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# ALLOPHONIC VARIATION IN THE SPANISH SIBILANT FRICATIVE

by

Alison Garcia

A dissertation submitted in

Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

in Linguistics

at

The University of Wisconsin-Milwaukee

May 2013

ABSTRACT

ALLOPHONIC VARIATION IN THE SPANISH SIBILANT FRICATIVE

by

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The University of Wisconsin-Milwaukee
Under the supervision of Professor Anne Pycha, 2013

In Spanish, the phoneme /s/ has two variants: [z] occurs in the coda when preceding a voiced consonant, and [s] occurs elsewhere. However, recent research has revealed irregular voicing patterns with regards to this phone. This dissertation examines two of these allophonic variations. It first investigates how speech rate and speech formality contribute to the gradient and variable nature of the voicing assimilation rule. Next, it explores possible intervocalic /s/ voicing in Highland Colombian Spanish.

In accordance with other studies, the results showed partial voicing of coda position /s/ before voiced consonants (25%-80% voiced frication noise). Furthermore, there was scarce evidence for intervocalic /s/ voicing in the Colombian data (3%-35% voiced frication noise). Both studies led to the same conclusion; that gestural blending is a prominent and frequently occurring process in Spanish. In both cases, the vocal chords begin to vibrate in anticipation of the following sound (either a voiced consonant or vowel) before the constriction needed to produce the fricative has ended.

The data revealed that there is a significant correlation between speech rate and the degree to which the adjacent segments overlap with one another. However, speech formality does not appear to be a function of the gestural overlap. In addition to the two factors tested (speech rate and speech formality), this dissertation also provides other possible factors which may affect the degree to which segments overlap such as its position within the syllable (onset versus coda) and following segment type (vowel versus consonant).

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## ACKNOWLEDGEMENTS

This dissertation would not have been possible without the guidance, help, and support of several individuals. I would first like to share my utmost gratitude to Professor Fred Eckman who continually encouraged me to push myself to be a better student and researcher. Thank you for always being there when I needed academic advice, guidance, or just wanted to talk, and for always believing in me as an aspiring linguist. Thank you for always finding the time to read my papers, and not getting frustrated with my countless typos. Without you, this journey would not have been as enjoyable as it was for me, and I sincerely appreciate every moment you spent helping me along the way.

I would also like to express my sincere appreciation to Professor Anne Pycha for taking me on as her advisee during my last year of study, and guiding me through the most difficult stages of the writing process. I am especially thankful for her sharing her knowledge and ideas on gestural blending. Without this, I would probably still be locked in my bedroom, looking for a pattern within my sporadic data.

Next, I wish to thank Professor Jae Yung Song for taking her time to teach me the details of measuring voicing and frication periods on PRAAT. Without this, I would not have been able to analyze my data. I am also indebted to her for patiently explaining to me how to run the statistics on my data, and how to interpret the results. To the rest of my committee members, Professor Hanyong Park and Professor Sandra Pucci, I thank you for your time, encouragement, support, and feedback.

To my parents, family, friends, and co-workers, thank you for encouraging me to pursue my doctoral degree, for always listening to my accomplishments and frustrations, and for helping me to stay positive throughout this process. It is because of you that I never let the stress of writing get the best of me.

Finally, this dissertation would not have been possible without the constant love, support, and encouragement from my husband, Alex Garcia. Thank you for encouraging me to pursue my doctoral studies and for never letting me look back when times were getting tough. Thank you for *ñoño-ing* such an amazing program for me to test my subjects, and for being my guinea pig in all of my experiments over the last three years. *Gracias sinceramente por estar siempre ahí. Te amo con todo mi ser y me siento tan afortunada de tener un esposo tan cariñoso y tierno como tú.*

# Chapter 1

# Introduction

## 1. Introduction

A problem that has long troubled phonologists is how to account for variability within a language's phonological system. Neu (1980) states that "phonological variation is an inherent characteristic of continuous speech" (37). Given its innate place among phonology, variation makes organizing the facts of a language into a set of phonological rules a daunting and arduous task. In this chapter, I review and compare two different approaches to Phonological Theory, Generative Phonology and Articulatory Phonology, and how they account for phonological variability among languages. I then take a closer look into the main focus of this dissertation, which is unaccounted for variation in the pronunciation of the Spanish sibilant fricative.

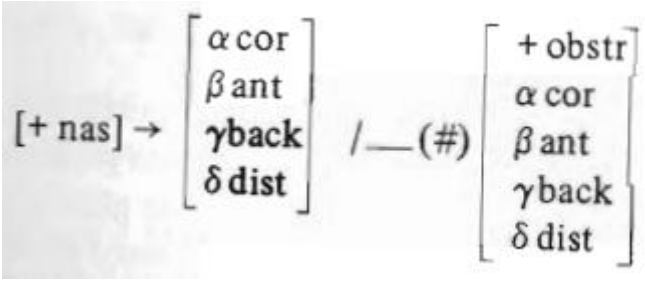
## 2. Generative Phonology

Generative phonology, created by Noam Chomsky and Morris Halle, makes up part of the theory of Transformational Generative Grammar (Goldsmith and Laks, forthcoming). Generally speaking, Generative Phonology is about grammaticality. More specifically, it aims to generate a set of rules which accurately describe a language's phonological system. This theory makes the claim that phonological representations are made up of distinct features, which describe aspects of both articulation and perception. These features are given binary values of + or -. A feature may emerge as one of two different levels of representation; a surface representation or an underlying

representation. The order in which the language's phonological rules are applied determine how underlying representations are transformed into surface representations, or rather, the actual pronunciation.

An example of how phonological rules, proposed in the Generative Phonology Theory, can correctly account for the surface representations can be seen in figure 1.1. Here, the rule states that in Spanish, a word final nasal will assimilate to the point of articulation of the following consonant.

**Figure 1.1**
*Nasal assimilation rule in Spanish (Harris, 1969).*




This rule reads as follows. An underlying nasal ([+nas]) will change (→) its place of articulation ([α cor, β ant, γ back, δ dist]) in the environment of pre-word boundary (/_)#)) before an obstruent of the following points of articulation ([+obstr α cor, β ant, γ back, δ dist]). To clarify, take for example the phrases *un nido* 'a nest', *un beso* 'a kiss', *un gol* 'a goal', and *un ñame* ' a yam'. In all of these phrases, the underlying representation of the word final nasal is alveolar; however, its surface representation changes according to the following consonant's place of articulation: *u[n] nido, u[m] beso, u[ŋ] gol, and u[ɲ] ñame.*

Unfortunately, many productive speech processes, such as assimilation, have variable pronunciations. For instance, in slow or disconnected speech, the word final nasal in Spanish may retain its alveolar place of articulation rather than assimilating to the following segment. The rule ordering proposed by Generative Phonology does not have a way of accounting for either inter-speaker or intra-speaker variance of speech production.

One possible solution to this problem, proposed by Silva-Corvalán (1989), was to sub-categorize the phonological rules. She proposed that there are categorical and variable rules. A categorical rule is one that expresses a systematic process of the language. One example of a categorical phonological rule is the alternation of [s] and [z] in the English plural marker. If a word ends in a voiceless consonant (cat) the voiceless variant is added to its plural form (cat[s]). Likewise, if a word ends in a voiced consonant (dog), the voiced variant is added to the plural form (dog[z]). In this case, there is no possible variation or alternation between the voiced and voiceless variants.

A variable rule, on the other hand, is one which is used to describe a non-categorical or non-systematic process of a language. These rules are also often referred to as "free" or "conditioned" variation. An example if an optional rule is the pronunciation of a word final /p, t, k/ in English. These sounds may be released ([kap$^{h}$]) or unreleased [kap']).

Although the addition of categorical and variable rules allows for a deeper interpretation of phonological variation, a new problem arose, which further complicated the generative description of a language's phonological processes. In addition to some processes being variable, they can also be gradient in nature. Place assimilation

processes, for instance, are almost always gradient (Ernestus, 2011). Zsiga, (1995) reports an example of gradient place assimilation in her study of American English palatalization. Alveolar obstruents assimilate to the palatility of following segments as in the phrase *woul[d j]ou* (would you). However, this assimilation rarely leads to a completely palatal segment, but rather the alveolar becomes more palatal through the course of its pronunciation.

Voice assimilation has also been shown to be a gradient process. Ernestus et. al (2006) investigated the regressive voicing assimilation of consonant clusters in Dutch, in which the first segment of the cluster will voice in the presence of a second voiced consonant. They found that although there were many cases in which glottal vibrations were seen throughout the entirety of the cluster, there were other instances in which the cluster was produced with no glottal vibration or with glottal vibrations during varying parts of the cluster.

Within the Generative Phonology framework, these processes, such as assimilation, reduction, and deletion, which have been shown to have gradient characteristics, were generally assumed to be categorical in nature (Ernestus, 2011). However, if they were truly categorical processes, the expected outcome should be identical to other segments with the same underlying features. For example, the Spanish [m] would be expected to have identical features in its surface representation regardless if it is the result of an underlying [m] as in the word *madre* 'mother', or if it is the result of a place assimilation as seen earlier in the phrase *u[m b]eso* 'a kiss'.

However, as Zsiga (1995) pointed out in her study on the palatalization of alveolar obstruents in English that the resulting segment is almost never identical to other

segments with the same underlying features; they have their own unique properties. In the previous example of *woul[d j]ou*, the [d] most often begins in the alveolar position, and slowly palatalizes throughout the duration of its realization. The resulting sound is much different than an underlying palatal obstruent, [c], in this case. Because of the different surface representations of the resulting sounds, the rules created by the Generative framework, whether they be categorical or variable, still cannot account for the gradient nature of many speech processes.

One proposed solution was that the difference between gradient and categorical speech production was a reflection of linguistic performance and linguistic competence (Ernestus, 2011). A speaker's linguistic competence would explain their knowledge of the categorical process of the languages, even though this was not always realized through their linguistic performance, perhaps due to physiological constraints, or articulatory effort, among other factors.

Other followers of the Generative Phonology Theory have looked to speech style as a way of describing why speech sounds may be realized in a variable or gradient way. Labov (1972) proposed that the quantification of speech style and stylistic variation should be considered an immediate problem for phonologists. A main component of speech style, as well as one of the most frequently researched, is speech formality.

Richards, Platt, and Weber (1986) define formal speech as "the type of speech used in situations when the speaker is very careful about pronunciation and choice of words and sentence structure. This type of speech may be used, for example, at official functions, and in debates and ceremonies" (p.109). Moreover, the problem with this definition is that it is vague and lacks a reliable way of determining in which formality

level a speaker is communicating. Because of this, other researchers have tried to quantify speech formality by considering the frequency of "formal" or "casual" words such as the *tú/usted* distinction in Spanish, or the presence or absence of the auxiliary verb "to be" in English (Heylighen and Dewaele, 1999). However, these classifications are quite limited, and not able to be generalized to other languages.

Regardless of the exact procedures used to determine speech formality, it is well agreed upon that formal speech occurs when the speaker pays special 'attention to form' (Labov 1972). For instance, in a formal situation, a speaker will try to approximate his or her grammar and pronunciation to the standard forms.

One of the first and most influential studies on language variation according to speech formality was Labov's 1972 "Social stratification of (r) in New York City department stores", in which he observed the variable pronunciation of non-prevocalic /r/. In this study, the participants who worked at Macy's retained this sound in their speech approximately 24% of the time. However, when they were asked to repeat their utterance, it was retained approximately 60% of the time. Labov concluded that the drastic change in the retention of this sound was due to that fact that speakers are more conscious of their speech when asked to repeat their utterance, thus approximating their speech to a more standard form as to not be misunderstood by the listener.

Harris (1969) also explored the idea of how speech formality can affect the degree of voicing assimilation of coda position /s/ in Spanish. He mentions that the phrase *es viudo* 'he is a widower' has a variable pronunciation and may be heard as [esbyuðo], [ezbyuðo] or [ezβyuðo]. He explains that the pronunciation without voicing assimilation would represent a "more careful" speech; likewise, the pronunciation with both complete

voicing assimilation, as well as complete voicing assimilation with spirantization of the following obstruent, represent a "less careful" speech. He concluded that the variable pronunciation is the result of the implementation of an optional rule which is controlled by the stylistic choice of the speaker.

An optional rule differs from the previously mentioned variable rule such that variable rules aim to add factors which govern how often particular variants may occur (Honeybone, 2011). In other words, optional rules contain less information about the exact context of application. This is an important distinction because the variation is not categorized as "orderly heterogeneity", but rather is truly dependent on the style the speaker wishes to portray with his or her speech. Unfortunately, the optional rules do nothing more than describe possible realizations of a sound sequence; they give no insight into *why* stylistic change alters pronunciation, or what is happening physically when a speaker changes their formality level. Furthermore, the optional rule still did not account for the gradient nature of sounds, as in the case of alveolar palatalization in English. It simply offers a finite set of phonetic outcomes, as previously seen in the Spanish example of *es viudo* realized as [esbyuðo], [ezbyuðo] or [ezβyuðo]. Because of this, alternate theories were offered with the end goal of accounting for and explaining the gradient and variable nature of sounds in a language's phonology.

## 3. Articulatory Phonology

Many researchers began to take notice of the fact that the categorical, variable, and optional phonological rules proposed by Generative Phonology lacked a component which successfully explained the gradient nature of sounds in connected speech, and

aimed their research at redefining how to describe a language's phonological system. One of the most influential theories comes from Browman and Goldstein (1986). Upset with the disconnect between phonological and physical descriptions, they proposed the theory of Articulatory Phonology. They stated that, "Human speech events can be seen as quite complex in the sense that an individual's utterance follows a continuous trajectory through space defined by a large number of potential degrees of freedom or dimensions" (p. 51). By observing the vocal tract, certain patterns can be seen such as the formation and release of a constriction, or the vibrations in the vocal cords. These features were given the name *articulatory gestures*.

Articulatory gestures are defined as *spatio-temporal* units (Gafos, 2002): The formation of a constriction causes its spatial dimensions. This constriction includes both the place of articulation (labial, alveolar, etc.) and the degree of constriction, or rather, the manner of articulation (fricative, stop, etc.) (Davidson, 2006). The temporal dimension comes from the fact that gestures unfold in time. During speech production, these gestures may either be activated sequentially, or overlap with one another.

The retiming of articulatory gestures, and the assumption that these gestures can be reduced and overlap with one another, makes Articulatory Phonology a powerful tool in the description of gradient sound processes, as it naturally explains the variability heard among sounds in speech. Take for instance the assimilation of point of articulation of word final nasals in Spanish. The rule created by generative phonology stated that the nasal in the phrase *un beso* will be realized as bilabial given the point of articulation of the following obstruent. Articulatory Phonology, however, argues that it is not a fixed assimilation rule which causes the bilabial place of articulation of the nasal, but rather it

is the result of an early onset of the bilabial closure during the realization of the preceding nasal. Furthermore, depending on the degree of overlap between the offset of the nasal production and the onset of the bilabial closure, this sound may be produced completely alveolar, or may begin alveolar and end bilabial.

Using these same principles, Articulatory Phonology can also account for the absence of many segments. In American English, a word final /t/ is often acoustically absent to the listener when preceding a bilabial stop, as in the phrase *perfec[t m]emory* (Brownman and Goldstein, 1990). However, it is not because this segment was deleted, but similar to what was seen in the example of Spanish nasal assimilation, the speaker had closed their lips for the bilabial sound before the /t/ was released, ultimately rendering it inaudible, even though it was still articulated.

Although each speaker and each language varies the extent in which gestures may reduce or overlap with adjacent segments, there are a few factors which promote higher reduction and overlap. The rate at which a speaker is articulating the utterances has a noteworthy effect on the degree of overlap; however this increase in overlap is mostly due to physiological constraints. As rate increases, speakers are put under time pressure to hit all of the points of articulation for a given utterance. In order to address this time constraint, reduction and overlap of articulatory gestures takes place. This effect has been studied by researchers such as Gay (1981), Munhall and Löfqvist (1992), Bryd and Tan (1996), and Davidson (2004), all of whom concluded that, although a fast speech rate is not necessarily a predicator of increased gestural overlap, the highest percentages of overlap are always found in the quickest speech rates.

Similar to Generative Phonologists, followers of Articulatory Phonology also agree that speech formality can alter the degree of gestural overlap. In fact, among all of the factors which favor increased gradient and variable pronunciations, speech formality is believed to be one of the most important (Ernestus, 2012).

Variable and gradient pronunciations are most often found in less formal speech styles. For example, Kerswill (1985) found that place assimilation of alveolar obstruents in American English is less common in more formal speech. Furthermore, extreme speech reductions, such as the pronunciation of *apparently* as [$p^{h}$ɛrī] are only found in very casual situations.

Phonological segments may be more prone to a gradient or variable pronunciation during casual speech because, according to Zsiga (1992), speakers have control over their articulators. Therefore, in a more formal context, they can consciously control the degree to which they allow the articulatory gestures to overlap with one another. This approximates their speech to a more standard for of the languages, and eases the communicative burden of the listener.

**4. Complementary Phonological Theories**

Both of the phonological theories detailed above have their own way of accounting for speech sounds. On the one hand, generative phonologists aim to find a set of rules which govern the use of speech sounds in a given language. Variability in the pronunciation of these sounds is then described using either variable or optional phonological rules. It does not, however, have a clear way of dealing with gradient pronunciations. On the other hand, articulatory phonology also describes speech sounds,

but predicts that the sounds will overlap with one another, thus causing a variable and gradient pronunciation.

However, it is not to say that these are two contradicting theories, but rather complement each other in their phonological descriptions. For instance, generative phonologists describe the normal processes that occur in a language. In Spanish, the generative voicing assimilation rule states that a coda position /s/ will voice to [z] when preceding a voiced consonant (*béi[z]bol)*. Although the degree to which this /s/ is voiced is variable, the generative rule tells us that voicing occurs (to any degree) in this position. This can be compared to English, which, even though it allows for /s/ to appear in the coda position before voiced consonants, it lacks this generative rule (ba[s]eball). Because of this, minimal to no voicing is expected in this position.

I argue that these two theories must be jointly considered in order to effectively account for a language's phonology. The generative rule, although in theory assumes an all-or-nothing approach, explains the generally tendencies of the language. From there, the articulatory phonological approach can detail why certain features of a given language are more prone to the variable and gradient pronunciations.

**5. The current study**

The aim of this dissertation is to investigate phonological variation in Spanish, and to try to uncover the source of this variation, whether it be from a categorical, variable, or optional phonological rule, or the result of overlapping or reducing articulatory gestures. More specifically, it will examine the allophonic variation in the pronunciation of the Spanish /s/.

Generative phonologists describe the sibilant fricative as having two corresponding allophones [s] and [z]. The current rule states that [z] occurs in the coda position before voiced consonants (*ci[z]ne* 'swan', *la[z] manos* 'the hands'), and [s] occurs elsewhere, including word initially (*la [s]opa* 'the soup'), word finally (*pe[s]* 'fish'), intervocallically (*ma[s]a* 'dough'), and in the coda position before voiceless consonants (*ha[s]ta* 'until').

However, studies have found other voicing patterns with respect to this phoneme which veer from the above mentioned distribution. For instance, many researchers, such as Harris (1969), Hooper (1972), Hualde (2005) and Navarro (1945), have documented a gradient and variable nature of the voicing assimilation rule; before voiced consonants, /s/ can remain voiceless, become partially voiced, or completely voice to [z].

Additional irregular voicing patterns of /s/ have been documented in specific dialects. For instance, Torreblanca (1986) noted voicing in the post-voiced consonantal position (such as *ganso* 'goose') in various towns in Central Spain. Also, intervocalic /s/ voicing has been documented in Highland Ecuadorian Spanish (HES), spoken in the Andes Mountains, including Cuenca, and the capital, Quito. In this dialect, the norm is for a word final /s/ to voice to [z] if followed by a word initial vowel as in the example *es uno* [ez.ú.no] 'it is one'.

Researchers have taken different approaches to describe the gradient and irregular /s/ voicing in Spanish. Traditionally, the voicing assimilation rule has been described as a categorical phonological process, and although claims have been that it is dependent on speech rate (Harris 1969) and speech style (Hualde, 2005), there is a lack of empirical evidence to support either of these claims.

The intervocalic /s/ voicing in Highland Ecuadorian Spanish, on the other hand, has been very well documented and described. According to Lipski (1989), this abnormal voicing is quite systematic and regular in the HES dialect, and is even independent of both speech rate and speech formality. The systematicity of the voicing in this dialect has led researchers, such as Lipski (1989) and Colina (2009), to take a Generative Phonology approach and try to come up with a set of rules which best explain this variation. (A complete description of these proposed rules can be seen in chapter 2 section 2.5).

Based on the abovementioned documented variation in the pronunciation of the Spanish sibilant fricative, I have posed the following research questions which will be addressed in this dissertation.

1).What causes the gradient and variable pronunciation of the voicing assimilation rule?

2). In addition to HES, do other dialects of Spanish systematically voice intervocalic /s/?

Upon reviewing the current research on the voicing assimilation rule in Spanish, I have concluded that, assuming a gradient voicing assimilation in Spanish, there are two possible reasons for the partial or incomplete assimilation: speech rate and speech formality.

Navarro (1967) states that a slower speech rate impedes the voicing of the fricative. Harris (1969) provides numerous examples of how a coda position fricative

may be realized as voiceless even before voiced consonants if the speech rate is slow enough, and how the fricative may be present in partial voicing (start voiced and end voiceless) during an intermediate speech rate.

Harris continues by mentioning that speech formality also plays a role in the degree of voicing assimilation. He compares the voicing of coda position /s/ to a native speaker's of English thoughts on the pronunciation of the intervocalic /t/ in a word such as *betty,* which can be heard as [tʰ] in more careful speech and as [ɾ] in less careful speech. Unfortunately, Harris provides these examples without any supporting data, and, to the best of my knowledge, no other researchers have experimentally compared the degree of voicing assimilation to either of these two factors.

The second research questions asks if there are other dialects of Spanish which voice intervocalic /s/, similar to what can be seen in the HES dialect. Given that a complete analysis of all of the Spanish dialects is far beyond the scope of this project, one dialect in particular, Highland Colombian Spanish (HCS), will be analyzed. This dialect was chosen for two reasons. First, it is a geographically and phonologically similar dialect to HES, which has already shown by far the most frequently occurring cases of intervocalic /s/ voicing. Also, other researchers have briefly mentioned the possibility of non-standard voicing patterns in this dialect. Torreblanca (1979), for instance, stated that "intervocalic /s/ does not occur only in Ecuador, but has also appeared in Mexico, El Salvador, Panama, and Colombia" (p. 501). However, there are no studies which offer data and evidence in favor of this voicing pattern in HCS.

This dissertation will test two hypotheses, each of which corresponds with the abovementioned research questions:

H1a. The Spanish voicing assimilation rule is positively correlated with speech rate; as speech rate increases, the degree of voicing of coda position /s/ will also increase.

H1b. The Spanish voicing assimilation rule is negatively correlated with speech formality; as speech style becomes more formal, the degree of voicing of coda position /s/ will decrease.

2. Speakers of Highland Colombian Spanish will voice intervocalic /s/.

In order to test hypotheses 1a and 1b, a group of 15 native speakers of Spanish, coming from various different cities and countries, were asked to complete a series of five tasks, each of which represented either a different speech rate or speech formality. They were asked to read aloud a word list three times. Before each reading they were instructed to either read it normally, slowly, or as quickly as possible. They were also asked to read a short story, and answer open-ended interview questions. The data was then imported into PRAAT where the duration of the frication noise, and the duration of the glottal vibrations were measured in order to obtain a total voicing percentage of the frication noise. Next, a repeated measures ANOVA was used in order determine if there was a significant correlation between the degree of /s/ voicing and speech rate or speech formality.

The procedures for testing the second hypothesis were the same as in H1a and H1b, with the exception of the participants. For this study, 15 native Spanish speakers from Bogotá, Colombia were asked to complete the five tasks: a word list read three times at three different speech rates, a reading passage, and interview questions. Similarly, the data collected from H2 was uploaded into PRAAT, and the percentage at which the intervocalic /s/ was produced as voiced was measured. A repeated measures ANOVA was used once again in order to determine if the voicing in this dialect is dependent on either speech rate or speech formality. More details on the procedures and results for both of the hypotheses tested can be seen in chapters 3 and 4 respectively.

This dissertation is organized as follows. In chapter 2, pertinent information regarding the Spanish sibilant fricative is provided. First, an overview of the history of the Spanish sibilants, as well as its current status, are provided. Next, variation among the pronunciation of this phoneme is discussed. The first variation of the sibilant fricative deals with the question of whether the Spanish voicing assimilation rule is a phonological rule, a general tendency, or a result of overlapping gestures. Next, other irregular voicing patterns will be examined, including the post-voiced consonantal voicing seen in Central Spain. Then, an in-depth look at the intervocalic /s/ voicing observed in the HES dialect in provided. Closing the literature review chapter is a brief discussion of possible intervocalic /s/ voicing in other Spanish dialects.

Chapter 3 begins with a restatement of the hypotheses being tested in this dissertation, followed by a review of the methodologies used to collect, transcribe, and code the data collected for both of the studies. The results and statistical analyses of the studies can be found in chapter 4. These results are then critically analyzed and discussed

in chapter 5. Here, I argue for gestural overlap as a way of accounting for the voiced frication noise present in the data from both studies. Finally, chapter 6 provides a summary of the main points of this dissertation.

# Chapter 2

# Literature review

## 1. Introduction

According to Obaid (1973), the sibilant fricative is the most unpredictable, elusive, shifting, erratic, and troublesome sound in the Spanish language. Subject to frequent and widespread modification, such as voicing, aspiration, and deletion, syllable and word final /s/ have formed the core of the greatest number of theoretical and descriptive inquiries in Spanish phonological studies (Lipski, 1989). What's more, in certain regions, some extreme modifications can even be heard in the word internal intervocalic position. In Bogotá, Colombia, for example, the phoneme can be heard in this environment with heavy aspiration such as in the word *nosotros* [no.hó.tros] 'we', and, according to Flórez (1973), this phenomenon is still continuing to develop and extend to other regions of the country.

Given the wide variation in the pronunciation of /s/, it has often been used by dialectologists as a classificatory feature for determining different Spanish dialect zones. In fact, Lipski (1984) states, "The behavior of the phoneme /s/ is one of the most variable phenomena characterizing Spanish phonology, and the differential behavior of this phoneme is perhaps the single most useful parameter in dialectological descriptions" (p. 34). An example of this can be seen with the aspiration of coda position /s/, which divides American Spanish into two main regions: Highland Spanish, spoken in Mexico City, Guatemala City, Bogotá, Lima, and Quito, retains the pronunciation of coda position /s/, whereas lowland Spanish, spoken in the Caribbean (including both the islands as well as the coastal regions of central and South America), Veracruz, Panamá,

and Caracas, aspirates coda position /s/ (Terrell, 1979). However, this clearly cannot be the only criterion for dividing American Spanish into dialect zones given that, despite the large homogeneity of the American highlands, there is still considerable variation from region to region.

In the following sections, some important variations with regards to the pronunciation of the Spanish sibilant fricative will be discussed. First, there will be a brief historical overview of the evolution of the Spanish sibilants. Next, the current status of this Spanish phoneme will be laid out, along with some modern variations in its realization. The first variation that will be discussed is the regressive voicing assimilation process, in which the coda position /s/ becomes voiced when preceding a voiced consonant. It has been argued that this process is a general tendency of the Spanish dialects which is dependent on speech rate and speech formality, rather than a mandatory phonological process. Finally, irregular voicing patterns of /s/ found in both Spain and Ecuador will be discussed.

## 2. Background

### 2.1 History and evolution of the Spanish sibilants

Latin came to be used in the Iberian Peninsula as a result of the large Roman influence at the beginning of the second Punic War around 218 B.C. After capturing the Carthaginians' capital of Cádiz in 206 B.C., the Romans began a gradual process of colonization of the diverse cultures living in the Peninsula at that time. The process of Romanization gradually spread westerly for approximately two centuries, until it reached the northern coastal region (present day Galicia) (Penny, 2004). The Latin spoken in the peninsula continued to develop and distance itself from other Latin varieties spoken at the

time, until it finally gave way to what is considered to be Old Castile Spanish (sometimes referred to as Medieval Spanish) during the early Middle Ages.

Old Castile Spanish contained two phonemic pairs of sibilant fricatives: [s, z], [ʃ, ʒ], as well as a pair of contrasting dental affricates, [t̪ˢ, d̪ᶻ], Since both [z] and [d̪ᶻ] developed from the intervocalic voicing of [s] and [t̪ˢ] respectively in Late Latin, and [ʒ] developed from the word-medial consonant clusters [kl, gl, lj] in Late Latin, the voiced sibilants in Old Castile rarely occurred outside of the intervocalic environment. Only a small group of borrowed words from Arabic or Gallo-Romance allowed a word initial [d̪ᶻ] or [ʒ] (Bradley and Delforge, 2006).

Table 2-1 illustrates the voicing opposition of the sibilant fricative and dental affricates in Old Castile Spanish.

**Table 2-1**
*Old Castile sibilants, taken from Penny (1993:82).*

| | | | | | |
|---|---|---|---|---|---|
| [de.t̪ˢir] | *deçir* | "to descend" | [de.d̪ᶻir] | *dezir* | "to say" |
| [fo.t̪ˢes] | *foçes* | "sickles" | [fo.d̪ᶻes] | *fozes* | "ravines" |
| [es.pe.so] | *espesso* | "thick" | [es.pe.zo] | *espeso* | "spent" |
| [o.so] | *osso* | "bear" | [o.zo] | *oso* | "I dare" |
| [ko.ʃo] | *coxo* | "he coked" | [ko.ʒo] | *kojo* | "I grasp" |
| [fi.ʃo] | *fixo* | "fixed" | [fi.ʒo] | *fijo* | "son" |

The first change to affect this system was a process of deaffrication of [t̪ˢ, d̪ᶻ]. This change began around the mid 13th century, and originally only affected these sounds

after apocope left them in the word final position. This deaffrication process next affected these sounds in the syllable initial position, and had completely reduced all of the dental affricates to dental sibilants by the 14th century, while still maintaining voicing contrast, as in the previous example of [de.s̪ir] "to descend" and [de.z̪ir] "to say" (Bradley and Delforge, 2006).

The next major change to affect this system marks the beginning of Early Modern Castilian Spanish, and occurred during the 15th and 16th centuries. During this time, the voiced phonemes [z̪, z, ʒ] merged with their voiceless counterparts in all phonological environments,[1] eliminating all minimal pair distinctions, as represented in table 2-2. This change occurred gradually, starting around the Burgos area, in the northernmost part of the peninsula, initiated by the youth and lower classes. It was not well established in the then-capital of Spain, Toledo, until much later. Evidence for this slow devoicing process can be seen in Modern Judeo-Spanish, spoken by the decedents of the Jews who were expelled from Spain during the early 16th century, which retains the voicing distinction in the intervocalic position (Hualde, 2011).

[1] The voiced sibilants still occurred allophonically in the syllable final position when followed by a voiced consonant.

**Table 2-2**
*Early Modern Castilian Spanish sibilant system around the 16th century.*

| | | | | | |
|---|---|---|---|---|---|
| [de.s̪ir] | *deçir* | "to descend" | [de.s̪ir] | *dezir* | "to say" |
| [o.so] | *osso* | "bear" | [o.so] | *oso* | "I dare" |
| [fi.ʃo] | *fixo* | "fixed" | [fi.ʃo] | *fijo* | "son" |

It is also important to note here, that given the belatedness of this devoicing process, the /s/-/z/ contrast was brought to America during the early colonization period, beginning in the late fifteenth century. For instance, the Spaniards first arrived to present day Colombia in 1509, right in the middle of the devoicing process (Lipski, 1994). Proof of this contrast in American Spanish can be seen in Spanish loanwords into various indigenous languages of the area. For example, the Spanish words for 'to marry' and 'to behave' were borrowed into Quichua as *cazaranza* and *cazuna* respectively, both with an intervocalic [z] (Toscano Mateus, 1953). However Cline (1972) noted that there is no evidence of intervocalic voicing in any of the American Spanish dialects after 1570.

The final step in the simplification of the Spanish fricatives was a systematic change in the point of articulation for both the dental and palatoalveolar phonemes, occurring in the 16th and 17th centuries. In both Northern and Southern Spain, /ʃ/ moved back in the mouth to become the velar fricative /x/. This transformation can be seen for example in the word *mujer* 'woman' which was pronounced in Old Castilian Spanish as [mu.ʒér]. After the devoicing process it was [mu.ʃér], and finally, in modern Spanish, is pronounced as [mu.xér].

The transformation of the dental sibilant, however, was different for both Northern and Southern Spain. In Southern Spain, it merged with the alveolar /s/, whereas in Northern Spain, the interdental fricative /θ/ replaced the dental sibilant. The complete sibilant transformation can be seen in the word *decir* 'to say' which was originally pronounced as [de.d̪ᶻ̪íɾ], followed by [de.z̪íɾ] after the deaffrication process. Next, devoicing left this word pronounced as [de.s̪íɾ], and finally, in Modern Spanish, it is pronounced as [de.θíɾ] in Northern Spain and [de.siɾ] in Southern Spain.

**2.2 Current status of the Spanish sibilant fricative**

Modern Spanish has a single sibilant phoneme, /s/. When it occurs in the coda position, the norm is for it to voice when preceding a voiced consonant both word internally, *chisme* [ʧíz.me] 'gossip' and across word boundaries, *dos manos* [doz.má.nos] 'two hands'. Furthermore, there is voicing assimilation before a word-initial glide (including cases of prefixation with *des*-) given that these sounds are consonantized in this position such as *las llamas* [laz.já.mas] the flames', *deshielo* [dez.jé.lo] 'I defrost' (Hualde, 2005).

**2.3 Variability and optionality of allophonic voicing assimilation rule**

Although the aforementioned sibilant fricative voicing assimilation rule has been documented and taught in nearly all Spanish phonology texts books, there are numerous researchers who believe that the voicing assimilation process is not necessarily a

mandatory phonological process, but rather a general tendency which is stylistically determined, gradient and variable (Dykstra (1955), Harris (1969), Hooper (1972), Hualde (2005), Navarro (1945) and Schmidt and Willis (2011). Hualde (2005), for instance, mentions that "the [z] is simply a possible realization of /s/ before certain consonants (before voiced consonants) as in *desde* /désde/ [dézðe] or [désðe] 'from', *mismo* /mísmo/ [mízmo] or [mísmo] 'same'" (p. 10). He continues by saying that "this segment may be present only partial or incomplete voicing" (p. 159).

Harris (1969) was among the first to consider the different factors which could cause the partial or incomplete voicing of this sound. First, he considers speech formality. He begins his discussion with the various possible pronunciations of the phrase *es viudo* 'he's a widower', which he says "may be heard as [es.byu.ðo], [ez.byu.ðo] or [ez.βu.ðo]" (p. 6). He concludes that the alternations of voicing must be described in terms of stylistic variation given that native speakers were in full agreement that "[es.byu.ðo] represents a 'more careful' and [ezβuðo] a 'less careful' pronunciation" (p. 7). He explains that their feelings towards the voicing of /s/ would be comparable to a native speaker's of English thoughts of the pronunciation of the intervocalic /t/ in a word such as *betty* as either [$t^h$] in more careful speech and as [ɾ] in less careful speech.

Although it is certainly reasonable to consider that the voicing of /s/ may be dependent on speech formality, with the highest degree of voicing occurring in "less careful" speech as proposed by Harris (1969), to the best of my knowledge, there are no studies which directly compare these two factors (speech formality and degree of fricative voicing).

Even more common than speech formality is the argument that speech rate determines the degree of voicing assimilation of the fricative. Even Navarro (1967), who states "*La /s/ sonora aparece únicamente en nuestra lengua en posición final de sílaba, precediendo inmediatamente a otra consonante sonora; en cualquier otra posición, su presencia es anormal y esporádica*" (The voiced /s/ only appears in our language in the syllable final position, immediately preceding another voiced consonant; in any other position, its presence is abnormal and sporadic) (p. 108), agrees that a slower speech rate impedes the voicing of the fricative.

Harris (1969, p. 7) categorizes and defines four different speech rates in which the degree of voicing assimilation may vary. These different categories are as follows:

> *Largo:* very slow, deliberate, over precise; typical of, for example, trying to communicate with a foreigner who has little competence in the language or correcting a misunderstanding over a bad telephone connection.
>
> *Andante*: moderately slow, careful, but natural. Typical of, for example, delivering a lecture or teaching a class in a large lecture hall without electronic amplification.
>
> *Allegretto*: moderately fast, casual, colloquial. In many situations one might easily alternate between Andante and Allegretto in mid-discourse or even mid-sentence.
>
> *Presto*: Very fast, completely unguarded.

Harris continues to explain that during *largo* or slow speech, there is no voicing assimilation of the fricative to the following consonant. During both *andante* and *allegretto* speech, there will be partial voicing assimilation, in so that the beginning portion of the fricative is voiceless, yet voices near the end of the frication noise. Finally, during *presto* speech, full voicing assimilation should be expected. Consider the

following examples given in table 2-3. Torreblanca (1978) further supports this claim when he stated that the regressive assimilatory process cannot occur in slow or emphatic speech (p. 499).

**Table 2-3**

*Pronunciation of asno 'donkey' according to speech rate, as proposed by Harris (1969).*

| Speech rate | Pronunciation |
|---|---|
| Largo | [ás.no] |
| Andante | [ás$^{z}$.no] |
| Allegretto | [ás$^{z}$.no] |
| Presto | [áz.no] |

Even though many researchers seem to be in concordance with the fact that /s/ may appear before voiced consonants as only partially voiced or completely voiceless depending on certain external factors such as speech rate and speech formality, there is a scarcity of non-impressionistic data which directly measures the phonetic realization of the voicing assimilation process. In fact, there are only three known studies which address this issue, Romero (1999), Campos-Astorkiza (2010) and Schmidt and Willis (2010).

Romero (1999) aimed to quantify both the magnitude and the laryngeal gestures of the assimilatory process. In order to do so, two different techniques were used as one native speaker of Castilian Spanish read aloud a list of words in a carrier sentence a total of six times per words. The techniques used were electromagnetic articulometry (EMMA), which consists of three transmitters that generate a magnetic field, along with various receiver transducer coils placed along the participant's vocal tract, and laryngeal

transillumination, which consists of a lights attached to the end of a endoscope that hangs in the participant's pharynx and a photoelectric cell which is placed on the participant's neck, just below the thyroid cartilage.

Romero's results showed a gradation in terms of the magnitude of the voicing with single voiced stops displaying the most voicing, indicated by a smaller glottal opening, while /s/ plus a voiceless consonant displayed the least amount of voicing, or rather, had the largest glottal opening. However, /s/ followed by a voiced consonant showed laryngeal gestures whose magnitude lies in between that of a single voiced consonant and an /s/ followed by a voiceless consonant.

In addition to measuring the magnitude of the voicing, Romero also looked at the timing between the laryngeal and supralaryngeal peaks in his participant's speech. His results showed the laryngeal gesture peak in /s/ + voiced stop clusters occurs between the supralaryngeal gesture peaks for /s/ and the stop. In other words, the state of the glottis changes before the point of articulation moves from alveolar for the /s/ to the appropriate point of articulation for the following consonant (either labial, dental or velar).

At the end of his study, Romero concluded that the voicing assimilation process in Spanish is not a categorical phenomenon, but rather a gradient feature of the language given the varying degrees of magnitude of the fricative. Furthermore, there is a mutual influence between the fricative and following obstruent given the timing of the gestural features, which suggests that the voicing assimilation is a result of gestural blending rather than voicing assimilation.

The second study to investigate the voicing assimilation rule was by Campos-Astorkiza (2010) who examined how stress and prosodic boundaries influence the

gradient nature of the assimilation of syllable final /s/ in Northern Peninsular Spanish. She measured the degree of fricative voicing under different stress conditions, prosodic boundaries, and intonational phrase boundaries, hypothesizing that the degree of voicing assimilation would decrease upon moving to higher prosodic boundaries (from word internal, to word boundary to intonational phrase boundary).

Her results showed that not all participants fully voiced /s/ when it preceded a voiced consonant. She first noted that while the stress of the preceding vowel affects the total duration of the fricative, there was no correlation between vowel stress and fricative voicing. As for the prosodic boundaries, preliminary results have suggested the assimilation does change in the hypothesized direction.

Finally, Schmidt and Willis (2010) also noticed the conflicting views about the phonetic realization of coda /s/ in Spanish, as well as the lack of research to discover the motivation for this variation, and thus aimed their research at trying to discover systematic assimilatory patterns of /s/ voicing in the greater Mexico City metropolitan area, according to both gender of the speaker and the following segment.

The twelve participants were asked to complete a picture-description task while being recorded. This method was used in order to elicit a more natural and continuous speech compared to reading tasks. Their analysis was limited to cases of word internal /s/ when preceding either a voiced or voiceless consonant or a vowel. However, due to a low frequency of Spanish words which contain an /s/ followed by a voiced consonant, the following segment was restricted to nasals, bilabial stops, and laterals. The following vowel was restricted to either a mid or low vowel.

The data was analyzed using PRAAT, where the sibilant segment was determined by the strong high-frequency frication noise around 8,000 to 9,000 hertz, and the voicing was determined by both the presence of visual and regular glottal pulses in the voice bar, and regular periodic patterns in the waveform.

Next, the total percentage of voicing was determined by subtracting the duration of the voicing from the total duration of the fricative segment. Based off of these measurements, the fricative was coded as being either voiced, if the majority, at least 60%, of the total frication period was voiced, or voiceless, if the majority of the total frication period was voiceless.

Their results found that in the normal voicing context (before voiced consonants), /s/ only voiced 63% of the time; the remaining 37% of the time, it remained voiceless (more than 60% of the total frication noise was voiceless). Their data was further analyzed according to the phrasal position. The coda /s/ was voiced before other voiced consonants 76% of the time when it was phrase internal, but only 53% of the time when it was phrase final (referring to the final word of the utterance rather than the final sound, as all token words consisted of word internal /s/). These results could be related back to Romero's study in which he found that the voicing of the fricative was due to gestural overlap given that Bryd and Saltzman (1998) predict a decreasing overlap at phrase boundaries.

Finally, they noted in their results that males followed the normal voicing assimilation rule slightly more than females. The females produced the voiceless variant in this position 41% of the time, whereas the males produced the voiceless variant only 33% of the time.

Schmidt and Willis concluded that the voicing assimilation rule, although is undoubtedly present in this dialect, is not a categorical process for their participants' demographics (young adults in Mexico City), but rather a general tendency as previously suggested by Hualde (2005). However, these conclusions cannot necessarily be generalized to other dialects of Spanish. They also argue that the voicing of /s/ should be viewed as both progressive and regressive given that the majority of their data displayed left-edge voicing, meaning that the preceding vowel, regardless of the consonant following the /s/, contributed to the degree voicing.

There are a few limitations and critiques of this study. Firstly, the token words were limited to word-internal contexts; it is unclear if the study would have yielded similar results if the coda /s/ had occurred at word boundaries. Furthermore, there was a wide range of variation in terms of the degree of /s/ voicing by the individual speakers. Although several participants used the voiced variant before other voiced consonants more than 85% of the time, others used the voiceless variant in this same context more than half of the time, and there is no discussion given as to why there may be such drastic individual differences.

Finally, they mention at the end of their study that the majority of the voicing was left-edge voicing, meaning that the frication noise started out as being voiced, and then ended voiceless, yet there was no discussion as to whether or not the preceding vowel had any effect over the degree of voicing.

Even though all three studies have shown that there can be cases of both partial and incomplete voicing of the fricative before voiced consonants, they all lack a control over the extra linguistic factors which were originally believed to play a role in the

voicing process: speech rate and speech formality. Because of this, there are still no known studies which directly compare the degree of voicing to speech rate and speech formality, which may then be used to either support or reject those previously stated claims made by Navarro (1945) Harris (1969) and Hualde (2005) that the voicing assimilation rule is directly correlated with these factors.

### 2.4 Intervocalic /s/ voicing in Spain

Further variation in the pronunciation of the Spanish /s/ can be seen in both Spain and Ecuador, where there is a tendency to voice intervocalic /s/. Instances of intervocalic [z] in place of /s/ are generally very rare in Spanish dialects. Navarro (1965) states, "*La /s/ sonora aparece únicamente en nuestra lengua en posición final de sílaba, precediendo inmediatamente a otra consonante sonora, en cualquier otra posición su presencia es anormal y esporádica* (The sonorous /s/ only appears in our language in the syllable final position, immediately preceding a voiced consonant, in any other position, its presence is abnormal and sporadic) (p. 108). However, there is considerable documentation of systematic intervocalic /s/ voicing in these two regions.

The research on this non-standard intervocalic /s/ voicing in Spain remains quite limited. Torreblanca (1986) was among the first to investigate this phenomenon in the dialects of Toledo, Caceres, and Avila, located in central Spain. He discovered that /s/ voiced not only intervocallically, but also prevocalically when preceded by a voiced consonant, both word internally, and across word boundaries. However, he points out that in this position (post-consonantal), the voicing is not continuous, but rather the phoneme both begins and ends as voiced, but there can be moments of voicelessness in

the middle. Table 2-4 displays the different environments in which /s/ tends to voice in these three dialects in Spain.

**Table 2-4**
*Sibilant voicing in Central Peninsular Spanish as found by Torreblanca (1986)*

| | | | |
|---|---|---|---|
| Intervocalic word internal | [gwé.zos] | *Huesos* | "bones" |
| Post (voiced) consonantal | [man.zo] | *Manso* | "tame" |
| Intervocalic word final | [pwé.zi] | *Pues sí* | "well, yes" |
| Intervocalic word initial | [a.βér.zi] | *A ver si* | "let's see if" |

Torreblanca continues by discussing the details of the pronunciation of the voiced variant, by first mentioning that the intervocalic /s/ voicing is much more frequently heard than post-consonantal voicing, especially when the flanking vowels are both unstressed; when /s/ follows a stressed vowel, it tends to retain its voicelessness. Furthermore, voicing is uncommon when following a pause, thus the two words must be in close juncture to one another in order for the voicing to occur.

Additionally, Torreblanca noted important social differences associated with the degree of voicing. In some dialectal areas in Central Spain, the elderly tend to only voice a word final intervocalic /s/, whereas the younger and middle aged interviewees voiced the intervocalic /s/ in any part of the word, although the final position did remain the most frequent.

Finally, Torreblanca analyzed how different parts of speech may serve as predicators for intervocalic /s/ voicing in this region. He discovered that the voicing most often occurs in prepositions and conjunctions, and tends to remain voiceless in nouns and verbs, with the exception of three common words in which intervocalic /s/ was almost

always realized as voiced: *hacer* ‘to do/make’, *ser* ‘to be’ and *cosa* ‘thing’. Adjectives, pronouns, and adverbs took an intermediate position.

The degree of voicing further varied by speech rate in different regions of Spain. In Toledo, for instance, voicing was reserved for fast, casual speech, whereas nearly all fricatives remained voiceless during emphatic pronunciation. However, in the smaller towns of Tietar and Avila, voicing was often heard in slow, careful speech, as well as casual speech.

Torreblanca concluded his investigation with a discussion about the origin of /s/ voicing in this region. He proposed two possible sources of this phenomenon. It was either a phonetic archaism or a new innovation.

His argument for the voicing being a phonetic archaism is that many common words in which the voicing was heard, such as *casa* and *hacer*, were historically pronounced as voiced, and it is possible that the systematic devoicing which occurred in Spain during the sixteenth century did not reach these smaller communities.

Espinosa (1935), who also investigated the voicing patterns in this region of Spain, stated that many children from Garrovillas spontaneously voice instances of intervocalic /s/, and admitted that the voiced variant felt more natural than the voiceless one. Additionally, one woman from Navasfrias even rejected the pronunciation of the word *grosero* ‘rude’ with the voiceless variant.

Torreblanca uses Espinosa’s findings as additional evidence for his claim that the /s/ voicing in these dialects of Peninsular Spanish may in fact be phonetic archaisms. In order to make these grammaticality judgments on the pronunciation of certain words, Espinosa’s participants had to have been able to acoustically distinguish the voiced from

the voiceless variant. If this were true, it would indicate that the modern voicing had to have begun during a time in which the old sonorous pronunciation was still conserved, and then simply spread to further phonological environments.

The second prediction made by Torreblanca is that rather than being an archaism, the voicing in these dialects is a new phonetic innovation. He claims that modern Spanish is experimenting with a general process of articulatory lenition which has manifested in many different ways such as the aspiration or loss of /s/, the loss of intervocalic /b, d, g/, and the voicing of previously voiceless consonants. Following this idea, the /s/ voicing in Peninsular Spanish is no more than a victim of a more generalized lenition process occurring in the language.

Evidence for this claim lies in the fact that the weakest phonological position for the /s/ is post-vocalic, while the strongest is absolute initial. Post-consonantal /s/ occupies an intermediate position. Because of this, the lenition process would be expected to affect each position differently, which is exactly what his findings suggest. Voicing in the intervocalic position was more commonly heard than in the post-consonantal position, and very rarely heard after a hesitation, or rather, in the absolute initial position.

Other researchers have briefly mentioned this phenomenon as well; however, their findings and explanations are generally exhausted within a few short sentences. For instance, Mendez-Pidal (1962) mentions that the distinction between the old voiced and voiceless variants is conserved in Caceres word internally, and is voiced word finally when preceding a vowel, but aspirated when preceding a consonant.

Espinosa (1935) offers a detailed list of regions of Peninsular Spanish in which the voiced/voiceless distinction is retained including a small area of Southwest Salamanca, along the border with Portugal, and several towns in the Northeast of Caceres. He explains that the voicing in these regions is very wide spread, with notable fidelity to the medieval use of these phonemes, but does not offer any insights as to why this distinction is retained in these areas, which speakers are making this distinction, and in which environments this distinction is most likely to occur.

More recently, McKinnon (2012) has documented additional irregular /s/ voicing patterns in the Spanish of Catalonia as well. For his study, McKinnon tested 16 Spanish Catalan bilinguals living in Catalonia; however, 11 of the participants claimed to use more Catalan than Spanish in their everyday lives. The participants were asked to read aloud a short paragraph, as well as answer interview questions about Catalonian culture and politics. The cases of intervocalic /s/ from the collected data were then analyzed and categorized as being voiceless, partially voiced, or fully voiced. A voiceless fricative was one in which less than 20% of the total frication noise was voiced. A partially voiced fricative was one in which 21-90% of the frication noise was voiced, and any fricative that was voiced for more than 91% of its total duration was considered to be voiced.

His results showed that the pronunciation of intervocalic /s/ for both tasks (interview and reading) was completely voiceless (less than 20% voicing) 48% of the time, and completely voiced (more than 91% voicing) 13% of the time. The remaining tokens were categorized as being partially voiced. McKinnon further broke down the data into the different environments in which the intervocalic /s/ occurred, and found that voicing was most frequent in the word final intervocalic position. There was not,

however, a large difference in the percentage of voicing according to the speech formality, or rather, the different tasks the participants were asked to perform.

McKinnon concluded that the voicing in Catalonia is distinct from the voicing in other regions of Spain such that the voicing in Catalonia occurs by means of the bilinguals imposing Catalan phonology onto their spoken Spanish, rather than through a process of lenition as proposed by Torreblanca.

Catalan, unlike Spanish, not only has a phonemic distinction between /s/ and /z/ ([ká.za] 'house' versus [ká.sa] 'he hunts'), but also voices word final /s/ when it precedes a vowel. Therefore it would not be unreasonable to believe that Catalan Spanish bilinguals may also voice word final /s/ when speaking Spanish.

This claim was further supported after McKinnon analyzed the biographical data of his participants. Five of the participants, all of whom identified themselves as being Catalan dominant, fully voiced intervocalic /s/ roughly 25% of the time. However, besides signaling that the five participants who were most likely to voice were all Catalan dominant, McKinnon does not clearly point out which of the participants were Spanish dominant, thus it is hard to make a close comparison of the two groups. Furthermore, it would be interesting to observe whether or not Spanish monolinguals living in Catalonia also show evidence of /s/ voicing due to the close contact of the two languages.

### 2.5 Intervocalic /s/ voicing in Highland Ecuadorian Spanish

Further variation in the pronunciation of intervocalic /s/ has been well documented in Highland Ecuadorian Spanish (henceforth HES). Robinson (1979) was the first to take notice of this variation while working as a Fulbright lecturer in the area, and aimed his research towards finding hard data which would support what he had heard

through his own personal exposure. He interviewed and recorded pairs of male students in their last year of secondary school in different provincial capitals in Ecuador.

In addition to the interview, the participants were also asked to read aloud a list of words. Included in this list were two unfamiliar terms: *desalar* (des-alar) 'to remove wings from' and *desalar* (de-salar) 'to remove salt from'.

The evidence of intervocalic /s/ voicing led Robinson to classify three distinct dialect zones in the Ecuadorian Highlands. The first dialect starts in the provenance of Imbabura in the North to Chimborazo in approximately the center of the country which includes the Capital city of Quito. The second dialect zone is the city Cuenca (provincial capital of Azuay). The third HES dialect runs from Carchi in the extreme North of the country to Loja in the extreme south. See figure 2-1.

**Figure 2-1**
*Ecuadorian Provinces*


The third dialect, which runs along the eastern-most part of the country, was the only one to solely implement standard Spanish voicing patterns (/s/ voices only in the coda position before voiced consonants).

In dialects one (including Quito) and two (Cuenca), in addition to the normal voicing before a voiced consonant, the voiced variant also appeared in the intervocalic word final position. Furthermore, in dialect two, there was voicing in the intervocalic prefix-final position. Table 2-5 shows the distribution of the sibilant fricative in all three HES dialects, as well as in standard Spanish.

**Table 2-5**
*Distribution of [s] and [z] in Highland Ecuadorian dialects and standard Spanish according to Robinson (1979)*

| Environment | Dialect 1 (Quito) | Dialect 2 (Cuenca) | Dialect 3 (Loja) | Standard |
|---|---|---|---|---|
| 1. V_#: Comes | [s] | [s] | [s] | [s] |
| 2. #_V: Seis | [s] | [s] | [s] | [s] |
| 3. C_: Cansa | [s] | [s] | [s] | [s] |
| 4. V_$C_{VL}$: Hasta | [s] | [s] | [s] | [s] |
| 5. V_V: Casa | [s] | [s] | [s] | [s] |
| 6. V_%V: Desayuno | [s] | [z] | [s] | [s] |
| 7. V_#V: Es una | [z] | [z] | [s] | [s] |
| 8. V_$C_{VD:}$ Desde | [z] | [z] | [z] | [z] |

In addition to what can be seen in table 2-5, Robinson also noted that both dialects one and two showed a significant amount of word final /s/ voicing when followed by a voiceless consonant (such as *es todo* [ez.tó.ðo), provided that the speaker hesitates at the word boundary. Thus, all non-standard voicing in these two dialects occurs in the word final position, as well as the prefix-final position for dialect 2.

Robinson argues that the voicing occurs in HES as a way of signaling the fricatives word-final status, thus avoiding the ambiguity which comes with phrases that are homophonous in standard Spanish such as *has ido* [a.sí.ðo] 'you have gone' and *ha*

*sido* [a.sí. ðo] ‘he/she has been’. However, this still left in question the case of prefix-final voicing for dialect two.

During his data collection, Robinson had the participants read aloud a list of words, containing two unknown words, *desalar* ‘to remove wings from’ and *desalar* ‘to remove salt from’. The first time the word list was read, there were no glosses given, and all of the participants, including those from Cuenca, produced the voiceless variant for both words. However, after receiving the gloss, the first *desalar* (*de+salar*) ‘to remove salt from’ remained voiceless, whereas in the second *desalar* (*des+alar*) ‘to remove wings from’ the prefix final /s/ was consistently voiced in the Cuenca dialect.

These results lead Robinson to believe that the Cuenca dialect goes one step beyond word boundaries, and carries their /s/ voicing onto prefix boundaries in order to further reduce the ambiguity which could be caused by sets of words such as those presented to his participants.

Moreover, many participants from this region produced other instances of intervocalic /s/ voicing which could not be attributed to either prefix or word boundaries, such as in the word *desastre* ‘disaster’. It is not plausible to say that *astre* can be recognized synchronically as a root which takes the prefix *des*, thus Robinson concluded that in the Cuenca area, non-standard syllable and prefix boundaries exist, so that the /s/ in *desastre* must have been perceived as being in a prefix final position, given that it is often realized in such a way when it forms part of the prefix *des-* as in the words *destapar* “to take off a lid” and *descorazonado* “without a heart”.

To sum up Robinson’s (1979) investigations on the intervocalic /s/ voicing in HES, there are three major dialect regions in Highland Ecuador. One dialect, located on

the Eastern most part of the country, only shows normal voicing patterns; there was no evidence of intervocalic /s/ voicing. Both of the other two dialects voice a word final intervocalic /s/, and the Cuenca dialect will also voice a prefix or perceived prefix final intervocalic /s/. He further concludes that /s/ will voice syllable finally, unless followed in close juncture by a voiceless consonant as in the case of *es…todo* 'it is…all' in which the /s/ voices to signify its word final position before the hesitation.

The next person to look at the /s/ voicing phenomenon in HES was Lipski (1989), who aimed his research at redefining the Ecuadorian voicing data provided by Robinson, and offering possible explanations as to why these non-standard voicing patterns exist. First, he provided a more-detailed account of the phonological environments and conditions in which the voicing occurs. As previously noted by Robinson, Lipski agrees that in addition to the normal voicing assimilation rule (/s/ voices to [z] before voiced consonants), HES also voices word final intervocalic /s/. Furthermore, he offers that the voicing is independent of grammatical structure and word class; all instances of word final intervocalic /s/ voice, regardless if it is an article (*los otros* [lo.zó.tɾos] 'the others'), adverb (*pues en* [pwé.zen] 'well in'), noun (*casas altas* [ká.sa.zą̱l.tas] 'tall houses'), or verb in any tense (*es él* 'e.zel] 'it is him'). He also found no correlation between the voicing and stressed versus unstressed syllables.

Additionally, Lipski adds to Robinson's discussion on the voicing of /s/ before voiceless consonants, by saying that the voicing can occur in the pre-pausal position, when the speaker intends on finishing the sentence, but hesitates in order to complete a thought or retrieve a lexical item. Voicing in this context can occur regardless of the

voicing or manner of the following segment. Table 2-6 shows some common examples of voicing in all possible contexts gathered by Lipski during his study.

**Table 2-6**
*Pre-pausal /s/ voicing in HES as documented by Lipski (1989)*

1. *Si el professor no e[z] ...lo suficientemente capaz.*
   'if the teacher is not...sufficiently capable'
2. *es, digamo[z] ...*
   it's, let's say…
3. *los precios de lo[z] ...comerciantes*
   'the prices of the...buisiness owners'
4. *no todos lo[z] ...profesionales*
   'not all…professionales'
5. *yo tenía, pue[z]*
   'I had, then…'

According to Lipski, one plausible reason as to why pre-pausal /s/ is voiced in this dialect, regardless of the following sound, is that there is a high statistical probability that the next word will begin with a voiced segment, either consonant or vowel, thus the speakers are preparing themselves for the following segment.

Voicing does not occur in the word initial post-vocalic position; however voicing of syllable initial intervocalic /s/ can be heard word-internally in Cuenca. Moreover, Lipski offers that the syllable-internal /s/ voicing is limited to the prefix final position (*deshechables* [de.ze.ʧá.bles] 'disposible'), and to words which have a general phonetic form of a prefix (*desastre* [de.zás.tre] 'disaster'). It would not be plausible to say that voicing occurs at morpheme boundaries since there are no noted cases in which a stem-final prevocalic /s/ voices before diminutives or derivational affixes (*pez+ecito*

[pe.se.cí.to] ‘little fish’, *feliz+idad* [fe.li.si.dád] ‘happiness’). Lipski adds that the presence of voicing, or any phonological change, in order to signal word boundaries is quite unusual given that normal phrase-level phonology in Spanish eliminates the marking of word boundaries by resyllabifying a word final /s/ to the onset of the following vowel-initial word (*los otros* [lo.só.tɾos]). However, in these dialects, he claims that the voicing phenomenon will occur quite systematically in normal connected speech and is independent of both speech rate and register.

Lipski continues by presenting several possible answers to the voicing pattern in HES. He starts by arguing that combining the syllable-final pre-consonantal voicing assimilation with the word-final prevocalic voicing into one general rule which states that /s/ will voice before [+voice] segments (both consonants and vowels), could never serve as a feasible solution given that intervocalic word internal /s/ is never voiced. Thus, he first proposes a reordering of phonological rules in these dialects as a potential explanation.

In general Spanish dialects, /s/ voicing occurs as a post-lexical process when in the coda position, and followed by a voiced consonant. However, resyllabification takes place before the voicing rule, which ultimately limits voicing to the pre-consonantal position. Lipski suggests that in HES, /s/ voicing occurs at the post-lexical level, before the resyllabification process, and that the voicing process will affect word final /s/ followed by any [+voice] segment. Table 2-7 demonstrates the differences in rule ordering for general Spanish dialects and HES.

**Table 2-7**
*Comparison of General Spanish dialects and HES Phonological rule ordering as proposed by Lipski (1989)*

**General Spanish dialects:**

| | |
|---|---|
| *Lexical level* | /las/ /alas/ |
| Syllabification | [las] [a.las] |
| *Postlexical level* | |
| Resyllabification | [la.sa.las] |
| /s/-voicing | - - - - - - |
| Output | [la.sá.las] |

**H.E.S.**

| | |
|---|---|
| *Lexical level* | /las/ /alas/ |
| Syllabification | [las] [a.las] |
| *Postlexical level* | |
| /s/ voicing | [laz] [a.las] |
| Resyllabification | [la.zá.las] |
| Output | [la.zá.las] |

The re-ordering of voicing and resyllabification rules successfully accounts for the word final intervocalic /s/ voicing in HES in so that a word final /s/ becomes voiced before any [+voice] segment, while leaving word initial, and word internal /s/ untouched.

Unfortunately, Lipski points out two major flaws with his first proposal. Firstly, this does not account for the prefix final voicing in the Cuenca dialect. Also, the resyllabification process in Spanish is dependent on both speech rate and register. In slow speech and/or formal speech, it is less common for a word final /s/ to resyllabify to the onset on the following vowel initial word. However, the word final intervocalic voicing in HES has shown to be independent on both speech rate and formality, thus for

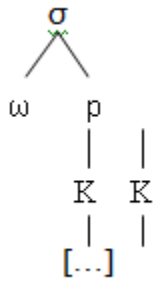
this first proposed solution to hold true, it would be expected that the word final voicing would only occur in fast, casual speech.

Furthermore, Robinson (1979), later confirmed by Lipski (1989), showed that voicing can even extend to pre-pausal contexts when the speaker intends on continuing their speech (regardless of whether the sentence is actually completed). In this case, the resyllabification process would not be possible given the large gap between the word final /s/ and the following word.

Finally, however adequate this reordering can descriptively explain the word final voicing situation, at least in normal, connected speech, it does not provide any explanations of the relationship between the voicing and the resyllabification process, or why voicing can be triggered by either consonants or vowels in HES, while the voicing in other dialects can only be triggered by voiced consonants.

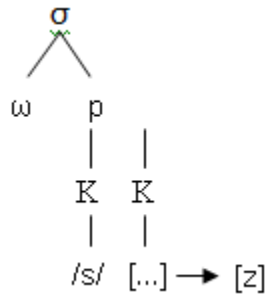
In response to the shortcomings of the first proposed solution, Lipski provides an alternative derivational analysis to help explain the word final intervocalic voicing in HES. With this analysis, Lipski suggests that all word final consonants (/r/, /l/, /n/ and /s/) are followed by an unattached slot in the derivation which represents a word boundary. See figure 2-2.

**Figure 2-2**
*Derivational analysis with word final consonant followed by unattached slot.*




Next, a rule is applied which voices word final /s/ when followed by an unattached slot. See figure 2-3.

**Figure 2-3**
*Voicing assignment rule*

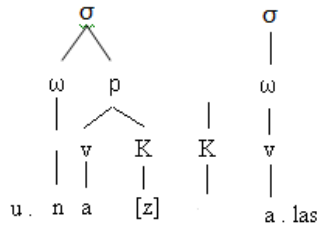



Finally, a deletion rule is needed in order to remove the unattached slot before the resyllabification process can take place, as well as a devoicing rule which is applied to [z] when the following word begins with a [-voice] segment. The complete derivational process can be seen below in figure 2-4 for the phrases (a.) *unas olas* 'some waves', (b.) *unas rosas* 'some roses', and (c.) *unas casas* 'some houses.' In (1) the unattached slot is added after the word final consonant, which causes the preceding /s/ to voice to [z] in all

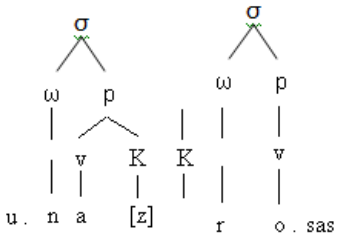
three phrases. In (2), the deletion rule removes the unattached slot, and then the devoicing rule is applied to obtain word final [s] before [-voice] segments. Finally, in (3), the phrases undergo the process of resyllabification, and the correct output is obtained.

**Figure 2-4**
*Derivational analysis proposed by Lipski to account for word final intervocalic /s/ voicing in HES*

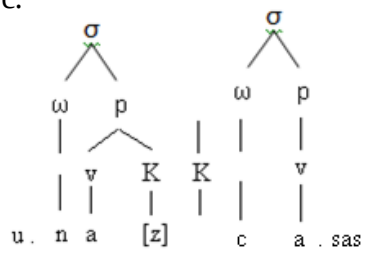
**(1)** a.



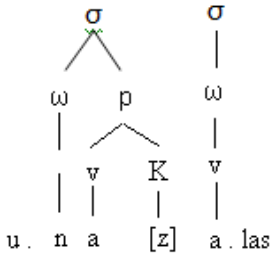

b.



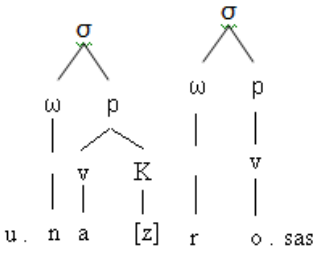

c.



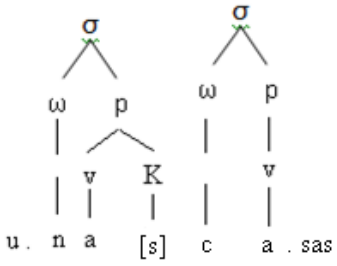

**(2)** a.




b.




c.



**(3)** a. *unas alas* [ú.na.zá.las] ‘some wings’

b. *unas rosas* [ú.naz.ró.sas] ‘some roses’

c. *unas casas* [ú.nas.ká.sas] ‘some houses’

Lipski’s proposed derivational analysis explains how the word final intervocalic voicing can be achieved in this dialect, yet it has still been critiqued, mostly by Bradley (2006) and Colina (2009), who seem to share the same viewpoints on this issue.

The first main critique mentioned by both Bradley and Colina is the plausibility of the proposed unattached slot which will trigger the voicing. There are no patrimonial Spanish words which allow for a consonant cluster in the syllable rhyme; The CVCC pattern does exist in Spanish, but only as a way of accommodating the exceptions such as *tórax* and *biceps*.

Additionally, the slot is only added to the derivation in order to trigger the voicing of the preceding /s/, but then must be removed before the resyllabification process, given that this consonantal slot would deter the movement of the coda /s/ to the onset of the following vowel initial word.

Finally, the addition of the devoicing rule is only needed to undo the effect of voicing caused by the unattached slot when /s/ precedes a voiceless consonant. Without the devoicing rule, non-occurring forms such as *estás* *[ez.tás] ‘you are’ and *las casas* *[laz.ká.sas] ‘the houses’ would be generated.

In order to avoid adding rules whose sole purpose is to counteract other previous rules, Colina (2009) proposed an optimality-theoretic (OT) account of the voicing patterns. The goal of her OT account was to show that the motivation for the word final

intervocalic voicing in HES is not necessarily a case of voicing assimilation, but rather a failure of the coda /s/ to license a laryngeal node.

Colina argues that HES has a ternary voice distinction ([+voice], [-voice] and [0voice]), and that a word-final /s/ is targetless with respect to voicing. This phoneme will remain as such until it is influenced by the surrounding segments, assuming the laryngeal position of that segment, given that it lacks its own voicing target.

Colina's final OT account for the Ecuadorian data consists of the following constraints, shown in order of their dominance:

1) $I_{DENT}$-OO(voice): The output voice specification is identical to that of its correspondent in isolation.

2) IDENTSTOP(voice):

3) *S: Sibilants cannot be targetless with respect to voicing.

3) 4) *z: No voiced alveolar fricatives.

5) *s: No voiceless alveolar fricatives.

6) IDENT (voice): The input is identical to the output with regard to the feature [voice].

7) NOLINK: No feature is associated to more than one segment in the output.

Tables 2-8 and 2-9 show how these constraints can correctly account for a word final intervocalic [z] in HES, with both /s/ and /z/ as underlying representations.

**Table 2-8**
*Surface targetless word final sibilant, underlying /s/*

/los otros/ [lo.So.troS]
&[loS]

| | $I_{DENT}$-OO (voice) | $L_{ICENSE}$[lar] | *S | *z | *s | $I_{DENT}$(voice) | $N_OL_{INK}$ |
|---|---|---|---|---|---|---|---|
| a. lo.zo.troS | *! | | (*) | * | | * | |
| b. lo.so.troS | *! | | (*) | | * | | |
| c. ☞lo.So.troS | | | (*) | | | *(S) | |

**Table 2-9**
*Surface targetless word final sibilant, underlying /z/*

/loz otros/ [lo.So.troS]
&[loS]

| | $I_{DENT}$-OO (voice) | $L_{ICENSE}$[lar] | *S | *z | *s | $I_{DENT}$(voice) | $N_OL_{INK}$ |
|---|---|---|---|---|---|---|---|
| a. lo.zo.troS | *! | | (*) | * | | | |
| b. lo.so.troS | *! | | (*) | | * | * | |
| c. ☞lo.So.troS | | | (*) | | | *(S) | |

These constraints select the optimal candidate as being targetless. That word final /s/ will then assume the laryngeal position of the following segment; if a voiced segment follows, it will voice to [z], and if a voiceless segment follows, it will become voiceless as well.

Colina argues that this newly proposed model offers a more adequate explanation as to why word final /s/ voicing occurs in this dialect since it shows a direct relationship between the voicing assimilation and coda devoicing (occurring before voiceless

consonants). Furthermore, it explains why word final /s/ will neutralize when there is no following segment to trigger the voicing assimilation process.

Both Lipski's and Colina's analyses correctly accounted for all of the HES voicing data at the time that they were proposed, however, more recently, Chappell (2011) found instances of intervocalic /s/ voicing in this dialect beyond the originally documented word final position, something that the previously analyses had not taken into consideration.

Chappell aimed her research at collecting Ecuadorian speech samples, and comparing them to Robinson's original results from 1979 in order to determine if the status of the intervocalic /s/ voicing in Ecuador had at all changed. She did so by transcribing recorded archives from a radio station in Quito. There were a total of five interviews, ranging from thirty to sixty minutes in length.

Her results showed that the /s/ voicing does not occur solely at the word boundary as had been previously believed, but rather there were instances of intervocalic /s/ voicing in other phonological environments as well.

The word final intervocalic voicing was by far the most wide-spread in her data, occurring 91% of the time. However, voicing also was found 11% of the time in the word medial position, and 6% of the time in the word initial intervocalic position.

Chappell next looked at various different factors such as word class, word frequency, preceding and following vowel height, gender, and morphological markers in order to see if there were any correlation between these factors and the environment in which /s/ was being voiced. She noticed that word frequency and the following vowel

height all contributed to the word final intervocalic voicing, with voicing more likely to occur in high frequency words, and preceding either /a/ or /o/.

Word medially, voicing seemed to be more influenced by the following vowel height (a [-high] [-back] vowel most often triggered the voicing). Furthermore, certain words were more prone to voicing such as *ese/esa/eso* 'this' and *nosotros* 'we'. Her results lacked sufficient tokens of word initial intervocalic /s/ to do a similar analysis, however she hypothesizes that voicing in this environment is due to a reanalysis of the syllable boundary, caused by the proximity of the first word final, and second word initial position.

Chappell's study provides the most recent accounts of /s/ voicing in HES, which include instances of voicing not previously mentioned, such as the word initial and word internal positions. Although Lipski and Colina's proposed analyses of the voicing can still correctly account for the voicing in the word final position, they are no longer adequate for explaining the word medial or word initial voicing in this dialect. However, given the low percentages of voicing in these two new environments (11% and 6% respectively), further investigation into the voicing process in this dialect is still needed in order to confirm these results, before reevaluating the previously proposed analyses.

### 2.6 Intervocalic /s/ voicing in other American Spanish dialects

All of the current research on /s/ voicing in American Spanish has taken place in the Ecuadorian highlands. This is because many researchers believe that this is an exclusive feature of this dialect. Canfield (1981), for instance, says that "*En la sierra ecuatoriana, salvo en el extremo norte (Tulcán), se oye un fenómeno único, por lo visto,*

*en América. La /s/ se manifiesta con sonoridad en fin de palabra ante vocal en la próxima*" (In the Ecuadorian mountain range, with the exception of the extreme north (Tulcán), a phenomenon, which seems to be unique to America, is heard. The /s/ declares itself with voicing at the end of the word, before a vowel in the next (word) (p. 81).

However, there has been brief mentioning of further intervocalic /s/ voicing in other American dialects. Obaid (1973) argues that he has repeatedly heard /s/ voicing in Monterrey (Mexico), not only in the intervocalic word final position as seen in Ecuador, but also in the absolute final position. What's more, he claims that in Monterrey, there is a deliberate and prolonged voicing of word final /s/, even when preceding a voiceless consonant.

Flórez (1973) also mentions irregular voicing in other American dialects. He claims that all of the voiceless consonants (/p, t, k, f, s/) will sometimes voice in rapid or spontaneous speech, albeit less systematic as it is in Ecuador. In Colombia, he has noted the examples of *posición* [po.zi.sjón] 'position' and *países* [pa.í.zes.] 'countries'. A few years later, Torreblanca (1983) contributes by stating that "intervocalic /s/ does not occur only in Ecuador, but has also appeared in Mexico, El Salvador, Panama, and Colombia (p. 501). Unfortunately neither of these two researchers provided any evidence or data to back up their claims that /s/ voicing occurs outside of the Ecuadorian highlands, nor has much research been done on investigating these other dialects since these claims were made.

## 3. Conclusion

The previous sections have given pertinent information about the history and the current status of the sibilant fricative in Spanish. Firstly, there have been many researchers who have claimed the regressive voicing assimilation process is gradient and variable, and that it is possible for the coda /s/ to occur partially voiced, or completely voiceless, depending on speech rate and formality. There have been a handful of studies which have directly measured the degree of voicing assimilation before voiced consonants depending on certain factors such as prosodic boundaries, and flanking vowels, but there are no known studies which directly compare speech rate and formality to the assimilatory process.

Also, further variation in the pronunciation of this phoneme was discussed. Irregular voicing patterns have been heard in both Spain and Ecuador. In Central Spain, /s/ is voiced when it is preceded by any [+voice] segment. In Catalonia, there is also a tendency to voice word final intervocalic /s/, however, this is likely due to the influence of Catalan in the area.

In Ecuador, intervocalic word final /s/ voicing has also been documented. This feature appears to be independent of both speech rate and formality. More recently, voicing has also been heard in the word initial intervocalic position, as well as word internal intervocalic position, although the voicing in these environments does not seem to be as systematic as in the word final position.

Finally, a few researchers have suggested that this voicing phenomenon does not occur exclusively in Ecuador and Spain, but can also be heard in a variety of other American Spanish dialects such as in Colombia, El Salvador, Monterrey, Mexico, and

Panama. However, there is no known research which has explicitly studied the voicing patterns in these regions.

# Chapter 3

# Methodology

## 1. Introduction

This chapter focuses on explaining the methodology that was used to conduct the two studies; the degree of voicing assimilation according to speech rate and speech style by native Spanish speakers, and the degree of intervocalic /s/ voicing by native Spanish speakers from Bogota, Colombia.

Section 2 restates the two hypotheses being tested in this dissertation, and gives a detailed description of their predictions. Section 3 and 4 describe the methodological procedure, including the participants, elicitation tasks, data collection process, and transcription and scoring for the first and second hypothesis respectively. Section 5 concludes this chapter.

## 2. The Research Hypotheses

This section reexamines the predictions of the hypotheses being tested in this dissertation, stated below:

1a.) Voicing assimilation in Spanish is positively correlated with speech rate; as speech rate increases, the degree of the sibilant fricative voicing will also increase.

1b). Voicing assimilation in Spanish is negatively correlated with speech formality; as speech style becomes more formal, the degree of the sibilant fricative voicing will decrease.

2). Speakers of Highland Colombian Spanish voice /s/ intervocallically.

Hypothesis 1a predicts that the degree of voicing assimilation of coda position /s/ before a voiced consonant is variable, and will be dependent on speech rate. Higher degrees of voicing assimilation are expected with a faster speech rate; likewise, lower degrees of voicing assimilation are expected with a slower speech rate. This is in accordance with Harris (1969) who categorizes speech into four distinct rates: *largo, andante, allegretto* and *presto*. He states that during largo, or slow speech, there will be no voicing assimilation (*mismo* [mi<u>s</u>.mo] 'same'). During andante/allegretto speech, there is only partial voicing assimilation ([mi<u>s</u>$^{z}$.mo]), and during presto, or fast speech, there is complete assimilation ([mi<u>z</u>.mo]). These same ideas have been supported in other research such as Navarro (1967) who states that slow speech impedes the voicing of the sibilant, and also in Quilis and Fernández (1985) who state that in fast speech, /s/ is nearly always produced as [z] before voiced consonants due to lack of control of the vocal folds.

This hypothesis will be supported if the data show that /s/ is realized as voiceless before voiced consonants in slow speech, and is completely voiced in fast speech. It is also being predicted that an intermediate speech rate will yield partial voicing, i.e. the beginning of the frication period will be voiceless and the end of the frication period will be voiced.

This hypothesis will not be supported if any of the following situations were to occur: (1) there is partial or complete voicing during slow speech, (2) there is either no

voicing assimilation or complete voicing assimilation during a normal speech rate, and (3) there is partial or no voicing assimilation during fast speech.

Hypothesis 1b predicts that the degree of voicing assimilation is negatively correlated with speech formality so that the highest degree of voicing assimilation will occur in the least formal situations. Similarly, there will be less voicing assimilation in more formal situations. Hualde (2005) says that the degree of voicing assimilation is stylistically determined, and both gradient and variable. However, there is a lack of evidence and experimental data to either support or reject this claim.

This hypothesis will be supported if the data collected from the formal elicitation task shows a higher degree of voicing assimilation than the data collected from the informal elicitation task. Similarly, this hypothesis will not be supported if either (1) there is a higher degree of voicing assimilation in the less formal task compared to the more formal task, or if (2) there is an equal amount of voicing in both elicitation tasks.

Hypothesis 2 predicts that speakers of Highland Colombian Spanish will voice intervocalic /s/, similar to Highland Ecuadorian Spanish. However, unlike HES in which voicing nearly exclusively occurs in the word final intervocalic position (*es una* 'it's one), the word internal (*casa* 'house'), and word initial intervocalic /s/ (*la* sopa 'the soup') will also be investigated in HCS in order to determine the extent, if any, of the voicing phenomenon.

There are already some contradicting viewpoints about the status of /s/ in this dialect. It is generally believed that intervocalic /s/ retains its voiceless fricative status in all phonological environments, due to the conservative nature of this dialect (Lipski, 1994). However, there have been noted cases of aspiration when occurring

intervocallically (Alvar, 1996). Furthermore, there is one known citation of intervocalic /s/ voicing in this dialect by Torreblanca (1978) who states that in Colombia, this phenomenon (the spontaneous voicing of voiceless consonants) has reached the consonants /*p, t, k, f, s/*.

This hypothesis will be supported if /s/ voices intervocallically. Likewise, this hypothesis will not be supported if it remains voiceless in this same environment.

If hypothesis 2 is supported by the collected data, and there is evidence of intervocalic /s/ voicing in the HCS dialect, then hypothesis 2a will be tested:

> 2a): Intervocalic voicing in Highland Colombian Spanish is independent of both speech rate and style.

Lipski (1989) noted that the intervocalic voicing in HES is extremely systematic, and independent of both speech rate and style. If this voicing phenomenon is also present in the HCS dialect, I predict it will be implemented in a similar manner, given that they are phonologically similar dialects. This hypothesis will be supported if the voicing of intervocalic /s/ is found in both slow and fast speech, as well as in both formal and informal situations. This hypothesis will not be supported if it is found that the intervocalic /s/ voicing is dependent on either speech rate or style.

**3. Study 1: Degree of Voicing Assimilation of Coda /s/ by Native Spanish Speakers**

The goal of this first study is to determine whether or not the degree of voicing assimilation of coda position /s/ is dependent on either speech rate or formality. This

study was designed in order to elicit a variety of words which contain a coda position /s/ before a voiced consonant, both word internally and across word boundaries, in five different elicitation tasks. The full methodological process, as well as details on the participants and the transcription and scoring, are described below.

## 3.1 Methodology

### *3.1.1 Participants*

Data for the first study was collected from 15 native speakers of Spanish (9 male speakers and 6 female speakers). The subjects were all currently living in Milwaukee, Wisconsin, but came from various different dialect regions. These 15 subjects represented 13 different cities from 10 Spanish speaking countries. Any participant who came from a dialect area in which coda position /s/ is normally aspirated or elided (generally the costal and Caribbean dialects) was excluded from the study.

The subjects' age ranged from 24-53 years old, with an average of 32.5 years. They had studied, or were currently studying, in the University for 3-10 years, with an average of 6.7 years. In addition to Spanish, all of the subjects had a high level of proficiency in English, as well as varying levels of proficiency in other Romance languages including Portuguese, Galician, Catalan, and French. The information for the 15 participants is shown in table 3-1.

**Table 3-1**
*Information on Spanish Speaking Subjects-Study 1*

| Subject | City, Country of origin | Gender | Age | Years of College education | Languages |
|---|---|---|---|---|---|
| S1 | Bogota, Colombia | Male | 29 | 8 | Spanish, English |
| S2 | Acoruna, Spain | Female | 25 | 7 | Spanish, English, Portuguese, Catalan, Galician |
| S3 | Guadalajara, Mexico | Female | 29 | 6 | Spanish, English |
| S4 | Santiago, Panama | Female | 44 | 10 | Spanish, English |
| S5 | Santiago, Chile | Male | 29 | 5 | Spanish, English |
| S6 | Oruro, Bolivia | Male | 27 | 4 | Spanish, English |
| S7 | Santiago, Chile | Female | 28 | 6 | Spanish, English |
| S8 | Asuncion, Paraguay | Male | 25 | 3 | Spanish, English |
| S9 | Lima, Peru | Male | 52 | 10 | Spanish, English, Portuguese, French |
| S10 | Tolima, Colombia | Male | 28 | 10 | Spanish, English |
| S11 | San Jose, Costa Rica | Male | 24 | 5 | Spanish, English |
| S12 | San Pedro Sula, Honduras | Female | 25 | 6 | Spanish, English |
| S13 | Mugardos, Spain | Male | 44 | 7 | Spanish, English, Portuguese, Galician |
| S14 | Sueros de Cepeda, Spain | Female | 53 | 6 | Spanish, English |
| S15 | Bogota, Colombia | Male | 25 | 7 | Spanish, English |

### *3.1.2 Stimuli*

In order to test the two hypotheses of the first study, three different data elicitation tasks were used: word-list reading, passage reading, and interview questions. Firstly, in order to examine how different speech rates affect the degree of fricative voicing, the participants were asked to read aloud a word list three different times. Before each

reading, they were instructed as to how it should be read, either normally, slowly as if speaking with a child or someone who does not understand their language well, and as quickly as possible. In order to determine the average speech rate for the different word list readings, three words were chosen at random from each word list reading from all of the participants, and were measured in syllables per second. On average, the duration of the words when instructed to read slowly was one syllable per 0.48 seconds. The average for the normal word list reading was one syllable per 0.29 seconds, and during the quick word list reading, the words were produced at a rate of one syllable per 0.22 seconds.

The three word list readings contained the same words, yet the words were randomized before each reading. The list consisted of 15 words with a word internal coda position /s/ before a voiced consonant (*cisne* 'swan'), and 15 words in which the coda position /s/ occurred word finally, followed by a word which began with a voiced consonant (*las manos* 'the hands'). Some of the words had both phonological environments present, for example *los mismos* (the same, plural), bringing the total of target words in each word list to 23. Additionally, there were 12 filler words, giving a total of 35 words presented on each word list. The list of targeted words, along with their phonetic representation and English translation are shown in table 3-2. (repeated in appendix A).

**Table 3-2**
*Word list: study 1*

| Spanish Word | Phonetic Representation | English Gloss |
|---|---|---|
| Islas | [íz.las] | Islands |
| Cisnes | [síz.nes] | Swans |
| Resmas | [réz.mas] | Reams |
| Cosméticos | [koz.mé.ti.kos] | Cosmetics |
| Desbullas | [dez.βú.jas] | Oyster shells |
| Fantasma | [fan.táz.ma] | Ghost |
| Esmalte | [ez.mál̪.te] | Nail polish |
| Béisbols | [bé̯iz.bols] | Baseballs |
| Musgos | [múz.ɣos] | Moss |
| Asnos | [áz.nos] | Donkeys |
| Esmoquin | [ez.mó.kin] | Tuxedo |
| Rasgos | [ráz.ɣos] | Features |
| Esmeraldas | [ez.me.ɾál̪.das] | Emeralds |
| Muslos | [múz.los] | Thighs |
| Mismos | [míz.mos] | Same |
| Los gatos | [loz.ɣá.tos] | The cats |
| Las nubes | [laz.nú.βes] | The clouds |
| Unas resmas | [ú.naz.réz.mas] | Some reams |
| Tres desbullas | [trez.dez.βú.jas] | Three oyster shells |
| Dos dedos | [doz.dé.ðos] | Two fingers |
| Tres botellas | [trez.βo.té. jas] | Three bottles |
| Dos béisbols | [doz.βé̯iz.bols] | Two baseballs |
| Los musgos | [loz.múz.ɣos] | The moss |
| Dos globos | [doz.gló.βos] | Two balloons |
| Tres lilas | [trez.lí.las] | Three lilies |
| Los rasgos | [loz.ráz.ɣos] | The features |
| Dos dados | [doz.ðá.ðos] | Two die |
| Dos muslos | [doz.múz.los] | Two thighs |
| Las vacas | [laz.βá.kas] | The cows |
| Los mismos | [loz.míz.mos] | The same |

Two additional elicitation tasks were used in order to determine if speech formality has an effect on the degree of voicing assimilation; a passage reading and interview questions. These two tasks were chosen since they each show a different level of formality, which, according to Labov (1969), is directly associated with how much

attention a speaker gives to their utterances. In the case of the two presented tasks, the reading passage is considered to be more formal due to the presence of written cues of the target words. The interview questions is considered to be less formal because there are no written cues for the participants to look at, thus they are likely to pay more attention to their thoughts and responses to the questions asked, rather than to how they are producing each word.

The reading passage lasted on average 90.01 seconds and contained 14 words in which the target sound occurred word internally, and 17 words in which the target sound occurred at the word boundary. The interview portion of the recording consisted of three hypothetical questions asked to the participants. A copy of both the reading passage and interview questions, followed by the English translation, are shown below in tables 3-3 and 3-4, repeated in appendices B and C respectively.

**Table 3-3**
*Reading passage: study 1*

*Todos los monstous que viven en la Isla Esmeralda salieron un día a buscar regalos para el día de la madre. Un fantasma le apostó a un trasgo que no podía recoger tantas flores como él. El trasgo caminó por tres horas, pero todavía no había recogido todas las mismas flores bellas como el fantasma, hasta que vio algunas violetas encima de una montaña tan alta que parecía tocar las nubes. Cuando escalaba la montaña para recoger las flores, el trasgo se resbaló en los musgos. Cuando se caía de la montaña, perdió todas las flores que ya había recogido. Se cayó en la bahía, y cansado y tristemente decidió levantarse para regresar a su madre sin un regalo, cuando de repente vio unas ostas en el agua. No eran tan hermosas como las flores, pero por lo menos no iba a regresar con las manos vacías. Cuando regresó, el fantasma se burló del trasgo y el regalo tan feo que le había traído a su mamá. Avergonzadamente, le dio las ostras a su mamá, pero al sopresa del tasgo, su mamá las abrió, y encontró las perlas más hermosas que había visto. El trasguito sintió un orgullo tremendo y aprendió que las cosas más bonitas del la vida a veces se esconden detrás de un disfraz.*

All of the monsters that live on Emerald Island went out one day to look for Mother's day gifts. A ghost bet a troll that he couldn't collect as many flowers as him. The troll walked for three hours, but still hadn't collected all the same beautiful flowers as the ghost, until he saw some violets on top of a mountain so high it seemed to touch the clouds. As he climbed the mountain to get the flowers, the troll slipped on the moss. As he fell from the mountain, he lost all of the flowers that he had already collected. He fell in the bay, and tired and sad, he decided to get up and return to him mom without a gift, when all of a sudden he saw some oysters in the water. They weren't as beautiful as the flowers, but at least he wasn't going to return with empty hands. When he returned, the ghost made fun of the troll and the ugly gift he had brought to his mom. Ashamed, he gave the oysters to his mom, but to the surprise of the troll, his mom opened them, and found the most beautiful pearls she had ever seen. The little troll felt a tremendous pride, and learned that sometimes the most beautiful things in life are hidden behind a disguise.

**Table 3-4**
*Interview questions: study 1*

*1. ¿Si ud. fuera de vacaciones, y sus destinos fueran islas, a dónde iría y qué tipos de cosas haría? Sea lo más descriptivo posible.*

If you were to go on vacation, and your destination was an island, where would you go and what types of things would you do? Be as descriptive as possible.

*2. ¿Qué haría si ud. fuera un fantasma por un día? Sea lo más descriptivo posible.*

What would you do if you were a ghost for a day? Be as descriptive as possible.

*3. ¿Qué haría si ganara dos millones de dólares en la lotería? Sea lo más descriptivo posible.*

What would you do if you won two million dollars in the lottery? Be as descriptive as possible.

Although all of the participants produced varying amounts of target words during the interview portion of the study, on average, the target sound was produced word internally 6.3 times per participant, and at the word boundary 10.8 times per participant. A breakdown of the number of target words in each elicitation task according to their environment can be seen in table 3-5

**Table 3-5**
*Number of target words produced during each elicitation task according to phonological environment*

| Elicitation task | Word internal | Word boundary |
|---|---|---|
| Work list | 15 | 15 |
| Reading passage | 14 | 17 |
| Interview questions | 6.3 | 10.8 |

### *3.1.3 Procedures*

The subjects participated individually in the study, in a quiet location, either in the researcher's or the subject's office at the University of Wisconsin-Milwaukee. Before beginning the recording process, the subjects were presented with an agreement in the IRB form, and signed a consent form. Afterwards, the subjects were given an explanation of the recording process, and then were left alone to do the recordings in privacy, however they were told that the researcher would remain close by and available if any problems or questions were to arise.

The program used to collect the recordings was created using Visual Basic 2010. Upon starting the program, the subject were first prompted to fill out a short biographical questionnaire which included information about their city and country of origin, age, gender, number of years they had studied in the university, and knowledge of any other languages besides Spanish. After completing the questionnaire, the subjects were presented with the five elicitation tasks. The reading passage and interview questions were the second and fourth tasks presented respectively. The word lists were presented

so that one third of the subjects began with the slow list, one third began with the normal list and one third began with the fast list. Before each task, the subjects were shown written instructions in Spanish as to how to complete the task. The recording process from start to finish ranged from 15-20 minutes, depending on the length of the answers given during the interview task. The subjects did not receive any compensation for their participation.

### 3.2 Transcriptions and scoring

After the recording process was complete, the sound files were coded using Praat. The total number of token words obtained for the first study was 1,176 (532 word internal token words and 644 word boundary token words). Several measurements were taken in order to determine the total percentage of voicing during the frication noise. First, the beginning and end of the frication noise were marked. This was determined by the aperiodic noise displayed in the spectrogram and waveform. The beginning of the frication noise was then subtracted from the end of the frication noise in order to obtain the total duration of the frication noise in milliseconds. Next, the beginning and the end of the voicing period were marked. This was determined by regular wave patterns in the spectrogram, as well as the presence of a voice bar in the waveform. In the case that there was a discrepancy between the voice bar and the regular wave patterns, and wave patterns in the spectrogram were used as the criteria for marking the voiced noise. The beginning of the voicing was then subtracted from the end of the voicing in order to obtain the total voicing duration in milliseconds. Finally, the voicing duration was divided by the frication duration and multiplied by 100 in order to obtain the percentage

of the frication noise that was produced as voiced. Figure 3-1 displays the spectrogram and waveform of a voiceless frication period, indicated by the aperiodic noise and lack of a voice bar. Figure 3-2 shows a completely voiced frication period, indicated by the regular wave patterns and the presence of the voice bar.

**Figure 3-1**
*Voiceless frication period*

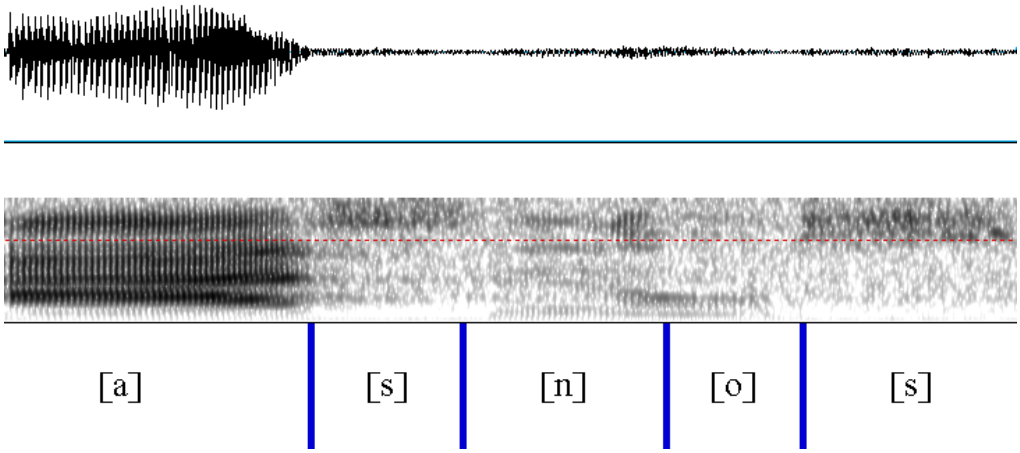
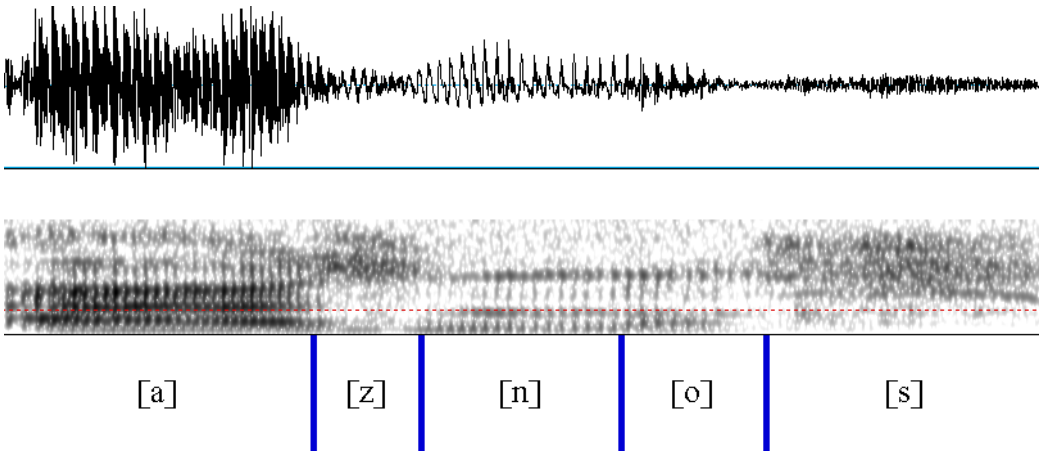



**Figure 3-2**
*Voiced frication period*



## 4. Study 2: Intervocalic /s/ voicing by Native Spanish Speakers of Highland Colombian Spanish.

The goal of the second study was to determine whether or not native speakers of Highland Colombian Spanish voice intervocalic /s/. If evidence of intervocalic /s/ voicing is present, then both the subjects' speech rate and speech formality will be examined in order to determine if the voicing process is dependent on either of these factors, or an independent feature, as in Highland Ecuadorian Spanish. Intervocalic /s/ was elicited in the word initial, word medial, and word final positions in five different elicitation tasks. The full methodological process, as well as details on the participants, and the scoring process, is described below.

### 4.1 Methodology

#### *4.1.1 Participants*

Data for this study was collected from 15 native speakers of Spanish (8 male speakers, and 7 female speakers). All of the participants were native to Bogota, Colombia. Ten of the participants were currently living in Bogota; the other five participants were currently living in Milwaukee, Wisconsin, but had lived a minimum of 20 years in Bogotá, Colombia. The subjects' age ranged from 20 to 45 years old, with an average age of 28 years. The subjects had studied, or were currently studying, at the university level for 3 to 10 years, with an average of 5.6 years. Finally, 5 of the 15 subjects were monolingual speakers of Spanish; the remaining 10 subjects had varying degrees of proficiency in English, and one subject also had knowledge of Portuguese. A breakdown of the participants by age, gender, years of college education, and known languages is shown in table 3-6.

**Table 3-6**
*Information on Highland Colombian Spanish Speaking Subjects*

| Subject | Gender | Age | Years of College education | Languages |
|---|---|---|---|---|
| C1 | Female | 28 | 5 | Spanish |
| C2 | Female | 28 | 5 | Spanish |
| C3 | Male | 27 | 8 | Spanish, English |
| C4 | Male | 25 | 4 | Spanish, English |
| C5 | Female | 23 | 5 | Spanish, English |
| C6 | Male | 29 | 6 | Spanish, English |
| C7 | Male | 26 | 6 | Spanish, English |
| C8 | Male | 23 | 7 | Spanish, English |
| C9 | Female | 20 | 3 | Spanish, English |
| C10 | Male | 28 | 3 | Spanish |
| C11 | Male | 26 | 4 | Spanish |
| C12 | Female | 28 | 6 | Spanish, English |
| C13 | Female | 45 | 6 | Spanish, English |
| C14 | Female | 36 | 10 | Spanish, English, Portuguese |
| C15 | Male | 29 | 6 | Spanish, English |

### *4.1.2 Stimuli*

The elicitation tasks used in the second study were the same as in the first study; word list reading, passage reading, and interview questions. As with the first study, the participants in the second study were also asked to read the word list a total of three times, once normally, once slowly, and once quickly. The average speed for the slow reading was one syllable per 0.63 seconds, for the normal reading was one syllable per

0.46 seconds, and for the fast reading was one syllable per 0.17 seconds. If intervocalic voicing is present in the Highland Colombian dialect, the three different readings of the word list will be used in order to evaluate whether speech rate is a determining factor in the degree of fricative voicing.

There were a total of 40 words on the list to be read. There were 12 words in each of the phonological environments being tested: word internal intervocalic /s/ (*usos* 'uses'), word final intervocalic /s/ (*dos alas* 'two wings'), and word initial intervocalic /s/ (*la sopa* 'the soup'). In some words, more than one phonological environment was represented, for example, in the word *dos osos* (two bears). Additionally, there were 11 filler words. The list of targeted words, along with their phonetic representation and English translation are shown in table 3-7 (repeated in appendix D).

**Table 3-7**
*Word list: study 2*

| Spanish Word | Phonetic Representation | English Gloss |
|---|---|---|
| Osos | [ó.sos] | Bears |
| Aces | [á.ses] | Aces |
| Esas | [é.sas] | Those |
| Beso | [bé.so] | Kiss |
| Husos | [ú.sos] | Spindles |
| Cosas | [kó.sas] | Things |
| Esos | [é.sos] | Those |
| Mesa | [mé.sa] | Table |
| Esa | [é.sa] | That |
| Masa | [má.sa] | Dough |
| Asas | [á.sas] | Handles |
| Usos | [ú.sos] | Uses |
| Dos osos | [do.só.sos] | Two bears |
| Tres aces | [tɾe.sá.ses] | Three aces |
| Dos alas | [do.sá.las] | Two wings |
| Tres ollas | [tɾe.ójas] | Three pots |
| Tres ajos | [tɾe.sá.xos] | Three (heads of) garlic |
| Esas uvas | [é.sa.sú.βas] | Those grapes |
| Los husos | [lo.sú.sos] | The spindles |
| Esos ejes | [é.so.sé.xes] | The axes |
| Dos hojas | [do.só.xos] | Two leaves |
| Dos ojos | [do.só.xos] | Two eyes |
| Las asas | [la.sá.sas] | The handles |
| Los usos | [lo.sú.sos] | The uses |
| La sopa | [la.só.pa] | The soup |
| Una cita | [ú.na.sí.ta] | An appointment |
| Una seña | [ú.na.se.ɲa] | A sign |
| La soja | [la.só.xa] | The soy bean |
| Cinco sapos | [cíŋ.ko.sá.pos] | Five toads |
| La zeta | [la.zé.ta] | The (letter) Z |
| La cera | [la.se.ɾa] | The wax |
| La suma | [la.sú.ma] | The sum |
| La soga | [la.só.ɣa] | The rope |
| Cinco salas | [cíŋ.ko.sá.las] | Five rooms |
| La ceja | [la.sé.xa] | The eyebrow |
| Una silla | [ú.na.sí.ja] | A chair |

The reading passage took on average 86.67 seconds to read, and contained a total of 36 token words: 14 with a word internal intervocalic /s/, 10 with a word final intervocalic /s/, and 12 with a word initial intervocalic /s/. The interview portion of the test included three open-ended questions for the participants to answer. On average, there were a total of 12.6 word internal, 7.7 word initial, and 8.6 word final intervocalic /s/'s produced by each participant during the interview task. The reading passage and the interview questions used in study 2, along with the English translations can be seen in tables 3-8 and 3-9 (repeated in appendices E and F respectively).

**Table 3-8**
*Reading passage: study 2*

*Ojos Galácticos por Ruben Moreno:*

*De lo que si estaba seguro, es que ella no era de este planeta. Esa mirada curiosa ya la conocía yo, en mis abundantes viajes a los confines del universo, sobre todo en las mujeres de un planeta amarillo, de lo cual ahora no recuerdo su nombre. Esa sensación de ser explorado desde los pies hasta la cabeza, la había sentido una fría noche cuando tuve que descender de emergencia, y a la distancia, unos ojos luminosos estaban mirándome, casi que me sentí desnudo.*

*Cuando dirigí mi mirada a aquellos ojos intrusos, inmediatamente se apagaron, pero en mí, quedó la sensación, de que más allá de la curiosidad que susita un extranjero, hubo una fascinación sobre lo desconocido. Yo me quedé estático, no sé por cuánto tiempo, y cuando restablecí mi prioridad, sentí que mi mente y cuerpo también sufrieron los embates de un sortilegio espacial.*

*Ahora después de tantos años, la casualidad me ha llevado a contemplar en esta fría noche, los ojos de esa mujer, y sentir el embeleso de su mirada, que atravesó distancias inimaginables, para volver a seducirme, y esta vez, no solo me conformaría con mirarla.*

Galactic Eyes by Ruben Moreno:

What I was certain about, is that she was not from this planet. That curious look, I had already known in my abundant trips to the edges of the universe, above all in the women from a yellow planet, of which right now, I don't remember its name. That sensation of being explored from the feet up to the head I had felt a cold night when I had to do an emergency decent, and in the distance, some illuminated eyes were watching me, almost that I felt naked.

When I lead my look to those intrusive eyes, they immediately turned off. But in me remained the sensation beyond the curiosity that a foreigner has, was a fascination about the unknown. I was left ecstatic. I don't know for how long, and when I reestablished my priority, I felt that my mind and my body suffered the ravages of a spatial being.

Now after so many years, chance has led me to contemplate on this cold night, the woman's eyes, and feel the rapture of her eyes, that crossed unimaginable distances to seduce me again, and this time, didn't just settle for looking at me.

**Table 3-9**
*Interview questions: study 2*

1. *¿Cuál es su lugar favorito para ir de vacaciones? ¿Por qué? Sea lo más descriptivo posible.*

What is your favorite place to go for vacation? Why? Be as descriptive as possible.

2. *¿Cuál es su actividad preferida para hacer los fines de semana? ¿Por qué? Sea lo más descriptivo posible.*

What is your preferred activity to do on the weekends? Why? Be as descriptive as possible.

*3. ¿Qué haría si ganara dos millones de dólares en la lotería? Sea lo más descriptivo posible.*

What would you do if you won two million dollars in the lottery? Be as descriptive as possible.

If intervocalic /s/ voicing is found in the Highland Colombian dialect, the results from the reading passage and the interview questions will be compared in order to determine if the voicing is dependent on speech formality. The reading passage is the more formal task, and the interview is the more informal task. As with the first study, the number of token words produced by each participant during the interview task varied. A breakdown of how many token words were produced in each phonological environment for all of the elicitation tasks for study two can be seen in table 3-10.

**Table 3-10**
*Number of target words produced during each elicitation task according to phonological environment*

| Elicitation task | Word internal intervocalic /s/ | Word initial intervocalic /s/ | Word final intervocalic /s/ |
|---|---|---|---|
| Word list | 12 | 12 | 12 |
| Reading passage | 14 | 12 | 10 |
| Interview questions | 12.6 | 7.7 | 8.6 |

### *4.1.3 Procedures*

The procedures for the second study are the same as in the first study. The subjects were first presented with an agreement in the IRB form, translated to Spanish, and signed a consent form. Afterwards, the subjects were given an explanation of the recording process in Spanish, and then were left alone to do the recordings in privacy, however they were told that the researcher would remain close by and available if any problems were to occur. The recordings took place in a home office in Bogotá, Colombia, or in a private office at the University of Wisconsin-Milwaukee.

The program used to collect the recordings was created using Visual Basic 2010. Upon starting the program, the subjects were first prompted to fill out a short biographical questionnaire which included information about their age, gender, number of years they had studied at the university and knowledge of any other languages besides Spanish. After completing the questionnaire, the subjects were presented with the five different tasks. The reading passage and interview questions were the second and fourth tasks presented respectively. The word lists were presented such that one third of the

subjects started with the slow list, one third started with the normal list, and one third started with the fats list. Before each task, the subjects were shown written instructions in Spanish as to how to complete the task. The recording process from start to finish ranged from 15-20 minutes, depending on the length of the answers given during the interview task. The subjects did not receive any compensation for their participation.

### 4.2 Transcriptions and scoring

The same scoring techniques used for the first study were also used in the second study. There were a total of 1,473 token words for this study (538 word internal, 489 word final, and 446 word initial intervocalic [s]). Using Praat, the total duration of the frication noise and voicing were determined. Using these measurements, the percentage of voicing was evaluated. Figures 3-3 and 3-4 display a voiceless frication period and a voiced frication period respectively for the word *esa* 'that, femn., sing.

**Image 3-3**
*Voiceless frication period*

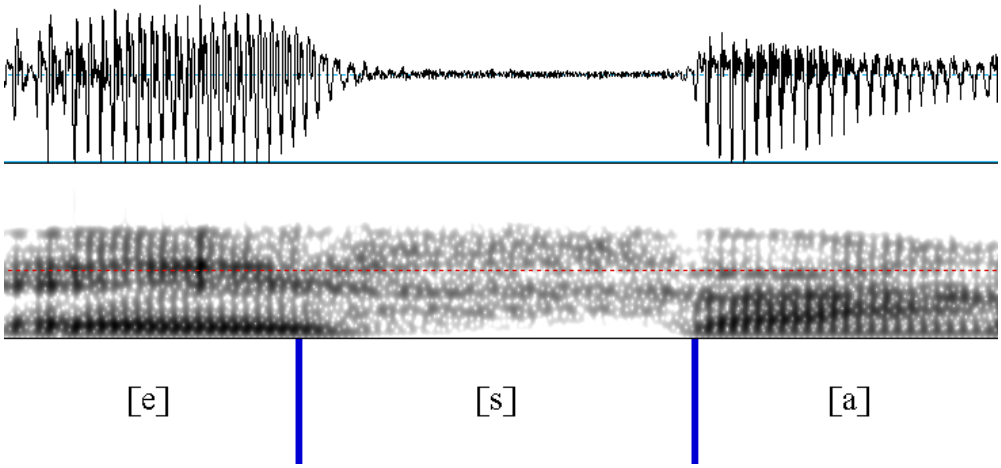
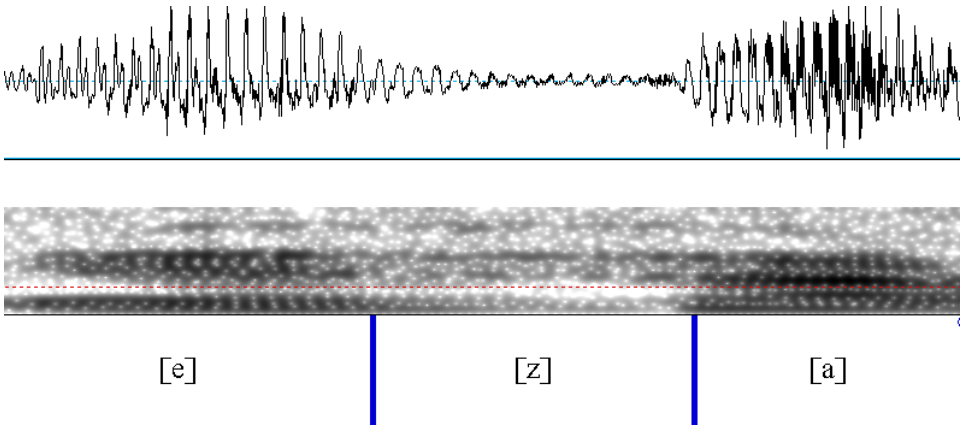



**Image 3-4**
*Voiced frication period*



## 5. Conclusion

This chapter was a summary of the details of the methodologies used for the two studies in this dissertation. It began by restating the three hypotheses that will be tested, as well as a review of their predictions in detail. Next, the methodology for the two studies, including information on the participants, elicitation tasks, procedures, and scoring methods were discussed. The results of these studies are reported in the following chapter.

# Chapter 4

# Results

## 1. Introduction

The previous chapter described the methodologies that were used in order to test the hypotheses presented in this dissertation. In this chapter, the results of the two different studies are presented. First, I characterize the degree of voicing assimilation of coda position /s/ according to both speech rate and speech formality (study 1). Next, I illustrate the irregular voicing patterns of Highland Colombian Spanish (study 2). This chapter will provide a statistical analysis of the results for both of these studies.

## 2. Results of study 1: The degree of voicing assimilation of coda position /s/ according to speech rate and speech formality

This section reports and describes the results of the hypotheses for the first study. First, the results of H1a, which states that the degree of voicing assimilation of coda position /s/ is dependent on speech rate, are reported, followed by the results of H1b, which states that there is an inverse relationship between the degree of voicing assimilation for coda position /s/ and speech formality, so that there will be higher degrees of voicing assimilation during less formal speech.

### 2.1 Results of voicing assimilation according to speech rate

A repeated measures Analysis of Variance (ANOVA) was used to compare the percentage of voiced frication noise according to three different speech rates, slow, normal, and fast, in both the word medial and the word final position. The ANOVA

revealed that speech rate has a significant effect on the voicing assimilation rule in both phonological environments: word medially, $F(1, 14) = 98.43$, $p < 0.001$, and word finally, $F(1, 14) = 62.77$, $p < 0.001$.

In both slow and normal speech, there was a higher degree of voicing assimilation in the word medial position (*M*=38.21% and *M*=62.61% respectively) compared to the word final position (*M*=24.29% and *M*=57.77% respectively). During fast speech, the word final /s/ voiced slightly more than the word internal /s/ (*M*=82.00% and *M*=79.57% respectively). The means and standard deviations for the three speech rates according to the phonological environment are shown in table 4-1.

**Table 4-1**
*Means and standard deviations according to speech rate and phonological environment*

| | Speech rate: Slow | | Speech rate: Normal | | Speech rate: fast | |
|---|---|---|---|---|---|---|
| Medial | *M*=38.21 | *SD*=18.54 | *M*=62.71 | *SD*=25.19 | *M*=79.57 | *SD*=13.86 |
| Final | *M*=24.29 | *SD*=20.61 | *M*=57.77 | *SD*=24.37 | *M*=82.00 | *SD*=14.25 |

The least amount of between subjects variation was found during fast speech, with a range of 59.9% in the word medial position and 52.81% in the word final position. The most variation was found during a normal speech rate, with ranges of 86.45% word medially, and 74.08% word finally. Additionally, there was a considerable difference between the individual subjects. For instance, subject 6 voiced more than 68% of the fricative in all three speech rates and both environments, whereas subject 3 never exceeds 50% voicing during fast speech, and less than 15% voicing in all other contexts. Table 4-

2 shows the degree of voicing assimilation by all 15 participants according to both the speech rate and the phonological environment.

**Table 4-2**
*Percentage of voicing assimilation according to speech rate and phonological environment per subject*

| | Word medial | | | Word final | | |
|---|---|---|---|---|---|---|
| | Slow | Normal | Fast | Slow | Normal | Fast |
| S1 | 71.33% | 96.75% | 97.82% | 59.55% | 86.41% | 99.55% |
| S2 | 36.27% | 72.51% | 70.92% | 13.38% | 58.57% | 85.34% |
| S3 | 14.21% | 11.26% | 50.11% | 13.01% | 13.62% | 47.19% |
| S4 | 44.71% | 68.30% | 86.97% | 22.48% | 56.93% | 77.73% |
| S5 | 37.72% | 58.72% | 77.31% | 9.03% | 26.27% | 75.75% |
| S6 | 67.92% | 79.37% | 79.06% | 71.85% | 85.12% | 73.33% |
| S7 | 46.25% | 44.45% | 75.47% | 25.74% | 49.44% | 91.08% |
| S8 | 30.99% | 50.21% | 83.26% | 17.31% | 49.22% | 97.57% |
| S9 | 16.05% | 19.08% | 51.63% | 8.50% | 22.41% | 64.51% |
| S10 | 3.23% | 78.03% | 85.55% | 5.62% | 65.24% | 83.74% |
| S11 | 42.74% | 82.62% | 80.52% | 34.36% | 87.52% | 86.06% |
| S12 | 46.52% | 83.41% | 95.52% | 7.01% | 40.52% | 70.31% |
| S13 | 30.87% | 17.56% | 37.92% | 17.56% | 61.63% | 91.24% |
| S14 | 23.13% | 73.52% | 91.85% | 9.24% | 82.70% | 100.00% |
| S15 | 52.25% | 84.51% | 89.54% | 49.64% | 80.96% | 86.65% |

**2.2 Results of voicing assimilation according to speech formality**

A repeated measures Analysis of Variance was once again used in order to compare the mean difference between the degree of voicing assimilation of coda position /s/ and speech formality in the word medial and word final positions. It revealed that there is no significant correlation between these two factors in either of the environments tested. In the word medial position, $F(1, 14) = 344.30$, $p = 0.961$, and in the word final

position, $F(1, 14) = 610.55$, $p = 0.978$. There was, however, a small difference in the mean duration of voiced frication noise. The informal interview tasks yielded slightly higher voicing percentage ($M$=74.58 word medially and $M$=75.26% word finally) compared to the more formal reading passage task ($M$=71.24% and $M$=73.24% respectively). Overall, the word final position also showed higher voicing percentages compared to the word medial position. The means and standard deviations for the two speech formalities according to the phonological environment are shown in table 4-3.

**Table 4-3**
*Means and standard deviations according to speech formality and phonological environment*

| | Formal: Reading passage | | Informal: Interview questions | |
|---|---|---|---|---|
| Word medial | *M*=71.24 | *SD*=20.69 | *M*=74.58 | *SD*=16.89 |
| Word Final | *M*=73.29 | *SD*=16.05 | *M*=75.26 | *SD*=17.00 |

Similar to the data collected according to speech rate, there is also a wide range of individual variation with the speech formality data, both across subjects and within subjects. Across subjects, we can see that some participants voiced the frication noise well over 90% of the time, whereas others, such as subjects 3 and 9 sometimes only voiced less than 30% of the frication noise. Within subject variation can also be seen, in particular with subject 3, who voiced considerably more frication noise during the informal tasks, in both phonological environments, compared to the formal task. A similar pattern can be seen as well in subject 4 who voiced over 20% more of the

frication noise when the coda position /s/ appeared in the word final position. The average of voiced frication noise produced by all 15 subjects according to the task and environment is shown in table 4-4.

**Table 4-4**
*Percentage of voiced frication period according to speech formality and phonological environment per subject.*

| | Word medial | | Word final | |
|---|---|---|---|---|
| | Formal | Informal | Formal | Informal |
| S1 | 92.86% | 88.86% | 88.92% | 36.46% |
| S2 | 76.79% | 83.71% | 50.17% | 72.49% |
| S3 | 23.21% | 95.60% | 30.60% | 84.30% |
| S4 | 56.36% | 52.06% | 71.24% | 92.98% |
| S5 | 94.55% | 69.42% | 77.56% | 76.03% |
| S6 | 94.39% | 91.40% | 83.73% | 87.22% |
| S7 | 79.68% | 86.8% | 82.69% | 87.22% |
| S8 | 57.64% | 74.98% | 73.54% | 82.73% |
| S9 | 39.84% | 29.87% | 63.47% | 36.05% |
| S10 | 88.17% | 88.65% | 86.15% | 76.04% |
| S11 | 82.17% | 69.43% | 81.43% | 89.33% |
| S12 | 80.50% | 69.73% | 89.55% | 83.44% |
| S13 | 63.94% | 81.23% | 64.04% | 73.74% |
| S14 | 75.70% | 67.46% | 93.61% | 86.13% |
| S15 | 62.94% | 71.49% | 72.63% | 73.24% |

### 3. Results of study 2: Intervocalic /s/ voicing in Highland Colombian Spanish according to speech rate and formality

Upon reviewing the collected data for study 2, evidence for intervocalic /s/ voicing was found in the HCS dialect, albeit scarcer than what is found in the HES dialect. Because of this, the addition and analysis of hypothesis 2A, which states that the

intervocalic /s/ voicing in the HCS dialect is independent of both speech rate and speech formality, is needed. The results of these analyses are shown in the following sections.

### 3.1 Results of intervocalic /s/ voicing according to speech rate

A repeated measures Analysis of Variance (ANOVA) was used to compare the mean percentage of voiced frication noise for the three different speech rates: slow, normal, and fast, in the three different phonological environments: word internal intervocalic, word final intervocalic, and word initial intervocalic. It revealed that speech rate has a significant effect on the degree of fricative voicing. In the three environments (word internal intervocalic, word final intervocalic, and word initial intervocalic) there was a higher degree of frication voicing during fast speech ($M$=34.21%, $M$=33.44%, $M$=19.18% respectively) compared to slow speech ($M$=20.41, $M$=16.96, $M$=2.69 respectively). The highest percentage of frication voicing occurred in the word internal, and word final intervocalic positions, when the word list was read as quickly as possible ($M$=34.21% and $M$=33.44% respectively). The word initial intervocalic /s/ was the least likely to voice ($M$=2.69).

The results for according to speech rate are as follows: word internally, $F(1, 14) = 26.35$, $p < 0.001$, word finally, $F(1, 14) = 23.28$, $p < 0.001$ and word initially, $F(1, 14) = 21.36$, $p < 0.001$. The means and standard deviations for the three speech rates according to the phonological environment are shown in table 4-5.

**Table 4-5**
*Means and standard deviations according to speech rate and phonological environment*

| | Speech rate: Slow | | Speech rate: Normal | | Speech rate: Fast | |
|---|---|---|---|---|---|---|
| Word internal intervocalic | *M*=20.41 | *SD*=17.10 | *M*=27.36 | *SD*=21.87 | *M*=34.21 | *SD*=19.08 |
| Word final intervocalic | *M*=16.96 | *SD*=15.91 | *M*=23.36 | *SD*=19.48 | *M*=33.44 | *SD*=19.16 |
| Word initial intervocalic | *M*=2.69 | *SD*=2.30 | *M*=11.59 | *SD*=15.20 | *M*=19.18 | *SD*=15.35 |

The least amount of variation between subjects occurred when the word list was read slowly, with a range of 59.3%, 48.77%, and 8.22% respectively according to the phonological environment. Additionally, there was less variation between subjects in the word initial intervocalic position, compared to the other phonological environments, with a range of 8.22% for slow speech, 49.07% for normal speech and 55.45% for fast speech.

The results also show a great deal of individual variation. For instance, subject 11 consistently voiced the frication noise more than 50% of the time, regardless of the speech rate or phonological environment, whereas other subjects, such as subjects 4 and 5, never voice more than a quarter of the frication noise during the quickest speech rate, and much less during slower speech rates. A complete list of the total percentage of fricative voicing by each participant according to the speech rate and phonological environment is shown in table 4-6.

**Table 4-6**
*Percentage of voiced frication period according to speech rate and phonological environment per subject*

| | Word internal intervocalic | | | Word final intervocalic | | | Word initial intervocalic | | |
|---|---|---|---|---|---|---|---|---|---|
| | Slow | Normal | Fast | Slow | Normal | Fast | Slow | Normal | Fast |
| S1 | 5.11 | 13.98 | 27.34 | 9.35 | 12.87 | 19.25 | 0.00 | 2.23 | 11.00 |
| S2 | 6.47 | 9.93 | 26.95 | 7.04 | 10.49 | 21.27 | 0.98 | 4.28 | 12.08 |
| S3 | 15.19 | 20.40 | 24.27 | 11.06 | 23.26 | 33.24 | 2.21 | 5.52 | 10.99 |
| S4 | 7.04 | 7.34 | 5.14 | 3.03 | 6.79 | 15.81 | 1.00 | 2.25 | 21.3 |
| S5 | 8.11 | 10.48 | 21.87 | 7.15 | 11.35 | 25.09 | 1.29 | 4.39 | 7.74 |
| S6 | 14.76 | 33.10 | 44.65 | 10.72 | 14.96 | 27.16 | 3.23 | 16.76 | 22.93 |
| S7 | 38.35 | 65.14 | 60.10 | 47.87 | 65.66 | 51.37 | 8.22 | 43.59 | 41.56 |
| S8 | 6.65 | 11.96 | 27.48 | 9.07 | 12.05 | 13.61 | 0.71 | 2.50 | 6.87 |
| S9 | 20.62 | 33.32 | 26.44 | 39.38 | 4.05 | 41.91 | 3.81 | 17.64 | 9.7 |
| S10 | 6.08 | 21.25 | 26.9 | 9.60 | 7.29 | 28.12 | 4.33 | 2.39 | 12.59 |
| S11 | 64.41 | 81.02 | 82.94 | 51.80 | 60.74 | 85.25 | 6.10 | 50.2 | 63.19 |
| S12 | 38.68 | 23.55 | 54.51 | 20.54 | 26.49 | 44.58 | 1.20 | 7.43 | 9.30 |
| S13 | 27.79 | 22.23 | 21.75 | 14.13 | 17.96 | 25.74 | 2.63 | 7.11 | 10.30 |
| S14 | 33.81 | 48.34 | 32.79 | 8.95 | 43.52 | 53.10 | 3.83 | 6.29 | 26.80 |
| S15 | 13.04 | 8.84 | 30.06 | 4.74 | 2.99 | 16.14 | 0.72 | 1.13 | 21.43 |

### 3.2 Results of intervocalic /s/ voicing according to speech formality

A repeated measures ANOVA was also used to compare the mean degree of voiced frication noise for the two different speech formalities, formal (reading passage) and, informal (interview questions) in the three different phonological environments, word internal intervocalic, word final intervocalic, and word initial intervocalic. It revealed that there was no significant correlation between these two factors in any of the environments tested. In the word internal intervocalic position, $F(1, 14)=0.270$, $p = 0.611$. In the word final intervocalic position, $F(1, 14)=0.036$, $p = 0.853$. In the word initial intervocalic position, $F(1, 14)=0.126$, $p =0.728$.

For both the formal and informal tasks, the highest degree of voicing occurred in the word final intervocalic position (*M*=25.29% and *M*=24.78% respectively), and lowest degree of voicing in the word initial intervocalic position (*M*=15.98% and *M*=17.19% respectively). The means and standard deviations for the two speech formalities according to the phonological environment are shown in table 4-7.

**Table 4-7**
*Means and standard deviations according to speech formality and phonological environment*

| | Formal: Reading passage | | Informal: Interview questions | |
|---|---|---|---|---|
| Word internal intervocalic | M=22.57 | SD=14.22 | M=23.74 | SD=13.50 |
| Word final intervocalic | M=25.29 | SD=15.59 | M=24.78 | SD=11.75 |
| Word initial intervocalic | M=15.98 | SD=12.45 | M=17.19 | SD=11.84 |

Unlike the word list readings, in which the word internal intervocalic /s/ showed the highest degree of fricative voicing, during the speech formality tasks, the word final intervocalic /s/ voiced with the highest percentage. The word initial intervocalic position remained the least likely to voice, regardless of the level of speech formality. A complete list of the total percentage of fricative voicing by each participant according to the speech formality and phonological environment is shown in table 4-8.

**Table 4-8**
*Percentage of voiced frication period according to speech formality and phonological environment per subject*

| | Word internal intervocalic | | Word final intervocalic | | Word initial intervocalic | |
|---|---|---|---|---|---|---|
| | Formal | Informal | Formal | Informal | Formal | Informal |
| S1 | 14.17 | 15.74 | 5.55 | 16.40 | 10.76 | 25.41 |
| S2 | 11.6 | 19.14 | 15.46 | 12.84 | 7.36 | 4.03 |
| S3 | 17.12 | 29.72 | 28.25 | 45.32 | 17.88 | 36.57 |
| S4 | 8.17 | 11.98 | 11.7 | 16.82 | 6.91 | 1.20 |
| S5 | 13.52 | 13.48 | 11.98 | 29.72 | 8.69 | 12.04 |
| S6 | 39.18 | 27.19 | 24.17 | 20.92 | 20.94 | 36.81 |
| S7 | 35.74 | 22.56 | 29.05 | 28.23 | 14.67 | 15.33 |
| S8 | 5.32 | 8.69 | 10.55 | 14.55 | 5.56 | 9.16 |
| S9 | 17.14 | 34.61 | 32.8 | 27.83 | 14,18 | 5.96 |
| S10 | 14.91 | 15.21 | 23.27 | 19.28 | 4.37 | 21.41 |
| S11 | 52.03 | 59.77 | 62.23 | 51.91 | 40.10 | 21.42 |
| S12 | 26.91 | 18.93 | 46.99 | 29.64 | 12.54 | 25.88 |
| S13 | 31.72 | 23.18 | 25.61 | 12.54 | 40.98 | 15.14 |
| S14 | 41.35 | 42.06 | 40.27 | 30.70 | 32.16 | 26.91 |
| S15 | 9.83 | 13.86 | 11.46 | 15.06 | 2.65 | 0.00 |

## 4. Conclusion

This chapter reported the results from the two different studies being tested. First, the results from hypotheses 1a, which states that the degree of voicing assimilation is positively correlated with speech rate, and 1b, which stated the degree of voicing assimilation of coda position /s/ is inversely correlated with speech formality, were presented. Using a repeated measures Analysis of Variance, it was found that there is a significant correlation between voicing and speech rate in both the word medial and word final position; however, there is no significant correlation between the degree of voicing and speech formality in either of the phonological environments.

Next, the data collected from the second study, which examined possible intervocalic /s/ voicing in Highland Colombian Spanish, was presented. Given that voicing was present in all of the completed tasks, a further analysis was needed in order to determine if it is dependent on either speech rate or speech formality, or if it is an independent phenomenon, similar to the Highland Ecuadorian data proposed by Lipski (1989). Using a repeated measures Analysis of Variance, it was found that the degree of intervocalic /s/ voicing in this dialect is dependent on speech rate, but independent of speech formality. The next chapter will provide a detailed discussion of the results from both of these two studies.

# Chapter 5

# Discussion

## I. Introduction

This chapter will discuss the results collected for both the hypotheses tested in this dissertation. Upon reviewing the data, I have concluded that that the results do not support any of the hypotheses; the voicing assimilation rule of coda position /s/ is not dependent on either speech rate or speech formality, and speakers of Highland Colombian Spanish do not voice /s/ intervocallically.

The rejection of these hypotheses, however, is not straightforward. For instance, in the first study, a significant correlation ($p < 0.001$) was found between speech rate and degree of voicing assimilation of coda position /s/ to the following segment. However, in this chapter I will argue that the voicing observed during the frication noise is not a result of an assimilation rule, as proposed by the Generative Phonology approach. Instead, I argue the side of Articulatory Phonology, and reject the idea that a voicing assimilation rule exists in Spanish; the voicing observed during the frication noise is the direct result of overlapping articulatory gestures.

In study 2, evidence of intervocalic /s/ voicing was found in the Highland Colombian Spanish data. However, compared to the Highland Ecuadorian data, the HCS voicing patterns are sporadic and variant. Because of this, it is not possible to generate a phonological rule which can correctly account for all of the data. The intervocalic /s/ voicing in this dialect is also a result of overlapping gestures.

Section 2 of this chapter provides an in depth discussion of gestural blending, and how certain factors, in particular speech rate and speech formality, affect the degree of

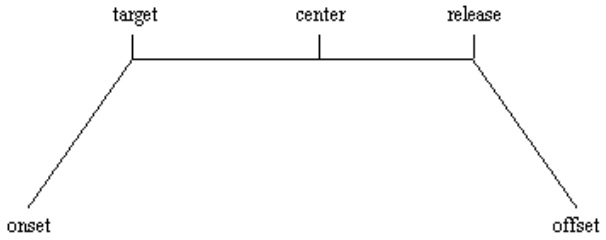
overlap between two adjacent gestures. Next, section 3 will evaluate the data collected for hypotheses 1a and 1b, and discuss studies in which gestural blending between two consonants has been observed. I will argue for gestural blending by comparing and opposing it to the traditional voicing assimilation rule proposed by generative phonologists. Section 4 will take a closer look at the data collected for hypothesis 2, and how gestural blending can also account for the intervocalic voicing seen in the HCS dialect, as well as discuss more specifics on gestural blending of intervocalic consonants. Section 5 will cover some general observations relating to both of the hypotheses. Section 6 mentions the limitations of this study, as well as direction for future research on this topic. Finally, section 7 provides some closing remarks on the discussion of the results.

**2. Gestural blending**

A gesture is defined as a *spatio-temporal* unit (Gafos, 2002): The formation of a constriction causes its spatial dimensions. This constriction includes both the place of articulation (labial, alveolar, etc.) and the degree of constriction, or rather, the manner of articulation (fricative, stop, etc.) (Davidson, 2006). The temporal dimension comes from the fact that gestures unfold in time. There are five main landmarks in a gestural life, shown in figure 5-1. The *onset* is the beginning of the movement of the articulator towards its target. Next is the attainment of the *target*. This is held throughout the *center,* until the *release* of the articulator. This also marks the point when the articulator begins to distance itself from the constriction. The *target, center*, and *release* of the

gestural life are known as its "plateau". Finally, the *offset* is when the articulator is no longer at the constriction needed for that particular gesture.

**Figure 5-1**
*The five landmarks of a gestural life*

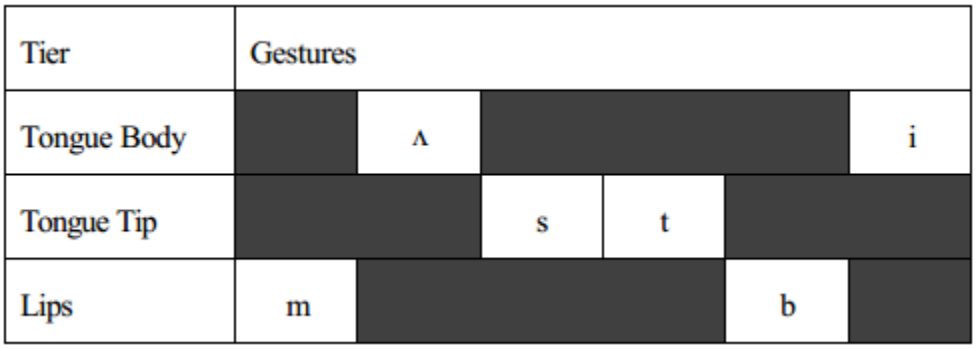



In slow and careful speech, it is easy to mark each of the landmarks of a gestural life. However, how do gestures interact with one another during casual and rapid speech? According to Morris (1998), there are two possibilities. One option is that the individual gestures may become shorter, ultimately decreasing the duration of the segments. The other option is that the individual gestures begin to overlap with one another, most often due to physiological constraints. Nittrouer and Studdert-Kennedy (1987), say that gestural overlap refers to the "overlapping movements in the production of neighboring or near neighboring segments" (p. 74). For example, it would be expected in a phrase such as "seven plus" that the lips would begin to round for the pronunciation of [p] before the tongue tip is released from the alveolar ridge for the [n] (Zsiga, 1992). This overlap most often occurs in casual and rapid speech due to the general "tendency to simplify speech patterns to increase ease of articulation" (Mannell, 2008. p. 10).

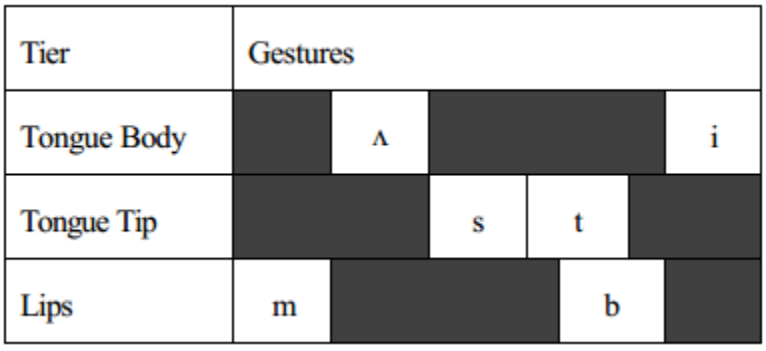
Browman and Goldstein (1991) provide a visual to represent how the articulators compress and overlap with one another in rapid speech. Figure 5-2a shows the English phrase *must be* according to a normal speech rate in which the segments are proportionately timed. In Figure 5-2b, the same phrase, yet in rapid speech, is shown. The rapid speech causes the segments to compress, producing an overlap between the [t] and the [b].

**Figure 5-2**
*Gestural overlap according to speech rate (*Browman and Goldstein (1991) p. 18)

**a**

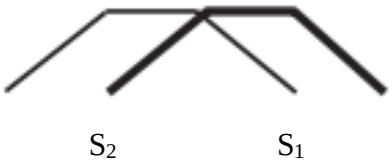



**b.**



This type of relationship between two overplaying gestures is referred to as *close transition* (Davidson, 2006). It occurs when the second segment reaches its target before the release of the constriction of the first segment. The *close transition* can be seen in figure 5-3.

**Figure 5-3**
*Close transition relationship between two consonants*




The *close transition* can affect different segments in very different ways. For example, Zhao (2003) notes that consonants in the word initial position with a front-to-back order (alveolar to velar) overlap more than segments with a back-to-front order (velar to alveolar). Mannell (2008) mentions that the degree of overlap between the two segments increases with greater articulator movement. For instance, more overlap is expected in an alveolar-velar sequence compared to an alveolar-palatal sequence. Finally, Pincas and Jackson (2004) found that the duration of overlap between two segments is dependent on the duration of the first segment. These concepts and studies on gestural overlap can help to explain the results of the data collected for this study. In the following section, more studies which directly investigate overlapping consonantal segments are discussed.

**3. Discussion of the results of hypothesis 1a and 1b**

Hypothesis 1a stated that the degree of voicing assimilation of coda position /s/ in Spanish is positively correlated with speech rate; as speech rate increases, the degree of voicing assimilation will also increase. This hypothesis is supported by the collected data; there was a significant correlation ($p < 0.001$) between these two factors both word medially and word finally.

Hypothesis 1b stated that the degree of voicing assimilation of coda position /s/ is Spanish is negatively correlated with speech formality; as speech becomes more formal, the degree of voicing assimilation will decrease. Likewise, as speech becomes less formal, the degree of voicing assimilation will increase. This hypothesis is not supported by the collected data; there is no significant correlation between these two factors in either of the environments tested. In the word medial position, $F(1, 14) = 344.30$, $p = 0.961$, and in the word final position, $F(1, 14) = 610.55$, $p = 0.978$.

These two hypotheses yielded different results, yet also had one thing in common; they were both formulated based on the assumption that Spanish has a generative phonological rule which states that a coda position /s/ will voice to [z] before voiced consonants. Moreover, the lack of systematicity and regularity in the voicing patterns degrades the validity of this rule. As seen with the current results, as well as mentioned by many other researchers such as Harris (1969), Hualde (2005), and Romero (1999) among others, this process is highly variable and gradient. Because of that, it is implausible to construct a categorical phonological rule; /s/ may voice to [z] before voiced consonants. This is merely one of many possible realizations for this sound sequence.

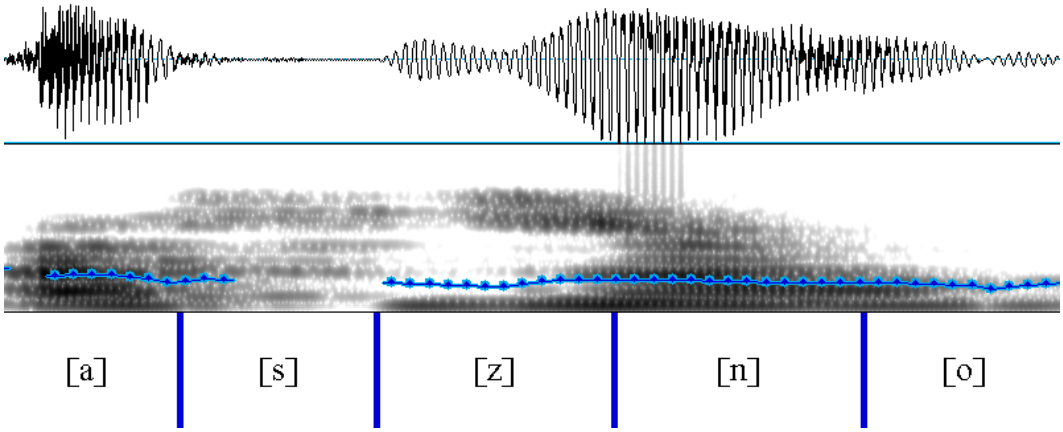
Because of this, I propose that a mere Generative Phonological account is not enough to correctly and efficiently describe the grammar of Spanish. Some researchers have tried to cover up this problem by saying that the gradient nature of the voicing assimilation rule is due to individual or random variation, however, obligatory phonological rules are not at the mercy of individual variation. A gestural blending account, on the other hand, specifically allows for variation in the pronunciation of a given segment.

Romero (1999) was the first of very few researchers who have considered gestural blending as a possible solution to the gradient and variable nature of the coda position /s/ in Spanish. Using laryngeal transillumination and electromagnetic articulometry, Romero discovered that the state of the glottis tended to change before the movements of the articulators. In other words, the vocal chords begin to vibrate in anticipation of the following voiced consonant, before the tongue tip moves from the alveolar position needed to produce the /s/, to the point of articulation for the following consonant. The overlap of the laryngeal and supralaryngeal gestural peaks causes the voicing of coda position /s/. (For more details on Romero's study, see chapter 2, section 2.3).

Although this study did not incorporate the same technologies for measuring the laryngeal and supralaryngeal peaks, the same overlap was observed viewing the waveforms and spectrogram in PRAAT. Figure 5-4 shows a screen shot from PRAAT during the pronunciation of the word *asno* 'donkey'. Here, it is easy to see that the fricative began without any vibrations of the vocal chords (as seen by the lack of a voice bar or systematicity in the wave form), and then became voiced approximately half way through. Again, this voicing was due to the fact that the vocal chords began to vibrate in

anticipation for the following segment (in this case [n]) before the tongue tip was released from the alveolar position.

**Figure 5-4**
*Gradient fricative voicing in the pronunciation of asno 'donkey'*




Gestural blending, in addition to accounting for the gradient nature of this phone in Spanish, can also account for the differences in the overall degree of fricative voicing among the different speech rates and formalities tested in this dissertation.

Several researchers have investigated the effects of rapid speech on gestural overlap such as Munhall and Löfqvist (1992), Bryd and Tan (1996), and Davidson (2006). Their results can directly compare the results of the speech rate elicitation tasks collected in this study.

First, Munhall and Löfqvist (1992) investigated the effects of speech rate on the articulation of voiceless consonant clusters at word boundaries. They found that during slow speech, each of the phonemes maintained its own glottal opening gesture; in other

words, the glottis opened to allow for the articulation of the first voiceless consonant, closed, and then reopened for the articulation of the second consonant. However, as speech rate increased, only one glottal opening was measured. They concluded that the reduction of two glottal openings to one during the production of voiceless consonant clusters was due to increased consonantal overlap which caused the blending of the glottal gestures.

In 1996, Bryd and Tan carried out extensive research on the effects of speech rate on the production and possible overlap of voiced consonant clusters in English. Five monolingual speakers of English participated. They each were set up with an artificial palate which would record their tongue-palate contact throughout the utterances. Next, they were shown a set of heterosyllabic sequences in which the consonant cluster in question occurred over a word boundary, and asked to read it "normal", "medium", "fast", and "fastest" successively.

The results from Bryd and Tan's study showed a general pattern of increased gestural overlap between the two consonants as speech rate increased, although not every combination of consonant clusters yielded the same results. Furthermore, the speakers with the fastest speaking rate also had the highest mean degrees of overlap. They concluded that producing consonant clusters which span word boundaries quickly decreases the articulatory duration, while at the same time, increases the temporal overlap of gestures. However, the degree of overlap may be dependent on the specific linguistic structures or individual speakers.

Finally, Davidson (2006) investigated gestural overlap as a possible cause of schwa elision in fast speech. In English, the elision of pretonic schwa

(tomorrow:[tm]orrow), is a common occurring phenomenon which Davidson hypothesized was due to the fact that "increased overlap between adjacent sounds may effectively render one of the sounds absent from the acoustic record" (p. 80). Her results indicated that the deletion of word initial pretonic schwa was not consistent with deletion rules normally associated with fast speech given that the application of a deletion rule would cause the formation of an initial consonant cluster, whereas her data still showed acoustic residue of the pronunciation of schwa. These results directly parallel those of this dissertation such that the degree of voicing is not consistent with the voicing assimilation rule.

These studies have systematically and experimentally shown that the amount of overlap between two gestures is, among others, a function of speech rate. It is not to say that no overlap is possible during slow speech, but as speech rate increases, more overlap is expected between the two adjacent segments. The findings of these studies are also consistent with the results collected during this study. I propose that the voicing assimilation rule of coda position /s/ in Spanish is not the result of a phonological rule, but rather of gestural blending between the fricative and the following voiced consonant, therefore, as the speaking rate of the participants increased, the amount of gestural overlap also increased, ultimately causing a higher percentage of voicing during the frication period.

Hypothesis 1b examined how speech formality can affect the degree of fricative voicing in Spanish, or now rather, the degree to which these two segments overlap with one another. Speech formality differs from speech rate in so that the degree to which the participants were paying attention to their utterances was considered, rather than the rate

at which they were speaking. Here, the reading passage was used as a formal task since the participants had visual cues and were conscious of what was being read, whereas the interview portion of the study was used as the informal task since the participants were more conscious of what they were saying rather than how they were saying it.

To the best of my knowledge, there are no known studies which experimentally compare the voicing assimilation rule in Spanish to speech formality, and few which mention possible implications of speech formality on gestural overlap. Browman and Goldstein (1991) predicted "gestures to show decreased magnitudes (in both space and time) and to show increasing temporal overlap" in casual speech (p. 17). Also, Zsiga (1992), later confirmed by Nicolaidis (2001), mentions that the coarticulatory affects are greatest during casual spontaneous speech, compared to words produced in isolation. However, unfortunately there was no data provided to explicitly test and confirm these predictions.

In that same study, Zsiga also noted that speakers always have control over their articulators, thus can control the degree of overlap between segments. A speaker may wish to lessen the degree of overlap in order to ease the communicative burden of the listener. Flege (1988) made similar observations stating that "[A] balance of two countervailing forces influences how phonetic segments are articulated: the need to maintain sufficient distinctiveness between segments to ensure the segments are recognized correctly, and the need to minimize the effort while rapidly interweaving the multistructural movements that characterize successive phonetic segments" (p.99).

However, even though with these statements that argue that gestural overlap is greater in informal speech, the data collected for this study indicate that increased overlap

is not a function of speech formality, as it is speech rate. The percentages of gestural overlap according to speech formality can be seen in table 4-3, as well as repeated below in table 5-1.

**Table 5-1**
*Means and standard deviations according to speech formality and phonological environment*

| | Formal: Reading passage | | Informal: Interview questions | |
|---|---|---|---|---|
| Word medial | *M*=71.24 | *SD*=20.69 | *M*=74.58 | *SD*=16.89 |
| Word Final | *M*=73.29 | *SD*=16.05 | *M*=75.26 | *SD*=17.00 |

There is no significant difference in the mean percentage of gestural overlap between the two segments in either level of speech formality or in either of the two environments tested. This data would then, in fact, also reject Zsiga's and Flege's previous statement that a speaker has the ability to control the degree of gestural overlap when they speak in order to make communication more efficient, because it would be expected that the participants would attempt to reduce the degree of gestural overlap in the more formal situation.

However, speech rate still plays a role in this data given that slow and fast informal data and slow and fast formal data were not collected. Reviewing the recordings, an average speech rate for both the formal and informal data can be obtained. The average speech rate for the formal reading passage task was 2.6 syllables per second, and for the informal interview questions, 3.2 syllables per second. Not only are the

speech rates comparable to the average rate when the word list was read quickly (2.7 syllables per second), the mean percentage of gestural overlap is also similar. Table 5-2 compares the mean percentages of gestural overlap for the fast reading list, the informal interview questions, and the formal reading passage, as well as the average speaking rate for each.

**Table 5-2**
*Mean rate (syllables/sec) and percentages of gestural overlap for the reading list, interview questions, and reading passage*

| | Fast word list | | Informal interview | | Formal reading passage | |
|---|---|---|---|---|---|---|
| | Rate | % gestural overlap | Rate | % gestural overlap | Rate | % gestural overlap |
| Word medial | 2.7 | 79.57% | 3.2 | 74.58% | 2.6 | 71.24% |
| Word final | 2.7 | 82.00% | 3.2 | 75.26% | 2.6 | 73.29% |

These percentages lead me to conclude that the mean percentage of gestural overlap remains a function of speech rate, rather than speech formality, and that speakers are not able to consciously control their articulators enough during rapid speech in order to impede overlap. However, this is not to say that Flege's previous statement is untrue. It is still a possibility that during slower, or even normal speech rates, a speaker would be able to control their articulators, however, given that speech formality and speech rate were not independently measured, the rate at which a speaker's ability to control their articulators is still unknown, yet could be easily tested by performing both formal and informal elicitation tasks at various speech rates.

Additionally, the lack of difference between the speech formalities is this study could also be due to a design flaw. The interview portion of the study was conducted through the computer. The participants were shown a question, and asked to respond freely. The lack of interpersonal communication during this task may have caused the formality level to remain elevated to the same level of the reading passage. If the participants considered both the reading passage and interview portion of this study to be formal tasks, a difference in the results should not be expected.

One remaining issue surrounding the data collected for hypotheses 1a and 1b is why there was no significant difference in the degree of gestural overlap between the fricative and following voiced consonant in the word medial position and the word final position. Bryd and Saltzman (1998) found that there is less gestural overlap among gestures separated by a boundary. Because of this, it would be expected that the data which contained a word final coda /s/ would display much shorter voiced frication periods compared to the word medial coda /s/, however, that was not the case in this study. Table 5-3 compares once again the degree of voiced frication noise per environment and elicitation task.

**Table 5-3**
*Mean degree of voiced frication noise per phonological environment and elicitation task*

| | Word list: Slow | Word list: normal | Word list: Fast | Reading passage | Interview questions |
|---|---|---|---|---|---|
| Word medial | 38.21% | 62.71% | 79.57% | 74.58% | 71.24% |
| Word final | 24.29% | 57.77% | 82.00% | 75.26% | 73.29% |

Given that examining the difference in the voicing of coda position /s/ in different environments was not part of the original hypotheses, there is insufficient data to make a claim as to whether this could influence the degree of gestural overlap. One possible reason as to why a difference in gestural overlap is not seen in this data is because all of the words presented on the word list consisted of a determiner and a noun. Often, these words are mentally stored as a single phonological, thus the word final /s/ would still act as though it were in the word medial position.

To sum up the results of the data collected from hypotheses 1a and 1b, I would like to reiterate that the voicing of pre-voiced consonantal /s/ in Spanish is not the result of a categorical phonological rule given its gradient nature and lack of systematicity, but rather the result of gestural blending between the fricative and the following consonant. The increase in the voicing of the frication noise with speech rate is due to the increase in gestural blending. In order to speak at quicker rate, the participants had to either shorten the length of the individual segments, and/or increase the overlap between the segments.

However, as previously stated in this dissertation, the theories of Generative Phonology ad Articulatory Phonology are complementary to one another, rather than contradictory. My rejection of these hypotheses does not automatically reject the idea of a voicing assimilation rule in Spanish, because without this rule, the coda position /s/ would be expected to maintain its voiceless properties, but rather it aims to highlight the importance of Articulatory Phonology in Spanish given that it can effectively describe the grandniece found in the assimilation rule.

Finally, even though some current research states that higher degrees of gestural overlap is more likely in casual speech, the data presented here did not show a significant

difference. This could be, however, due to structural problems in the organization of elicitation tasks. First, both the formal and informal tasks were performed at a speech rate similar to the fast word list. It is possible that the fast speech rate masked the possible differences in overlap between the two speech formalities. Also, the difference in the formality level between the two tasks was minimal. It is more likely that there would have been a significant difference in the degree of overlap had there been a greater difference between the formality levels of the elicitation tasks. The next section will discuss how gestural blending can also account for the voicing seen in the HCS data.

**4. Discussion of the results of Hypothesis H2**

The second hypothesis presented in this dissertation stated that speakers of Highland Colombian Spanish would voice intervocalic /s/. This prediction was made base on scarce research, such as by Flórez (1973) and Torreblanca (1983), who noted a few instances of intervocalic /s/ voicing in Colombia, as well as the strategic intervocalic voicing patterns found in Highland Ecuadorian Spanish, a phonologically similar dialect. Furthermore, it was predicted that if the voicing were present in this dialect, it would be independent of both speech rate and speech formality, given that it is implemented in such a way in HES, according to Lipski, (1989).

The results from the five different elicitation tasks (three words lists, a reading passage, and interview questions) showed that intervocalic /s/ voicing does occur in the HCS dialect. These results are presented in tables 4-5 and 4-7 (repeated below in table 5-4 for convenience).

**Table 5-4**
*Mean percentage of intervocalic /s/ voicing in HCS according to phonological environment and elicitation task*

| | Word list: Slow | Word list: Normal | Word List: Fast | Reading passage | Interview questions |
|---|---|---|---|---|---|
| Word medial intervocalic | 20.41% | 27.36% | 34.21% | 22.57% | 23.74% |
| Word final intervocalic | 16.96% | 23.36% | 33.44% | 25.29% | 24.78% |
| Word initial intervocalic | 2.69% | 11.59% | 19.18% | 15.98% | 17.19% |

Even though intervocalic /s/ voicing occurred in all three phonological environments, and in all five elicitation tasks, the voicing is still quite minimal. The highest degree of voicing was found in the word medial intervocalic position, during the fastest reading of the word list, yet still only voiced for about one third of the total frication period. On the other hand, the intervocalic /s/ voicing patterns in HES is highly systematic and frequently occurring. For comparison sake, table 5-5 displays the mean percentage of intervocalic /s/ voicing in all three phonological environments presented by Chappell (2011), along with the combined mean percentage of intervocalic /s/ voicing from normal word list, reading passage, and interview questions collected in this study.

**Table 5-5**
*Mean percentage of intervocalic /s/ voicing in HES from Chappell (2011) compared to mean percentage of intervocalic /s/ voicing in HCS*

| | HES (Chappell, 2011) | HCS Word list: normal | HCS reading passage | HCS interview questions |
|---|---|---|---|---|
| Word medial intervocalic | 11% | 27% | 23% | 24% |
| Word final intervocalic | 91% | 23% | 25% | 15% |
| Word initial intervocalic | 6% | 12% | 16% | 17% |

In the HES dialect, word final intervocalic /s/ voicing occurs 91% of the time. However, in the same position in HCS, the voicing only occurs between 15% and 25%. This drastic difference leads me to reject the previously stated hypothesis. In other words, based on the presented data, I propose that HCS does not voice intervocalic /s/ to [z] in any phonological environment. Nevertheless, if this claim is made, another explanation must be given in order to explain why voicing still occurred between 12% and 27% of the frication period. I propose that the intervocalic /s/ voicing seen in the HCS data is also a result of gestural overlap between the fricative and the flanking vowels.

Once again, gestural overlap occurs due to the general "tendency to simplify speech patterns to increase ease of articulation" (Mannell, 2008. p. 10). The presence of gestural overlap between vowels and fricatives in particular can be seen in a variety of different ways. For instance, vowel rounding may cause the frequency of sibilant fricative to lower by as much as 300-500 Hz (Bell-Berti and Harris, 1979). Also, at the end of the frication period, when the constriction begins to widen, the presence of F2

peaks can be seen, especially in the context of high vowels (Soli, 1981). This overlap can also be seen with regards to voicing, as seen with the data collected during this study.

In the case a post-vocalic /s/, the articulators begin to move to the alveolar position, and the constriction for the frication noise begins before the vibration of the vocal chords from the production of the preceding vowel ceases. The opposite would be true for a pre-vocalic /s/: the vibration of the vocal chords for the production of the following vowel would begin before the constriction from the frication noise is released.

Stevens. et. al. (1992) aimed their study at quantifying the degree to which an intervocalic /s/ may overlap with either the preceding or following segment and still be considered acoustically voiceless. They concluded that both anticipatory and preservative blending effect the fricative approximately equally.

In their study, Stevens et. al. (1992) recorded one male and two female speakers producing nonsense words in carrier sentences. The nonsense words contained a singleton consonant in the intervocalic position (vSv), two fricative consonants with different places of articulation, but the same voicing feature (vSFv), two fricative consonants with different places of articulation and different voicing features (vSZv), or a singleton consonant in the utterance final position (vS). For the sake of the discussion of hypothesis 2, only the voiceless singleton consonant in the word medial position will be mentioned, however, the vSZv position will be discussed in section 5.

The analysis of their data consisted of two steps. First, they measured the total duration of both the vowels and fricatives. The onset of the frication noise was determined to be when the shape of the spectrum significantly changed from the systematic waves of the preceding vowel. Likewise, the end of the frication noise was

determined by the onset of systematic waves for the following vowel. The average duration of a voiceless intervocalic /s/ for the three participants was 101 ms.

The second part of their data analysis consisted of measuring the duration of the glottal vibrations within the frication period. In order to obtain this measurement, they started several tens of ms before the onset of the frication noise and ended several tens of ms after. The presence of glottal vibration was determined by measuring the amplitude of the first harmonic, which indicates the strength of the glottal vibrations. The first harmonic is a good determiner given that if the glottal pressure drops, which occurs when the glottal pulses decrease, the $H_1$ will also decrease.

Their results showed that nearly all of the intervocalic voiceless singleton fricatives had some glottal vibration residue. Additionally, the glottal residue is about 10 ms longer at the onset of the fricative compared the boundary with the following vowel. On average, there was 13 ms of glottal vibration overlap at the vowel-VL fricative boundary, and 5 ms of glottal vibration overlap at the VL fricative-vowel boundary, however, there was also considerable variability between participants and between tokens. After plotting all of the glottal vibration overlap on a distribution curve, Stevens et. al. proposed a duration of glottal vibration criteria to best discriminate voiced from voiceless fricatives. This criterion is 30 ms for fricatives which follow a vowel, and 20 ms for fricatives which precede a vowel. In other words, if an intervocalic fricative has less than 30 ms of glottal vibration in its onset, and/or less than 20 ms of glottal vibration in its offset, it should be classified as voiceless. If the total glottal vibration overlap exceeds either of these two numbers, the fricative should be classified as voiced.

The data collected during this study can now be re-evaluated using these new criteria. Rather than measuring the degree of voiced frication noise, a fricative was labeled as voiceless if it met the criteria proposed by Stevens et. al, and as voiced if it exceeded their criteria. The new percentages of voiced versus voiceless intervocalic fricatives according to the phonological environment can be seen in table 5-6. It is important to note here, however, that the criteria given for determining the voicing of a fricative is based off of the research of Stevens et. al., and should not necessarily be considered a global measurement. It would have been more precise to report these criteria in the form of a percentage based on the total frication duration. Yet since the total frication duration for voiceless intervocalic fricatives obtained in their study is comparable to the measurements of the current study, the same 30/20 criteria will be applied.

**Table 5-6**
*Percentage of voiced and voiceless intervocalic fricatives according to phonological environment and elicitation task*

| | Word list: Slow | Word list: Normal | Word list: Fast | Reading passage | Interview questions |
|---|---|---|---|---|---|
| Word medial intervocalic | 21% VD<br>79% VL | 22% VD<br>78% VL | 25% VD<br>75% VL | 11% VD<br>89% VL | 12% VD<br>88% VL |
| Word final intervocalic | 21% VD<br>79% VL | 19% VD<br>81% VL | 24% VD<br>76% VL | 13% VD<br>87% VL | 13% VD<br>87% VL |
| Word initial intervocalic | 2% VD<br>98% VL | 5% VD<br>95% VL | 12% VD<br>88% VL | 11% VD<br>89% VL | 12% VD<br>88% VL |

Using the new criteria to classify the voicing characteristics of fricatives, the intervocalic /s/ voicing in HCS occurs less frequently than before, thus strengthening the idea that it is not a systematic phonological process as seen in HES, but rather a result of gestural overlap. The highest percentage of voiced fricatives still occurred in the word medial position during the fast reading of the word list, but was reduced from 34% to 25%. The word initial position remained the least likely to voice.

The same patterns of gestural overlap seen with the results of hypotheses 1a and 1b can be seen here. Within the voiceless fricatives, more gestural overlap is seen as speech rate increases. In fact, for some participants, the gestural overlap increases enough to change the classification of the fricative from voiceless to voiced. Again, speech formality does not seem to play a role in the degree of overlap between the gestures.

**5. Discussion of results from both hypotheses**

The data collected during this study provide a strong argument for gestural overlap in fricative-stop and vowel-fricative-vowel sequences in Spanish. However, the degree of overlap for these two combinations varies quite drastically. Table 5-7 compares the percentage of gestural overlap collected for the normal reading list, reading passage, and interview questions per environment.

**Table 5-7**
*Percentage of gestural overlap per elicitation task and phonological environment*

| | Word list-normal | Reading passage | Interview questions |
|---|---|---|---|
| Pre-voiced consonantal (*cisne)* | 80% | 75% | 71% |
| Intervocalic (*oso)* | 27% | 23% | 24% |

The coda position /s/ is far more likely to overlap with the adjacent segment than is the intervocalic /s/ in all elicitation tasks. However, if all fricative voicing in Spanish is due to gestural overlap between the adjacent segments, then why would these percentages not be more similar to one another? Stevens et. al. (1992) proposed the 30-20 ms criteria for determining the voicing properties of an intervocalic /s/, but also examined the voicing overlap between two adjacent fricatives with different voicing properties. Unfortunately, they came to the conclusion that a simple measurement of glottal vibration (as used to measure the intervocalic fricatives) was not sufficient, and that there other parameters which may have to be included in the analysis such as F1 transitions. Also, they found that with their data, there may have been cases in which a target fricative may have been voiced, but it was implemented as voiceless due to complete assimilation. In these cases, the first fricative in the sequence took on the voicing characteristics of the second fricative.

Nevertheless, there are still two other possibilities as to why the data from the first study (with fricative-consonant sequences) contained higher percentages of gestural overlap compared to the vowel-fricative-vowel sequences. First, consonants may cause increased overlap compared to vowels. Bryd (1996) observed an average of 59% overlap

between two adjacent consonants, with a range of 80% when using electropalatography (EPG) to measure the degree of overlap in consonant clusters across word boundaries. Although this average is quite a bit lower than the ones observed here, the ranges are comparable. On the other hand, Stevens et. al. noted an approximate 20% overlap for fricative-vowel sequences (a maximum of 20ms of overlap between a fricative and following vowel, divided by their average fricative duration of 101 ms).

Also, Solé (2003) investigated the aerodynamic characteristics of fricatives in the onset and coda positions and noted that "The observed aerodynamic and acoustic data are compatible with a reduced oral gesture and reduced amplitude of frication for coda as opposed to onset fricatives" (p. 4). The reduction of the amplitude of the frication noise makes the coda position /s/ more likely to be affected by overlapping gestures. This statement if fully supported by the data presented here in so that there was more overlap in the coda position /s/ across all elicitation tasks than in the onset /s/ (intervocalic /s/). This is something that, unfortunately, cannot be tested in Spanish given that the language does not allow for an /s/ as part of a consonant cluster to be in the onset position, but could be examined, however, looking at data sets from other languages.

## 6. Limitations and future research

Although this study provides data on the implications of speech rate and speech formality on gestural overlap, it still has its limitations. First, the sample size for both studies was relatively small (15 participants in each). There was a lot of individual variation among the participants, but it is unknown if the same percentage of intra-participant variability would have changed had there been a larger sample size.

Also, a flaw was found with the elicitation tasks used given that the speech formality results returned inconclusive. The speech formality results for the first study yielded similar gestural overlap percentages to the fast word list reading. Upon further analysis, it was found the participants used comparable speaking rates in all three tasks, therefore it is not possible to separate the two variables. Flege (1988) suggests that speakers have control over their articulators, and can impede the overlapping of gestures in order to maintain the "distinctiveness" of segments. Assumedly, a speaker would control this overlap and maintain the distinctiveness in more formal situations. This idea was confirmed by Zsiga (1992) who stated that gestural overlap is expected to be greater during informal spontaneous speech. These researchers, although not supported by the current data, may still be correct in their statements; however it is possible that after a certain speech rate, participants no longer have the same control over their articulators. In other word, it is very possible that the participants wanted or to control their articulators, but speech rate has a stronger influence on the gestural overlap, thus trumping the wants of the participants to control their speech.

This idea could be easily tested with the addition of other elicitation tasks. Ideally, there would be three different formality tasks, such as a word list, reading passage, and interview questions, each preformed at various speech rates: slow, normal and fast. If speech formality has a significant effect on the degree of gestural overlap, the data collected at the same speech rate for each speech formality level should show a significant difference. For example, the word list read slowly should show the least amount of overlap given that it is the most formal task. The reading passage read slowly would show slightly more overlap, and the interview questions answered slowly would

show the highest degree of gestural overlap. Furthermore, within a task, the fastest speech rate would also have the highest degree of overlap. For example, the reading passage read at the quickest speech rate would have the most overlap between gestures, and the least overlap between gestures when read at a slower rate.

Another problem with the design of this study is that the interview questions appeared electronically, in the same format as the word lists and reading passage. Although the participants spoke freely when answering these questions, the fact that they were speaking to a computer may not have reduced the degree of formality enough to see a difference in the results. A better decision would have been to have a recorded interactive conversation between the researcher and participant.

Finally, Bryd and Saltzman (1998) made the claim that less overlap is expected when the gestures are adjacent to a boundary, yet in this study, similar degrees of overlap were seen regardless of the prosodic boundary. However, I believe that this is due to the nature of the words and phrases chosen in this study. The majority of the words consisted of a determiner and a noun, something which is often mentally stored as a single unit. Because of this, the word final /s/ would be expected to act as if it were in the word medial position. This is something which could also be tested in future research by adding a variety of phrases to the word list reading, each of which represents the coda position /s/ at a different prosodic boundary such as word medial (*esmalte* 'nail polish), word final in a determiner-noun sequence (*las vacas* 'the cows'), and word final in other phrases such as verb-noun (*comes rápido* 'you eat quickly') or noun-verb (*los perros lardran* 'the dogs bark').

## 7. Conclusion

The data collected for both of the hypotheses shows evidence of gestural overlap between adjacent segments in Spanish. In the first study, the tongue and the glottis begin to change in anticipation for the following consonant before the constriction for the preceding coda position /s/ ends. This overlap is what causes the gradient nature of the voicing during the frication period. It is because of this the generative phonological rule which states that /s/ must voice to [z] when preceding voiced consonants is not enough to sufficiently describe the language's phonology. In order for Generative Phonology to correctly account for this Spanish data there must be a high degree of regularity and consistency among speakers. However, what current research, including the data presented in this dissertation, has found is that the voicing of coda position /s/ is highly variable. In order to account for the variability and grandniece, both the Generative Phonology and Articulatory Phonology approaches must be considered together.

Based on the Articulatory Phonology approach, the results show that both oth speech rate and speech formality can affect the degree to which adjacent segments overlap with one another. A strong correlation was found between the degree of overlap and speech rate. This is because, as speech becomes more rapid, gestures must either shorten, or increase their overlap with one another in order to accommodate the speech rate.

Even though current research predicts increased overlap in casual speech, my data showed no significant correlation between these two factors. However, one explanation to this could be a design flaw with the elicitation tasks. Both the formal and informal tasks were performed at a rate comparable to the fast word list. It could be that the fast

speech rate overpowered any differences there may have been between the two speech formalities. This is something can could easily be addressed in future research by adding slow and fast formal and slow and fast informal tasks to the study.

The second study yielded similar results to the first. The minimal intervocalic voicing found in the HCS data cannot be attributed to the same phonological rules proposed by generative phonologists to account for the /s/ voicing in Highland Ecuadorian Spanish given that the voicing in HCS is quite minimal and sporadic. Instead, it can be attributed to gestural blending. In this case, the onset of the constriction for the fricative begins before the vocal cord vibration for the previous vowel ends. Likewise, the onset of the voicing for the following vowel occurs before the constriction for the preceding fricative has ended.

Parallel with the first study, the degree of gestural overlap seems to be a function of speech rate; as speech rate increased, so did the degree of overlap. Speech formality does not appear to have an effect on gestural overlap. The next chapter will conclude this dissertation with some final observations and remarks.

# Chapter 6

## Conclusion

The aim of this dissertation was to investigate allophonic variation in the Spanish sibilant fricative. More specifically, it looked at non-standard voicing patterns in two distinct environments. First, the Spanish voicing assimilation rule was re-examined after researchers have argued that the coda position /s/ does not necessarily fully voice before voiced consonants as stated by the generative phonological rule, but rather may only partially voice, or remain voiceless. Also, possible voicing of intervocalic /s/ in Highland Colombian Spanish was investigated in order to determine if there are any parallels with Highland Ecuadorian Spanish, in which a word final intervocalic /s/ is systematically voiced to [z] as a way of marking its place at the word boundary.

Based on the above-mentioned information, the following hypotheses were tested: 1a) Voicing assimilation in Spanish is positively correlated with speech rate; as speech rate increases, the degree of the sibilant fricative voicing will also increase, 1b) Voicing assimilation in Spanish is indirectly correlated with speech formality; as speech style becomes more formal, the degree of the sibilant fricative voicing will decrease and 2) Speakers of Highland Colombian Spanish voice /s/ intervocallically.

In order to test these hypotheses, 15 subjects were asked to perform 5 tasks, each of which elicited different speech rates and speech formalities. The results from hypotheses 1a and 1b showed that the voicing of coda position /s/ before voiced consonants is in fact variable and gradient. There was a significant correlation between the percentage of voiced frication noise and speech rate, however, there was no correlation between the voicing of the fricative and speech formality. The results from

hypothesis 2 showed that native speakers of Highland Colombian Spanish partially voice intervocalic /s/ in the word initial, medial, and final positions, although the degree to which the fricative was voiced was considerably lower compared to the Ecuadorian data. Similar to the first study, speech rate had a significant effect on the degree of intervocalic fricative voicing, but there was no correlation between the degree of fricative voicing and speech formality.

After a closer examination on the data, I came to the conclusion that results from both studies shared one very important feature. The voicing seen in the sibilant fricative is not the result of a categorical voicing rule previously proposed, but rather provides strong evidence for gestural overlap in Spanish. However, the presence of the Generative rule is still necessary in order to predict where the highest degrees of voicing should be expected. Several important conclusions were made upon reevaluating the data from a gestural overlap perspective.

First, Articulatory Phonology better accounts for the voicing of pre-voiced consonantal /s/ given that a phonological rule assumes systematicity and regularity, whereas the data collected in this study, as well as by many other researchers including Romero (1999), Campos-Astorkiza (2010) and Schmidt and Willis (2010), show that the fricative voicing in this position is gradient and highly variable between subjects and tasks.

With the Articulatory Phonology approach, another important conclusion can be made. That is that the degree of gestural overlap is a function of speech rate. In both studies, there was a significant correlation between these two factors. This correlation exists because as speech rate increases, one must either shorten each individual segment,

or increase the overlap between adjacent segments in order to keep pace. This claim is supported by other researchers as well, including Gay (1981), Munhall and Löfqvist (1992), Bryd and Tan (1996), and Davidson (2006).

The present data also leave room for much expansion in the area of gestural overlap. First, there is a contradiction between the research of Browman and Goldstein (1991), Zsiga (1992) and Nicolaidis (2001) on the one hand, and the results presented in this dissertation, on the other hand. The abovementioned researchers all concluded that higher degrees of gestural overlap are expected in more casual speech, whereas the results of the current data do not show any significant correlation between these two factors.

However, this could, in part, be a design flaw in the elicitation tasks given that both the formal and informal data were collected at a speech rate comparable to the data collected during the fast reading of the word list. It is possible that speech rate has a greater influence on the degree of overlap than does speech formality, and because of this, there was no significant difference found in my data. However, more research is still needed in order to truly evaluate the effects of speech formality on the degree of overlap between adjacent segments. More specifically, the speech formality elicitation tasks should be performed at different speech rates in order to determine how these two factors really interact with one another.

One last remaining question about the presented data is why was there considerably more overlap found in the coda position /s/ of the first study than in the intervocalic /s/ of the second study? One possible answer is the position of the fricative. Solé (2003) noted that a coda position /s/ is more likely to be affected by gestural overlap

compared to an onset /s/. Another possibility is that consonants cause a greater percentage of overlap compared to vowels. This is partially supported by other researchers. For example, Bryd (1996) observed a 59% overlap between fricative-consonant sequences, whereas Steves et. al (1992) observed a 20% overlap between fricative-vowel sequences.

Finally, in response to the hypotheses tested in this dissertation, I propose that Spanish does not have a voicing assimilation rule. Furthermore, the intervocalic /s/ voicing seen in the Highland Colombian Spanish is not a systematic occurrence as in Highland Ecuadorian data. Rather, both of these voicing phenomena are due to the overlap between the fricative and the following segment. The vocal cords begin to vibrate in anticipation of the following voiced consonant or vowel, before the constriction needed to produce the fricative has been released. Therefore, there are no categorical rules that could describe this data, but rather Articulatory Phonology best accounts for all of the observed variation.

# APPENDICES

## Appendix A: Word list-Study 1

Table A-1 shows the words that were presented to the participants during the three speech rate tasks for the first study. Also provided are the phonetic representations, and the English translation under the heading 'English gloss'.

**Table A-1**

| Spanish Word | Phonetic Representation | English Gloss |
|---|---|---|
| Islas | [íz.las] | Islands |
| Cisnes | [síz.nes] | Swans |
| Resmas | [réz.mas] | Reams |
| Cosméticos | [koz.mé.ti.kos] | Cosmetics |
| Desbullas | [dez.βú.jas] | Oyster shells |
| Fantasma | [fan.táz.ma] | Ghost |
| Esmalte | [ez.má̰l̪.te] | Nail polish |
| Béisbols | [bḛ́iz.bols] | Baseballs |
| Musgos | [múz.ɣos] | Moss |
| Asnos | [áz.nos] | Donkeys |
| Esmoquin | [ez.mó.kin] | Tuxedo |
| Rasgos | [ráz.ɣos] | Features |

| | | |
|---|---|---|
| Esmeraldas | [ez.me.ɾál̪.das] | Emeralds |
| Muslos | [múz.los] | Thighs |
| Mismos | [míz.mos] | Same |
| Los gatos | [loz.ɣá.tos] | The cats |
| Las nubes | [laz.nú.βes] | The clouds |
| Unas resmas | [ú.naz.réz.mas] | Some reams |
| Tres desbullas | [trez.dez.βú.jas] | Three oyster shells |
| Dos dedos | [doz.dé.ðos] | Two fingers |
| Tres botellas | [trez.βo.té. ʝas] | Three bottles |
| Dos béisbols | [doz.βéi̯z.bols] | Two baseballs |
| Los musgos | [loz.múz.ɣos] | The moss |
| Dos globos | [doz.gló.βos] | Two balloons |
| Tres lilas | [trez.lí.las] | Three lilies |
| Los rasgos | [loz.ráz.ɣos] | The features |
| Dos dados | [doz.ðá.ðos] | Two die |
| Dos muslos | [doz.múz.los] | Two thighs |
| Las vacas | [laz.βá.kas] | The cows |
| Los mismos | [loz.míz.mos] | The same |

**Appendix B: Reading passage-Study 1**

Below is the reading passage presented to the participants, used as the informal task in study 1. An English translation is provided below the passage.

Todos los monstros que viven en la Isla Esmeralda salieron un día a buscar regalos para el día de la madre. Un fantasma le apostó a un trasgo que no podía recoger tantas flores como él. El trasgo caminó por tres horas, pero todavía no había recogido todas las mismas flores bellas como el fantasma, hasta que vio algunas violetas encima de una montaña tan alta que parecía tocar las nubes. Cuando escalaba la montaña para recoger las flores, el trasgo se resbaló en los musgos. Cuando se caía de la montaña, perdió todas las flores que ya había recogido. Se cayó en la bahía, y cansado y tristemente decidió levantarse para regresar a su madre sin un regalo, cuando de repente vio unas ostas en el agua. No eran tan hermosas como las flores, pero por lo menos no iba a regresar con las manos vacías. Cuando regresó, el fantasma se burló del trasgo y el regalo tan feo que le había traído a su mamá. Avergonzadamente, le dio las ostras a su mamá, pero a la sopresa del tasgo, su mamá las abrió, y encontró las perlas más hermosas que había visto. El trasguito sintió un orgullo tremendo y aprendió que las cosas más bonitas del la vida a veces se esconden detrás de un disfraz.

All of the monsters that live on Emerald Island went out one day to look for Mother's day gifts. A ghost bet a troll that he couldn't collect as many flowers as him. The troll walked for three hours, but still hadn't collected all the same beautiful flowers as the ghost, until he saw some violets on top of a mountain so high it seemed to touch the clouds. As he climbed the mountain to get the flowers, the troll slipped on the moss. As he fell from the mountain, he lost all of the flowers that he had already collected. He fell in the bay, and tired and sad, he decided to get up and return to him mom without a gift, when all of a sudden he saw some oysters in the water. They weren't as beautiful as the flowers, but at least he wasn't going to return with empty hands. When he returned, the ghost made fun of the troll and the ugly gift he had brought to his mom. Ashamed, he gave the oysters to his mom, but to the surprise of the troll, his mom opened them, and found the most beautiful pearls she had ever seen. The little troll felt a tremendous pride, and learned that sometimes the most beautiful things in life are hidden behind a disguise.

**Appendix C: Interview questions-Study 1**

Below are the three interview questions presented to the participants in the first study, and used as the formal elicitation task. An English translation is provided below each question.

1. ¿Si fuera de vacaciones, y sus destinos fueran islas, a cuáles lugares iría y qué cosas haría? Sea lo más descriptivo posilble.

If you were to go on vacation, and you destination were an island, where would you go and what would you do? Be as descriptive as possible.

2. ¿Si ud. fuera un fantasma por un día, que tipos de cosas haría? Sea lo más descriptivo posible.

If you were a ghost for one day, what types of things would you do? Be as descriptive as possible.

3. Qué haría si ganara dos millones de dólares en la lotería? Sea lo más descriptivo posible.

What would you do if you won two million dollars in the lottery? Be as descriptive as possible.

**Appendix D: Word list-Study 2**

Table A-2 shows the words that were presented to the participants during the three speech rate tasks for the second study. Also provided are the phonetic representations, and the English translation under the heading 'English gloss'.

**Table A-2**

| Spanish Word | Phonetic Representation | English Gloss |
|---|---|---|
| Osos | [ó.sos] | Bears |
| Aces | [á.ses] | Aces |
| Esas | [é.sas] | Those |
| Beso | [bé.so] | Kiss |
| Husos | [ú.sos] | Spindles |
| Cosas | [kó.sas] | Things |
| Esos | [é.sos] | Those |
| Mesa | [mé.sa] | Table |
| Esa | [é.sa] | That |
| Masa | [má.sa] | Dough |
| Asas | [á.sas] | Handles |
| Usos | [ú.sos] | Uses |
| Dos osos | [do.só.sos] | Two bears |
| Tres aces | [tɾe.sá.ses] | Three aces |
| Dos alas | [do.sá.las] | Two wings |

| | | |
|---|---|---|
| Tres ollas | [tɾe.ójas] | Three pots |
| Tres ajos | [tɾe.sá.xos] | Three (heads of) garlic |
| Esas uvas | [é.sa.sú.βas] | Those grapes |
| Los husos | [lo.sú.sos] | The spindles |
| Esos ejes | [é.so.sé.xes] | The axes |
| Dos hojas | [do.só.xos] | Two leaves |
| Dos ojos | [do.só.xos] | Two eyes |
| Las asas | [la.sá.sas] | The handles |
| Los usos | [lo.sú.sos] | The uses |
| La sopa | [la.só.pa] | The soup |
| Una cita | [ú.na.sí.ta] | An appointment |
| Una seña | [ú.na.se.ɲa] | A sign |
| La soja | [la.só.xa] | The soy bean |
| Cinco sapos | [cíŋ.ko.sá.pos] | Five toads |
| La zeta | [la.zé.ta] | The (letter) Z |
| La cera | [la.se.ɾa] | The wax |
| La suma | [la.sú.ma] | The sum |
| La soga | [la.só.ɣa] | The rope |
| Cinco salas | [cíŋ.ko.sá.las] | Five rooms |
| La ceja | [la.sé.xa] | The eyebrow |
| Una silla | [ú.na.sí.ja] | A chair |

**Appendix E: Reading passage-Study 2**

Below is the reading passage presented to the participants, used as the informal task in study 2. An English translation is provided below the passage.

Ojos Galácticos por Ruben Moreno:

De lo que si estaba seguro, es que ella no era de este planeta. Esa mirada curiosa ya la conocía yo, en mis abundantes viajes a los confines del universo, sobre todo en las mujeres de un planeta amarillo, de lo cual ahora no recuerdo su nombre. Esa sensación de ser explorado desde los pies hasta la cabeza, la había sentido una fría noche cuando tuve que descender de emergencia, y a la distancia, unos ojos luminosos estaban mirándome, casi que me sentí desnudo.

Cuando dirigí mi mirada a aquellos ojos intrusos, inmediatamente se apagaron, pero en mí, quedó la sensación, de que más allá de la curiosidad que susita un extranjero, hubo una fascinación sobre lo desconocido. Yo me quedé estático, no sé por cuánto tiempo, y cuando restablecí mi prioridad, sentí que mi mente y cuerpo también sufrieron los embates de un sortilegio espacial.

Ahora después de tantos años, la casualidad me ha llevado a contemplar en esta fría noche, los ojos de esa mujer, y sentir el embeleso de su mirada, que atravesó distancias inimaginables, para volver a seducirme, y esta vez, no solo me conformaría con mirarla.

Galactic Eyes by Ruben Moreno:

What I was certain about, is that she was not from this planet. That curious look, I has already known in my abundant trips to the edges of the universe, above all in the women from a yellow planet, of which right now, I don't remember its name. That sensation of being explored from the feet up to the head I had felt a cold night when I had to do an emergency decent, and in the distance, some illuminated eyes were watching me, almost that I felt naked.

When I lead my look to those intrusive eyes, they immediately turned off. But in me remained the sensation beyond the curiosity that a foreigner has, was a fascination about the unknown. I was left ecstatic. I don't know for how long, and when I reestablished my priority, I felt that my mind and my body suffered the ravages of a spatial being.

Now after so many years, chance has led me to contemplate on this cold night, the woman's eyes, and feel the rapture of her eyes, that crossed unimaginable distances to seduce me again, and this time, didn't just settle for looking at me.

**Appendix F: Interview questions-Study 2**

Below are the three interview questions presented to the participants in the second study, and used as the formal elicitation task. An English translation is provided below each question.

1. ¿Cuál es su lugar favorito para ir de vacaciones? ¿Por qué? Sea lo más descriptivo posible.

What is your favorite place to go for vacation? Why? Be as descriptive as possible.

2. ¿Cuál es su actividad preferida para hacer los fines de semana? ¿Por qué? Sea lo más descriptivo posible.

What is your preferred activity to do on the weekends? Why? Be as descriptive as possible.

3. Qué haría si ganara dos millones de dólares en la lotería? Sea lo más descriptivo posible.

What would you do if you won two million dollars in the lottery? Be as descriptive as possible.

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- Fourth semester Spanish grammar (SPA 202): Spring 2013
- Spanish for the professions (SPA 305): Spring 2013

**Graduate Teaching Assistant**
Department of Linguistics, University of Wisconsin-Milwaukee
Full course responsibility

- Diversity of Human Language (LING 100) Fall 2012, Online course

Discussion instructor

- Diversity of Human Language (LING 100): Under the supervision of Prof. Ahrong Lee; Fall 2010, Spring 2011
- Diversity of Human Language (LING 100): Under the supervision of Prof. Carolyn Zafra; Fall 2011, Spring 2012
- Power of Words (LING 210): Under the supervision of Prof. Sandra Pucci; Fall 2012

**Associate Lecturer of Spanish**, Fall 2009-Spring 2010

Department of World Languages, University of Wisconsin-Washington County, West Bend, WI

Full course responsibility

- First semester Spanish grammar (SPA 101): Fall 2009
- Second semester Spanish grammar (SPA 102): Spring 2010
- Third semester Spanish grammar (SPA 201): Fall 2009
- Fourth Semester Spanish grammar (SPA 202): Spring 2012

**Graduate Teaching Assistant**, Fall 2007-Summer 2009

Department of Spanish and Portuguese, University of Wisconsin-Milwaukee

Full course responsibility

- First semester Spanish grammar (SPA 103): Fall 2007, Spring 2008
- Second semester Spanish grammar (SPA 104): Fall 2008, Spring 2009, Summer 2009

## AWARDS AND GRANTS

Department of Linguistics Travel Grant, $500 for the 30th annual Second Language Research Forum (SLRF), Iowa State University, Ames, IA, Fall 2010

Chancellor's Graduate Student Awards, University of Wisconsin-Milwaukee, 2010-2011

Sigma Delta Pi, National Honor Society. Member since 2007. President 2007-2008.

## PUBLICATIONS

Garcia, A. (forthcoming). The effects of L2 proficiency of L3 phonological acquisition: A preliminary test of the L2 proficiency hypothesis. *Selected Proceedings of the 2010 Second Language Research Forum: Innovation in Second Language Acquisition Research: Converging Theory and Practice*: Cascadilla Proceedings Project.

## LANGUAGES

English (native), Spanish (fluent), Portuguese (intermediate).