiency from L1 speaking proficiency. Similarly, relative understanding proficiency was measured by subtracting self-reported L2 understanding proficiency from L1 understanding proficiency. Higher values on either of these measures indicated a more L1 (as compared to L2) proficient language profile. In addition, participants’ self-reported percentage of average use in L1 was used to index relative language usage (participants were instructed to report average percentage of use for each language and to ensure that values summed to 100% across languages). Higher values on this usage measure indicated a more L1 dominant language use profile.

2.3. Data Analysis

2.3.1. Data cleaning. For all computerized behavioral tasks (e.g., all tasks excluding the NDRT), a three step data cleaning procedure was conducted. First, at the individual trial level, reaction times to incorrect trials and reaction times that exceeded 3 +/- standard deviations from the mean (calculated on correct trials only) were removed before calculating condition means. Next, at the individual participant level, a participant's data for a particular task was removed from further analysis if any of the relevant conditions for a dependent variable had less than three, usable, individual trials (this resulted in the exclusion of 0.5% of the data) or the participant's overall task (collapsed across conditions) performance was below chance (for the naming tasks, in which it is difficult to accurately calculate chance a 50% overall accuracy cutoff was use; this resulted in the exclusion of 0.3% of the data). Finally, at the group level, a participant's data for a particular task was removed from further analysis if the value of their dependent variable for that task was greater than 3 +/- standard deviations from the group mean for that task (this resulted in the exclusion of 1.1% of the data).

2.3.2. Structural equation modeling. The hypothesized relations between L2 reading skill, L1 to L2 interactions, and the predictors of those interactions were tested through a structural equation model. Structural equation modeling is beneficial as a statistical approach as constructs of interest are analyzed as latent variables. Estimation using latent variables, unlike other statistical methods (e.g., bivariate correlations), allow for an examination of estimated relations unaffected by random measurement error. While previous research has utilized similar statistical techniques to understanding individual differences in L2 reading skill, no studies to date have examined the role of the primary construct of interest in the current study (e.g., L1 to L2 interactions). In the present study, four factors (and their associated paths) were estimated: (1)

Relative Language Proficiency, (2) Executive Attention, (3) L1 to L2 Interactions, and (4) L2 Reading. To control for differences in variance scale, all dependent variables were normalized before being entered into the model. The lavaan package (Rosseel, 2012) in R (R Core Team, 2013) was used to conduct a confirmatory factor analysis and estimate the path model. Parameter estimations were made using full information maximum likelihood. Five fit indices were examined to evaluate overall model fit: Chi-Square, Comparative Fit index (CFI), Tucker-Lewis index (TFI), Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). Good model fit is indicated by a Chi-Square with a significance values greater than 0.5, CFI value greater than 0.95, TFI value greater than 0.90, RMSEA value less than 0.06, and SRMR value less than 0.08 (Hu & Bentler, 1999).

Chapter 3. Results

3.1. Task Descriptives and Bivariate Correlations

Means, standard errors, and ranges for all task dependent variables are displayed in Table 2. Bivariate correlations for dependent variables within each factor are displayed in Table 3.

Table 2

Task Descriptives

	N	Mean (SE)	Minimum	Maximum
Nelson Denny Comprehension*	243	39.75 (1.49)	1.00	96.00
Nelson Denny Vocabulary*	246	37.85 (1.35)	1.00	95.00
Homograph Sentence Task+	236	17.56 (0.75)	-15.00	45.00
Simon Task^	254	79.53 (2.27)	-23.45	201.85
Spatial Stroop Task^	251	91.80 (2.57)	7.09	265.55
Flanker Task^	244	57.79 (2.72)	-59.51	299.55
Word-Word Task^	251	-33.65 (3.68)	-207.94	162.41
Color-Word Task^	244	86.95(4.10)	-69.91	280.23
Picture-Word Task^	252	69.41 (6.18)	-199.48	432.74
Word Naming Task^	253	16.92 (2.95)	-250.60	143.78
Word Identification Task^	236	12.44 (0.86)	-16.00	50.77
Lexical Decision Task^	253	125.87 (5.47)	-52.25	516.42

Note. * = Percentile Score; + = Accuracy Effect; ^ = Reaction Time Effect (in ms).

Table 3

Bivariate Correlations by Factor

	2	3	5	6	8	9	10	11	12	14	15
1. NDC	.540***	-.116†									
2. NDV		-.283***									
3. HG											
4. SI			.223***	.081							
5. SS				.040							
6. FL											
7. WW					.046	.084	-.224***	-.118†	.027		
8. CW						.195**	-.066	-.010	.003		
9. PW							-.057	-.083	-.067		
10. WN								.103	-.070		
11. WI									.031		
12. LD											
13. L1-L2 SP										.775***	.512***
14. L1-L2 UP											.430***
15. L1 AU											

Note. NDC = Nelson Denny Comprehension; NDV = Nelson Denny Vocabulary; HG = Homograph Sentence Task; FL = Flanker; SI = Simon; SS = Spatial Stroop; CW = Color-Word, WW = Word-Word; PW = Picture-Word; WN = Word Naming; WI = Word Identification; LD = Lexical Decision; AU = Average Use; SP = Speaking Proficiency; UP = Understanding Proficiency. $\dagger = p \leq .10$, $* = p \leq .05$, $** = p \leq .01$, $*** = p \leq .001$.

3.2. Structural Equation Model

To test the primary hypothesis, the structural equation model displayed in Figure 3 was estimated. All of the goodness-of-fit indices (χ^2 (86) = 105.99, *p* = 0.07; CFI = 0.97; TLI = 0.96; RMSEA = 0.03; SRMR = 0.06) revealed a well-fitting model. An evaluation of the factor loadings (see Figure 4) revealed that higher values on the Relative Language Proficiency factor reflected a higher degree of relative L1 proficiency, higher values on the Executive Attention factor reflected a larger degree of conflict experienced (or poorer conflict management), higher values on the L1 to L2 Interaction factor reflected less influence from L1 (or greater L2 autonomy), and higher values on the L2 Reading factor indicated better L2 reading skill. Thus to facilitate comprehension, the factors have been relabeled in Figure 4 to reflect direction, with greater scores always reflecting more of what is labeled: Relative L1 Proficiency, Non-linguistic Conflict, L2 Autonomy, and L2 Reading Skill. These labels will be used throughout the discussion as well. Finally, the path analysis revealed a significant relation for all estimated paths. Specifically, consistent with the hypothesis tested herein, both Relative L1 Proficiency and Non-linguistic Conflict were found to negatively influence L2 Autonomy (ß = -0.824 and ß = -0.384, respectively), and L2 Autonomy was found to strongly positively predict L2 Reading Skill (ß = 0.758). Unstandardized factor loadings and associated standard errors are displayed in Table 4.

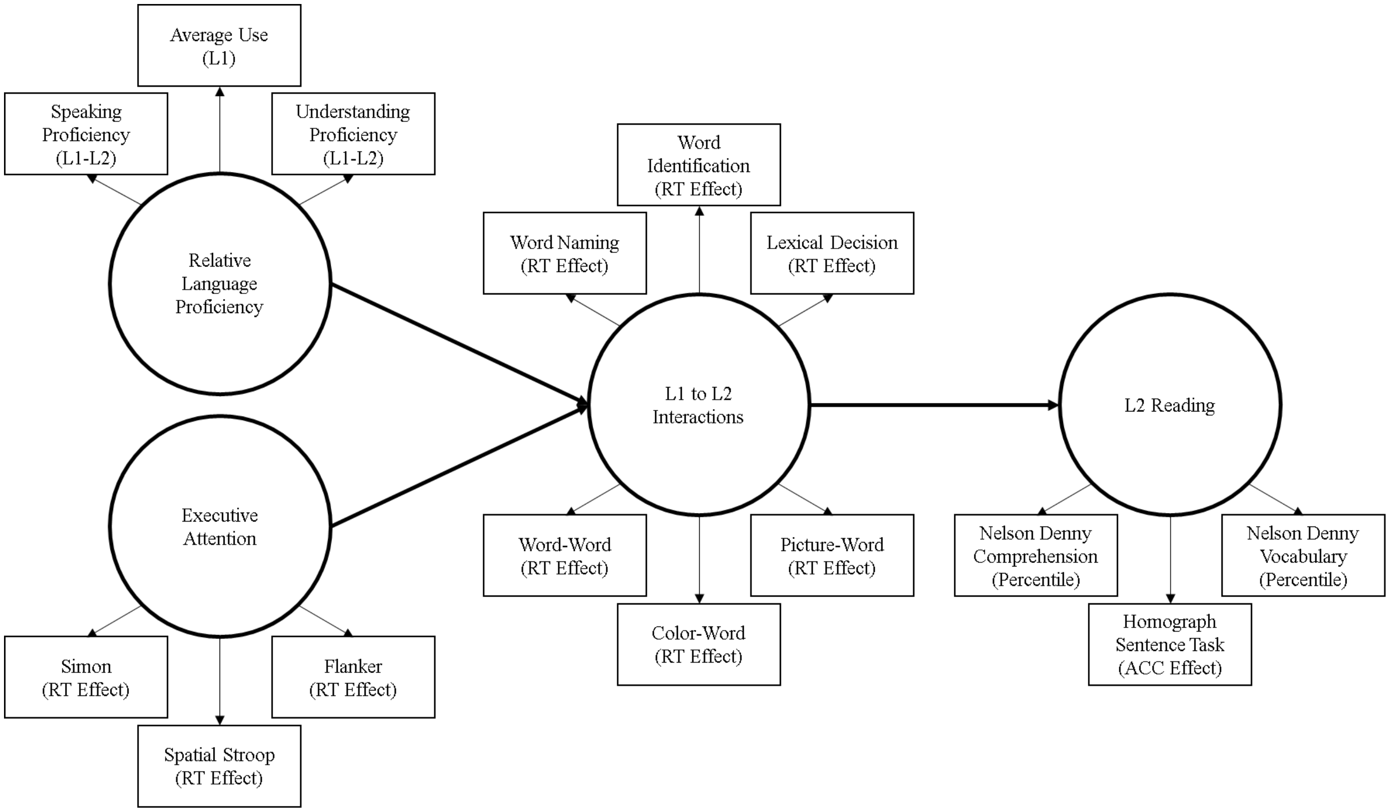
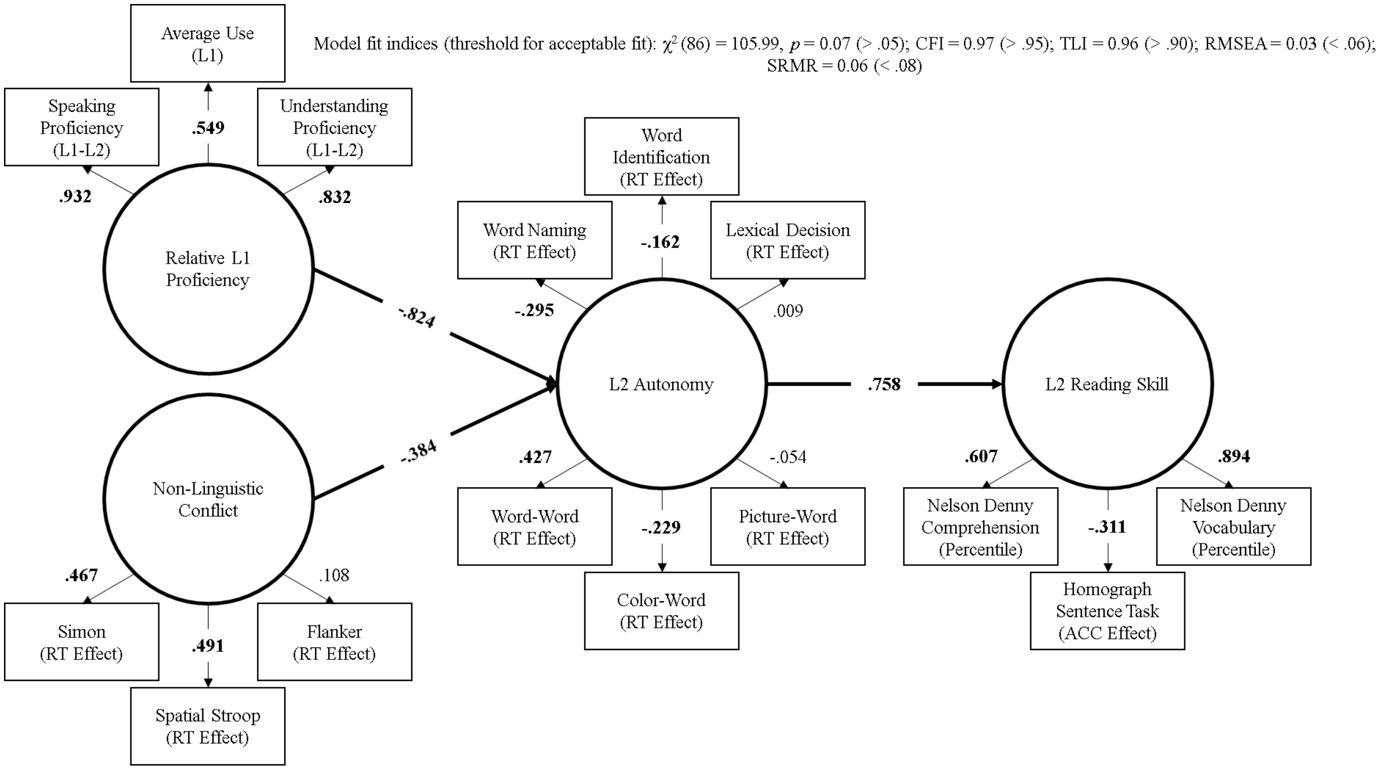


Figure 3. Hypothesized structural equation model. Latent variables indicated by circles, measured variables indicated by rectangles, and error terms omitted. RT = reaction time; ACC = accuracy.



Model fit indices (threshold for acceptable fit): χ^2 (86) = 105.99, p = 0.07 (> .05); CFI = 0.97 (> .95); TLI = 0.96 (> .90); RMSEA = 0.03 (< .06); SRMR = 0.06 (< .08)

Figure 4. Standardized coefficients presented for hypothesized structural equation model (significant coefficients are bolded). Latent variables indicated by circles, measured variables indicated by rectangles, and error terms omitted. RT = reaction time; ACC = accuracy; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual.

Table 4

Unstandardized Factor Loadings (Standard Error)

	L2 Reading Skill	Non-Linguistic Conflict	L2 Autonomy	Relative L1 Proficiency
Nelson Denny Comprehension	1.00			
Nelson Denny Vocabulary	1.48 (0.21)			
Homograph Sentence Task	-0.51 (0.12)			
Simon Task		1.00		
Spatial Stroop Task		0.23 (0.23)		
Flanker Task		0.23 (0.23)		
Word-Word Task			1.00	
Color-Word Task			-0.54 (0.21)	
Picture-Word Task			-0.13 (0.17)	
Word Naming Task			-0.69 (0.19)	
Word Identification Task			-0.38 (0.19)	
Lexical Decision Task			0.02 (0.18)	
L1-L2 Speaking Proficiency				1.00
L1-L2 Understanding Proficiency				0.90 (0.06)
L1 Average Use				0.59 (0.06)

Chapter 4. Discussion

Results from this experiment support the novel hypothesis that individual differences in L1 to L2 cross-linguistic interactions predict L2 reading skill. Specifically, they demonstrate that higher L2 autonomy (or lower L1 to L2 interactions) is correlated with better L2 reading skill. The data also show that both linguistic and non-linguistic cognitive factors predict individual differences in these cross-linguistic interactions. Not surprisingly, greater relative L1 proficiency was associated with more L1 to L2 interactions (or a less autonomous L2). Additionally, better non-linguistic conflict management was also related to fewer L1 to L2 interactions. Taken together, these findings extend previous knowledge about the nature of L2 reading skill by providing three novel contributions: (1) that L1 to L2 interactions constrain L2 reading skill; (2) that both relative L1 vs. L2 proficiency and non-linguistic conflict management independently contribute to variability in L1 o L2 interactions, and (3) that these individual differences in L2 reading skill are observable in relatively proficient young adult readers.

4.1. Understanding the Role of Linguistic Interactions in L2 Reading

Only a handful of studies have used multivariate analyses or latent variable modeling to understand individual differences in L2 reading skill; and while some models have included both L1 and L2 variables (e.g., L1 or L2 proficiency), none of the previous work has considered interactions between L1 and L2. Thus, to the best of our knowledge, the current study is the first to consider how these cross-linguistic interactions contribute to individual differences in L2 reading skill. As predicted, the results of the model tested herein support the hypothesis that individuals who experience more L1 to L2 interactions would display poorer L2 reading skills. Given that cross-linguistic interactions can manifest as either interference (e.g., as indexed by slower reaction times on conflict trials on the Stroop task) or facilitation (e.g., as indexed by faster naming times for related targets on the Word Naming priming task), one might have predicted that only L1 to L2 interference effects would contribute to poorer L2 reading skill. However, this was not the case. Importantly, both tasks eliciting L1 to L2 interference and L1 to L2 priming loaded significantly onto the L1 to L2 interaction factor. Therefore, the results of the current study illustrate that any type of L1 interaction with L2 hinders L2 reading skill, likely by creating additional demands.

While the central hypothesis in the current study focuses on cross-linguistic interactions, specifically those from L1 to L2, it is possible that the observed relation between variability in linguistic interactions and L2 reading skill relates more generally to linguistic interaction management (both within and across languages). In fact, considerable research has linked the ability to efficiently select the correct word forms and syntactic structures in the face of ambiguity within a language to individual differences in reading skill (e.g., Gernsbacher, Varner, & Faust, 1990). To directly test the hypothesis that variability in within-L2 interactions also contributes to individual differences in L2 reading skill, an additional model was estimated in which all of the L1 to L2 interaction variables were replaced with within-L2 interaction variables. While this model did converge, an examination of the goodness-of-fit indices indicated that the model was of poor fit. In fact, only 2 of the 5 fit indices indicated acceptable fit (χ^2 (86) = 140.29, $p < .001$; CFI = 0.86; TLI = 0.83; RMSEA = 0.05; SRMR = 0.07) and therefore interpretability of the results is limited. Nonetheless, a cautious, preliminary evaluation of the associations between the four factors revealed that greater within-language interference (only tasks that elicited interference loaded onto the Within-L2 Interaction factor) was associated with better L2 reading. Individual differences in within-language interference were primarily driven by differences in language proficiency (the relation between within-L2 interactions and conflict management was marginal), with more relative L2 proficient individuals experiencing more within-L2 interference. In contrast to the interpretation of the cross-linguistic interaction model, the within-language interaction model appears to reflect the relation between quality of lexical representations and reading skill. According to the Lexical Quality Hypothesis (Perfetti & Hart, 2002), the quality of lexical representations, which contributes to the ease with which lexical items can be accessed, scaffolds up to influence individual differences in reading skill (Perfetti, 2007). It may be presumed that individuals who are more dominant in their L2, and thus have more experience using their L2, may have developed higher quality L2 lexical representations. High quality representations are easier and more quickly accessed, and thus co-activations among related lexical alternatives are more likely to occur. This may then contribute to higher levels of within-language interactions, as was observed for the individuals in the current study. While this interpretation is in line with a prominent model of individual differences in reading skill (e.g., the Lexical Quality Hypothesis; Perfetti & Hart, 2002), it is important to note that the interpretation of this model must be taken with caution as the model was of poor fit.

4.2. Understanding the Contributions of Relative Language Proficiency on L1 to L2 Interactions

Motivated by previous research demonstrating that ease of access to linguistic representations can influence the degree of cross-linguistic interaction (e.g., Beauvillain & Grainger, 1987; Bijeljac-Babic, Biardeau, & Grainger, 1997; Chen & Ho, 1986; Mägiste, 1984; Preston & Lambert, 1969; Tzelgov, Henik, & Leiser, 1990; van Heuven, Dijkstra, & Grainger, 1998), it was predicted that the relative proficiency a bilingual reports in his or her L1 and L2 would drive the amount of interaction experienced. Consistent with this prediction, a strong negative association was observed between the Relative L1 Proficiency factor (where higher values correspond to a more L1 proficient language profile) and the L2 Autonomy factor (where higher values correspond to greater L2 autonomy). However, given that linguistic representations in a bilingual's L1 and L2 can develop semi-independently, it is possible that absolute language experience in one or the other of their languages is actually driving the observed relative proficiency effect. This is also consistent with previous models which have shown that both L1 and L2 proficiency relate to L2 reading comprehension (e.g., Hdstijn & Bossers, 1992). Therefore, to test this hypothesis, two additional models were run in which the L1-L2 proficiency and use variables were replaced by L1 or L2 variables individually. Both models were able to be estimated, however in both cases only 2 of the 5 goodness-of-fit indices indicated acceptable model fit (L1 model: χ^2 (86) = 140.29, p < .001; CFI = 0.86; TLI = 0.83; RMSEA = 0.05; SRMR = 0.07; L2 model: χ^2 (86) = 129.94, p = 0.002; CFI = 0.92; TLI = 0.91; RMSEA = 0.04; SRMR = 0.06). Given the poorer model fit, interpretability is more limited; however a preliminary evaluation of the relation between the Language Proficiency (formerly Relative L1 Proficiency) factor and the L2 Autonomy factor revealed a significant association for both models. As might be expected, the L1 model indicated that higher L1 proficiency was associated with more L1 to L2 interaction and the L2 model indicated that higher L2 proficiency was associated with less L1 to L2 interaction. Taken together, the fact that both the L1 and L2 models fit less well than the relative proficiency model suggests that the relative language proficiency profile seems to be more important than the individual proficiency levels for understanding individual differences in L1 to L2 interactions.

4.3. Understanding the Contributions of Conflict Management on L1 to L2 Interactions

Based on our preliminary study (Yamasaki & Prat, 2014) and on research investigating bilingual language control (e.g., Festman & Münte, 2012; Festman, Rodriguez-Fornells, &

Münte, 2010), we predicted that better non-linguistic conflict management, as measured by standard executive attention tasks, would results in smaller L1 to L2 interactions. In support of this prediction, a strong negative association was observed between the Non-Linguistic Conflict factor (where higher values correspond to greater conflict experieinced, or poorer conflict management) and the L2 Autonomy factor (where higher values correspond to greater L2 autonomy). Only a small number of studies to date have included non-linguistic cognitive measures as predictors of L2 reading skill, and the majority of these have focused on meta-cognitive skills (e.g., Ayatollahi, Rasekh, & Tavakoli, 2012; Guo & Roehrig, 2011). Furthermore, in these few cases, only direct relations between these factors and reading skill have been measured. Thus, to the best of our knowledge, no studies to date have tested a proposed mechanism by which general cognitive skills support L2 reading. The present study addressed this gap in the literature by providing evidence that the relation between executive attention, specifically as it relates to non-linguistic conflict management, and L2 reading is mediated by controlling L1 to L2 interactions.

It is worth noting that only two of the three executive attention tasks loaded significantly onto the Non-Linguistic Conflict factor. In particular, the Simon and Spatial Stroop tasks loaded onto the factor, whereas the Flanker task did not. While all three tasks are thought to index individual differences in executive attention, it is possible that there may be differences in the type of conflict experienced under different circumstances. For example, in both the Simon and Spatial Stroop tasks, the interference experienced on an incongruent trial consists of interference between the stimulus location and the response (e.g., circle presented on the left, right-hand button press required). The mechanisms engaged to overcome this stimulus-response incompatibility (e.g., response conflict) may be different from the mechanisms recruited to overcome the distractor interference experienced between the target (e.g., center arrow) and the flanking stimuli on the Flanker task. The fact that executive attention and conflict management are multifaceted constructs is consistent with several lines of research showing that traditional executive attention tasks share variance, but ultimately load onto separable factors (e.g., Friedman & Miyake, 2004). Future research might seek to better understand the types of cognitive tasks that relate to variability in cross-linguistic interactions. This work would ultimately contribute to a better understanding of the mechanism(s) by which interactions between languages are managed.

4.4. Modeling Individual Differences in L2 Reading in Young Adults

Of the few existing studies that have used multivariate or latent variable models to understand individual differences in L2 reading skill, many have been conducted with children (e.g., Babayiğit, 2015; Gottardo & Mueller, 2009; Lesaux, Crosson, Kieffer, & Pierce, 2010; Proctor, Carlo, August, & Snow, 2005; Uchikoshi, 2013). The results of the current study extend this work by examining individual differences in L2 reading skill among relatively proficient young adult readers. In contrast to early developing English readers, all participants included in the current study are assumed to have a much higher level of English proficiency as they are all being educated at an English-speaking university. Given their level of English proficiency, it may have been predicted that individual differences in reading skill would be more limited in this population. However, large individual differences in L2 reading skill were observed in the current study (e.g., performance on the Nelson Denny Comprehension Test ranged from 1-96%). This finding highlights the fact that individual differences in L2 reading occur not only during acquisition or at lower levels of processing, but also during much later stages of L2 reading development. It is unclear, however, whether the sources of individual differences in developing and proficient speakers and readers are the same. Previous research examining lexical and semantic organization in bilingual children has shown that even before children begin to learn to read there is evidence of cross-linguistic interactions (e.g., Singh, 2014; Von Holzen & Mani, 2012). Additionally, comparisons between adults and children have shown that both groups show comparable levels of semantic interference (e.g., Rosinski, Golinkoff, & Kukish, 1975). Therefore, it might be predicted that children, like the adults tested in the current study, may have to deal with the demands associated with cross-linguistic interactions during reading. Additional work is necessary to better understand how this unique source of variability for adult readers, namely cross-linguistic interactions, contributes to individual differences in the early developmental stages of L2 reading.

4.5. Limitations

Certain facets of this study limit the interpretations that can be drawn from it. First, it is important to note that cross-linguistic interactions were only measured from L1 to L2 in the current study. While this decision was made based on the fact that the goal of the study was the understand variability in L2 reading skill, it is unclear from the current experiment the extent to which cross-linguistic interactions as a whole predict reading skill. Thus, future models aiming to extend the findings of the current study would benefit from a more complete characterization of cross-linguistic interactions (e.g., an inclusion of L2 to L1 interactions). Additionally, some of the tasks used in this experiment did not significantly load onto their respective factors. This may have been due to low reliability in some of the behavioral tasks. Given the large number of tasks that had to be completed by each participant, there were limitations in the length of time each task could take. Thus, some tasks may have had fewer trials per condition than necessary to establish a reliable estimate of the construct of interest. Alternatively, this may also have been driven by low construct validity. For example, as previously discussed (see section 4.3), the Flanker task may not have loaded onto the Non-Linguistic Conflict factor because performance on this task may reflect a different executive attention mechanism than that of which is recruited on the Simon and Spatial Stroop tasks. While multi-task models, such as the one tested herein, are highly beneficial in improving our understanding of the complex associations between multiple constructs, future studies may benefit from a more directed analysis of fewer constructs that allow for more reliable estimations of each construct. Finally, language similarity has been demonstrated to contribute to variability in cross-linguistic interactions (e.g., Dyer, 1971; Fang, Tzeng, & Alva, 1981; van Heuven, Conklin, Coderre, Guo, & Dijkstra, 2011). In an effort to model this source of variability, L2 English bilinguals with four different language profiles (Mandarin-, Korean-, Spanish-, and Japanese-English bilinguals) were recruited for the current study. However, primarily driven by the demographic make-up of the participant pool, 75% of participants in the current study were Mandarin-English bilinguals. Therefore, ultimately, the ability to understand the role of language similarity in the relations observed, and, more importantly, the extent to which the results from the model tested herein were driven by bilingual individuals with more distant language profiles or reflect a more general relation between L1 to L2 interactions and L2 reading skill was limited. To resolve this uncertainty, future investigations should consider testing the present model with a more heterogeneous population.

4.6. Final Conclusions

The model tested herein represents the first model of L2 reading skill to be centered on understanding the role of cross-linguistic interactions. The findings from this study demonstrate that L1 to L2 interactions constrain L2 reading skill, and that variability in these interactions are driven by both relative language proficiency and non-linguistic conflict management skill. These results are important because they highlight the centrality of a novel, widely understudied demand that is unique to bilingual readers, and may be particularly burdensome on L2 readers. Additionally, this work provides a foundation on which assessments of L2 reading skill can be made in a way that allows for targeted recommendations for remediation. For instance, the results of this study suggest that an individual might be a poor L2 reader because he or she is less proficient in his or her L2 as compared to his or her L1, or because of deficits in conflict management skills. These two sources of difficulty would call for remarkably different interventions. In summary, this research provides a new window for understanding the nature of L2 reading, providing evidence of the centrality of cross-linguistic interactions and outlining ample questions for future research.

Chapter 5. References

Altarriba, J., Carlo, M. S., & Kroll, J. F. (1992, March). *Language dominance and the processing of cross-language ambiguity*. Poster presented at the Fifth Annual CUNY Conference on Human Sentence Processing, New York, NY.

Altarriba, J., & Gianico, J. L. (2003). Lexical ambiguity resolution across languages: A theoretical and empirical review. *Experimental Psychology*, *50*(3), 159-170.

Andrews, S. (1989). Frequency and neighborhood effects on lexical access: Activation or search? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*(5), 802-814.

Ayatollahi, M. A., Rasekh, A. E., & Tavakoli, M. (2012). Learner beliefs, self-regulated learning strategies and L2 academic reading comprehension: A structural equation modeling analysis. *World Applied Sciences Journal*, *17*(1), 36-49.

Babayiğit, S. (2015). The relations between word reading, oral language, and reading comprehension in children who speak English as a first (L1) and second language (L2): A multigroup structural analysis. *Reading and Writing*, *28*(4), 527-544.

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

Bell, L. C., & Perfetti, C. A. (1994). Reading skill: Some adult comparisons. *Journal of Educational Psychology*, *86*(2), 244-255.

Bijeljac-Babic, R., Biardeau, A., & Grainger, J. (1997). Masked orthographic priming in bilingual word recognition. *Memory & Cognition*, *25*(4), 447-457.

Brown, J. I. (1960). *The Nelson-Denny Reading Test*. Oxford, England: Houghton Mifflin.

Chen, H. C., & Ho, C. (1986). Development of Stroop interference in Chinese-English bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *12*(3), 397-401.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, *82*(6), 407-428.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, *19*(4), 450-466.

Degani, T., & Tokowicz, N. (2010). Semantic ambiguity within and across languages: An integrative review. *Quarterly Journal of Experimental Psychology*, *63*(7), 1266-1303.

DeWalt, D. A., Berkman, N. D., Sheridan, S., Lohr, K. N., & Pignone, M. P. (2004). Literacy and health outcomes. *Journal of General Internal Medicine*, *19*(12), 1228-1239.

Dijkstra, T. & van Heuven, W. J. B. (1998). The BIA model and bilingual word recognition. In J. Grainger & A. Jacobs (Eds.), *Localist Connectionist Approaches to Human Cognition* (pp. 189-225). Hillsdale, NJ: Erlbaum.

Dijkstra, T., & van Heuven, W. J. (2002). The architecture of the bilingual word recognition system: From identification to decision. *Bilingualism: Language and Cognition*, *5*(3), 175-197.

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

Dyer, F. N. (1971). Color-naming interference in monolinguals and bilinguals. *Journal of Verbal Learning and Verbal Behavior*, *10*(3), 297-302.

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics*, *16*(1), 143-149.

Fang, S. P., Tzeng, O. J., & Alva, L. (1981). Intralanguage vs. interlanguage Stroop effects in two types of writing systems. *Memory & Cognition*, *9*(6), 609-617.

Festman, J., & Münte, T. F. (2012). Cognitive control in Russian–German bilinguals. *Frontiers in Psychology*, *3*(115), 1-12.

Festman, J., Rodriguez-Fornells, A., & Münte, T. F. (2010). Individual differences in control of language interference in late bilinguals are mainly related to general executive abilities. *Behavioral and Brain Functions*, *6*(5), 1-12.

Forster, K. I., & Chambers, S. M. (1973). Lexical access and naming time. *Journal of Verbal Learning and Verbal Behavior*, *12*(6), 627-635.

Fox, E. (1996). Cross-language priming from ignored words: Evidence for a common representational system in bilinguals. *Journal of Memory and Language*, *35*(3), 353-370.

Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent-variable analysis. *Journal of Experimental Psychology: General, 133*(1), 101-135.

Gernsbacher, M. A., Varner, K. R., & Faust, M. E. (1990). Investigating differences in general comprehension skill. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*(3), 430-445.

Grainger, J., & Dijkstra, T. (1992). On the representation and use of language information in bilinguals. In R. J. Harris (Ed.), *Advances in Psychology* (pp. 207-220). Amsterdam, The Netherlands: North-Holland.

Grainger, J., O'regan, J. K., Jacobs, A. M., & Segui, J. (1989). On the role of competing word units in visual word recognition: The neighborhood frequency effect. *Perception & Psychophysics*, *45*(3), 189-195.

Grainger, J., & Segui, J. (1990). Neighborhood frequency effects in visual word recognition: A comparison of lexical decision and masked identification latencies. *Perception & Psychophysics*, *47*(2), 191-198.

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition*, *1*(2), 67-81.

Gottardo, A., & Mueller, J. (2009). Are first-and second-language factors related in predicting second-language reading comprehension? A study of Spanish-speaking children acquiring English as a second language from first to second grade. J*ournal of Educational Psychology*, *101*(2), 330-344.

Guo, Y., & Roehrig, A. D. (2011). Roles of general versus second language (L2) knowledge in L2 reading comprehension. *Reading in a Foreign Language*, *23*(1), 42-64.

Hentschel, U. (1973). *Two new interference tests compared to the Stroop Color-Word Test*. Lund, Sweden: Lund University.

Hdstijn, J. H., & Bossers, B. (1992). Individual differences in L2 proficiency as a function of L1 proficiency. *European Journal of Cognitive Psychology*, *4*(4), 341-353.

Howes, D. H., & Solomon, R. L. (1951). Visual duration threshold as a function of word-probability. *Journal of Experimental Psychology*, *41*(6), 401-410.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1-55.

Jackson, R. A. (1955). Prediction of the academic success of college freshmen. *Journal of Educational Psychology*, *46*(5), 296-301.

Jeon, E. H., & Yamashita, J. (2014). L2 Reading comprehension and its correlates: A meta-analysis. *Language Learning*, *64*(1), 160-212.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review*, *99*(1), 122-149.

Kawamoto, A. H. (1993). Nonlinear dynamics in the resolution of lexical ambiguity: A parallel distributed processing account. *Journal of Memory and Language*, *32*(4), 474-516.

Kellas, G., Paul, S. T., Martin, M., & Simpson, G. B. (1991). Contextual feature activation and meaning access. In G. B. Simpson (Ed.), *Understanding Word and Sentence* (pp. 47-71). Amsterdam, The Netherlands: North-Holland.

Koda, K. (2007). Reading and language learning: Crosslinguistic constraints on second language reading development. *Language Learning*, *57*(1), 1-44.

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language*, *33*(2), 149-174.

Lesaux, N. K., Crosson, A. C., Kieffer, M. J., & Pierce, M. (2010). Uneven profiles: Language minority learners' word reading, vocabulary, and reading comprehension skills. *Journal of Applied Developmental Psychology*, *31*(6), 475-483.

Long, D. L., Prat, C., Johns, C., Morris, P., & Jonathan, E. (2008). The importance of knowledge in vivid text memory: An individual-differences investigation of recollection and familiarity. *Psychonomic Bulletin & Review*, *15*(3), 604-609.

Mägiste, E. (1984). Stroop tasks and dichotic translation: The development of interference patterns in bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *10*(2), 304-315.

Marian, V., Blumenfeld, H. K., & Kaushanskaya, M. (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech, Language, and Hearing Research*, *50*(4), 940-967.

Marian, V., & Spivey, M. (2003). Competing activation in bilingual language processing: Within-and between-language competition. *Bilingualism: Language and Cognition*, *6*(2), 97-115.

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: An account of basic findings. *Psychological Review*, *88*(5), 375-407.

McGinnies, E., Comer, P. B., & Lacey, O. L. (1952). Visual-recognition thresholds as a function of word length and word frequency. *Journal of Experimental Psychology*, *44*(2), 65-69.

Meuter, R. F., & Allport, A. (1999). Bilingual language switching in naming: Asymmetrical costs of language selection. *Journal of Memory and Language*, *40*(1), 25-40.

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (1998). *The University of South Florida word association, rhyme, and word fragment norms*. Retrieved from http://www.usf.edu/FreeAssociation/.

Neumann, E., McCloskey, M. S., & Felio, A. C. (1999). Cross-language positive priming disappears, negative priming does not: Evidence for two sources of selective inhibition. *Memory & Cognition*, *27*(6), 1051-1063.

Peeters, D., Runnqvist, E., Bertrand, D., & Grainger, J. (2014). Asymmetrical switch costs in bilingual language production induced by reading words. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *40*(1), 284-292.

Perfetti, C. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading*, *11*(4), 357-383.

Perfetti, C. A., & Hart, L. (2002). The lexical quality hypothesis. In L. Verhoeven, C. Elbro, & P. Reitsma (Eds.), *Precursors of Functional Literacy* (pp. 67-86). Amsterdam, The Netherlands: John Benjamins Publishing Co.

Proctor, C. P., Carlo, M., August, D., & Snow, C. (2005). Native Spanish-speaking children reading in English: Toward a model of comprehension. *Journal of Educational Psychology*, *97*(2), 246-256.

Potter, M. C., So, K. F., Von Eckardt, B., & Feldman, L. B. (1984). Lexical and conceptual representation in beginning and proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior*, *23*(1), 23-38.

Preston, K. A. (1935). The speed of word perception and its relation to reading ability. *The Journal of General Psychology*, *13*(1), 199-203.

Preston, M. S., & Lambert, W. E. (1969). Interlingual interference in a bilingual version of the Stroop color-word task. *Journal of Verbal Learning and Verbal Behavior*, *8*(2), 295-301.

R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from http://www.R-project.org/.

Raudenbush, S., & Kasim, R. (1998). Cognitive skill and economic inequality: Findings from the National Adult Literacy Survey. *Harvard Educational Review*, *68*(1), 33-80.

Robertson, M. H., & Harrison, M. M. (1960). Reading skill as a predictor of college achievement. *The Journal of Educational Research*, *53*(7), 258-262.

Rosinski, R. R., Golinkoff, R. M., & Kukish, K. S. (1975). Automatic semantic processing in a picture-word interference task. *Child Development*, *46*(1), 247-253.

Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling and more. Version 0.5–12 (BETA). *Journal of Statistical Software*, *48*(2), 1-36.

Schwanenflugel, P. J. (1991). Contextual constraint and lexical processing. In G. B. Simpson (Ed.), *Understanding Word and Sentence* (pp. 23-45). Amsterdam, The Netherlands: North-Holland.

Shor, R. E. (1970). The processing of conceptual information on spatial directions from pictorial and linguistic symbols. *Acta Psychologica*, *32*, 346-365.

Simon, J. R., & Rudell, A. P. (1967). Auditory SR compatibility: The effect of an irrelevant cue on information processing. *Journal of Applied Psychology*, *51*(3), 300-304.

Simpson, G. B. (1981). Meaning dominance and semantic context in the processing of lexical ambiguity. *Journal of Verbal Learning and Verbal Behavior*, *20*(1), 120-136.

Simpson, G. B., & Burgess, C. (1985). Activation and selection processes in the recognition of ambiguous words. *Journal of Experimental Psychology: Human Perception and Performance*, *11*(1), 28-39.

Singh, L. (2014). One world, two languages: Cross-language semantic priming in bilingual toddlers. *Child Development*, *85*(2), 755-766.

Snodgrass, J. G., & Mintzer, M. (1993). Neighborhood effects in visual word recognition: Facilitatory or inhibitory? *Memory & Cognition*, *21*(2), 247-266.

Stanovich, K. E. (1982). Individual differences in the cognitive processes of reading: I. Word decoding. *Journal of Learning Disabilities*, *15*(8), 485-493.

Tabossi, P. (1988). Accessing lexical ambiguity in different types of sentential contexts. *Journal of Memory and Language*, *27*(3), 324-340.

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

Tzelgov, J., Henik, A., & Leiser, D. (1990). Controlling Stroop interference: Evidence from a bilingual task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*(5), 760-771.

Uchikoshi, Y. (2013). Predictors of English reading comprehension: Cantonese-speaking English language learners in the US. *Reading and Writing*, *26*(6), 913-939.

U.S. Census Bureau (1992). *Table 4. Languages Spoken at Home by Persons 5 Years and Over, by State: 1990 Census* (Report No. CPHL-96). Retrieved from https://www2.census.gov/programs-surveys/decennial/tables/cph/cph-l/cph-l-096-table4.txt

U.S. Census Bureau (2003). *Table 4. Language Spoken at Home and Ability to Speak English for the Population 5 Years and Over by State: 2000* (Report No. PHC-T-20). Retrieved from https://www2.census.gov/programs-surveys/decennial/2000/phc/phc-t-20/tab04.pdf

U.S. Census Bureau (2015). *Table 1. Detailed Languages Spoken at Home and Ability to Speak English for the Population 5 Years and Over for United States: 2009-2013*. Retrieved from https://www.census.gov/data/tables/2013/demo/2009-2013-lang-tables.html

van Heuven, W. J., Conklin, K., Coderre, E. L., Guo, T., & Dijkstra, T. (2011). The influence of cross-language similarity on within-and between-language Stroop effects in trilinguals. *Frontiers in Psychology*, *2*(374), 1-15.

van Heuven, W. J., Dijkstra, T., & Grainger, J. (1998). Orthographic neighborhood effects in bilingual word recognition. *Journal of Memory and Language*, *39*(3), 458-483.

Von Holzen, K., & Mani, N. (2012). Language nonselective lexical access in bilingual toddlers. *Journal of Experimental Child Psychology*, *113*(4), 569-586.

Vineyard, E. E., & Bailey, R. B. (1960). Interrelationships of reading ability, listening skill, intelligence, and scholastic achievement. *Journal of Developmental Reading*, *3*(3), 174-178.

Whaley, C. P. (1978). Word—nonword classification time. *Journal of Verbal Learning and Verbal Behavior*, *17*(2), 143-154.

Yamasaki, B. L., & Prat, C. S. (2014). The importance of managing interference for second language reading ability: An individual differences investigation. *Discourse Processes*, *51*(5-6), 445-467.