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ABSTRACT

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For adult learners of a second language, the similarities and differences in acoustic properties between their native language and the language they are learning can affect how they perceive the sounds of the new language. How learners perceive these acoustic properties will directly affect their ability to communicate. According to the Perceptual Assimilation Model (PAM) (Best 1995), learners will perceive the sounds of a language that is new to them based on how similar or different the sounds are from the learner's native language. Between the English and Spanish language, there are some sounds that share acoustic properties and others that show contrast. Such is the case with the stop consonants /p/, /t/, /k/, /b/, /d/, and /g/. These consonants exist in both Spanish and English, and though they are similar, there are important differences in how they should be perceived and produced. Despite the differences, these sounds are likely to be confused by L2 learners due to similarity in acoustic cues. This study will use Best's Perceptual Assimilation Model (PAM) as a framework. It will test the L2 perception of native English-speaking adults who are L2 learners of Spanish, have spent between 18 and 24 months speaking the target language as Latter-day Saint (LDS or Mormon) missionaries in the United States, and who are also currently university students enrolled in an upper-level Spanish course. It will focus on their perception of the acoustic cue of Voice Onset Time (VOT) of stop consonants.

Keywords: perceptual assimilation model, voice onset time

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CHAPTER 1

Introduction

For someone to adequately acquire a second language, he or she must be able to perceive the different sounds in that language and identify their relation to each other, so they can have meaning. All speakers possess mechanisms for perceiving and producing sounds in their native language, and native language abilities are specifically tied to the properties of that language. According to some studies, the ability to correctly perceive L2 (second language) sounds and to pronounce them are closely connected (Ingham, 2014; Munro, 2008; Rosenman, 1987). Thus, for adult learners of a second language, the differences in the acoustic properties between the sounds in their L1 (native language) and L2 language can affect their perception of L2 sounds. According to the Perceptual Assimilation Model (PAM) (Best, 1995), learners will perceive sounds that are new to them based on how similar or different they are from the learner's native language. For L2 learners, L1 and L2 sounds that are more similar to each other are harder to differentiate between than L1 and L2 sounds that are more obviously different (Major, 2001).

Between the English and Spanish languages, there are many sounds with shared acoustic properties, but that still have important differences. The stop consonants /p/, /t/, /k/, /b/, /d/, and /g/ share considerable similarities between Spanish and English but are not exactly the same. The difference lies in the acoustic cue of Voice Onset Time (VOT), which measures the amount of time between the vibration of the vocal folds and the release of air. Consequently, some of the sounds that are represented differently between the two languages (/b d g/ in English, /p t k/ in Spanish, respectively) share similar VOT's. Due to the characteristics shared between them, some of these sounds are likely to sound the same or very similar to L2 learners. Testing students' perception of Spanish (L2) stop consonants will allow for an analysis of their language

development and the effect that their learning experience and their native language have had on their L2 abilities.

This study uses Best's Perceptual Assimilation Model (PAM) as a theoretical framework. It focuses on native English-speaking adults who are L2 learners of Spanish, have spent between 16 and 24 months as religious missionaries speaking the target language, and who are also currently university students enrolled in an upper-level Spanish course. Although many religious missionaries learn a foreign language while living in a country where that language is the majority language, the participants in this study were missionaries in their country of origin, the United States. Learning Spanish and communicating with native Spanish-speakers was an assigned part of their missionary experience. Their language learning experience as missionaries will be referred to as an "extended partial immersion experience". The other group in this study did not receive the extended partial immersion experience but were taking the same course as the first group at the time this study was performed. Rather than an immersive experience, their previous Spanish language learning consisted primarily of classroom instruction. While some research has already been done on the language proficiency of Latter-day Saint (LDS) missionaries with extended time abroad (e.g., Crane, 2011; Dewey & Clifford, 2012; Kirk, 2014), no study has focused on the L2 perception of LDS missionaries who learned Spanish while still in the United States. This study will focus on both groups' perception of the acoustic cue of Voice Onset Time (VOT) of L2 stop consonants with single Spanish words in word initial position.

Research Questions

The research questions concerning this study are as follows:

1. To what extent are native English-speaking learners of Spanish with an extended partial immersion experience able to perceive the voicing contrast between voiced and voiceless stops in Spanish?
2. In Spanish, where is the VOT value cutoff at which L2 learners can perceive a stop as voiced or voiceless?
3. Is there a significant difference between the perception of voicing contrast in L2 Spanish stop consonants of students with an extended partial immersion experience outside the classroom and those with only a classroom language learning experience?

The expectation is that, based on the PAM, the native language of the participants will have a significant effect on their perception of non-native sounds. Nevertheless, it is still expected that their perception of L2 consonants will be relatively close to the assumed native Spanish speaker level of consonant perception (using average native Spanish VOT production values), based on the participants' previous experience with the language. It is also expected that the participants with an extended partial immersion experience, due to having more exposure to Spanish, will perceive VOT at a more native-like level than those who simply took Spanish courses.

CHAPTER 2

Review of the Literature

Stop Consonants

Sounds represented as /p/, /t/, /k/, /b/, /d/, and /g/ exist in both Spanish and English. The sounds are referred to as "stops" because they are characterized by an obstruction of airflow at some point on the vocal tract. One way in which the mentioned stops can be categorized is based on place of articulation. This indicator tells how articulatory organs such as the tongue and lips are positioned in order to produce the sound. In Spanish, /p/ and /b/ are both bilabial, /t/ and /d/ are dental, and /k/ and /g/ are velar (Alba, 2001; Yavas, 2006). Spanish has two versions of the phonemes /b d g/. There is an occlusive version that is produced with a total closure [b, d, g], which occurs after a pause or a nasal. There is also an approximant allophone [β, ð, ɣ] for each, which is produced instead of the occlusive in all other phonetic contexts (Yavas, 2006). Approximants allow some air to pass through, unlike occlusives, which are caused by a complete closure. The phonetic context used in this study for Spanish stops is at word initial position after a pause, so the focus of this study will be limited to the occlusive variant of each of these phonemes.

According to Yavas (2006), some of the mentioned stops have different allophonic distributions in English than they do in Spanish. English /b/ and /p/, as in Spanish, are bilabial occlusives. In contrast to Spanish, English /t/ and /d/ are apico-alveolar occlusive stops. English /k/ and /g/ are similar to Spanish in that they are velar (Carr, 2012) and that the exact place of articulation can vary depending on the surrounding vowel sounds.

Voicing Contrast and Voice Onset Time

According to Caramazza et al (1973), /p t k/ can be distinguished from /b d g/ in English on the basis of voicing and aspiration. “Voicing” refers to the vibration of the vocal folds, which occurs with the sounds /b d g/ in Spanish, while there is an absence of voicing in the Spanish sounds /p t k/. In this realm, the aspiration of stops is what differentiates English from Spanish. “Aspiration” is defined as a “stronger puff of air” (Carr, 2012). According to Hualde (2005), when /p t k/ appear at word-initial or syllable onset position in English, aspiration occurs.

Before 1964, researchers distinguished between groups of stops like /b d g/ and /p t k/ by the articulatory force (or lack thereof) exerted by the speaker, the presence or absence of aspiration, or by the presence or absence of a glottal buzz (Lisker & Abramson, 1964). The voicing distinction alone was not enough to classify the actual difference between the sounds. In an attempt to more accurately classify stops, Lisker and Abramson (1964) introduced the measurement of VOT, which they described as the “interval between the release of the stop and the onset of glottal vibration.” The data provided in their study proved VOT to be a “sufficient acoustic differentiator” and the most reliable metric by which to distinguish between voiced and voiceless stops in any language.

Zampini (2008) refers to VOT as the time that elapses between the release of obstructed airflow (release burst) and the beginning of the vibration of the vocal folds (voicing). Figure 1 is a visual representation of the waveform of a voiceless stop, showing the point on the soundwave at which VOT occurs. The described VOT measurement is the space between where air is released (release burst) and where the vibration of the vocal folds begins (from Zampini & Green, 2001).

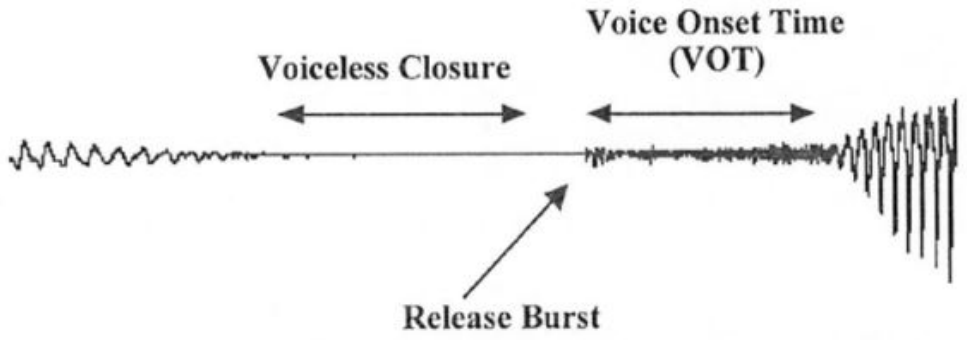


Figure 1. Waveform representation of a stop consonant. Adapted from Zampini & Green, 2001.

Voice Onset Time of English and Spanish Stops

The VOT of a stop can be categorized as either pre-voiced, short-lag, or long-lag, depending on if the vibration of the vocal folds begins before the release burst of air (pre-voiced), less than 30 milliseconds after (short-lag), or more than 30 milliseconds after (long-lag). The aforementioned aspiration of English stops is what causes them to be long-lag. These categories are visible in the following diagram from Zampini, Clark and Green (2000), which illustrates the differences and similarities between the VOT's of English and Spanish stops.

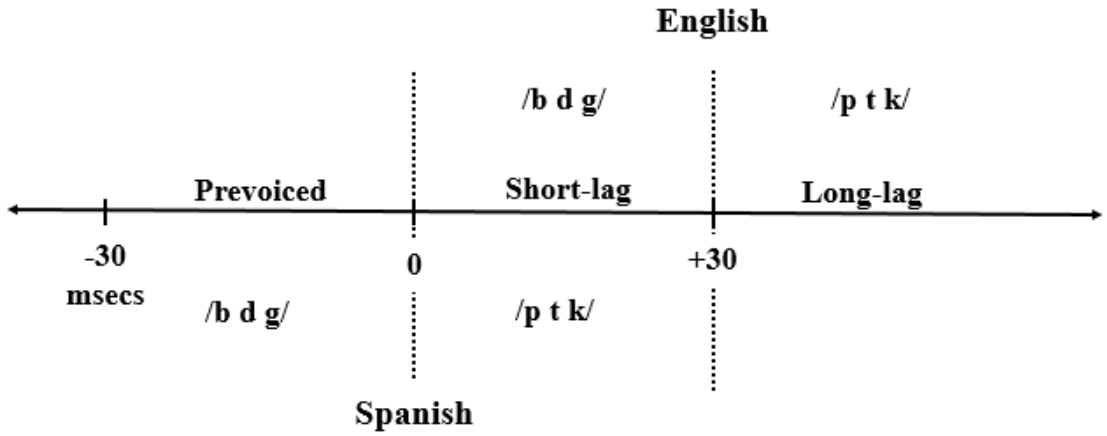


Figure 2. Different categories of VOT of English and Spanish stops. Adapted from Zampini, Clark & Green (2000).

Lisker and Abramson (1964) studied VOT's in eleven different languages and recorded averages of speakers of each language in their study. Their American English language results, combined with those of Castilian Spanish from Castañeda Vicente (1986), fall into the categories in Figure 2. Spanish voiced stops are pre-voiced, also referred to as having "voicing lead," which makes their VOT values negative: /b/ = -69.8 ms, /d/ = -77.7 ms, /g/ = -58 ms. Voiceless stops in Spanish are short-lag, having values of less than 30 milliseconds: /p/ = 6.5 ms, /t/ = 10.4 ms, /k/ = 25.7 ms (Lisker & Abramson 1964). The VOT values from both studies mentioned here are averages based on a small sample size and are not exact. They are being used to give an idea of what typical VOT values might be for the two languages.

As seen in Figure 2, the VOT's of English stop consonants are positive values, meaning that the beginning of the vibration of the vocal folds occurs after the release burst of air. Voiced stop consonants in English are short-lag, with values of less than 30 milliseconds: /b/ = 1 ms, /d/ = 5 ms, /g/ = 21 ms. Voiceless stops in English yield the highest VOT values in Spanish or English, with long-lag values over 30ms: /p/ = 58 ms, /t/ = 70 ms, /k/ = 80 ms.

Phonetic Factors Affecting VOT

As Blumstein et al. (1980) explain, the actual VOT of a consonant sound will vary based on place of articulation. There is an observed tendency that stop consonants whose points of articulation are further back in the mouth will have longer VOT's (Banov, 2014; Castañeda Vicente, 1986; Lisker & Abramson, 1964). Due to assimilation in both Spanish and English, the place of articulation of velar stops will vary depending on the surrounding sounds. Additionally, while most stops with voicing contrast have roughly the same place of articulation in English and Spanish (/p/ and /b/ are bilabial; /k/ and /g/ are velar), the stop consonants /t/ and /d/ have a different place of articulation in English (alveolar) than they do in Spanish (dental). Some studies have mentioned that VOT differences may be due to the lips and tip of the tongue moving faster than the back of the tongue, which may be due to differences in size and weight of the different parts of the tongue or the tongues of different speakers (Cho & Ladefoged, 1999; Hardcastle, 1973; Kuehn & Moll, 1976).

Speaking rate has been found to have an effect on stops (Boucher, 2002; Magloire & Green, 1999; Schmidt & Flege, 1996), but only on the production of stops. This study controls for that factor by keeping the rate of speech constant. This was done by using the same audio clip as the base for all of the stimuli within each of the three perception tests.

L2 Perception and the Perceptual Assimilation Model

Best (1995) explains that all gestural constellations, in this case speech sounds, draw from the same possibilities of the human vocal tract, or universal phonetic domain. Therefore, overlap is likely to occur between languages at the segmental level, as is the case in this study. While there is a clear contrast between the VOT's of Spanish /b d g/ and English /p t k/, there is

an overlap point at which English /b d g/ and Spanish /p t k/ all have short-lag VOT's. Under the assumption that a sound must be perceived at a native level before it can be pronounced at a native level, this similarity can pose a challenge to speakers of either language who attempt to learn the other (Best, 1995; Best, McRoberts, & Goodell, 2001; Flege, 1987; Flege & Eefting, 1989). The focus of this study is the effect that L1 perception can have for L2 learners of Spanish who are native speakers of English. The PAM predicts how the differences will be perceived by learners.

The Perceptual Assimilation Model (PAM) of cross-language speech perception posits that non-native segments are likely to be perceived based on how similar or different they are in relation to the native phonological system (Best, 1995; Best, McRoberts & Goodell, 2001). The PAM predicts three different kinds of assimilation, or interpretation, of L2 sounds: "Assimilated to a native category, assimilated as uncategorizable speech sound, and not assimilated to speech (nonspeech sound)" (Best, 1995, p. 195). Speaking of what can be assimilated to a native category in this model, Best says, "A good exemplar of that category, an acceptable but not ideal exemplar of the category, or a notably deviant exemplar of the category" (Best, 1995, p. 194).. It is reasonable to assume that for a native speaker of English, a Spanish language stop would fall under one of those descriptions for the category of stop consonants. For example, due to similarities in VOT, a Spanish /p/ would sound very similar to an English /b/ to a native English speaker. The speaker would assimilate the Spanish /p/ to the abstract perceptual category in their mind to which English /b/ belongs.

Numerous studies have tested listeners' categorization of L2 stimuli. Some studies, or at least part of the studies' results, found the PAM to be an accurate predictor of L2 learners assimilation of sounds (e.g., Best, McRoberts & Goodell, 2001; Flege, 1987; Francis, Ciocca &

Ng, 2003; Harnsberger, 2001; Polka, 1991; Zampini, 1994), while others showed results that suggest the categorization of L2 sounds is not necessarily congruent with PAM (Faris, Best & Tyler, 2016; Flege & Eefting, 1988).

In addition to the PAM, Flege's Speech Learning Model (SLM) several other theories also suggest that the same mechanisms that are used by a speaker to perceive L1 sounds can be used to perceive L2 sounds (Flege, 1995; Major, 2001). Flege's SLM hypothesizes that L1 and L2 sounds are related to each other on a position-sensitive allophonic level rather than an abstract phonemic level. It also predicts that bilinguals can form a new L2 category if they are able to discern the difference between the closest L1 sound. Another similar model that relates to this study is Major's Ontogeny Phylogeny Model (2001), which predicts that similar language phenomena will be acquired more slowly than dissimilar phenomena. Major's model is tested by measuring pronunciation of L2 learners. According to Flege, the SLM is more concerned with the attainment of L2 pronunciation and focuses primarily on bilinguals who have spoken the language for several years. Despite the theoretical similarities—for example, the shared idea of "equivalence classification"—shared with Major's and Flege's models, Best's Perceptual Assimilation Model more adequately fits this study due to its focus on the perception level of L2 learners. The other mentioned models are more focused on pronunciation as an indicator. They also give particular attention to bilinguals with more experience, such as those with several years of study or time spent abroad, than the participants in this study.

PAM with Spanish and English VOT

Of the studies that have been done to test the PAM with VOT's, Flege & Eefting (1988) found that monolingual Spanish and English speakers and Spanish-English bilinguals

categorized L2 VOT's before imitating them. This was based on modal shifts and new categories that were created in their production of the new VOT's. Zampini, Clarke and Green (2000) studied the voicing contrast perception of late English-Spanish bilinguals with experience abroad. (This is roughly the same group in this study, only with a more advanced level of instruction.) Their study found that the participants' experience with their L2 allowed them to achieve significantly more native-like Spanish VOT's than those of monolingual English speakers. Crane (2011) conducted a similar study with similar results and put emphasis on factors such as years of instruction, time spent abroad, amount of time speaking with native speakers while abroad, and time spent speaking L2 since returning. The studies mentioned focused more on production of VOT than perception, while the main focus of this study is perception.

One of the assumptions of the PAM (as well as the SLM) is that "new" sounds will be easier to produce than those that are similar to the participants' L1. Since the participants in this study have some experience with Spanish and are being tested with Spanish words that contain sounds familiar to them, the "new" sounds are of less interest. Since this study uses a VOT continuum, the common middle area in which the average VOT's for L1 and L2 overlap will be the focus. In this common middle area, the study participants may allow their L1 perception to affect how they classify L2 consonant sounds, assimilating them to the closest L1 category.

Classroom Instruction and Immersion Abroad

An important factor in L2 perceptual studies is the level of classroom instruction that the participants have received. Díaz-Campos (2004) found that students' perception and/or pronunciation of L2 phones increased with simple formal language instruction at roughly the

same pace whether accompanied by experience abroad or not. Other studies found that L2 learners who are receiving instruction will improve their L2 perception if they receive explicit phonetic training (Cebrian & Carlet, 2014; Huensch, 2013; Hurtado & Estrada 2010), which the participants in the present study have not received. Some research has even shown that adult L2 learners can achieve a "native-like" level of proficiency in a short time of phonetic instruction that barely disrupts a standard language class (Elliot, 1995; Neufeld and Schneiderman, 1980). González-Bueno (1997) observed specifically that instruction has a positive effect on the acquisition of Spanish stops for native English speakers who are L2 learners of English. Ingham (2014) found the same to be true with L1 speakers of Bengali who were learning English.

Crane (2011) concluded that classroom instruction received before study abroad had a significant effect, as did the percentage of time speaking with native speakers while abroad and since returning. Several studies have monitored the effects of time spent abroad on L2 phonological acquisition (Crane, 2011; Cubillos, Chieffo & Fan, 2008; Hurtado & Estrada, 2010; Isabelli-García, 2006) with mixed results. Many of those studies found that an extended immersion experience abroad had a significant effect on language proficiency. The factor that makes this study more unique and less predictable than prior studies is the participants' partial immersion experiences. Their time was not spent abroad, but rather in the United States presumably speaking Spanish with members of a Spanish-speaking community.

According to a 2016 census survey, 13.2% of people in the United States speak Spanish in the home (US Census Bureau, 2016). The participants in this study spent time as missionaries in nine different states. Based on the census information, there are native Spanish speakers who speak Spanish in the home in every state of the US. This means that, based on the circumstances, LDS missionaries in the US could potentially have frequent contact with native Spanish

speakers. Chapter 3 will address the percentages of people who speak Spanish in the home in each of the states in which the missionaries of this study resided.

Perception Testing

The type of test used in a perception study will dictate the ease with which data is gathered and, therefore, its reliability (Gerrits & Schouten, 2004). For testing the PAM, there are two types of perception tests: identification and discrimination. Discrimination tests are known to be more reliable for perception due to lower memory load, response bias, and stimulus uncertainty for the participants (McGuire, 2010; Strange & Schafer, 2008). In other words, identification requires more work for the listener, while discrimination provides options and is able to eliminate distractions, such as having to remember stimuli for a long amount of time. This leads to more reliable results. One common type of discrimination test is an AX or "same-different" test. The AXB test is another type of discrimination test. Rather than simply differentiating between two options, the AXB test requires matching one of two options to a given sample (McGuire, 2010). Best & Strange (1992) used the AXB test in their study on Japanese-speakers' perception of English approximants because the test does not demand high levels of memory, nor does it reflect participants' sensitivity to observer bias. Mora (2007) found the use of nonce words in an AXB test to yield the most accurate results since the listeners' attention was focused on acoustic cues rather than their phonemic level of perception. Many previous studies have employed AXB tests to verify the validity of PAM due to these methodological advantages (e.g., Best, McRoberts & Goodell, 2001; Best & Strange, 1992; Cebrian & Carlet, 2014; Harnsberger, 2001; Højen & Flege, 2006; Huensch, 2013; Ling & Schafer, 2016; Mora, 2007).

It is necessary to revisit the research questions that constitute the focus of the study:

1. To what extent are native English-speaking learners of Spanish with an extended partial immersion experience able to perceive the voicing contrast between voiced and voiceless stops in Spanish?
2. In Spanish mode, where is the VOT value cutoff at which learners can perceive a stop as voiced or voiceless?
3. Is there a significant difference between the perception of voicing contrast in L2 Spanish stop consonants of students with an extended partial immersion experience outside the classroom and those with only a classroom language learning experience?

CHAPTER 3

Methodology

Participants

Participants in this study consisted of 18 native English speakers who were students of Spanish at Brigham Young University at the time the data was collected. The students are divided into two groups. 13 of the students are in Group 1. They each spent between 18 and 24 months as missionaries in different parts of the United States, where they interacted and communicated with native Spanish speakers throughout each day. At the time data was collected, they were enrolled in the first Spanish course they had taken since returning from their time spent as missionaries. Group 1 had what will be referred to as an "extended partial immersion experience" (EPI) and will be labeled as EPI. Group 2 is comprised of five students who were taking the same class but did not spend any time learning the language as missionaries. They either received sufficient secondary Spanish learning education to be in the same course as Group 1, or they took the university Spanish courses leading up to Spanish 206 (see next paragraph). Group 2 is used for comparison for the sake of knowing the further implications of the effectiveness of instruction and experience inside and outside of the classroom. They will be referred to as "classroom learners" (CL).

At Brigham Young University, there is a unique set of Spanish courses that cater to the different groups of students who traditionally enroll. Foundational Spanish 1 and 2 are meant for students with no previous Spanish education. University Spanish 1, 2, and 3 are for students with sufficient secondary Spanish education to feel comfortable diving more quickly into the intermediate grammar and broader functions of the language. Spanish 321, or "Third Year Spanish Reading, Grammar, and Culture," is mainly taken by students who have just finished

LDS missions during which they spoke Spanish, whether inside or outside the US. Spanish 206 (Intensive Spanish Skills Development), the course in which the participants of this study are enrolled, comes directly after University Spanish 3 but before Spanish 321. The purpose of the course is to bridge the gap between intermediate 2nd year courses and upper-level Spanish courses, thus allowing for more grammar and conversation practice for Second year students and giving returned LDS missionaries with a less thorough language experience an opportunity to take a slightly less advanced course than 321. Spanish 206 students who were missionaries most likely served their missions in the US, having had slightly or significantly less exposure to the Spanish language than a missionary who served in a foreign country. It is easy to assume that students in Spanish 321 who spent time abroad would have a high level of L2 perception due to their extended time abroad, but students taking Spanish 206 may or may not be able to perceive L2 sounds at a near-native level. Students have the option to take a placement test called the WebCape if they are unsure about their proficiency level and which course would best suit their needs. The WebCape roughly determines which BYU Spanish course is best for them based on their answers. Independent of their placement exam results or counsel they receive from faculty, the students are free to choose which course they take. Students who served as Spanish-speaking missionaries, whether inside or outside of the US, are able to freely decide whether to take 321 or 206. If they chose to take 206, they either were advised to do so, or they decided that the lower level class would better suit them. Some possible reasons could be limited exposure to the language during their mission or less confidence in their ability to learn or speak a second language. The students of Spanish 206 that were participants in this study were missionaries who all happened to serve in the United States.

The participants in this study comprise a unique group that has experienced the rough equivalent of time abroad. They spent between 18-24 months learning and using a new language. The difference between these participants and other LDS missionaries is that they remained in the United States, still interacting with native Spanish speakers and learning the language, but not necessarily as immersed in the language as they would have been in a foreign Spanish-speaking country.

Nonetheless, the United States is one of the largest Spanish-speaking countries in the world. In fact, the Hispanic population in the United States is 57.5 million and Spanish is spoken in the home by people in every state (US Census Bureau 2016). When LDS missionaries are sent to preach in the US, they are often assigned to learn Spanish. These missionaries spend time learning the language, as well as seeking out and conversing with native Spanish speakers in the regions where they are assigned to serve. While it does not technically, or by definition, count as time "abroad" learning the language, it could be considered as a partial immersion experience within Hispanic/Latino communities in the United States. It is unique because they may or may not be speaking Spanish on a daily basis, and when they do, it could be with people of any number of nationalities or cultural backgrounds. It remains true that they most likely will not receive the same exposure to the language that someone who spends time in a foreign country will receive.

Because the experiences of Spanish-speaking missionaries in the US can vary so widely, a survey was administered to the participants before taking the test. Table 1 shows their responses to the survey, which was done on Qualtrics. The top row shows the questions as they appeared on the survey along with some details added in parentheses. The first column assigns a number to each participant in Group 1. Shown in column 2 is the number of years of Spanish

classes that each participant took before becoming a missionary. Column 3 shows the state (US) in which each participant from Group 1 was a missionary. Column 4 shows the number of months that each of them spent in that state as a missionary, not counting the six weeks that they spent in training at the Missionary Training Center (MTC). (This training period is standard for Spanish-assigned LDS missionaries.) It should be noted that those six weeks include daily Spanish instruction, and that missionaries in training are encouraged to speak the target language as much as possible. Their training time was spent speaking Spanish with other L2 learners and an instructor who may or may not have been a native speaker of Spanish. Column 5 shows the self-reported total percentage of time that each participant felt they spent speaking Spanish during their time as a missionary. Column 6 shows how many months have passed since they returned from their missions. Column 7 contains the gender of the participants. Seven members of Group 1 were female, and six were male.

Table 1

Information about Group 1(EPI) participants as self-reported in a survey.

Participant	How many years of Spanish classes did you take prior to your mission?	Where did you serve? (mission location)	How many months were you in the mission field (not including MTC time)? (MTC = Missionary Training Center)	What percentage of your time would you say was spent speaking Spanish?	How long has it been since you returned? (months)	Male, Female, Other, or Prefer not to respond ?
1	5	California	16	85%	7	F
2	5	California	6	80%	8	F
3	4	Indiana	16.5	60%	3.5	F
4	4	California	16.5	30%	5	F
5	3.5	California	5	60%	6	F
6	3	Florida	22	20%	24	M
7	2.5	Texas	24	33.33%	9	M
8	2	Arizona	23	50%	3	M
9	2	Minnesota	17.5	50%	4	F
10	2	Washington St.	17	50%	9	F
11	2	Wisconsin	22	20%	20	M
12	2	Texas	22	10%	4	M
13	0	Colorado	16	40%	3	M
Avg.	3.7	-	16.08	45.26%	8.12	Total: M=6, F=7

All five members of Group 2 (classroom learners) were female and had an average of 3.1 years of classroom Spanish experience, with a range of 2-5 years. One important limitation of this study is the lack of information obtained about the classroom learners group. All that is known (besides the number of years of classroom instruction) is that they were in the same class as the other participants, that they are not native speakers, and that they did not go on missions or study abroad programs. This lack of information, along with the vast diversity of the EPI group and overall small sample size, limits the cohesion of the groups and the ability to actually call them true "groups" that can be generalized. The study still can, however, tell a lot about Spanish students' ability to differentiate between Spanish stops.

The 13 students in Group 1 were missionaries in nine different states (though they each were assigned to only one state), including Arizona, California (four participants), Colorado, Florida, Indiana, Minnesota, Texas (two participants), Washington State, and Wisconsin. As mentioned in Chapter 2, census information indicates that 13.2% of Americans speak Spanish in the home (US Census Bureau 2016), but that number varies substantially by state. For the states in which the participants in Group 1 were missionaries, the respective percentages are: Arizona, 20.5%; California, 28.7%; Colorado, 11.8%; Florida, 21.3%; Indiana, 4.7%; Minnesota, 4.6%; Texas, 29.5%; Washington State, 8.4%; Wisconsin, 4.6% (US Census Bureau 2016). The higher population of native Spanish speakers in the states along the southern edge of the US (Arizona, California, Florida, Texas) are likely to have provided more language exposure to the participants who were missionaries there. Due to the small number of participants, this study was unable to control for mission location in the statistical analysis.

Some possible limitations of this study can be seen in the variation that exists among Group 1 in their responses to all of the questions that were asked. Their exposure to the language

varies based primarily on three factors. The first of those factors is the state in which they resided, and the second is how much time they spent there. The length of residence varies from 5 to 24 months, with an average of 16.08 months. Only two of the participants' missions were significantly shorter than the rest, totaling 5 and 6 months. The final component to be considered is how much of their time they spent speaking Spanish. The reported percentages range from 10% to 85%, with an average of 45.26%. The amount of variation in these numbers shows how much disparity there can be in the experiences of Spanish-speaking LDS missionaries in the US. Some have frequent and extensive exposure to the language, while others have a limited experience.

The percentage of their time speaking Spanish depends on how many Spanish speakers they were able to seek out, how many were referred to them by members of the LDS church, and how many Spanish-speaking members of the church they were able to communicate with. LDS missionaries spend a large portion of their day out in public looking for people to talk to or in peoples' homes conversing with them. Communicating with Spanish speakers does not guarantee that those people would always speak Spanish with the missionaries. Another factor is how much Spanish they spoke with their companions—LDS missionaries are always in pairs—and other missionaries, and whether their companions were native speakers of Spanish or not.

Some of the participants in this study received classroom instruction (aside from their missionary training) prior to their missionary service, but received only limited instruction after their return. Others received little to no language instruction in their lives. One of the purposes of this study is to find out if their extended time speaking Spanish with native speakers was more valuable for their L2 perception than classroom instruction, or if both components are necessary in L2 acquisition. The participants in this study reported having taken an average of 3.7 years of

Spanish courses before their missions, ranging from 0 to 5 years (Table 1). It is assumed that this is their first Spanish course after returning from their mission, but there is variation (Table 1) in how much time had passed since their return and their participation in this study.

Method for Obtaining Participants

Participation was a required assignment in the students' Spanish 206 class. This was done to avoid potential complications with monetary compensation or extra credit. If participation in the study were offered as extra credit, an equivalent option for extra credit would have to be offered for those who chose to opt out. Also, there was no way to guarantee that students would arrive and participate unless it was a required assignment that took place during class time. Since the study has educational value for the class the students are taking, it was an effective use of 15 minutes of class time. A short linguistic lesson on the perception of voiced and voiceless consonants accompanied their participation in the study. Participants had the option to request that the data provided by them not be used for research. None of them chose to opt out.

Data Gathering

The study consisted of one computer-based, forced choice perception test that operated on a scale of VOT intervals ranging from pre-voiced to long-lagged. The participants heard a generated clip of audio of a Spanish word containing an initial stop consonant. Upon hearing the audio clip of the word, the participants were asked to identify the word, and were given two text options to choose from. One choice contained the voiceless stop consonant and the other contained the voiced stop consonant. The same type of question was repeated 70 times for each of the three Spanish consonant contrasts, with the appropriate minimal pair of Spanish words

appearing as options on the screen for each sequence of 70 questions. They were asked to rate the same recording ten times each, for seven different recordings (70 questions total). All 70 were in random order. What changed between the seven recordings was the stimulus, i.e. the VOT of the initial stop in the audio clip. Those values are shown in Table 2.

Table 2

VOT Values of Stimuli for this Study

Consonant Contrast	VOT Values of Stimuli in ms						
P/B	-79	-56	-33	-10	13	36	59
T/D	-79	-56	-33	-10	13	36	59
K/G	-61	-38	-15	8	31	54	77

Each of the three tests corresponding with each consonant contrast contained seven different audio clips, which together represented a continuum of VOT values. The voiced end of the continuum corresponded roughly with the Spanish average VOT (Spanish: /p/ = 6.5ms, /t/ = 10.4ms, /k/ = 25.7ms, /b/ = -69.8 ms, /d/ = -77.7ms, /g/ = -58ms) (Castañeda Vicente, 1986; Lisker & Abramson, 1964), while the voiceless end of the continuum stretched further into positive VOT to closer represent English VOT's (English: /p/ = 58 ms, /t/ = 70 ms, /k/ = 80 ms, /b/ = 1ms, /d/ = 5ms, /g/ = 21ms) (Lisker & Abramson, 1964). This information is displayed in Table 3. The position on the continuum at which the participant could hear the difference (or consistently reported to hear one word rather than the other) was meant to answer the research question: In Spanish, where is the VOT value cutoff at which L2 learners can perceive a stop as voiced or voiceless? The intervals between stimuli (audio clips) were the same for each contrast pair, but larger intervals were used in comparison to previous studies (Shockley, Sabadini & Fowler, 2004). This was done to allow for a larger VOT spectrum to be covered, and the

intervals are still small enough that the differences between bordering stimuli should not be clearly discernible. The seven VOT values for each contrast (Table 2) maintain 23ms intervals and stretch to or beyond the known negative VOT averages for Spanish found in Castañeda Vicente (1986) and near the average voiceless VOT's found for English in Lisker and Abramson (1964). This allowed for possible error by the participants in either direction, but most importantly in the positive VOT realm, since that is where the participants' native language of English is most likely to affect their perception. Table 3 displays the average VOT values of Spanish and English voiced and voiceless stops found in Castañeda Vicente (1986) and Lisker and Abramson (1964) that were used as reference for the stimuli created in this study.

Table 3

Average VOT Values from Castañeda Vicente (1986) and Lisker and Abramson (1964)

Avg. VOT in ms	/p/	/t/	/k/	/b/	/d/	/g/
Spanish	6.5	10.4	25.7	-69.8	-77.7	-58
English	58	70	80	1	5	21

The test, which used recorded audio from a native speaker, was created using PsychoPy software. It included the following three minimal pairs created by voicing contrast in Spanish: *poca* and *boca* (/p/ and /b/); *tensa* and *densa* (/t/ and /d/); *callo* and *gallo* (/k/ and /g/). There was one original audio recording used for each consonant contrast, which represented one extreme of the spectrum. Using Audacity audio editing software, each audio recording was manipulated six times to create a total of seven stimuli with varying VOT values on a scale from voiced to voiceless. Varying amounts of periodic voicing were added to create the voiced stimuli and varying amounts of aperiodic noise were added to create the voiceless stimuli. Figures 3 and 4

show examples of a waveform diagram of part of a /k g/ stimulus used in the test. Figure three had periodic pre-voicing copied and lined up from the original audio to create the desired VOT. Figure 4 is made from the same base audio clip. Aperiodic noise was taken from the same female native speaker pronouncing a Spanish voiceless stop. The aperiodic noise was copied and added to the base /k g/ to maintain uniformity in speed and length of the other sounds in the clip. The added noise replaced the pre-voicing.

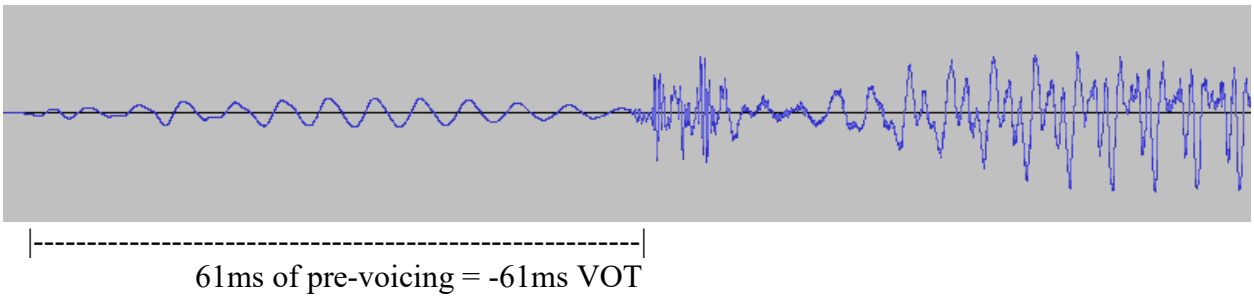


Figure 3. Waveform diagram of the stop sound at the beginning of stimulus 1 for /k g/ with a VOT of -61ms. (pre-voiced). Manipulated to achieve -61ms VOT.

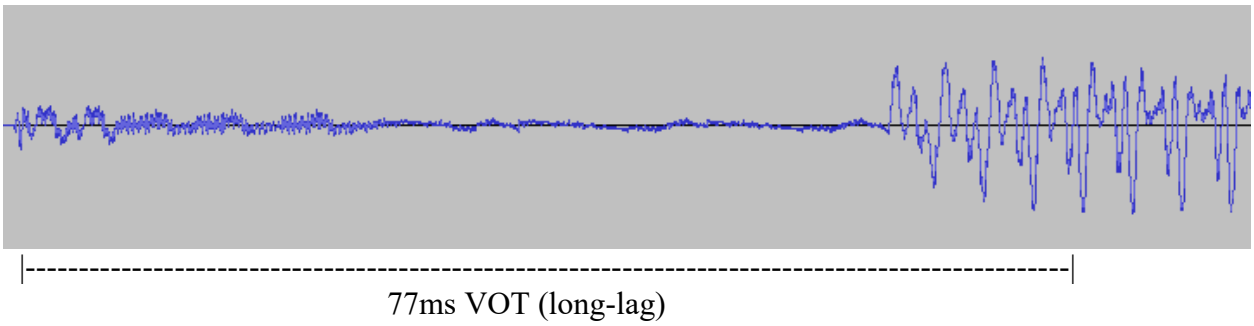


Figure 4. Waveform diagram of the stop sound from stimulus 7 for /k g/ with a long-lag VOT of 77ms. Labeled with 77 ms of aperiodic noise taken from separate clip of the same native speaker saying “callo”, multiplied, and added to the same base audio clip as the view of Figure 3 to achieve the desired VOT.

Randomization

An online true random number generator was used to generate numbers 1-7, 70 times, to determine the ordering of the 70 stimuli for each test. That included 10 repetitions of each of the

seven stimuli. With each stimulus being assigned a number, they were then ordered as the random number generator dictated. Once ten repetitions of any given stimulus had been included, it would be skipped if it was generated again. Consecutive appearances of the same stimulus were allowed. The process with the same true random order was repeated for each of the three consonant contrasts.

Pre-Test

The instructions were a key aspect of achieving accuracy in the data. All instructions were given in Spanish to assist with the goal of achieving Spanish listening mode, which will be explained hereafter. It was explained to the participants that they would hear a sound repeated 70 times, and that each time they must choose the option (between the two words given to them) that they thought the sound most resembled to them. It was emphasized that there was not a right answer, but that the important thing was that they chose what they heard and that it be their first impression upon hearing the sound. They were reassured that, even though there were many repetitions and it would seem mentally taxing, the test would only last a few minutes. They were also asked to respond immediately after the sound and that the test would continue to the next question a couple seconds after each sound.

Before the test, it was necessary that the participants get into Spanish listening mode in order to more adequately identify the stimuli that was to be presented to them in Spanish. Spanish listening mode, as pertinent to this study, means that their focus is on Spanish rather than English and that they are in the appropriate mind frame to adequately display their level of L2 perception (Grosjean, 2001). In order to achieve this, they listened to a two-minute clip of a

native Spanish speaker. The clip used was a YouTube video from 2014 of a male *Univisión* news anchor explaining the effect of falling oil prices on the Venezuelan government's funds.

Data Collection

There were a number of obstacles that originally impeded the administration of this test. The ideal setting for administration of the test was thought to be in a closed room with individual computers and headphones. Such a setting would have been ideal for limiting distractions. Though the test was created with PsychoPy software, the computers that were available on the BYU campus for administration of the test were not capable of running the program. After much trial and error and reservation of different computer labs, it was determined by a coder that the folder that was running the Python script required by the program could only be accessed with an administrative password. Thus, due to the extenuating circumstances that made it difficult to achieve this, another method of administration of the test was formulated in which it would be displayed on a projector screen, using the laptop on which the PsychoPy software was able to run. It would be administered to an entire class this way, where the students would see the words and hear the stimuli on a speaker as a group. They would then be asked to select which word they heard on a Qualtrics survey, which could be accessed on their phones. The questions and their accompanying audio stimuli were numbered 1-70, which numbers were visible in Qualtrics on their phones and were called out before each sound by the individual who administered the test. Despite the potential distractions of using smartphones and not using headphones, there were other benefits to this method. It was able to be administered in the traditional classroom where the students would already be having class, not in a separate computer lab. Also, using Qualtrics for data gathering was especially user-friendly, both in the interface for the perception

test and in the manner of displaying the results for analysis. The view of the interface that the subjects used to record their responses during the perception test is shown in Appendix C.

Perception Testing Factors

This section will address some of the factors mentioned in Chapter 2 that are involved in the administration of the perception test. Manipulation of these variables could potentially reduce the risk of distraction and help obtain results that accurately represent the L2 perception of the participants (Best & Strange, 1992; Mora, 2007; McGuire, 2010; Strange & Schafer, 2008). The manner in which the variables were manipulated in this study is detailed here:

1. Timing - In order to make sure the participants did not second-guess themselves, they were given only about three seconds to choose an answer. They were asked to select the word that represented their first impression immediately after hearing the sound.
2. Real or Nonce Words - Real words in Spanish are necessary since the goal is to ascertain details concerning the participants' perception in their L2 of Spanish. Another reason and benefit of using real Spanish language words was for the sake of familiarity and the participants' comfort level with the test.
3. Memory Load - Since the participants heard a new audio clip stimulus for every question they answered, the memory load for this study was extremely low. Low memory load is a significant advantage, since the participants did not have the added difficulty of having to remember a stimulus for an extended period of time or for the duration of more than one question.

4. Distractors/Response Bias - Distractors were not used during data collection. The main reason for this was the duration of the perception test and the need for the participants to hear each sound as many times as possible to secure more reliable numbers. If distractors had been added, the test would have been too long and would have exhausted the focus of the participants and consequently affecting their perception of the sounds. It was also decided that if the participants were to discern the purpose of the test, it would not significantly affect how they answered. The fact remained that they simply needed to choose which of the two words on the screen better matched the sound they heard. An important contributor to effective distraction was the randomization process detailed above.
5. Stimulus Uncertainty - Since the goal was for the participants to find the cutoff point for perceiving voicing contrast, there was a necessary level of uncertainty. In order for their responses to be as representative of their actual perception as possible, they were asked to select answers based on their first impression and to make their selections immediately after hearing the stimuli.

Data Analysis

Three different types of analysis were performed on the data. First, the raw data was organized into graphs to show the percentage of total answers that were given for each option. This provided a way to simply look at the participants responses. The second analysis shows the amount of years of classroom instruction for each participant, along with their raw responses out of 10 for the voiceless option for each test, only for stimulus 5, which is the estimated stimulus at which native Spanish-speakers' responses would be categorically voiceless. The third analysis

was a logistic regression analysis. For this statistical analysis, the binary or dichotomous dependent variable was the answer given by the participants, or in other words, which of the two words on the screen was chosen. The independent variable was the stimulus, or the seven audio clips that represented a scale of VOT. The random effect in this logistic regression analysis was the "listener", or the participants in the study. This means that the test takes into account the variation between all of the participants, regardless of whether they were extended partial immersion or classroom only learners. Separating the groups was achieved by including a "y" for yes or a "n" for no as to whether they had participated in an extended partial immersion experience. Using a long form workbook of all the responses categorized by listener and then by stimulus, a GLIMMIX procedure was run to model the probability that the answer would be the word with the voiced initial consonant (*boca*, *densa*, or *gallo*) for each of the three sets of results.

CHAPTER 4

Results

Identification of Stimuli

The first analysis looked at the simple identification of stimuli by percentage. For each of the three tests (/p b/, /t d/, /k g/), the analysis took the percentage of all the participants' total responses—70 for each participant for each test—for either of the two words that were presented as options. The participants were divided into two groups: Group 1, comprised of 13 students with the aforementioned missionary language learning experience (outside of the classroom); Group 2, comprised of five students who had essentially only received classroom language instruction. They were then placed in graphs that show, for each consonant contrast (presented in each test), what percentage of the total responses for each of the different stimuli was one of the consonants (represented by the word that forms a minimal pair with the other) and what percentage was the other. The percentage data in graph form is presented in Figures 5-7. The seven stimuli are represented on the x-axis and are shared within each test or consonant contrast. The y-axis shows the percentage of the responses for the word containing the consonant for which the graph is labeled for each of the seven stimuli on the continuum. The contrasting consonants mirror each other in percentages since the test was binary and the participants had to choose one or the other. This means that for all the responses not shown in the graph, the other option was chosen.

It should be noted that for each consonant pair, the set of stimuli (1-7) represent a VOT continuum (as found in Chapter 3) where 1 represents the furthest extreme of the voiced spectrum (pre-voicing) and 7 represents the voiceless, or long-lag VOT, end of the spectrum. This means that the consonants /b d g/, which are voiced, were more likely to have more

responses on the left side of the graph. Likewise, the consonants /p t k/ were more likely to have more responses on the right side of the graph.

The results show that the point of differentiation between consonants, or the point at which they hear the difference between one sound or the other, is somewhere close to the middle point on the VOT continuum represented in the stimuli. As should be expected with the extremes, there is less variation in the responses for stimuli 1 and 7 and the other surrounding stimuli. They are close to 100% or 0%. Near the middle of the stimulus range is where the responses are more evenly split, meaning that somewhere in the middle is the point at which they participants are able to discern the difference between the two consonants in Spanish.

The responses for both Group 1 (students with an extended partial immersion experience) and Group 2 (students with classroom experience only) are visibly similar in the graphs for each of the three tests. The difference between groups was determined to not be statistically significant (see Table 9).

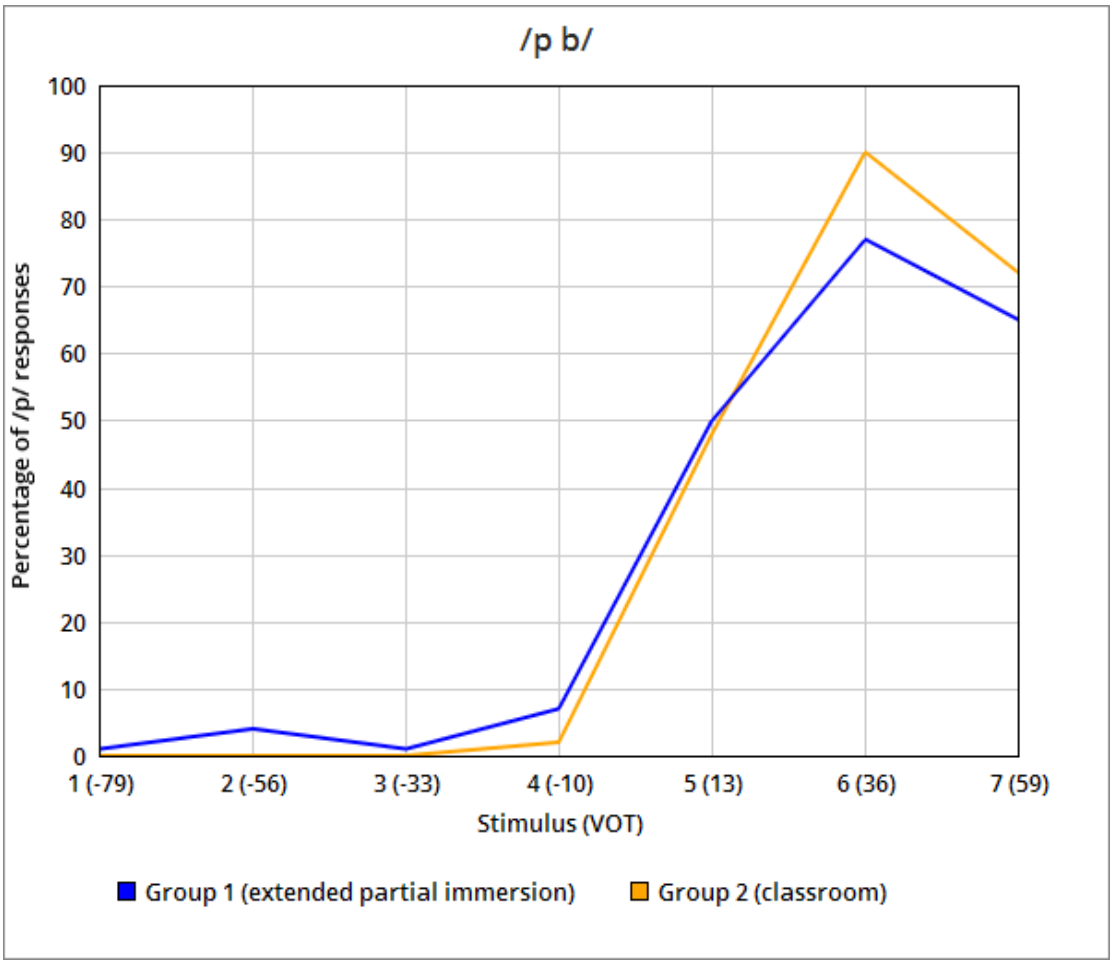


Figure 5. Percentage of /p/ responses out of the total responses for each stimulus for each group.

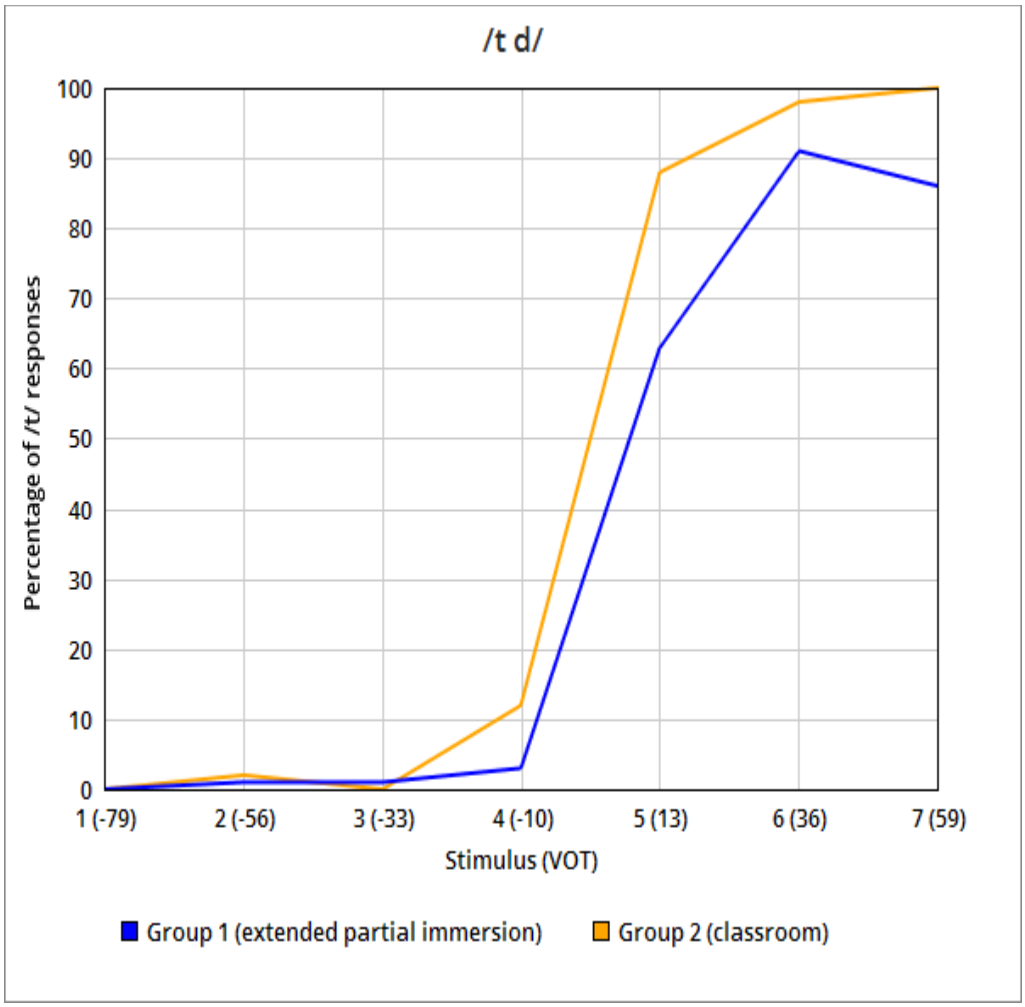


Figure 6. Percentage of /t/ responses out of the total responses for each stimulus for each group.

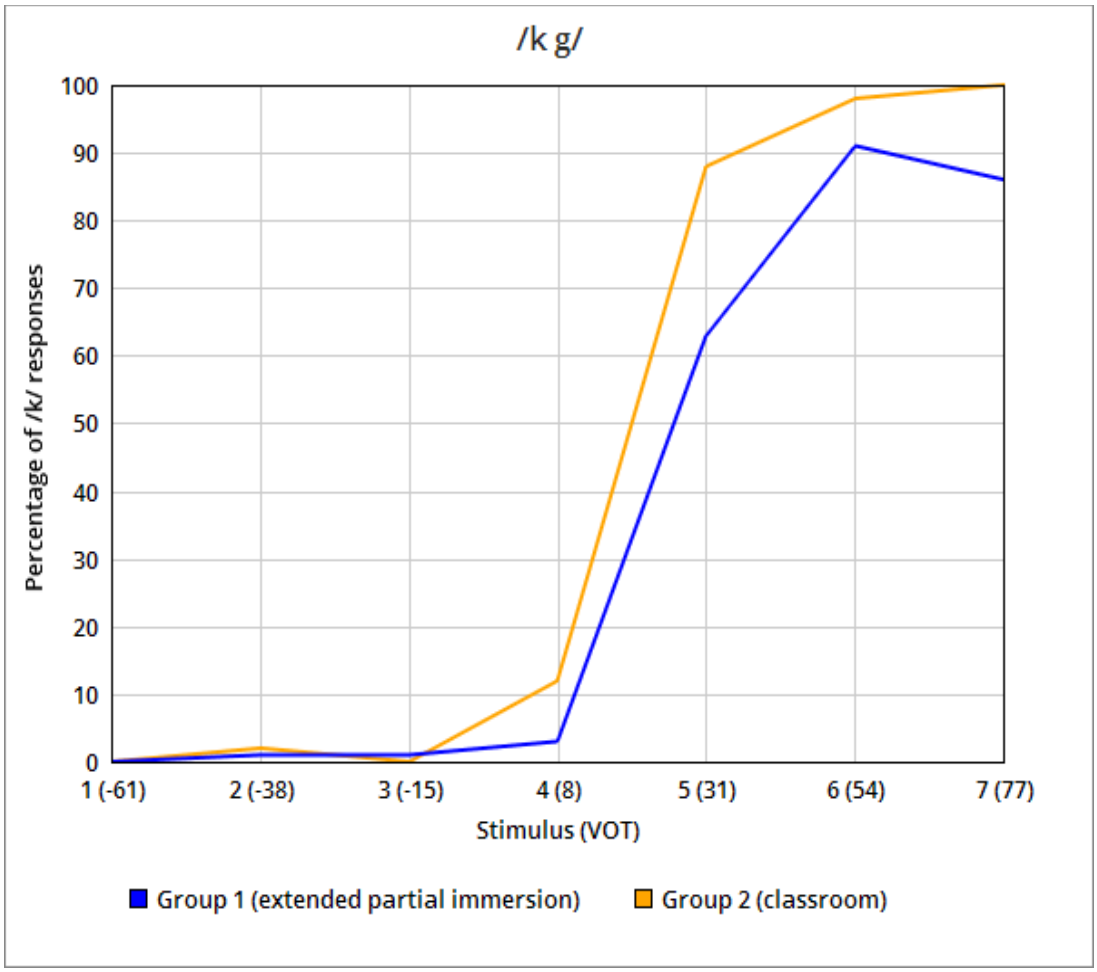


Figure 7. Percentage of /k/ responses out of the total responses for each stimulus for each group.

It is important to take into consideration the fact that the stimuli used in this study were fashioned to cover the average voiced end of the VOT spectrum in Spanish, and to stretch beyond the average voiceless Spanish VOT to reach a value closer to the average English voiceless VOT (Castañeda Vicente, 1986; Lisker & Abramson, 1964). The way in which the continuum of stimuli was constructed in this test may be viewed as a way to either predict or allow for the possibility that the participants, who have had varying levels of exposure to Spanish, may still be heavily influenced in their perception by their English-speaking background. Unfortunately, since there is no data for native speakers on this task, we don't know

the exact cutoff points for native speakers. They can only be inferred based on Castañeda Vicente (1986) and Lisker and Abramson (1964). Tables 4-6 show the comparison between the averages from those studies and the stimulus VOT values used in the audio clips of this study.

Table 4

/p b/ Horizontal linear representation of VOT on a scale relative to zero. Shows values of stimuli from this test, along with native averages for English and Spanish (Castañeda Vicente, 1986; Lisker & Abramson, 1964).

←----------0----------→

P/B Stimuli	-79	-56	-33	-10	13	36	59
Spanish avg. VOT B-P	-69.8 (/b/)				6.5 (/p/)		
English avg. VOT B-P					1 (/b/)		58 (/p/)

Table 5

/t d/ Horizontal linear representation of VOT on a scale relative to zero. Shows values of stimuli from this test, along with native averages for English and Spanish (Castañeda Vicente, 1986; Lisker & Abramson, 1964).

←----------0----------→

T/D Stimuli	-79	-56	-33	-10	13	36	59
Spanish avg. VOT D-T	-77.7 (/d/)				10 (/t/)		
English avg. VOT D-T					5 (/d/)		70 (/t/)

Table 6

/k g/ Horizontal linear representation of VOT on a scale relative to zero. Shows values of stimuli from this test, along with native averages for English and Spanish (Castañeda Vicente, 1986; Lisker & Abramson, 1964).

←----------**0**----------→

K/G Stimuli	-61	-38	-15	8	31	54	77
Spanish avg. VOT G-K	-58 (/g/)				25.7 (/k/)		
English avg. VOT G-K					21 (/g/)		80 (/k/)

Considering the averages based on Castañeda Vicente (1986) and Lisker and Abramson (1964), it will be assumed for the purposes of this study that for each consonant contrast, stimulus 5 would be the point at which native Spanish speakers would categorically hear the voiceless consonant. The level of L2 perception of the participants of this study will be judged based on that assumption. Table 7 shows their amount of responses out of 10 (for Stimulus 5) that were voiceless.

Table 7

Participants ordered by group and by years of classroom instruction, with the amount of responses out of 10 that they chose each voiceless consonant for Stimulus 5.

Participant	**Years of Classroom Instruction**	**For Stimulus 5, times out of 10 that the voiceless consonant was selected.**		
EPI		**/p/**	**/t/**	**/k/**
1	5	8	2	5
2	5	9	7	7
3	4	7	2	7
4	4	4	1	2
5	3.5	4	8	7
6	3	2	6	9
7	2.5	4	7	9
8	2	7	10	3
9	2	2	6	5
10	2	8	7	9
11	2	0	9	3
12	2	8	7	4
13	0	4	10	7
Avg.	**3.7**	5.15	6.31	5.92
CL				
14	5	4	6	3
15	4	9	9	2
16	2.5	7	9	6
17	2	3	10	9
18	2	1	10	3
Avg.	**3.1**	4.8	8.8	4.6

In Table 7, there appears to be no correlation between years of classroom instruction and ability to perceive Stimulus 5 as voiceless. Based on averages for the total responses for each group, the participants were only able to perceive Stimulus 5 as voiceless about half the time. The average number of voiceless responses out of 10 are as follows: EPI, /p/ = 5.15, /t/ = 6.31, /k/ = 5.92; CL, /p/ = 4.8, /t/ = 8.8, /k/ = 4.6. The one exception lies in the results for the /t d/ test

for classroom learners, with an average of 8.8 responses out of 10. Table 7 gives a clearer look at the raw data from this study at the point at which it was determined to be the most relevant.

Logistic Regression Analysis

The function of the logistic regression analyses that were performed on the data was to model the probability that the participants would answer one particular word (*boca*, *densa*, *gallo*) rather than its opposing counterpart (*poca*, *tensa*, *callo*).

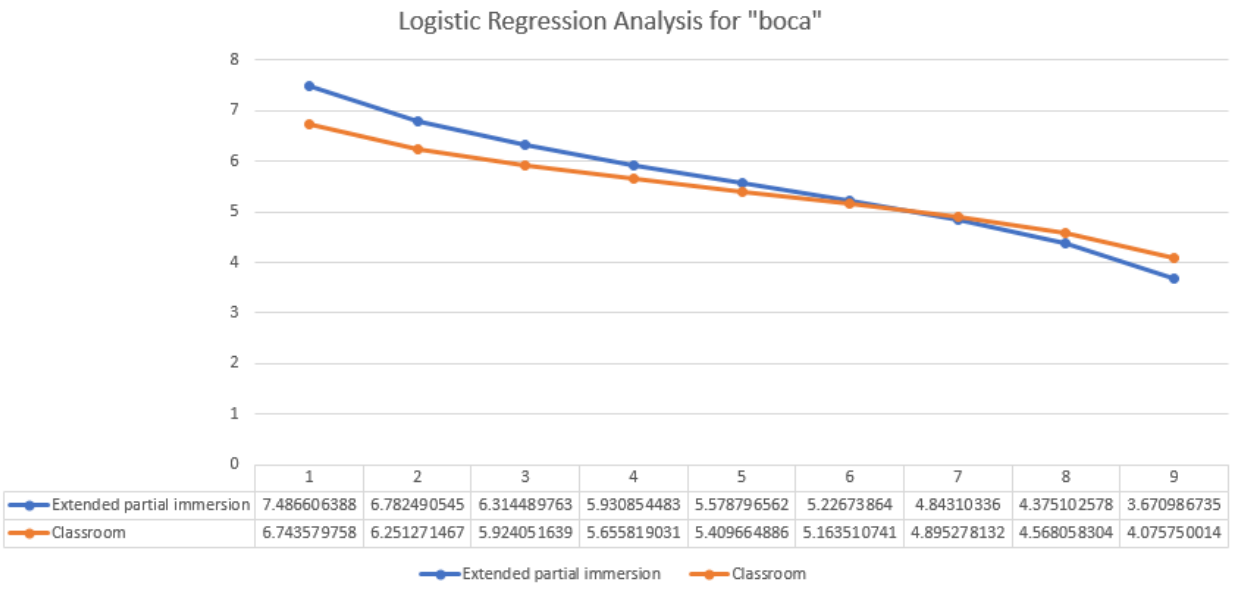
Logistic regression analyses center around a binary dependent variable. In this analysis, the two possible answers, both words, in the test represent the dependent variable, while the stimuli are the independent variables. The listeners, divided into two groups, one of extended partial immersion learners and the other of classroom learners, represent the random effect. This means that they represent two populations that comprise a portion of a larger group, L2 learners of Spanish who are taking the same Spanish class. To account for any variation between the participants, the listeners were identified as the random factor.

In Figures 8-10, the values that have previously been shown on the x-axis are now on the y-axis, that is, the stimuli numbers 1-7. The numbers 1-9 that appear on the x-axis represent the proportion, out of 10, or the chances that one particular word will be the response. The values underneath the proportions on the x-axis are the stimulus values (also measured along the y-axis) at which 10% (1 on the x-axis), 20% (2 on the x-axis), etc. of the answers will be *boca*, *densa*, or *gallo*, depending on which of the three tests was being analyzed.

In the framework of this statistical analysis, the word with the voiced initial consonant is the “positive response” and considered the “correct” answer. For example, with a stimulus of 5.57 a participant of Group 1 (extended partial immersion) would correctly identify *boca* 50% of

the time, since that is the stimulus value that appears at the 5 on the x-axis. There is not necessarily any legitimately correct answer, but what it means to say is simply that 50% of that group's answers will be *boca* at that exact point on the stimulus continuum. 50% of Group 2 (classroom learners) answers would be *boca* if the stimulus were 5.40 The VOT values that that are represented by the stimuli mentioned in this paragraph are found in Table 8.

One noticeable issue with the plot is that some of the values reach beyond a stimulus of 7, which was the highest stimulus. If the data fit the model perfectly, there would not be anything above 7 or below 1. Due to a lack of uniformity in the outer limits of the data, it is possible to get predicted stimulus values out of the range. This is not a significant issue, since the focus of the data is the center point at which 50% of the answers would be *boca*, *densa*, or *gallo*.



	1	2	3	4	5	6	7	8	9
Extended partial immersion	7.486606388	6.782490545	6.314489763	5.930854483	5.578796562	5.22673864	4.84310336	4.375102578	3.670986735
Classroom	6.743579758	6.251271467	5.924051639	5.655819031	5.409664886	5.163510741	4.895278132	4.568058304	4.075750014

Figure 8. Logistic Regression Analysis for *boca*, where the y-axis shows the stimulus at which the x-axis value out of ten answers will be *boca*.

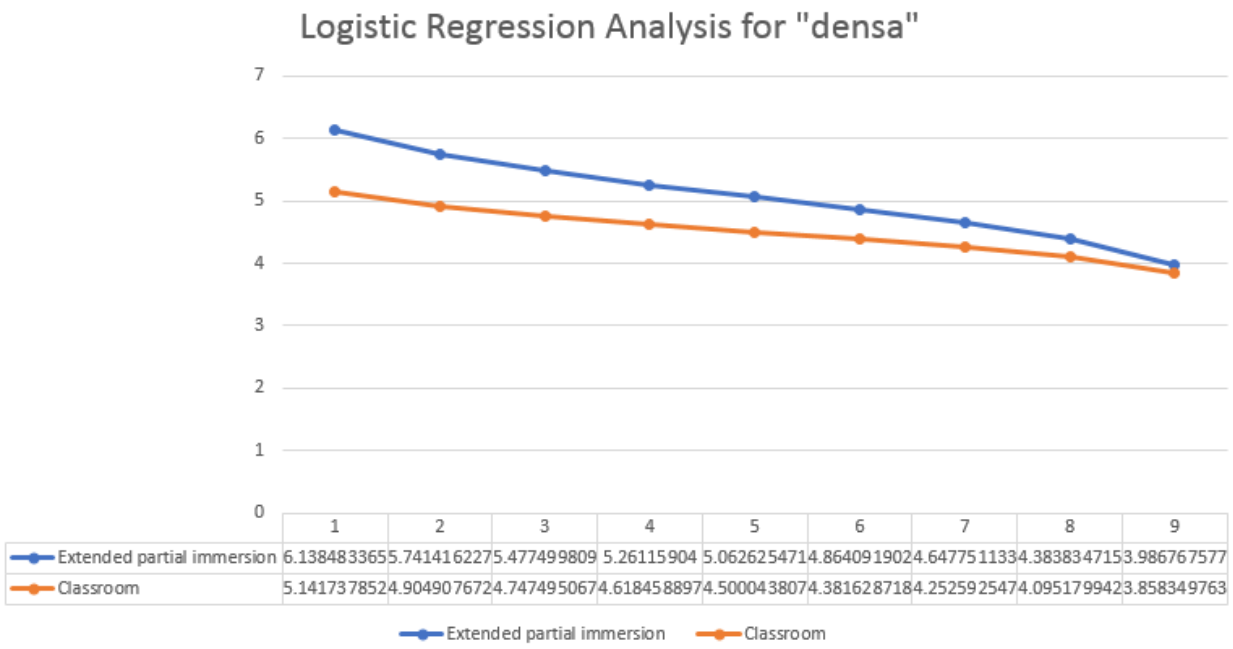


Figure 9. Logistic Regression Analysis for *densa*, where the y-axis shows the stimulus at which the x-axis value out of ten answers will be *densa*.

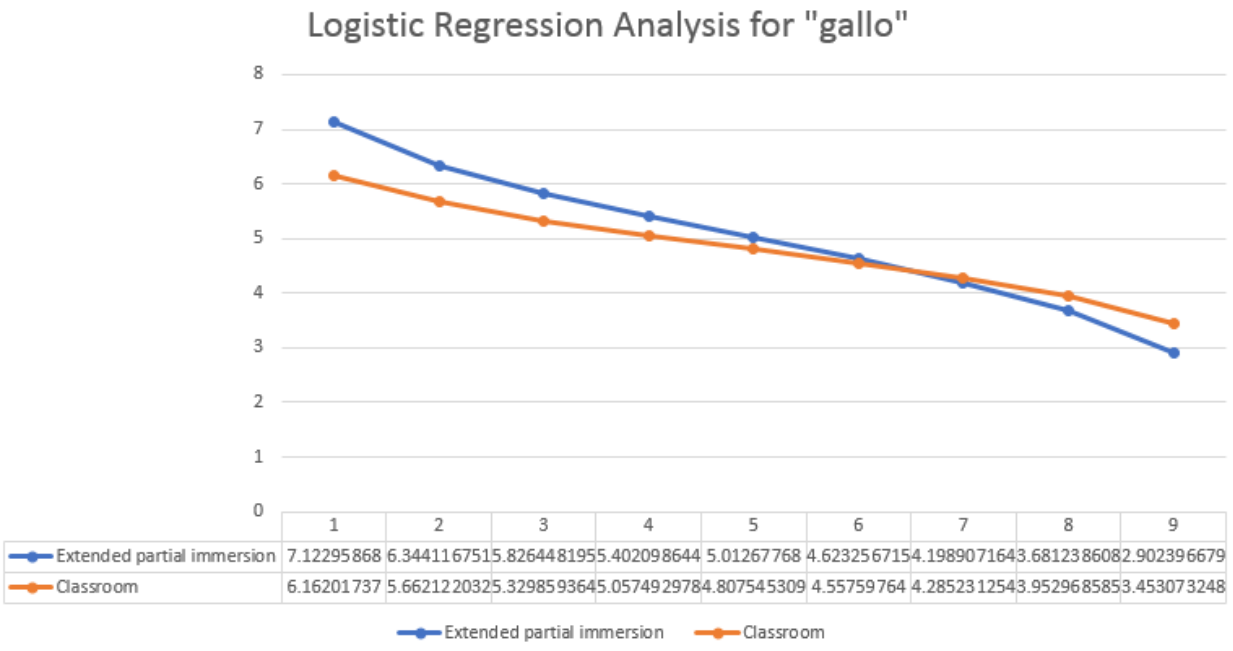


Figure 10. Logistic Regression Analysis for *gallo*, where the y-axis shows the stimulus at which the x-axis value out of ten answers will be *gallo*.

Since the stimulus values do represent a VOT, that value is significant. The inflection point of the curve is the main interest in this analysis. It is that stimulus VOT value at which the answers are predicted to be 50/50 that answers the research questions, “To what extent are native English-speaking learners of Spanish with an extended partial immersion experience able to perceive the voicing contrast between voiced and voiceless stops in Spanish?” and “In Spanish, where is the VOT value cutoff at which L2 learners can perceive a stop as voiced or voiceless?” Obtaining a VOT value for the 50/50 stimulus will answer the latter question, and a closer analysis of where that value falls in relation to L1 and L2 VOT’s will answer the former of the two questions. Table 8 shows the VOT values that are represented by the stimuli at which exactly half of the answers are predicted to be *boca*, *densa*, or *gallo*. The data is shown for each group and for each of the three tests. To get the VOT equivalent, the amount that the 50/50 stimulus value went beyond the last whole number was multiplied by the 23ms interval between stimuli and the result was added to the VOT value of the next lowest whole number stimulus.

Table 8

Based on the logistic regression analysis, the VOT values for the 50/50 stimulus points

Perception Test & Group	50/50 Stimulus	Equivalent VOT in ms
/p b/ EPI	5.578796562	26.31
/p b/ CL	5.409664886	22.42
/t d/ EPI	5.062625471	14.44
/t d/ CL	4.500043807	1.50
/k g/ EPI	5.01267768	31.29
/k g/ CL	4.807545309	26.57

Due to the interaction between the variables of stimulus and group (extended partial immersion or classroom), the significance of a difference between the results of the two groups

only matters for each of the seven stimuli for each test. This means that the main effect for the logistic regression analysis is irrelevant here. Because of the nature of the study and the daabsta, the p-value of each separate stimulus for each separate test must be referenced to find if there is a significant difference between the EPI students and the CL students. For the data in Table 9, if $p < .05$, then there is a significant difference between the responses of the two groups for that stimulus and that test. For all of the stimuli in the /k g/ test (1,2,6,7) and in the /d t/ test (5,6,7) that showed a statistically significant difference, classroom learners chose the more accurate stop consonant (based on native Spanish production averages) more often than the students with an extended partial immersion experience.

Table 9

P-value for each stimulus, for each of the three perception tests

Stimulus	p-value /p b/	p-value /t d/	p-value /k g/
1	0.0583	0.0514	**0.0119**
2	0.0941	0.1100	**0.0272**
3	0.1859	0.3725	0.1001
4	0.4401	0.5400	0.5391
5	0.9892	**0.0121**	0.4084
6	0.4290	**0.0013**	**0.0448**
7	0.1555	**0.0011**	**0.0086**

CHAPTER 5

Conclusions and Discussion

Research Questions

1. To what extent are native English-speaking learners of Spanish with an extended partial immersion experience able to perceive the voicing contrast between voiced and voiceless stops in Spanish?
2. In Spanish, where is the VOT value cutoff at which L2 learners can perceive a stop as voiced or voiceless?
3. Is there a significant difference between the perception of voicing contrast in L2 Spanish stop consonants of students with an extended partial immersion experience outside the classroom and those with only a classroom language learning experience?

Since the participants in this study likely spent most of their language learning experience having frequent exposure to the English language, and since they are native English speakers, it is most likely that such influence prevented them from perceiving consonants closer to where a native Spanish speaker would most likely perceive them. The fact that the center point for the participants' responses falls in or around the overlap point between Spanish and English average VOT's suggests that both languages have an effect on the participants' perception of Spanish consonant contrasts.

Being native English speakers broadens the range of VOT that they can perceive, but since it is shared between the two languages and their L2 Spanish skills are significantly lower than their native English ability, the broad range of VOT in their scope of perceptibility affects

their L2 perceptual acuity negatively. When given that full range and asked to discern between only Spanish VOT's, the participants showed that their tendency was to hear the sounds on a slightly more English-leaning scale.

The analysis in Table 7 indicates that listeners from both groups were only able to perceive Stimulus 5, which is assumed to be categorically voiceless for native Spanish-speakers, as voiceless about half the time. This goes against the assumption that the participants in this study would perceive Spanish voicing contrast at a near-native level. This analysis indicates that all the participants still have a hard time hearing the difference between voiced and voiceless in Spanish at a VOT that would be obviously discernable for a native speaker of Spanish. Since they have difficulty perceiving the difference with a positive VOT, the effect of their native language of English on their L2 perception is evident. This confirms one of the assumptions of Best's PAM, that L2 segments will be categorized based on the listener's L1. The numbers in Table 7 confirm the finding that there was no significant difference between the supposed groups, and also appear to show no significant correlation between perception level and years of classroom instruction.

According to the logistic regression analysis, the point upon the VOT continuum at which the participants were most likely to tell the difference between the two consonants was as follows: For /p b/, EPI: 26.31 ms, CL: 22.42 ms; For /t d/, EPI: 14.44 ms, CL: 1.5 ms; For /k g/, EPI: 31.29 ms, CL: 26.57 ms. Looking at the Spanish average VOT's from Lisker and Abramson (1964), it is clearer what this means. The average Spanish VOT for /b/ is -69.8 ms and for /p/, 6.5 ms (Lisker & Abramson 1964). The English averages, on the other hand, range from 1 ms (/b/) to 58 ms (/p/) (Lisker & Abramson 1964). It is clear that these students with an extended partial immersion language learning experience do not perceive the voicing contrast in Spanish near to

where a native Spanish-speaker would be expected to. Their responses showed a strong tendency to the positive end of the voicing scale.

Tables 10-12 show the 50/50 values from the logistic regression analysis in a vertical view with the stimulus continuum of this study, along with the average native production VOT's of the two languages (Castañeda Vicente, 1986; Lisker & Abramson, 1964). This will allow for a linear look at the VOT values and a more visually comprehensible comparison.

Table 10

/p b/ stimulus values in ms from the perception test, along with the 50/50 VOT points for the logistic regression analysis and middle points for English and Spanish native averages

←----------0----------→

P/B Stimuli in ms	-79	-56	-33	-10	13	36	59
Spanish avg. VOT B-P	-69.8 (/b/)		-31.65 (mid)		6.5 (/p/)		
English avg. VOT B-P					1 (/b/)	29.5 (mid)	58 (/p/)
Group 1 LR 50% VOT						26.31	
Group 2 LR 50% VOT						22.42	

Table 11

/t d/ stimulus values in ms from the perception test, along with the 50/50 VOT points for the logistic regression analysis and middle points for English and Spanish native averages.

←----------0----------→

T/D Stimuli in ms	-79	-56	-33	-10	13	36	59
Spanish avg. VOT D-T	-77.7 (/d/)		-33.85 (mid)		10 (/t/)		

English avg. VOT D-T		5 (/d/)	37.5 (mid)	70 (/t/)
Group 1 LR 50% VOT		14.44		
Group 2 LR 50% VOT		1.5		

Table 12

/k g/ stimulus values in ms from the perception test, along with the 50/50 VOT points for the logistic regression analysis and middle points for English and Spanish native averages.

←----------0----------→

K/G Stimuli in ms	-61	-38	-15	8	31	54	77
Spanish avg. VOT G-K	-58 (/g/)		-16.15 (mid)		25.7 (/k/)		
English avg. VOT G-K					21 (/g/)	50.5 (mid)	80 (/k/)
Group 1 LR 50% VOT					31.29		
Group 2 LR 50% VOT					26.57		

Tables 10-12 show a comparison of the average native VOT values for each language, with a middle point for reference to where a native speaker might possibly discern between the two sounds. This can be compared to the averages of the participants' answers, as well as the 50% values derived from the logistic regression analysis. While the predicted middle values from the regression analysis are closer to zero than the averages from the raw data, it is still evident that the participants have assimilated the non-native L2 sound of the short-lag Spanish stop consonant into an L1 category that has a similar VOT, as predicted by the PAM. One benefit of this study is that it shows that L2 learners of Spanish who are native English speakers and have

been learning Spanish for an extended period of time are still highly affected in their L2 perception abilities by their L1 perceptual mechanisms.

In regard to research question number 3, "Is there a significant difference between the perception of L2 Spanish stop consonants of students with an extended partial immersion experience outside the classroom and those with only a classroom language learning experience?" the results of this study show that, for the most part, there is no significant difference between the perception levels of the two groups. Table 9 shows that there are some stimuli for some of the tests that showed p-values below .05. Since most of them are not at the stimulus center point of VOT (Table 10), nor do they span all the stimuli of a given test, they are of little significance. Nevertheless, for those stimuli at which there was a significant difference, the classroom learners chose the more native-like Spanish option more often than the extended partial immersion students. The focus of this study is the middle point at which the VOT distinction is made, not the outliers. While it was hypothesized that there would be an overall difference between the two groups of students, the only test that showed a significant difference was the /k g/ perception test, which had a significant p-value for stimulus 5. This is significant because the 50/50 stimulus point for that test, at which half of the answers are predicted to be *densa*, was 14.44ms, which is just beyond stimulus 5. It can be derived from the majority of the data in Table 9 that someone who has an extended partial immersion experience as an LDS missionary in the US is not more likely to perceive Spanish stop consonants at a near-native level than someone who has learned Spanish only through classroom instruction.

Possible Limitations

The complications of administering the perception test in a distraction-free environment (Ch. 3), which may have affected the accuracy of the responses, is a limitation to this study. The different language learning experiences of the participants are also a significant possible limitation. The students in this study could have had vastly different classroom learning experiences, and even more vastly different partial immersion experiences. Furthermore, the variation in percentage of Spanish-speakers in the states in which the participants from Group 1 were missionaries is problematic. They also reported different amounts of time as missionaries and different amounts of their time spent speaking Spanish. There is not enough known about the LDS missionary experience (in the US) to be able to truly classify a group that would have generalizable results, and that which is known about the experience is too varied. The same is true of the classroom learners in this study. They could have a had a variety of different experiences in the classroom based on location, level, instructor, etc. They also may have had other experiences with the language, such as speaking with coworkers or friends or being exposed to Spanish in entertainment and the media. It is also necessary to mention that confusion between L2 words (based on VOT) outside of context doesn't create significant problems for communication, which means it is not a focus in the classroom.

Future Research

In order for the claims in this study to be strengthened, native speakers of Spanish and monolingual English speakers, as well as LDS missionaries who spent extended time abroad will need to be given this same perception test. Native perception levels need to be compared to those of the subjects from this study. If this study were replicated, more information would need to be taken concerning the extent of the classroom learning experience and partial immersion

experiences of the participants. Also, data of the LDS missionaries who had more exposure to the language should be compared to those who had a more limited amount of exposure. With more information about the language experiences of LDS missionaries in the US, as well as the experiences of the classroom learners, more conclusions could be drawn about the language learning benefits of an LDS mission in relation to classroom instruction. For the results to apply at a broader linguistic level, more phonetic contexts other than Spanish word initial should be used. In addition, the implications of similarities in acoustic cues between English and Spanish should be further explored with this kind of perception test.

APPENDIX A

Perception Test Survey

Q0 What is your first name and last initial? (ex. Jeremy I.) (It will not be used, but it is just needed to connect this info to the data you provide in the study)

_____

Q1 Are you a native speaker of Spanish?

o Yes (1)

o No (2)

Q2 Did you serve a Spanish-speaking LDS mission?

o Yes (1)

o No (2)

Skip To: End of Block If Q2 = No

Q2.1 Where did you serve?

_____

Q2.2 How many months were you in the mission field (not including MTC time)?

_____

Q2.3 What percentage of your time would you say was spent speaking Spanish?

_____

Q2.4 How many years of Spanish classes did you take prior to your mission?

_____

Q2.5 How long has it been since you returned?

_____

End of Block: Default Question Block

Start of Block: Block 1

Q3 Have you participated in a Spanish language study abroad?

o Yes (1)

o No (2)

Skip To: End of Block If Q3 = No

Q3.1 Where did you go for the study abroad?

_____

Q3.2 How long did the study abroad last?

_____

Q3.3 What percentage of your time would you say was spent speaking Spanish?

_____

Q3.4 How many years of Spanish classes did you take prior to your study abroad?

_____

Q3.5 How long has it been since you returned?

_____

End of Block: Block 1

APPENDIX B

True Random Number Order

Column 1: Test Question Number

Column 2: Random Generated Stimulus Number

Question	Stimulus
1	7
2	1
3	7
4	6
5	7
6	2
7	7
8	5
9	4
10	7
11	4
12	6
13	3
14	1
15	6
16	1
17	4

Question	Stimulus
18	4
19	7
20	5
21	2
22	5
23	5
24	4
25	7
26	1
27	5
28	1
29	2
30	4
31	6
32	7
33	1
34	7

35	3
36	4
37	4
38	2
39	7
40	6
41	2
42	5
43	2
44	5
45	3
46	6
47	3
48	3
49	4
50	5
51	4
52	6

53	2
54	5
55	3
56	5
57	1
58	3
59	1
60	2
61	1
62	2
63	1
64	6
65	3
66	3
67	2
68	6
69	6
70	3

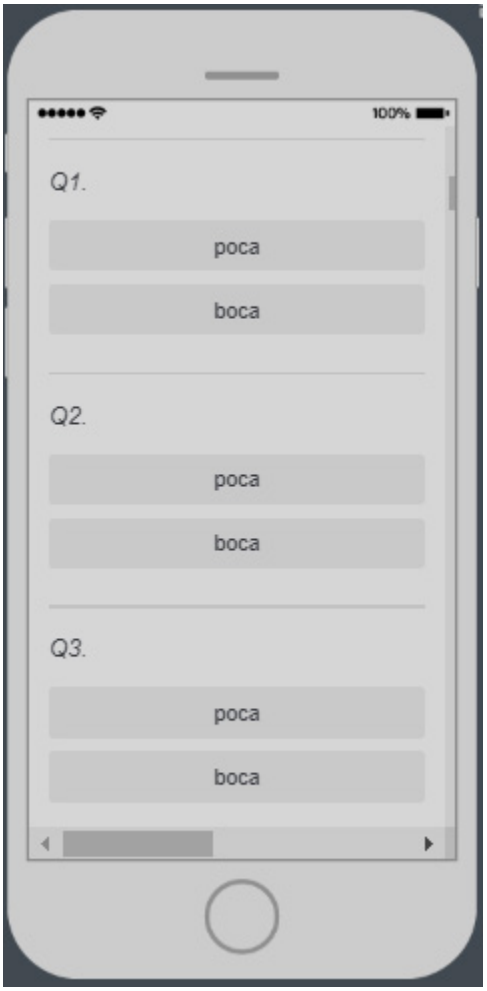
APPENDIX C

View of Qualtrics survey interface used for perception test

Both web browser and app version are included. Each of the three tests appeared as seen here, but with their respective words, depending on whether the participants chose to use a web browser or the mobile app. Each test showed the same word options for questions(Q) 1-70.

Web browser view:

Mobile app view:



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