Evaluating the Missing-Letter Effect in Proficient Spanish-English Bilinguals

BY

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THESIS

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This thesis is dedicated to my parents whose unconditional support and excitement towards my research have been key elements throughout this process.

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LIST OF ABBREVIATIONS

MLE	Missing Letter Effect
GO model	Guidance-Organization model
AD model	Attentional Disengagement model
LHQ	Language History Questionnaire
DELE	Diplomas de Español como Lengua Extranjera
UIC	University of Illinois at Chicago
LA	Universidad de Los Andes
RAE	Real Academia de la Lengua Española
H1	Hypothesis 1
H2	Hypothesis 2
H3	Hypothesis 3
L2	Second language

SUMMARY

Previous research has shown that the cognitive processes involved in reading and text comprehension change as a function of language proficiency. One important change is that word processing becomes more efficient as language proficiency increases (Bovee & Raney, 2016). However, there is very little research exploring how word processing efficiency changes in proficient bilinguals. This thesis explored word processing in English-Spanish bilinguals using the letter detection task to measure word processing efficiency. In the letter detection task, people are shown a passage of text on paper and are asked to read the passage normally for comprehension while simultaneously circling every instance of a target letter (e.g., circle every letter t). A common finding is that people miss more target letters on function words than on content words, and this is called the Missing letter effect (MLE). Bovee and Raney (2016) had English-Spanish bilinguals complete the letter detection task. Their bilinguals were proficient in English and not proficient in Spanish. They found a normal MLE for English passages and a small, reversed MLE (more errors on content words than function words) for Spanish passages. The present study replicated Bovee and Raney's study using highly proficient English-Spanish bilinguals. Data was collected from two groups of proficient bilinguals (an English dominant group from the University of Illinois at Chicago and a Spanish dominant group from los Andes University in Bogota, Columbia). Both groups produced normal MLE when reading English passages and small, reversed MLE when reading Spanish passages, which replicates Bovee and Raney's study. Because both groups were highly proficient bilinguals, language proficiency cannot explain the reversed MLE found in the present study. One possible explanation is that because Spanish is a gender-marked language function words play a more important role.

SUMMARY (Continued)

This leads to changes in how words are processed and might be used to explain the reversed MLE when reading Spanish.

I. Introduction

Previous research has shown that the cognitive processes involved in reading and text comprehension change as a function of language proficiency (Bovee & Raney, 2015). One important change is that word processing becomes more efficient as language proficiency increases (Bovee & Raney, 2015). However, there is relatively little research exploring how word processing efficiency changes in bilinguals. One important question that remains to be answered is, does word processing efficiency change in the same way in each of a bilingual's language? For example, can a person be less proficient in word processing in one language and more proficient in the other? The research presented here was designed to explore how proficient bilingual readers process texts, and to investigate if the cognitive processes involved in word processing differ between a bilingual's two languages.

The task used for measuring text processing is the letter detection task. In this task people are simply asked to read a text for comprehension while circling each occurrence of a specific letter, which is called the target letter. A common finding is that people miss more target letters in function words than in content words, and this is called the Missing-Letter Effect (MLE). I will explain this finding in detail below, but in short, researchers have found that the size of the MLE changes as a function of language proficiency (Hatch et al., 1974; Koriat & Greenberg, 1993; Tao et al., 1997; Thomas et al., 2007; Bovee & Raney, 2015). Therefore, letter detection can be used as a measure of word processing efficiency when bilinguals read in each of their languages. The research described here uses bilinguals who are proficient in English and Spanish. Unfortunately, there is no published research based on the letter detection task using proficient Spanish speakers. Therefore, the current research also provides much needed information about how proficient English-Spanish bilinguals perform the letter detection task.

I begin by further describing the letter detection task and theoretical explanations of the missing letter effect. I will then describe the findings of Bovee and Raney (2015), which serves as the methodological basis for the current research. I will then describe a pilot study that extends Bovee and Raney's procedure by using proficient English-Spanish bilinguals, and then the current study.

A. The Letter Detection Task and The Missing Letter Effect

In the letter detection task, readers are instructed to read a text presented on paper while simultaneously circling every instance of a predetermined target letter, such as the letter *t*. When performing this task, readers make detection errors, that is, they do not circle (miss) some of the target letters. The proportion of errors reflects how proficiently words are processed. For example, very common words are processed more efficiently and faster than uncommon words, and this leads to more letter detection errors on common words than uncommon words. In essence, because less time is spent reading common words than uncommon words, readers are more likely to miss target letters in common words. Readers also make more errors when reading short words (words with few characters) than long words (words with many characters) because short words are easier to process. Better readers tend to make more errors than poor readers presumably because better readers process words more efficiently (Bovee & Raney, 2015; Klein & Saint-Aubin, 2016; Greenberg, Healy, Koriat, & Kreiner, 2004). Accordingly, letter detection task can be used to differentiate more proficient (good) from less proficient (poor) readers (Foucambert & Baillé, 2011).

A common finding of the letter detection task is that readers make more detection errors on function words, such as "the," than on content words, such as "tip" (Healy, 1994; Moravcsik

& Healy, 1995; Greenberg et al., 2004). This is called the Missing-Letter Effect (MLE). The MLE reflects the fact that function words are generally easier to process than content words.

There are two prominent models that explain why the MLE occurs. The first is the Guidance-Organization model (GO model) proposed by (Greenberg et al., 2004). This model accounts for the MLE in two ways. The first key factor is unitization. According to the GO model, low frequency words are processed letter-by-letter whereas high frequency words are processed as single units, which is called unitization. This unitization process occurs because as proficient readers become more familiar with words, they increase the length of reading units from letter-by-letter units to groups of letters and eventually to entire word units. High frequency words (very familiar words) with few letters can be processed as a whole before the individual letters are fully processed. If a word is processed as a whole, readers might access the word's meaning before fully recognizing all the individual letters. As a result, the readers will be more likely to make errors (not detect target letters) on words that are processed as a unit compared to long words or low frequency words that are not processed as a single unit. This unitization process allows readers to recognize a word without having fully identified every one of its individual letters, which also supports faster, more efficient processing. Once a word has been identified, readers shift their attention to the next word in the sentence. This shift of attention leads readers to make more detection errors in high frequency words, these words are more likely to have become unitized and thus the individual letters are not fully processed before the attention shifts to the next word (Healy, 1994; Moravcsik & Healy, 1995; Greenberg et al., 2004).

Note that in the GO model, letter and word processing are assumed to be independent processes. If the letters in a word are identified before the whole word is recognized, the individual letters will be fully processed, which increases the likelihood of detecting target letters within the word. If a word is recognized as a whole word before the individual letters are fully processed, letter identification is interrupted, and attention is directed to the next word. This increases the likelihood of missing target letters.

The second key factor that explains the MLE in the Guidance Organization model is the role a word plays within a sentence (Greenberg et al., 2004). Because readers use function words to guide their attention to the more important content words, readers spend less time fixating function words than content words, which in turn means that function words receive less attention than content words. This leads to more missed target letters in function than in content words.

Prior to the development of Greenberg et al.'s (2004) GO model, several researchers had argued that the MLE can be categorized as reflecting a bottom-up process (Healy, 1994) or a top-down process (Greenberg & Koriat, 1991; Koriat & Greenberg, 1991; Koriat, Greenberg, & Goldshmid, 1991), but not both. According to Healy (1994) and Moravsik & Healy (1995), readers miss more target letters in function than in content words because of the higher frequency of function words. They assumed processing function words as a whole unit happens at the word level, and it interrupts the processing at the letter level, so "function words are more likely to be identified as a whole before their constituent letters are fully processed than are less frequent content words" (Klein & Saint-Aubin, 2016, p. 421). Contrary to this view, Koriat and Greenberg (1991), explained the MLE with a top-down hypothesis. According to them, target letters in function words are more likely to be missed because readers have a mental representation of the upcoming text structure, a structure that is used to support the integration of meaning in sentences that works by rapidly concealing function words in order to guide the reader towards the upcoming content word. In essence, in their structural account, word function is the key factor influencing the MLE, not word frequency. Greenberg et al.'s (2004) GO model incorporates bottom-up and top-down processes.

The second model used to explain the MLE is the Attentional Disengagement (AD) model, which was proposed by Roy-Charland, Saint-Aubin, Klein, and Lawrence (2007). In the AD model, the shifting of attention from one word to the next is the main factor that explains the MLE. Word frequency and word class are secondary factors that indirectly affect the MLE by influencing when attention is disengaged from a word and shifted to the next word (Bovee & Raney, 2015). Accordingly, as soon readers recognize a word, the amount of attention dedicated to that word starts decaying. High frequency function words require less attention than most content words; therefore, attention shifts away from function words faster than from content words. If a word is recognized and attention decays and starts shifting to the next word before a target letter has been detected, the target letter is more likely to be missed (not detected). The attentional disengagement model assumes that attention is gradually disengaged from one word and then shifted to the next word (Roy-Charland et al., 2007).

The GO model and the AD model clearly overlap. In both models, word frequency and word class are important because both of these factors influence processing difficulty. Word frequency and word class play the primary roles in the GO model, but there are many other factors that influence processing difficulty. Factors such as whether a word is involved in introducing a new idea or it maintains the current idea, can be accounted for by the AD model but not by the Go model. According the AD model, anything that affects the time to access the meaning of a word will influence letter detection. This makes the AD model a broader model.

This also makes the AD model more difficult to disprove because "anything" that affects processing time potentially can be accounted for in the model.

Another difference between the GO and AD models is the speed of the attention shift from one word to the next word. According to the GO model, as soon as a word is recognized attention quickly shifts to the next word (Greenberg et al., 2004). In the AD model, attention does not immediately shift upon identifying a word, attention gradually, but quickly, decays. Consequently, readers still have a small chance of detecting the target letter after the word has been recognized as attention is shifted to the next word (Bovee & Raney, 2015).

After more than a decade of disagreements over which model accounts for more of the factors that explain the MLE, researchers have come to the conclusion that the MLE cannot be completely accounted for solely by a top down or a bottom up view, because both word frequency and grammatical structure influence letter detection accuracy, meaning that the MLE has to be accounted by a view that shared both top down and bottom up contributions (Klein and Saint-Aubin, 2016). The current version of the attentional disengagement model was created with this in mind, and it mixes ideas from both the bottom up and top down perspectives. Klein and Saint-Aubin state that the MLE is explained by the fact that attention is disengaged faster from function than from content words, because function words are more frequent and have to carry less semantic information, which allows for a faster lexical access. Because the MLE is influenced by several factors, such as word frequency (Roy-Charland & Saint-Aubin, 2006), reading skills (Bovee & Raney, 2015), word class (Hatch et al., 1974), and text familiarity (Plamondon et al., 2017) that reflect both top down and bottom up processes, the MLE will continue to be used as a tool to assess a broad range of cognitive processes involved in reading and text comprehension.

B. Letter Detection in Bilingual Readers

The Guidance Organization (GO) and Attentional Disengagement (AD) models can be used to predict what would happen if the letter detection task was performed in a reader's second language. Both the GO and AD models would predict lower overall error rates when reading texts presented in a second, non-proficient language because words are processed less efficiently in the second language. Less efficient word processing leads to more time spent on each word, which in turn leads to more complete processing at the letter level before word level processing is completed. This would reduce errors on all words. Furthermore, the reader might not automatically or immediately distinguish between function words and content words because the words in the non-proficient language are less well known. This also would reduce the size of the MLE.

Fortunately, the letter detection task has been used to assess language proficiency in both proficient and non-proficient second languages (see Bovee and Raney, 2015; Hatch et al., 1974; Tao et al., 1997). The MLE has been observed in several languages with somewhat consistent results; there is a standard, large missing letter effect for the language in which readers are most proficient, and a smaller and, in very few occasions, reversed MLE (fewer errors in content words than function words) for non-proficient languages. However, to date there are only two published studies have measured the MLE in Spanish (Bovee & Raney, 2015; and Thomas, Healy & Greenberg, 2007). Below I begin by summarizing relevant studies regarding letter detection in proficient and non-proficient languages. I will then describe the two studies conducted with English-Spanish bilinguals, and then explore the current study.

Hatch, Polin, and Part (1974) tested the role of word and syllable stress on letter detection as a function of language proficiency. Across two experiments, they tested native English speakers and English learners from different language backgrounds and with different proficiency levels (Advanced, Intermediate, and Elementary English learners). In their first experiment, they compared native English speakers to advanced English learners (i.e., students with a high proficiency score on their university English entrance examination). Participants read one of four versions of a passage, and the only difference was that the syntax and vocabulary changed across passage versions. One version of the passage was written using frequent vocabulary and simple syntax; the second version was written using frequent vocabulary but complex syntax; the third version was written using infrequent vocabulary and simple syntax; and the fourth version was written using infrequent vocabulary and complex syntax. Across participants, passage version was counterbalanced such that each passage version was read by participants from each language group. All participants were instructed to read the passage for meaning while marking out (detecting) all the target letters. Hatch et al. found that both the native English group and the advanced English learners produced a standard MLE, that is, they missed more target letters in function words than in content words. They also found that the native English group missed the same number of letters in all four passage versions whereas the advanced English learners made more errors than in the passages in which the vocabulary was less frequent, or the syntax was more complex, (i.e., versions 2, 3, and 4). The pattern for the advanced English learners is the opposite of what one would expect. They attributed this finding to the idea that when reading passages with less frequent vocabulary and/or more complex syntax, non-native readers were more concerned with remembering the content of the passage than with marking out the target letters. This didn’t change their function versus content word letter-detection ratio, it simply made them mark less target letters overall.

In their second experiment, Hatch, Polin, and Part (1974) compared the native English group to the Intermediate English Learners and Elementary English Learners. They found a standard MLE (i.e., more errors on function than on content words) for all three groups. However, the MLE varied as a function of language proficiency. The MLE was largest for the native speakers, next largest for the intermediate English group, and smallest for the beginner or elementary English learning group. This finding led them to conclude that less proficient speakers were reading more words letter-by-letter, and were therefore missing fewer target letters, and that because beginners have less knowledge about the language, they relied more on function words to understand the texts.

Tao, Healy, and Bourne (1997) used the letter detection task with native English speakers and three groups of native Chinese speakers with three different levels of English proficiency (a group with no English knowledge, an intermediate English group, and an advanced English group). Each group read an English passage. Their results showed a large MLE for the native English speakers, and a smaller MLE for the Chinese speakers that decreased in size as knowledge of English increased. Specifically, the MLE was larger for the native Chinese speakers with advanced English knowledge than for Chinese speakers with intermediate English knowledge. In addition, they found no MLE for Chinese speakers that had no knowledge of English. These results are consistent with the idea that as readers gain more experience with a language, they use more efficient strategies to process texts, such as increasing the size of their reading units (i.e., they go from reading letter by letter to reading words as groups of letters), and as a result make more errors in the letter detection task.

Koriat and Greenberg (1993) were the first to report a reversed MLE (i.e., more errors on content than on function words) using the letter detection task. They conducted an experiment using proficient Hebrew speakers to compare the role of morphemes in content and function words when reading in Hebrew. Their experiment was designed to explore if the MLE would change as a function of (1) whether the target letter was part of the prefix or the stem of the word (prefixes, such as *dis* in the content word *dislike,* or a function prefix signifying the word *THE*); (2) the number of letters in the prefix (1 to 4 letters, like *dis* which is a 3-letter prefix versus *in* in *insert*, which is a 2-letter prefix); and (3) the position of the target letter in critical words that had multiple target letters (the first, second or third target letter in a word). Two findings are relevant here: First, there was no MLE for the target letters in the prefixes (e.g., *dis* in *dislike*). Second, they found a reversed MLE for target letters that were the second or third occurrence in a word (e.g., the second and third *t* in *totality*). According to Koriat and Greenberg, readers use function morphemes as the most reliable cues of phrase structure. Once a target letter of a function unit has been detected, the next function morphemes can be treated as part of the content that follows, which might increase the chance of being detected. This might make readers detect more of the target letters in the later morphemes of function words, making the MLE disappear or even reverse in some occasions (Koriat & Greenberg 1996).

Chitiri and Willows (1997) also found evidence of a reversed MLE using the letter detection task with native Greek readers who were advanced English bilinguals. They asked participants to read a passage in English and a passage in Greek for comprehension while crossing out every instance of the target letter *o* in both languages. They found a standard MLE for the Greek passage (the native language) and a reversed MLE for the English passage (the second language). They attributed this finding to the possibility that their participants lacked the ability to discriminate between function and content words due to insufficient syntactic knowledge of their second language. Their conclusion was that the reversed MLE was caused by an insufficient automatization of word recognition subskills, which in turn made it harder for the bilingual readers to incorporate syntactic information in their second language. This suggests that their participants were not advanced English bilinguals. Their findings are hard to interpret because the order of presentation of the passages also had a significant effect on the MLE. The reversed MLE was only present when the English passage was presented first.

Greenberg and Saint-Aubin (2004) found a reversed MLE when participants performed letter detection in a language they did not know. They had English-French bilinguals process interlingual homographs that were, for example, a function word in English (e.g., *or*) but a content word in French (*or* means gold in French). They divided their participants into three groups: English speaking monolinguals, English-French bilinguals (English was the first language), and French-English bilinguals (French was the first language). They found that monolinguals produced a standard MLE in English but a reversed MLE in French. The English-French bilinguals produced a standard MLE in English and a smaller, but standard MLE in French. Finally, the French-English bilinguals also produced a standard MLE in English and smaller, but standard MLE French. Thus, for participants who had knowledge of both languages, the MLE appears to change in size as knowledge of each language changes.

Greenberg and Saint-Aubin (2008) conducted a follow up study in which they measured the MLE in English-French mixed passages with English monolinguals and native French-English bilinguals. Participants read passages that alternated between English and French sentences. They found a standard MLE for English sentences in both groups. The French-English bilinguals made fewer errors overall in the English sentences than in the French sentences. Importantly, they produced a standard MLE for English passages. The English monolinguals produced a reversed MLE in French. In short, these results serve as evidence for the idea that not knowing a language or not being proficient in the language transforms the letter detection task into a more of a search task for the target letter. This then leads to a smaller MLE that varies as a function of language proficiency, and that in extreme cases can even cause a reversed MLE (Bovee and Raney, 2015).

In the prior reviews I have not stated the size of the MLEs, I did this intentionally because the size of the MLE varies depending on how the task is performed. For example, factors such as the number of comprehension questions included, instructions (e.g., whether you tell people to read normally or quickly), the difficulty of the passages, target letter position within a word, and word type all influence the error rates and therefore the size of the effect (Saint-Aubin et al., 2007). For example, Chitiri and Willows (1997) found an MLE of only 3.5%, whereas Greenberg and Saint-Aubin (2008) found an MLE of 21%, yet both of these were statistically significant. Some of the differences in their procedures that might have had an influence on the size of the effect could be the fact that in Chitiri and Willow's experiment, participants were performing the task in Greek, selecting the letter "o" as the target and they were performing the task on all words. Contrary to this, Greenberg and Saint-Aubin's participants performed the task in French, selected the target letters "a" and "r" and were interested in seeing how the introduction of interlingual homographs would change the MLE. The key point here is the common finding of a MLE when people read in their native or dominant language.

The studies summarized above provide evidence that the missing letter effect changes as a function of language background, although the results are not entirely consistent across studies. Due to the limited research with English-Spanish bilinguals, Bovee and Raney (2015) conducted a letter detection study using English-Spanish bilinguals. I describe their study in detail because my study extends their methodology.

C. Evaluating Missing-Letter Effects and Comprehension in Proficient And Non-Proficient Languages (Bovee and Raney, 2015)

Bovee and Raney (2015) tested 45 English-Spanish bilinguals with a high proficiency level in English and a low proficiency level in Spanish. Basic knowledge of Spanish was ensured by only using participants who had taken at least two years of high school Spanish or two semesters of college Spanish and by giving them a Spanish proficiency test.

Participants read four texts in each language and answered six comprehension questions about each passage. Within each language, two texts were read while performing the letter detection task and two texts were read normally (no letter detection task). Passage language and task type were blocked and block order was counterbalanced across participants. This produced eight versions of the experiment. For example, in version 1, participants read two passages normally in English, then performed letter detection on two passages in English, then read two passages normally in Spanish, then performed letter detection on two passages in Spanish. In version 2, participants performed letter detection before reading normally (read two passages normally in English, then performed letter detection on two passages in English, then read two passages normally in Spanish, then performed letter detection on two passages in Spanish).

The passages and comprehension questions were taken from a norming study by Daniel and Raney (2007). The passages consisted of 400-word descriptions of the procedures involved in common activities such as making coffee or brushing your teeth. Because the passages and questions were created in English, they were translated into Spanish by two native Chicago Spanish Speakers (i.e., Native Spanish speakers who were born un the U.S. and were educated in an English-speaking education system). The passages were presented on paper and participants were instructed to circle every instance of the target letter *T* in English and the letter *L* in Spanish. Different target letters were used for each language to make sure the target letter in both languages had a similar frequency and occurred in the word *the* and plural *they* in English and the Spanish equivalents of *the* and *they* (el, ellos, los, la, ellas, las, which represent the masculine singular, masculine plurals, feminine singular, feminine plurals). The letters *T* in English and *L* in Spanish are one of the three most commonly used letters in each language (Brysbaert & New, 2009). Participants answered six, multiple-choice comprehension questions after reading each passage. The comprehension questions required knowledge of a variety of information, such as what words occurred in a passage (fill-in-the-blank), what the text actually stated (fact recall), or mild inferences.

Consistent with prior literature, Bovee and Raney found that participants had smaller overall letter detection error rates in Spanish (the second language, or L2) than in English, (the first language, or L1), and a normal MLE for the English passages. Interestingly, they found a small but significant, reversed MLE in Spanish (more errors on content words than function words). Regarding comprehension, they found that performing the letter detection task significantly reduced comprehension only for the English passages. Bovee and Raney suggested that because participants' knowledge of Spanish was basic, they might have emphasized the search component of the letter detection task more than the comprehension component of the reading task when reading Spanish passages. This would explain why overall comprehension was not affected by the letter detection task in Spanish. Emphasizing the search component can also explain the reversed MLE. Because function words tend to be shorter (fewer characters) in length than content words, target letters should be easier to identify in function words due to fewer letters surrounding the target letters. The letter detection task was completed slower in Spanish than English, which could also explain the lower overall error rate.

Bovee and Raney's results indicate that when performing the letter detection task in the less-proficient language, reader's attention was more focused on word features, like letters, and less focused on more important features such as grammatical class or word function. Consequently, performing the letter detection task in the non-proficient language resulted in lower overall comprehension and slower reading times. This in turn led to fewer overall detection errors. Bovee and Raney suggested that the target letter search component of the task was emphasized in Spanish. This would lead to better letter detection in shorter words, which tend to be function words, than in longer words, which tend to be content words.

Adding the results of Bovee and Raney to the literature leads me towards the conclusion that as language proficiency decreases, knowledge of word features such as word function, word frequency, and word roles also decreases, which increases the attention given to performing the letter detection task while reading for comprehension. This then leads to slower reading times, which in turn supports detection of more target letters (lower error rates), especially in shorter words. In essence, reduced proficiency leads to an overall smaller standard MLE or even a reversed MLE if the readers have a very basic or no knowledge of the second language.

D. Evaluating Missing-Letter Effects in Proficient Bilinguals: A Pilot Study

One reason Bovee and Raney (2015) might have found a reverse MLE in Spanish is that their participants were of low proficiency in Spanish. A logical prediction is that if they used bilinguals who were proficient in both languages, they might not have found a reversed MLE in Spanish. To explore this prediction, I performed a pilot study that replicated Bovee and Raney's procedure, but used bilinguals who were native English speakers who were also highly proficient in Spanish.

To ensure participants were proficient in in both languages, I had participants complete a short Language History Questionnaire (LHQ) to collect data on their language backgrounds and self-ratings of proficiency on the languages they know. They also completed the vocabulary tests and cloze tests in both languages that Bovee and Raney used to establish a proficiency measure. The English vocabulary test was developed by Raney, whereas the Spanish vocabulary test and the cloze tests for each language were taken from the diplomas de Español como Lengua Extranjera (http://www.dele.org), adapted by Montrul (2005). The vocabulary tests were used to assess word knowledge in each language. For the Spanish measure, participants had to choose from four options what would best fit a blank in a sentence. For the English test, participants were required to choose the best definition for a given word from 5 alternatives. In order to assess grammatical knowledge, participants also completed a cloze test in each language. In these tests, participants read a passage in each language with many words missing. The English cloze test uses a 291-word passage that had 40 missing words (represented as blank lines), the Spanish cloze test uses a 313-word passage that had 20 missing words. After reading an entire passage, participants had to choose the best of 3 options to fit each blank in the passage. Based on these measures, the most proficient participants were used to make sure all participants were highly proficient bilinguals (See these proficiency measures in Appendix A and B).

Other than using proficient English-Spanish bilinguals, the only difference between the pilot study and Bovee and Raney's study was that I only used four of their eight passages in the pilot study. For each language, participants read one passage while performing the letter detection task and read one passage normally. The passages in English were exactly the same as in Bovee and Raney. However, the Spanish passages were changed slightly. Prior to running the pilot experiment, two proficient bilinguals who were native Spanish speakers born outside of the U.S. and completed their basic and undergraduate education in a Spanish-speaking education system proofread the original translations and found a small number of errors. I was one of these individuals (I was born in Bogotá, Colombia). The other person was a Hispanic Linguistics Ph.D. student who was born in Alicante, Spain. The passages used by Bovee and Raney had to be revised because there were some mistakes in gender marking and accents (e.g., un alternativa instead of una alternativa). We created and "international" Spanish version of the passages, this changed about 4% of the words, details about this are provided in the methods section of the primary experiment below. These corrections did not change the meaning of any words or sentences. Correcting the passages ensured they could be used with Spanish speaking people who grew up in Chicago as well as with native Spanish speakers across Latin American countries and Spain. One possible reason for the errors is that most native Spanish speakers in Chicago are raised in an English-speaking education system and read and write in Spanish much less frequently than in English. As such, they are not as proficient in reading and writing Spanish as they are in speaking and comprehending Spanish. They also tend to be education in English-only speaking schools. This leads to minor errors when writing in Spanish.

The procedure and task instructions were the same as in Bovee and Raney. Participants were given a paper package with the passages for the letter detection task and for normal reading. The instructions and comprehension questions were administered using a computer. Participants were instructed to either read normally or read while circling every instance of the target letter (*T* in English and *L* in Spanish). Because our participants were highly proficient in both languages, I expected a standard MLE for both languages, meaning no reversed MLE for

Spanish. I also expected a slightly larger MLE in English since English is the dominant language for most of the participants.

I found a standard MLE in English (7% more errors on function words than content words). Contrary to my predictions, I found a reversed MLE in Spanish (4% more errors on content words than function words). This matches the pattern found Bovee and Raney, who found a 15% MLE in English and a 7% reversal in Spanish. To further examine the reversed MLE, I calculated the MLE in three ways: I compared all content words to all function words (the same method used by Bovee and Raney), all content words to only the word *the* or the Spanish equivalents (since *the* is the most common word in the English language), and all content words to all function words excluding *the* or the Spanish equivalents. I found the same pattern in each comparison.

These new intriguing results support the conclusion that the reversed MLE found by Bovee and Raney for the Spanish passages cannot be explained by their use of non-proficient Spanish speakers. If language proficiency cannot explain the reversed MLE, then alternative explanations are needed. Two explanations seem reasonable. First, there might be critical differences between the English and Spanish languages that support the different MLEs. One important difference is that Spanish is a gender marked language. Function words play a more important role in Spanish because they prepare the reader to process the following content word with a specific gender. As a result, more attention might be given to function words in Spanish, which might substantially alter the letter detection error rate. Second, the education system bilinguals go through might also play an important role in how words are processed, which would in turn influence the MLE. Because Bovee and Raney's bilinguals typically attended English-language dominant schools, they don't have as much experience reading in Spanish as they do in English. Consequently, their bilinguals might have paid less attention to the syntactic structure of Spanish, such as not fully attending to the function words. In some sense, the participants might be reading the Spanish passages using English reading processes. Together, this could have led Bovee and Raney's bilinguals to detect more target letters in function words than in content words, producing a reversed MLE.

E. Gender Roles in Spanish and the Importance of Gender Marking and How It Influences Language Processing

One explanation for the results of my pilot study is that gender marking might influence the MLE. When processing a gender marked language, readers might pay more attention to function words because they carry more syntactic and semantic information than in non-gender marked languages. In Spanish there are gender roles for every word.

Several researchers have shown the important role gender marking plays in language processing. For example, Sato and Athanasopoulos (2018) conducted two experiments with French-English bilinguals designed to assess the extent to which grammatical gender influences bilinguals' judgments about perceptual gender. In their first experiment, French-English bilinguals were presented with images of a pair of objects that have a specific grammatical gender or a neutral gender followed by a facial image. Participants were asked to decide as quickly as possible if the facial image was represented by the two objects. Half of the object prime pairs were grammatically feminine and the other half were grammatically masculine. The object primes were matched with either masculine facial images, feminine facial images, or gender-neutral (ambiguous) facial images. They found that gender-neutral triads took significantly longer time to judge than gender-laden triads. They also found a significant effect of gender congruency, meaning that when the grammatical gender of the prime objects matched the gender of the facial image (e.g., two masculine prime objects and a masculine facial image), responses were significantly faster than with grammatically incongruent triads (e.g., two masculine prime objects and a feminine facial image). These results suggest that bilinguals use prior conceptual and grammatical knowledge to make categorical judgments about gender, and that the processing facilitation created by having gender marking can increase and decrease response times in decision tasks. These results also show that grammatical gender has a robust and persisting effect on bilinguals, meaning that retrieval of gender grammatical information is an automatic process that is independent of task requirements. In short, bilinguals might automatically pay more attention to function words because they indicate the gender of the noun that follows them.

Brouwer et al. (2017) designed a study using eye tracking to investigate whether Dutch children were able to use gender marking in article words preceding object images to anticipate an upcoming label for the objects. They were also interested in understanding whether children's online processing and production of gender marking of articles were related. Forty-nine monolingual Dutch-speaking children and 19 native Dutch-speaking adults were presented sets of object images that corresponded to nouns on a computer screen while they received verbal instructions that contained an article that was either gender-marked or gender-neutral (i.e., *de* for "the" masculine and feminine articles of gender marked nouns, or the article *het* for neuter nouns). Articles such as *de* in Dutch do not provide much information because they can be used with both genders (e.g., *de zangeres* for female singer or *de zanger* for male singer). However, the article *het* immediately tells the reader that the coming noun is gender neutral (e.g., *het huis* for the gender neutral noun for house). In their experiment, participants were presented the images while listening to simple phrases like "the house or the shoe." The gender of the article *the* was changed on each set to investigate whether this influenced the fixations participants made on each object. For instance, an article-noun pair such as *the shoe* in Dutch, is feminine (*de schoen*) as indicated by the use of *de*, but it in some instances it was presented as neuter by using the article *het*. Brouwer et al. measured fixation counts, fixation times, and gaze durations to determine whether gender marking supported anticipation effects (i.e., before the onset of the noun) and facilitation (i.e., from noun onset) and, as well as to evaluate the time course of the gender marking manipulation. They found that participants had significantly more fixations on a target noun when the article was presented with a different gender than when it was presented with the same gender. Likewise, they also found that for the gender-neutral nouns, participants were able to use gender marking from the noun onset but not in an anticipatory way. In short, they found participants were able to use gender marking both before the onset of a noun (anticipation) and from the noun onset (facilitation). These findings suggest that Dutch comprehension is facilitated online by gender marking, and that the influence of gender marking might begin even before a target word has been heard. Once more, this provides evidence that gender marking plays a vital role in sentence processing.

Guillelmon and Grosjean (2001) examined gender marking in French and concluded that noun recognition is strongly affected by the gender marking of the function word that precedes it. Guillelmon and Grosjean presented native French-speaking monolinguals and early English-French bilinguals a set of 36 French nouns (half masculine and half feminine) along with a gender-marked adjective. They manipulated the gender marking of the adjective to create three conditions: a correctly gender marked adjective, an incorrectly marked adjective, and a gender-neutral adjective. Participants listened to a phrase that contained an adjective (in one of the three conditions) and a noun (e.g. *le joli glace*, the nice mirror), after which they were asked to repeat the noun as quickly as possible. They found a significant gender congruency effect. Response times were fastest (facilitation) when the gender of the adjective had the correct gender marking for the noun that followed, slower when the adjective was gender-neutral, and slowest (inhibition) when the adjective's gender was incorrect. Their results provide evidence that monolinguals and early bilinguals show a facilitation and inhibition effect due to gender marking.

Bobb and Mani (2013) found that even toddlers use gender information. They conducted an object identification experiment using 24-month-old German toddlers. Participants heard a label for a familiar target object (e.g., an apple) and saw two side-by-side images of familiar objects, one of which was the target (i.e., the apple). Pairs of images could share gender and were categorically related or not. These pairs were categorized into four conditions: (1) a semantically congruent and gender incongruent pair (i.e., two fruits that are semantically congruent but each fruit has a different grammatical gender); (2) a semantically congruent and gender congruent pair (i.e., two fruits that are semantically congruent and have the same grammatical gender); (3) a semantically incongruent and gender incongruent pair (i.e., a fruit and an animal represent a semantically incongruent pair with different grammatical gender); and (4) a semantically incongruent and gender congruent pair (i.e., a fruit and an animal to meet the semantically incongruency requirement but with the same grammatical gender). To determine whether the toddlers had identified the target object, the proportion of time children looked at the target was calculated. Toddlers looked at the target object sooner and looked at it for a longer period of time when there were either semantic or gender incongruences. This indicates that the toddlers were able to form both semantic and grammatical gender categories, which demonstrates that gender was activated as a source of information during the object identification task. This shows that grammatical gender marking is not only a key factor when processing language, it's also something that children whose native language is gender marked are learning very early in their lives.

Padovani et al. (2005) showed that the brain responds to gender information. They conducted an fMRI study with the purpose of mapping grammatical gender processing in native Italian speakers. They found frontal activation in the right hemisphere (BA 44) while participants performed a metalinguistic gender decision task. They also found activation in middle temporal gyrus (BA 21) associated with comparing morphological suffix information and the lexical representation of gender. This shows that the grammatical gender processing has neural basis.

In summary, there is evidence that children and adults automatically process gender information in their L1 or advanced proficiency L2. When the gender of a function word is correct and matches the subsequent content word or image, the content word or image is processed faster than if there is a mismatch (a grammatical gender error). Taken together, these findings support the conclusion that function words play a more important role in gender marked languages than they do in non-gender marked languages. However, no one has taken into account how grammatical gender marking could affect the MLE, and there is very little research on the MLE with Spanish speaking bilinguals. The present study fills this gap by providing important information regarding how gender marking influences the MLE in proficient English-Spanish and Spanish-English bilinguals.

F. Present Study

Previous research has shown that for some languages the MLE changes as a function of the reader's language proficiency. However, these studies did not take into account the possible influence grammatical gender marking could have on the MLE. Differences in the MLE as a function of gender marking might help explain the rare finding of a reversed MLE in bilingual readers with both low and high proficiency in their second language, which is usually a gender marked language such as Spanish, French, or Hebrew (Koriat & Greenberg, 1993; Greenberg & Saint-Aubin, 2004, Bovee & Raney, 2015). The aim of the present study is to test how proficient and of gender marking in language affect the MLE.

To accomplish this, I extended Bovee and Raney's (2015) research by conducting the same experiment with two different participant samples. Bovee and Raney's participants were English dominant, non-proficient bilinguals who had Spanish as their second language and who grew up and were educated in an English-speaking country. Their participants use of Spanish was likely very limited. The present study uses two groups of bilinguals who were highly proficient in both English and Spanish. The first group is composed of English-Spanish bilingual students from the University of Illinois at Chicago who have English as their dominant language. These students had Spanish as their native language (although some simultaneously learned English), were raised in an English-dominant location (the Chicago metropolitan area), began learning English at a very early age, and were educated in an English-speaking school systems. The second group is composed of Spanish-English students from Los Andes University in Bogotá, Colombia. These students had Spanish as their native language (although some simultaneously learned English), were raised in a Spanish-dominant location (the Bogotá metropolitan area), began learning English at an early age, and were educated in a Spanish-speaking school systems, although some of the school systems included bilingual education. In essence, I used English-Spanish bilinguals from UIC and Spanish-English bilinguals from Los Andes.

By using highly proficient bilinguals, I'll be able to confirm the results of my pilot study (which also used proficient bilinguals from UIC), which showed a reversed MLE in Spanish for proficient English-Spanish bilinguals. By including proficient bilinguals who were educated in English-dominant and Spanish-dominant cultures and educational systems, I'll be able to investigate whether language dominance influences the MLE. Using these participant groups allowed me to test three competing hypotheses for the reversed MLE in Spanish found by Bovee and Raney (2015).

1. If the reversed MLE in Spanish happens because participants are not proficient in Spanish, then using highly proficient bilinguals should eliminate the reversal in Spanish. In other words, there should be a standard MLE for both participant groups (UIC and Los Andes) in both English and Spanish. This prediction reflects only a main effect of Word Type (see Figure 2 for a graphic illustration of this prediction).
2. If the reversed MLE is caused by Spanish being the non-dominant language, then English-Spanish bilinguals from UIC, for whom English is the dominant language, should produce a normal MLE for English and a reversed MLE for Spanish (the non-dominant language). In contrast, Spanish-English bilinguals from Los Andes, for whom Spanish is the dominant language, should produce a normal MLE for Spanish (the dominant language) and a reverse MLE for English (the non-dominant language). This prediction reflects a Language Dominance X Word Type X Passage Language interaction. If overall error rates also change as a function of which language is the dominant language, participants should produce higher error rates for the passages in their dominant language than in their non-dominant language (see Figures 3A & 3B for a graphic illustration of this prediction).

3. If the reversed MLE in Spanish happens because Spanish is a gender marked language, using proficient bilinguals should not eliminate the reversed MLE in Spanish. In which case, I expect a reversed MLE in Spanish and a standard MLE in English for both groups of bilinguals. This prediction reflects a Word Type X Passage Language interaction (see Figure 4 for a graphic illustration of this prediction).

II. METHOD

A. Participants

After excluding 50 participants that didn't meet some of the requirements (which will be explain later). The current study has 80 undergraduate students from two universities. The first group was 40 students from Universidad de Los Andes (Bogotá, Colombia) who were given course credit for their participation. Students from Los Andes were native Spanish speakers who were proficient in English (their second language). To ensure proficiency in English, the students must have attended a bilingual speaking high school for at least 2 years and scored high on the English proficiency measures (described below). The second group was 40 native Spanish speaking students from the psychology subject pool at the University of Illinois at Chicago (UIC). To ensure proficiency in both languages, UIC participants were required to have begun learning Spanish before the age of 6 and scored high on the proficiency measures. All UIC participants had at least 10 years of experience reading English in an educational setting, such as school. Participants from both universities were proficient in each language (assessed using vocabulary tests in both languages and a language history questionnaire that will be described below in the materials section), but the dominant language for UIC students was English and the dominant language for Los Andes students was Spanish.

B. Materials

1. Proficiency measures

Following Bovee and Raney's (2015) procedure, proficiency for each language was measured using a combination of vocabulary tests and a Language History Questionnaire (see Appendix A and B). The vocabulary tests provide measures of word knowledge in each language. Using the same combination of proficiency tests as Bovee and Raney allowed me to make direct comparisons of the results across studies.

I used the English vocabulary test developed by Raney, which is a 30-question multiple-choice test, with 5 options per item. The test was designed to have an average score of approximately 15 for first-year college students. Both the Los Andes (*M* = 17.33, *SD* = 3.66) and UIC (*M* = 14.18, *SD* = 3.38) participants obtained scores near the expected average, and above the minimum required to be considered knowledgeable of English (i.e., 8 points or above). Raney's vocabulary test has been used in prior related studies (Bovee et al., 2008; Minkoff & Raney, 2000, Therriault & Raney, 2007) and has shown to be moderately correlated with comprehension ability (*r* = 0.40 to 0.52). The test also has been shown to be correlated with existing standardized tests of vocabulary knowledge (Ferguson et al., 2018). Raney (2020, personal communication) has found that scores on the test tend to increase as students progress through college (i.e., first-year students tend to score lower than fourth-year students). This might explain why the Los Andes students, who tended to be third- and fourth-year students, scored slightly higher than UIC students, who tended to be second to third-year students.

The Spanish vocabulary test was taken from the diplomas de Español como lengua extranjera (http://www.dele.org), adapted by Montrul (2005), which also is a 30-question multiple-choice test. Participants had to choose from four options what would best fit a blank in a sentence. Both the Los Andes (*M* = 29.18, *SD* = 1.01) and UIC (*M* = 23.33, *SD* = 3.47) participants obtained scores above the minimum required to be considered highly knowledgeable of Spanish (i.e., 20 points or above).

2. <u>Language History Questionnaire (LHQ)</u>

I used a shortened version of the Language History Questionnaire as Bovee and Raney to collect participants' self-ratings of language proficiency, language background, and general experience with each language they know. Participants completed the language history questionnaire via a Qualtrics survey. This questionnaire asked participants about their experience with every language they know or have attempted to learn (up to five languages). However, because I'm only interested in their ratings and experience with English and Spanish, a shorter version was created that limits their ratings to their native language and their second language, which were English (L1) and Spanish (L2) for UIC participants, and Spanish (L1) and English (L2) for Los Andes participants.

The LHQ includes participant self-ratings of comprehension proficiency when listening, speaking, writing, and reading; time and percentage of use of each language; how the languages were learned; which language they spoke first; which language they consider their native language; where they use each language the most; age of exposure to each language; and amount of weekly exposure and type of use for each language (how often do they read, write, listen to music, or watch TV). As expected, UIC students rated themselves as slightly more proficient in English than in Spanish, whereas Los Andes students rated themselves as slightly more proficient in Spanish than in English.

TABLE I

AVERAGE LANGUAGE HISTORY QUESTIONNAIRE SELF-REPORTED SCORES FOR ENGLISH

Measure	Group	M	SD
Speaking	UIC	9.55	0.78
	LA	6.82	2
Understanding	UIC	9.53	0.85
	LA	7.93	1.4
Writing	UIC	9.3	0.9
	LA	6.58	1.8
Reading	UIC	9.49	0.9
	LA	8	1.2

TABLE II

AVERAGE LANGUAGE HISTORY QUESTIONNAIRE SELF-REPORTED SCORES FOR SPANISH

Measure	Group	M	SD
Speaking	UIC	8.73	1.45
	LA	9.8	0.46
Understanding	UIC	9.13	1.14
	LA	9.84	0.37
Writing	UIC	7.83	1.71
	LA	9.47	0.81
Reading	UIC	8.48	1.54
	LA	9.62	0.61

3. Passages and comprehension questions

The passages and comprehension questions were taken from Bovee and Raney (2015), which were derived from the set of normed stimuli by Daniel and Raney (2014). As in the pilot, I used four of the eight original passages for the experiment as well as two practice passages used by Bovee and Raney. Each passage had three comprehension questions. Only four passages were used (as opposed to all eight in Bovee and Raney) because there was a 60-minute time limit for experiments at Los Andes University.

The passages were 400-word expository texts that describe common everyday actions such as brushing your teeth or gardening. The passages and questions were translated for the pilot study by two native Spanish speakers who created one agreed-upon translation. The final translation was checked and modified by two native Spanish speaking graduate students from the Psychology and Spanish departments at the University of Illinois at Chicago, who created an *international Spanish* version that was 96% similar to the original version of the passages used by Bovee and Raney (2015). As described earlier, the original passages contained several errors in gender assignment and other errors. The gender of approximately 35 words per passage (less than 10% of the passage) was changed in the revised version based on the correct standard of the RAE (Real Academia de la Lengua Española). This ensures correct gender marking based on a formal standard so that the passages can be used with Spanish-speakers from all over the world.

Each passage had a set of three multiple choice questions: one surface form question that tested memory for wording; one text-based question that test comprehension and memory for content; and one situation model question that required the ability to apply knowledge to a new topic (i.e., make a simple inference). The primary purpose of the comprehension questions was to ensure that students read for meaning. However, the comprehension questions can also serve as a secondary measure of language proficiency.

4. Reading Tasks

Participants read two of the texts in English and two in Spanish. Passage language was counter-balanced across participants. Language was blocked such that participants always read two texts in one language and then two texts in the other language. According to Grosjean (1998), blocking by language helps put participants in a given language mode. Within each language block, participants read one of the passages normally for comprehension and completed letter detection on the other passage. Task order was counter-balanced across participants. After reading each passage, participants answered the three comprehension questions in the corresponding language. Eight versions of the experiment were created to ensure that each of the four passages was used both for normal reading and letter detection and to counterbalance the order of passage presentation and conditions across participants.

For the normal reading passages, participants were instructed both in the paper packet and on the computer to read for comprehension. For letter detection passages, participants were instructed both in the paper packet and on the computer to read the passage and circle every instance of the target letter (*T* for English and *L* for Spanish) as quickly and accurately as possible. They were also instructed not to correct any mistakes they noticed (i.e., do not go back to circle a target letter they noticed they missed).

C. Procedure

Participants were tested in small groups of up to seven participants. Before beginning the experiment, participants read and sign the informed consent form. Each participant had a separate desk with an empty desk between participants so that they could not see each other’s materials. The paper packets included instructions and were used to read the passages in the normal reading condition and perform the letter detection task. This ensured that the presentation format for normal reading and letter detection were identical. Passages were presented double-spaced in Courier 12-point font. Participants were also given a computer with a Quatrics survey that was used to provide instructions, measure normal reading and letter detection times, answer the multiple-choice comprehension questions after each passage, complete the language history questionnaire, and complete the vocabulary tests.

Participants began the session by completing the reading and letter detection tasks (in the order of the experiment version they were randomly assigned). Before reading a passage, participants' mouse clicked on the "Next" button on the bottom right of the computer screen to signal that they were starting a passage and then clicked it again to signal they were done reading the passage so that reading time/task time was collected, as seen in Table 3.

TABLE III

AVERAGE PASSAGE READING TIMES FOR NORMAL READING AND LETTER DETECTION

Language Group	Passage Language	Normal Reading		Letter Detection	
		M	*SD*	*M*	*SD*
UIC	English passages	163	53.2	307	86.9
	Spanish passages	216	61.2	290	79.2
LOS ANDES	English passages	195	59.9	343	82.7
	Spanish passages	169	56.9	289	70.7

After reading each passage, participants answered the comprehension questions on the computer. As seen in Figure 1, after finishing the task in both languages, participants completed the vocabulary tests and the Language history questionnaire via a Qualtrics survey.

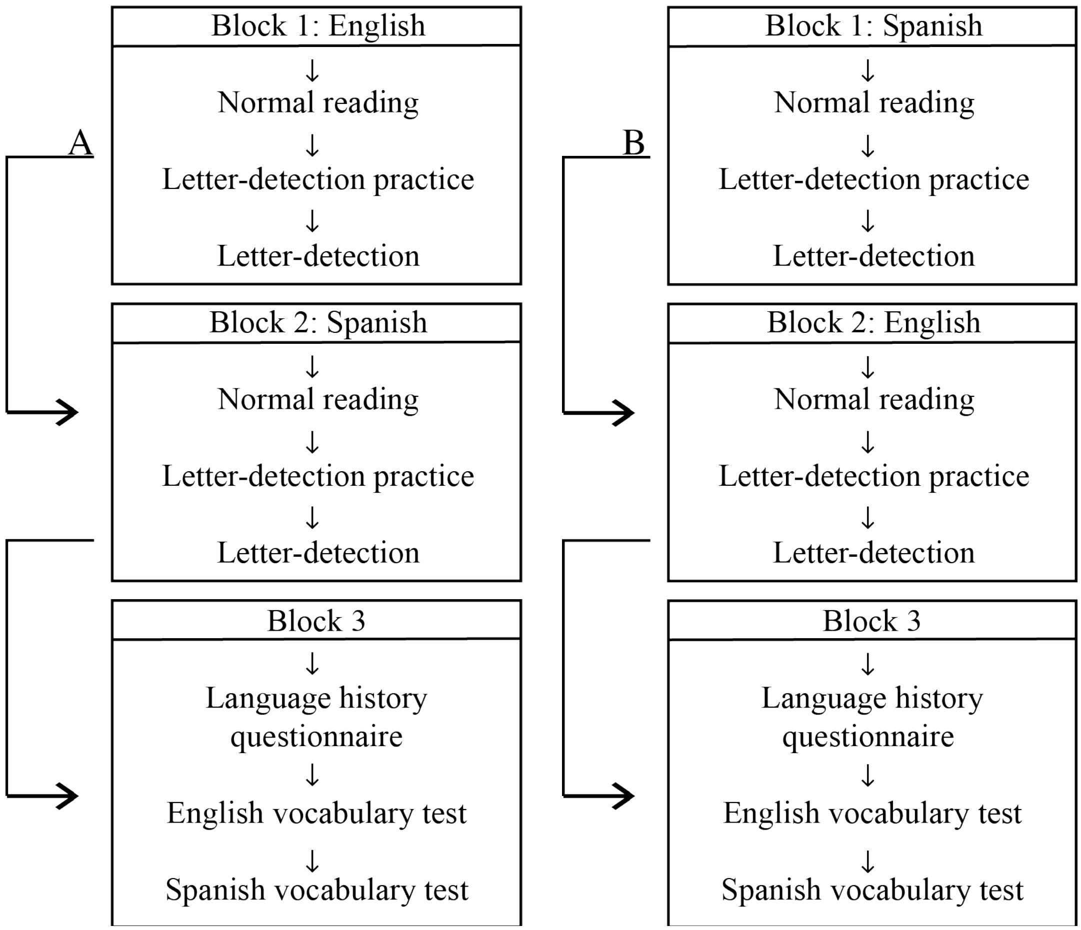

Figure 1. Experiment procedure diagrams.

III. RESULTS

Data from 69 participants from UIC and 61 participants from Los Andes were collected for a total of 130 participants. Due to a programming error on the Qualtrics Survey used to collect the reading and task time data, 25 people were initially excluded. Participants were instructed to press the space bar when they began letter detection and again when they completed letter detection. If participants held down the space bar or inadvertently pressed it twice in succession, their letter detection task times were not recorded. This problem was solved by changing the program to not allow two space bar presses in quick succession after starting the letter detection task.

Of the remaining 105 participants, several were excluded for not meeting one or more of our selection criteria. Specifically, 2 participants were excluded for not meeting the minimum Comprehension Score (a comprehension score of two standard deviations below the mean); 15 were excluded for reading very quickly, which was taken as evidence of not taking the task seriously (a reading time of three standard deviations bellow the mean); 2 were excluded for not meeting the minimum Spanish proficiency requirement as defined by a vocabulary score above 80%; and 1 participant was excluded for not being bilingual (i.e., having language proficiency self-reports of less than 8 out of 10 points on reading, writing, speaking or understanding one of the two languages). After filtering the data set to meet these criteria a total 12 participants from the UIC sample and 8 from the Los Andes sample were excluded, leaving 40 participants in the UIC sample and 45 participants in the Los Andes sample. To create equal sample sizes, 5 participants from the Los Andes group were randomly removed.

Each letter detection passage was scored to calculate letter detection error rates (i.e., the proportion of missed target letters) and the MLE (i.e., the proportion of error for function words minus the proportion of error of content words) for each participant for each passage. These measures were calculated based on the first instance of a target letter in a word (i.e., only the first t in *ticket* was scored). For words with multiple target letters, the second and third instances of the target letters were excluded from the analysis. The analyses were repeated using words with only one target letter (e.g., the word *ticket* was excluded). The results were extremely similar; therefore, results based on words with only one target letter are not presented.

A. <u>Error percentage</u>

A 2 X 2 X 2 mixed-designed analysis of variance (ANOVA) was performed to examine the effect of Dominant Language (English Dominant, Spanish Dominant), Passage Language (English, Spanish), and Word Type (Function vs. Content) on error percentage. Dominant Language was a between-subjects factor, and Passage Language and Word Type were within-subjects factors. Participants from UIC comprise the English-dominant group and participants from Los Andes comprise the Spanish-dominant group, for simplicity from now on I will refer to the English-dominant group as the UIC group and the Spanish-Dominant group as the Los Andes group.

There was a significant main effect of Passage Language, $F(1, 78) = 75.83$, $p < .001$, such that participants made 12% more errors on the English Passages ($M = 0.40$, $SE = 0.01$) than on the Spanish passages ($M = 0.28$, $SE = 0.01$). There was also a significant main effect of Word Type, $F(1, 78) = 4.79$, $p = .03$, showing that participants made 3% more errors on Function words ($M = 0.36$, $SE = 0.01$) than on Content words ($M = 0.33$, $SE = 0.01$). There was no significant main effect of Dominant Language, such that the error percentage of the UIC group ($M = 0.34$ $SE = 0.02$) did not differ substantially from the Los Andes group ($M = 0.35$, SE = 0.02), $F(1, 78) = 0.01$, $p = .86$. Additionally, there was a significant Dominant Language X

Passage Language interaction, $F(1, 78) = 25.99$, $p < .001$, a significant Word Type X Dominant Language interaction, $F(1, 78) = 7.35$, $p = .008$; and a significant Word Type X Passage Language interaction, $F(1, 78) = 47.27$, $p < .001$. Finally, there was no significant Word Type X Dominant Language X Passage Language interaction $F(1, 78) = 2.88$, $p = .09$

To follow up the Dominant Language X Passage Language interaction, planned comparisons using a Tukey correction were performed to examine whether the UIC and Los Andes participants had different error rates for English and Spanish passages (i.e., simple effects). As shown in Figure 5, for Spanish passages, the UIC group made significantly fewer errors ($M = 0.25$, $SE = 0.02$) than the Los Andes group ($M = 0.32$, $SE = 0.02$), $t(107) = -2.12$, $p = .03$. In contrast, for the English passages, the UIC group made more errors ($M = 0.44$, $SE = 0.02$) than the Los Andes group ($M = 0.38$, $SE = 0.02$), $t(107) = 1.88$, $p = .06$, but in this case the difference only approached significance. These findings are in line with the idea that participants make more errors in their dominant language.

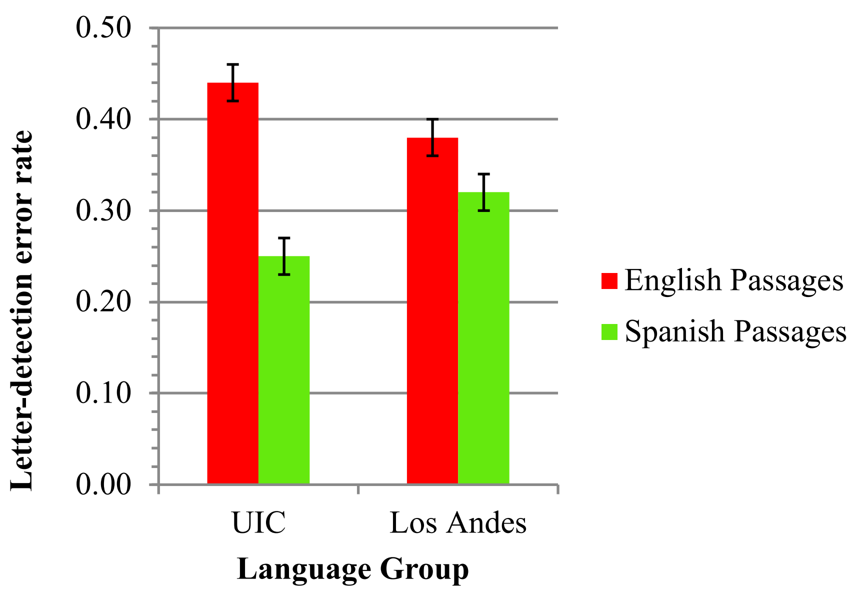

Figure 2. Dominant Language X Passage Language interaction. Error bars represent ± 1 standard error.

To follow up the Word Type X Dominant Language interaction, planned comparisons using a Tukey correction were performed to examine whether the UIC and Los Andes participants had different error rates for function words and content words. As shown in Figure 5, the UIC group made significantly more errors on Function words ($M = 0.37$, $SE = 0.02$) than on Content words ($M = 0.32$, $SE = 0.02$), $t(78) = 3.4$, $p < .001$. Generating an overall MLE of 5% that I'll present later. However, for the Los Andes group, error rates on Function words ($M = 0.34$, $SE = 0.02$) and Content words ($M = 0.35$, $SE = 0.02$) did not differ, $t(78) = -0.36$, $p = .71$. Which led to no overall MLE for this group.

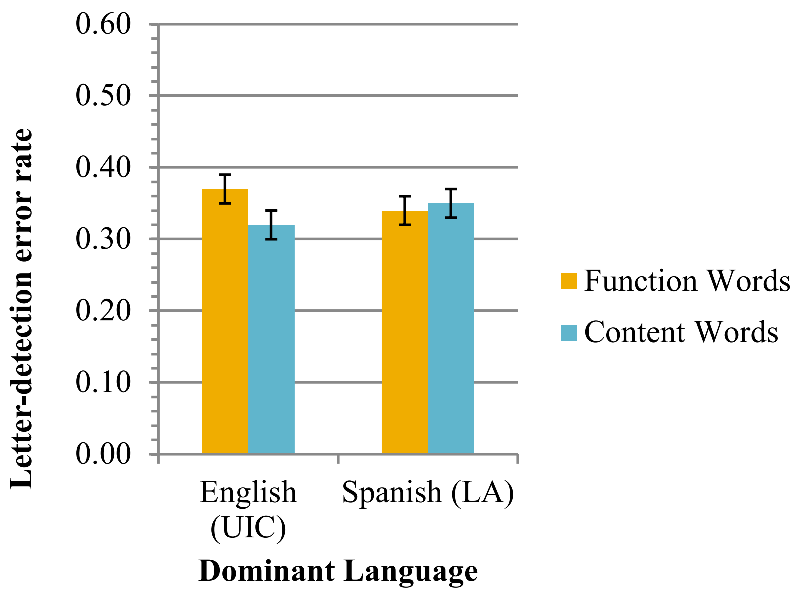

Figure 3. Word Type X Dominant Language interaction. Error bars represent ± 1 standard error.

To follow up the Word Type X Passage Language interaction, planned comparisons using a Tukey correction were performed to examine whether the error rates for function words and content words differed for English and Spanish passages. As shown in Figure 7, when reading passages in English, participants made significantly more errors on Function ($M = 0.45$, $SE = 0.01$) than on Content words ($M = 0.37$, $SE = 0.01$), $t(150) = 6.03$, $p < .001$. Which reflected a standard MLE of 8%. On the other hand, when reading passages in Spanish, participants made significantly less errors on Function words (*M* = 0.27, *SE* = 0.01) than on Content (*M* = 0.30, *SE* = 0.01), *t*(150) = -2.64, *p* = .009. This reflects a small, reversed MLE of 2% for Spanish.

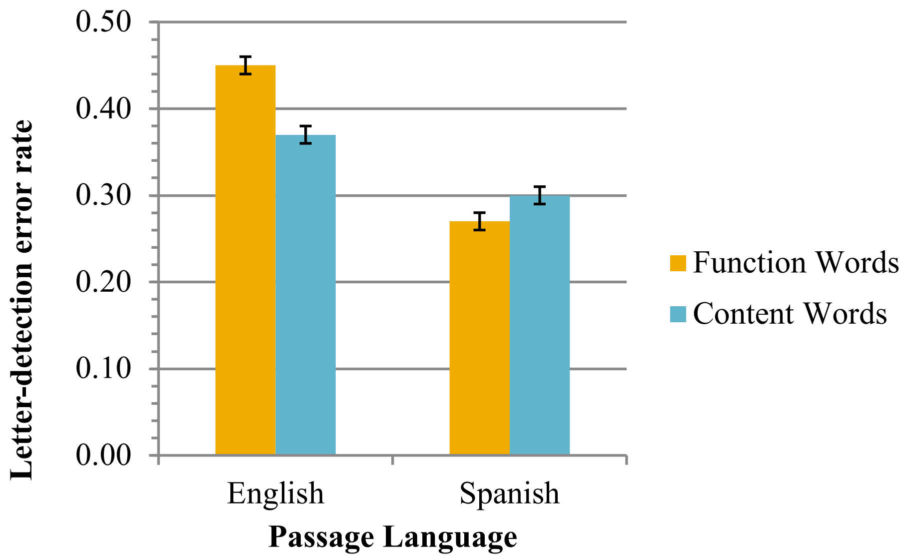

Figure 4. Word Type X Passage Language interaction for both groups. Error bars represent ± 1 standard error.

In summary, the error percentage findings showed that participants had higher error rates for the English Passages than for the Spanish passages, higher error rates for function than for content words, and that the overall error rates for the UIC group and the Los Andes group didn't differ. Most importantly, for English passages participants had higher error rates for Function than for Content words, and the opposite pattern occurred for Spanish passages—higher error rates for Content than for Function words. In essence, participants showed a standard MLE for English passages and a small but reversed MLE for Spanish passages.

B. <u>Missing Letter Effect</u>

The MLE was analyzed because it can be considered a more sensitive measure of the difference in function word and content word error rates because the MLE is calculated within each participant whereas differences in error rates between word type are calculated based on group means in the error rate analysis. As an example, if the error rate for one participant is 20% for function words and 15% for content words, the difference (MLE) is 5%. If the error rate for a second participant is 25% for function words and 20% for content words, the difference (MLE) is still 5% even though the overall error rate for the second participant is larger than the first participant. This reduces subject variability in the MLE analysis relative to the error rate analysis.

A 2 X 2 analysis of variance (ANOVA) was performed to examine the effect of Dominant Language (English Dominant, Spanish Dominant) and Passage Language (English, Spanish) on the Missing Letter Effect (MLE). Dominant Language was a between-subjects factor, and Passage Language was a within-subjects factor. Participants from UIC comprise the English-dominant group and participants from Los Andes comprise the Spanish-dominant group. Because the MLE represents the difference in error rates for function and content words, any main effects in this analysis are redundant with the interactions with Word Type in the error rate analysis. For instance, a main effect of Dominant Language in the MLE analysis is equivalent to the Dominant Language X Word Type interaction in the error rate analyses because both show that the difference between error rates for function words and content words (the MLE) changes as a function of Dominant Language (English or Spanish).

There was a significant main effect of Dominant Language, $F(1, 78) = 9.85$, $p = .002$, such that the UIC group showed a significantly larger MLE ($M = 0.05$, $SE = 0.01$) than the Los Andes group ($M = 0.003$, $SE = 0.01$). There was a significant main effect of Passage language, $F(1, 78) = 53.38$, $p < .01$, such that participants showed a significantly larger MLE on the English Passages ($M = 0.08$, $SE = 0.01$) than on the Spanish passages ($M = -0.02$, $SE = 0.01$).

Finally, there also was a significant Dominant Language X Passage Language interaction, $F(1, 78) = 5.95$, $p = .02$. This is equivalent to a Word Type X Dominant Language X Passage Language interaction in the error rate analysis, but note that this 3-way interaction was not significant in the error rate analysis.

To follow up the Dominant Language X Passage Language interaction, planned comparisons using a Tukey correction were performed to test for simple effects of Dominant Language (English Dominant and Spanish Dominant) at both levels of the Passage Language. For English passages, the UIC group showed a significantly larger MLE ($M = 0.12$, $SE = 0.01$) than the Los Andes group ($M = 0.03$, $SE = 0.01$), $t(151) = 3.97$, $p < .001$. However, for Spanish passages, the UIC group did not show a significantly larger MLE ($M = -0.01$, $SE = 0.01$) than the Los Andes group ($M = -0.03$, $SE = 0.01$), $t(151) = 0.85$, $p = .39$, which reflects that fact that the MLE is close to zero for UIC and Los Andes participants.

To summarize, the MLE was larger for the UIC group than for the Los Andes group, and there was a larger MLE for the English Passages than for the Spanish passages. Furthermore, the Dominant Language X Passage Language interaction showed that for the English passages, the UIC group had a larger MLE than the Los Andes group. However, the most important finding in this section is that for the Spanish passages, the MLE of both groups was not only smaller, but represents a slight reversal of the normal MLE.

IV. DISCUSSION

The results of the present study are easily summarized. First, when reading English passages, there was a standard MLE across both the UIC and Los Andes participants. Second, when reading Spanish passages, there was a very small, slightly reversed MLE across both the UIC and Los Andes participants. Third, participants had larger error rates (missed target letters) in their dominant language. Thus, UIC participants made more detection errors in English than did Los Andes participants, and Los Andes participants made more detection errors in Spanish than did UIC participants.

By testing proficient bilinguals, I was able to examine whether the reversed MLE for Spanish passages found by Bovee and Raney (2015) resulted from using non-proficient bilinguals. My first hypothesis (H1) was that the reversed MLE for Spanish found by Bovee and Raney (2015) was driven by the use of non-proficient bilinguals. If this was true, using highly proficient bilinguals should eliminate the reversed MLE in Spanish. I did not find this pattern; therefore, the results do not support H1. My second hypothesis (H2) was that using English-dominant participants caused the reversed MLE for Spanish. Recall that Bovee and Raney only tested English dominant bilinguals. If this hypothesis was true, my results should have replicated Bovee and Raney's findings for the UIC participants, who were highly proficient in English and Spanish but were English dominant. In contrast, I should have found the opposite pattern for our Los Andes participants (a standard MLE for Spanish and a reversed MLE for English), who were highly proficient in English and Spanish but were Spanish dominant. I found a standard MLE in English and a reversed MLE in Spanish for both the UIC and Los Andes participants; therefore, the results do not support H2. My third hypothesis (H3) was that the reversed MLE for Spanish was a consequence of Gender Marking in Spanish, which increases the importance of function words. If this was true, there should be a standard MLE for English passages and a reversed MLE for Spanish passages for both the UIC and Los Andes participants. My results fit this pattern; therefore, the results support H3. To summarize, the results best fit the hypothesis that gender marking in Spanish increases the importance of function words. This leads to increased attention given to function words, which in turn leads to increased letter detection accuracy for function words and a reversed MLE.

These results conflict with the predictions of both the Guidance Organization (GO) model and the Attentional Disengagement (AD) model. From a proficiency point of view, according to these models, letter detection error rates decrease because words are processed less efficiently in the second language. Consistent with this prediction, I found that the UIC group had lower error rates in Spanish (their second language) than in English (their dominant language), and the Los Andes group had lower error rates in English (their second language) than in Spanish (their dominant language). However, only the AD model has the potential to explain the reversed missing letter effect. Because gender marking could increase the importance of function words, increased attention should be given to function words, which in turn would lead to lower error rates for function words. Even if this is true, there is no reason to expect function words to become more important than content words, which would be necessary according to the AD model to explain the reversed MLE.

Overall, the results of this study shed light on the fact that neither of the GO model or the AD model can explain a reversal of the MLE. The consistent finding of a reversed MLE by Bovee and Raney (2015) and in the present study suggest that there is a gap in both models. The reversal found in Spanish, which is unrelated to language proficiency, is not consistent with either of the models. In the GO model, function words are pointers that guide the attention to content words. Because function words play a smaller role than content words in this model, there is no way to explain a reversed MLE. The GO model does state that different content words receive different amounts of attention. If different function words received different amounts of attention, then the GO model could explain some variation in error rates on function words, but the model cannot explain a reversal.

According to the AD model, the importance of a word guides the amount of attention given to the word. As soon as a word is accessed from memory, attention starts gradually shifting to the next word, with this process being slower for words that are given more attention. Like the GO model, the AD model does not contemplate the idea that function words could be more important than content words, even if these function words carry gender information. Consequently, the AD model also cannot explain why a reversed MLE occurs in Spanish.

Other researchers have found a reversal however, these reversals have not been consistent and have many methodological differences among them. Recall that previous experiments, such as Koriat and Greenberg (1993), found a reversed MLE when scoring only the second or third occurrence of a target letter in a word, which made readers detect more of the target letters in the later morphemes of function words. I found a slightly reversed MLE for Spanish even though scoring was based only on the first target letter in a word. To ensure my findings replicate Koriat and Greenberg's (1993) findings, I also examined error rates for the second and third instances of the target letters. For this scoring method I found slightly less overall error rates but exactly the same pattern of results. This confirms my results and provides evidence that the reversed MLE can be found when scoring only the first instance of a target letter.

To my knowledge only two other experiments have tested the MLE in Spanish bilinguals, but neither of them used high proficiency bilinguals. Thomas, Healy and Greenberg (2007) found a standard MLE using intermediate bilinguals, whereas Bovee and Raney (2015) found a reversal using low proficient bilinguals. Given that I found a reversed MLE for Spanish passages using highly proficient bilinguals, and Bovee and Raney (2015) found a reversal using low proficient bilinguals, why Thomas, Healy and Greenberg (2007) did not find a reversal is unclear. Furthermore, if gender marking alone leads to a reversed MLE, the reversal should occur in other gender marked languages, such as French. As previously discussed, Greenberg and Saint-Aubin (2004) found a standard MLE in French using English-French bilinguals, and later found a reversed MLE in French when they had English monolingual readers do the letter detection task in French (Greenberg and Saint-Aubin, 2008). The latter result can be ignored because the participants had no knowledge of French, but the former result is not consistent with my findings.

Given the inconsistent finding with gender-marked languages, perhaps additional properties of a language could be influencing letter detection accuracy. For example, the dominant word order in English is Subject-Verb-Object, Spanish word order is also Subject-Verb-Object. However, different word orders might emphasize the importance of content and function words differently. If this is true, then word order could influence letter detection accuracy and, consequently, the MLE. With this in mind, in the introduction I mentioned that the reversed MLE was found in French, Greek and Hebrew, which is why it is important to explore if these languages have different word orders. French is probably the best language for a comparison with Spanish because it is also a gender marked language with the same dominant word order as Spanish (Subject-Verb-Object). As mentioned before, Greenberg and Saint-Aubin (2004 & 2008) found a reversed MLE in French when performing the letter detection task on English monolinguals, but they attributed the reversal to their lack of knowledge in French. In essence their participants turned the task into a simple search task reversing the effect. However, their French-English bilinguals produced a standard MLE. Finding a standard MLE in a gender marked language with the same word order as Spanish suggests that gender marking cannot fully explain why I found a reversed MLE for Spanish. Perhaps word order is playing a role here.

On the other hand, Greek has both Subject-Object-Verb and Subject-Verb-Object word order instances. As mentioned before, Chitiri and Willows (1997) found a standard MLE for the Greek passages. The fact that Greek allows multiple word orders does not help clarify whether different word orders can cause a reversed MLE. Hebrew's Subject-Verb-Object word order also matches English. Koriat and Greenberg (1993) found a reversed MLE only for target letters that were the second or third occurrence in a word, which makes the word order comparisons a bit more complicated. They attributed this reversal to the fact that readers detected more of the target letters in later morphemes of function words, making the MLE disappear or even reverse. Koriat and Greenberg did not discuss word order.

While word order might play a role in the importance readers give to content and function words, the literature reviewed here provides inconsistent results that suggest this issue needs to be explored in future research. Word order might be interacting with gender marking or other language properties. For example, maybe gender marking might affect the MLE only in languages with certain word orders. But because of the inconsistencies found in the literature and the lack of information regarding the importance of word order, I think it's worth pointing out that although there is flexibility within these languages some interaction between gender marking and word order might be playing a role in reversing the MLE.

A. Limitations and future research

Because this is one of the first studies using letter detection in Spanish, is important to understand the limitations of the current study and the implications that can be drawn from the same. A potential issue that needs to be addressed in future research is the fact that a Standard MLE has been found in other languages that are gender marked, such as French (see Greenberg and Saint-Aubin, 2004). However, different studies have used differently scoring methods (e.g., scoring the second and third occurrences of a target letter in a word) and criteria for selecting target words (e.g., scoring "standard" words versus "special" words such as interlingual homographs, scoring all functions words or only equivalents of "the", or omitting words that appear on the left edge of the line or that start a sentence). I was less restrictive on these issues and found that my results did not change due to the position of the target letter in a word (i.e., first, second, or third occurrence). Because of this, it is important to follow this line of research with as much consistency as possible in order to be able to compare results across studies.

One potential limitation of the present study is that I did not use the same target letter for both languages. I chose to use the letters T and L because they are among the most common letters in each language and because these letters occur in the most frequent function words in each language (i.e., *the* in English and the equivalents in Spanish, *el, ellos, los, la, ellas*). In addition, because I was repeating the procedure used by Bovee and Raney (2015), I needed to use their target letters. However, previous research has demonstrated that different target letters produce different overall error rates, and this could change the letter detection patterns (Saint-Aubin, 2019, personal communication). If the error rates are very low for one of the target letters, then there might not be an MLE simply because very few target letters were missed. For instance, the lower-case letter "l" is symmetrical, which might make it easy to detect. This could lead to low error rates and no MLE, or even a reversal because the target letter might be easier to detect in function words than content words because function words tend to be shorter than content words. A follow up study using the same target letter in each language could address this issue. For example, the target letter *E* occurs in the word *the* in English and in several of the Spanish equivalents, *el, ellos,* and *ellas*. If I found the same pattern of results with the target letter *E*, this would confirm the importance and gender marking in the Missing Letter Effect. One problem with using the target letter *E* is that it does not occur in all Spanish equivalents of the, such as *los, la*. This would lead to substantially fewer target letters in Spanish passages than in English passages. This points out is that no method is perfect, so we must look for converging evidence across studies.

So, what's next? With all these possible alternative explanations for the reversal, the influence that gender marking might have on the MLE needs to be further explored. One possible next step is to compare gender marked and non-gender marked languages with the same word order so that I can separate the impact of gender marking from word order. A second step is conduct a follow up experiment in that uses the same target letter in each language, so that any difference in target letter detectability cannot account for the different results for English and Spanish passages.

B. Conclusion

My findings demonstrate that although language proficiency affects the Missing Letter Effect, this is not the explanation for the reversed MLE in Spanish. I used highly proficient English-Spanish and Spanish-English bilinguals and found the same pattern of results as Bovee and Raney (2015), who used low proficiency English-Spanish bilinguals. Given that I used English dominant and Spanish dominant bilinguals, I can also rule out language dominance as the cause of the reversed MLE in Spanish found by Bovee and Raney. Consequently, gender marking might be the explanation that best fits my data.

Because of the gender information that both function and content words carry in Spanish, readers need to pay more attention to the relationship between function and content words to ensure the gender information matches. The gender marked article primes a set of words that excludes those that do not match in gender. Meaning that in Spanish, function words play a more important role because they prepare the reader to process the following content word with a specific gender. As a result, more attention is given to function words in Spanish, which could explain why letter detection error rates are much lower for function words in Spanish. Of course, there might be other explanations for this reversal (e.g., the target letters used, how target letters are scored, word position, or language word order), but only future research will help clarify why I obtained opposite patterns of results for English and Spanish passages.

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APPENDICCES

Appendix A

English Vocabulary Quiz

Instructions: Pick the answer option that best defines the word

1. **ASCEND**
   A. to go up or mount*
   B. consent
   C. improve with time
   D. to leave behind
   E. to replace a leader

2. **WARY**
   A. tired out
   B. rude; uncouth
   C. perturbed
   D. brand-new
   E. cautious; careful*

3. **NURTURE**
   A. helped by man
   B. to feed or nourish*
   C. to educate
   D. to protect by nature
   E. to cook

4. **INFINITESIMAL**
   A. very long
   B. very slow
   C. well defined
   D. uncompromising
   E. very small*

5. **BELLIGERENT**
   A. informative
   B. blunt
   C. tiring
   D. war-like*
   E. pro-active

6. **INDIFFERENT**
   A. similar
   B. unconcerned*
   C. diffident
   D. solicitous
   E. opposite

7. **PERJURE**
   A. to save from indignity
   B. to improve or rectify
   C. to demand support
   D. to lie under oath*
   E. day by day

8. **VERBOSE**
   A. slow
   B. impressive
   C. complicated
   D. wordy*
   E. meaningless

9. **OPAQUE**
   A. transparent
   B. slippery
   C. impenetrable by light*
   D. gem-like
   E. financially well-off

10. **SYNTHESIS**
   A. musical rendition of a written work
   B. a theory of immoral behavior
   C. the combination of parts to form a whole*
   D. watching or guarding
   E. properties of artificial chemicals

11. **SPONTANEITY**
   A. unwanted laughter
   B. uncontrollable danger

C. unplanned action*
D. unneeded socialism
E. stand-up attitude

12. VALIDATE
A. to prove*
B. to get paid back
C. to expire
D. to run away
E. to complete successfully

13. SUBORDINATE
A. to hypothesize in abstract
B. to practice with instruction
C. to levy upon others
D. to go on vacation
E. to rank in importance*

14. MEAGER
A. not full, inadequate*
B. to beg
C. without self-respect
D. in good shape, healthy
E. wise, full of advice

15. EQUIVOCAL
A. premier, establishing new precedent
B. popular, known by everyone
C. exciting, causing a commotion
D. peculiar, one of a kind
E. uncertain, having two meanings*

16. REBUKE
A. to dispute
B. poor reputation
C. to scold harshly*
D. to stop at midpoint
E. to overfill

17. ECLECTIC
A. providential
B. of religious origins
C. purified
D. out of fashion
E. from various sources*

18. TERSE
A. concise*
B. private
C. angry
D. outdated
E. harsh-sounding

19. ILLUSORY
A. bright
B. deceptive*
C. unhealthy
D. making a reference to
E. sometimes friendly, sometimes undependable

20. DIVULGE
A. to discourage
B. to pay for
C. to turn away
D. to reveal*
E. to infiltrate

21. REPROVE
A. to reverse an argument
B. to be clean of
C. to express disapproval*
D. to grovel for forgiveness
E. to encourage hope

22. IMPLAUSIBLE
A. could happen at any moment
B. not believable*
C. unyielding
D. considered tactless
E. to serve or worship

23. INCONTROVERTIBLE
A. useless
B. prone to trouble making
C. indisputable*
D. successful
E. unprotected

24. QUERY
A. excavation
B. prey

C. inquiry*
D. strange occurrence
E. strange, odd

25. DISPERSE
A. to seize one's assets
B. to live in exile
C. to break up and scatter*
D. to weaken connections
E. to make vacant

26. VACILLATE
A. to prepare for action; lubricate
B. to show indecision; to waver*
C. to hold firmly, to be stubborn
D. to wait until the last second, delay
E. to scatter; to create chaos

27. SUPERFLUOUS
A. gay, happy
B. reserved, waiting
C. trivial; unimportant
D. unnecessary; excessive*
E. undecided; variable

28. AUTONOMOUS
A. unknown identity
B. having many names
C. uncontrollable
D. independent existence*
E. self-confidence

29. PRECEDENT
A. an expectation
B. most important event
C. a leader
D. a prior occurrence*
E. a forgotten time

30. BOLSTER
A. to disagree, strongly
B. to defend, proudly
C. to reinforce, strengthen*
D. to agonize, repeatedly
E. brutalize, merciless

Appendix B

Spanish Vocabulary Quiz

Instructions: Each of the following sentences contains a blank indicating that a word or phrase has been omitted. Select the choice that best completes the sentence.

1. Al oír del accidente de su buen amigo, Paco se puso __________.
a. alegre b. fatigado c. hambriento d. desconsolado*

2. No puedo comprarlo porque me_______________.
a. falta* b. dan c. presta d. regalan

3. Tuvo que guardar cama por estar ______________.
a. enfermo* b. vestido c. ocupado d. parado

4. Aquí está tu café, Juanito. No te quemes, que está muy ______________.
a. dulce b. amargo c. agrio d. caliente*

5. Al romper los anteojos, Juan se asustó porque no podía _______ sin ellos.
a. discurrir b. oír c. ver* d. entender

6. ¡Pobrecita! Está resfriada y no puede ________________.
a. salir de casa* b. recibir cartas c. respirar con pena d. leer las noticias

7. Era una noche oscura sin _______.
a. estrellas* b. camas c. lágrimas d. nubes

8. Cuando don Carlos salió de su casa, saludó a un amigo suyo: -Buenos días,____.
a. ¿Qué va? b. ¿Cómo es? c. ¿Quién es? d. ¿Qué tal? *

9. ¡Qué ruido había con los gritos de los niños y el _______ de los perros!
a. olor b. sueño c. hambre d. ladrar*

10. Para saber la hora, don Juan miró el __________.
a. calendario b. bolsillo c. estante d. despertador*

11. Yo, que comprendo poco de mecánica, sé que el auto no puede funcionar sin _______.
a. permiso b. comer c. aceite* d. bocina

12. Nos dijo mamá que era hora de comer y por eso ____________.
a. fuimos a nadar b. tomamos asiento* c. comenzamos a fumar d. nos acostamos pronto

13. ¡Cuidado con ese cuchillo o vas a ____________ el dedo!
a. cortarte* b. torcerte c. comerte d. quemarte

14. Tuvo tanto miedo de caerse que se negó a ___________ con nosotros.
a. almorzar b. charlar c. cantar d. patinar*
15. Abrió la ventana y miró: en efecto, grandes lenguas de _______ salían llameando de las casas.
a. zorros b. serpientes c. cuero d. fuego*

16. Compró ejemplares de todos los diarios pero en vano. No halló ____________.
a. los diez centavos b. el periódico perdido c. la noticia que deseaba* d. los ejemplos

17. Por varias semanas acu4dieron colegas del difunto profesor a _______ el dolor de la viuda.
a. aliviar* b. dulcificar c. embromar d. estorbar

18. Sus amigos pudieron haberlo salvado pero lo dejaron ______________.
a. ganar b. parecer c. perecer* d. acabar

19. Al salir de la misa me sentía tan caritativo que no pude menos que _________ a un pobre mendigo que había allí sentado.
a. pegarle b. darle una limosna* c. echar una mirada d. maldecir

20. Al lado de la Plaza de Armas había dos limosneros pidiendo ________.
a. pedazos b. paz c. monedas* d. escopetas

21. Siempre maltratado por los niños, el perro no podía acostumbrarse a ________ de sus nuevos amos.
a. las caricias* b. los engaños c. las locuras d. los golpes

22. ¿Dónde estará mi cartera? La dejé aquí mismo hace poco y parece que el necio de mi hermano ha vuelto a ________.
a. dejármela b. deshacérmela c. escondérmela* d. acabármela

23. Permaneció un gran rato abstraído, los ojos clavados en el fogón y el pensamiento ___.
a. en el bolsillo b. en el fuego c. lleno de alboroto d. Dios sabe dónde*

24. En vez de dirigir el tráfico estabas charlando, así que tú mismo ____________ del choque.
a. sabes la gravedad b. eres testigo c. tuviste la culpa* d. conociste a las víctimas

25. Posee esta tierra un clima tan propio para la agricultura como para _________.
a. la construcción de trampas b. el fomento de motines c. el costo de vidad d. La cría de reses*

26. Aficionado leal de obras teatrales, Juan se entristeció al saber _____________ del gran actor.
a. del fallecimiento* b. del éxito c. de la buena suerte d. de la alabanza

27. Se reunieron a menudo para efectuar un tratado pero no pudieron __________.
a. desavenirse b. echarlo a un lado c. rechazarlo d. llevarlo a cabo*

28. Se negaron a embarcarse porque tenían miedo de ___________.
a. los peces b. los naufragios* c. los faros d. las playas

29. La mujer no aprobó el cambió de domicilio pues no le gustaba ____________.
a. el callejeo b. el puente c. esa estación d. aquel barrio*

30. Era el único que tenía algo que comer pero se negó a ______________.
a. hojearlo b. ponérselo c. conservarlo d. repartirlo*

VII. HUMAN SUBJECTS COMMITTEE PROTOCOL APPROVAL

This research was approved by the University of Illinois Human Subjects Institutional Review Board under protocol 2012-0637.

VIII. CURRICULUM VITAE

Cesar Riano Rincon
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EDUCATION

University of Illinois at Chicago
Doctoral Program, Cognitive Psychology
Advisor: Gary Raney
Fall 2017-present

Doctor of Philosophy in Cognitive Psychology (in progress): University of Illinois at Chicago, 2017-present

Master of Arts in Psychology, University of Illinois at Chicago, 2021

Bachelor of Arts, Psychology, *Universidad de los Andes, Bogotá, Colombia,* 2016

AWARDS

Psychonomic Society Yates Student Conference Award, 2020

PUBLICATIONS

Reali, F., & **Riaño, C**. (2018). Emotion metaphors in Spanish retain aspects of spatial meaning. *Metaphor and the Social World, 8*(2), 229-246. doi:https://doi.org/10.1075/msw.17015.rea.

Riano, C. & Reali, F. (2016). Spatial Meaning is Retained in Emotion Metaphors: Some Evidence from Spanish. In A. Papafragou, D. Grodner, D. Mirman, & J.C. Trueswell (Eds.), *Proceedings of the 38th Annual Conference of the Cognitive Science Society* (pp. 426). Austin, TX: Cognitive Science Society.

CONFERENCE PRESENTATIONS

Raney, G.E., **Riaño Rincon, C.**, Miller, K. A., Christofalos, A. L., Pambuccian, F. S., & Campbell, S. J. (2020). Linguistic Experience is a Tapestry: The More Languages You Know, the More Familiar the Metaphor. Presentation at UK Cognitive Linguistics Conference, Virtual conference organized by the University of Birmingham.

Riano Rincon, C., Raney, G. E. (2019). *The Missing Letter Effect is Missing in Spanish*. Poster presented at Psychonomic Society's 60th Annual Meeting in Montréal, Québec, Canada.

Riano Rincon, C., & Raney, G.E. (2019). *Computer- and Paper-Based Normative Ratings of Metaphors: They are Similar in Some Ways and Different in Other Ways*. Presentation at the Metaphor Festival, Amsterdam, Netherlands.

Riano Rincon, C., Raney, G. E. (2018). *Computer- and Paper-Based Normative Ratings of Metaphors: They are Similar in Some Ways and Different in Other Ways*. Presentation at the Meeting of the Society for Computers in Psychology, New Orleans, Louisiana, USA.

Raney, G.E., Campbell, S.J., **Riano Rincon, C.**, Miller, K., Christofalos, A.L. (2018). *Spanish-English Bilinguals Perceive Less-Familiar English Metaphors as Being More Familiar Than Do English Spanish Bilinguals and English-Speaking Non-Bilinguals*. Presentation at Psychonomic Society, New Orleans, Louisiana.

Raney, G. E., Christofalos, A, L., Miller, K. A., Pambuccian, F. S., & **Riaño Rincon, C. E**. *Figurative Language Research at UIC*. (October, 2017). Colloquium given at the DePaul University Psychology Department.

Riano C. & Reali F. (2016). *Spatial Meaning is Retained in Emotion Metaphors: Some Evidence from Spanish*. Poster presented at the 38th Annual Conference of the Cognitive Science Society. Philadelphia, Pennsylvania USA.

TEACHING EXPERIENCES

Teaching Assistant at Department of Psychology, University of Illinois at Chicago, Chicago, IL. Fall 2017 – Spring 2021

PSCH 242: Intro to Research in Psychology, Prof. C. Baker.

PSCH 353: Memory and Cognition, Prof. G. Raney. Summers 2018 & 2020.

Teaching Assistant at Department of Psychology, Universidad de los Andes, Bogotá, Colombia. Fall 2015

PSCH 2316: Psychology of Perception, Prof. F. Reali. Fall Semester

OTHER ACCOMPLISHMENTS

Research Assistant at the Learning practices and Cognition research group, Department of Psychology, Universidad de los Andes, Bogotá, Colombia. Spring 2014 - Fall 2016

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