An Analysis of English and Spanish Stop Production in Heritage Spanish Speech: The Columbus, Ohio Speech Community

Undergraduate Research Thesis

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By

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TABLE OF CONTENTS

I. Introduction 3

1.1 Literature Review 7

1.2 The Current Study 13

II. Methodology 14

2.1 Participants 14

2.2 Materials 15

2.3 Data Analysis 17

III. Results 19

3.1 Voiceless Sounds 19

3.1.1 Linguistic Factors 19

3.1.2 Individual Speaker Analysis 21

3.1.3 Sociolinguistic Factors 23

3.2 Voiced Sounds 27

3.2.1 Linguistic Factors 27

3.2.2 Individual Speaker Analysis 33

3.2.3 Sociolinguistic Factors 36

III. Discussion 39

4.1 Voiceless Stops 39

4.2 Voiced Stops 40

IV. Conclusion 41

V. References 43

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I. Introduction

With only 107 consonants recognised in the world's over 7,000 languages, a great number of variances are found in the articulation and production of these sounds (Eberhard, Simons & Fennig, 2019). As globalization of our society increases, so do interactions between the world's languages, leading to a rising number of bi- and multilingual speakers, people who are fluent in two or more languages. These speakers provide an interesting opportunity to observe how languages interact in a very close and more easily measured "environment", as even the most minor contact between languages can lead to any number of divergences to either or both of the involved languages (Chomsky 1981; Crain and Lilo-Martin, 1999). Understanding how bilingual speech affects language allows us to further understand how the brain processes and stores language as well as account for the differences observed in everyday speech production and better predict what changes may be realized in the future.

This study concentrates on Heritage speakers, a type of bilingual speaker who grew up with some degree of exposure to a minority language as their first language [L1] while living in a country with some other majority language which is learned as their second language [L2] (Valdés, 2000; Deusen-Scholl, 2003; Kondo-Brown, 2010; Helmer, 2011; Rao & Kuder, 2016). The focus of this study is specifically on Spanish Heritage speakers living in Columbus, Ohio. Spanish is the most commonly used language in the United States following English due to an over 160% increase in Hispanic and Latinx immigrants over the 2000s (Census 2010; Lipski,

2008) This group is expected to show an even further increase upon the conclusion of the 2020 Census count (Data USA, 2018). As the number of Heritage speakers grows, so has the interest in the study of Heritage Spanish. Over the past twenty years, there has been an emergence of research covering these particular speakers, however these studies tend to focus on "traditionally" Spanish-speaking areas such as the southwest, Miami, Chicago, and New York (Rua, 2001; Gonzalez, 2001; Garcia, 2003; Potowski 2004; Schecter & Bayley, 2005; Porcel, 2006; Achugar, 2008; Torres & Potowski 2008; Potowski, 2009; Villa and Rivera-Mills, 2009; Velazquez, 2009; Cashman, 2009; Alvord, 2010; Balukas & Koops, 2015) When branching out to other states such as Ohio, researchers tend to drift to the large Puerto Rican communities surrounding the Cleveland area, ignoring the substantial Heritage speaking population living in the capital (Lipski, 2008; Ramos-Pellicia, 2007). This made the choice of studying Heritage speakers within the Columbus area much more interesting as this is a relatively unstudied population.

Typically, the focus of these studies has been on either describing the grammar of these speakers, or mapping potential gaps in the linguistic processing and acquisition of the language. These studies show an incomplete grammatical, morphological, and syntactic acquisition in Heritage speakers, leaving a void in phonological studies as they have shown that whether or not a speaker completely acquires a sound varies from person to person, with no clear explanation as to why (Flege, 1991; Au et al, 2002; Montrul 2002, 2007, 2009; Potowski, Jegerski, and Morgan-Short, 2009; Mikulski 2010; Beadurie & Fairclough, 2012; Lunde, 2015) This study focuses to help fill this gap by observing and analyzing Heritage speaker productions of voiceless stops /p,t,k/ and voiced stops /b,d,g/ in both their English and Spanish speech, as well as tracking a variety of external factors in an effort to identify a pattern between some factor and phonological production. It is worth noting that previous studies have found that the phonological acquisition of phonemes existing in both the speaker’s L1 and L2 with only minor articulatory differences is much more difficult than acquiring a novel phonemes, hence why these sounds are particularly intriguing to investigate (Wolff, 1950; Haugen & Weinreich, 1954; Briere, 1966; Flege & Hillenbrand, 1984).

In word initial environments, Spanish /p/ appears as [p], an unaspirated bilabial consonant, in contrast with English /p/, which appears as [pʰ] an aspirated bilabial consonant; Spanish /t/ appears as [t̪], an unaspirated dental consonant, in contrast with English /t/ which appears as [t̲ʰ], an aspirated alveolar consonant; and Spanish /k/ appears as [k], an unaspirated velar consonant, in contrast with English /k/ which appears as [kʰ], an aspirated velar consonant (Lado, 1956). When these consonants appear between two vowels, otherwise known as an intervocalic environment, both English and Spanish /p/ and /k/ and Spanish /t/ follow the patterns above. English /t/ only follows the above pattern when the syllable is stressed; intervocalic English /t/ in unstressed syllables can appear as either [t̲], an unaspirated alveolar consonant, or [ɾ], an unaspirated alveolar flap (Lado, 1956). These articulatory differences can be viewed using a spectrogram and measured through voice onset time [VOT]. VOT is defined as the measurement from the initial burst or release of the voiceless stop to the onset voicing of the following vowel. Both English and Spanish have distinct VOT ranges for the production of /p,t,k/ making them easily distinguishable, English stops having a long-lag VOT while Spanish stops measure much shorter (Lado, 1956; Langdon & Merino, 1992).

Voiced stops cannot simply be split into word initial and intervocalic environments as the sound preceding the voiced stop can affect its production. Following a pause or nasal consonant Spanish /b/ appears as [b], an unaspirated, voiced, bilabial stop, /d/ appears as [d̪], a, unaspirated, voiced, dental stop, and /g/ appears as [g], an unaspirated, voiced, velar stop (Lado, 1956). Additionally, /d/ will appear as [d̪] following the consonant [l] (Lado, 1956). English voiced stops found in environments not following a vowel appear very similar to those of their Spanish counterparts following a pause or nasal; /b/ appears as [b], an unaspirated, voiceless bilabial stop, /d/ appears as [d̳], an unaspirated, voiceless, alveolar stop, and /g/ appears as [g], an unaspirated, voiceless, velar stop (Lado, 1956). If the environment directly preceding a Spanish voiced stop ends in a vowel or a non-nasal consonant, regardless of whether or not it crosses a word boundary, /b/ appears as [β], a bilabial approximant, /d/ appears as [ð], a dental approximant, and /g/ appears as [ɣ], a velar approximant (Lado, 1956). These are in contrast with English stop consonants found in an environment directly following a vowel where /b/ appears as [b], a bilabial stop, /d/ appears [d̳], an alveolar stop, in stressed environments and as [ɾ], an alveolar flap, in unstressed environments, and /g/ appears as [g], a velar stop (Lado, 1956, Universidad de Sevilla, 2019). Rather than VOT, the allophones of the voiced consonants are measured using intensity. Intensity is calculated by finding the lowest point of intensity located within the voiced consonant and the highest point located within the following vowel, then dividing the two to determine the C/V intensity ratio which provides a distinct separation between English and Spanish voiced stops (Langdon & Merino, 1992) This ratio, scoring between 0 and 1, shows the degree of weakening of the consonant; the higher the intensity, the weaker the consonant. As

Spanish undergoes more weakening than English, it is expected that the allophones of Spanish stop consonants will have a higher ratio.

1.1 | Literature Review

Spanish and English having distinct and separate measurements for VOT in their voiceless stops make it an easy choice for measuring the differences between speaker productions of these tokens. Studies exploring these patterns have shown that speakers learn to mimic VOT through exposure, native speakers matching down to the millisecond. Earl Brown and Mary Copple sought to uncover how bilinguals are able to create and maintain separate two distinct VOT categories for the same sound (2016). Focusing on Spanish Heritage speaker production of English stops /p,t,k/, researchers were able to determine that separate categories for the production of English and Spanish voiceless stops are able to be maintained due to the high noticeability of VOT to the brain (Brown & Copple, 2016). It is therefore the primary cue for bilinguals in separating Spanish and English voiceless stops and one of the easiest things to study (Brown & Copple, 2016).

The ranges of VOT for bilingual speakers may diverge from those of monolingual speakers however. James Fledge and Wieke Eefting chose to measure not only the production of a speaker's L2 sounds, but also their perception of those sounds when spoken by a native speaker (1987). Participant groups included native Spanish speakers who had learned English as an adult, native Spanish speakers who had learned English as a child, and native Spanish-speaking 9-10 year-olds who began learning English by the age of 5-6 (Fledge & Eefting, 1987). All subjects produced English stops similarly, significantly different from the production of their Spanish stops, but also significantly different from a monolingual English stop; their VOT measurements settled in a range between the two (Fledge & Eefting, 1987). When measuring the perception of these same stops however, all groups were found to identify sounds within the scale of a normal, monolingual English speaker (Fledge & Eefting, 1987). This suggests that while bilingual speakers do develop separate phonetic categories for both Spanish and English stops, these categories differ from that of a monolingual speaker (Fledge & Eefting, 1987). Researchers noted that they lacked data to prove this idea however as they failed to consider how external factors, such as level of education, might have had an effect on phoneme production (Fledge & Eefting, 1987). This sentiment has been echoed in many past studies, Dianne Thornburgh and John Ryalls in their 1998 study going as far to remark that as they had been so confident in their hypothesis that age of exposure would be the determining factor, they chose not to collect any additional information from participants, discovering only at the end of their analysis that their research left something to be desired (Thornburgh & Ryalls, 1998).

In fact, many studies researching phonological acquisition choose to focus on age of acquisition which may be due to the popularity of a long disputed hypothesis supporting the existence of an L2 phonological critical period. Supporters of this hypothesis believe that beyond a certain age, ranging from as young as three to as old as twelve, speakers will never be able to accurately produce L2 sounds, while opponents argue that rather than a critical period, a number of other factors affect a speaker's phonological production (Singleton & Lengyel, 1995; Jackson, 2000; Muñoz & Singleton 2010; Saito, 2015). Flege in his 1991 study of Spanish/English bilinguals found that those who learned Spanish as a child produced the voiceless stop /t/ with a similar VOT to Spanish monolinguals whereas bilinguals who learned as an adult were found to produce /t/ significantly different. Various other studies have found similar results, supporting the belief that age of acquisition is a leading factor on L2 sound acquisition, however these studies lack analysis considering other factors which might affect sound production (Fledge & Eefting, 1987; Thornburgh & Ryalls, 1998; MacLeod & Stoel Gammon, 2005, 2010; Olson, 2013; Lunde, 2015; Brown & Copple, 2016).

Molly Lunde of the University of New Mexico was curious about investigating other potential factors and so additionally asked participants to describe their ethnic identity prior to collecting their speech (2015). She found that while all participants produced a similar VOT for /p,t,k/, the participant who had the most English-like VOT was the sole participant who identified as white (Lunde, 2015). Unfortunately, due to the small group size and lack of questions concerning other factors, such as how important it is for the speaker to be perceived as a native speaker or how often or in what type of environments each speaker used each language, she was ultimately not able to determine whether or not there is a significant link between speaker identity and L2 sound production. In fact, all speakers' VOT measurements in the study were found to not significantly differ from those of a monolingual English speaker and so the researchers determined that within their data set, L1 did not have a phonological effect on L2 speech (Lunde, 2015).

Ji-Young Kim in his 2011 study focused specifically on Heritage Spanish speakers who were English dominant, those who are more comfortable and competent in their L2 English despite Spanish being their L1, as he wanted to determine whether this shift in dominance affected voiceless stop production in both or either language. Dominance was measured via a background questionnaire Kim created, based on two previous studies measuring age of acquisition, frequency of use, and proficiency. He found that the shift in dominance did positively correlate to a speaker's voiceless stop production as there was no significant difference between participant VOT and that of a monolingual speaker in their English speech (Kim, 2011). However, when measuring their Spanish speech the opposite was found as participants were found to produce voiceless stops significantly different from that of a monolingual Spanish speaker (Kim, 2011). These results mimic those of the previous study, that L1 did not have an effect on L2, and go a step further showing that L2 has an effect on L1 stop production when the L2 has made the shift to become the dominant language.

The realization of the effect language dominance has on phonological production spurred the development of the tool known as the Bilingual Language Profile [BLP]. The BLP was developed in 2012 as part of the Bilingual Assessment Project at the Center for Open Educational Resources and Language Learning as a way to standardize the evaluation of bilingual language dominance (Birdsong, Gertken, & Amengual). Through a questionnaire, test subjects receive a score ranging from -212 to 212 showing which language the speaker holds more dominant (Birdsong, Gertken, & Amengual, 2012). It is worth noting that though they are often correlated and may be confused, dominance is distinct and separate from proficiency. Whereas a speaker may be proficient in both Spanish and English, if they do not regularly use or think in Spanish, they would not be Spanish dominant. The questionnaire is split into four categories; language history, language use, language proficiency, and language attitudes; which are individually weighted as to ensure that the importance of all components is measured equally (Birdsong, Gertken, & Amengual, 2012). All questions accept only multiple-choice scalar responses to avoid potential difficulties in grading open ended questions (Birdsong, Gertken, &

Amengual, 2012). Since its inception, the BLP has been cited in a growing number of published articles concerning bilingualism and bilingual individuals, allowing the linguistic community to more easily relate their findings as all participants are graded on an identical scale (Birdsong, Gertken, & Amengual, 2012).

One of the creators of the BLP, Mark Amengual, published a study in 2011 exemplifying the need for such a tool. In his research, data was collected from both Heritage English and Heritage Spanish speakers, seeking to determine whether or not cognate status affected sound production. He measured the voiceless stop /t/ in unstressed environments and found that both groups of Spanish/English bilinguals produced a longer VOT in their English voiceless stops when the token is found in a cognate (Amengual, 2011). There was no effect on their Spanish speech (Amengual, 2011). As this suggests that cognate status influences a speaker's phonological productions, phonemes found in cognates were not included in the current study's token count. Amengual's study also suggests that Spanish seems to have the larger effect upon English, regardless of which language is considered L1. This was echoed in Balukas and Koops' 2014 study researching New Mexican Spanish/English bilinguals where participants once again were found to produce a shorter VOT in their English speech while no effect was found on their Spanish productions. Unfortunately, it is hard to directly compare this and other studies as they fail to measure which language a speaker holds dominant which has been proven an important factor to consider when studying bilingual phonology (Kim, 2011; Birdsong, Gertken, & Amengual, 2012; Lunde, 2015) For these reasons, this study utilizes the BLP not only as a separate factor by which to track speaker production, but also to more easily relate this study to others.

Having a standard measure of language dominance would be especially useful when comparing two different bilingual groups as in Au et al's 2002 study. They analyzed both voiced and voiceless stops in Heritage Spanish speakers and regular Spanish L2 learners (Au et al., 2002). They found that Heritage speakers were able to better produce monolingual-like VOT in their /p,t,k/ productions and intensity in their /b,d,g/ productions over the L2 learners, though their productions did feature more articulatory weakening (Au et al., 2002). A similar study concerning both Heritage and L2 learner bilinguals reported that though Heritage speakers produced a more monolingual-like intensity of their voiced stops, /g/ was found to be stronger than both /b/ and /d/ (Knightly et al., 2003). The analyses of both studies credited this to Heritage speakers' early exposure of the language however, many external factors weren't considered during their reports, something that could have been better accounted for with an assessment such as the BLP.

Several additional factors that are important to consider are explored in Rao's 2015 study. He found that a speaker's ability to produce /b,d,g/ was tied to a speaker experience, syllable stress, and token location (Rao, 2015). He continued his research into /b,d,g/ with his 2015 study, choosing to focus specifically on the voiced stop consonants of Heritage Spanish speakers appearing in intervocalic environments, where monolingual Spanish speakers would produce them as pure approximates. Participants' productions were found to vary between pure approximants, tense approximants, and stops (Rao, 2015). Interestingly, while /d/ and /g/ often appeared as pure approximants, /b/ appeared as a pure approximant at a significantly lower rate, especially in stressed syllables and at word boundaries (Rao, 2015). This may be due to the fact that [ð] and weakened, approximant-like productions of /g/ both exist in English, something /b/ lacks (Lado, 1956).

1.2 | The Current Study

This study focuses on voiceless stops /p, t, k/ and voiced stops /b, d, g/ found in the inventories of both Spanish and English. As both languages have various allophones for each of the sounds listed above, environments have been limited for both sets. Tokens of voiceless stops will be constricted to word-initial [WI] and intervocalic [IV] environments. Tokens of Spanish voiced stops will be constricted to those that follow a vowel or non-nasal consonant [VV] and those that follow a break or a nasalized consonant [VC]. Tokens of /d/ that follow /l/ are also included in the VC count. The matched groups of tokens of English voiced stops will be constricted to those that follow a vowel [VV] and those that do not [VC]. Tokens appearing in cognate words were not included in the analysis.

Following data collection, factors such as language used, stress, location within the word, and place of articulation will be analyzed to discern any effects they may have on the overall and individual productions of VOT and intensity ratio. Various factors including BLP score showing language dominance, highest level of education completed, age of exposure, and amount of exposure will also be considered to determine their effect on individual sound production. Amount of exposure will be further divided into two categories: time spent using English in a work or school setting, and time spent using English with friends. A positive BLP score will show Spanish dominance while a negative score will show English dominance.

II. Methodology

2.1 | Participants

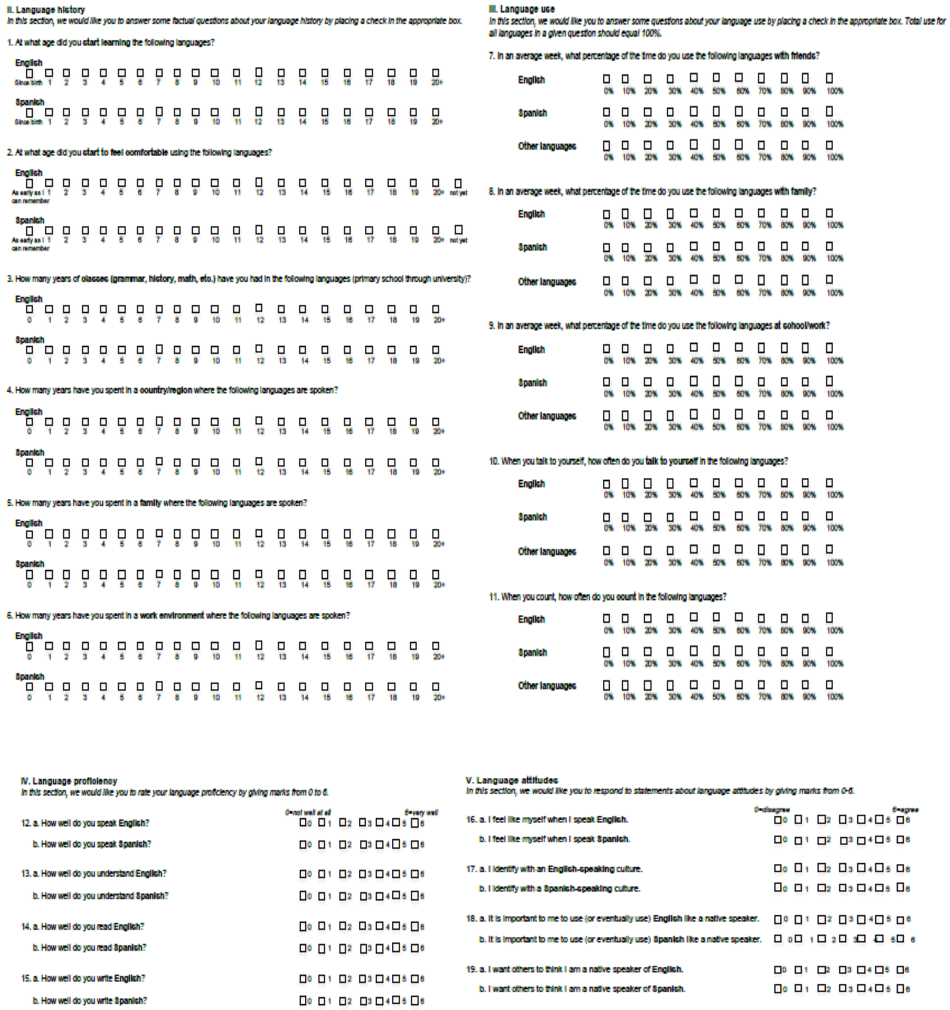
Four men and two women [P1-P6] currently living within the Columbus, Ohio speech community were recruited from outside the university. All participants are Heritage speakers of Spanish and are considered fluent speakers of English, having begun their study at an average age of 5.5 and becoming fully comfortable using English by the average age of 8.5. The two women and one of the men were born in Ohio, while the remaining men were born outside of the US and immigrated with their families by the age of 8. Participants had a variety of heritage backgrounds, coming from Mexico, Puerto Rico, Honduras, and Colombia. The two women, Participants 1 and 4, interact with one another on a daily basis at their place of employment. Two of the men, Participants 2 and 5, interact weekly at their place of employment. The two remaining men, Participants 3 and 6, are unknown to the other speakers or each other and come from independant speech communities within Columbus. Ages vary from late teens to late thirties. All speakers have no history of any speech delays or impairments. Participants are ordered by their BLP score, Participant 1, the only English dominant speaker, and Participants 2-6, Spanish dominant speakers being listed from the least Spanish dominant, Participant 2, to the most Spanish dominant, Participant 6. (Table 1)

Speaker	BLP	Age	Sex	Education Level	Age of Exposure	% of English Use at Work/School	% of English Use with Friends
P1	-4.09	26	Female	Associate's	5	50	50
P2	2.27	19	Male	High School	5	50	20
P3	8.17	39	Male	Master's	3	85	15
P4	16.35	27	Female	Some College	5	70	90
P5	28.61	25	Male	High School	7	95	90
P6	48.12	26	Male	Bachelor's	8	50	30

Table 1. Participant Data Table

2.2 | Materials

Speech data was collected using an Acer Chromebook R11 and a USB headset. The program *Easy Voice Recorder* made by Digipom was used to record speech. Researcher and participants met in a quiet room to collect clear audio. Speakers were first orally interviewed in Spanish to collect their background data as well as collect their answers for the BLP questionnaire. (Fig 1) Upon completion, participants were fitted with the headset, given the chromebook with the digital recorder running, and shown a Google Slides presentation. (Fig 2) Various images were selected to prompt commonly occuring words to fulfill each category requirement: WI, /p,t,k/ in word initial environments; IV, /p,t,k/ in intervocalic environments; VV, Spanish /b,d,g/ following a vowel or non-nasal consonant and English /b,d,g/ following a vowel; and VC, Spanish /b/ or /g/ following a pause or nasal, Spanish /d/ following a pause, nasal or /l/, and English /b,d,g/ following a pause. (Table 2)



II. Language history

In this section, we would like you to answer some factual questions about your language history by placing a check in the appropriate box.

1. At what age did you **start learning** the following languages?

English: Since birth 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

Spanish: Since birth 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

2. At what age did you **start to feel comfortable** using the following languages?

English: As early as I can remember 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+ not yet

Spanish: As early as I can remember 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+ not yet

3. How many years of **classes (grammar, history, math, etc.)** have you had in the following languages (primary school through university)?

English: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

Spanish: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

4. How many years have you spent in a **country/region** where the following languages are spoken?

English: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

Spanish: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

5. How many years have you spent in a **family** where the following languages are spoken?

English: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

Spanish: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

6. How many years have you spent in a **work environment** where the following languages are spoken?

English: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

Spanish: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

III. Language use

In this section, we would like you to answer some questions about your language use by placing a check in the appropriate box. Total use for all languages in a given question should equal 100%.

7. In an average week, what percentage of the time do you use the following languages **with friends**?

English: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Spanish: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Other languages: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. In an average week, what percentage of the time do you use the following languages **with family**?

English: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Spanish: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Other languages: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. In an average week, what percentage of the time do you use the following languages **at school/work**?

English: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Spanish: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Other languages: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. When you talk to yourself, how often do you **talk to yourself** in the following languages?

English: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Spanish: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Other languages: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

11. When you count, how often do you **count** in the following languages?

English: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Spanish: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Other languages: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

IV. Language proficiency

In this section, we would like you to rate your language proficiency by giving marks from 0 to 6.

(0=not well at all … 6=very well)

12. a. How well do you speak **English**? 0 1 2 3 4 5 6

b. How well do you speak **Spanish**? 0 1 2 3 4 5 6

13. a. How well do you understand **English**? 0 1 2 3 4 5 6

b. How well do you understand **Spanish**? 0 1 2 3 4 5 6

14. a. How well do you read **English**? 0 1 2 3 4 5 6

b. How well do you read **Spanish**? 0 1 2 3 4 5 6

15. a. How well do you write **English**? 0 1 2 3 4 5 6

b. How well do you write **Spanish**? 0 1 2 3 4 5 6

V. Language attitudes

In this section, we would like you to respond to statements about language attitudes by giving marks from 0-6.

(0=disagree … 6=agree)

16. a. I feel like myself when I speak **English**. 0 1 2 3 4 5 6

b. I feel like myself when I speak **Spanish**. 0 1 2 3 4 5 6

17. a. I identify with an **English-speaking** culture. 0 1 2 3 4 5 6

b. I identify with a **Spanish-speaking** culture. 0 1 2 3 4 5 6

18. a. It is important to me to use (or eventually use) **English** like a native speaker. 0 1 2 3 4 5 6

b. It is important to me to use (or eventually use) **Spanish** like a native speaker. 0 1 2 3 4 5 6

19. a. I want others to think I am a native speaker of **English**. 0 1 2 3 4 5 6

b. I want others to think I am a native speaker of **Spanish**. 0 1 2 3 4 5 6

Figure 1. BLP Questionnaire

Figure 2. Google Slides Presentation

Spanish Words		English Words	
Abogado	**Gato**	**Alphabet**	**Goat**
Aguacate	**Gobierno**	**Bagel**	**Gun**
Boca	**Jabón**	**Boy**	**Hotel**
Boda	**Pato**	**Body**	**Paper**
Caballo	**Pera**	**Cabin**	**Potato**
Casa	**Perro**	**Cake**	**Puppet**
Diente	**Tambor**	**Cookie**	**Rabbit**
Dinero	**Tenedor**	**Cracker**	**Soccer**
Equipo	**Tocino**	**Dad**	**Teapot**
Gallina	**Queso**	**Dancer**	**Tornado**
	Zapato	**Dog**	**Wagon**

Table 2. Prompt Words

Cognates were not included to avoid phonological interference. Participants were asked to create nine short stories utilizing all of the images appearing on each slide. In order to avoid any bias from the amount of English they had already spoken that day, speakers were first asked to create stories in Spanish for the first five slides, followed immediately by four stories in English for the remaining slides. Two prompt slides were included in the slideshow to visually confirm which language the speakers were to be using.

2.3 | Data Analysis

Following collection, speech data was converted to a .wav file and uploaded into Praat for analysis. Tokens of /p,t,k/ had their VOT measured from from the initial burst of the sound to the onset of the following vowel. (Fig 3) Tokens of /b,d,g/ had boundaries marked for both the token and the following vowel. The lowest intensity measurement, which is shown as a yellow line on top of the spectrogram, was taken from the consonant and the highest intensity measurement was taken from the following vowel. (Fig 4) Each token was also marked to note the manner of articulation (stop, flap, approximant) and surrounding environment. Measurements were pulled from Praat .textgrid files using a script and organized into a Google Sheets document where pivot tables were used to descriptively analyze observed patterns. Linear regression was also used to determine whether there were any statistically significant effects of language, stress, word location, and place of articulation on VOT and intensity ratio. The R Project for Statistical Computing was used to complete the statistical analysis.

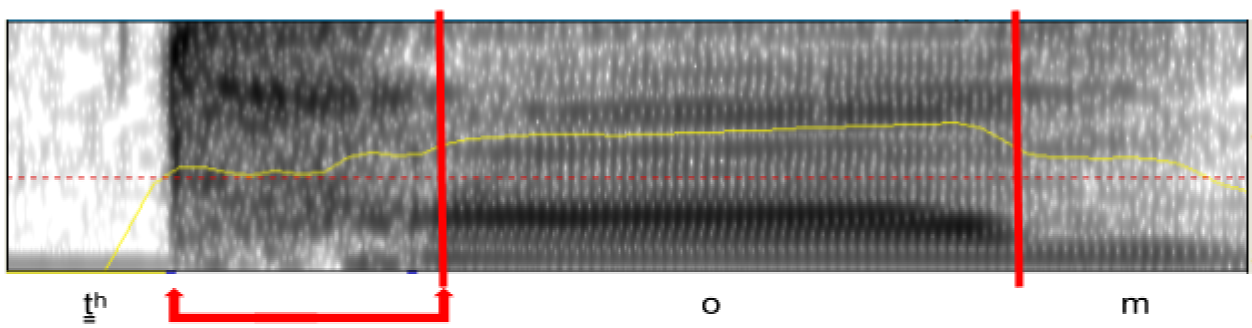


Figure 3. Spectrogram of [t̪ʰom]

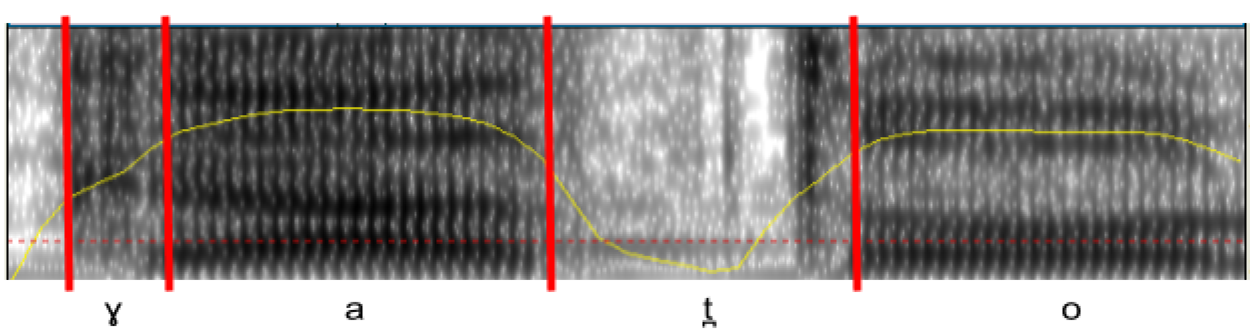


Figure 4. Spectrogram of [ɣat̪o]

III. Results

3.1 | Voiceless Sounds

3.1.1 | Linguistic Factors

735 tokens of /p,t,k/ were measured and included in the data count. A statistically significant difference was found between the English and Spanish productions. As can be seen in table 3, English was found to have an overall longer average VOT, 58.25ms, than Spanish which measured at 31.16ms. Tokens were further analyzed by point of articulation. Significant differences were found for all three Spanish/English sound pairs. In English, /t/ was found to have the longest VOT at 71.18ms followed by /k/ at 61.29ms, then /p/ at 34.68ms. In Spanish, /k/ was found to have the longest VOT at 42.97ms, followed by /t/ at 27.58ms, then /p/ at 19.61. No significant differences were found between the productions of English /t/ and English /k/. In this data set, /t/ was found to have the largest difference in the VOT of Spanish and English voiceless sounds.

Language	*Phoneme*	Average VOT (ms)
English	/p/	34.68
	/t/	71.18
	/k/	61.29
English Overall VOT		58.25
Spanish	/p/	19.61
	/t/	27.58
	/k/	42.97
Spanish Overall VOT		31.16

Table 3. Average VOT of /p,t,k/ by Language

Stress was found to have a significant effect on English voiceless stops. As seen in table 4, English stops in stressed syllables were found to have a longer average VOT, measuring at 65.13ms, whereas those in unstressed syllables measured at 42.28ms. Stress was not found to have a significant effect on the VOT of Spanish voiceless stops as they measured at 30.04ms and 32.42ms for stressed and unstressed syllables respectively.

Language	*Stress*	Average VOT (ms)
English	unstressed	42.28
	stressed	65.13
Spanish	unstressed	32.42
	stressed	30.04

Table 4. Average VOT by Stress

Location within the word was found to have a significant effect on both English and Spanish voiceless stops, however the effect is greater on English stops. Shown in table 5, English word initial stops measured at 63.25ms while word medial measured 48.8ms. Spanish initial stops measured at 33.52ms while word medial stops measured at 27.03ms. This followed the expected pattern that word initial stops have a longer VOT than word medial stops in both languages. When further analyzed considering point of articulation, all sounds except for Spanish /p/ were found to follow the previously determined VOT pattern. Location was found to have no significant difference effect on Spanish /p/ was as word initial measured at 19.59ms while word medial measured 19.68ms.

Language	*Location*	Average VOT (ms)
English	word initial	63.25
	word medial	48.80
Spanish	word initial	33.52
	word medial	27.03

Table 5. Average VOT by Word Location

3.1.2 | Individual Speaker Analysis

When analyzing individual speaker data, shown in table 6, all speakers followed the pattern of /t/ having the largest difference in VOT seen in the overall measurements. Participant 1, the only English dominant speaker, was found to have the largest difference in the VOT of their Spanish and English productions. Participant 6, the speaker with the highest score of Spanish dominance, was found to have the smallest difference in VOT between their Spanish and English productions. In fact, Participant 6 is the only participant to have a longer VOT for a Spanish sound than an English sound, their English /p/ measuring at 21.39ms while their Spanish /p/ measured at 22.50ms, though this is a very minor difference. Participants 2, 3, and 4 smallest difference in VOT was found in their /p/ productions while Participants 1 and 5 smallest difference in VOT was found in their /k/ productions. Participant 4 was found to have the largest difference between their overall Spanish and English VOTs with a difference of 46.24ms, followed by Participant 5 with a difference of 35.62ms.

Language	*Phoneme*	*Speaker: BLP Score; Average VOT (ms)*					
		P1: -4.09	P2: 2.27	P3: 8.17	P4: 16.35	P5: 28.61	P6: 48.12
English	/p/	41.33	30.54	42.88	30.76	44.09	21.39
	/t/	98.21	52.95	81.19	53.79	88.30	55.62
	/k/	65.24	46.90	67.00	57.47	64.80	63.66
English Overall VOT		76.09	44.59	62.71	47.14	71.59	54.51
Spanish	/p/	18.58	14.21	17.46	18.27	23.18	22.50
	/t/	27.85	20.89	33.20	21.65	29.47	28.94
	/k/	38.72	27.60	46.21	31.20	52.73	52.88
Spanish Overall VOT		29.85	21.96	34.21	24.21	35.97	35.09
Difference in VOT		46.24	22.63	28.50	22.93	35.62	19.42

Table 6. Average VOT by speaker

As English stops are produced with a much longer VOT than Spanish stops, bilingual speakers who have more separate and distinct phonetic categories for their Spanish and English sounds would be expected to have a larger difference in the VOT of their Spanish and English productions. The more similar their VOT measurements, the more merged these categories have become. It is therefore expected that whatever sociolinguistic factor has the greatest effect on sound production would follow a pattern of most to least amount of difference in VOT measurements or vice-versa. The pattern shown below from largest to smallest difference in individual VOT productions is as follows: Participant 1 had the largest difference in VOT between their Spanish and English sounds, measuring at 46.24ms; Participant 5, 35.62ms; Participant 3 had a difference of 28.50ms; Participant 4, 22.93; Participant 2, 22.63ms; and finally Participant 6 with the smallest difference in the Spanish/English VOT measuring

19.42ms. This is the overall pattern which will be compared with sociolinguistic factors in order to determine whether or not any effect is found.

3.1.3 | Sociolinguistic Factors

The first factor considered for possible effect on a speaker's VOT was language dominance through their BLP score, hence why the Participants were named in order of this factor. It can easily be remembered that Participant 1 is the only English dominant speaker and Participants 2-6 are all Spanish dominant, becoming more dominant as the participant number goes up. As it has been shown that L2 has an effect on L1 stop production when the L2 has made the switch to the dominant language, it was expected that the more English dominant a speaker is, the longer their Spanish VOT would be (Kim, 2011). Speakers close to a true neutral BLP score of 0 were also expected to have the largest difference in their Spanish and English productions as their sound inventories for both languages would be the closest to monolingual speakers for either language (Birdsong, Gertken, & Amengual, 2012). This pattern was not closely observed in the data, shown in table 6. As the expected patterns were only minorly produced in participant data, it suggests that language dominance may have an effect on VOT production, but it may not be the most important factor.

Amount of education completed was next considered for its potential effect on speaker /p,t,k/ VOT. It was expected that should education have an effect on VOT, the more education a participant completed, the larger the difference between their Spanish and English productions would be as speakers would have more fully formed, monolingual like VOT categories. The less education a speaker had completed would therefore be expected to have smaller, more merged categories. The reverse of this could also be found and would still show a link between this factor and speaker VOT production. Using the information shown in table 18, no patterns nor similarities were observed in the data and it was determined that level of education did not have an effect on speaker VOT production.

Speaker	Education Level	Difference in VOT (ms)
P1	Associate’s	46.24
P5	High School	35.62
P3	Master’s	28.50
P4	Some College	22.93
P2	High School	22.63
P6	Bachelor’s	19.42

Table 18. VOT Differences by Level of Education

Age of exposure [AOE] was the next factor considered for its effects on VOT. It was expected that should AOE affect VOT production that the earlier a speaker was exposed to a language, the more monolingual-like, and therefore more separate, their VOT ranges would be as shown in several past completed studies (Flege, 1991; Singleton & Lengyel, 1995; Jackson, 2000). Shown in table 19, the expected patterns were only minorly produced in participant data, suggesting that AOE may have an effect on VOT production, but it may not be the most important factor.

Speaker	Age of Exposure	Difference in VOT (ms)
P1	5	46.24
P5	7	35.62
P3	3	28.50
P4	5	22.93
P2	5	22.63
P6	8	19.42

Table 19. VOT Differences by Age of Exposure

Time spent using English at work and school was then considered. It was expected that those who used English more in a work or school setting would have better formed independant phonetic categories and therefore would produce a larger difference in the VOT of their English and Spanish stops. This factor has not been considered in any past studies concerning Heritage stop production. As shown in table 20, the expected pattern was strongly produced in participant data, which suggests that the use of English at work/school does have an effect on VOT production and it may be the most important factor. Participant 1's deviation can be explained as they are the only English dominant speaker which has been shown to affect VOT (Kim, 2011).

Speaker	English Use at Work/School (% of time)	Difference in VOT (ms)
P1	50	46.24
P5	95	35.62
P3	85	28.50
P4	70	22.93
P2	50	22.63
P6	50	19.42

Table 20. VOT Differences by English Use at Work/School

The last factor considered for its effect on speaker VOT production was time spent using English with friends. It was expected that the more often a speaker used English with friends, the more distinct their categories would be, therefore having a larger difference between their English and Spanish productions. This factor has not been considered in any past studies concerning Heritage stop production. Shown in table 21, the expected patterns were only minorly produced in participant data, suggesting that the use of English with friends may have an effect on VOT production, but it may not be the most important factor.

Speaker	English Use with Friends (% of time)	Difference in VOT (ms)
P1	50	46.24
P5	90	35.62
P3	15	28.50
P4	90	22.93
P2	20	22.63
P6	30	19.42

Table 21. VOT Differences by English Use with Friends

3.2 | Voiced Sounds

3.2.1 | Linguistic Factors

488 tokens of /b,d,g/ were included in data count. Type of realization and the environments in which they appear were first analyzed before moving on to measure the effects of various factors on the C/V Ratio. As can be seen in table 7, the expected pattern of approximants occurring more often in Spanish than English was observed; approximants accounting for 75% of all voiced Spanish sounds. It is interesting to note that 23.63% of English voiced sounds appeared as approximants which was not expected as they are not a common occurrence in standard, monolingual English. As expected, flaps were only found in English and for this reason were not included in the following analyses.

Realization	English	Spanish
Approximants	23.63%	75.00%
Flap	12.64%	0%
Plosives	63.74%	25.00%

Table 7. Realization Frequency of /b,d,g/ by Language

Shown in table 8, when separated by point of articulation [ɣ] was found to be the most frequently occuring approximant in English, with 33.33% of all productions of /g/ appearing as an approximant. English /d/ appeared as an approximant the least, accounting for 22.92% of all tokens. No significant differences between points of articulation were found in the Spanish analysis as all three appeared as approximants nearly 75% of the time.

Phoneme	English		Spanish	
	Approximant	Plosive	Approximant	Plosive
/b/	25.00%	75.00%	75.63%	24.37%
/d/	22.92%	77.08%	74.78%	25.22%
/g/	33.33%	66.67%	74.32%	25.68%

Table 8. Realization Frequency by Point of Articulation

As expected, approximants appeared more often in Spanish independent of stress, however in both languages approximants appeared more often in unstressed positions as shown in table 9. Also as expected, plosives appeared more often in English speech independent of stress, and in both languages they were found to appear more often in stressed positions.

Stress	*Realization*	English	Spanish
Unstressed	Approximant	35.38%	84.35%
	Plosive	64.62%	15.65%
Unstressed Total		100%	100%
Stressed	Approximant	21.28%	66.46%
	Plosive	78.72%	33.54%
Stressed Total		100%	100%

Table 9. Realization Frequency by Stress

Table 10 shows the further analysis the effects of stress on realization separated by point of articulation, both Spanish and English [β,ɣ,ð] were found to appear more often in unstressed positions. Spanish [β] was the most commonly occuring approximant in unstressed positions appearing 88.64% of the time while English [β] occured the least frequent accounting for 29.41% of all English /b/ in unstressed environments. In stressed environments Spanish [ð] appeared the most frequent, accounting for 70% of all Spanish /d/ tokens while it appeared the least frequent in English, accounting for 15.38% of all tokens. Following the overall analysis, [ɣ] was the most frequently occuring English approximant in both stressed and unstressed environments, accounting for 24% and 42.31% of all tokens respectively.

Phoneme	*Stress*	English		Spanish	
		Approximant	Plosive	Approximant	Plosive
/b/	unstressed	29.41%	70.59%	88.64%	11.36%
	stressed	23.26%	76.74%	68.00%	32.00%
/d/	unstressed	31.82%	68.18%	80.00%	20.00%
	stressed	15.38%	84.62%	70.00%	30.00%
/g/	unstressed	42.31%	57.69%	85.42%	14.58%
	stressed	24.00%	76.00%	53.85%	46.15%

Table 10. Realization Frequency by Point of Articulation and Stress

Shown in table 11, location within the word was found to have a significant effect on realization as expected, with Spanish having more approximants appear in VV environments and English having more plosives appear in VC environments. In VV environments, 83.68% of Spanish tokens appeared as an approximant while only 44.23% of English tokens appeared as such. It is also interesting to note that 44.93% of Spanish tokens and 18.69% of English tokens in VC environments appeared as approximants. This was not expected as in monolingual speech stop consonants would appear in this environment. These patterns continued when further analyzed by point of articulation.

Location	*Realization*	English	Spanish
VC	Approximant	18.69%	44.93%
	Plosive	81.31%	55.07%
VC Total		100%	100%
VV	Approximant	44.23%	83.68%
	Plosive	55.77%	16.32%
VV Total		100%	100%

Table 11. Realization Frequency by Location

When analyzing the overall C/V intensity ratio, a significant difference was found between Spanish and English approximants. Table 12 shows that as expected, Spanish approximants had a higher intensity ratio than the English, .886 to .829, showing that Spanish produced weaker approximants. No significant difference was found in the intensity English and Spanish plosives, measuring at .824 and .822. As there is no difference between Spanish and English plosives, further analyses will only include approximants, except for the speaker analysis.

Realization	English	Spanish
Approximants	0.829	0.886
Plosives	0.824	0.822

Table 12. Overall Average C/V Intensity Ratio by Realization and Language

A significant difference was found between the Spanish/English approximant pairs, however no difference was found between English [β] and [ð] or Spanish [β] and [ð]. Shown in table 13, it is observed that overall English approximants appeared stronger than Spanish, English [β] measuring .850 to Spanish [β] .892, and English [ð] measuring .864 to Spanish [ð]

.895. [ɣ] was found to appear the strongest in both Spanish and English speech, measuring .863 and .788 respectively, as it was the place of articulation with the lowest ratio score in both languages.

Place of Articulation	English	Spanish
[β]	0.850	0.892
[ð]	0.864	0.895
[ɣ]	0.788	0.863

Table 13. Average C/V Intensity Ratio of [β,ð,ɣ]

Stress was found to have a significant effect on the intensity of both Spanish and English approximants, as both languages have stronger approximants in stressed positions. As shown in table 14, English approximants were found to have an intensity of .798 in stressed environments while unstressed environments had a measurement of .856. Spanish approximants were found to have an intensity of .869 in stressed environments while unstressed environments measured in at .901.

Realization	*Stress*	English	Spanish
Approximants	unstressed	0.856	0.901
	stressed	0.798	0.869

Table 14. Average C/V Intensity Ratio by Stress

Location within the word was also found to have a significant effect on the intensity of Spanish approximants as those in VC environments were found to be significantly stronger than those in VV environments, as can be seen in table 15. Spanish VC approximants had an intensity of .860 while Spanish VV approximants measured at .890. There was also a significant difference found in the intensity of English approximants as those in VC environments measured .809 while those in VV environments measured .847.

Realization	*Location*	English	Spanish
Approximants	VC	0.809	0.860
	VV	0.847	0.890

Table 15. Average C/V Intensity Ratio by Localization

3.2.2 | Individual Speaker Analysis

When analyzing individual speaker realization data, the same pattern observed in the overall realization count was found. As can be seen in table 16, it is interesting to note that Participants 1 and 4 had very low occurrences of approximants in their English speech, they accounted for 3.85% and 2.86% of their total English sounds respectively. For all other speakers, approximants accounted for at least 35% of their total English sounds. Participant 2 had the greatest occurrence of approximants in their English speech, appearing as 69.23% of all English sounds as well as was the only speaker who did not produce flaps in their English speech. It's interesting to note that the only English dominant speaker, Participant 1, has the lowest occurrence of approximants and highest occurance of plosives in their Spanish speech out of all speakers.

Language	*Realization*	*Speaker: BLP Score*					
		P1: -4.09	P2: 2.27	P3: 8.17	P4: 16.35	P5: 28.61	P6: 48.12
English	Approximants	3.85%	69.23%	35.48%	2.86%	45.45%	37.21%
	Plosives	96.15%	30.77%	64.52%	97.14%	54.55%	62.79%
English Total Count		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Spanish	Approximants	69.74%	81.82%	70.27%	86.96%	80.49%	71.43%
	Plosives	30.26%	18.18%	29.73%	13.04%	19.51%	28.57%
Spanish Total Count		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 16. Realization Frequency by Speaker

When analyzing the C/V intensity data by speaker, all participants were found to produce weaker approximants in their Spanish speech following the overall pattern. Shown in table 17, Participants 1 and 2 produced the weakest approximants overall, .922 and .891 for their Spanish approximants and .874 and .873 for their English approximants respectively. Their English approximants were produced at a similar intensity to the Spanish approximants produced by Participants 4, .873, and 5, .876. Participant 5 produced the strongest approximant overall, .763, for their English approximants. Participant 3 produced the strongest Spanish approximant with a ratio of .862. Following the overall pattern, Participants 1, 2, 4, and 6 produced no significant difference between their English and Spanish plosives. Participant 3 produced stronger English plosives, .758 to .862, while Participant 5 produced stronger Spanish plosives, .790 to .867.

		Speaker: BLP Score					
Language	*Realization*	P1: -4.09	P2: 2.27	P3: 8.17	P4: 16.35	P5: 28.61	P6: 48.12
English	Approximants	0.874	0.873	0.807	0.825	0.763	0.838
	Plosives	0.856	0.810	0.758	0.859	0.867	0.789
English Intensity Total		0.857	0.854	0.775	0.858	0.820	0.807
Spanish	Approximants	0.922	0.891	0.862	0.873	0.876	0.886
	Plosives	0.852	0.818	0.827	0.856	0.790	0.769
Spanish Intensity Total		0.901	0.878	0.852	0.871	0.859	0.852
Difference in Intensity		.044	.024	.077	.013	.039	.045

Table 17. Average C/V Intensity Ratio by Speaker

As English produces stronger voiced sounds than Spanish, bilingual speakers who have more separate and distinct phonetic categories for their Spanish and English sounds would be expected to have a larger difference in the intensity of their Spanish and English productions. The more similar their intensity measurements, the more merged these categories have become. It is therefore expected that whatever sociolinguistic factor has the greatest effect on sound production would follow a pattern of most to least amount of difference in intensity measurements or vice-versa. The pattern shown below from largest to smallest difference in individual intensity productions is as follows: Participant 3 had the largest difference in intensity between their Spanish and English sounds, measuring at .077; Participant 6 had a difference of .045; Participant 1, .044; Participant 5, .039; Participant 2, .024; and finally Participant 4 with the smallest difference in the Spanish/English VOT measuring .013. This is the overall pattern which will be compared with sociolinguistic factors in order to determine whether or not any effect is found.

3.2.3 | Sociolinguistic Factors

The first factor considered for possible effect on a speaker’s intensity was language dominance through their BLP score. As it has been shown that L2 has an effect on L1 stop production when the L2 has made the switch to the dominant language, it was expected that the more English dominant a speaker is, the stronger their Spanish approximants would be (Kim, 2011). Speakers close to a true neutral BLP score of 0 were also expected to have the largest difference in their Spanish and English productions as their sound inventories for both languages would be the closest to monolingual speakers for either language (Birdsong, Gertken, & Amengual, 2012). These patterns were not observed in the data, shown in table 17. As no patterns nor similarities were observed in the data it was determined that language dominance did not have an effect on speaker intensity.

Amount of education completed was next considered for its potential effect on speaker /b,d,g/ intensity. It was expected that should education have an effect on VOT, the more education a participant completed, the larger the difference between their Spanish and English productions would be as speakers would have more fully formed, monolingual like inventories. The less education a speaker had completed would therefore be expected to have smaller, more merged inventories. Using the information shown in table 22, except for Participant 4 this pattern was strongly produced in the data which suggests that level of education does have an effect on speaker intensity.

Speaker	Education Level	Difference in Intensity
P3	Master’s	.077
P6	Bachelor’s	.045
P1	Associate’s	.044
P5	High School	.039
P2	High School	.024
P4	Some College	.013

Table 22. Intensity Differences by Level of Education Completed

Age of exposure [AOE] was the next factor considered for its effects on intensity. It was expected that the earlier a speaker was exposed to a language, the more monolingual-like, and therefore more separate, their intensity ratios would be. Shown in table 23, a slight, opposite of the expected pattern was found. Except for Participants 3 and 5, the data shows that the younger a speaker was exposed to L2, the more merged their categories had become. As the pattern was only minorly produced in participant data, it suggests that AOE may have an effect on intensity, but it may not be the most important factor.

Speaker	Age of Exposure	Difference in Intensity
P3	3	.077
P6	8	.045
P1	5	.044
P5	7	.039
P2	5	.024
P4	5	.013

Table 23. Intensity Differences by Age of Exposure

Time spent using English at work and school was then considered. It was expected that those who used English more in a work or school setting would have better formed independant phonetic categories and therefore would produce a larger difference in the intensity of their English and Spanish stops. This factor has not been considered in any past studies concerning Heritage stop production. As shown in table 24, the expected pattern is only slightly produced in participant data, which suggests that the use of English at work/school may have an effect on intensity but it may not be the most important factor.

Speaker	English Use at Work/School (% of time)	Difference in Intensity
P3	85	.077
P6	50	.045
P1	50	.044
P5	95	.039
P2	50	.024
P4	70	.013

Table 24. Intensity Differences by English Use at Work/School

The last factor considered for its effect on speaker intensity was time spent using English with friends. It was expected that the more often a speaker used English with friends, the more distinct their categories would be, therefore having a larger difference in the intensity of their English and Spanish productions. This factor has not been considered in any past studies concerning Heritage stop production. Shown in table 25, the expected patterns conversely followed with the exception of Participant 2; that is to say that the less often a speaker used English with their friends, the larger the difference they have in the intensity of their voiced stops. This suggests that the amount of time spent using of English with friends does have an effect on intensity production.

Speaker	English Use with Friends (% of time)	Difference in Intensity
P3	15	.077
P6	30	.045
P1	50	.044
P5	90	.039
P2	20	.024
P4	90	.013

Table 25. Intensity Differences by English Use with Friends

Discussion

4.1 | Voiceless Stops

All participants produced distinct VOT categories for their English and Spanish stops confirming what has been previously seen in other studies (Brown & Copple, 2016). Participants did however produce different VOT durations for their English and Spanish data and seem to have several different categories that they fall into, but some factors were found to regularly influence how different those categories are. The data strongly suggests that the most important sociolinguistic factor in determining whether or not the a speaker's L1 and L2 VOT categories will be merged is the amount of time spent using English in a work/school environment. For all participants but one, the more often they used English, the larger difference they produced in their Spanish and English VOT. The amount of time spent using L2 with friends, BLP and AOE also produced patterns which suggest they may have an effect on VOT production, however more research into this topic is needed to make a clear determination. In this study, BLP and AOE both had very narrow ranges that could be improved upon by recruiting more participants. Education was determined to not have an effect on VOT.

In the linguistic feature analyses, both stress and token location were also found to have a significant effect on VOT production. This has been confirmed in previous studies and these features should be included in individual analyses as well to study how they interact with the investigated sociolinguistic features, however again due to the small sample size this was not possible (Amengual, 2011; Rao, 2015). Future studies should seek to include more participants as well as increase the amount of data collected from individual speakers to account for these additional factors.

4.2 | Voiced Stops

Participants seem to have distinct pronunciations for both Spanish and English voiced stops as they produce more approximants in their Spanish speech and more stops in their English. Participants also produce different intensities for their English and Spanish data and seem to have several categories they fall into, but some factors were found to regularly influence how different those categories are. The data strongly suggests that the most important factors in determining whether or not a speaker's L1 and L2 intensity categories will be merged is education level and time spent using L2 with friends. The more education a speaker had completed in English, the bigger the difference in the intensity of their Spanish and English production. Surprisingly, a converse pattern to that of VOT was found to link intensity and English use. The more time that was spent using English with friends, the more merged speaker intensity became; specifically the weaker their English sounds became, showing L1 interference as shown in past studies as well (Au et al., 2002). This could be due to the fact that the more often a speaker uses their L2 the more comfortable they become speaking, and therefore relaxing and allowing for interference. AOE and amount of time spent using English in a work/school environment were also found to have a minor effect on intensity. Once again, a converse pattern to that of VOT was found with AOE as the younger a speaker was exposed the more merged their intensity values were, once again specifically because their English stops were being weakened through L1 interference. No link was found with BLP.

Sociolinguistic factors were only analyzed for their effect on a speaker's overall intensity in each language, though as intensity varies depending on type of realization this should have been considered in the analyses as well. Future studies should seek to additionally include type of realization in their analyses concerning voiced stops. Additionally, both stress and location in a word were also found to have a significant effect on intensity in both this study and others, and future studies should seek to take these into account during individual analyses as well (Amengual, 2011; Rao, 2015). Again due to the small sample size, this was not possible to achieve in this study. Future studies should seek to include more participants as well as increase the amount of data collected from individual speakers to account for these additional factors.

Conclusion

Focusing on the Columbus, Ohio speech community has given insight into an under researched speech community, one that is a melting pot of different cultures and backgrounds. The participants, while spending a majority of their life here, come from many different countries, all of which produce their own dialects and linguistic features. It is interesting to see how speakers come together from various linguistic backgrounds to form the collective Columbus, Ohio Heritage Spanish speech community with distinct linguistic features, rather than focusing on speech communities which are built of speakers with the same linguistic background. Many Heritage speaker studies choose instead to focus on speech communities comprising speakers of a specific background, such as Puerto Rican, Mexican or Cuban, which doesn't allow us to observe how speakers from many differing backgrounds assimilate to the same local dialect of both languages (Schecter & Bayley, 2005; Ramos-Pellicia, 2007; Lipski, 2008; Torres & Potowski 2008; Alvord, 2010).

While some sociolinguistic factors were implicated to have a strong effect on speaker production of VOT and intensity, ultimately small participant size and small amounts of speech data collected from each participant left some to be desired. Rather than finding a key sociolinguistic factor which would affect both VOT and intensity in the same way as expected, several factors were found to have the opposite effect on voiced and voiceless stops which brings new questions to be explored, such as if language interference only affects one type of sounds. It is clear from the study results that L2 use in daily life, either at work/school or more informally with friends, has a medium to strong link to the production of both VOT and intensity and therefore future phonological studies should seek to include these factors in their analyses.

References

Achugar, M. (2008). Counter-Hegemonic Language Practices and Ideologies: Creating a New Space and Value for Spanish in Southwest Texas. *Spanish in Context*, *5*(1), 1–19. doi: 10.1075/sic.5.1.02ach

Alvord, S. M. (2010). Miami Cuban Spanish Declarative Intonation. *Studies in Hispanic and Lusophone Linguistics*, *3*(1). doi: 10.1515/shll-2010-1064

Au, T. K.-F., Knightly, L. M., Jun, S.-A., & Oh, J. S. (2002). Overhearing a Language During Childhood. *Psychological Science*, *13*(3), 238–243. doi: 10.1111/1467-9280.00444

Balukas, C., & Koops, C. (2014). Spanish-English bilingual voice onset time in spontaneous code-switching. *International Journal of Bilingualism*, *19*(4), 423–443. doi: 10.1177/1367006913516035

Beaudrie, S., & Fairclough, M. (2012). Spanish as a Heritage Language in the United States. *Georgetown Studies in Spanish Linguistics*.

Briere, E. J. (1966). An Investigation of Phonological Interference. *Language*, *42*(4), 768. doi: 10.2307/411832

Cashman, H. (2009). The dynamics of Spanish maintenance and shift in Arizona: Ethnolinguistic vitality, language panic and language pride. *Spanish Maintenance and Loss in the U.S. Southwest Spanish in Context*, *6*(1), 43–68. doi: 10.1075/sic.6.1.04cas

Chomsky, N. (1981). Knowledge of Language: Its Elements and Origins. *Philosophical Transactions of the Royal Society of London. B, Biological Sciences*, *295*(1077), 223–234. doi: 10.1098/rstb.1981.0135

Crain, S., & Lillo-Martin, D. (1999). *An Introduction to Linguistic Theory and Language Acquisition*. Malden: Blackwell Publisher.

Data USA. (2018). Columbus, OH. Retrieved from https://datausa.io/profile/geo/columbus-oh/#demographics

Deusen-Scholl, N. V. (2003). Toward a Definition of Heritage Language: Sociopolitical and Pedagogical Considerations. *Journal of Language, Identity & Education*, *2*(3), 211–230. doi: 10.1207/s15327701jlie0203_4

Eberhard, D., Simons, G., & Fennig, C. (2019). Languages of the World. Retrieved from http://www.ethnologue.com/

Flege, J. E., & Hillenbrand, J. (1984). Limits on Phonetic Accuracy in Foreign Language Speech Production. *The Journal of the Acoustical Society of America*, *76*(3), 708–721. doi: 10.1121/1.391257

Flege, J. E. (1991). Age of learning affects the authenticity of voice-onset time (VOT) in stop consonants produced in a second language. *The Journal of the Acoustical Society of America*, *89*(1), 395–411. doi: 10.1121/1.400473

García, M. (2003). Recent Research On Language Maintenance. *Annual Review of Applied Linguistics*, *23*, 22–43. doi: 10.1017/s0267190503000175

González, N. (2001). I Am My Language: Discourses of Women and Children in the Borderlands. *Tucson: University of Arizona Press*.

Haugen, E., & Weinreich, U. (1954). Languages in Contact: Findings and Problems. *Language*, *30*(3), 380. doi: 10.2307/410136

Helmer, K. (2011). 'Proper' Spanish is a Waste of Time”: Mexican-Origin Student Resistance to Learning Spanish as a Heritage Language. *Culturally Relevant Pedagogy*, 135–163.

Kondo-Brown, K. (2010). Curriculum Development for Advancing Heritage Language Competence: Recent Research, Current Practices, and a Future Agenda. *Annual Review of Applied Linguistics*, *30*, 24–41. doi: 10.1017/s0267190510000012

Lado, R. (1956). A Comparison of the Sound Systems of English and Spanish. *Hispania*, *39*(1), 26. doi: 10.2307/335188

Langdon, H., & Merino, B. (1992). Acquisition and Development of a Second Language in the Spanish Speaker. *Hispanic Children and Adults with Communication Disorders: Assessment and Intervention*.

Lipski, J. M. (2008). *Varieties of Spanish in the United States*. Washington, DC: Georgetown Univ. Press.

Lipski, J. M. (2008). *Varieties of Spanish in the United States*. Washington, DC: Georgetown Univ. Press.

Lunde, M. P. (2015). Voice Onset Timing in the English of Spanish Heritage Speakers. *Interacción*, *14*, 17–26. doi: 10.18041/1657-7531/interaccion.0.2334

Mikulski, A. M. (2010). Receptive Volitional Subjunctive Abilities in Heritage and Traditional Foreign Language Learners of Spanish. *The Modern Language Journal*, *94*(2), 217–233. doi: 10.1111/j.1540-4781.2010.01018.x

Montrul, S. (2002). Incomplete acquisition and attrition of Spanish tense/aspect distinctions in adult bilinguals. *Bilingualism: Language and Cognition*, *5*(01). doi: 10.1017/s1366728902000135

Montrul, S. A. (2007). Interpreting Mood Distinctions in Spanish as a Heritage Language. *Spanish in Contact IMPACT: Studies in Language and Society*, 23–40. doi: 10.1075/impact.22.04mon

Montrul, S. (2009). Knowledge of tense-aspect and mood in Spanish heritage speakers. *International Journal of Bilingualism*, *13*(2), 239–269. doi: 10.1177/1367006909339816

Porcel, J. (2006). The Paradox of Spanish among Miami Cubans. *John Wiley & Sons*, *10*(1).

Potowski, K. (2004). Spanish Language Shift in Chicago. *Southwest Journal of Linguistics*.

Potowski, K. (2009). Forms and Functions of Codeswitching by Dual Immersion Students: A Comparison of Heritage Speaker and L2 Children. *First Language Use in Second and Foreign Language Learning*, 87–114. doi: 10.21832/9781847691972-008

Potowski, K., Jegerski, J., & Morgan-Short, K. (2009). The Effects of Instruction on Linguistic Development in Spanish Heritage Language Speakers. *Language Learning*, *59*(3), 537–579. doi: 10.1111/j.1467-9922.2009.00517.x

Ramos-Pellicia, M. (2007). Lorain Puerto Rican Spanish and 'r' in Three Generations. *Selected Proceedings of the Third Workshop on Spanish Sociolinguistics*, 53–60.

Rao, R., & Kuder, E. (2016). Investigaciones sobre la fonética y la fonología del español como lengua de herencia: implicaciones pedagógicas y curriculares. *Journal of New Approaches in Educational Research*, *5*(2), 99–106. doi: 10.7821/naer.2016.7.171

Rúa, M. (2001). Colao Subjectivities: PortoMex and MexiRican Perspectives on Language and Identity. *Centro Journal*, *13*(2), 117–133.

Schecter, S. R., & Bayley, R. J. (2005). *Language as Cultural Practice Mexicanos en el Norte*. Taylor and Francis.

Torres, L., & Potowski, K. (2008). A comparative study of bilingual discourse markers in Chicago Mexican, Puerto Rican, and MexiRican Spanish. *International Journal of Bilingualism*, *12*(4), 263–279. doi: 10.1177/1367006908098571

Universidad de Sevilla. (2019). Allophonic Variants of English Stops. Retrieved from http://www.siff.us.es/fil/publicaciones/apuntes/teresals/apartado 9-0.pdf

US Census Bureau. (2010). Decennial Census Datasets. Retrieved from https://www.census.gov/programs-surveys/decennial-census/data/datasets.2010.html

Valdés, G. (2000). Bilingualism and Language Use Among Mexican Americans. *New Immigrants in the United States*, *99136*.

Velázquez, I. (2009). Intergenerational Spanish transmission in El Paso, Texas: Parental perceptions of cost/benefit. *Spanish Maintenance and Loss in the U.S. Southwest Spanish in Context*, *6*(1), 69–84. doi: 10.1075/sic.6.1.05vel

Villa, D., & Rivera-Mills, S. (2009). An Integrated Multi-Generational Model for Language Maintenance and Shift: The Case of Spanish in the Southwest. *Spanish in Context*, *6*(1), 26–42. doi: 10.1075/sic.6.1.03vil

Wolff, H. (1950). Comparative Siouan II. *International Journal of American Linguistics*, *16*(3), 113–121. doi: 10.1086/464065