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Phonological Interaction in Spanish-English Bilinguals: Effects of Cognate Usage on Voice Onset Time of Voiced Stops

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PHONOLOGICAL INTERACTION IN SPANISH-ENGLISH BILINGUALS: EFFECTS OF COGNATE USAGE ON VOICE ONSET TIME OF VOICED STOPS

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Sophia Andrea Younes

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To: Director, Linguistics Program
College of Arts, Sciences and Education

This MA Project, written by Sophia Andrea Younes, and entitled Phonological Interaction in Spanish-English Bilinguals: Effects of Cognate Usage on Voice Onset Time of Voiced Stops, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this MA Project and recommend that it be approved.

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The MA Project of Sophia Andrea Younes is approved.

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DEDICATION

This research project is dedicated to my father, to whom I owe my life, all that I am, and all that I have accomplished. Baba, thank you always for raising me to be diligent and insightful. Your unwavering support throughout my whole life will never be forgotten.

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ABSTRACT OF THE RESEARCH PROJECT

PHONOLOGICAL INTERACTION IN SPANISH-ENGLISH BILINGUALS:

EFFECTS OF COGNATE USAGE ON VOICE ONSET TIME OF VOICED STOPS

by

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Miami, Florida

Professor Mehmet Yavaş, Major Professor

This study compared Spanish-English bilinguals' and English monolinguals' VOT values for voiced stops in cognates and non-cognates. VOT norms for voiced stops are 0 to +35 ms in English and -235 to -45 ms in Spanish. Participants (twelve monolinguals, fourteen bilinguals) were administered a picture-naming task balanced for cognates and non-cognates. VOTs of 30 target words per participant, per language were measured.

Bilinguals' English VOTs exhibited greater lead voicing (*M*=-31.53 ms) than monolinguals' (*M*=8.86 ms), and all participants' /b/ had longer lead voicing (*M*=-17.44 ms) than /d/ (*M*=-10.74 ms) and /g/ (*M*=-5.83 ms). Comparing bilinguals' Spanish versus English VOTs revealed significant differences by language (English shorter), differences between /b/ and /g/, and between cognates (*M*=-45.49 ms) and non-cognates (*M*=-53.26 ms). Further results showed shorter (more English-like) lead voicing in cognates in bilinguals' Spanish /d/ and English /b/ productions. The conclusion is that the bilinguals' VOT values exhibited cross-linguistic influence related to cognate usage, in the direction towards their dominant language (English).

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ABBREVIATIONS AND ACRONYMS

FIU	Florida International University
H1	Hypothesis 1
H2	Hypothesis 2
H3	Hypothesis 3
H4	Hypothesis 4
IRB	Institutional Review Board
L1	First language; native language
L2	Second language
M	Statistical mean
ms	Milliseconds
N	Number of the whole set of participants
n	Number of a subset of participants
p	*p*-value; level of statistical significance
POA	Place of articulation
PPVT	Peabody Picture Vocabulary Test
RMANOVA	Repeated Measures Analysis of Variance
SD	Standard deviation
SLM	Speech Learning Model
SPSS	Statistical Package for Social Sciences
TVIP	Test de Vocabulario en Imágenes Peabody
VOT	Voice onset time

I. INTRODUCTION

Recent research has demonstrated that interaction between the semantic systems in bilinguals is widespread, especially in the case of cognates (Gathercole, Pérez-Tattam, Stadthagen-González, & Thomas, 2014), or lexical items that are closely related semantically, phonetically, and sometimes orthographically across two languages. Many studies have shown that this cognate effect is positive in that it can facilitate lexical mappings across bilinguals' two languages (Costa, Caramazza, & Sebastian-Galles, 2000; Hoshino & Kroll, 2008; Lemhöfer, Dijkstra, & Michel, 2004; Van Hell & Dijkstra, 2002), though some have found limitations on the facilitative effects of cognates (Canizares, 2016; Peeters, Dijkstra, & Grainger, 2013). Despite the popularity of research on cross-language interaction in bilinguals' semantic systems, relatively few studies have focused on testing for a possible interaction between bilinguals' two phonological systems. The scarcity of such investigations leaves certain questions unanswered, such as whether cognate usage affects bilinguals' phonological representations and distinctions, realized acoustically as variation in voice onset time (hereafter "VOT").

Greater insight into such cognate effects on VOT could provide further evidence in the domain of phonetics to support the notion of bilingual language system interaction (see study by Flege & Port, 1981), as well as reveal a possible relationship between cognate usage and "compromised" VOT values, which could be contributing to a perceived "foreign accent" from some bilingual speakers (Flege & Eefting, 1987; Flege, Munro, & MacKay, 1995; Yavaş, 2002). The ensuing study thus aims to contribute to the currently growing body of research concerned with the relationship between cognate effects and VOT in bilingual speech productions. In particular, the study endeavors to

provide an answer to the question of whether early Spanish-English bilinguals' VOT values for voiced stops /b, d, g/ differ significantly from English monolingual norms more often in cognates than in non-cognates.

II. A REVIEW OF RELEVANT LITERATURE

While there are comparatively few studies that examine the relationship between cognates and VOT in bilingual speakers' productions of the voiced stop group, several previous investigations have examined VOT as it relates to bilingualism, and some have looked at cognate effects on the VOTs of voiceless stops. This literature review provides a survey of such studies insofar as they are relevant to the research question detailed above. The review is organized in the following fashion: first, a brief overview of VOT and its ranges in Spanish and English will be given; then, factors of influence on VOT as found in previous studies will be discussed; and finally, the theoretical implications of the mentioned literature will be reviewed. The findings of these works will provide a framework for the ensuing study's examination of early Spanish-English bilingual productions of the voiced stops /b, d, g/ in cognates versus non-cognates.

Voice Onset Time: A Brief Overview

VOT is defined as "the time difference between the release of the stop closure and the beginning of vocal cord vibration" (Yavaş, 2016). In languages such as Japanese, German, Spanish, and English, the phonemic contrasts of stop consonants are acoustically perceptible due to variations in VOT values (Fabiano-Smith & Bunta, 2012).

Yavaş (2016) identifies four general categories of VOT that languages seem to favor: (1) fully voiced (VOT from approximately -125 to -75 ms, but can extend even further on the negative continuum), (2) partially voiced (voicing begins sometime during the stop closure and continues into the following vowel), (3) voiceless unaspirated (VOT from approximately 0 to +25 ms), and (4) voiceless aspirated (VOT from approximately +60 to +100 ms). VOT duration has often been a factor of interest in studies investigating the native-likeness and/or foreign-accentedness of bilinguals' L2 stop consonant productions (e.g., Flege, 1980; Flege & Hillenbrand, 1987; Thornburgh & Ryalls, 1998, among many others). A series of works have examined differences in VOT values in Spanish versus English; these provide a basis for the present study.

Voice Onset Time in Spanish vs. English

Since much of the existing research comparing VOT trends in Spanish and English has focused on the voiceless stop group, it is instructive to first review these trends in preparation for an examination of how these two languages differ on the voiced stop group. According to Amengual (2012), the VOT for Spanish voiceless stops lies between 0 and +20 ms, while the VOT for English voiceless (aspirated) stops lies between +30 and +120 ms. Approaching a certain VOT range when producing stops in these languages would cause productions to become more "native-like", and previous studies have found that second language learners of English whose native languages belong to the Romance family are able to achieve VOTs within the monolingual English range for voiceless stops (Amengual, 2012). Additionally, voiceless stops are not aspirated in Spanish, but they are in English, unless preceded by /s/ (Thornburgh &

Ryalls, 1998). Because of this difference in aspiration trends, there is a perceived acoustic overlap with the VOTs of Spanish voiceless stops and English voiced stops, which generally lie within the VOT range of 0 to +35 ms, or -155 to -20 for English speakers who tend to produce lead voicing, in word-initial position (Procter, Bunta, & Aghara, 2014; see Lisker and Abramson, 1964, for explanation of the two different ranges for English initial voiced stop VOT).

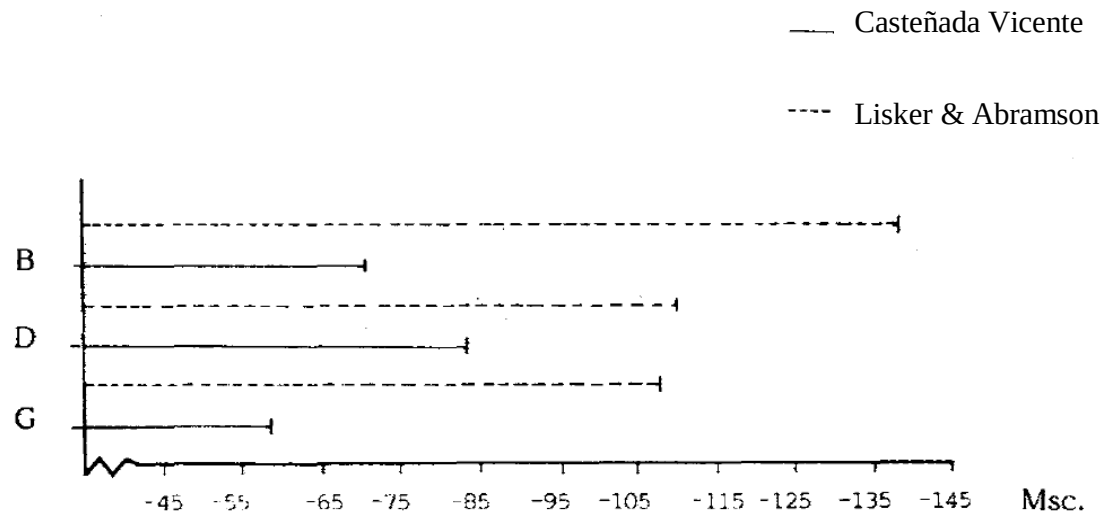
Regarding the voiced stop group, stops in word-initial position in Spanish tend to exhibit lead voicing, which yields a negative VOT measurement, and are hence classified as fully voiced stops, whereas voiced stops in English tend to have little-to-no lead voicing and are thus classified as partially voiced, or more simply, unaspirated. Lisker and Abramson (1964) pinpointed VOT norms and ranges typically produced in English and Spanish stops in a seminal study expounding on cross-linguistic VOT trends (see Table 1 below for the voiced stop values in word-initial position). These norms were found to be typical for monolingual speakers of each language, though it should be noted that Lisker and Abramson's (1964) study gathered data from only two speakers of the Puerto Rican Spanish dialect, and only four speakers of American English. Additionally, a later study by Casteñada Vicente (1986) that had ten participants reported shorter lead voicing values on average for voiced stops in Spanish than those reported by Lisker and Abramson (1964). Graph 1, displayed further below, shows the comparison of Casteñada Vicente's (1986) and Lisker and Abramson's (1964) findings for average VOT values of voiced stops in Spanish.

Table 1. VOT norms for English and Spanish voiced stops (adapted from Lisker & Abramson, 1964)

English			**Spanish**		
	Average VOT (ms)	VOT Range (ms)		Average VOT (ms)	VOT Range (ms)
/b/	1 / -101	0:5 / -130: -20	/b/	-138	-235: -60
/d/	5 / -102	0:25 / -155: -40	/d/	-110	-170: -75
/g/	21 / -88	0:35 / -150: -60	/g/	-108	-165: -45

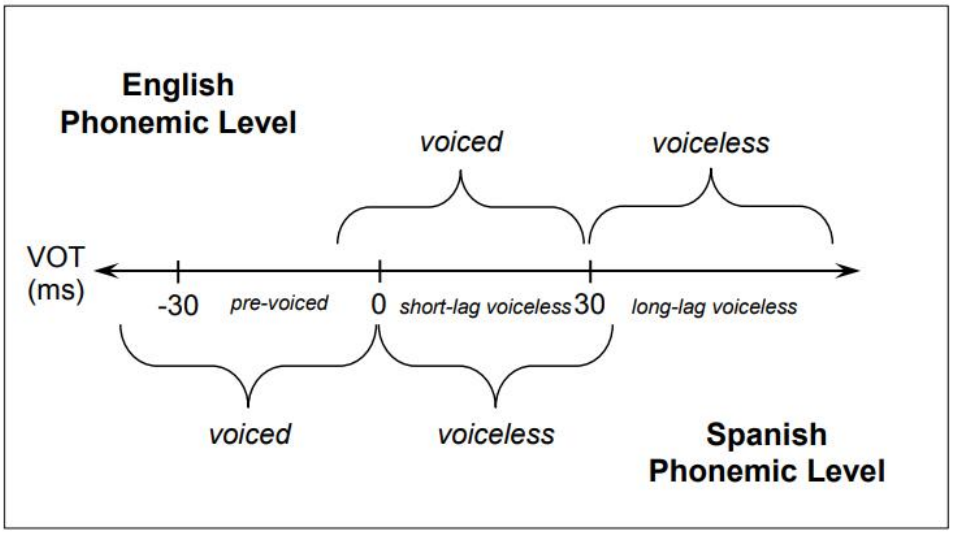
Lisker and Abramson's (1964) findings for English voiced stop VOT norms revealed that in word-initial position in isolated words in English, there are trends that include either voicing lead (negative VOT) or voicing lag (positive VOT), hence they noted two different VOT norms for English voiced stops, which include both positive and negative measurements. It is interesting to note that of the four participants Lisker and Abramson collected data from for these English norms, one in particular was responsible for 95% of all the stops produced with voicing lead (1964). As has been discussed in more recent publications, this could be due to possible differences in voicing trends across American English dialects (Jacewicz, Fox, & Lyle, 2009; Purnell, Salmons, & Tepeli, 2005; Purnell, Salmons, Tepeli, & Mercer, 2005).

Graph 1. Comparison of Casteñada Vicente's (1986) and Lisker and Abramson's (1964) findings for average VOT values of voiced stops in Spanish (retrieved from Casteñada Vicente, 1986)



Taking into account both Lisker and Abramson's (1964) and Casteñada Vicente's (1986) findings, the noted differences between Spanish and English VOT ranges raise the question of whether Spanish-English bilinguals differentiate between or approximate the VOT values of stop consonants in Spanish and English. As is illustrated in Figure 1 below, the fact that there is some overlap between Spanish voiceless stops and English voiced stops, and that the voiceless aspirated stops in English are completely outside of the phonological options in Spanish, might have ramifications for how successful bilinguals may be with acquiring monolingual-like VOT values for stops in these two languages. However, as will be discussed in the following section, there are other factors that have been shown to affect the VOT values of speakers' stop productions.

Figure 1. "Phonetic category classification of English and Spanish stop consonants" (retrieved from Banov, 2014; adapted from Zampini & Green, 2001)



Factors of Influence on Voice Onset Time

Utterance position and place of articulation. Given the previous discussion of the functions and tendencies of VOT, most would agree that the presence of voicing during a stop closure is the most reliable acoustic cue of what is classified as a voiced stop. However, this is not always the case. Flege and Brown (1982) stated that "the most obvious mismatch between the feature value of phonological voicing (± *Voice*) and the physical presence or absence of voicing (glottal pulsing) occurs in utterance-initial position, where the nominally 'voiced' stops /b, d, g/ are often produced without voicing", and that voiced stops are sometimes devoiced when produced in a post-stressed position, especially before a word boundary or pause (p. 336). Additionally, "the phonologically 'voiceless' stops /p, t, k/…sometimes manifest voicing during the initial portion or even the entire period of closure, especially when both preceded and followed by other phonologically + *Voice* sounds" (Flege & Brown, 1982, p. 336).

In their study investigating the extent to which English bilabial stops exhibit "inappropriate" voicing (+ *Voice* stops produced without voicing, and - *Voice* stops produced with voicing), Flege and Brown (1982) found that the presence of voicing during a stop closure generally is a reliable indication of the voicing contrast between /p/ and /b/ in English, but that this reliability is stronger in utterance-medial positions and weaker in the utterance-final position. Other studies have corroborated this finding, demonstrating that voiced stops are more likely to be produced with voicing in the intervocalic position than in the word-initial or word-final positions (Westbury, 1983; Westbury & Keating, 1986), given that "the intervocalic position enhances the 'articulatory ease' which can facilitate continuous voicing through the oral closure of a single voiced stop" (Jacewicz, Fox, & Lyle, 2009).

Other work has shown that another factor of influence on VOT duration in English stop consonant productions is place of articulation. In a study investigating the effects of place of articulation and vowel height on Spanish speakers' acquisition of English voiceless stops, Yavaş and Wildermuth (2006) found that "VOT and place of articulation of the stop behave in a significantly linear manner in that VOT increases as the place of articulation progresses farther back in the oral cavity (bilabial to alveolar to velar)" (p. 260). Data from numerous prior studies have also shown that place of articulation is a factor of influence on VOT in English stops in that the time difference between the stop release and the initiation of voicing increases as the place of articulation moves from labial to alveolar to velar (Lisker & Abramson, 1967; Thornburgh & Ryalls, 1998; Volaitis & Miller, 1992; Yavaş, 1996, 2002; Zlatin, 1974).

Age of L2 acquisition onset. Extensive research has been conducted on the question of how age of L2 acquisition affects bilinguals' phonological representations and consequent phonetic realizations. Thornburgh and Ryalls (1998) began their research on the premise that "the learning of phonemic categories in the first language may interfere with formation of phonemic categories in the second language" (p. 216-217), meaning that second language learners might mistakenly perceive L2 sounds that are similar to their L1 sounds as allophones of their L1 sounds. To test for effects of age of L2 acquisition, Thornburgh and Ryalls (1998) compared productions of both voiced and voiceless stops by Spanish-English bilinguals who learned English before the age of 12 with those of Spanish-English bilinguals who learned English at or after the age of 12. Their hypothesis was that the earlier English learners would produce more English-like VOT values than the later English learners for both voiced and voiceless stops.

Thornburgh and Ryalls ultimately found that both acquisition age groups were able to produce VOT values that fell within the acceptable range in English (1998). They commented that the pre-12 learners contrasted VOT values more than the post-12 learners, meaning that the earlier learners of English differentiated voiced from voiceless stops to a greater degree than the later learners. However, there was no significant correlation found between age of English acquisition and mean amount of VOT contrast between voiced and voiceless stops. Thus, Thornburgh and Ryalls (1998) concluded that other factors might be at play when bilinguals acquire phonological knowledge, whatever their age may be.

Amengual (2012) found similar results in that his study on cross-language influence and cognate effects in bilinguals did not yield statistically significant

differences between the VOT values of early versus late bilinguals. Amengual also found that all bilinguals in his study maintained VOT values congruent with the English monolingual range for /t/ (2012). Similar to Thornburgh and Ryalls (1998), Amengual (2012) found that the early bilinguals' VOT values were closer to monolingual English norms, but that the later bilinguals still produced VOT values within the acceptable range in English, and concluded that "highly proficient L2 learners are also able to produce segments in Spanish that are not significantly different from simultaneous bilinguals" (p. 525).

Likewise, in a study on differences in VOT productions of early versus later Spanish-English bilinguals, Yavaş (1996) found that although the early bilinguals' VOT values were much closer to monolingual English speakers' VOT norms for voiceless stops, the later bilinguals' VOT values still fell within the acceptable range of possible monolingual English speaker productions. Thus, Yavaş (1996) concluded that the notion that an L2 age of acquisition of eleven or twelve years is too late to achieve "authentic" VOT productions is unjustified, and that based on their VOT measurements, such "later" learners cannot be classified as having non-native voiceless stop VOT values. That these studies all demonstrated that later bilinguals' VOTs fell within acceptable monolingual ranges raises evidence against the notion that age of L2 acquisition has a significant effect on bilinguals' VOT realizations, which have been found to be salient indicators of speakers' phonetic category formation and acoustically-perceived foreign accent (Flege & Eefting, 1987; González-Bueno, 1997; Ioup, 2008; Schoonmaker-Gates, 2015; Zampini, 2008).

In contrast to the above works, a seminal study by Flege (1991) comments on the inhibitory effect age of L2 acquisition can have on the acquisition of monolingual-like phonetic realizations. In his study on age of acquisition and the authenticity of VOT in stop consonants produced by early and late Spanish L1-English L2 learners, Flege found that late L2 English learners exhibited "compromise" VOT values that were longer than the short-lag values typical for Spanish monolinguals, but shorter than the long-lag values typical for English monolinguals. However, the early bilingual learners in Flege's (1991) study were successful in attaining VOT values comparable to the English monolingual norms. Thus, Flege concluded that early L2 learners, but not later L2 learners, are able to acquire monolingual-like phonetic categories in the L2. In another study on the production and perception of English stops by native Spanish speakers, Flege and Eefting (1987) found that even native Spanish-speaking children who acquired English by 5 or 6 years of age realized voiceless stops with significantly shorter VOT values in English than did age-matched monolingual English speakers, suggesting that acquiring English as an L2 by 5 or 6 is still too late to attain monolingual-like VOT productions.

Similarly, Banov (2014) found that Spanish-English bilinguals who acquired both languages before 5 years of age did not produce English or Spanish VOTs within the monolingual norms published in previous studies, and another study by Williams (1977) found that Spanish-English bilingual adults who had acquired their L2 either before or upon entering primary school still "carried over" the prevoicing tendency from Spanish to English in word-initial voiced stops. However, Williams (1977) also noted that because prevoicing of word-initial voiced stops can occur even in monolingual English-speaker

productions, the Spanish-English bilingual "carry-over" should not interfere with perceptual acceptability of bilingual productions.

Finally, in a study on the relationship between age of onset of acquisition and ultimate attainment of phonetic nativelikeness, Abrahamsson (2012) investigated the phonetic "intuition" of Spanish-speaking L2 learners of Swedish who acquired Swedish between 1 and 30 years of age. He predicted that age of onset of acquisition would be the strongest predictor of ultimate attainment of phonetic intuition, that no late L2 learner would demonstrate nativelike results on a categorical perception test of VOT, and that very few early L2 learners would demonstrate non-nativelike results on the same phonetic test. These hypotheses were all confirmed by the study's results, and Abrahamsson (2012) concluded that "nativelikeness in both morphosyntactic and phonetic intuition is highly probable if L2 acquisition starts in early childhood (AO $\leq$ 6), relatively rare if it starts in later childhood (AO 7–13), and highly unlikely (or even impossible) if first L2 exposure occurs after puberty (AO > 13)" (p. 209). Given this dissonance in the literature, more conclusive evidence that demonstrates the effects of age of L2 acquisition on VOT is thus necessary to better determine whether the Critical Age Hypothesis (Patkowski, 1994) is valid regarding bilinguals' phonological representations and consequent phonetic realizations.

Bilingual phonological systems and phonemic representations. Under the umbrella topic of age of L2 acquisition onset as it relates to bilinguals' VOT outcomes and resulting degree of foreign-accentedness lies a corpus of research dedicated to investigating the phonological systems and phonemic representations of bilinguals. The main questions addressed in such studies are whether bilinguals construct one

comprehensive, or two distinct, phonological system(s), and whether bilinguals' phonemic representations match or approximate those of monolinguals in their two languages. Flege's (1995) Speech Learning Model (SLM) outlines a number of postulates and hypotheses about second language sound acquisition that illustrate one way in which we might understand the development of bilinguals' phonological systems, phonetic categories, and phonemic contrasts, as well as explain the phonological processes that underlie some bilinguals' perceived foreign accent (see Table 2 below).

Table 2. "Postulates and hypotheses forming a speech learning model (SLM) of second language sound acquisition"
(retrieved from Flege, 1995)

	Postulates
P1	The mechanisms and processes used in learning the L1 sound system, including category formation, remain intact over the life span, and can be applied to L2 learning.
P2	Language-specific aspects of speech sounds are specified in long-term memory representations called *phonetic categories.*
P3	Phonetic categories established in childhood for L1 sounds evolve over the life span to reflect the properties of all L1 or L2 phones identified as a realization of each category.
P4	Bilinguals strive to maintain contrast between L1 and L2 phonetic categories, which exist in a common phonological space.
	Hypotheses
H1	Sounds in the L1 and L2 are related perceptually to one another at a position-sensitive allophonic level, rather than at a more abstract phonemic level.
H2	A new phonetic category can be established for an L2 sound that differs phonetically from the closest L1 sound if bilinguals discern at least some of the phonetic differences between the L1 and L2 sounds.
H3	The greater the perceived phonetic dissimilarity between an L2 sound and the closest L1 sound, the more likely it is that phonetic differences between the sounds will be discerned.
H4	The likelihood of phonetic differences between L1 and L2 sounds, and between L2 sounds that are noncontrastive in the L1, being discerned decreases as AOL increases.
H5	Category formation for an L2 sound may be blocked by the mechanism of equivalence classification. When this happens, a single phonetic category will be used to process perceptually linked L1 and L2 sounds (diaphones). Eventually, the diaphones will resemble one another in production.
H6	The phonetic category established for L2 sounds by a bilingual may differ from a monolingual's if: 1) the bilingual's category is "deflected" away from an L1 category to maintain phonetic contrast between categories in a common L1–L2 phonological space; or 2) the bilingual's representation is based on different features, or feature weights, than a monolingual's.
H7	The production of a sound eventually corresponds to the properties represented in its phonetic category representation.

Flege's (1995) SLM provided a framework for understanding L2 sound acquisition upon which many later studies investigating bilingual phonological development were based. In a speech-production study comparing the phonetic systems of French-English bilingual children with those of their monolingual peers in both languages, Mack, Bott, and Boronat (1995) found that although the bilinguals had been exposed to input from monolingual speakers of both French and English from very early on, few of them produced stop consonants using two distinct VOT categories for French and English, and that the bilinguals' English productions did not match, but approximated the English monolingual productions.

However, the results of the study also revealed that the bilinguals' French productions closely matched those of the French monolinguals in terms of VOT values. Based on these results, Mack et al. (1995) theorized that early exposure to both languages does not prevent the unidirectional and/or bidirectional interaction of bilinguals' phonological systems. Similarly, in their study on cross-language phonetic influences on the speech of French-English bilinguals, Fowler, Sramko, Ostry, Rowland, and Hallé (2008) also found that their simultaneous bilingual participants exhibited VOT categories for voiceless stops that did not match, but fell intermediately between, those exhibited by monolingual English and French speakers. Fowler et al. (2008) thus concluded that their data support Flege's (1995) hypothesis that bilinguals' two phonological inventories are linked perceptually to one another.

Likewise, a group of studies by Mora and Nadeu (2012), Navarra, Sebastián-Gallés, and Soto-Faraco (2005), and Sebastián-Gallés, Echeverría, and Bosch (2005) examined speech perceptions and productions by Catalan-Spanish bilinguals in order to

investigate whether the phonological systems of early bilinguals undergo cross-language interaction. Although these works focus not on stop consonants, but on the bilinguals' ability to perceive and produce the vowel contrast /e/–/ɛ/ in Catalan, the same principles underlying the connection between bilinguals' two phonological systems as described in Flege's (1995) SLM apply.

In particular, Mora and Nadeu (2012) stated that their results suggest that extensive use and exposure to an L2 can affect a bilingual's L1 phonetic categories, demonstrating cross-linguistic interaction between the bilinguals' phonological systems. Navarra et al. (2005) found that "early linguistic experience dramatically influences the way in which L2 phonemic categories are organized" (p. 916), suggesting that even proficient bilinguals implicitly accommodate L2 phones to L1 phonemic categories just as Flege's (1995) SLM hypothesized. And Sebastián-Gallés et al. (2005) reported that the Spanish-Catalan bilinguals in their study failed to perceive the Catalan contrast despite early and intensive exposure to both languages, arguing that even simultaneous bilinguals have a dominant language that "prevails" phonologically over the non-dominant language.

Similar results were found in a study by Antoniou, Tyler, and Best (2012) on early-sequential Greek-English bilinguals' perception of stop voicing contrasts in their two languages. In that study, Antoniou et al. (2012) were concerned with finding out whether bilinguals' two phonological systems are integrated or separate. The results of their study showed that the bilinguals' phonetic contrast discrimination performance was better in their dominant language. Antoniou et al. (2012) thus concluded that bilinguals' phonological systems are integrated into a common space that is in favor of their

dominant language when discriminating sound contrasts acoustically, which is evidence for "the possibility that it is language dominance, rather than the order in which their languages were acquired, that influences bilinguals' discrimination performance" (p. 592).

Cognate effects. Amengual's (2012) study on cross-language influence and cognate effects in bilinguals is one work that relates directly to the topic of the present study. His research was based on the observation that in everyday speech, Spanish–English bilinguals are tasked with adjusting their VOTs when speaking either language in order to produce acceptable stop consonants that adhere to "native-like" standards. Importantly, Amengual noted that cognates, defined as "lexical items with considerable phonological, semantic and orthographic overlap", might influence bilinguals' phonological contrasts (2012, p. 517). In particular, he posited that cognates might affect bilinguals' ability to maintain native-like contrasts in both languages since cognates tend to demonstrate greater degrees of cross-linguistic influence than non-cognates (Amengual, 2012). Amengual's study endeavored to determine whether language dominance, age of acquisition, and language environment cause Spanish-English bilinguals to produce a more English-like /t/ in cognates versus non-cognates in their Spanish productions.

Amengual hypothesized that all types of Spanish-English bilinguals would produce longer, more English-like VOTs for voiceless stops in cognates in Spanish, and shorter, more Spanish-like VOTs for voiceless stops in non-cognates. This is exactly what he found. Thus, Amengual's (2012) work found support for the idea that cognates can influence the VOT productions of Spanish-English bilinguals, at least in the case of

the voiceless dental stop /t/ in Spanish. In a similar study on cross-linguistic influence in the pronunciation of cognates, Brown and Amengual (2015) found that articulations of word-initial /d/ in Spanish-English cognates were more English-like in the Spanish productions of Puerto Rican Spanish-English bilinguals, while this cognate effect was not present for monolingual Spanish speakers from the same community. Brown and Amengual also found evidence for significant influence of English on the articulations of word-initial /t/ in Spanish cognates, resulting in lengthened VOT productions for Spanish-English bilinguals (2015). Brown and Amengual (2015) thus concluded that "cross-language lexical connections affect phonetic categories in the speech production of Spanish-English bilinguals" (p. 59).

Theoretical Implications

Of all the factors found to influence VOT discussed here, the least-researched is cognate effects; this study aims to help fill this gap in the literature. Taken all together, the mixed findings within the group of works reviewed here raise questions about where the phonological systems of bilingual speakers fit into theories of bilingual language system interaction and a critical period for second language learning. The idea that there may be maturational and language interference effects that prevent second language learners from acquiring monolingual-like phones requires further investigation in light of the disparate evidence found in the literature discussed here. The findings discussed above make it clear that there are several factors at play regarding bilinguals' abilities to achieve monolingual-like VOT productions in both of their languages: utterance position and place of articulation, age of L2 acquisition, bilingual phonological system interaction,

language dominance, and cognate effects all seem to be factors of influence on bilinguals' VOT perceptions and productions. However, further research is necessary to determine a more precise relationship among these factors, particularly regarding cognates and VOT of the voiced stop group in English, as most VOT works have focused on voiceless stops.

III. METHODOLOGY

The present study aims to provide further clarity on the issue of whether bilinguals' phonetic realizations undergo cross-language influence. More specifically, the study will examine whether the VOT values of voiced stops /b, d, g/ in the speech productions of early Spanish-English bilinguals differ significantly from English monolingual norms more often in cognates than in non-cognates. Given the findings of previous works discussed in the review of related literature, the hypotheses regarding this research topic are thus:

H1: The bilinguals' VOT values in English productions will differ significantly from the English monolinguals' VOT values.

H2: The bilinguals' VOT values in their Spanish productions will be significantly different from the VOT values in their English productions.

H3: The bilinguals' VOT values will show greater cross-linguistic influence from the offline language on the language being spoken in their productions of cognates than in their productions of non-cognates.

H4: Place of articulation will have a significant effect on all participants' VOT values.

The results of this study could provide a better understanding of language interaction in fully developed bilinguals, and in a broader context, the study could determine a more precise relationship between the factors of place of articulation, age of L2 acquisition, language dominance, and cognate effects as they relate to bilinguals' phonetic productions. If it is the case that the use of cognates versus non-cognates elicits greater cross-linguistic convergence of phonetic productions in bilingual speech, this research could provide support for the notion that cognates, words with great semantic and phonetic overlap, interfere with bilinguals' phonemic distinctions between their two language systems.

Participants

The participants included in this study (N = 26; 20 females, 6 males) were recruited in Miami, Florida. The participants all fell within the age range of 19-31 years (M = 23.64, SD = 3.03). The participants were categorized into two groups: an English-monolingual control group (n = 12; 8 females, 4 males), and a Spanish-English bilingual group (n = 14; 12 females, 2 males). All participants in the English-monolingual group identified their heritage nationality as American and self-identified as monolingual, reporting 100% of their language exposure at home to be in English. All participants in the Spanish-English bilingual group identified their heritage nationality as Cuban and self-identified as bilingual in Spanish and English. All bilingual participants were early bilinguals who acquired both languages at or before 5 years of age ($M_{English}$ = 2.29, SD =

2.15; $M_{Spanish}$ = 0.63, *SD* = 1.07). Eight of the bilinguals self-reported their L1 to be Spanish and their L2 to be English (age of English acquisition in years: *M* = 4.25, *SD* = 0.82), and six of the bilinguals reported that they began acquiring both languages simultaneously from birth. Thirteen of the bilinguals self-reported their dominant language to be English, and one bilingual reported both English and Spanish to be her dominant languages.

All bilingual participants were tested for vocabulary proficiency in each language using the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 2007) and the Test de Vocabulario en Imágenes Peabody (TVIP; Dunn, 1986). All bilinguals, with the exception of two outliers, fell well above the monolingual English raw score norm for the PPVT, which is 196 (M_{PPVT} = 208.17, *SD* = 5.47). Additionally, all bilinguals, with the exception of one outlier, fell above the monolingual Spanish raw score norm for the TVIP, which is 106 (M_{TVIP} = 112.77, *SD* = 6.02) (Stadthagen-González, Gathercole, Pérez-Tattam, & Yavaş, 2013).

Stimuli

Linguistic stimuli. Two main types of target words were elicited using a picture-naming task with auditory stimuli in order to gather VOT data for the three sounds of interest: Spanish-English cognates with /b, d, g/ in word-initial position, and Spanish-English non-cognates with /b, d, g/ in word-initial position. Additionally, Spanish-English filler cognates and non-cognates with sounds other than /b, d, g/ in word-initial position were used as distractors from the main target words. For this study, cognates were defined as words that have a similar form and meaning in both languages, while

non-cognates were defined as words that have somewhat similar forms in both languages but have different meanings. False cognates were avoided because the study focuses on the extent to which lexical connections across Spanish-English bilinguals' two languages affects their VOTs for voiced stops; since false cognates (phonetically-, but not semantically-equivalent words) do not present the same lexical connections across the bilinguals' two language systems, using them for this study could yield conflicting results.

For the target group, five cognate pairs (one word in English paired with one word in Spanish) and five non-cognate pairs were assigned to each of the voiced stops, giving a total of 30 target words to be elicited per participant and per language. In addition, for distractors, fifteen pairs of cognates and fifteen pairs of non-cognates with initial sounds other than /b, d, g/ were assigned, giving a total of 30 distractor words to be elicited per participant and per language. The targets for the filler categories were chosen to distract participants from the focus on initial /b, d, g/ and thus contained a variety of initial sounds other than /b, d, g/. Phonetic environment was controlled for the true targets: all word-initial /b, d, g/ environments were followed by a vowel or diphthong, and vowel height, backness, and roundness were varied evenly within each initial sound group. The target words are shown in Table 3 below, while the distractor words are shown in Table 4.

Table 3. Target English-Spanish word pairs, cognates and non-cognates

	Cognates	**IPA Transcription**	**Non-Cognates**	**IPA Transcription**
/b/	Battery/Batería	[bærə˞i]/[baţɛɾia]	Basket/Basura [*garbage*]	[bæskətˀ]/[basuɾa]
	Baseball/Béisbol	[besbɑl]/[bɛsβoɬ]	Bake/Beca [*scholarship*]	[bek]/[bɛka]
	Bicycle/Bicicleta	[baɪsək l̩]/[bisikɬɛţa]	Bigger/Bigote [*mustache*]	[bɪgɻ]/[bigoţɛ]
	Bottle/Botella	[bɑɾl̩]/[boţeja]	Bold/Bolsa [*bag*]	[bold]/[boɬsa]
	Buffalo/Búfalo	[bʌfəlo]/[bufalo]	Board/Burro [*donkey*]	[bɔɹd]/[buro]
/d/	Data/Datos	[deɾə]/[ɖaţos]	Diner/Dañar [*to damage*]	[daɪnə˞]/[ɖaɲaɾ]
	Dentist/Dentista	[dɛntəst]/[ɖɛnţisţa]	Dead/Dedo [*finger or toe*]	[dɛdˀ]/[ɖɛðo]
	Diary/Diario	[daɪjəɹi]/[ɖiaɾio]	Deer/Día [*day*]	[diɹ]/[ɖia]
	Doctor/Doctor	[dɑktɻ]/[ɖokţoɾ]	Door/Dormir [*to sleep*]	[dɔɹ]/[ɖoɾmiɾ]
	Duplicate/Duplicar	[dupləketˀ]/[ɖupɬikaɾ]	Dusty/Dulce [*sweet*]	[dʌsti]/[ɖuɬsɛ]
/g/	Gallery/Galería	[gæləɹi]/[gaɬɛɾia]	Gate/Galleta [*cracker*]	[getˀ]/[gajɛţa]
	Garage/Garaje	[gəɹɑdʒ]/[gaɾahɛ]	Gargoyle/Garganta [*throat*]	[gɑɹgɔɪl̩]/[gaɾgaɳţa]
	Guitar/Guitarra	[gətɑɹ]/[giţara]	Guilty/Guiñar [*to wink*]	[gɪlti]/[giɲaɾ]
	Goal/Gol	[gol]/[goɬ]	Goat/Gota [*drop of liquid*]	[gotˀ]/[goţa]
	Gorilla/Gorila	[gəɹɪlə]/[goɾiɬa]	Gold/Gorra [*sports cap*]	[gold]/[gora]

Table 4. Distractor English-Spanish word pairs, cognates and non-cognates

Cognates	IPA Transcription	Non-Cognates	IPA Transcription
Actor/Actor	[æktɹ̩]/[ak̪toɾ]	Carrot/Caro [*expensive*]	[kɛɹət̚]/[kaɾo]
Coffee/Café	[kɑfi]/[kafɛ]	Coach/Cuchillo [*knife*]	[koʧ]/[kuʧijo]
Cereal/Cereal	[sɪɹijəl]/[sɛɾiał]	Fetch/Fecha [*calendar date*]	[fɛʧ]/[fɛʧa]
Hospital/Hospital	[hɑspəɾl̩]/[ospi̪tał]	Freezer/Fresa [*strawberry*]	[fɹizɹ̩]/[fɾɛsa]
Hotel/Hotel	[hotɛl]/[ot̪ɛł]	Ladder/Ladrillo [*brick*]	[lærɚ]/[lad̪ɾijo]
Menu/Menú	[mɛnju]/[mɛnu]	Laptop/Lápiz [*pencil*]	[læptɑp]/[łapis]
Pasta/Pasta	[pɑstə]/[pasta]	Man/Mano [*hand*]	[mæn]/[mano]
Perfume/Perfume	[pɚfjum]/[pɛɾfumɛ]	Messy/Mesa [*table*]	[mɛsi]/[mɛsa]
Piano/Piano	[pjæno]/[piano]	Mermaid/Mermelada [*jam*]	[mɜ˞med̚]/[mɛɾmɛłaða]
Plastic/Plástico	[plæstək]/[płastiko]	Pan/Pan [*bread*]	[pæn]/[pan]
Radio/Radio	[ɹeɾijo]/[ɾad̪io]	Plum/Pluma [*feather*]	[plʌm]/[płuma]
Taxi/Taxi	[tæksi]/[t̪aksi]	Rain/Reina [*queen*]	[ɹen]/[ɾena]
Television/Televisor	[tɛləvɪʒən]/[t̪ɛłɛvisoɾ]	Tie/Talla [*clothing size*]	[taɪ]/[t̪aɪja]
Towel/Toalla	[tæwəl]/[t̪owaɪja]	Target/Tarjeta [*card*]	[tɑɹgət̚]/[t̪aɾhɛt̪a]
Violin/Violín	[vaɪjəlɪn]/[violin]	Tires/Tijeras [*scissors*]	[taɪɻz]/[t̪ihɛɾas]

Each target and distractor word had two different elicitation prompts and two different corresponding images in each language, which were split and counterbalanced evenly between participants. The auditory stimulus assigned to each target word consisted of a pre-recorded question that related to the definition of the target word at hand and was intended to narrow participants' responses down to a specific word when naming the image. The English elicitation recordings were collected from the author of this study, who is an English-dominant simultaneous Spanish-English bilingual. The author's mean VOT values for the English target words fell within the English

monolingual norms published by Lisker and Abramson (1964) ($M_{/b/}$ = 1.40 ms; $M_{/d/}$ = 12.50 ms; $M_{/g/}$ = 22.10 ms). The Spanish elicitation recordings were collected from a native speaker of Spanish who is of Cuban origin and a late learner (after age 33) of English. Sample prompts are given in Table 5 below.

Four pseudo-randomized orders were created for the target word elicitations in each language and were alternated for each participant, to prevent an order effect from interfering with the results. For the bilingual participants, the order of the two language sessions (Spanish first versus English first) was alternated for each participant to prevent further order effects. If the initial auditory stimulus paired with the image did not elicit the target word, the researcher gave the participant an additional rhyming prompt (in English sessions, "It rhymes with [X]", and in Spanish sessions, "Se rima con [X]"), which consisted of a word in the same language that rhymes closely with the target word. (All participants in this study required at least one additional rhyming prompt.) Samples of the additional rhyming prompts are also shown in Table 5.

Table 5. Sample elicitation prompts and additional rhyming prompts, with bracketed translations for Spanish items

English		
Target	**Main Prompt**	**Rhyming Word**
Bicycle	"What is this thing called?"	Icicle
Dusty	"How can you describe something that has a film of small grey particles on it?"	Rusty
Hotel	"What is this place called?"	Motel
Plum	"What do you call this oval fleshy fruit that is purple, reddish, or yellow when ripe?"	Slum
Spanish		
Target	**Main Prompt**	**Rhyming Word**
Bicicleta	"¿Cómo se llama lo que está montando la niña?" [*What do we call what the girl is riding?*]	Servilleta [*napkin*]
Dulce	"¿Cómo se puede describir algo que tiene mucho azúcar?" [*How can something that contains a lot of sugar be described?*]	Luce [*it shines*]
Hotel	"¿Cómo se llama un hospedaje capaz de alojar con comodidad a viajeros?" [*What do we call a lodging capable of comfortably accommodating travelers?*]	Motel [*motel*]
Pluma	"¿Cómo se llama esta cosa?" [*What is this thing called?*]	Fuma [(*s*)*he smokes*]

Non-linguistic stimuli. Each target word was matched with a corresponding image to be shown to participants simultaneously with the pre-recorded elicitation prompt. The images were collected online from a store of freely available clip art. The visual stimuli were counterbalanced by having two different corresponding images for each target word pair, to accompany the distinct prompts in the two languages. The counterbalancing necessitated four different PowerPoints for each language, each of which contained one pseudo-randomized set of the counterbalanced images and corresponding elicitation prompts. Sample images are shown in Figure 2 below.

Figure 2. One example each of the images used to elicit "bicycle," "dusty," "hotel," and "plum"

Procedure

Prior to the data collection, this study was approved by the Institutional Review Board at Florida International University. Trials were conducted in individual meetings between the researcher and each participant in the Linguistics Experimental Research Lab (LERL) at FIU. To begin, participants filled out an IRB-approved consent document and questionnaire on their language history, which focused on the quantity and quality of language input and output experienced by each participant. Participants were told that the study compares language processes of bilinguals with those of monolinguals. Afterward, instructions detailing what the participant would be doing during the session were given in English.

The instructions informed participants that (1) they would see images of everyday objects or animals and hear pre-recorded questions that correspond with each image in a PowerPoint, (2) they must wait until the entire question is heard, and then provide one word that answers the question and names the image, (3) if they happened not to recall a word at first, a rhyming word would be provided to further elicit the target word, (4) there would be no time limit, so they should speak as they would naturally, and (5) their responses would be recorded by an audio-recorder. Practice trials were held before the experimental trials in order for participants to become accustomed to the procedure. The practice target words were unrelated to the study's focus of initial /b, d, g/ and consisted of items such as "cat" and "apple". During the practice trials, participants were instructed not to utter determiners with the target words, as uttering any preceding sounds would most likely affect the VOT of initial sounds in the target words.

Participants were then shown the PowerPoint presentation that displayed images and pre-recorded question prompts that corresponded to each target word. The bilingual participants were tested in separate sessions of Spanish and English, and the English monolingual participants were only tested in English. All sessions were conducted by the author of this study, who is a Spanish-English bilingual. Each participant's responses were recorded on a digital recording device to be measured for the VOT values.

IV. RESULTS

VOT values were measured using Praat (Boersma & Weenink, 2018). The data consisted of a total of 2,400 elicited words (both target words and distractors), 1,200 of which were target words measured for VOT duration. Examples of the VOT measurements are shown in Figure 3 and Figure 4 below, with the relevant VOT area highlighted in pink.

Figure 3. VOT measurement of English monolingual production of "diary"

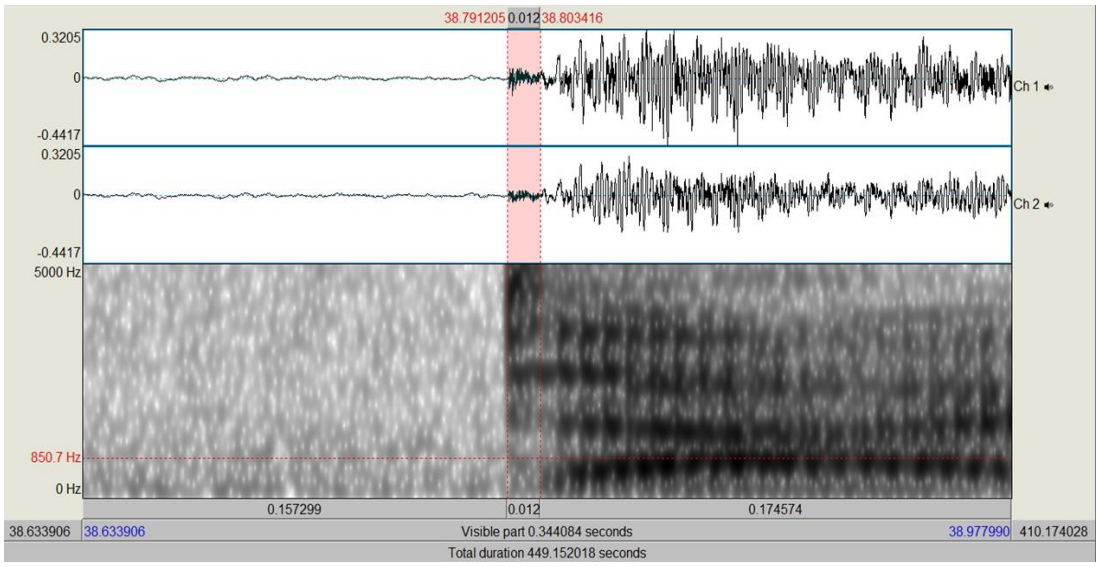
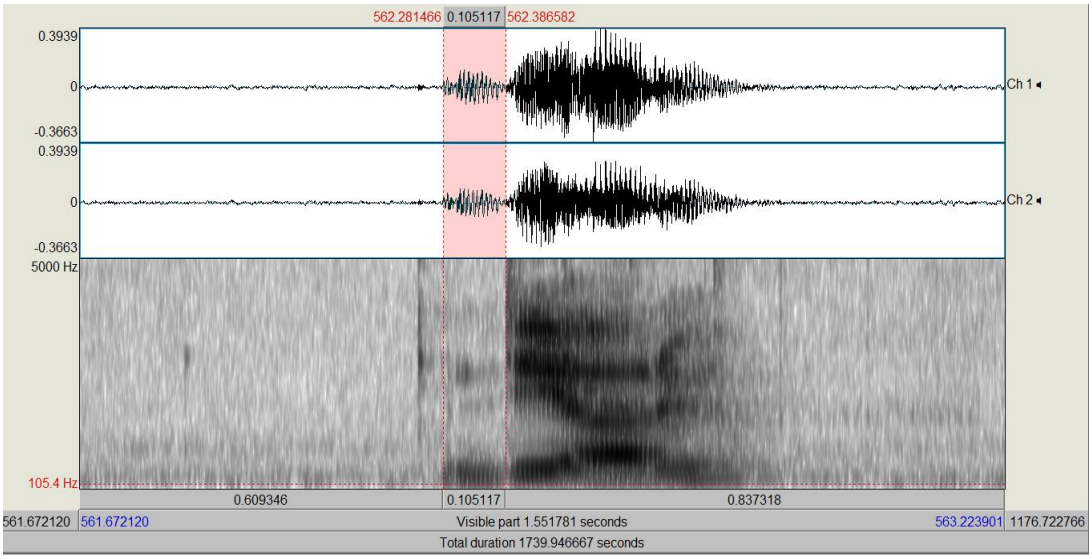


Figure 4. VOT measurement of bilingual production of "diario"



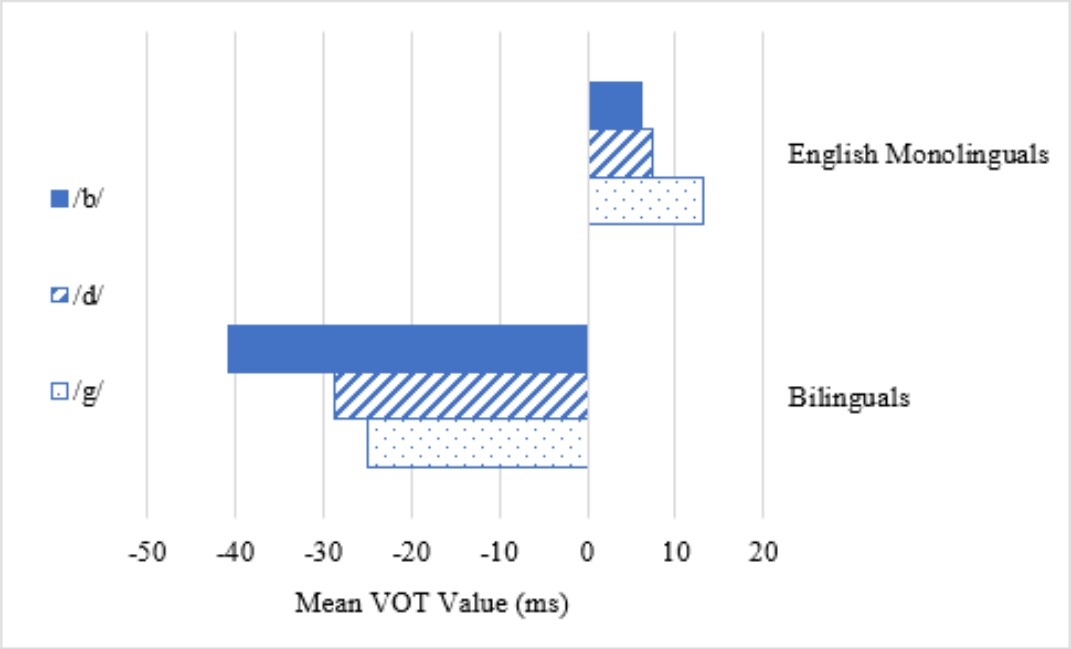
Statistical analyses were conducted using SPSS 23 (IBM Corp., 2015). An initial Repeated Measures Analysis of Variance (RMANOVA) was conducted on only the English monolingual data to test for any main effects of Place of Articulation (/b, d, g/) and Cognate Status (cognate or non-cognate) on the English monolinguals' VOT values. No significant effects from these variables were found in the English monolingual data. Preliminary analyses also examined possible influence from PPVT and TVIP performance on the bilinguals' VOT values in English and Spanish, respectively, and these did not show any significant effects given that the bilinguals generally performed at ceiling on these tests.

To test for possible effects of language spoken, place of articulation, and cognate usage on the bilinguals' VOT values, two RMANOVAs were run to compare (1) the bilinguals' average VOTs in English with the English monolinguals' average VOTs, which showed whether the bilinguals deviated from English monolingual norms; and (2) the bilinguals' average VOTs for their Spanish versus their English productions, which

showed whether the bilinguals were producing their VOTs differently in the two languages.

Bilingual to English Monolingual Comparison

Graph 2. Bilingual to monolingual comparison in English productions



In the first analysis comparing the bilinguals' English productions with those of the English monolinguals, Place of Articulation (/b, d, g/) and Cognate Status (Cognate or Non-Cognate) were entered as within-subject variables, while Participant Type (English Monolingual or Early Bilingual) was entered as the between-subjects variable. The analysis showed a significant main effect for Place of Articulation: $F(2, 48) = 3.92$, $p = .03$, suggesting that the VOT values in the English productions overall were affected by place of articulation ($M_{/b/}$ = -17.44 ms; $M_{/d/}$ = -10.74 ms; $M_{/g/}$ = -5.83 ms). Pairwise comparisons with Bonferroni correction showed only a near-significant difference

between /b/ and /g/ (p = .091). Without the conservative Bonferroni correction, pairwise comparisons revealed a significant difference between /b/ and /g/ (p = .03), and a near-significant difference between /b/ and /d/ (p = .056).

A highly significant main effect was also found for Participant Type: $F(1, 24) = 17.40$, $p < .001$, indicating that the bilinguals' VOT values in their English productions overall were statistically different from the English monolinguals' ($M_{Bilinguals}$ = -31.53 ms; $M_{Monolinguals}$ = 8.86 ms). No significant main effect was found for Cognate Status in this analysis. Graph 2 above shows VOT performance in English productions by Place of Articulation (POA) and Participant Type. No significant interactions between variables were found in this analysis.

Within-Bilingual Language Comparison

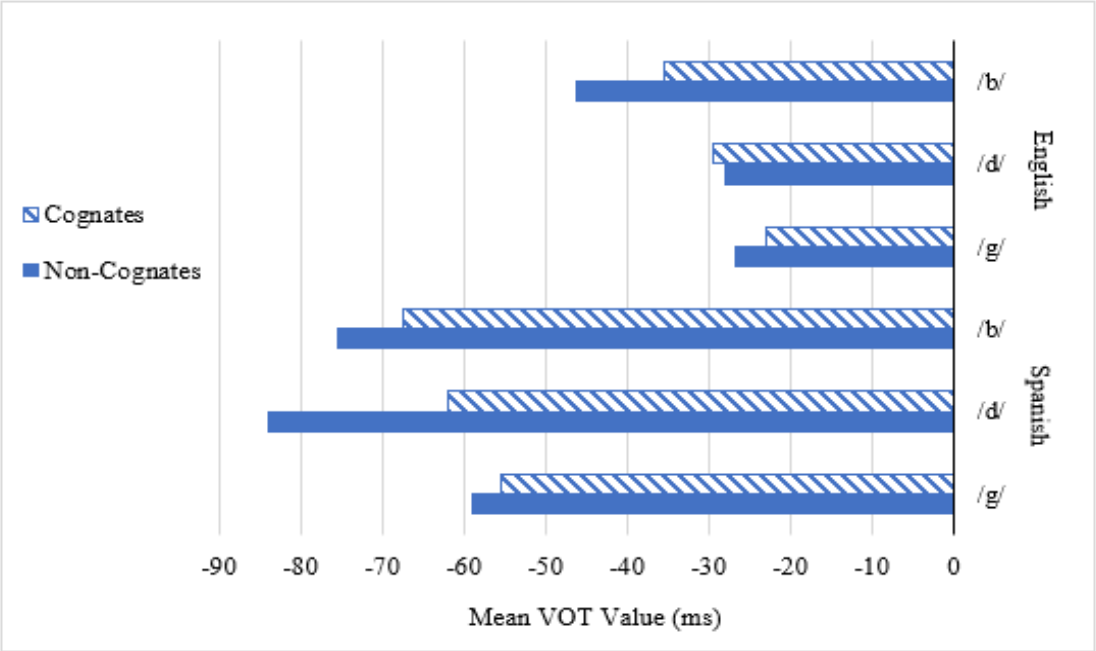
The second analysis compared the bilinguals' productions in English with their productions in Spanish. Language (English and Spanish), Place of Articulation (/b, d, g/), and Cognate Status (Cognate and Non-Cognate) were entered as within-subject variables. This analysis yielded significant main effects for Language: $F(1, 13) = 16.51$, p = .001, Place of Articulation: $F(2, 26) = 5.14$, p = .01, and Cognate Status: $F(1, 13) = 5.41$, p = .04. The significant effect of Language indicates that the bilinguals' VOT values differed between their English and Spanish productions, with their Spanish VOTs exhibiting longer lead voicing: $M_{English}$ = -31.53 ms; $M_{Spanish}$ = -67.22 ms.

The significant main effect of Place of Articulation indicates that the bilinguals' VOT values differed by place of articulation, with the length of lead voicing decreasing

as place of articulation moved from bilabial to alveolar to velar: $M_{/b/}$ = -56.14 ms; $M_{/d/}$ = -50.95 ms; $M_{/g/}$ = -41.04 ms. Pairwise comparisons with Bonferroni correction revealed a significant difference between /b/ and /g/ (p = .04). Without Bonferroni correction, the pairwise comparisons showed a significant difference between /b/ and /g/ (p = .01), and a near-significant difference between /d/ and /g/ (p = .069). Finally, the significant main effect of Cognate Status indicates that the bilinguals' VOT values differed between their productions of cognates versus non-cognates, with the cognates exhibiting shorter lead voicing than the non-cognates: $M_{Cognates}$ = -45.49 ms; $M_{Non\text{-}Cognates}$ = -53.26 ms.

A near-significant three-way interaction was also found for Language X Place of Articulation X Cognate Status: $F(2, 26) = 2.69$, p = .087. To explore this interaction, paired-sample t-tests were conducted to compare, for each Language X Place of Articulation, the VOT values for Cognates and Non-Cognates. The results revealed a significant difference between cognates and non-cognates for Spanish productions beginning with /d/: $t(13) = 2.96$, p = .01, with the cognates exhibiting significantly shorter lead voicing (M = -62.06 ms, SD = 24.55) than the non-cognates (M = -84.08 ms, SD = 21.97). There was also a near-significant difference between cognates and non-cognates for English productions beginning with /b/: $t(13) = 1.88$, p = .082, with the cognates demonstrating a tendency for shorter lead voicing (M = -35.41 ms, SD = 33.37) than the non-cognates (M = -46.34, SD = 34.78). Graph 3 below illustrates the interaction between Language, Place of Articulation (POA), and Cognate Status.

Graph 3. Bilingual VOT performance by Language, POA, and Cognate Status



V. DISCUSSION

This study explored the question of whether early Spanish-English bilinguals' VOT values for voiced stops /b, d, g/ differ significantly from English monolingual norms more often in cognates than in non-cognates. The first statistical analysis that was conducted compared the bilinguals' English productions with those of the English monolinguals and showed that Place of Articulation significantly affected the overall VOT values for English word productions, with the average VOT values for all participants increasing in a linear manner as the place of articulation moved from bilabial to alveolar to velar. This finding is consistent with Lisker and Abramson's (1964) and Yavaş and Wildermuth's (2006) conclusions on the effect of place of articulation on

VOT. This result confirms this study's fourth hypothesis that place of articulation will have a significant effect on all participants' VOT values. The first analysis also showed that the bilinguals' overall VOT values were significantly different from the monolinguals' overall durations, with the bilinguals' English productions on average exhibiting lead voicing (negative VOT) while the monolinguals' productions on average exhibited short voicing lag (positive VOT).

Based on the fact that stops in word-initial position in Spanish tend to exhibit lead voicing while voiced stops in English tend to exhibit voicing lag, this finding supports the idea that the bilinguals' L2 (English) phonological categories are influenced by those from their L1 (Spanish), and also confirms this study's first hypothesis that the bilinguals' VOT values in English productions will differ significantly from the English monolinguals' VOT values. However, the first analysis yielded no significant effects related to Cognate Status, thus providing a negative response to this study's question of whether early Spanish-English bilinguals' VOT values for voiced stops /b, d, g/ differ significantly from English monolingual norms more often in cognates than in non-cognates.

The second analysis that was conducted compared the bilinguals' productions in English with their productions in Spanish. This analysis showed that Language, Place of Articulation, and Cognate Status all significantly affected the bilinguals' VOT values. The analysis indicated that the bilinguals' VOTs in their Spanish productions exhibited significantly longer lead voicing than the VOTs in their English productions, which also exhibited lead voicing, but to a lesser degree. This again supports the notion that the bilinguals' L2 (English) phonological categories are somewhat influenced by those from

their L1 (Spanish), and confirms this study's second hypothesis that the bilinguals' VOT values in their Spanish productions will be significantly different from the VOT values in their English productions. This analysis also indicated that the bilinguals' overall VOT values increased as the place of articulation moved from bilabial to alveolar to velar, mirroring the finding from the previous analysis. Finally, this analysis showed that the bilinguals' VOT values in the cognate productions exhibited overall shorter lead voicing than did the non-cognates. This finding alone does not yield much information about a possible cognate effect; however, the near-significant interaction of Language X Place of Articulation X Cognate Status showed that performance on cognates differed by language and place of articulation.

Upon further exploration, this interaction revealed a significant difference in VOT duration between cognates and non-cognates for the bilinguals' Spanish productions beginning with /d/, with the cognates exhibiting shorter lead voicing (more English-like) than the non-cognates. This finding, at least for the alveolar place of articulation, supports this study's third hypothesis that the bilinguals' VOT values will show greater cross-linguistic influence from the language that is not online, in this case English, on the language being spoken in their productions of cognates than in their productions of non-cognates, and corroborates Brown and Amengual's (2015) findings. Further investigation into the three-way interactive effect also revealed a near-significant difference between cognates and non-cognates in the bilinguals' English productions beginning with /b/, with the cognates demonstrating shorter lead voicing than the non-cognates.

This near-significant finding shows that the bilinguals' VOTs for cognates were closer to English monolingual norms than their VOTs for non-cognates were, which is

counter to this study's third hypothesis that the bilinguals' VOT values will show greater cross-linguistic influence from the offline language on the language being spoken in their productions of cognates than in their productions of non-cognates. These results reveal, then, that for these bilinguals, cognates can facilitate cross-linguistic phonological interaction, but here the influence is perhaps from the dominant language (recall that, even though all bilinguals were proficient in both languages, all but one reported English as their dominant language).

Given this study's findings, it is clear that the bilinguals' VOT values exhibited some cross-linguistic influence in relation to cognate usage to support the argument that cognates interfere with bilinguals' phonological distinctions between their two language systems, but not in the direction predicted. Rather, the data show that the bilinguals' dominant language (in this case, English) is the more influential language. The data also provide evidence to support existing theories about the effects place of articulation and bilingualism have on VOT.

Agenda for Future Research

The methodological design employed in this study controlled for language spoken, place of articulation, and cognate status to explore the question of whether early Spanish-English bilinguals' VOT values for voiced stops /b, d, g/ differ significantly from English monolingual norms more often in cognates than in non-cognates. Additional factors that would be interesting to add to future studies on this topic are word frequency, neighborhood density, and number of syllables, since these factors have been found to influence word duration and phonetic reduction in spoken productions. Previous

studies have found that words that occur in a language more frequently tend to be phonetically reduced (Bell, Brenier, Gregory, Girand, & Jurafsky, 2009; Gahl, 2008); that words from dense phonological neighborhoods tend to be shortened and produced with centralized vowels (Gahl, Yao, & Johnson, 2012); and that VOT in disyllabic words tends to be 8% to 10% shorter than in monosyllabic words (Klatt, 1975; Yavaş, 2002). It would thus be beneficial for future work to incorporate controls for these variables as well.

It has also been found that, in running speech, the VOT values of English stop consonants that occur in unstressed syllables can lose the typical attributes that delineate the voiced-voiceless distinction (Flege & Brown, 1982; Lisker & Abramson, 1967). However, the present study did not control for stress pattern given that it was nearly impossible to match the stress pattern of all target words while also accounting for the existence of cognate word pairs that have voiced stops in word-initial position in each language. Finally, a goal for future research is to expand this study to include data from Spanish monolinguals, against which the bilinguals' Spanish productions can be compared. While this was initially the intent with the present study, it was nearly impossible to find a large sample of true Spanish monolinguals to do such an analysis in the largely bilingual context of Miami, Florida. Thus, the future expansion of this study will require Spanish monolingual data to be collected from an area with a larger community of Spanish monolinguals.

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