L1-L2 phonetic interference in the production of Spanish heritage speakers in the US

Ji Young Kim

University of Illinois at Urbana-Champaign

Kim, Ji Young(2011), L1-L2 phonetic interference in the production of Spanish heritage speakers in the US, *The Korean Journal of Hispanic Studies*, 4, 1-28.

The present study examined how bilingual speakers produce L1 and L2 speech sounds when the L2 is more dominant than the L1. According to Flege (1999), L1 and L2 speech sounds coexist in one phonetic space and bilinguals strive to maintain phonetic contrast between them. In such phonetic space, L1-L2 phonetic interference, the direction and strength of which is determined by language dominance, is inevitable. The aim of this study was to identify whether Spanish heritage speakers whose English (L2) is stronger than Spanish (L1) have their Spanish stop consonants influenced by their English stop consonants.

A production task was conducted in which Spanish heritage speakers produced English and Spanish words beginning with voiced stops /b, d, g/ and voiceless stops /p, t, k/. Spanish heritage speakers' VOT was measured and later compared to those of the native speakers of each language. Results show that when compared with the native control groups, Spanish heritage speakers did not differ from native English speakers when producing English stop consonants, but, when producing Spanish stop consonants, they performed differently from native Spanish speakers. This finding implies that Spanish heritage speakers experienced phonetic interference from L2 to L1 when producing Spanish and English stops.

Key Words: Stop consonants/ L2 phonology/ Bilingualism

1. Introduction

In research on second language acquisition, it is widely accepted that the earlier one learns a second language(L2)[1], the better; children are more likely to eventually reach native-like L2 levels than adults. This is especially true in the area of L2 phonology (Boschetal., 2000; Flege, 1995; Gildersleeve-Neumann et al., 2009; Sebastián-Gallés & Soto-Faraco, 1999; Strange, 1995). When it comes to early bilingual speakers, who have been exposed to two languages from very young age, it appears that their pronunciation in both languages is completely native-like (Guion, 2003). However, many studies have shown that L1 and L2 sound systems are not completely independent and, thus, mutual influence of the two languages on one another is inevitable (Flege, 1995; Fowler et al., 2008; Grosjean, 2010; Schnitzer & Krasinski, 1994; Weinreich, 1953). Schnitzer and Krasinski(1994) argued that even balanced bilingual speakers sometimes show traces of phonetic interference in one or both of their native languages.

Phonetic interference has been observed in many studies but, in most cases, the focus has been on the interference from L1 to L2 sound system (Flege et al., 1995; Flege et al., 1999; Kuhl et al., 2003); the opposite direction, i.e., the interference from L2 to L1 sound system, has rarely been investigated. When comparing language dominance of L1 and L2, usually it is the L1 that is the stronger language, but this is not always the case; there are bilingual speakers who start with one language as the dominant language and then at a later point in their lives find it replaced by a second language (Grosjean, 2010).

---

1) In the present research, “L1” and “L2” refer to the order of language acquisition, not language dominance. That is, the language that is acquired first is indicated as“L1” and the language that is acquired after the first language is indicated as “L2”.

In the present study, the production of Spanish and English voiced and voiceless stop consonants by Spanish-English early bilingual speakers who are more dominant in English(L2), i.e., Spanish heritage speakers[2], was investigated. The aim of this study was to examine whether phonetic interference occurs from L2 to L1 when L2 is the stronger language.

2. Literature review

2.1. Age constraint in the acquisition of L2 phonology

In the field of SLA, especially in L2 phonology, it is well established that there is an opportunity window during which it is optimal to learn a L2 (Long, 1990; Johnson & Newport, 1989; Werker & Tees, 2005). We find evidence of an opportunity window in foreign accents that adult L2 learners have even after living in a L2 speaking country for decades (Flege et al., 1995; Flege et al., 1999; Johnson & Newport, 1989; Mayberry & Fisher, 1989) and in difficulties that adult learners experience when perceiving L2 contrasts that do not exist in their L1 (Lively et al., 1993; Kuhl et al., 2003).

If age is such an important factor in acquiring L2 phonology, an

2) Valdés (2001) defines heritage speakers as "[An individual] who is raised in homes where a non-English language is spoken, speak or merely understand the heritage language, and is to some degree bilingual in English and the heritage language". Generally, heritage speakers are second or early 1.5 generation immigrants from a non-English-speaking country and their parents are native speakers of the heritage language. The heritage language is the minority language which is acquired at home as an L1, and English is not exposed systematically until the heritage speakers enter institutional settings such as kindergarten or elementary school. As heritage speakers grow up, their use of English gradually increases, while their use of the heritage language decreases, which results in a gradual shift of language dominance from heritage language to English.

important questions arises, i.e., when does this opportunity window end? There is no consensus yet on the exact age of the offset of the opportunity window, but it is claimed to occur very early in life for phonology, sometime between 5 and 7 years of age (Birdsong, 1999; Flege, 1991, 1995; Gildersleeve-Neumann et al., 2009; Long, 1993; Pallier et al., 1997; Strange, 1995; Dupoux et al., 2010). In the case of Spanish, previous studies on child research reported that Spanish sound system becomes fairly complete by the age of 5 (Acevedo, 1993; Jimenez, 1987; Gildersleeve-Neumann et al., 2009; Linares, 1981; Nuñez-Cedeño, 2007). Moreover, Flege (1992) argued that foreign accents first become evident at some time between the ages of 5 and 7 years. The temporal coincidence between the appearance of foreign accents and the mastering of the production of native speech sounds provides implications that native speech production establishes sometime during this period.

2.2. Phonetic interference between L1 and L2 sounds

If there is an opportunity window in the acquisition of L2 phonology, would a bilingual speaker, who was exposed to both L1 and L2 during this period, be able to perform like two monolingual speakers? Although it is widely accepted that early bilinguals are more likely to discern phonetic differences between L1 and L2 speech sounds than late bilinguals (Bosch et al., 2000; Flege, 1995; Gildersleeve-Neumann et al., 2009; Sebastián-Gallés & Soto-Faraco, 1999; Strange, 1995), it is impossible to control two languages exactly the same way as two monolinguals (Flege, 1999; Grosjean, 2010).

According to Flege's Speech Learning Model (SLM) (Flege, 1995; Flege et al., 2003), L1 and L2 sound systems are not independent, but coexist in one phonetic space. This naturally creates competition

between the speech sounds of L1 and L2. In a combined L1+L2 phonetic space, mutual interference between L1 and L2 sound categories is inevitable, which suggests that phonetic interference occurs "bidirectionally"; it does not only occur from L1 to L2 (Flege et al., 1995; Flege et al., 1999; Kuhl et al., 2003), but also from L2 to L1 (Flege, 1995; Grosjean, 1989; Major, 1992). The direction and strength of interference depends on language dominance; the stronger language influences the weaker language, either in a permanent manner or in an ephemeral way (Flege, 1999; Grosjean, 2010).

The present study examined the production of voicing contrast of Spanish (L1) and English (L2) stop consonants (i.e., /b, d, g/ vs. /p, t, k/) in word-initial position by Spanish-English early bilingual speakers who are more dominant in English (L2), i.e., Spanish heritage speakers.

2.3. Creation of stop categories by bilingual speakers

2.3.1. Spanish and English stop consonants

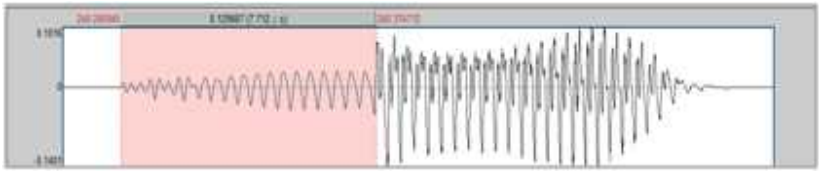
Investigating stop consonants is a good measure to understand Spanish-English bilinguals' L1-L2 phonetic interference, because phonologically both Spanish and English have voiced and voiceless stop consonants (/b, d, g/ and /p, t, k/, respectively), but phonetically they are realized differently. In the phonological level, Spanish and English are similar in that both languages show voicing contrast for stop consonants in word-initial position (Hualde, 2005). However, this contrast is realized differently in the phonetic level. In Spanish, the contrast is between prevoiced /b, d, g/ and voiceless unaspirated /p, t, k/; in English, it is between voiceless unaspirated /b, d, g/[3], on the

3) In some cases, English /b, d, g/ are also produced with prevoicing, but in

one hand, and voiceless aspirated /p, t, k/, on the other (Lisker & Abramson, 1964; Zampini & Green, 2001). For this reason, Jansen(2004) called languages like Spanishas “voicing languages” and languages like English as “aspirating languages”. According to Lisker and Abramson (1964), this distinction can be quantified by the Voice Onset Time (VOT), an articulatory property of stop consonants which is defined as the time between the release of the stop consonant and the onset of subsequent vocal fold vibration. If the vocal folds start vibrating before the release of occlusion, it is considered as “voice lead” and the VOT values are negative. If the vocal folds start vibrating at or soon after release, it is considered as “short voice lag” and the VOT values are between 0 milliseconds and 30 milliseconds. If the vocal folds start vibrating long after release, it is considered as “long voice lag” and the VOT values are larger than 30 milliseconds (Hualde, 2005). Thus, in Spanish, voicing contrast occurs between voice-lead /b, d, g/ and short-lag /p, t, k/ with the VOT boundary at 0 ms., while, in English, it occurs between short-lag /b, d, g/ and long-lag /p, t, k/ with the VOT boundary at +30 ms..

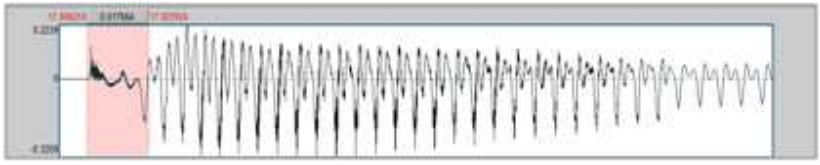
Figure 1. VOT of Spanish and English stop consonants

A. Voice-lead VOT (Spanish /b, d, g/)



word-initial position it is more common that they are produced as voiceless unaspirated as in Spanish /p, t, k/ (Hoonhorst et al., 2009).

B. Short-lag VOT (Spanish /p, t, k/, English /b, d, g/)



C. Long-lag VOT (English /p, t, k/)

2.3.2. Previous studies on bilinguals' stop consonants

If a bilingual acquires two languages, one of which is a voicing language and the other is an aspirating language (Jansen, 2004), what would happen to the creation of stop consonants? Stop consonants of early bilinguals is a popular topic that have been treated in numerous studies. The majority of the studies on bilinguals' voicing contrast argued that bilinguals create a merged category for /b, d, g/ and separate categories for /p, t, k/. In a case study of an early French-English bilingual, Mack(1990) found that /b, d, g/ of French which is a voicing language, were produced with short-lag VOTs, instead of with voice-lead VOTs. However, English /b, d, g/ were produced according to the phonetic norm (i.e., short-lag). Regarding /p, t, k/, both French and English /p, t, k/ were produced with much longer VOTs than the phonetic norm, but they were still different from each other. Flege and Eefting(1988) found similar results with early Spanish-English bilinguals. In an imitation task of VOT

continuum ranging from prevoiced /da/ to long-lag /ta/, bilinguals showed abrupt shifts with VOT values falling into three modal ranges, i.e., voice-lead /d/, short-lag /t/, and long-lag /t/, whereas monolinguals of Spanish and English showed only two modal ranges. Simon(2010) investigated the production of prevoicing in Dutch, a voicing language, by an L1 Dutch speaker who had moved to the US and had been exposed mostly to English since then (i.e., heritage speaker of Dutch). The results showed that the majority of Dutch /b, d, g/ were produced with prevoicing in the first session (i.e., category assimilation), but as the English acquisition process went on, the prevoicing decreased, i.e., Dutch phonetics moved in the direction of the English target realizations.

However, many of these studies did not successfully control for language mode, which is an important factor in understanding bilinguals' stop categories. Grosjean(2010) proposed that bilinguals find themselves at various points in their daily lives along a continuum of different language modes: from monolingual mode in L1 at one end to monolingual mode in L2 at the other, with bilingual mode of L1 and L2 in between. Therefore, in order to fully understand whether bilinguals are able to distinguish stop categories in L1 and L2, it is important to place them in the proper language mode. However, previous studies failed to control for this factor. For instance, in Flege and Eefting(1988), the language of instruction was not determined according to the language of the task, but randomly chosen. Simon(2010) intended to put the subject in the proper language mode by inserting a gap of 15 minutes during which the experimenters played with the subject (a child) in the target language prior to the commencement of the recording session. However, it is not certain whether 15 minutes were sufficient to deactivate the language of the previous session. Thus, it can be assumed that the data collection of the previous studies was done is such a way that the bilinguals were

put closer to the bilingual mode in which both bilinguals' L1 and L2 were activated. Zampini and Green(2001) argued that this could have been the reason that the bilinguals in some studies were not able to distinguish the voiced stops in L1 and L2.

Unfortunately, there are few studies that have considered all these factors. Magloire and Green(1999) and Sundara et al.(2006) are the only studies that have been found so far that carefully controlled for language mode. In Magloire and Green(1999), the subjects first completed the English portion of the experiment and were asked if they were interested in participating in a different study on the production of Spanish at another lab, to which they all agreed. At a later date, they were contacted in Spanish by a different experimenter for participation and completed the Spanish portion of the experiment. Results show that the bilinguals produced separate categories for /b/ and /p/ that were comparable to those of the native speakers. However, this finding is contrary to what the SLM posits. Recall that L1 and L2 sound systems coexist in one phonetic space, which naturally creates competition between the speech sounds of L1 and L2 (Flege, 1995; Flege et al., 2003). Thus, according to this view, it is impossible to control two languages exactly the same way as two monolinguals (Flege, 1999; Grosjean, 2010). Sundara et al.(2006) argued that even simultaneous bilinguals show phonetic interference in their two languages. In a study on the production of /d/ and /t/ by simultaneous bilinguals, Sundara et al.(2006) found that simultaneous bilinguals were able to distinguish /d/ and /t/ in both French and English. In French, the majority of the /d/ tokens (73.6%) were produced with voice-lead VOTs and all the /t/ tokens were produced with short-lag VOTs; in English, all the /d/ and /t/ tokens were produced with short-lag and long-lag VOTs, respectively. However, when compared to the native speakers of each language, the bilinguals produced English and French /d/ tokens differing in VOT values; they

produced English /d/ with more prevoicing than the native English speakers and French /d/ with less prevoicing than the native French speakers. Thus, the bilinguals performed similarly, but not identically to the native speakers.

Based on previous research, the present study focused on Spanish heritage speakers who are more dominant in English(L2). Their production of Spanish and English stop consonants were investigated in order to answer the following research questions: 1) When language mode is controlled, are Spanish heritage speakers able to distinguish Spanish stop consonants from English stop consonants?; and 2) Do Spanish heritage speakers perform similarly with native speakers of each language?

3. Research Method

3.1. Subjects

3.1.1. Spanish Heritage Speakers

Since the purpose of this study was to investigate the speech of Spanish heritage speakers who are more dominant in English, specific criteria were applied to determine heritage speakers' language dominance. Following previous studies (Guion, 2003; Grosjean, 2010), language dominance was determined by the combination of three factors: (1) age of acquisition of L2 (L2 AOA), (2) frequency of use, and (3) language proficiency. L2 AOA was determined by whether massive exposure to English began prior to age 7. Frequency of use was determined by a five-point Likert scale from 1 meaning "I use Spanish 100% of the time" to 5 meaning "I use English 100% of the

time". Lastly, language proficiency was determined using both objective and subjective measures (Grosjean, 2010). Subjective proficiency was reported by speakers' self-rating of Spanish and English skills with a five-point Likert scale from 1 meaning "I understand but cannot speak Spanish / English" to 5 meaning "I understand and speak fluently like a native speaker of Spanish / English"; objective proficiency was evaluated by a cloze test. Thus, in the present study, English-dominant Spanish heritage speakers were defined as L1-Spanish speakers (1) who were exposed to both Spanish and English prior to age 7, (2) use English more frequently than Spanish, and (3) whose ratio of Spanish to English proficiency scores was lower than 1 (i.e., Spanish < English) in both objective and subjective measures. A thorough language background questionnaire was conducted in order to evaluate these criteria.

In total, 7 heritage speakers (6 female and 1 male) with an average age of 19.43 years met these criteria and were considered in the present study. All the subjects in the present study were undergraduate or graduate students of an American University in the Midwest. The language background questionnaire revealed that all the heritage speakers, except one, were born in the US in a Hispanic family (i.e., second generation immigrants); either both parents were born in a Spanish-speaking country (mostly from Mexico) and arrived to the US as adults, or only one of them were born abroad and the other was born in the US in a Hispanic family. One heritage speaker that was not born in the US was born in Puerto Rico and arrived to the US at age 6 (i.e., early 1.5 generation immigrant). The heritage speakers reported that they were raised by a family member (i.e., mother, aunt, grandmother) or a baby-sitter who spoke to them either in Spanish only or in both Spanish and English. Thus, the heritage speakers either began to learn both Spanish and English at birth or began to learn English after Spanish but no later than 7 years of age.

The heritage speakers reported that they used Spanish with parents, siblings, relatives, and other bilingual friends before entering elementary school. Given that the main circle of communication during this period is generally limited to family and friends, it is assumed that even though the heritage speakers were exposed to both Spanish and English from birth or from a very young age, Spanish was the main language used. Indeed, the frequency of Spanish use before age 6 (i.e., when elementary school begins) showed that the heritage speakers used Spanish with average 71.43% of the time. Once the subjects entered elementary school, the use of Spanish became more limited. The heritage speakers reported that from this period they used mostly English even with siblings and other bilingual friends, with whom they used to speak Spanish before; the only people they used Spanish with consistently were their parents. Given that English was the majority language outside of home and, at the same time, the primary language at school, it can be assumed that from this point the heritage speakers gradually switched the main language of communication from Spanish to English. The percentage of language use through the lifespan revealed that the use of Spanish has decreased since elementary school; it was 42.86% in elementary school, 39.29% in middle school, 17.86% in high school, and 14.29 % from college until now. With regard to language proficiency, the ratio of Spanish to English cloze-tests was average 0.85 and the ratio of Spanish to English self-rating was 0.74. This indicates that although the heritage speakers were able to understand and speak Spanish, they do so with more difficulty than in English.

3.1.2. Native Control Groups

Since L1 and L2 sound systems cannot be separated, but influence

one another (Flege, 1999; Grosjean, 2010), it would be ideal if the native speakers were monolinguals. However, finding participants that are "pure" monolinguals is extremely difficult, due to globalization in the modern world in which learning a second language is mandatory for many speakers. Therefore, in the present study, late L2 learners who were more dominant in L1 were selected as the native speakers. The same factors were used as before, i.e., L2 AOA, frequency of use, and language proficiency, but in the opposite way. That is, the selection criteria for the native speakers were: L1-Spanish or L1-English speakers who (1) first had immersed instructions in the L2 or prevalently used the L2 after age 7[4], (2) use their L1 more in their daily lives, and (3) whose ratio of L1 to L2 proficiency scores was higher than 1 (i.e., L1>L2[5]) . A separate language background questionnaire was conducted for the native speakers.

In total, 5 native Spanish speakers (5 female), with an average age of 29.2 years, and 5 native English speakers (4 female and 1 male), with an average age of 24.33 years, met the criteria and were considered in the present study. The questionnaire revealed that the native Spanish speakers were first immersed in their L2 (English) at age 25.17 in average, while the native English speakers were first immersed in their L2 (Spanish) at age 19 in average. The native speakers reported that they were using their L1 more than their L2; the native English speakers were using English 87.5% of the time and

4) The present study did not consider L2 AOA as the time when first foreign language class was taken, since the native speakers reported that the exposure to L2 were limited to classroom only at the time, and in most cases the instructions were conducted in the L1. Thus, L2 AOA was considered as the age when massive exposure to the L2 first occurred, i.e., the age when immersed instructions in or prevalent use of L2 first occurred (e.g., exchange program in an L2-speaking country, summer camp in which only the L2 was used).

5) In order to use the same language set and tools as the heritage speakers (i.e., self-rating of English and Spanish proficiency, and English and Spanish cloze tests), only native Spanish speakers who were L2 learners of English and native English speakers who were L2 learners of Spanish were considered in the present study.

the native Spanish speakers were using Spanish 69% of the time[6]. With regard to language proficiency, the ratio of L1 to L2 cloze-tests was average 1.17 for the native English speakers and 1.2 for the native Spanish speakers; the ratio of L1 to L2 self-rating was average 1.5 for the native English speakers and average 1.33 for the native Spanish speakers.

3.2. Research Materials

36 real words with word-initial stop consonants, i.e., 6 words for each stop consonant, were recorded in each language. Equal numbers of fillers that began with consonants other than stop consonants were also used in order to keep the participants from knowing the purpose of the study. Only words that are commonly used were chosen in order to avoid frequency effect. The high frequency English words were found in Corpus of Contemporary American English (COCA)[7] (Davies, 2011) and the high frequency Spanish words were found in Davis(2006) and Corpus del Español[8] (Davies, 2004).

3.3. Procedures

A production task was conducted in a sound-attenuating booth using AKG C520 head-mounted microphone and the recordings were digitized at a sampling rate of 44.1 kHz using Marantz PMD570 digital recorder. The two native speaker groups were recorded in their native

6) Although this value seems to be relatively low, given that the native Spanish speakers in the present study were recruited in the US and thus, English should be used primarily, it was not considered as a critical confound in the present study.
7) Available at: http://www.americancorpus.org/
8) Available at: http://www.corpusdelespanol.org/

language, i.e., in Spanish for the native Spanish speakers and in English for the native English speakers. With regard to the heritage speakers, the experiment was first done in Spanish and later in English. In order to put the heritage speakers close to a monolingual mode, the two sessions were conducted one week apart and the instructions were given in the proper language. The target and filler words were presented on a computer screen in a random order. The participants verbally produced each word in a carrier phrase. Carrier phrases were used in order to encourage naturalistic productions and to minimize variability within subjects in stress patterns and pitch contours, which are possible factors that affect the VOT values (Robb et al., 2005).

In total, 1728 tokens were considered (heritage speakers = 36 target words × 7 subjects × 2 languages × 2 repetitions; native control groups = 36 target words × 5 subjects × 2 repetitions × 2 groups). Heritage speakers' VOT values of each word were measured using Praat phonetics software (Boersma & Weenink, 2005) and compared with those of the native speakers (i.e., with the native Spanish speakers for the Spanish words and with the native English speakers for the English words). VOT was calculated as the time in milliseconds that elapsed between the consonant release (i.e., onset of an aperiodic burst in the waveform) and voicing onset (i.e., onset of a regular periodic signal in the waveform) (Lisker & Abramson, 1964). All statistical analyses and plotting were carried out using R statistical software (Ihaka & Gentleman, 1996).

4. Results and discussions

4.1. Creation of Stop Consonants

When comparing Spanish heritage speakers' Spanish and English stop consonants, results show that heritage speakers produced Spanish /b, d, g/ as prevoiced (i.e., voice-lead VOTs) 55.56% of the time[9] and as unaspirated[10] (i.e., short-lag VOTs) 44.44% of the time (average 10.71ms.), whereas they produced English /b, d, g/ as unaspirated 100% of the time (average 18ms.). With regard to voiceless stop consonants, heritage speakers produced all Spanish /p, t, k/ as unaspirated (average 18.19ms.), whereas their English /p, t, k/ were all produced as aspirated (i.e., long-lag VOTs) (average 87.99ms.) (Table 1).

Table 1. Spanish heritage speakers' Spanish and English stop categories

	/b, d, g/	/p, t, k/
Spanish	voiced-lead or short-lag	short-lag
English	short-lag	long-lag

Thus, unlike previous studies that argued that bilinguals create a merged L1-L2 category for voiced stop consonants, the results of the present study show that Spanish heritage speakers were able distinguish the two languages in both voiced and voiceless stop

9) Given that the carrier sentence in the Spanish session was *Dicen _____ para mí* 'They say _____ to me', measuring the VOTs for prevoicing was not possible, because in the acoustic signals the nasality of /n/ in *Dicen* masked the prevoicing of /b, d, g/ that came after. However, despite this limitation, it was possible to measure the VOTs of target stop consonants that were not prevoiced (i.e., those that were produced with short-lag or long-lag VOTs) due to a silence after /n/ that was created from voiceless occlusion in forming these sounds.

10) With regard to the overlap that was created between Spanish /b, d, g/ with short-lag VOTs and Spanish /p, t, k/ which was also produced with short-lag VOTs, it is assumed that cues other than VOTs are in play to distinguish these two categories (e.g., fundamental frequency of the following vowel).

consonants. This finding supports that bilingual speakers are able to distinguish stop categories in L1 and L2 when put into the proper language mode (Magloire & Green, 1999; Sundara et al., 2006; Zampini & Green, 2001).

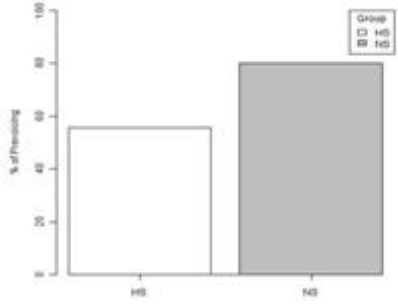
4.2. Comparison with native speakers

In order to examine whether Spanish heritage speakers are able to perform like two monolingual speakers, their production of Spanish and English stop consonants was compared to that of the native control groups, i.e., heritage speakers' Spanish stop consonants were compared with those of native Spanish speakers and heritage speakers' English stop consonants were compared with those of native English speakers.

4.2.1. Spanish stop consonants

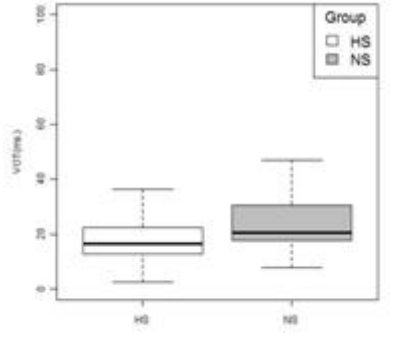
When producing Spanish /b, d, g/, heritage speakers produced these sounds with prevoicing 55.56% of the time, while native Spanish speakers produced them with prevoicing 80% of the time (Figure 2). A bivariate χ2 test between Group (heritage speakers / native speakers) and Prevoicing (prevoiced / not prevoiced) was conducted and the results show that the percentages of the two groups were significantly different ($\chi^2 = 12.86$, df = 1, $p < 0.001$).

Figure 2. Percentage of prevoicing of Spanish /b, d, g/ by heritage speakers (HS) and native Spanish speakers (NS)



With regard to the production of Spanish /p, t, k/, both the native Spanish speakers and the heritage speakers produced these sounds with short-lag VOTs (25.86 ms. and 18.19 ms., respectively) (Figure 3). An independent-samples t-test revealed that the difference in VOTs between the two groups was significantly different, $t(129.23) = -5.152$, $p < 0.001$.

Figure 3. VOTs of Spanish /p, t, k/ by heritage speakers (HS) and native Spanish speakers (NS)

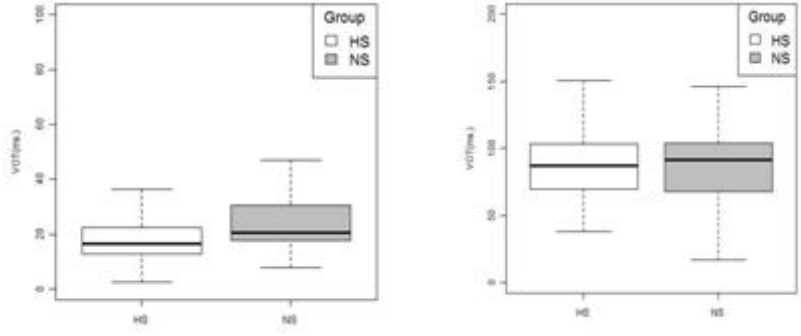


4.2.2. English stop consonants

With regard to the production of English stop consonants, heritage speakers' VOTs of English stop consonants were compared to those of native English speakers. As seen in Figure 3, overall, both native English speakers and heritage speakers produced the English /b, d, g/ with short-lag VOTs (average 17.67 ms. and 18 ms., respectively) and the English /p, t, k/ with long-lag VOTs (average 89.94 ms. and 87.99 ms., respectively). Independent-samples t-tests revealed that the VOTs produced by native English speakers and heritage speakers produced were similar in both English /b, d, g/, t(178.96) = 0.1847, *n.s.* , and English /p, t, k/, t (112.81) = -0.31,*n.s.*.

Figure 3. VOTs of English stop consonants by heritage speakers (HS) and native Spanish speakers (NS)

A. English /b, d, g/ B. English /p, t, k/



Results show that when compared to native Spanish speakers Spanish heritage speakers produced Spanish stop consonants differently from the native Spanish speakers. However, no significant difference

was found between Spanish heritage speakers and the native English speakers in the production of English stop consonants. The reason to this discrepancy should be investigated in more detail in future study, but it is suspected that language dominance had an effect. Flege(1999) and Grosjean(2010) argued that the direction and strength of phonetic interference depends on language dominance. Thus, if a bilingual speaker is more dominant in the L2, there will be more phonetic interference from L2 to L1 than from L1 to L2 (Gildersleeve-Neumann et al., 2009; Simon, 2010). Since the heritage speakers in the present study were L2-dominant bilinguals, it could have been that the phonetic interference occurred to a larger degree from L2 to L1 than from L1 to L2. Thus, it is assumed that, whereas the interference from L2 to L1 was strong enough to demonstrate significant difference in the performance between the heritage speakers and the native Spanish speakers, the interference from L1 to L2 was not. This view supports Flege et al.(2003) in that, when a bilingual speaker approximates the phonetic norm of an L2 speech sound, the production of the corresponding L1 speech sound diverges from the L1 phonetic norms.

5. Conclusion and Implications

The purpose of this study was to examine whether phonetic interference from L2 to L1 sound system occurs if the L2 is more dominant than the L1. The present study focused on the production of Spanish and English /b, d, g/ and /p, t, k/ of Spanish heritage speakers who are more dominant in English. Previous studies regarding VOT in early bilingual speech production showed two possibilities in the creation of stop categories; some studies support that bilinguals create a merged category for /b, d, g/ and separate

categories for /p, t, k/ (Flege & Eefting, 1988; Mack, 1990), while others posit that bilinguals are able to create separate categories for both /b, d, g/ and /p, t, k/ (Magloire & Green, 1999; Sundara et al.,(2006). Zampini and Green(2001) argued that the merging of /b, d, g/ occurred in some studies because the language mode was not carefully controlled and for this reason the bilinguals in those studies were put closer to the bilingual mode in which both bilinguals' L1 and L2 were activated. In order to fully understand whether bilinguals are able to distinguish stop categories in L1 and L2, the present study intended to place the heritage speakers in the proper language mode by conducting the Spanish and English sessions one week apart and by giving instructions in the proper language. The results showed that heritage speakers' Spanish /b, d, g/ and /p, t, k/ were significantly different from the English counterparts, which implies that they were able to distinguish stop categories in L1 and L2 when put into the proper language mode.

When heritage speakers' production in Spanish and English was compared to that of the native control groups, results showed that the heritage speakers' Spanish /b, d, g/ and /p, t, k/ were significantly different from those of the native Spanish speakers, while their English /b, d, g/ and /p, t, k/ were similar with those of the native English speakers. This finding implies that there is a strong relationship between language dominance and the direction of phonetic interference in Spanish heritage speakers' production of stop consonants.

However, there are several limitations that should be addressed in future research in order to confirm whether these findings can be generalized to all heritage speakers who are more dominant in their L2. To begin with, the present study only provided tendencies shown in a small number of subjects that are heritage speakers of Spanish. However, these subjects may not represent the general public. In order

for these tendencies to be generalized, a larger number of subjects should be considered to execute thorough statistical analyses. Moreover, heritage speakers of different languages (e.g., heritage speakers of Korean or Arabic) should also be taken into account to verify whether the discrepancy only occur in a specific heritage group or in all heritage speakers that are L2-dominant. Also, the factors considered (language, group, voicing) or controlled for (language dominance, word frequency, language mode) in the present study may be sufficient to provide implications for the direction of phonetic interference, but they do not provide the full picture. In fact, numerous studies have shown that VOT varies strongly as a function of speech rate for voiceless aspirated (i.e., long-lag) stops; it increases as one speaks more slowly and, vice versa (Allen et al., 2003; Kessinger & Blumstein, 1997; McCrea & Morris, 2005). Apart from speech rate, it has been reported that gender also has an important role in the variability in VOT; women tend to produce longer VOTs than men regardless of age (Whiteside & Irving, 1997; Robb et al., 2005).

References

Acevedo, M.(1993), 'Development of Spanish consonants in preschool children', *Journal of Childhood Communication Disorders*, 15, no.2, 9-15.

Allen, S., Miller, J., & DeSteno, D.(2003), 'Individual talker differences in voice-onset-time', *Journal of Acoustic Society of America*, 113(1)o.1, 544-552.

Birdsong, D.(1999), 'Whys and why nots of the Critical Period Hypothesis for second language acquisition', In D Birdsong (ed.), *Second language acquisition and the Critical Period Hypothesis*, Lawrence Erlbaum, Mahwah, NJ.

Blumstein, S., Myers., E., & Rissman, J.(2005), 'The Perception of Voice Onset

Time: An fMRI Investigation of Phonetic Category Structure', *Journal of Cognitive Neuroscience,* 17(9), 1353 - 1366.

Boersma, P. & Weenink, D.(2005), *Praat 4.3.19: Doing phonetics by computer* [Computer program]. Retrieved from http://www.praat.org

Bosch, L., Costa, A., & Sebastián-Gallés, N.(2000), 'First and second language vowel perception in early bilinguals', *European Journal of Cognitive Psychology*, 12, 189 - 221.

Davies, M.(2004), *El uso del Corpus del Español y otros corpus para investigar la variación actual y los cambioshistóricos*, Sophia University, Tokyo.

_____(2006), *A frequency dictionary of Spanish: core vocabulary for learners*, Routledge, New York.

_____(2011), 'The Corpus of Contemporary American English as the First Reliable Monitor Corpus of English', *Literary and Linguistic Computing,* 25, 447-465.

Dupoux, E., Peperkamp, S., & Sebastián-Gallés, N.(2001), 'A robust method to study stress "deafness."', *Journal of the Acoustical Society of America*, 110, 1606-1618.

_____(2010), 'Limits on bilingualism revisited: Stress 'deafness' in simultaneous French-Spanish bilinguals', *Cognition*, 114, 266-275.

Flege, J.(1991), 'Age of learning affects the authenticity of voice-onset time (VOT) in stop consonants produced in a second language', *Journal of the Acoustical Society of America*, 89, 395 - 411.

_____(1995), 'Second language speech learning: Theory, findings, and problems. In W Strange (ed.), *Speech perception and linguistic experience: Issues in cross-language research*, York Press, Timodium, MD.

_____(1999), 'Age of learning and second language research', In D Birdsong (ed.), *Second language acquisition and the critical period hypothesis*, Lawrence Erlbaum, NewJersey.

_____ & Eefting, W.(1988), 'Imitation of a VOT continuum by native speakers of English and Spanish: Evidence for phonetic category

formation', *Journal of the Acoustical Society of America,* 83(2), 729-740.

_____, Munro, M., & MacKay, I.(1995), 'The effect of age of second language learning on the production of English consonants', *Speech Communication*, 16, 1-26.

_____, Schirru, C., & MacKay, I.(2003), 'Interaction between native and second language phonetic subsystems', *Speech Communication*, 40, 467-491.

_____, Yeni-Komshian, G., & Liu, S.(1999), 'Age constraints on second language learning', *Journal of Memory and Language*, 41, 78-104.

Fowler, C., Sramko, V., Ostry, D., Rowland, S., & Halle, P.(2008), 'Cross language phonetic influences on the speech of French - English bilinguals', *Journal of Phonetics*, 36, 649-663.

Gildersleeve-Neumann, C., Peña, E., Davis, B., & Kester, E.(2009), 'Effects on L1 during early acquisition of L2: Speechcchanges in Spanish at first English contact', *Bilingualism: Language and Cognition*, 12(2), 259-272.

Grosjean, F.(1989), 'Neurolinguists, beware! The bilingual is not two monolinguals in one person', *Brain and Language*, 36, 3-15.

_____(2010), *Bilingual: life and reality*. Harvard University Press, Cambridge.

Guion, S.(2003), 'The vowel systems of Quichua - Spanish bilinguals: Age of acquisition effects on the mutual influence of the first and second languages', *Phonetica*, 60, 98 - 128.

Guion, S., Harada, T., & Clark, J.(2004), 'Early and late Spanish-English bilinguals' acquisition of English word stress patterns', *Bilingualism: Language and Cognition*, 7, 207 - 226.

Hornberger, N. & Wang, S.(2008), 'Who are our heritage language learners?', In D. Brinton, Kagan, O, & Bauckus, S (eds.), *Heritage language education: a new field emerging*, Routledge, New York.

Hualde, J.(2005), *The sounds of Spanish*. Cambridge University Press, Cambridge.

Ihaka, R. & Gentleman, R.(1996), 'R: A language for data analysis and

graphics', *Journal of Computational* and Graphical Statistics, 5, 299-314.

Jansen, W.(2004), *Laryngeal contrast and phonetic voicing: A laboratory phonology approach to English, Hungarian, and Dutch*, PhD thesis, University of Groningen, Groningen.

Jimenez, B.(1987), 'Acquisition of Spanish consonants in children aged 3-5 years, 7 months', *Language, Speech, and Hearing Services in Schools*, 18(4), 357-363.

Johnson, J. & Newport, E.(1989), 'Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language', *Cognitive Psychology*, 21, 60 - 99.

Jusczyk, P., Friederici, A., & Wessels, J.(1993), 'Infants' sensitivity to the sound pattern of native language words', *Journal of Memory & Language*, 32, 402 - 420.

Kessinger, R. & Bloomstein, S.(1997), 'Effects of speaking rate on voice-onset time in Thai, French, and English', *Journal of Phonetics*, 25, 143-168.

Kuhl, P., Conboy, B., Coffey-Corina, S., Padden, D., Rivera-Gaxiola, M., & Nelson, T.(2008), 'Phonetic learning as a pathway to language: new data and native language magnet theory expanded (NLM-e)', *Philosophical Transactions of the Royal Society B*, 363, 979-1000.

Kuhl, P. & Iverson, P.(1995), 'Linguistic experience and the "Perceptual Magnetic Effect"', In W Strange (ed.), *Speech perception and linguistic experience: Issues in cross-language research*, York Press, Timodium, MD.

Kuhl, P., Tsao, F., & Liu, H.(2003), 'Foreignlanguage experience in infancy: Effects of short-term exposure and social interaction on phonetic learning', *Proceedings of the National Academy of Sciences*, 100, 9096 - 9101.

Linares, T.(1981), 'Articulation skills in Spanish-speaking children', In R. Padilla (ed.), *Ethnoperspectives in bilingual education research: Bilingual education technology* (Ethnoperspectives in Bilingual Education), Eastern Michigan University Bilingual Programs, Ypsilanti, MI.

Lisker, L. & Abramson, A.(1964), *Stop categorization and voice on set time*. Paper presented to the fifth International Congress of Phonetic Sciences, Münster, 16-22 August.

Lively, S., Logan, J., & Pisoni, D.(1993), 'Training Japanese listeners to identify English /r/ and /l/: II. The role of phonetic environment and talker variability in learning new perceptual categories', *Journal of the Acoustical Society of America*, 94, 1242 - 1255.

Logan, J., Lively, S., & Pisoni, D.(1991), 'Training Japanese listeners to identify English /r/ and /l/: a first report', *Journal of the Acoustic Society of America*, 89, 874-876.

Long, M.(1990), 'Maturational constraints on the language development', *Studies in Second Language Acquisition*, 12, 251 - 285.

Mack, M.(1989), 'Consonant and vowel perception and production: Early English-French bilinguals and English monolinguals', *Perception & Psychophysics*, 46, 187-200.

_____(1990), 'Phonetic transfer in a French-English bilingual child', In P Nelde (ed.), *Language attitudes and language conflict*, Dümmler, Bonn, Germany.

Magloire, J. & Green, K.(1999), 'A cross-language comparison of speaking rate effects on the production of voice onset time in English and Spanish', *Phonetica*, 56, 158-185.

Mayberry, R., & Fischer, S.(1989), 'Looking through phonological shape to lexical meaning: The bottleneck of non-native sign language processing', *Memory & Cognition*, 17, 740 - 754.

Major, R.(1992), 'Losing English as a first language', *The Modern Language Journal*, 76, 190-208.

McCrea, C. & Morris, R.(2005), 'The effects of fundamental frequency level on voice onset time in normal adult male speaker', *Journal of Speech, Language, and Hearing Research*, 48, 1013-1024.

Montrul, S.(2008), *Incomplete acquisition in bilingualism: Re-examining the age factor*, John Benjamins, Amsterdam.

Nuñez-Cedeño, R.(2007), 'The acquisition of Spanish codas: A frequency/

sonority approach', *Hispania*, 90, 147-163.

Pallier, C., Bosch, L., & Sebastián Gallés, N.(1997), 'A limit on behavioral plasticity in speech perception', *Cognition*, 64, B9 - B17.

Polka, L.(1992), 'Characterizing the influence of native language experience on adult speech perception', *Perception & Psychophysics*, 52, 37 - 52.

Robb, M., Gilbert, H., & Lerman, J.(2005), 'Influence of gender and environmental setting on voice onset time', *Folia Phoniatrica et Logopaedica*, 57, 125-133.

Saalfeld, A.(2009), *Stress in the beginning Spanish classroom: an instructional study*, PhD thesis, University of Illinois, Urbana-Champaign.

Schnitzer, M. & Krasinski, E.(1994), 'The development of segmental phonological production in a bilingual child', *Journal of Child Language*, 21, 585-622.

Sebastián-Gallés, N. & Soto-Faraco, S.(1999), 'Online processing of native and non-native phonemic contrasts in early bilinguals', *Cognition*, 72, 111-123.

Simon, E.(2010), 'Child L2 development: A longitudinal case study on Voice Onset Times in word-initial stops', *Journal of Child Language*, 37, 159-173.

Strange, W.(1995), 'Cross-language studies of speech perception: A historical review', In W Strange (ed.), *Speech Perception and Linguistic Experience: Issues in Cross-Language Research*, York Press, Timonium, MD.

Sundara, M., Polka, L., & Baum, S.(2006), 'Production of coronal stops by simultaneous bilingual adults', *Bilingualism: Language and Cognition*, 9, 97 - 114.

Takagi, N.(2002), 'The limits of training Japanese listeners to identify English /r/ and /l/: Eight case studies', *Journal of the Acoustical Society of America*, 111, 2887 - 2896.

Valdés, G.(2001), 'Heritage language students: Profiles and possibilities', In J Preyton, J Ranard, & S McGinnis (eds.), *Heritage Languages in America: Preserving a National Resource*, The Center for Applied

Linguistics and Delta Systems, McHenry, IL.

Weinreich, U.(1953), *Languages in Contact*. Mouton, The Hague.

Werker, J. & Tees, R.(2005), 'Speech perception as a window for understanding plasticity and commitment in language systems of the brain', *Developmental Psychobiology*, 46(3), 233-251.

Whiteside, S. & Irving, C.(1997), 'Speakers' sex differences in voice onset time: Some preliminary findings', *Perceptual and Motor Skills*, 85, 459-463.

Williams, L.(1977a), 'The voicing contrast in Spanish', *Journal of Phonetics*, 5, 169-184.

_____(1977b), 'The perception of stop consonant voicing by Spanish-English bilinguals', *Perception and Psychophysics*, 21(4), 289-297.

Zampini, M. & Green, K.(2001), 'The voicing contrast in English and Spanish: The relationship between perception and production', In J. Nicol (ed.), *One Mind, Two Languages,* Blackwell, Oxford.

Ji Young Kim
University of Illinois at Urbana-Champaign
Department of Spanish, Italian, & Portuguese
Foreign Languages Building, MC-176
707 S. Mathews Ave., Urbana, IL, USA 61801
E-mail: jkim315@illinois.edu

Recieved: September 28, 2011
Revised: November 12, 2011
Accepted: November 14, 2011