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Cross-Linguistic Orthographic Effects in Late Spanish/English Bilinguals

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Abstract: Through the use of the visual world paradigm and eye tracking, we investigate how orthographic–phonological mappings in bilinguals promote interference during spoken language comprehension. Eighteen English-dominant bilinguals and 13 Spanish-dominant bilinguals viewed 4-picture visual displays while listening to Spanish-only auditory sentences (e.g., *El detective busca su banco* 'The detective is looking for his bench') in order to select a target image. Stimuli included two types of trials that represent potential conflict in bilinguals: *b-v* trials, e.g., *banco-vaso* 'bench-glass', representing homophonous phonemes with distinct graphemic representations in Spanish, and *j-h* trials, e.g., *juego-huevo* 'game-egg', representing interlingual homophonous phonemes with distinct graphemic representations. Data were collected on accuracy, reaction time (RT), and mean proportion of target fixation. Reaction Time results indicate that Spanish-dominant speakers were slower when the competitor was present in *b-v* trials, though no effects were observed for English-dominant speakers. Eye-tracking results indicate a lack of competition effects in either set of trials for English-dominant speakers, but lower proportional target fixations for Spanish-dominant speakers in both sets of trials when an orthographic/phonological distractor was present. These results suggest that Spanish-dominant bilinguals may be influenced by the orthographic mappings of their less-dominant L2 English, providing new insight into the nature of the interaction between the orthography and phonology in bilingual speakers.

Keywords: bilingualism; spoken word recognition; orthography; phonology; eye-tracking; visual-world

1. Introduction

Although bilinguals often use only one language during a single conversation, decades of research have shown that the other language(s) does not simply lay dormant. In fact, during both comprehension and production and during either visual word or spoken language processing, linguistic information from both languages tends to interact and compete for selection. One of the main interests of psycholinguistic research is to explore and understand this interaction. As a result, bilinguals do not behave like two monolinguals in a single brain [1]. Though studies in the past have provided evidence of language independence [2,3], more recent empirical evidence supports the notion of language non-selectivity [4–6]. As a result, many studies have been carried out in order to observe which aspects of a bilingual's language inventories interact and the consequences of this interaction. Said interaction may be bi-directional in that the dominant language (typically the L1) may influence the less dominant language (typically the L2) and vice versa. These effects have been observed in a variety of linguistic domains, including the lexicon, semantics, phonology, syntax, and discourse, during comprehension and production and among oral and written mediums, i.e., reading/writing or speaking/listening. However, a fairly understudied area is that of the interaction between competing orthographic mappings while processing spoken language input in bilinguals. Due to the nonselective nature of a bilingual's linguistic repertoire, we believe that phonological input may be influenced prelexically by underlying orthographic information and that this interaction may be observed through online linguistic measures, such as eye tracking. The primary goal of the study reported here is to examine this interaction in two groups of Spanish–English and English–Spanish late bilinguals.

The paper is organized as follows. The next section reviews the previous literature to situate the present research project in context and to justify it. Section 3 describes the research project and presents the current results. Section 4 returns to the research questions in light of the results. Lastly, Section 5 presents future directions and conclusions.

1.1. Interaction of Phonology and Orthography in Bilinguals

It is logical to assume that the domains of phonology and orthography would interact due to the fact that orthography is the written representation of the spoken word; a speaker must first decode orthographic information and proceed to map on the appropriate phonological information. Several studies have shown cross-linguistic orthographic interference in perception, comprehension and acquisition [7–10]. A model that supports these findings is Dijkstra and van Heuven's (2002) BIA+ model of visual word recognition in bilinguals [11]. This model predicts that orthographic, phonological and semantic representations are decoded in the initial stages of processing, and are then sent to the 'task schema' in order to make final lexical decisions. As a result, orthographic and phonological information of both languages would be simultaneously activated before lexical decisions are made, which results in competition. Studies that have examined these effects claim that proficiency in each language is a significant factor, in that patterns of cross-language influence are modulated by increasing L2 proficiency [8,9,12–14].

The majority of the research on the interaction between phonology and orthography in bilinguals has focused primarily on the processing of the written word, employing tasks such as lexical decision and naming tasks, eye-tracking while reading, event-related potentials (ERPs), and other brain imaging techniques [8,10,15,16]. Results of such studies have shown that various factors may influence the extent of cross-linguistic interference, such as similarity of orthographic structure (linguistic neighbors, e.g., Spanish-English *cara-card*, interlingual homographs, e.g., French-English *pain-pain*), phonological structure (interlingual homophones, e.g., French-English *poule-pool*), or phonological/orthographic and semantic overlap (cognates, e.g., French-English *plante-plant*).

Schwartz, Kroll, and Diaz (2007) showed that varying degrees of orthographic and phonological similarity can have distinct effects of cross-linguistic influence [17]. The authors engaged 18 English–Spanish bilinguals (two of which were considered English-dominant native speakers of Spanish) in a word-naming task (two blocks: Spanish-only, English-only). The authors utilized Spanish stimuli paired with their English translations. The authors subsequently obtained a separate measure of orthographic similarity and phonological similarity for each pair. The results showed that participants were significantly slower when naming cognates that were more orthographically similar, but more phonologically distinct, as compared to cognates with a higher level of phonological similarity. The authors interpret this as evidence of feed-forward activation from orthography to phonology across languages; evidence of feed-back activation was not as strong.

1.2. Orthographic Effects in Spoken Language

In contrast to the literature reviewed above, there is a scarcity of research when considering similar effects of orthography in spoken language processing. Of the existing studies, some have examined effects of orthography while considering a phenomenon known as the 'Cohort Effect' [18,19]. In a nutshell, the cohort model predicts that as language is processed as it unfolds over time, initial input (i.e., phonemes) activates potential lexical candidates (thus forming the cohort). As further input is received, candidates that do not meet the criteria of the input are eliminated until enough input is received and the appropriate lexical selection can be made. The question then becomes whether or not this effect exists cross-linguistically; that is, are candidates from both languages in a bilingual's lexicon simultaneously activated and thus compete for selection?

Spivey and Marian (1999) attempted to answer this question with eye-tracking by engaging twelve late Russian–English highly proficient bilinguals in a task involving stimuli that were phonologically similar across the two languages presented using the visual world paradigm [20,21]. Participants reacted to auditory stimuli instructing them to interact with four objects placed symmetrically on a white board in front of them. Instructions included Russian phrases such as *Poloji marku nije krestika* 'Put the stamp below the cross'. In this experimental trial, *marku* 'stamp' is co-present visually with an object serving as an interlingual distractor, i.e., phonologically similar word in English (*marker*). The remaining two objects on the board were not phonologically similar with the target word and served as control objects. Previous research with monolingual speakers has demonstrated that objects (or pictures presented on a computer screen) that overlap in phonology (e.g., *candy* vs. *candle*) lead to reduced eye fixations to the target object and increased fixations to the phonologically competing distractor item, demonstrating that participants use phonological information as it unfolds to anticipate upcoming target items [22]. Similarly, the results indicated that participants were significantly more likely to fixate interlingual distractors than control objects. Sessions were performed in blocks of Russian and English. There was no main effect of language. Results of this experiment are taken as strong evidence of interlexical competition and co-activation in bilinguals.

Using a similar visual world paradigm, Chamber and Cooke (2009) also investigate the effects of interlingual phonological competition with the addition of biasing sentential context as a means of attenuating these effects [23]. Proficiency was taken into consideration as well, as this has been shown to modulate the effects of cross-linguistic competition [24]. Twenty late English–French bilinguals completed a Language Background Questionnaire and an image-selection task while their eye movements were recorded. Experimental trials included images of a target word alongside an inter-lingual near-homophone serving as a competitor, e.g., French *poule* 'chicken' and English *pool*. The stimuli were then placed in a restrictive (i.e., biasing) or nonrestrictive sentence context:

a Restrictive: *Marie va nourrir la poule* 'Marie will feed the chicken'
b Non-restrictive: *Marie va décrire la poule* 'Marie will describe the chicken'

Results indicated that listeners demonstrated temporary consideration of the interlingual distractor, reflecting cross-linguistic lexical competition. However, these effects were dramatically reduced when introduced via semantically biasing contexts. In contrast, proficiency was not shown to affect cross-linguistic competition. To this end, the present study utilizes a neutral nonbiasing carrier phrase in order to account for the effects that biasing sentence may have on cross-linguistic competition.

The previously mentioned studies focus on interlingual phonological competition, yet no study to date has considered the role of competing orthographic information and its mapping relationship to phonology in bilinguals. Nevertheless, studies in second language acquisition (SLA) have shown that the relationship between L1–L2 orthographic systems can either facilitate or hinder lexical acquisition in the L2. For example, Erdener and Burnham (2005), investigated the effects of differing L1 orthographic systems on L2 speech perception and production, specifically observing effects of orthographic depth [25–27]. Orthographic depth concerns the degree to which graphemes correspond to their respective phonemes; languages with a shallow or 'transparent' orthography show a more one-to-one grapheme–phoneme correspondence, whereas languages with a deep or 'opaque' orthography deviate from this type of relationship in order to preserve morphological similarity. Participants included a group of Turkish L1 (transparent orthographic system) speakers and a group of Australian English L1 (opaque orthographic system) speakers, tested on the production of nonwords using Irish (opaque) or Spanish (transparent) orthographic conventions. In each condition, participants were given varying combinations of auditory, visual, and orthographic information. Results showed that in the conditions where orthography was not provided, the Turkish L1 participants consistently outperformed their Australian English L1 counterparts. However, on orthographic conditions, a general pattern emerged.

With Spanish stimuli, a facilitative effect was found for Turkish L1 speakers, whereas with Irish stimuli, this effect was attenuated to the point where they performed significantly worse than their Australian English L1 counterparts. The authors conclude that when presented with visual information, due to the transparency of the L1 orthographic system, the Turkish L1 speakers rely more heavily on orthography, whereas the Australian English L1 speakers rely less on orthography and more so on alternative visual cues, due to the inconsistency of the grapheme–phoneme correspondences in their L1 system. These results suggest that the nature of the L1 orthographic system modulates L2 orthographic speech perception and production. The success of this integration depends on the corresponding nature of the L2 system(s).

Similarly, Escudero et al. (2014) aimed to investigate how incongruency between orthographic mappings affects the acquisition process, namely in terms of perception and in this case, vowel perception [24]. Participants in this study include two groups of Spanish L1 speakers split by prior experience with L2 Dutch: Dutch learners and naïve listeners (no exposure to Dutch). Both groups of participants took part in a word-learning task. The stimuli used were Dutch pseudowords, consisting of minimal pairs that differed only by the vowel, (e.g., 'pag'–'puug'), along with line drawings of non-objects representing the pseudowords. As there is a clear difference in the orthographic representation of vowels in Spanish and Dutch, each set of minimal pairs was classified as either perceptually easy or perceptually difficult for Spanish learners (this classification was made based on error results in a prior study [28]). Finally, the participant groups were split so that, during training, half of each group would receive auditory stimuli only (Audio-Only Condition), whereas the other group would receive auditory and orthographic stimuli (Auditory + Orthographic Condition). The results revealed that orthographic information presented during word learning yielded a negative effect on listeners' performance with minimal pairs whose grapheme–phoneme correspondences were incongruent across languages but yielded a positive effect when these were congruent. This is in line with previous studies "that have found orthographic cues which do not follow the native orthographic conventions to be a hindrance to speech perception [28] and word learning [29]" [24] (p. 394). Results from this study highlight the significant role that orthographic mappings play in lexical competition in bilinguals.

2. Current Study

There are two examples of competing orthographic–phonological mappings in English and Spanish that will be used in the present study. In the first set of trials, we compare <b>[1] and <v>. In Spanish, both <b> or <v> may be used to represent the phoneme /b/, whereas in English, only <b> is used to represent /b/ while <v> represents the labiodental fricative, /v/, a phoneme which is absent in non-contact varieties of Spanish. In fact, this pair of phonological elements has proven to be a common struggle in the classroom for English L1 learners of Spanish. Elliott (1997) includes the lack of [β][2] and production of [v] in a list of sounds that most contribute to a foreign accent in Spanish as judged by Spanish instructors, professors, and graduate students, which suggests that these impose phonological difficulty during the acquisition process [30]. Face and Menke (2009) claim that the difficulty stems from orthographic influence in that "they must first disassociate the written v from the L1 phoneme /v/ and then associate it with another phoneme, /b/" [31] (p. 46).

Moreover, Face and Menke (2009) provide a glimpse into the development of these sounds for English-speaking learners of Spanish [31]. Fifty-three L1 English speakers were used as participants and were of various course levels: students enrolled in a fourth-semester Spanish course, graduating Spanish majors, and Ph.D. students in Spanish. Participants completed a task in which they read aloud a short story in Spanish. Using acoustic measurements, the authors observed instances of /b/ /d/ and /g/ production. Focusing on /b/, stimuli were represented orthographically as either <b> or

1 We use the <> notation for grapheme representations throughout the remainder of the paper.
2 [β] is a phonetic allophone of /b/ that is found in certain phonological contexts in Spanish.

<v>, and participants' output was judged to be produced as a fricative [v], an approximant [β], or a stop [b]. They found that at all levels, proficiency and orthography were a significant factor, such that approximant production increased with proficiency although all groups differentiated orthographic <b> (increased production of stops) and <v> (increased production of approximants). In contrast to the observed results of /d/ or /g/ production, <b> was not produced as a fricative at any level. However, <v> was produced as a fricative at the earlier proficiency level changing into an approximant at the upper level, and was rarely produced as a stop, suggesting that the learners aimed to maintain a distinction between these two graphemes. Even at the highest level, i.e., Ph.D. students, <v> was almost always produced as an approximant, while <b> was produced several times as a stop.

The second set of trials, which we call *j-h* trials, represents a more complex system of mappings. In English, the phoneme /h/ is typically represented orthographically with <h>. In Spanish, this phoneme (varying dialectally between /h/, /x/ and /χ/) is represented orthographically with either <j> or <g> when followed by an <e> or <i>. Nevertheless, the orthographic <h> is maintained in Spanish, as in the word *hada* ['a.ða] 'fairy', though <h> represents a null phoneme. The question is, when interpreting the phoneme /x/, if an image representing *joven* ['xo.βen] is presented alongside an image of a word beginning with <h> such as *hoja* ['o.xa], will a bilingual of English and Spanish experience competition due to the influence of the English orthographic mappings? In other words, will cross-linguistic orthographic mappings affect spoken language processing in a purely auditory task?

The intent of the present study is to investigate the effects of competing orthographic–phonological mappings in English and Spanish in bilinguals during spoken-word competition. More specifically, this study aims to address the following research questions (RQ):

RQ#1: Will English-dominant bilinguals experience effects of competition in *b-v* trials? Will this differ from Spanish-dominant bilinguals?
RQ#2: Will English-dominant bilinguals experience effects of competition in *j-h* trials? Will this differ from Spanish-dominant bilinguals?
RQ#3: Will these effects be modulated by level of language proficiency?

2.1. Hypotheses

RQ#1: Considering previous research on cross-linguistic activation in bilinguals, due to the fact that in English <b> and <v> represent two different phonemic categories, English-dominant bilinguals will not display effects of competition, unlike the Spanish-dominant bilinguals, who upon receiving ambiguous input, i.e., [b], will demonstrate effects of phonological competition, which will be observable through eye-tracking.
RQ#2: In *j-h* trials, due to the influence of L1 orthography, the English-dominant group should display competition effects. However, as the task is in Spanish, the Spanish-dominant group will have an easier time suppressing competing information from the less-dominant L2 and will thus not show effects of competition. As a result, we predict that English-dominant bilinguals will fixate the interlingual distractor proportionally higher than the Spanish-dominant group.
RQ#3: Finally, we predict that proficiency will be a significant predictor of cross-linguistic interference. Specifically, we predict that different proficiency groups will yield distinct competition effects between trials [24].

2.2. Justification of the Present Study

Understanding the intricate nature in which bilinguals juggle the myriad of information between multiple language systems is one of the principle aims of psycholinguistic research. Current research continues to explore the inevitable interaction between the various linguistic domains. Previous studies focusing on the interaction between phonology and orthography in bilinguals have shown that during auditory comprehension, lexical items with similar phonology are simultaneously activated cross-linguistically and compete for selection [20]. Likewise, distinct orthographic representations across languages may result in negative effects on the acquisition process [24]. Nevertheless, the majority of these studies have focused on similar cross-linguistic phonologies (e.g., *poule-pool* [23]) and the extent to which this information interacts with distinct orthographic mappings is yet to be understood. The current study aims to investigate this phenomenon in English-dominant and Spanish-dominant late bilinguals of Spanish and English.

2.3. Participants

A total of 36 students at the University of Florida participated in this study. The experimental procedure was approved by the Institutional Review Board at the University of Florida. Prior to beginning the experimental session, participants were provided with a written consent form and a brief explanation of the general procedure. Particip[ants were provided an opportunity to ask clarifying questions. Participants subsequently signed the written consent forms. Participants either participated voluntarily or for course credit. Data from five participants were excluded for various technical reasons (e.g., the eye movements of two participants were not registered by the eye-tracker). In the end, a total of 31 participants were used for this study. All participants had normal hearing as well as normal or corrected vision. The participants were classified as either 'English-dominant' or 'Spanish-dominant' speakers, based on the data provided in the Language Background Questionnaire. Of the total number of participants, 18 were L1 English learners of Spanish and 13 were L1 speakers of Spanish who were all functional speakers of L2 English. About half of the L1 Spanish participants spoke Peninsular Spanish (n = 6) while the other half spoke Latin American varieties of Spanish (n = 5; Chile, Peru, Ecuador, Argentina) as well as one speaker of Puerto Rican Spanish. In terms of dialectal variation, oral production of the phone used in *j-h* trials may differ between dialects (i.e., [χ] in Peninsular Spanish, [x] in Latin American varieties, and [h] in Caribbean Spanish). However, as these are all allophones of a single phonemic category, this should not be an issue in the current study. Similarly, though some of the Latin American varieties of Spanish may make a distinction between [b] and [v] (e.g., Chilean Spanish [32–35]; Paraguayan Spanish [36–38]; some variants of Mexican and Southwester US Spanish [39,40]), this distinction is also considered an allophonic difference of a single phonemic category /b/, which is not impacted by the orthographic representation of <b> or <v> (see [41], Chapter 14 for an extended discussion).

Additional measures were taken in order to determine each participants' proficiency in the less dominant language. As a result, the English-dominant speakers completed an adapted version of the Diploma de español como lengua extranjera (DELE, 'Spanish as a Foreign Language Diploma' [42]) in order to measure proficiency in Spanish, and the Spanish-dominant speakers completed an adapted version of the Michigan English Language Institute College English Test (MELICET [43]) in order to measure proficiency in English. Both standardized tests consisted of 50 multiple choice questions that presented a combination of a reading cloze passage and grammar section. Additionally, a portion of the Language History Questionnaire collected self-reported proficiency ratings from each participant. Results from these tests can be seen in Table 1, where the L2 Grammar (i.e., DELE/MELICET) is reported on a scale of 0–50 and the self-rated proficiency scores are reported on a scale of 1–10. We conducted 2-sample t-tests on the L2 grammar and L2 self-reported proficiency scores. Although the standardized grammar scores are not directly comparable to each other, the t-tests revealed that the Spanish-dominant group scored higher in the MELICET than the English-dominant group in the DELE ($t(15.42) = 4.42$, $p < 0.001$). In contrast, there was no difference in their self-reported L2 proficiency ($t(19.27) = 1.56$, $p = 0.135$).

Table 1. Summary of mean L2 Grammar proficiency scores (Diploma de español como lengua extranjera, DELE; Michigan English Language Institute College English Test, MELICET), L2 self-rated proficiency scores, and Age of Acquisition (AoA), with range reported in parentheses[3].

Group	*n*	L2 Grammar	L2 Self-Rated Proficiency	L2 AoA
Spanish-dominant	12	33.54 (21–47) *MELICET*	7.4 (5–9)	10.25 (5–18)
English-dominant	16	22.31 (16–27) *DELE*	6.48 (5–9.5)	11.38 (7–16)

2.4. Materials and Methods

A total of 192 images were used in this study, along with their corresponding audio recordings, subsequently edited and spliced onto a carrier phrase using PRAAT [44]. Images used as stimuli were collected from various sources at Google Images (http://images.google.com). Images were matched for style as much as possible. The intended format consisted of colored images with a neutral white background, with western style 'clip-art' animation along with a similar size and luminance. See the Supplementary Materials for all images used in the present study, audio recordings, and their stimuli names. Stimuli names and images were normed by consultation with lab group members. The visual stimuli consisted of 24 target quartets and 24 filler quartets. The 24 target quartets contained one target image, one image that served as a distractor, along with two unrelated control images. The stimuli were distributed among four unique conditions, all of which pertained to the orthographic representation of the word that corresponded to each image. Table 2 summarizes the conditions with examples and their respective translations provided.

Table 2. Sample of the counterbalance design by condition.

Condition 1		**Condition 2**		**Condition 3**		**Condition 4**	
b	**Ø**	***b***	***v***	***j***	**Ø**	***j***	***h***
target *banco* 'bench'	control *cisne* 'swan'	target *banco* 'bench'	distractor *vaca* 'cow'	target *jabón* 'soap'	control *martillo* 'hammer'	target *jabón* 'soap'	distractor *hacha* 'axe'

The letters defining each condition correspond to the first letter of the initial phoneme in each word. The not-symbol (Ø) refers to a word whose initial phoneme would not serve as a distractor, i.e., for <b> conditions, a word that does not begin with <b> or <v>, e.g., *cisne* 'swan'. In these cases, there would be one target word and three control images. In the experimental conditions (1 and 4), the initial syllable of both the target word and distractor consisted of the consonant designated by the above-mentioned condition, as well as an identical vowel. That is, a word such as *banco* 'bench' may be paired with *vaca* 'cow', but not with *vino* 'wine'.

As an added measure, unique lists of the aforementioned stimuli were compiled in order to circumvent any confounding factors resulting from either ordering effects or placement on the screen. The first two lists were created using a Latin-square design, so that half of the participants were exposed to one set of word-pairs for each condition, and the other half were exposed to a different set of pairs for each condition. Finally, these two lists were each counterbalanced by placement on the screen, which resulted in eight separate lists (i.e., four versions of each list).

The recordings of each stimulus word were made using a Marantz PMD660 Solid State Recorder. The speaker was a Spanish speaker from Mexico and a trained linguist. The speaker spoke into an AKG C214 microphone paired with a Steadman Proscreen 101 pop filter attached to a Gator Frameworks adjustable speaker stand. In addition to the recordings of each stimulus word, a carrier phrase was also recorded. Previous research has shown that biasing sentence context can influence lexical decision [23,45]. In order to isolate the effects of phonological transfer in the present study, a neutral context was used as a carrier phrase, *El detective busca su banco* 'The detective is looking for his bench'. Moreover, L2 speakers have demonstrated the ability to use grammatical gender information encoded in Spanish articles to anticipate upcoming nouns [46]. Therefore, in order to avoid any anticipatory effects, a neutral determiner, *su*, was used in the carrier phrase instead of a gendered determiner per

[3] We were not able to obtain L2 Grammar scores from two participants in the English-dominant group. Additionally, two participants from the English-dominant group and one participant from the Spanish-dominant group did not report self-rated proficiencies. As a result, these scores were not included in proficiency analyses or the 2-sample *t*-tests.

stimulus word. Finally, due to the fact that each stimulus word was positioned at the end of the carrier phrase, the speaker was instructed to record each word with a downward intonation pattern, as is normally seen at the end of declarative sentences in Spanish (in English as well).

Upon completion of the recordings, the stimuli were spliced onto the carrier phrase using PRAAT [44]. The entire recording for each trial lasted approximately 1820 ms, consisting of ≈150 ms of silence prior to the carrier phrase, the carrier phrase, and ≈50 ms of silence between the carrier phrase and the stimulus word. The style of image was controlled as much as possible in order to control for factors that could potentially differentiate the picture outside of its semantic content. Each image selected for the task was Clipart collected on Google Images (http://images.google.com, see the Supplementary Materials).

After providing informed consent, participants sat down in front of a 24-inch BenQ XL2420Z LED monitor and rested their chins on a desktop-mounted chinrest placed approximately 70 cm from the computer monitor. In order to familiarize participants with the process of the experiment, each participant began by taking part in a practice session. This session was built around a similar visual-world paradigm as the experimental session, consisting of four images on the screen accompanied by an auditory stimulus. The practice session lasted for six trials. Each image in this session as well as its corresponding audio stimulus was distinct from those used in the experimental session. Immediately following the practice session, the experimental session began. The majority of the instruction during the entire experiment was given in Spanish.

Participants began by reading the context of the experiment, which explained that a detective was looking for various objects. System calibration was then performed, prior to the onset of experimental trials. Participants' eye movements were recorded using a desktop-mounted Eyelink 1000 Plus eye-tracker manufactured by SR Research (Ottawa, Ontario, Canada). Viewing was binocular, but eye movements were recorded from the right eye only. At the beginning of each trial, participants fixated onto a small dot in the center of the screen. Once the experimenter initiated each trial, four images appeared on the screen (An example can be seen in Figure 1, with added orthographic representations for explanatory purposes, though crucially this was not seen by participants). A period of 1250 ms elapsed before the audio stimulus for each trial was played.

Upon hearing the audio stimulus, participants clicked on the image they believed to be the one named in the sequence. The experimental session consisted of 48 trials, lasting approximately 18 min in total. Participants then concluded the experimental session with the Language History Questionnaire (LHQ) and standardized proficiency measure.

Figure 1. Sample of Experimental Trial. Written words are provided for visual aid and were not included in the original experiment. English glosses clockwise from top left are 'jaguar,' 'stick,' 'fairy,' and 'lettuce.' Images retrieved from http://images.google.com (see the Supplementary Materials).

3. Results

Once data collection and extraction was complete, several analyses were carried out using the R program [47]. Measurements used in the analyses include accuracy (proportion of selection of correct target), reaction time (via mouse-click), and proportion of target-fixation (eye fixation data) over time. We will summarize results from each measurement taken.

3.1. Accuracy

Figure 2 represents the mean accuracy per condition. As can be seen from the figure, the Spanish-dominant group scored at ceiling, showing no variation in accuracy regardless of the distractor condition. In regards to the English-dominant group, in order to determine if accuracy was hindered due to the presence of a distractor, a 2 × 2 repeated-measures analysis of variance (ANOVA) was performed on correct trials. Within-subject factors included trial type (*b-v*, *j-h*) and presence of distractor (Competitor, None). Results indicate a marginal effect[4] for Type, $F_1(1, 19) = 3.29$, $p = 0.086$, $\eta_G^2 = 0.024$, such that *j-h* trials are trending towards lower accuracy than *b-v* trials.

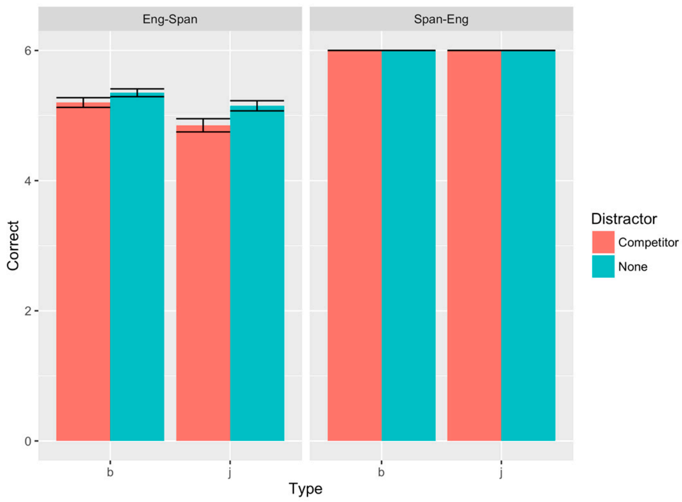

Figure 2. Mean accuracy of target item selection in the presence or absence of phonological competitors out of six trials. Graphs are split between bilingual group and trial type (*b* and *j* trials). Error bars indicate the standard error of the mean.

3.2. Reaction Time

Reaction time (RT) data was recorded from target noun onset until the moment participants selected the target image via the mouse button in order to determine if the presence of a competitor resulted in slower performance for each group. Figure 3 represents the mean RT per condition in milliseconds.

Subsequently, a 2 × 2 × 2 repeated-measures ANOVA was performed for both groups. Within-subject factors included type (*b-v*, *j-h*) and distractor (Competitor, None). Group (Spanish-dominant, English-dominant) was included as a between-subjects factor. Results reveal a main effect for group, $F_1(1, 31) = 29.96$, $p < 0.000$, $\eta_G^2 = 0.37$, in that the Spanish-dominant group was significantly faster than the English-dominant group; due to the fact that the task was in entirely in Spanish, this is not unexpected. In addition, there was a marginal effect for Type, $F_1(1, 31) = 3.55$, $p < 0.07$, $\eta_G^2 = 0.016$, in that the *b-v* trials are faster than *j-h* trials. Finally, the analysis indicates a significant effect of Group ×

[4] A reviewer points out that $p = 0.086$ is not marginal in all fields. We are following the convention where marginal effects are $0.05 < p < 0.10$.

Distractor interaction, $F_1(1, 31) = 17.16$, $p < 0.001$, $\eta_G{}^2 = 0.05$. Due to this interaction, separate ANOVAs were conducted for each group. In terms of the Spanish-dominant group, results revealed a main effect for Distractor, $F_1(1, 12) = 5.58$, $p < 0.04$, $\eta_G{}^2 = 0.04$, and a Type × Distractor interaction, $F_1(1, 12) = 3.94$, $p < 0.07$, $\eta_G{}^2 = 0.02$. The distractor effect was present in *b-v* trials for the Spanish-dominant group, but not in the *j-h* trials. As for the English-dominant group, a main effect of Distractor was found, $F_1(1, 19) = 13.66$, $p < 0.002$, $\eta_G{}^2 = 0.07$, indicating a distractor effect for both trials, yet results show this effect in the reverse direction, in that competitor trials were actually quicker than non-competitor trials. This was an unexpected finding to which we will return in the Discussion.

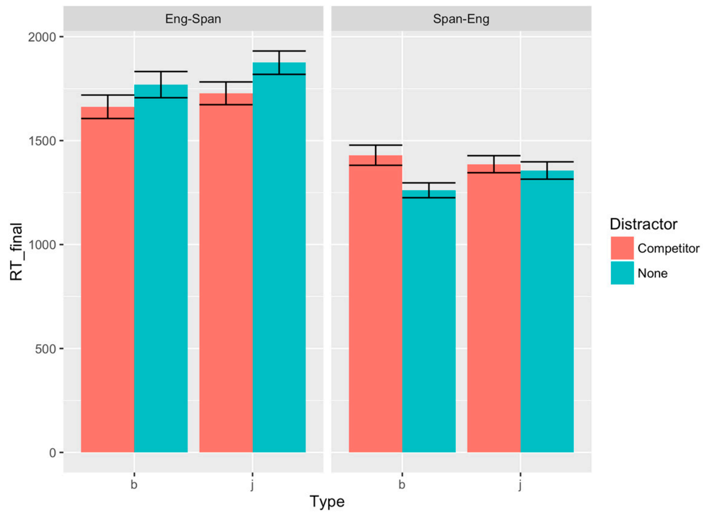

Figure 3. Mean reaction time (RT) for item selection in the presence or absence of phonological competitors. Graphs are split between bilingual group and trial type (*b* or *j* trials). Error bars indicate the standard error of the mean.

3.3. Eye-Tracking Results

Figure 4 represents the mean target fixation over time, beginning from the onset of the target noun in each experimental trial extended through 1200 ms. The graph shows a comparison of mean proportion of target fixation in competitor trials and non-competitor trials with each trial type. The left column represents the English-dominant group and the right column represents the Spanish-dominant group. The first two conditions, shown in the upper quadrants, represent *b-v* trials; Similarly, the lower quadrants represent *j-h* trials. Competitor trials are presented in orange. In order to test for distractor effects, a 2 × 2 × 2 repeated-measures ANOVA was performed with a time region of 300 to 900 ms post word-onset. This aggregate time window was selected because planned eye movements are launched approximately 150–200 ms after a critical event [48] and due to visual inspection of the graph. Only trials in which participants selected the correct item were included in the eye-tracking analysis. Within-Subject factors included type (*b*, *j*) and distractor (Competitor, None), and Group (Spanish-dominant, English-dominant) was included as a Between-Subjects factor.

Results of the aggregate proportion of fixations analysis indicated a main effect of Group, $F_1(1, 29) = 47.45$, $p < 0.000$, $\eta_G{}^2 = 0.42$; overall, the Spanish-dominant group had a higher proportion of target fixation than the English-dominant group across trials. Due to the fact that the task was performed entirely in Spanish, this difference was expected. Further results indicate a marginal effect for Type, $F_1(1, 29) = 2.96$, $p = 0.09$, $\eta_G{}^2 = 0.012$, a Group × Type interaction, $F_1(1, 29) = 9.16$, $p < 0.006$, $\eta_G{}^2 = 0.037$ as well as a significant Group × Distractor interaction, $F_1(1, 29) = 7.27$, $p < 0.002$, $\eta_G{}^2 = 0.077$. In order to take a closer look at the effects, the time region was subsequently split into an early and a late region. The early region was set between 300–600 ms from noun-onset and the late region between 600–900 ms from noun-onset.

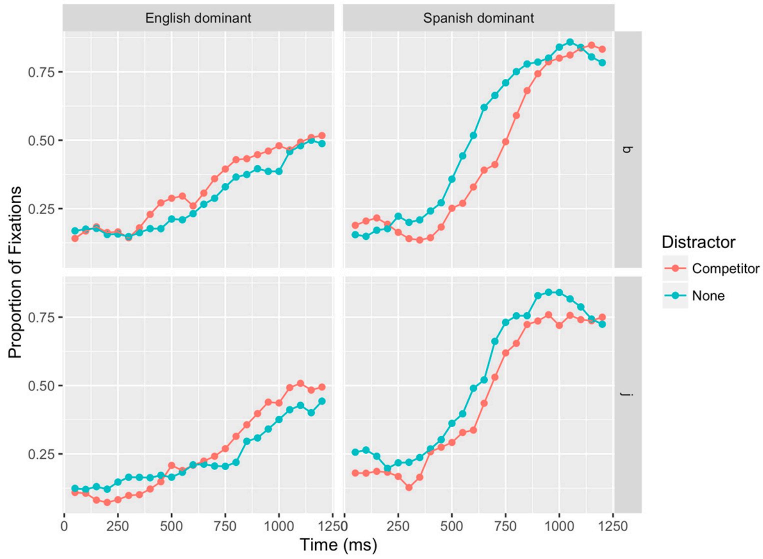

Figure 4. Mean proportion of target fixations split by bilingual group and trial type (*b* or *j* trials), beginning at noun onset.

In regards to the early region, the analysis revealed a main effect for Group, $F_1(1, 29) = 7.03$, $p < 0.02$, $\eta_G{}^2 = 0.057$ as well as a marginally significant Group × Type interaction, $F_1(1, 29) = 3.23$, $p = 0.083$, $\eta_G{}^2 = 0.019$. However, no significant distractor effects were found. In regards to the late region, results revealed a main effect for Group, $F_1(1, 29) = 71.95$, $p < 0.0000$, $\eta_G{}^2 = 0.51$, and a marginal effect for Type, $F_1(1, 29) = 3.59$, $p < 0.07$, $\eta_G{}^2 = 0.017$, a significant Group × Type interaction, $F_1(1, 29) = 6.34$, $p < 0.02$, $\eta_G{}^2 = 0.029$ and a significant effect of Group × Distractor interaction, $F_1(1, 29) = 7.59$, $p < 0.01$, $\eta_G{}^2 = 0.076$. The Group × Distractor interaction leads us to explore post-hoc comparisons split by group comparing competitor trials to non-competitor trials. Subsequent ANOVAs were conducted in order to compare means of target-item fixation in competitor trials to non-competitor trials.

In regards to the English-dominant group, results from the early-region analysis revealed no significant effects. Results from the late-region revealed a main effect for Type, $F_1(1, 17) = 8.7$, $p < 0.009$, $\eta_G{}^2 = 0.102$, indicating that *b-v* trials yielded a greater proportion of looks to the target than *j-h* trials, yet no distractor effects were found. In terms of the Spanish-dominant group, results from the early-region analysis revealed no significant effects, similar to the English-dominant group. However, late-region results revealed a main effect of Distractor, $F_1(1, 12) = 6.104$, $p < 0.029$, $\eta_G{}^2 = 0.13$, indicating that target fixation is lower in both sets of trials when a competitor is present when compared to trials in which the competitor is not present. This distractor main effect for the Spanish-dominant group stands in contrast to the RT results reported above in which only *b-v* trials resulted in a distractor effect[5].

4. Discussion

The intent of the present study was to investigate the role of the mapping relationship between orthography and phonology as it relates to the well-studied interactive nature of bilingual spoken language processing. More specifically, we tested two groups of Spanish–English bilinguals—an English-dominant group and a Spanish-dominant group—targeting pairs of graphemes that exist in both English and Spanish, yet differ in terms of their corresponding phonological mappings.

[5] A reviewer suggests that this difference may reflect different processing strategies such that the English-dominant group engages bottom-up processing whereas the Spanish-dominant group shows top-down processing. This potential account of processing differences should be further investigated in future studies.

In order to test for effects of orthographic interference during online processing, a visual-world paradigm was utilized to engage participants in a picture-selection task while their eye-movements were recorded. Due to the scarcity of research on orthographic effects on processing spoken language, only audio-stimuli were used with no direct exposure to the orthography.

Two sets of stimuli were chosen for the study: *b-v* (e.g., *banco-vaca* 'bench-cow') and *j-h* (e.g., *jabón-hacha* 'soap-axe'). Each set was predicted to yield a distinct processing effect in each group, i.e., the English-dominant group and the Spanish-dominant group. For *b-v* trials (RQ #1), we predicted that the English-dominant group would demonstrate similar behavior among both competitor and non-competitor trials, due to the fact that English employs these two graphemes—<b> and <v>—to represent distinct phonemic categories, i.e., /b/ and /v/ respectively. Conversely, as these two graphemes represent a single phonemic category in Spanish, i.e., /b/, we predicted that the Spanish-dominant speakers would in fact show effects of competition in these trials. If English-dominant speakers were to display effects of competition, however, we could interpret this as a successful reorganization of orthographic mapping in accordance with the Spanish phonology. Likewise, the absence of competition for the Spanish-dominant speakers could also suggest an influence of the later acquired English-orthographic system impacting their L1.

Results support our first hypothesis. In regards to English-dominant speakers, no significant competitor effects were found. Analysis shows a slight dip in accuracy on competitor trials, but this was not found to be significant. Analyses of RT and eye-tracking not only fail to show a hindrance on competitor trials, but even suggest a reversal effect in that speakers seem to be less hindered on competitor trials when compared to non-competitor trials, potentially indicating a delayed processing effect for non-competitor trials. As this effect was unexpected, we can only speculate that this anti-competitor effect may have arisen due to weaker lexical links with non-competitor control distractors as further evidenced by the numerically higher RT on non-competitor trials. This anti-competitor effect arose only in our processing measures as accuracy reflected trends towards lower accuracy for competitor trials.

Spanish-dominant speakers, in accordance with our hypothesis, present a clear competitor effect, demonstrated by both the RT and eye-tracking analyses, in that these speakers were significantly slower on *b-v* trials containing a competitor (i.e., a word beginning with <v>). Though the orthographic system may have played a role in influencing the English-dominant group, allowing them to ignore competing items associated with a distinct initial grapheme, we cannot as easily draw this same conclusion with the Spanish-dominant speakers, who did experience competition; that is, we cannot fully attribute these results to orthographic influence, in that this may be a result of pure phonological competition within the L1, as <b> and <v> map onto the same phoneme. Since participants were not exposed to orthographic information, it is difficult to pinpoint the role of orthographic competition in these trials. Nonetheless, we can interpret these results as demonstrating a difference in processing strategies between the two groups of bilinguals in these trials.

With respect to the *j-h* trials (RQ #2), we predicted that English-dominant speakers would show effects of competition, due to the fact that Spanish and English have distinct ways of orthographically representing the phoneme /x/ or /h/, i.e., <j> and <h>, respectively. We predicted that at the onset of this initial phoneme, not only would the orthographic information from Spanish be activated, but the English grapheme linked to this phoneme would be activated as well, thus competing for selection, causing the speakers to fixate the target (<j>) as well as the distractor (<h>). Conversely, we predicted that the Spanish-dominant speakers would not experience competition due to the fact that the task was done in the dominant L1-Spanish, and that intervening information from the less-dominant L2 English would be more easily suppressed. To our surprise, the results did not support either hypothesis.

Beginning with the English-dominant speakers, an analysis of the accuracy data showed a slight reduction in accuracy in *j-h* trials, which was diminished in *b-v* trials. This may be indicative of competition in *j-h* trials, in that conflicting information (i.e., <j> and <h>) hindered the selection of the correct target in the short amount of time they were given per trial. However, further data collection would be necessary to rule out other possible factors, such as word-frequency. Nonetheless, the analysis of the eye-tracking data did not yield any significant competitor effects. It is possible that the lack of significant competitor effects as well as the dip in accuracy in *j-h* trials for this group may be rooted in task difficulty, in that the L2-stimuli used in the trials may have been too taxing for the English-dominant group (see [49–51] for similar arguments).

On the other hand, effects found in the Spanish-dominant group yielded interesting results. Firstly, in terms of accuracy, we see no effects by condition, as the speakers were at ceiling, reflecting the simplicity of the task for dominant Spanish speakers. Similarly, reaction time analyses showed no significant competitor effect for *j-h* trials, as was found for *b-v* trials, suggesting that in these trials, selection of the correct target for Spanish-dominant speakers was not hindered in the presence of an image whose orthography begins with the <h> grapheme. However, the eye-tracking data points toward a different outcome. An analysis of the late region (600–900 ms from noun onset) demonstrated a significant competitor effect for *j-h* trials, similar to what was found for *b-v* trials. We will now discuss the implications of this finding. As stated before, competitor effects produced in *b-v* trials for Spanish-dominant speakers can be interpreted as pure phonological competition within the L1. However, due to the fact that the <h> grapheme in Spanish does not map onto the input that the participants received (i.e., /x/), phonological competition alone cannot explain this interference. Activation of cross-linguistic orthographic information, then, becomes the missing piece of the puzzle.

For a monolingual speaker of Spanish, we would not expect competition between the <j> and <h> graphemes, as these map onto completely separate phonological categories. However, for a bilingual, this information becomes intertwined[6] with information from the second language, resulting in overlap and ultimately interference. In this case, when the participant hears a word like 'jabón' /xa'bon/, not only is the L1 Spanish <j> activated, but the L2 English <h> is activated as well, both graphemes competing for selection. In a sense, the acquisition of the second language creates a 'bridge' for phonological competition.

Nevertheless, it is difficult at this point to tease apart whether this is a true competitor effect or a rhyming effect [22]. As mentioned earlier, the words that were depicted in the distractor images not only contained the initial phoneme/grapheme as specified by the condition, but also were matched for initial vowel to the target image. This was not necessarily the case for control images (although some did share this feature). Therefore, in order to mitigate this issue, we decided to conduct post-hoc analyses of English proficiency scores provided by the MELICET. If we are correct in assuming an influence of the L2 English on the L1 Spanish, then we should see a tendency towards English proficiency modulating this effect. In order to examine this prediction, we elected to use a median split in order to divide participants into higher and lower groups, similar to the method used in [46]. As the median score in the English grammar MELICET was 33, all participants who scored 32 or lower were labeled 'Span-Low' and all participants who scored 33 or higher were labeled 'Span-High'. Figure 5 displays the mean target fixation for the Spanish-High and Spanish-Low groups.

Graphically, it appears that the group with a higher level of English proficiency seems to be driving the competitor effect as compared to the group with a lower level of proficiency. Though we have a low number of participants, we conducted a *t*-test on *j-h* trials between 300 and 900 ms after noun onset on the Span-dominant group, split by proficiency. Results indicate a marginal distractor effect ($p = 0.086$) in the Spanish-high group, which was not demonstrated in the Spanish-low group ($p = 0.356$). Tentatively, this suggests that it is proficiency in English that is giving rise to the effect rather than the phonological effect itself; in order to more robustly test this account, we would need a higher number of participants.

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6 A reviewer points out that this greater competition may also be a result of code-switching, i.e., the fluid alternation between languages in bilingual speech. We do not dispute this possibility but lack any insight into this matter in our current study.

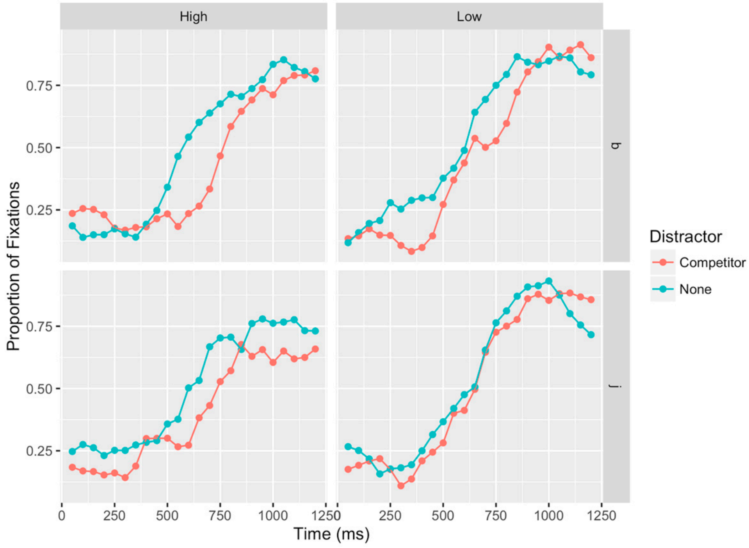

Figure 5. Mean proportion of target fixations for Spanish-dominant speakers, starting at noun onset split by English proficiency and trial type (*b* and *j* trials).

In regards to the lack of effects found in the English-dominant group, it is possible that this was due to the overall difficulty of the task, which is evident from the overall lower proportion of target fixation across trials. It is also important to note that this interaction was not demonstrated in either of the behavioral methods, yet only appeared in the analysis of the eye-tracking data, suggesting that this interaction represents a highly subtle, automatic process that could only be captured through eye-tracking. Results of this study are corroborated by previous studies in that as effects of interference from the first language on the less-dominant L2 may be more apparent [8,52–54], the L2 can affect the dominant L1 as well [53], resulting in an alteration of how certain aspects of the L1 are processed.

In order to gain a more complete understanding of this phenomenon, more Spanish-dominant speakers will need to be recruited. Due to the small number of participants (n = 13), many of the effects were marginal, although studies such as Spivey and Marian (1999) demonstrated robust results with a small group of participants (N = 12, [20]). As a reviewer points out, the large number of trials per participant (N = 48) in that study may have also helped to compensate for the lack of participants. Additionally, previous studies have shown that frequency and proficiency have significant effects on how language interaction in bilinguals is moderated. Although items were controlled for frequency as a whole[7], individual item frequencies were varied and could have resulted in various levels of language activation. It is possible that the task may have been too difficult for English-dominant speakers and thus were not able to uncover potential effects of competition. However, more proficient speakers may reveal interesting insights into L2 processing. In addition, in order to understand if English-dominant bilinguals truly do not experience an effect or if the task was simply too difficult, a similar visual world paradigm could be used, with the exception of direct orthographic representations in place of images. Additionally, immersion in English may have led to the L2 effect on the L1 for the *j-h* trials in our eye-tracking data. All of our Spanish-dominant participants have been immersed in an L2-English environment, and are studying/working in this language, and thus are more exposed to the L2 orthographic system than the English-dominant participants. Future studies may disentangle

[7] Paired *t*-tests were run on *j-h* stimuli and *b-v* stimuli, as well as filler sets in order to check for significant differences in frequencies. Groups were not significantly different. In order to render more concrete conclusions, future versions of this study will include more in-depth analyses of word frequency, word-length, and syllable-position, as these factors may affect processing speed.

this potential immersion factor by testing Spanish-dominant speakers who continue to be immersed in their L1 [55,56]. Lastly, in regards to the Spanish-dominant speakers, it would be interesting to see how dialectal differences may modulate comprehension, i.e., some dialects may produce more fricative /v/ and may in fact be less sensitive to effects of competition.

5. Conclusions

Through this study, we have shown that learning a second language may result in consequences on the dominant L1. In this case, we have shown that native speakers of Spanish with a functional level of English are influenced by the less-dominant L2 in spoken language processing. As previous studies have demonstrated that bilinguals experiencing cross-linguistic activation of lexical items with similar phonology and orthography show effects of cross-language competition, this study has shown that both phonological and orthographic features compete for selection, even if these representations are asymmetrical across languages. All in all, this study contributes to the further understanding of the mechanisms involved in bilingual sentence processing.

Supplementary Materials: Experimental trials and fillers are available online at http://www.mdpi.com/2226-471X/2/4/24/s1.

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Author Contributions: C.D. and J.V.K. conceived and designed the experiments; C.D. performed the experiments; C.D. and J.V.K. analyzed the data; C.D. and J.V.K. wrote the paper.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Grosjean, F. Neurolinguists, beware! The bilingual is not two monolinguals in one person. *Brain Lang.* **1989**, *36*, 3–15. [CrossRef]
2. Scarborough, D.L.; Gerard, L.; Cortese, C. Independence of lexical access in bilingual word recognition. *J. Verbal Learn. Verbal Behav.* **1984**, *23*, 84–99. [CrossRef]
3. Gerard, L.D.; Scarborough, D.L. Language-specific lexical access of homographs by bilinguals. *J. Exp. Psychol. Learn. Mem. Cognit.* **1989**, *15*, 305. [CrossRef]
4. Green, D.W.; Abutalebi, J. Language control in bilinguals: The adaptive control hypothesis. *J. Cognit. Psychol.* **2013**, *25*, 515–530. [CrossRef] [PubMed]
5. Bialystok, E.; Craik, F.I.M.; Green, D.W.; Gollan, T.H. Bilingual minds. *Psychol. Sci. Public Interest* **2009**, *10*, 89–129. [CrossRef] [PubMed]
6. Kroll, J.F.; Bobb, S.C.; Wodniecka, Z. Language selectivity is the exception, not the rule: Arguments against a fixed locus of language selection in bilingual speech. *Biling.-Lang. Cognit.* **2006**, *9*, 119–135. [CrossRef]
7. Grainger, J.; Dijkstra, T. On the representation and use of language information in bilinguals. *Adv. Psychol.* **1992**, *83*, 207–220.
8. Jared, D.; Kroll, J.F. Do bilinguals activate phonological representations in one or both of their languages when naming words? *J. Mem. Lang.* **2001**, *44*, 2–31. [CrossRef]
9. Sunderman, G.; Kroll, J.F. First language activation during second language lexical processing: An investigation of lexical form, meaning, and grammatical class. *Stud. Second Lang. Acquis.* **2006**, *28*, 387–422. [CrossRef]
10. Van Heuven, W.J.; Dijkstra, T.; Grainger, J. Orthographic neighborhood effects in bilingual word recognition. *J. Mem. Lang.* **1998**, *39*, 458–483. [CrossRef]
11. Dijkstra, T.; Van Heuven, W.J. The architecture of the bilingual word recognition system: From identification to decision. *Biling.-Lang. Cognit.* **2002**, *5*, 175–197. [CrossRef]
12. Bijeljac-Babic, R.; Biardeau, A.; Grainger, J. Masked orthographic priming in bilingual word recognition. *Mem. Cognit.* **1997**, *25*, 447–457. [CrossRef] [PubMed]
13. Kroll, J.F.; Michael, E.; Tokowicz, N.; Dufour, R. The development of lexical fluency in a second language. *Second Lang. Res.* **2002**, *18*, 137–171. [CrossRef]

14. Talamas, A.; Kroll, J.F.; Dufour, R. From form to meaning: Stages in the acquisition of second-language vocabulary. *Biling.-Lang. Cognit.* **1999**, *2*, 45–58. [CrossRef]
15. Altarriba, J.; Kroll, J.F.; Sholl, A.; Rayner, K. The influence of lexical and conceptual constraints on reading mixed-language sentences: Evidence from eye fixations and naming times. *Mem. Cognit.* **1996**, *24*, 477–492. [CrossRef] [PubMed]
16. Van Heuven, W.J.B.; Schriefers, H.; Dijkstra, T.; Hagoort, P. Language conflict in the bilingual brain. *Cereb. Cortex* **2008**, *18*, 2706–2716. [CrossRef] [PubMed]
17. Schwartz, A.I.; Kroll, J.F.; Diaz, M. Reading words in Spanish and English: Mapping orthography to phonology in two languages. *Lang. Cogn. Process.* **2007**, *22*, 106–129. [CrossRef]
18. Marslen-Wilson, W. Functional parallelism in spoken word recognition. *Cognition* **1987**, *25*, 71–102. [CrossRef]
19. Marslen-Wilson, W.; Welsh, A. Processing interactions during word-recognition in continuous speech. *Cognit. Psychol.* **1978**, *10*, 29–63. [CrossRef]
20. Spivey, M.J.; Marian, V. Cross talk between native and second languages: Partial activation of an irrelevant lexicon. *Psychol. Sci.* **1999**, *10*, 281–284. [CrossRef]
21. Tanenhaus, M.K.; Spivey-Knowlton, M.J.; Eberhard, K.M.; Sedivey, J.C. Integration of visual and spatial information in spoken language comprehension. *Science* **1995**, *268*, 1632–1634. [CrossRef] [PubMed]
22. Allopenna, P.D.; Magnuson, J.S.; Tanenhaus, M.K. Tracking the time course of spoken word recognition using eye movements: Evidence for continuous mapping models. *J. Mem. Lang.* **1998**, *38*, 419–439. [CrossRef]
23. Chambers, C.G.; Cooke, H. Lexical competition during second-language listening: Sentence context, but not proficiency, constrains interference from the native lexicon. *J. Exp. Psychol. Learn. Mem. Cognit.* **2009**, *35*, 1029. [CrossRef] [PubMed]
24. Escudero, P.; Simon, E.; Mulak, K.E. Learning words in a new language: Orthography doesn't always help. *Biling.-Lang. Cognit.* **2014**, *17*, 384–395. [CrossRef]
25. Erdener, V.D.; Burnham, D.K. The role of audiovisual speech and orthographic information in nonnative speech production. *Lang. Learn.* **2005**, *55*, 191–228. [CrossRef]
26. Katz, L.; Frost, R. The reading process is different for different orthographies: The orthographic depth hypothesis. In *Orthography, Phonology, Morphology, and Meaning*; Frost, R., Katz, L., Eds.; Elsevier Science Publishers: Amsterdam, The Netherlands, 1992; pp. 67–84.
27. Klima, E.S. How Alphabets Might Reflect Language. In *Language by Ear and by Eye*; Kavangah, J.F., Mattingly, I.G., Eds.; MIT Press: Cambridge, MA, USA, 1972; pp. 55–80.
28. Escudero, P.; Wanrooij, K. The effect of L1 orthography on non-native vowel perception. *Lang. Speech* **2010**, *53*, 343–365. [CrossRef] [PubMed]
29. Hayes-Harb, R.; Nicol, J.; Barker, J. Learning the phonological forms of new words: Effects of orthographic and auditory input. *Lang. Speech* **2010**, *53*, 367–381. [CrossRef] [PubMed]
30. Elliott, A.R. On the teaching and acquisition of pronunciation within a communicative approach. *Hispania* **1997**, *80*, 96–108. [CrossRef]
31. Face, T.L.; Menke, M.R. Acquisition of the Spanish voiced spirants by second language learners. In *Selected Proceedings of the 11th Hispanic Linguistics Symposium*; Collentine, J., García, M., Lafford, B., Marín, F.M., Eds.; Cascadilla Proceedings Project: Somerville, MA, USA, 2009; pp. 39–52.
32. Sadowsky, S. El alófono labiodental sonoro [v] del fonema/b/en el castellano de Concepción (Chile): Una investigación exploratoria. *Estud. Fon. Exp.* **2010**, *19*, 231–261.
33. Sadowsky, S. Variación sociofonética de las consonantes del castellano chileno [Sociophonetic variation in Chilean Spanish consonants]. *Sociolinguist. Stud.* **2015**, *9*, 71–92. [CrossRef]
34. Vergara Fernández, V. Relación entre alfabetización y producción de los alófonos de /b/: estudio del habla cuidada de hablantes prealfabetizados y alfabetizados. *Onomázein* **2013**, *27*, 158–170.
35. Vergara Fernández, V.; Pérez, H.E. Estudio de la incidencia de la representación gráfica (escritura) en la producción del alófono labiodental [v] del fonema /b/. *Bol. Filol.* **2014**, *48*, 119–128. [CrossRef]
36. Cassano, P. La [b] del español del Paraguay, en posición inicial. *Revue Romane* **1972**, *7*, 186–188.
37. Granda, G. de Observaciones sobre la fonética del español en el Paraguay. *Anuario de Letras. Lingüística y Filología* **1982**, *20*, 145–194.
38. Kallfell, G. Fonética y fonología del español paraguayo. Efectos concomitantes del contacto con el guaraní. *UniverSOS* **2009**, *6*, 81–104.

39. Lope Blanch, J.M. La labiodental sonora en el español de México. *Nueva Revista de Filología Hispánica* **1988**, *36*, 153–170. [CrossRef]
40. Torres Cacoullos, R.; Ferreira, F. Lexical frequency and voiced labiodental -bilabial variation in New Mexican Spanish. *Southwest J. Linguist.* **2000**, *19*, 1–17.
41. Hualde, J.I. *Los Sonidos del Español*; Cambridge University Press: Cambridge, UK, 2014.
42. Ministry of Education, Culture, and Sport of Spain. Diploma de Español como Lengua Extranjera (Spanish as a Foreign Language Diploma) Examination. 2006. Available online: https://www.dele.org/ (accessed on 3 September 2011).
43. English Language Institute. *MELICET—GCVR User's Manual*; English Language Institute, The University of Michigan: Ann Arbor, MI, USA, 2001.
44. Boersma, P.; Weenink, D. Praat: Doing phonetics by computer [Computer program]. Available online: http://www.praat.org/ (accessed on 1 February 2017).
45. Schwartz, A.I.; Kroll, J.F. Bilingual lexical activation in sentence context. *J. Mem. Lang.* **2006**, *55*, 197–212. [CrossRef]
46. Dussias, P.E.; Valdés Kroff, J.R.; Guzzardo Tamargo, R.E.; Gerfen, C. When gender and looking go hand in hand. *Stud. Second Lang. Acquis.* **2013**, *35*, 353. [CrossRef]
47. R Core Team. R: A language and environment for statistical computer [Computer program]. R Foundation for Statisical Computing: Vienna, Austria. Available online: http://www.cran.r-project.org (accessed on 3 September 2016).
48. Altmann, G.T.M. The mediation of eye movements by spoken language. In *The Oxford Handbook of Eye Movements*; Liversedge, S.P., Gilchrist, I.D., Everling, S., Eds.; Oxford University Press: Oxford, UK, 2011; pp. 979–1004.
49. Hopp, H. Differential learning of prediction. *Linguist. Approaches Biling.* **2015**, *5*, 476–481. [CrossRef]
50. Kaan, E. Predictive sentence processing in L2 and L1: What is different? *Linguist. Approaches Biling.* **2014**, *4*, 257–282. [CrossRef]
51. McDonald, J.L. Beyond the critical period: Processing-based explanations for poor grammaticality judgment performance by late second language speakers. *J. Mem. Lang.* **2006**, *55*, 381–401. [CrossRef]
52. Marian, V.; Spivey, M. Bilingual and monolingual processing of competing lexical items. *Appl. Psycholinguist.* **2003**, *24*, 173–193. [CrossRef]
53. Van Hell, J.; Dijkstra, T. Foreign language knowledge can influence native language performance in exclusively native contexts. *Psychon. Bull. Rev.* **2002**, *9*, 780–789. [CrossRef] [PubMed]
54. Weber, A.; Cutler, A. Lexical competition in non-native spoken-word recognition. *J. Mem. Lang.* **2004**, *50*, 1–25. [CrossRef]
55. Dussias, P.E.; Sagarra, N. The effect of exposure on syntactic parsing in Spanish-English bilinguals. *Biling.-Lang. Cognit.* **2007**, *10*, 101–116. [CrossRef]
56. Valdés Kroff, J.R.; Guzzardo Tamargo, R.E.; Dussias, P.E. Experimental contributions of eye-tracking to the understanding of comprehension processes while hearing and reading code-switches. *Linguist. Approaches Biling.* **2017**. [CrossRef]