Social and Linguistic Factors Conditioning the Glottal Stop in Nicaraguan Spanish

Dissertation

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Abstract

This dissertation investigates the word-final, intervocalic glottal stop [ʔ] in Nicaraguan Spanish, a highly understudied variant in an equally understudied dialect of Spanish. The glottal stop occurs most frequently in western Nicaragua as an allophone of word-final, intervocalic /s/ (the V/s/#V environment), e.g. [maʔal.to] for más alto ‘higher’, but the glottal stop also surfaces between vowels at the word boundary where there is no underlying segment (the V#V environment), e.g. [laʔo.la] for la ola ‘the wave’. The studies to date on the glottal stop in dialects of Spanish, i.e. Argentinian/Paraguayan (Sanicky 1989, Thon 1989), Yucatan (Lope Blanch 1987), Filipino (Lipski 2000), and Puerto Rican (Valentin-Márquez 2006), propose a contact hypothesis: when Spanish is in close contact with another language and the glottal stop is used in that language, bilingual speakers transfer the sound into their Spanish. However, the contact hypothesis falls short in Managua, Nicaragua, as no other languages are in contact with Spanish nor have other languages been in contact with Spanish for some time. Instead, I propose that the glottal stop is a language internal innovation in western Nicaragua, motivated by phonological, phonetic, and social factors.

After collecting data in an informal sociolinguistic interview, a guided image identification task, and a more formal reading task from 36 Managuan participants, I conducted an acoustic analysis of 3,701 variants in the V/s/#V environment and 3,431...
variants in the V#V environment and fit binomial logistic regression models with random effects to the data. The results indicate that both linguistic and social factors condition the glottal stop. In the V/s/#V environment, the glottal stop is significantly more likely to occur before a following stressed vowel, between high frequency word pairings (e.g. determiner-noun strings), following words with a high number of syllables, and in the more formal reading task. The effect of social factors on the glottal stop’s likelihood is task-specific: the youngest speakers are more likely to use the glottal stop in the informal sociolinguistic interview than the oldest speakers, but the oldest speakers are actually more likely to use the glottal stop in the formal reading task than the youngest speakers. The most educated speakers are less likely to use the glottal stop in the more formal tasks than the lower education groups, and these less educated speakers are also most likely to insert glottal constriction in the V#V environment where there is no underlying segment in the formal reading task.

Linguistically, the glottal stop in the V/s/#V environment is used to 1) saliently mark the underlying segment 2) strengthen strong prosodic positions, i.e. stressed, word-initial vowels, and 3) maximally demarcate between adjacent vowels to resolve postlexical hiatus in environments where deletion rates are the highest, i.e. following long words. The less educated speakers’ extension of the glottal stop into the V#V environment is not surprising phonetically: even though there is no underlying segment, the glottal stop in the V#V environment continues to strengthen strong prosodic positions and maximally demarcate between adjacent vowels. Socially, the glottal stop is the most ‘neutral’ variant, or the variant least imbued with social meaning, which allows the
glottal stop to serve the aforementioned linguistic purposes without evoking strong social correlates like the other variants in the V/s/#V environment.

Finally, I propose that the phonological system has been reanalyzed for speakers of Nicaraguan Spanish: instead of underlying coda /s/, Managuans operate with underlying coda /h/. This argument is supported by high rates of glottal frication in the data and the likelihood of the glottal stop in strong environments. This distribution suggests that the glottal stop is a strengthened variant of /h/, providing greater and more salient gestural closure while maintaining the glottal place of articulation with no oral gesture. Further substantiating this argument is the fact that some speakers never use or incorrectly use sibilance, suggesting that sibilance simply does not correspond with these speakers’ underlying representation. I conclude that coda sibilance is not a local variant for Nicaraguan speakers, but speakers with more recent or greater exposure to prescriptive Spanish norms, i.e. younger and more educated speakers, learn to approximate coda sibilance in formal speech as a global formality strategy. However, speakers with less exposure to prescriptive Spanish norms, i.e. older and less educated speakers, instead use the glottal stop in formal speech, hyperarticulating the /h/ with a local formality strategy.
Dedication

This document is dedicated to all the Nicaraguans who generously offered their time and opened their homes to this strange, microphone-wielding gringa with endless questions.

Your kindness and linguistic innovation made this dissertation possible.
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Vita

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Chapter 1: Introduction

According to Lipski (1994), Nicaraguan Spanish is an advanced aspirating dialect, where “reduction of syllable- and word-final /s/ occurs to a greater extent… than in any other Central American variety, with frequencies comparable to Caribbean dialects” (291). Before a pause, full deletion is standard, and [s] generally only occurs in carefully monitored speech. However, deletion before another consonant is rare, with [h] being the norm, giving a “breathy quality” to Nicaraguan Spanish. In fact, Lipski argues that aspiration is so advanced in Nicaraguan Spanish that it is free of social stratification.

In spite of the preconsonantal uniformity described by Lipski (1994), I observed a great deal of variation word-finally before a vowel in Nicaragua. Lipski (1984) claims that three variants occur in this word-final, intervocalic position: sibilance, aspiration, and deletion. In his public speech data Lipski finds high rates of glottal frication word-finally before an unstressed vowel, ranging from 88.4%-90.4% depending on education level. He also notes that Nicaraguan speakers’ use of glottal frication continues to be the norm but decreases word-finally before a stressed vowel, ranging in use from 62.8% to 70.2%, again based on education.

As far as the other variants are concerned, Lipski (1984) finds that in news speech the use of sibilance is nearly categorical, occurring with 100% frequency before a stressed vowel and with 94% frequency before an unstressed vowel. However, sibilance
is not the local norm, and Lipski argues that such speech represents a “highly artificial
dialect which is at odds with the linguistic reality of the areas in question” (176). The
author also shows relatively infrequent deletion in his data: elision ranges from 2.1%-13.1%
of the variants before a stressed vowel and between 2.2% and 8.2% before an
unstressed vowel, with the lowest education levels eliding /s/ the most.

/s/ reduction is the most widely studied phonological process in Spanish
Linguistics (Brown and Torres Cacoullos 2002), and an important consequence of total
elision of /s/ between vowels at the word boundary is the creation of postlexical hiatus, or
a heterosyllabic vowel-vowel sequence. Hiatus is dispreferred across languages (Casali
1998) and across dialects of Spanish (Hernández 2009), and said hiatus is often resolved
through diphthongization, vocalic elision, coalescence, or epenthesis. Hernández (2009)
and Garrido (2007) show that approximants are inserted between heterosyllabic, adjacent
vowels to resolve hiatus in the Spanish of Mexico and Colombia, respectively, and the
glottal stop is used for the same purpose in other dialects of Spanish (Lope Blanch 1987;

In the summer of 2010 I observed higher rates of full /s/ deletion in Nicaraguan
Spanish than those described by Lipski (1984), e.g. [da.u.na] for das una ‘you give one’,
as well as a variant not mentioned in Lipski’s (1984) analysis: the use of the glottal stop,
e.g. [da.?u.na] for das una ‘you give one’. I found the glottal stop to be a very salient
division between the two adjacent vowels, and I hypothesized that the glottal stop was
incorporated in Nicaraguan Spanish as a hiatus resolution strategy: where extreme /s/
reduction results in total elision, creating dispreferred hiatus, the glottal stop may be
inserted to resolve the vowel-vowel sequence. I also noticed the glottal stop in Nicaraguan Spanish between vowels at the word boundary even without an underlying /s/ (the V#V environment), e.g. [laʔuβa] for *la uva* ‘the grape’, which supports my hypothesis that the glottal stop is inserted to resolve hiatus even without an underlying segment. Both the V/s/#V and V#V environments will be explored in this dissertation following a discussion of /s/ lenition that creates hiatus (chapter 2) and hiatus resolution strategies (chapter 3) in Spanish.

Unfortunately, very little information exists about the glottal stop in Nicaraguan Spanish. Rosales Solís (2010) mentions the glottal stop as a variant of /s/ between vowels at the word boundary in Nicaraguan Spanish along with [s], [h], and ø (144), and Quesada Pacheco (1996) explains that the glottal stop occurs in the speech of both Nicaraguans and *Guanacastecos*. This parallelism is not unexpected, as Guanacaste, the western province of Costa Rica, used to form part of Nicaragua and still maintains many of the linguistic features associated with Nicaragua (Lipski 1994, 2008). Quesada Pacheco (1996) alleges that the environments in which the glottal stop occurs in Nicaragua and Guanacaste are distinct, with the glottal stop occurring as a variant of word-final /s/ between stressed vowels in Guanacaste, e.g. [loʔ’indjoh] for *los indios* ‘the Indians’, while glottal frication is more common before unstressed vowels, e.g. [lɔhani’maleh] for *los animales* ‘the animals’ (104). Citing Lipski (1984), Quesada Pacheco claims that in Nicaragua the glottal stop occurs before a sonorous consonant, e.g. [’miʔmo], but this appears to be a misreading of Lipski (1984), who explains that voiced glottal aspiration occurs before a sonorant consonant in Nicaragua, e.g. [mifimo].
The studies listed in the preceding paragraph are based on casual observations and have only briefly mentioned the existence of the glottal stop. To my knowledge, no previous studies have discussed the glottal stop in Nicaraguan Spanish in depth, suggesting that it has either been overlooked in the past or is a relatively new phenomenon. In this dissertation I seek to fill that void, explaining the linguistic and social motivations for the glottal stop in Nicaraguan Spanish.

The presence of the glottal stop has been noted in other dialects of Spanish, including Spain (Lorenzo Criado 1948; Cortés Gómez 1979), the Philippines (Lipski 2000), the Yucatan Peninsula (Lope Blanch 1987/1993; Michnowicz 2006), Argentina and Paraguay (Sanicky 1989; Thon 1989; Mackenzie, n.d.), and Puerto Rico (Valentín-Márquez 2006, Tellado González 2007). While the glottal stop in the Philippines, the Yucatan Peninsula, Argentina, and Paraguay can be convincingly classified as a feature of language contact, the glottal stop in Spain, Puerto Rico, and Nicaragua cannot be so easily attributed to contact.

Due to the void in the literature on Nicaraguan Spanish, I conducted a study to investigate the variation that occurs in Managua in the summers of 2011 and 2012. My research questions for the project were the following:

1. Where does the glottal stop occur in Nicaraguan Spanish?
2. What factors condition the use of the glottal stop in Nicaraguan Spanish?
3. What is the phonetic motivation for the glottal stop’s emergence in Nicaragua?
4. What is the social meaning of the glottal stop (if any) in Nicaraguan Spanish?
In order to investigate these research questions, I recorded 36 Nicaraguans born and raised in Managua with equal divisions of gender (male/female), age groups (between 18 and 30, between 30 and 49, and 50 and older), and education levels (no high school diploma, high school diploma, and a college degree). There were three tasks in this study: first, I conducted a sociolinguistic interview with each participant for approximately 45 minutes to see which variants emerged in the word-final, intervocalic environment in a naturalistic, informal task. Participants were then asked to read 45 sentences that specifically targeted the V/s/#V and V#V environments, manipulating different linguistic factors such as preceding and following stress, preceding and following vowel, word class, the number of syllables in the preceding word, etc. Finally, the subjects participated in an image identification task with 10 pictures designed to elicit intervocalic /s/ at the word boundary with different following vowels and following stress, but this final task removed any potential influence of orthographic <s>. These tasks also varied in level of formality: while the sociolinguistic interview consisted only of a casual conversation with my participants, the image identification task involved a less naturalistic but unread task, and the reading task involved the least naturalistic, most formal task.

After an acoustic analysis of 3,701 tokens of /s/ in the V/s/#V environment and 3,431 tokens in the V#V environments, I found several variants in the V/s/#V position: ø, [ʰ], [ʔ], creaky voice, [s], and [s] followed by glottal constriction (both the glottal stop and creaky voice). In the V#V environment, where there is no underlying /s/, only non-insertion, glottal stop insertion, and creaky voice insertion take place. The glottal stop
primarily occurs in a word-final, intervocalic position where there is an underlying /s/, e.g. [maʔal.to] for más alto ‘higher’, but, as previously mentioned, some glottal stop realizations also take place in the V#V environment, e.g. [plaʔaʔen] plata en ‘money in’.

In order to investigate the factors conditioning the glottal stop and the other variants that occur in the same environment, I conducted several binary logistic regression models fitted to the variants in either the V/s/#V or V#V environment across all tasks. Two variants are of particular interest to my hypothesis, i.e. the glottal stop and deletion, as full deletion leads to dispreferred hiatus which can be resolved through glottal stop insertion. For these two variants, I also conducted separate models within each task to avoid the unwanted aggregation of data across all tasks and observe specific task-based differences. Based on the results of these statistical models, I conclude that both linguistic and social factors condition the use of the glottal stop in Nicaraguan Spanish.

Linguistic factors of note include the length of the word containing the final /s/: deletion of this final /s/ is more likely in longer words, and glottal stop insertion is more common in longer words as well. These results support my initial hypothesis. That is, where deletion rates are the highest and more postlexical hiatus is created, glottal stops are more likely to be inserted to resolve this dispreferred hiatus.

In the case of following stress, where we find less deletion before a stressed vowel and more glottal stop insertion, previous research offers an explanation. Casali (1998) argues that word-initial, stressed vowels are special positions particularly resistant to deletion or reduction in hiatus resolution strategies across languages. Therefore, when
/s/-deletion is so advanced that it extends to this special phonological environment (see section 2.3.3), glottal stops are more likely to avoid this particularly dispreferred hiatus. In addition to protecting this special prosodic environment from diphthongization or deletion, the glottal stop serves as a fortition strategy in many languages (Borroff 2007). The glottal stop is used to reinforced prosodically strong positions, which helps listeners segment the signal into separate words, identify boundaries, and more easily identify the lexical units (see Fougeron and Keating 1997). In short, the stability of stressed, word-initial vowels paired with the tendency to strengthen these prosodically prominent domains explains the increased rate of glottal stop use in this position, as it protects against vowel deletion or reduction in hiatus resolution strategies and strengthens the prosodically prominent position.

Finally, certain pairings of preceding and following word classes, referred to as “paired word class” throughout the dissertation, also significantly predict the occurrence of the glottal stop. A two-part explanation is needed to account for this factor’s influence on glottal stop use. First, I show that full deletion is least likely between high frequency word pairings such as determiner-noun, e.g. mis amigos ‘my friends’ and verb-preposition, e.g. vamos a ‘we are going to’, while deletion is more likely between low frequency word pairings, e.g. después otro ‘afterwards another’. Previous studies on dialects with extreme /s/ reduction (Ma and Herasimchuk 1971; Cedergren 1973) have shown higher [s] retention rates in these high frequency environments, supporting Bybee (2000a, 2000b, 2001, 2002a, 2002b, 2006), who suggests that determiner-noun pairings and other high frequency pairings are actually stored in speakers’ memories as a single
chunk and are therefore subject to reduction as a single unit. If these high frequency strings are stored as a single unit in memory, the underlying /s/ may be perceived as occurring between vowels unit-internally instead of at a word boundary, and word-internal intervocalic /s/ very rarely undergoes reduction. In the case of Nicaraguan Spanish, I argue that the underlying segment has been reanalyzed as /h/, meaning a glottal gesture should be preserved more in these high frequency strings.

While determiner-noun and verb-preposition pairings, both high frequency strings, share a low likelihood of full deletion, the glottal stop is most likely between determiner-noun pairings and glottal frication is most likely between verb-preposition pairings. The second part of this explanation accounts for these variant differences by referring to following stress. While verbs are most commonly followed by unstressed vowels in prepositions, e.g. *a ‘at’ or en ‘to’, determiners are often followed by stressed vowels in nouns, e.g. *obras ‘works’ or *usos ‘uses’. In other words, while elision is unlikely between both high frequency strings, fortition with the glottal stop takes place when there are following stressed vowels and glottal frication occurs where there are more following unstressed vowels.

In the model fitted to the glottal stop across all tasks, no social factors emerge as significant. However, a more detailed analysis focusing on the behavior of social groups in individual tasks sheds more light on social groups’ use of the glottal stop. In the task-based models, gender is not a significant predictor of the glottal stop or any other variant, but the social factors of age and education do show interesting and significant differences. In the less formal sociolinguistic interview, for example, the youngest age
group uses the glottal stop significantly more than the oldest age group, but the oldest age group uses the glottal stop significantly more than the youngest age group in the more formal reading task. Then, in spite of relative uniformity across education levels in the casual sociolinguistic interview and an overall increase in glottal stop use in the more formal image identification task, the least educated speakers diverge from the other education levels in the most formal reading task. While the highest and middle education levels both decrease their use of the glottal stop in favor of sibilance, the least educated group increases its use of the glottal stop. The two most educated groups are more influenced by prescriptive forces and a global, sibilant-using Spanish target. On the other hand, the least educated group relies more on a local target of formality, in which the hypoarticulated variants of deletion and aspiration are avoided in favor of the hyperarticulated glottal stop, which serves to saliently mark the underlying segment and to maximally demarcate between two adjacent vowels with full glottal closure.

I also contend based on the age groups and education levels’ use of the variants that of the available variants in the V/s/#V environment, the glottal stop is the most neutral and the most free of social meaning. The use of the glottal stop allows speakers to mark an underlying segment and clearly demarcate between the word-final and word-initial vowels without evoking class-based or age-based associations.

The glottal stop is being extended from the V/s/#V environment, where it marks an underlying segment, to the V#V environment, primarily by speakers of the lowest education level in the most formal tasks. I posit that there is a phonetic reason these less educated speakers are driving the extension. The glottal stop in the V/s/#V environment
not only marks the presence of an underlying segment but also serves to maximally demarcate between a word-final and word-initial vowel. Glottal constriction in the V#V environment serves the same purpose: closure of the glottis separates two adjacent vowels, resolving the hiatus created postlexically. Given that the lower education levels use the glottal stop the most in the V/s/#V environment in the formal reading task as a hyperarticulated variant to increase their level of formality, it is unsurprising that they incorporate the same hyperarticulation strategy in the V#V environment to increase formality, even if there is not an underlying /s/.

Finally, I argue that coda /s/ has been so extremely reduced in Nicaraguan Spanish through debuccalization that the underlying element has actually been reanalyzed in speakers’ phonological inventory as /h/. In casual conversations, speakers may be faithful to the underlying segment, producing [h], reduce the underlying segment in weak positions, producing ø, or strengthen the underlying segment with a glottal stop, which has the same place of articulation as the underlying segment but involves greater gestural closure. The presence of /h/ as the underlying segment also explains the very low levels of sibilance in casual speech and can account for some speakers’ misuse of [s] in formal speech. Because /s/ is not their underlying segment, they are not always sure when to incorporate [s] in their formal speech.

This dissertation contributes to the dialectological, variationist, phonetic, and phonological literature by providing an analysis of a little understood phenomenon in the Spanish-speaking world that has too often been oversimplified as a categorical case of language contact. Rather than a contact explanation, this dissertation provides a concrete,
quantitative analysis, determining the linguistic and social factors constraining the variant’s use and provides both a phonetic and social explanation to account for the emergence of the glottal stop in this understudied dialect of Spanish, framing its use within cross-linguistic and cross-dialectal tendencies of /s/-lenition and hiatus resolution.

The dissertation is arranged into six chapters. Following this introduction, a literature review is provided on /s/ lenition (chapter 2) to explain the social and linguistic tendencies in dialects similar to Nicaraguan Spanish. /s/ lenition is particularly important in this dissertation because when intervocalic /s/ is completely elided, which is common in Nicaraguan Spanish, dispreferred postlexical hiatus is created. Chapter 3 discusses the literature on hiatus resolution strategies across languages and across dialects of Spanish, including the insertion of a glottal stop to demarcate between adjacent vowels. In chapter 4, the methodology of my experiment in Nicaragua is detailed, followed by a statistical analysis of the data to determine which social and linguistic factors condition the variants in the V/s/#V and V#V environments (chapter 5). Finally, I provide a discussion of the results in linguistic and social terms before providing a conclusion to the dissertation (chapter 6).
Chapter 2: /s/ lenition

This chapter presents the previous studies and theoretical framework necessary to understand processes of /s/ lenition across the world’s languages and, in particular, across dialects of Spanish. A discussion of the literature on /s/ lenition is crucial to fully understand the processes at work in Nicaraguan Spanish: it is extreme /s/ lenition in Nicaraguan Spanish that leads to much postlexical hiatus and brings about hiatus resolution through glottal stop insertion. For example, muchísimaños ‘many years’ may be realized as [mu.tʃi.si.mʊ.aɲo], creating cross-linguistically dispreferred hiatus (Casali 1998) that can be resolved with the epenthesis of a glottal stop.

This chapter begins with an introduction to /s/ lenition across languages and then explores the dialectal variation found in Spanish, presenting a brief overview of /s/ lenition in Spain and a more detailed discussion of /s/ in Latin America. Next, the phonological and social factors said to contribute to /s/ lenition in the Spanish-speaking world are detailed. Finally, I explore the phonetically-motivated accounts of /s/ lenition in Spanish, explaining the articulatory, acoustic, and perceptual motivations that have been proposed to explain the lenition process.
2.1 Introduction

Cross-linguistically, [s] is very common and is generally very stable as a fricative: the UCLA Phonological Segment Inventory Database (UPSID) notes that more than 80% of the world’s languages have /s/ as a phoneme. While [s] may initially arise from affricate simplification (which may come about from [t] affrication followed by simplification), devoicing, borrowing, or [ʃ] fronting to [s] (‘reversion to the unmarked’ according to Ferguson 1990: 62), [s] tends to persist historically, except in cases of s > h reduction. [h], the glottal fricative, is also a very common fricative, occurring in over 60% of the languages attested in UPSID. However, [h] is highly variable in comparison to [s] and often results in deletion, preceding vowel lengthening, tonal feature spreading or ‘murmur’ spreading. [h] arises very frequently as the result of k > x > h or other debuccalized fricatives and stops—and much more infrequently from the glottal stop and sonorants (Ferguson 1990). In fact, Lass (1984) claims that “the majority of /h/ in present-day languages can be traced back to the lenition of other obstruents” (179), most commonly [s]. [h] may also be inserted to resolve hiatus or epenthesized before a word-initial vowel (Ferguson 1990).

/s/ reduction can best be classified as debuccalization; that is, [s] > [h] constitutes a case of lenition brought about by the deletion of an oral gesture. This debuccalization of /s/ seems to be a common cross-linguistic process. In fact, Krishnamurti (1998) explains that “The change from s to h is a natural phonetic change found in many languages of the
world like Greek, Iranian, Indic (Sinhala and Assamese), and Iberian (Spanish and Portuguese)” (211). Section 2.2 will explore this process in Spanish.

2.2 Dialectal analysis of /s/ lenition

Syllable-final /s/ shows a great deal of variation across dialects of Spanish, ranging from word-final, intervocalic /s/-voicing in Ecuadorian Spanish to syllable and word-final /s/ aspiration and deletion in southern Spain, the Caribbean, Central America and the Southern Cone (Lipski 1994). In extremely advanced /s/ weakening dialects with total elision of /s/ such as Dominican Spanish, /s/ hypercorrection is observed, or the non-standard insertion of [s] in hablar fisno ‘fancy talk’ (Morgan 1998). The use of a glottal stop in syllable or word-final position for /s/ has been attested in certain Spanish speaking dialects as well (see section 3.3), suggesting that syllable and word-final /s/ environments are a rich source of variation across the Spanish-speaking world.

If both internal and external factors involved in all these processes are compared, a pattern of /s/ innovations may appear, demonstrating a certain coherence in the face of immense variability. In this section, I analyze the factors that condition /s/ lenition in Spanish and explain the patterns that emerge across dialects, enabling identification of the linguistic and extralinguistic trends for /s/ lenition that are common and potentially universal in Spanish.

Syllable-final /s/ reduction is the most widely discussed phonological variable in the field of Hispanic Linguistics (Brown and Torres Cacoullos 2002), with a great deal of
variation across dialects. Penny (2000) explains that syllable-final /s/ weakening is more complex in Latin America Spanish than in Peninsular Spanish due to the varying degrees of contact maintained throughout Latin America with Spain. A review of Peninsular and Latin American /s/ reduction will be provided in sections 2.2.1 and 2.2.2.

2.2.1 /s/ lenition in Spain

Penny (2000) describes /s/ reduction as a widespread phenomenon in southern Spain, particularly in Andalusia, Murcia, the Canaries and Extremadura, and explains that the phonological variable is presently extending into New Castile. The most geographically widespread variant of weakened /s/ in Spain is low-intensity glottal frication, which is spreading north throughout all social classes in all of Murcia, New Castile and Extremadura. Penny (2000) argues that usage of [h] is currently advancing in the capital even though this variant in Madrid can be traced back to novels from the late 1800s by Benito Pérez Galdós (Williams 1987: 114-118).

Although less widespread, other variants of /s/ reduction occur in Andalusia as well, including [ɦ] and [ʁ], glottal frication that assimilates in voicing or both voicing and nasal quality to a following nasal consonant, e.g. [mî̃fismo] or [mî̃fismo] mismo ‘same’. Assimilation can also lead to gemination of the following consonant, e.g. [boʰk.ke] (Gerfen 2001), which is infrequent outside of Andalusia.¹ According to Penny (2000),

¹ There are reports of syllable-final liquid assimilation in Cuban Spanish similar to Andalusian gemination (refer to Almendros 1958 and Alfaraz 2007, among others).
this gemination is generally a trait found in less educated speakers, but Gerfen (2001) finds widespread gemination even in educated speakers. Less common than gemination is the merging of the two adjacent sounds (fricative + spirant), but said merging may occur as well. The voiceless fricative assimilates in its place of articulation to the following /b/, /d/ or /g/, resulting in [lafakah] las vacas ‘the cows’, [loθeβaneh] los desvanes ‘the attics’ and [dihuhto] disgusto ‘disgust’ (Penny 2000).

In aspirating regions of Western Andalusia, resyllabification rules may even position /s/ aspiration syllable initially across a word boundary and between vowels, resulting in the more socially stigmatized production of [laholah] las olas ‘the waves’. This aspiration may even appear word-internally, e.g. [nohotroh] nosotros ‘we’, but Penny (2000) explains that this is a reanalysis of the morpheme boundaries of the word; if speakers analyze nosotros as nos#otros just like los#otros, /s/ aspiration applies here as one would anticipate.

Recent studies on Western Andalusia (Moya Corral 2007; Torreira 2007a, 2007b, 2012; Ruch 2008; Parrell 2011; Horn 2013) have also detailed the change in production of /st/ clusters from [st] > [ht] (pre-aspiration) > [th] (post-aspiration) > [ts] in Seville Spanish, with a high percentage of these /st/ sequences realized as affricates (Ruch 2008). Torreira (2012) finds that pre-aspiration and closure duration show an inverse relationship with post-aspiration duration, suggesting coarticulatory compensation. Most recently, Horn (2013) shows that the longest post-aspiration occurs word-internally with preceding stress, and she argues that post-aspiration has also been extended to /sk/ clusters but not to /sp/ clusters. While conflicting results have emerged for social factors,
younger and more educated speakers may be driving the change (Moya Corral 2007; Torreira 2007a; Ruch 2008).

2.2.2 /s/ lenition in Latin America

/s/ weakening was extended from Spain to Latin America, and according to Penny (2000), it is typically found in areas culturally isolated from Spain. Areas that had more political and economic importance to Spain, and therefore maintained closer contact with the empire (such as Bolivia, Ecuador, Peru, the majority of Mexico and parts of Colombia), drew more prestigious /s/-retaining speakers from central Castile. In regions with less Spanish contact, dialects of southern Spain prevailed in phonetic influence, making aspiration particularly common on the Pacific coast, Central America, the Caribbean, the southern cone, and the southwest of the US.

Another generalization that can be made about Latin American /s/ reduction is that /s/ weakening is a characteristic typical of island, coastal, and lowland Spanish-speaking areas, while /s/ retention is typical of highlands Spanish (Canfield 1981). Penny (2000) notes that Mexican Spanish provides a good example, as the Gulf coast, the Pacific coast, and southern areas near Guatemala and Belize show /s/ reduction (Lipski
1994: 280-283), while the rest (and the majority) of the country is highlands, showing /s/ retention.  

Penny (2000) claims that while Latin American /s/ reduction is historically more complex, there is more diversity among the /s/ variants in Peninsular Spanish. He writes, “There are only infrequent reports of the kinds of assimilation of the aspirate to the following consonant (and of this consonant to the aspirate) which so frequently occur in Andalusia” (149), but this may well be due to the fact that many regions of aspirating Latin America have not been studied in detail. This lack of information in Latin American Spanish is supported by the fact that previous studies have described only three of four variants in the V/s/#V environment in Nicaraguan Spanish (Lipski 1984), while my acoustic analysis revealed eight variants in the same environment.

Finally, certain patterns of /s/ reduction are more frequent in Latin American Spanish, and Penny (2000) establishes a frequency hierarchy, shown below in (1) from the most common patterns of /s/ reduction to the least common:

(1)

1. aspiration of syllable-final /s/ word-externally, word-finally (before a word-initial consonant), and phrase-finally: [é\textipa{h}ta\textipa{h} muhéré\textipa{h}] estas mujeres.
2. aspiration of syllable-final /s/ word-externally and word-finally (before a word-initial consonant), with deletion in phrase-final position: [é\textipa{h}ta\textipa{h} muhéré].

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2 It should be noted that Lipski’s (1994: 46-47) take on /s/-lenition in Latin America is different than Penny’s: Lipski argues that it was not isolation from Spain, but rather contact with aspirating southern Spain that led to /s/-lenition along the coasts and lowlands of Latin America.

3 I emphasize that this list does not represent the path of /s/-lenition diffusion, but rather a list of the most frequent to least frequent /s/-lenition patterns across dialects. For a discussion of the path of /s/-lenition, see section 2.4.
3. aspiration of syllable-final /s/ word-internally, with deletion word-finally (before a word-initial consonant) and in phrase-final position: [ɛʰta muhére].

4. deletion in all these positions: [éta muhére].

5. aspiration of word-final /s/ before a word-initial vowel (with or without deletion of aspiration in internal syllable-final position): [ɛʰta hοβɾa] estas obras.

6. deletion of word-final /s/ in all positions, including before a word-initial vowel: [éta óβɾa] estas obras.

7. Extension of aspiration to word-initial /s/: [éta heɲɾa] esta señora (150).

Penny notes that this frequency hierarchy may correspond with social factors as well: higher-class speakers in lowland areas with /s/ weakening may be less likely to produce the innovative, cross-dialectally infrequent variants than working class speakers. It should be noted before considering the factors that influence /s/ lenition in section 2.3 that in more advanced dialects of /s/ reduction, [s] as a variant would be almost non-existent. In these dialects, [h] would then serve as the prestige variant while ø would be the innovative yet stigmatized variant.

2.3 Factors influencing /s/ lenition

In this section, I explore the linguistic and extralinguistic factors influencing /s/ lenition and deletion in Spanish to determine which factors may influence /s/ lenition in Nicaraguan Spanish. The findings in the literature about the role of /s/ as a lexical or
plural/verbal marker, phonological environment, stress, word length and social factors are detailed across dialects of Spanish in the following discussion.

2.3.1 The role of /s/ as a lexical or plural/verbal marker

Functionalist hypotheses like Kiparsky’s (1972) ‘distinctness conditions’ revolve around the idea that important semantic information will be retained on the surface level; one would not expect phonological processes to occur in positions that would eliminate plural or verbal distinctions. This hypothesis predicts that in Spanish, grammatical /s/, e.g. las cosas ‘the things’, tienes ‘(you) have’, which carries a functional load, should be retained more frequently than lexical /s/, e.g. entonces, which does not. Bolstering this claim, Guy (1994) discovered more [-t, -d] deletion in monomorphemic lexical units like mist than missed, where the [-t] forms its own morpheme.

However, the results of many studies on Spanish pose a challenge for functionalist claims: Poplack (1980) actually finds a higher number of deletions of inflections in Puerto Rico, e.g. lo-s ‘the’, than monomorphemic forms, e.g. mes ‘month’. The same results emerged for Cedergren in Panama (1973: 110), who found a higher number of inflectional (r) deletions than monomorphemic (r) deletions, and in Cuban Spanish, plural/verbal /s/ is fully elided more frequently than lexical /s/: 52.3% compared to 47.7% (Dohotaru 1998). These facts indicate that the plural or verbal status of /s/ is neither the only nor the most important factor in determining deletion.
Poplack’s (1980) findings for plural markings at the string level, or across several lexical units, are unexpected given the functionalist hypothesis as well: a null realization favors following null realizations and plural marker production favors other plural marker production. However, not all authors agree with Poplack’s (1980) conclusion: Dohotaru (1998) argues that there is a strong likelihood that at least one marker of plurality will be retained in noun phrases with multiple modifiers, usually in the first position, and the likelihood of /s/ elision increases with a later position in the noun phrase. She claims that this is not merely an artifact of the data, as both monosyllabic and polysyllabic words follow this general pattern. Terrell (1979) and Uber (1989) reach the same conclusion, suggesting that if plurality will be overtly marked in a string, it will appear in first position much more frequently than in any later position.

While many studies on Spanish refute the functional hypothesis in its strong form, other studies support a weaker form of the hypothesis. That is, other work has proposed that if phonological deletion occurs with a plural or verbal /s/, a morphosyntactic element will be added to preserve the semantic information. In support of this argument, Poplack (1979: 79) finds a lower percentage of subject pronouns for third person singular (7%) than for second person singular verbs where ambiguity might arise (48%). Hochberg (1986) reaches the same conclusions, suggesting that pronoun use is increased to retain semantically relevant information following /s/ deletion. Countering these findings, however, Ranson (1991) argues that in Puente Genil Andalusian Spanish, subject pronouns are not consistently inserted to counter the ambiguity created by /s/ deletion. Ruiz-Sánchez (2004) finds the same result in Caracas, Venezuela: not all plural/verbal
markers are retained, and pronouns are not inserted to clarify this semantic information when the plural or verbal /s/ is deleted.

Based on this discussion, we can conclude that grammatical /s/ is not always preserved more than lexical /s/, and Terrell (1987) ultimately concludes that “morphological contrast seems to play no role in constraining a phonological rule of deletion” (27). Even in its weaker form, it is not always the case that more overt pronouns appear in second person singular position to eschew obfuscation. However, it should be noted that many of these previous studies have taken a simplistic approach in applying the functionalist hypothesis, as context can also help clarify person and number, resolving the ambiguity caused by /s/ deletion.\(^4\)

\[ \text{2.3.2 The role of phonological environment in /s/ lenition} \]

Similar patterns of /s/ retention and /s/ reduction are noted across Caribbean dialects. Terrell and Tranel (1978) explain that across Caribbean Spanish dialects, more specifically in Puerto Rican, Cuban, and Venezuelan Spanish, aspiration occurs least commonly before a pause, more commonly preceding a vowel and most commonly preceding a consonant, illustrated below in figure 1.

\[^4\text{While context may resolve singular-plural ambiguity at times, the circularity of this argument should be noted. If the context does not indicate plurality in a dialect with deletion, the researcher would clearly be unable to code for plurality (Scott Schwenter, p.c. March 7, 2012).}\]
As shown above, sibilant retention in Puerto Rican, Cuban, and Venezuelan Spanish follows the inverse pattern of aspiration. However, this generalization does not hold in one exception: the /s/ of a word-final prenominal modifier before a stressed vowel, e.g. las horas ‘the hours’, maintains the sibilant to a much higher degree, ranging from 85% to 89% across these three dialects of Caribbean Spanish, compared with a range of only 4-25% sibilant retention in all other phonological contexts. This special environment will be discussed in more detail in section 2.3.3.

Dohotaru’s (1998) data from Havana, Cuba provide more details about the most common phonological environments for both aspiration and deletion. She finds that word-internally, aspiration is the norm for syllable-final /s/, occurring across 92.4% of the realizations; ø is unlikely (6.9% frequency); and sibilance is nearly non-existent. Word-finally, however, elision is actually the most common variant regardless of following environment. Caracas, Venezuela Spanish shows similar results (Ruiz-Sánchez 2004).

Analyzing the following environment more precisely, Dohotaru finds that while total elision rates in Havana are similar for word-final tokens before both consonants and vowels (44.9% and 43.5%, respectively, which differs from Terrell and Tranel 1978), word-final /s/ deletion rates skyrocket in prepausal position to 75.3%. Also of note is the
fact that sibilance is nearly nonexistent before a consonant both word-internally and
word-finally, but word-finally before a vowel, 10.3% of the realizations are maintained as
sibilants and before a pause, 20.4% of realizations are sibilants. This makes aspiration
word-finally before a pause very unlikely, with only 4% of prepausal realizations as [h].

Cedergren (1973) runs a “best-fit estimation” on her data for /s/ reduction in
Panama, and her results largely parallel those of Dohotaru (1998). She finds that the most
important factor favoring aspiration is a following consonant. Word-internal position also
favors aspiration, bolstering the similar results of Cuban (Vallejo-Claro 1970) and
Puerto Rican (Ma and Herasimchuk 1971) Spanish studies. /s/ deletion, on the other
hand, shows a reversal of the phonological constraints found in aspiration: deletion is
favored before a pause or, to a lesser degree, before a vowel.

The data from certain parts of Mexico and Colombia are quite different, due to the
fact that syllable-initial aspiration takes place more commonly than syllable-final
aspiration. López Chávez (1977) finds that in La Cruz, Sinaloa, /s/ aspiration occurs in
onset position, namely between vowels, word initially or following /r/, and he concludes
that aspiration favors contact with a sonorant, either a consonant or vowel. López Chávez
hypothesizes that the phenomenon is relatively modern, and suggest that men aspirate
more than women, and young people aspirate more than older generations.

Brown and Torres Cacoullos (2003) analyze data from Chihuahua, Mexico, and
they find that syllable-initial word-medial /s/ lenition actually occurs more frequently

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5 This syllable-final aspiration refers to the coda position at the word level. While the word-final,
intervocalic sibilant in, for example, las obras “the works” is resyllabified to onset position in speech, at the
lexical level the /s/ occurs syllable-finally and would be subject to reduction.
than syllable-final word-medial /s/ lenition, at rates of 34% and 22%, respectively. When compared to /s/ reduction in Cuba and Argentina, Chihuahua patterns very differently, going against the patterns of /s/ reduction found in other dialects. Brown and Torres Cacoullos present their own explanation of syllable-initial /s/ reduction, arguing that this process occurs in dialects exhibiting the criteria shown below in (2).

(2)

1. word final /s/ reduction is greater before a pause and a vowel than before a consonant
2. overall final /s/ reduction rates are low. (35)

This dialect offers evidence against the traditionally proposed order of diffusion for reduced /s/ and, on a broader level, provides evidence against a unified method of /s/ aspiration diffusion in Spanish.

The type of aspiration described by Brown and Torres Cacoullos (2003) and López Chávez (1977) differ from the majority of /s/ aspirating dialects, and more studies are needed on these divergent dialects. Additionally, more research is needed on the social factors at play in syllable-initial /s/ reduction, but the phenomenon seems to be more common among less educated, lower-class individuals in areas lacking a strong prescriptive influence.

With the exception of the dialects described in the preceding paragraphs, the general pattern of phonological environments that condition aspiration and deletion is summarized nicely in Tennant et al.’s (2008) GoldVarb results for Cuban Spanish, shown below.
Aspiration

<table>
<thead>
<tr>
<th>Aspiration</th>
<th>Occurrences</th>
<th>N</th>
<th>Proportion</th>
<th>Factor Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Internal</td>
<td>184</td>
<td>420</td>
<td>43.8%</td>
<td>0.72</td>
</tr>
<tr>
<td>Final before C</td>
<td>87</td>
<td>236</td>
<td>36.9%</td>
<td>0.55</td>
</tr>
<tr>
<td>Final before V</td>
<td>33</td>
<td>135</td>
<td>24.4%</td>
<td>0.40</td>
</tr>
<tr>
<td>Final before pause</td>
<td>14</td>
<td>239</td>
<td>5.9%</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Range: 55

Table 1: GoldVarb analysis of aspiration in Holguín, Cuban Spanish from Tennant et al. (2008).

As illustrated in table 1, aspiration is most common before a consonant both in Cuban Spanish, and other aspirating dialects tend to follow this pattern as well. Another cross-dialectal trend visible in these GoldVarb results for Cuban Spanish is that aspiration is highly disfavored word-finally before a pause.

Table 2 below shows the same authors’ results for deletion.

<table>
<thead>
<tr>
<th>Deletion</th>
<th>Occurrences</th>
<th>N</th>
<th>Proportion</th>
<th>Factor Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final before C</td>
<td>71</td>
<td>236</td>
<td>30.1%</td>
<td>0.81</td>
</tr>
<tr>
<td>Final before V</td>
<td>29</td>
<td>135</td>
<td>21.5%</td>
<td>0.71</td>
</tr>
<tr>
<td>Final before pause</td>
<td>33</td>
<td>239</td>
<td>13.8%</td>
<td>0.59</td>
</tr>
<tr>
<td>Word internal</td>
<td>13</td>
<td>420</td>
<td>3.1%</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Range: 60

Table 2: Tennant et al. (2008) GoldVarb analysis of deletion in Holguín, Cuban Spanish.

Table 2 shows that deletion, on the other hand, is favored at the word boundary and highly disfavored word-internally. This trend is also notable across aspirating dialects of Spanish, establishing the pattern for most /s/ deleting dialects.

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6 Table 2 also shows that deletion is rare pre-pausally, which goes against Cedergren’s (1973) results in Panama. While /s/ pre-pausally may favor either [s] retention or full deletion depending on the dialect in question, an important cross-dialectal tendency is that [h] is rare in this position.
2.3.3 The role of stress in /s/ lenition

Returning to the earlier mention of the special environment of stress, /s/ before a stressed vowel at the word boundary undergoes elision much less frequently than /s/ before an unstressed vowel in the same position. In fact, Terrell (1979) finds that before an unstressed vowel the rate of retention is only 19%, while before a stressed vowel the rate of retention is 39%. Deletion is highly unlikely before a stressed vowel in other studies as well (see Poplack 1979; López Morales 1980; Alba 1982). In a closer analysis, sibilants appear to be maintained nearly categorically when a determiner precedes a stressed vowel (89% /s/ retention), e.g. los otros, los únicos, muchos árboles, but other /s/-final categories before a stressed vowel only show retention in 18% of the tokens (Terrell 1979). Other studies also support the notion that the determiner is the grammatical category most likely to retain unlenited [s] (Ma and Herasimchuk 1971; Cedergren 1973; Guy and Braga 1976).

Dohotaru (1998) reaches the same conclusion about the importance of following stress in her Havana data: total /s/ elision rates dip to 24.7% before a stressed vowel, while 49.1% of /s/ realizations are ø before an unstressed vowel. Sibilance and aspiration are used nearly evenly before a stressed vowel, accounting for 37.8% and 37.4% of the tokens, respectively, showing a dramatic rise in sibilant use: only 2.1% of pre-unstressed vowel realizations are sibilant. This seems to fall in line with Casali (1998), who argues that stressed vowels and word-initial vowels are special positions particularly resistant to
vowel elision in hiatus resolution (see chapter 3); this resilience may hold true for preceding consonants that, when resyllabified, form part of that strong syllable as well. The importance of a following stressed vowel at the word boundary is apparent in other phenomena as well, such as glottal stop insertion in Spanish (Lope Blanch 1987; Sanicky 1989; Tellado González 2007 in section 3.3), which suggests there is something universally special about this position in Spanish.

While other studies have focused on following stress, Alba (1982) claims that the lexical accent of the syllable containing the /s/ is equally important in Dominican Republic /s/ deletion. He argues that lexically unaccented words such as articles, possessive adjectives, and prepositions, among others (Garde 1972; Quilis 1976), show retention of /s/ much more than lexically accented words, which show deletion in 56.8% of /s/ realizations. Alba then makes an even finer-grained distinction, showing that it is unaccented words before a tonic syllable that show a great deal of retention, while accented words with final /s/ before a tonic syllable show less retention.7

Alba explains this trend with the proclitic nature of the unaccented determiners that retain /s/: he argues that unaccented words need the support of another accented word. Consequently, a readjustment of sorts takes place, making the two words members of one accentual unit in most cases, but some degree of autonomy is maintained in the noun phrase at the lexical boundary, occasionally allowing for deletion. Alba argues that the following, stressed syllable is important to /s/ retention because the stressed syllable in Spanish goes hand in hand with an increase in duration, intensity and pitch (Quilis

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7 However, it should be noted that Alba’s overall token count is low in the latter category, with only 9 occurrences.
1971), which serves to slow weakening processes on their way to elision. Alba claims that this follows word-internally as well, as deletion of syllable-final /s/ is much lower in stressed syllables than in unstressed syllables. Alfaraz (2000) reaches the same conclusion in her VARBRUL analysis on Cuban Spanish, finding stress to be the only factor affecting variation word internally.

One problem emerges with these studies on preceding stress. It is difficult to determine whether the most important factor at work here is the preceding word’s lexical status as a determiner, the unaccented nature of the preceding word, the generally monosyllabic nature of the preceding word, or the frequency effects of the preceding word with a following noun. More studies are needed to tease apart these distinctions, but some categories may be difficult to fully separate from others.

2.3.4 The role of word length in /s/ lenition

Following environment and stress are not the only factors that condition /s/ reduction. Terrell (1979), for example, finds that word length is the primary constraint on verbal and lexical /s/ deletion in Cuban Spanish, with polysyllabic words (conflated into a single polysyllabic category) showing deletion of /s/ more frequently than monosyllabic words. Ruiz-Sánchez (2004) finds word length an important factor in Caracas, Venezuela as well: monosyllabic words show more /s/ retention than polysyllabic words, which
were analyzed by the number of syllables in the word from two to six\(^8\). In Dohotaru’s (1998) data on Havana, the /s/ in polysyllabic words is completely elided with 73.2% frequency compared to the 34.1% frequency of full elision in monosyllabic words ending in lexical /s/, again demonstrating the importance of word length as a factor. The word with lexical /s/ that shows the least total elision in her data is más, with only 31.6% deletion, compared to entonces, the word with the highest rate of lexical /s/ elision, at 93.6%.

### 2.3.5 Social factors influencing /s/ lenition

Unfortunately, “social variation in American Spanish has been very much less well studied than geographic variation” (Penny 2000: 161), and this is also the case in Spain. The information that is available on sociolinguistic variation is characteristic of the first wave of sociolinguistic inquiry (Eckert 2005), which correlates linguistic variation with broad social categories like age, gender and social class.

In the Spanish-speaking world, the broad extralinguistic factors of age, formality, gender and social class/education level all appear to play some role in /s/ lenition to varying degrees, and they tend to follow the general distinctions discussed by Labov (1972; 2001): innovations away from the prestige variant (either [s] or [h], depending on the dialect) are led by younger generations, men, and speakers from lower education levels.

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\(^8\)Terrell (1979) and Dohotaru (1998) find this length effect independent of the status of /s/ as a lexical and plural/verbal marker.
levels or socioeconomic statuses. For example, Dohotaru (1998) finds that sibilance retention is highest with the most educated participants in her study on Havana, Cuba, with the mid-level education group preferring aspiration, and the less educated participants deleting more frequently than the other groups.

Cross-dialectally, if there is a difference based on age, it seems to be the case that older generations aspirate or delete /s/ less than younger generations, suggesting a more advanced state of lenition across generations (Longmire 1976; Terrell 1978). However, it should be noted that younger generations may also halt the progression of /s/ reduction to avoid stigmatization, and there is variation in the youth’s behavior based on the popular attitudes towards the variants in different dialects (Lafford 1986). A desire to move away from the stigmatized variant based on social pressure may well be what leads to the adoption of other less stigmatized strategies like glottal stop insertion, as argued by Valentín-Márquez (2006).

If there is a gender distinction, women tend to opt for the conservative variant more often, either [s] or [h], depending on the dialect, while men drive aspiration or deletion (Cedergren 1973; López Chavez 1977; Cepeda 1995; Dohotaru 1998). Differences in the formality of the task also affect /s/ lenition, with more formal tasks favoring retention and less formal tasks showing higher rates of aspiration or deletion (Cedergren 1973; Lafford 1986).

Lafford (1986) comes to the conclusions shown below in (3) about the social significance of the variables in Cartagena, Colombia:
1. La variante [s], siendo más común en estilos más formales, es una variante prestigiosa asociada con alta posición social.

‘The [s] variant, being more common in more formal styles, is a prestigious variant associated with a high social position.’

2. La variante [ø], siendo más prevalente en los estilos informales, es una variante estigmatizada asociada con baja posición social.

The [ø] variant, being more prevalent in informal styles, is a stigmatized variant associated with a low social position.

3. La variante [h], que actúa o como [s] (en los estilos A y B) o como [ø] (en los estilos C y D)\(^9\) puede ser la variante más neutra de las tres; es posible que el uso de la [h] no esté estrechamente asociado a ningún grupo social y por consiguiente no tendría un valor estable ni de prestigio ni de estigma (58).

‘The [h] variant, that acts like [s] (in styles A and B) or like [ø] (in styles C and D) could be the most neutral variant of the three; it is possible that the use of [h] is not strictly associated with any social group and consequently would not have a stable, prestigious, or stigmatized value.’

Obviously, these conclusions represent very broad generalizations about entire groups of people and do not illustrate very clearly how individuals agentively use the variants in a meaningful way to construct an identity within the larger social structure. A few, more recent studies have begun to touch upon the notion of the variants of /s/ as socially meaningful: for example, Alfaraz (2000) argues that ø is employed in Cuban Spanish to demonstrate solidarity and locality among residents in post-Castro Cuba. In response to this increase in local, Cuban pride through ø, there has been a resurgence of [s] among Miami-born Cubans. Lynch (2008) argues that these Cuban-Americans use the sibilant as a marker of differentiation to distinguish themselves from /s/ deleting Cuban immigrants who arrived in the past two decades. The Cuban-Americans perceive the ø

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\(^9\) A and B are the more informal styles in Lafford’s (1986) study, while C and D are the more formal styles.
variant to be symbolic of low social status and low levels of education, and they incorporate [s] to distance themselves from these associations.

There is a serious lack of sociolinguistic studies on /s/ with a social emphasis, but studies such as Alfaraz (2000) and Lynch (2008) provide a point of departure for future examinations of the way in which the variants are employed in different Spanish-speaking communities to create social meaning.

2.4 Phonetic motivations for /s/ lenition in Spanish

Many authors have proposed that Spanish sibilant lenition is based on articulatory principles, with [h] emerging as a debuccalized form of /s/. Guitart (1976) tentatively argues that although /s/ is cross-linguistically considered the least marked continuant, [h] is arguably less physiologically complex, meaning there is less articulatory effort involved in its production. Guitart explains that from a mechanical perspective, while an oral gesture is involved in [s] and [f] production, the oral gesture is avoided entirely in [h] production (1976: 74), resulting in an articulatorily simpler sound. Other authors have supported Guitart’s claims: Seklauoi (1989) suggests that in Romance languages, articulatory economy guides /s/ weakening, resulting in assimilation of articulatory sounds, easier transitions and even total deletion of sounds (13).
Ferguson (1990), Méndez Dosuna (1996), Lipski (1999) and others have argued that /s/ lenition follows a predictable pattern\(^\text{10}\). Lipski (1999) explains that /s/ lenition originates in preconsonantal environments (both diachronically and synchronically), with [h] appearing in [lah mesas] las mesas ‘the tables’ and [ahta] hasta ‘until’. In dialects with lower rates of aspiration, this is the only environment in which /s/ lenition occurs. In the second stage, which is characteristic of transitional zones between dialects with higher levels of aspiration and lower levels of aspiration, /s/ lenition is extended to prepausal environments. In this stage, word-final contexts before a consonant and before a pause are affected by /s/ lenition, but prevocalic /s/ at the word boundary remains unaffected, e.g. es así remains [es asi]. The final stage of /s/ lenition, prevocalic syllable-final /s/ lenition, occurs only in the more advanced dialects. In this stage, the syllable-final /s/ lenition extends to word-final, prevocalic /s/ contexts.

In the most extreme aspirating dialects (including Caribbean, Andalusian, and Extremeño Spanish) aspiration may spread even further (Méndez Dosuna 1996). In the final two stages aspiration extends to the word-internal prevocalic environment and word-initial environment, as illustrated in Méndez Dosuna’s course of change shown below in (4).

\(^{10}\) Ferguson (1990) argues that s > h lenition appears to follow two separate paths of diffusion. In the Spanish type, aspiration originates in ‘weak’ positions, occurring syllable- and word-finally before spreading to prosodically ‘stronger’ positions. In the Greek type, on the other hand, s > h actually originates in ‘strong positions’, preferring intervocalic and word-initial positions before a vowel. Méndez Dosuna (1996) disagrees with Ferguson (1990), arguing that the diffusion of s>h is regular across languages but depends on a language’s phonological structure.
(4).  
   i. /Vs$C/   | las moscas   | [lah móhkas]   | ‘the flies’
   ii. /Vs##/ | las moscas   | [lah móhkah]   |
   iii. /Vs#V/| las alas      | [lah álal]      | ‘the wings’
   iv. /VsV/  | ¿qué pasa?   | [ké páha]       | ‘what’s up?’
   v. /##sV/  | sí señor     | [hí heñó]       | ‘yes, sir’

(Méndez Dosuna 1996: 98).

However, not all dialects of Spanish fall neatly within this proposed pattern of diffusion: Brown and Torres Cacoullos (2003) point to Chihuahua, Mexican Spanish as an exception, a dialect that shows greater rates of syllable- and word-initial aspiration than syllable-final aspiration. The authors contend that this dialect provides evidence against the traditionally proposed order of diffusion for reduced /s/ and, on a broader level, provides evidence against a unified method of /s/ aspiration diffusion of in Spanish.

While Ferguson (1990) and Lipski (1999) do not analyze the spread of /s/-lenition in terms of licensing by cue (see Steriade 1997/2001), a perceptual explanation could easily be connected with their argument. Steriade (1997) states that neutralization actually has to do with phonetic implementation, and that linguistic contrast is lost in positions where the cues are reduced or lost. For example, Steriade’s approach accounts for the neutralization of alveolar and retroflex /t/ in Indian English; neutralization of the retroflex forms occurs word finally or before a stop when there is no CV transition to make the difference between the two sounds more salient. In a VCV environment, Steriade explains, the transitions between VC are the same for alveolar and retroflex /t/, but the transitions are different for CV, which is why neutralization takes place when the
CV transition is not present. When perception is difficult, i.e. word finally and before a stop, the contrast is not preserved. When more cues are available, the distinction is maintained.

In the case of Spanish /s/ reduction, Steriade’s (1997) licensing by cue approach would explain why aspiration first occurs within the lexical unit in a cue-impoverished environment, as transitional consonantal cues are less audible preconsonantally. Aspiration is then extended to a postlexical cue-impoverished environment, where the cues are again less audible preconsonantally across word boundaries. Lastly, aspiration may extend via analogy to a postlexical cue-rich environment, between vowels at the word boundary, meaning the cue-rich context is the least likely to be affected by /s/ > [h] aspiration. The relative consistency of the cues explains the distinction between lexical and post-lexical /s/ lenition: word-internally, the pre-consonantal, cue-impoverished phonological environment is unchanging, encouraging neutralization of fricatives. Post-lexically, on the other hand, the lenited /s/ may be followed by a consonant, pause or vowel, environments that differ in their cue-richness, resulting in a slower diffusion of /s/ lenition until it ultimately spreads to the most cue-rich intervocalic environment.

I should note that Gerfen (2001) disagrees that Steriade’s (1997) licensing by cue is sufficient to explain the aspiration phenomena in Eastern Andalusian Spanish (EAS) compared to Standard Peninsular Spanish (SPS), and he uses this phenomenon to argue in favor of the importance of broader phonological categories like syllable structure. In EAS, aspiration occurs word finally and word internally before another consonant. Within the word a type of gemination occurs, resulting in a lengthening of the following
consonant, e.g. bosque → bohkke. In other words, [s] only occurs in contexts with a transition into a vowel.

Gerfen explains that it is syllable position that licenses this aspiration and gemination in EAS. Unlike intervocalic stops, the cues of which are primarily based in the vocalic transitions to either side of the stop, the main cues for fricatives are internal to those fricatives. In other words, fricatives have strong internal cues (Steriade 1997) instead of transitional cues. According to Gerfen, this fact undermines Steriade’s argument in favor of abandoning the licensing by prosody approach, which makes use of broader phonological categories, for the licensing by cue approach. However, studies such as Mann and Repp (1981) demonstrate that the following vowel in fricative-vowel sequences contains information about the preceding fricative that contributes to listener perception. These findings indicate that some transitional cues are available as well, offering an explanation for aspiration within Steriade’s (1997) framework.

Finally, aerodynamic reasons may also be called upon in part to explain this onset-coda difference in /s/ lenition: as Solé (2003) explains, coda fricatives actually have a slower build-up of oral pressure, a lower pressure peak, and they require more time to reach the drop in pressure needed for perceptible frication than onset fricatives. Coda fricatives are also much more sensitive to reduced pressure, which decreases the possibility of creating audible frication, leading to reduction or elision of the fricative in coda position.
2.5 Conclusion

In this chapter I have introduced the process of /s/ lenition across languages and, more specifically, I have provided a discussion of /s/ lenition in dialects of Spanish. I also detailed the linguistic factors that have been found to influence /s/ reduction in dialects of Spanish, such as following stress and word length, and the social factors contributing to this reduction as well, including gender, education, and age. Finally, I presented articulatory, perceptual, and aerodynamic motivations for /s/ lenition to account for this common reduction process in Spanish. Next, in chapter 3 I discuss the literature on hiatus resolution strategies and glottal stop use across languages and in dialects of Spanish to eventually explain the glottal stop’s motivation in Nicaraguan Spanish.
Chapter 3: Hiatus resolution

Chapter 2 demonstrated that in advanced /s/-reducing dialects of Spanish, including Nicaraguan Spanish, /s/ is often fully elided word-finally between vowels, creating heterosyllabic vowel-vowel sequences, i.e. hiatus. In this chapter, I introduce the relevant literature on hiatus and hiatus resolution strategies, both in the world’s languages and in different dialects of Spanish. The literature shows that while some Spanish dialects tolerate hiatus more readily than others, most dialects of Spanish prefer to resolve hiatus through diphthongization, deletion, coalescence, or epenthesis. The discussion that follows demonstrates that Spanish is no linguistic exception in this regard: numerous languages make use of the same strategies to resolve hiatus, suggesting that hiatus is cross-linguistically and, in Spanish, cross-dialectally dispreferred.

This chapter opens with a review of hiatus resolution strategies across languages in section 3.1 before exploring in greater detail the hiatus resolution strategies in Spanish in section 3.2: diphthongization (3.2.1), vocalic elision (3.2.2), coalescence (3.2.3), and epenthesis (3.2.4, also known as insertion). This chapter then discusses the specific case of the glottal stop in Spanish in section 3.3, both as a contact feature in other dialects of Spanish (3.3.1) and a language internal strategy in Spain, Puerto Rican, and Nicaraguan Spanish (3.3.2).
3.1 Hiatus resolution cross-linguistically

As Casali (1998) notes, “many languages do not readily tolerate adjacent hetereosyllabic vowels” (3), and languages may opt for resolution strategies other than heterosyllabification, or the maintenance of both vowels in two separate syllables. The tendency to resolve hiatus may stem from the unmarkedness of the CV syllable structure crosslinguistically, as all known languages allow for this structure (Kager 1999: 95), which may be indicative of its cross-linguistic “naturalness”. When hiatus is resolved in the world’s languages, Casali (1998) notes that the main strategies are diphthong formation, or the merging of the two originally heterosyllabic vowels into a single nucleus\(^\text{11}\), e.g. [peljar] for pelear ‘to fight’; vocalic elision, or the deletion of one of the vowels, e.g. [liɣlesja] for la iglesia ‘the church’; epenthesis, or the addition of a consonant between the vowels, e.g. [kanoYa] for canoa ‘canoe’ (Hernández 2009); and coalescence, or the creation of a third, different vowel with features of both the first and second vowel, e.g. [lęskwela] or [liskwela] for la escuela ‘the school’ (Jenkins 1999). These processes are not mutually exclusive and may co-occur in any given language (Casali 1998; Barberia 2012).

Certain universal tendencies emerge in Casali’s data that focus on vocalic elision. For example, when the hiatus occurs between two lexical words in languages that tend to

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\(^{11}\) Casali (1998) distinguishes between diphthongization, or the creation of a semiglide in the second vowel (V2), and glide formation, or the creation of a semivowel in the first vowel (V1). For the present purposes, I conflate these concepts under the term “diphthongization”.
elide a vowel to resolve hiatus, the first vowel is always elided. When hiatus is created by a lexical word followed by a function word, the first vowel is more commonly elided, but numerous languages delete the second vowel in certain function words. Vowel elision is restricted to the first vowel between a CV prefix and a root, but elision of either vowel is possible between a root and a suffix. Casali argues that “the existence of these regular patterns shows strongly that the choice of which vowel is elided is not merely an idiosyncratic property of individual languages, but is to some extent predictable from the context in which hiatus arises” (21). In other words, some universal principles must be at work in vocalic elision hiatus resolution strategies to explain the patterns in the data.

Word-initial vowels seem to hold a special position synchronically, avoiding elision when hiatus is formed, and also diachronically, as word-initial vowel loss is much less common than the loss of vowels word-medially and word-finally. Consonants also appear to be maintained more commonly word-initially. For example, neutralization of word-initial obstruents is quite rare, even though word-initial obstruents should favor voicelessness just as much as word-final obstruents based on articulatory considerations (Westbury and Keating 1986), where neutralization is common. However, if a voicing contrast exists in a language, it will generally be preserved in initial position.

Casali (1998) explains that the universal tendency to preserve the features of word-initial segments is a result of the greater duration and amplitude found at the beginning of words, which makes word-initial featural cues more salient. Following Jun (1995) and Steriade (1995), word-initial segments’ greater acoustic prominence may lead to the preservation of its features. Processing considerations may also make word-initial
position an inherently special prosodic position. The higher number of contrasts in initial-position may aid in word recognition for two reasons: first, evidence suggests that native speakers store words in their mental lexicon by the first phoneme and secondly, speakers can acquire more lexical information earlier in the word (MacEachern 1995). In other words, more distinctions word-initially decrease cognitive processing, as the list of possible words under each initial phoneme decreases.

The tendencies described by Casali (1998) make it clear that the beginning of a lexical word nearly categorically maintains its vowel in vowel-elision hiatus resolution strategies: this suggests that certain, special positions are more likely to maintain contrasts of features and/or segments (Steriade 1993), and vowels in certain positions may also be more resistant to change. Chitoran and Hualde (2007) support this line of reasoning in Spanish, arguing that word-initial sequences disfavor reduction through diphthongization. They also argue that stressed and pretonic syllables are less likely to undergo diphthongization, e.g. while the /ia/ in di-á-lo-go ‘dialogue’ and di-a-ló-go ‘I converse’ show heterosyllabification in their respective tonic or pretonic positions, the /ia/ in dia-lo-gó ‘he or she conversed’ is diphthongized in pre-pretonic position.

These conclusions about word-initial, stressed vowels as special phonological environments are particularly relevant to my study. The statistical analysis in chapter 5 reveals that stressed and unstressed vowels behave very differently in regard to /s/ deletion and glottal stop use, and in chapter 6 I show that fortition processes are at work to strengthen these special phonological environments and protect them from hiatus created by extreme /s/ reduction.
3.2 Hiatus resolution in Spanish

As Casali (1998) explains, universal tendencies guide the hiatus resolution strategy of vocalic elision across languages. It follows that universal principles may be at work in other hiatus resolution strategies as well, which will be explored in this section on the strategies used across dialects of Spanish. The discussion will begin with the strategy of diphthongization (3.2.1), followed by an account of vocalic elision (3.2.2), coalescence (3.2.3), and consonantal epenthesis (3.2.4). The glottal stop as a contact feature in different dialects of Spanish is explored in section 3.3.1, including Yucateco Spanish, the Spanish of Paraguay and Argentina, and Chabacano Spanish in the Philippines, and section 3.3.2 discusses the glottal stop in dialects of Spanish not so easily attributed to contact, including Spain, Puerto Rican, and Nicaraguan Spanish.

3.2.1 Diphthongization

Barberia (2012) defines diphthongization, which she refers to as acoustic diphthongization, as “a strategy to resolve hiatus, in which a nucleic non-high vowel in the vowel sequence suffers significant durational reduction. The change may lead to a certain degree of qualitative assimilation to the other vowel in the sequence, showing a smooth transition” (65). In her dissertation Barberia (2012) distinguishes between
acoustic diphthongization and gliding, which she explains as another hiatus resolution strategy “in which a nucleic non-high vowel in the vowel sequence suffers significant durational reduction and rises to a glide, showing a smooth transition from one segment to the next. Consequently, the syllable in which the glided vowel is needs resyllabification to the adjacent nucleic vowel” (66). While Barberia shows an acoustic distinction between acoustic diphthongization and gliding, only 1% of her data (N = 10) constitutes gliding, while diphthongization accounts for 19% of the realizations (N = 184). As the acoustic difference between the two is small and only ten tokens fall into her gliding category, I conflate both under the category of diphthongization for the purposes of this dissertation.

The general, prescriptive rule of hiatus vs. diphthong production is that when two non-high vocoids co-occur, e.g. boa ‘boa constrictor’ [bo.a], a hiatus is produced, whereas if a non-high and a high vocoid occur side by side, a diphthong is produced, e.g. [boj] voy ‘I go’. A hiatus is also produced with a non-high and high vocoid when the high vocoid bears word stress, e.g. [di.a] día ‘day’, and a diphthong is produced if two high vocoids co-occur, with the first serving as a glide and the second serving as the nucleus, e.g. [fwi] fui ‘I went’ (Face and Alvord 2004).

There exists a diachronic tendency for Spanish to resolve hiatus with diphthongs, e.g. Hispan[i.a.] > Hispan[ja] (> España) and Ital[i.a.] > Ital[ja], and diphthongs have also been created after intervocalic consonant deletion creates hiatus, e.g. regina > re.i.na > réj.na (Garrido 2007). The diachronic tendency toward diphthongization paired with the tendency to perceive diphthongs over hiatus when listeners are presented with
conflicting cues (Face and Alvord 2004) suggests that the drift toward diphthongization is common in Spanish.

Garrido (2007) and Hernández (2009) emphasize that in spite of the prescriptive rules on hiatus and diphthong formation, hiatus resolution strategies vary greatly across dialects of Spanish. For example, Latin American dialects of Spanish seem to favor diphthongization more than Peninsular dialects (Hualde 2005), but certain dialects, such as Bolivian Spanish, exhibit a tendency to conserve hiatus (Coello Vila 1996). In other words, the hiatus maintenance or resolution strategy employed depends largely on the dialect in question. In dialects that resolve hiatus with diphthongs, two possibilities occur: diphthong formation with a raised mid-vowel or a glide, resulting in either [pʒon] or [pjon] for peón ‘pawn’ (Hualde 2005).

Alonso (1930) noted that frequently-diphthongized lexical units in Spain and the Americas, e.g. león > [ljon] ‘lion’, date back to the late 1800s and early 1900s. He explains that the resolution of hiatus through diphthongization spread much more in Latin America than in Spain, due in large part to anti-diphthongization prescriptive norms in Spain imposed by the Spanish Academy and literary canons. On the other hand, this resolution strategy flourished in Argentina, Chile, Colombia, Mexico, Guatemala, El Salvador, Nicaragua, Costa Rica, Venezuela, Ecuador, Perú, and Bolivia. More recently, Frago-Gracia and Franco-Figueroa (2001) have noted that the diphthongization of hiatus is a tendency across all of Latin America except Paraguay, which they argue favors hiatus forms because of Guarani influence.

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12 Morgan (2010: 135) notes that non-high mid vowel glides are also common in Spanish.
13 Alonso’s (1930) account contradicts Coello Vila (1996).
Quilis (1999) also notes this preference for diphthongization in Spanish, explaining that there is an anti-hiatus tendency across dialects of Spanish that prevents the occurrence of hiatus. The trend is particularly notable in Chetumal Mexican Spanish. Hernández (2009) explains that Mexican Spanish resolves hiatus with diphthongization both word-internally (*teatro* ‘theater’), at the lexical level, and across word boundaries (*te aviso* ‘I warn you’), at the postlexical level. This type of hiatus across a word boundary is particularly common in Spanish, as many words in Spanish end or begin with vowels and may be juxtaposed in longer strings (Alba 2006). Diphthongization is by far the preferred method of hiatus resolution in Mexican Spanish, and the prevalence of this strategy is reflected in Mexican orthographical errors, e.g. ‘*pelió*’ instead of *peleó* ‘he/she fought’, ‘*voltié*’ instead of *volteé* ‘I turned’, and ‘*maiz*’ and ‘*raiz*’ instead of *maíz* ‘corn’ and *raíz* ‘root’ (Hernández 2009: 5). This diphthongization is both the product of stress dislocation, e.g. [ma.ís] *maíz* ‘corn’ > [máis], and vowel quality changes, e.g. *petróleo* ‘oil’ [pe.tró.le.o] > [pe.tro.ljo] (Garrido 2007: 30).

In Colombia, Garrido (2007) examined hiatus resolution across two different locations: Bucaramanga in the interior highlands, which is known for its more conservative Spanish, and Cesar and Atlántico regions in the Caribbean dialectal zone among young participants (ages 18-25) in a reading and story-telling task. Using duration and F1 formant values to measure the diphthong-hiatus distinction, Garrido finds that Caribbean Spanish speakers diphthongize hiatus sequences more than Andean Spanish speakers in the reading task, neutralizing the durational differences that the Andean Spanish speakers preserve between [jo] and [e.o]. Andean Spanish speakers also preserve
the vowel quality contrast between \([j]\) and \([e]\) to a greater extent than Caribbean Spanish speakers, who show lower \([e]\) F1 values in their productions that are actually closer to \([j]\) F1 values.

In the more informal story-telling task, the difference between Andean and Caribbean Spanish speakers was neutralized, and the distinction Andean Spanish speakers made between \([e.\text{o}]\) and \([jo]\) vowel sequences in the reading task is minimized. Garrido (2007) concludes that Caribbean Spanish speakers use diphthongization to resolve hiatus even in formal styles to create and maintain their coastal identity, while Andean Spanish speakers avoid this diphthongization to differentiate their dialect from what is seen as more stigmatized, rural, and uneducated Spanish speech.

Even in South American dialects that use a glottal stop to resolve hiatus like Misiones, Argentina, Sanicky (1989) finds that diphthongs are still the most common way to resolve hiatus, especially when both vowels are atonic, e.g. \([mjermáno]\) \textit{mi hermano} ‘my brother’, following standard resyllabification rules of Spanish. Sanicky (1989) notes that hiatus is only maintained in this environment in Misiones in emphatic, normative speech, e.g. \([la-eh.kwé.la]\) \textit{la escuela} ‘the school’. While diphthongization is more frequent than glottal stop insertion or hiatus maintenance overall, glottal stop insertion and hiatus maintenance are more likely in this dialect when the second vowel is accented and most likely when both vowels are tonic.

Hiatus resolution through diphthongization is also found in North America, and Alba (2006) notes its frequent occurrence in New Mexico and Colorado Spanish in \(/a/#V\) sequences. While Alba only compares hiatus maintenance to hiatus resolution, conflating
diphthongization, deletion, coalescence, and insertion into a single category, he contends that vowel quality and stress influence hiatus resolution to the greatest extent: low and mid vowels and unstressed vowels are much more likely to induce resolution. Alba’s results align with previous studies in finding vowel quality and stress to be the most influential predictors of on hiatus resolution, showing cross-dialectal similarities.

Finally, in a production task involving eight Peninsular Spanish speakers Barberia (2012) finds that diphthongization is more likely word-internally than it is across the word boundary. She also shows that diphthongization (and hiatus maintenance) are more likely in vowel sequences not followed by a coda, but when a coda does follow the vowel-vowel sequence, the hiatus is more likely to be longer and realized as a diphthong (or maintained) if the following coda is an obstruent (excluding /s/+).

### 3.2.2 Vocalic elision

Barberia (2012) defines vocalic elision (or deletion) as the “resyllabification of hiatus into a single syllable, resulting in the deletion of one of the original vowels” (69). This author focuses on vocalic elision in a lexical decision task in which her Peninsular Spanish-speaking participants judged the acceptability of deletion affected by word type, syllable type, vowel position and quality, coda type, and word boundaries. Their reaction times were also measured. Barberia (2012) finds a strong effect of word boundary: vowel sequences across the word boundary are shorter than vowel sequences word-internally, and hiatus at the word boundary is resolved with coalescence and deletion more
commonly than word-internal hiatus, which, as noted in section 3.2.1, is more often maintained or resolved with diphthongization. Additionally, listeners judged elision at the word boundary as “correct” in Spanish more often than elision word-internally. Their reaction times were faster with elision at the word boundary as well. Barberia also finds an effect of vowel position and quality, with /e/ producing shorter vowel sequences than /a/ and /o/ in V1 or V2 position, but /e/ only tends to undergo deletion in /ea/ sequences. When /o/ is the first vowel in a vowel-vowel sequence, however, deletion is significantly more likely.

Finally, Barberia discusses an effect of syllable type and coda type. She shows that vowel sequences followed by a coda are durationally shorter and tend to be resolved most with coalescence and deletion. As mentioned above in 3.2.1, vowel sequences not followed by a coda are longer and tend to either maintain the hiatus or resolve the hiatus through diphthongization. Similarly, when this coda is an obstruent (excluding /s/), the duration of the vowel-vowel sequence tends to be longer and either hiatus maintenance or acoustic diphthongization is most likely. If the coda is /s/, on the other hand, the hiatus is most likely to be resolved through deletion. Barberia notes that multiple factors all interact to predict the different types of hiatus resolution that take place in Spanish.

While diphthongization serves as the most common hiatus resolution strategy by far in Chetumal Mexican Spanish, Hernández (2009) finds several other strategies for hiatus resolution in this dialect as well. Aside from various types of hiatus maintenance and diphthongization, elision of a low vowel, e.g. la iglesia as [liɣlesja] and elision of
one of two identical vowels, e.g. *lo odio* as [lo.ðjo]\(^{14}\) are two other possibilities (24); this hiatus resolution strategy appears to be driven by younger generations in Mexico and avoided by older generations (Vuskovich 2006). These conclusions support Casali’s (1998) argument that within a given language or dialect, hiatus resolution strategies are not mutually exclusive.

In Misiones, Argentina, two homologous vowels are resolved into one short vowel when both of the vowels are atonic (a rule prescriptively taught in Spanish pronunciation) e.g. [lasáða] *la asada* ‘barbecued meat’ (Navarro Tomás 1961: 137) or when a tonic vowel precedes an atonic vowel, e.g. [básjendo] *va haciendo* ‘he/she is doing’ (Quilis 1973: 147). However, two homologous vowels become a long vowel when both vowels are tonic, e.g. [bá:hta] *va hasta* ‘he/she goes until’, or when an atonic vowel precedes a tonic vowel, e.g. [mí:xa] *mi hija* ‘my daughter’ (Sanicky 1989).

\(^{14}\) Hernández (2009) calls this coalescence, but this definition differs from Casali’s (1998) and Barbería’s (2012) definition of coalescence; I will simply refer to it as elision to avoid confusion.
3.2.3 Coalescence

As explained by Casali (1998), coalescence involves the creation of a third, different vowel from the V1V2 sequence with properties of both the first and second vowel. Because a single vowel is phonetically produced in both coalescence and deletion, Aguilar (2003) considers these the same hiatus resolution strategy: monophthongization. Barberia (2012) notes that a clear, acoustic distinction between coalescence and deletion has not been made in the previous literature, and she defines coalescence as “resyllabification of a hiatus into a single syllable, the resulting vowel is a combination of the F1/F2 values of the original vowels” (68).

Few studies discuss coalescence as a hiatus resolution strategy in Spanish. In his study on New Mexican Spanish, Jenkins (1999) claims that 7.1% of postlexical vowel-vowel sequences are resolved with coalescence. However, his study relied on auditory perception and not acoustic analysis, which calls into question the ability to clearly distinguish between coalescence and deletion by auditory impression alone. This approach also makes the study difficult to reproduce.

In Peninsular Spanish, Barberia (2012) finds that a staggering 42% of vowel-vowel sequences produced by her participants result in coalescence. Only 12% of vowel-vowel sequences resulted in hiatus maintenance, 19% in acoustic diphthongization, 1% in gliding, and 26% in deletion, making coalescence the most common hiatus resolution strategy. More studies are needed to investigate the prevalence of coalescence as a hiatus resolution strategy across dialects of Spanish.
Another resolution strategy in Spanish is insertion of a consonant, which occurs in numerous dialects of Spanish. For instance, in Mexican Spanish ‘mojo’ can be found in written online speech for *moño* ‘mold/mildew’, showing insertion of [x] between two adjacent vowels with the same vowel quality (Hernández 2009). The insertion of a velar approximant is found in Columbian Spanish e.g. [ka.no.ya] for *canoa* ‘canoe’ (Garrido 2007) and the insertion of the bilabial approximant appears in Mexican Spanish [kre.i.βa] for *creía* ‘I/he/she believed’ (Hernández 2009). Spanish-speaking children resolve hiatus in much the same way: according to Dr. Rebeka Campos-Astorkiza (p.c. 11/30/2011), her son, whose primary Spanish input is from the Bilbao dialect of northern Spain, has resolved hiatus with epenthesis since the approximate age of 1:11, inserting a velar approximant between two heterosyllabic vowels, e.g. [le.on] ‘lion’ becomes [le.yon].

Most important for the present analysis, numerous dialects of Spanish epenthesize a glottal stop to resolve hiatus, e.g. [paraʔiso] for *paraiso* ‘paradise’ (Sanicky 1989, detailing Misiones, Argentina), a strategy that will be discussed in detail in section 3.3.
3.3 The case of the glottal stop

Linguistic analyses of the glottal stop in the Spanish-speaking world are few and far between, and all too often the phenomenon is glossed over as a dialectal peculiarity due to a language contact situation. This section lays out the research that is available on dialects of Spanish with a glottal stop and presents my hypotheses about the glottal stop in Nicaraguan Spanish.

Before detailing the glottal stop in the Spanish-speaking world, I will first explain how the glottal stop is produced and discuss some existing literature on the glottal stop in languages other than Spanish. According to Esling et al. (2005), the glottal stop is generally thought of as occurring with constriction strictly at the glottis. As these authors explain based on laryngeoscopic studies, glottal stops are most commonly realized with “an adduction of the arytenoid cartilage, complete adduction of the vocal folds, a partial adduction of the ventricular folds, and moderate narrowing of the laryngeal vestibule through its epilaryngeal sphincter mechanism” (386). Other studies (Esling 2002; Esling and Edmondson 2002; Carlson, Esling, and Harris 2003; Esling and Harris 2003; Edmondson et al. 2005) confirm these findings.

Esling et al. (2005) also find that the production of the glottal stop is often more complex than simple glottal closure, arguing that “a glottal stop typically requires supraglottic reinforcement to arrest the vibration of the vocal folds” (386), as it is difficult to stop vocal cord vibration without additional supralaryngeal closure. Without this supralaryngeal closure, airflow is likely to continue to pass through the glottis due to
subglottal and supralaryngeal pressure differences, and this continuing passage of air facilitates ongoing voicing. However, additional supralaryngeal constriction in the ‘laryngeal vestibule’ (386-387) decreases the differences in pressure between subglottal and supralaryngeal air and helps to achieve full glottal closure. The difficulty described by Esling et al. (2005) in ceasing vocal cord vibrations without co-occurring supralaryngeal constriction can help explain the use of creaky voice observed in my data.

Now that I have detailed the production of the glottal stop, the literature on the glottal stop as a contact feature in different dialects of Spanish is reviewed in section 3.3.1, including the Spanish of the Philippines, the Yucatan peninsula, Paraguay and Argentina. Dialects of Spanish with a glottal stop that cannot so easily be explained by contact are then detailed in section 3.3.2, including Peninsular, Puerto Rican, and Nicaraguan Spanish.

3.3.1 The glottal stop as a contact feature in Chabacano, Yucateco, and Paraguayan and Argentinian Spanish

In his documentation of Chabacano Spanish, Lipski (2000) explains that one of the most salient features of the Spanish-based creole is the insertion of a glottal stop before vowel-initial words, e.g. el hombre [el-ʔom-bre] ‘the man’. Instead of resyllabifying the first syllable’s coda liquid to the onset of the second syllable, Chabacano speakers preserve the /l/ in its coda and insert a glottal stop. Lipski notes that glottal stops are also inserted to resolve hiatus within a word, e.g. maíz [ma-ʔis] ‘corn’,
which is the pronunciation that would be employed in Spanish by native speakers of other languages in the Philippines. As a result of glottal stop insertion instead of resyllabification, the phonetic boundaries between two words tend to be much more perceptible in Chabacano Spanish. Lipski argues that this glottal stop insertion is a result of contact with other languages in the Philippines, and that all Spanish-speaking Filipinos employ the feature in their Spanish.

The second dialect of Spanish with contact-induced glottal stop insertion is Yucatan Spanish. Lope Blanch (1987) explains that in Yucatan Spanish, the use of the glottal stop is irregular but common, particularly in the central region of the peninsula among less educated, bilingual speakers of Mayan and Spanish, although glottal stops can be heard even in the speech of the most educated Yucatecos. Particularly interesting for the present study is the fact that glottal stops arise most frequently between vowels. Lope Blanch notes that one of the most frequent environments for the glottal stop is between two tonic vowels, e.g. [yo sí ? áblo]\textsuperscript{15} yo sí hablo ‘I do talk’, in which case the glottal stop tends to be very strong and clear. Favoring the insertion of the glottal stop even more is the context atonic vowel followed by tonic vowel, e.g. [deskánsa ? úno] descansa uno ‘one rests’, which Lope Blanch explains is by far the most common environment for the intervocalic glottal stop. A stressed syllable followed by an unstressed vowel at the word boundary, on the other hand, shows considerably less glottal stop insertion, although occasionally the glottal stop does surface in this position, e.g. [está ? empesándo] está empezando ‘he/she/it is beginning’. Proportionally, glottal stops between two atonic

\textsuperscript{15} The transcriptions in this section come from Lope Blanch (1987): the author uses [r] for what I can only assume is [ɾ] and [y] for what I assume is [ʝ]. All phonetic symbols appear as in the original.
vowels are less frequent than the previously mentioned environments for glottal stop insertion, but examples can be found in [kwandoʔ entráron] _cuando entraron_ ‘when they entered’. Lope Blanch notes that the epenthetic consonant is much weaker and briefer following atonic vowels than tonic vowels.

In post-vocalic, phrase-final position, e.g. in the tag questions [noʔ] or [siʔ], glottal stops are very common but also tenser, produced as affricates more than in other positions. These glottal stops almost always occur after tonic vowels, with Lope Blanch finding only a few examples of phrase-final glottal stop insertions after atonic vowels, e.g. [por ésoʔ]17. Lope Blanch explains that phrase-initial glottal stops tend to be produced in a clear and strong manner, but they are produced less frequently than phrase-final glottal stops, occurring in about 1/5th the number of instances. However, they can occur phrase-initially before tonic or atonic vowels, e.g. [ʔúnade] _una de_ ‘one of’ or [ʔaki] _aquí_ ‘here’.

The glottal stop may even appear word internally, but this appears to mark a morpheme boundary or perceived morpheme boundary, e.g. [nosʔótrous] _nosotros_ ‘we’ or [desʔáse] _deshace_ ‘he/she/it undoes’. There are few cases of glottal stop insertion following a consonant if the next vowel is atonic, but there are examples such as [dósʔer man os] _dos hermanos_ ‘two brothers’ or [lasʔobligous] _las obligo_ ‘I force them’. Also, there are few glottal stops across a word boundary with a word-final vowel and a word-initial voiced stop, but some examples do occur, such as [ásíʔgrán de] _así grande_ ‘that

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16 As Lope Blanch (1987) does not elaborate on this point, it is not entirely clear what the author means by an affricated glottal stop here.

17 Lope Blanch (1987) uses / to indicate phrase-final position.
big’ and between two consonants or /s/ followed by a voiced stop, e.g. [dósʔbolas] dos bolas ‘two balls’. However, when a vowel at the word boundary is followed by a voiceless stop, the author notes three times more glottal stops before /k/ than before the other voiceless stops, e.g. [estáʔkhansáda]. Considerably fewer glottal stops occur before /t/ and even fewer occur before /p/. Weaker epenthetic approximants are more likely to occur before /t/ and /p/, suggesting that coarticulation may be easier before /k/ than before anterior consonants.

Lope Blanch (1987) argues that the occurrence of the glottal stop in Yucatan Peninsula Spanish represents a case of language contact with Mayan, a language with contrastive glottalized consonants and contrastive long vowel laryngealization. He argues that it is the power and strength of the Mayan language in this region that allows language interference to take place: while other Amerindian languages have a glottal stop phoneme, they do not have the social power to impact Spanish in this way. However, the picture painted by Lope Blanch (1987/1993) may be changing: in his more recent pilot study on glottal stops in Yucatan Spanish, Michnowicz (2006) finds that it is older speakers from lower-class, Mayan-dominant households that insert the glottal stop, suggesting that the use of the glottal stop may be dying out in younger, more affluent parts of the population.

Like the glottal stop in Chabacano and Yucatan Peninsula Spanish, Mackenzie (n.d.) explains the glottal stop in Paraguay as a language contact feature, as Spanish-Guarani bilingualism is very common in the region. Previous studies have drawn attention to the different behavior of vowels in the Guarani area compared to other
dialects of Spanish (Alonso 1930, Vidal de Battini 1964): diphthongization, common across dialects of Spanish, does not take place in Argentinian Spanish in contact with Guaraní. Vocalic preservation, often ensured by glottal stop insertion between heterosyllabic vowels, is a very salient feature of this dialect (Thon 1989).

Pruñonosa (2000) claims that the glottal stop is very common in field data from Guaraní-influenced Argentine Spanish, particularly at the word boundary when the preceding word ends in a consonant and the following word begins with a vowel; he also notes that word-internal use of the glottal stop between vowels is rare. Sanicky (1989) finds that while the glottal stop is used quite frequently in Misiones, Argentina, its presence is most common when the second vowel in the sequence is stressed. This glottal stop can be found between homologous vowels, e.g. [ká.ʔa.ɲo] cada año ‘each year’, different vowels across a word boundary [kwán.do.ʔén.tra] cuando entra ‘when he/she comes in’ and different vowels word-internally, e.g. [pa.ɾaʔío] paraíso ‘paradise’ (700). Sanicky does not mention whether the glottal stop can occur between homologous vowels word-externally, e.g. [al.coʔol] alcohol ‘alcohol’, but she explains that the glottal stop occurs less frequently when the first syllable is accented and the second is not, e.g. [fwéʔa] fue a ‘he/she went to’, and it is virtually nonexistent when both vowels are unstressed. Interestingly, these linguistic constraints on the glottal stop are very similar to the ones mentioned by Lope Blanch (1987) for Yucatan Peninsula Spanish and Tellado González (2007) for Puerto Rican Spanish (see section 3.3.2), falling under three of Casali’s (1998) special positions: (a) word-initially, (b) in a lexical (content) word or morpheme and (c) in a stressed syllable. The combination of these three factors may
make this word-initial, tonic position highly stable, on the one hand, and much more likely to require an onset than other less salient positions, on the other.

In Corrientes Spanish (Thon 1989), another Argentinian Spanish dialect in contact with Guarani, the glottal stop is mainly concentrated in the environment of the stressed low vowels /á é/ and mid vowel /ó/ (210). This is particularly interesting because Gregores and Suárez (1967) indicate that in Guarani [ʔ] is in complementary distribution with [x ~ h] word-finally: [ʔ] occurs following /á é ó/ and [x ~ h] occurs in all other environments, suggesting that the Guarani vocalic system has been superimposed on the Spanish vocalic system, and the environments that require glottal stop insertion in Guarani are being transferred into Spanish. Thon concludes that the glottal stop is most pronounced in the regions of Mercedes, San Luis and Curuzu-Cuatia, all regions where the population has a high percentage of Guarani speakers.

Geographical location influences glottal stop realizations in Argentina: in the east of Misiones, where the Spanish spoken is more removed from Guarani and more in contact with Brazilian Portuguese, diphthongization is the preferred strategy, and hiatus maintenance is preferred over glottal stop insertion before a tonic syllable. On the other hand, in the western zone of Misiones, where the Spanish spoken is more in contact with Guarani and more removed from the influence of Brazilian Portuguese, glottal stop insertion is more frequent than hiatus maintenance or diphthongization in the same environment (Sanicky 1989). The same is true of Yucatan Spanish: areas with greater numbers of Mayan speakers show more glottal stop use (Lope Blanch 1987).
In Argentina and Paraguay, “the glottal stop is an extended phonetic feature… mainly realized by men, mostly of rural residence and low educational background” (Thon 1989: 210). Extralinguistic factors influencing the glottal stop in Argentina, Paraguay and the Yucatan Peninsula are similar: in Misiones, Argentina, age and “cultural level” influence glottal stop usage, with older participants and participants in the lower “cultural level” exhibiting more glottal stop usage (Sanicky 1989). Mackenzie (n.d.) clarifies that the higher social classes in Paraguay speak Spanish much like speakers of other dialects of Spanish in the southern cone, while the lower social classes display more Guaraní interference in their Spanish, particularly notable in eastern Paraguay near the Paraná rivers and in neighboring areas of Argentina, i.e. Misiones, Formosa, Chaco and sections of Corrientes. Michnowicz’s (2006) results in the Yucatan Peninsula suggest a similar trend, indicating that Yucatan Spanish and Paraguayan/Argentinian Spanish in contact with Guaraní behave similarly in their patterns of glottal stop insertion.

3.3.2 The glottal stop in Peninsular, Puerto Rican, and Nicaraguan Spanish

Cortés Gómez (1979) provides a dialectological classification of the Spanish spoken in Higuera de Vargas, a municipality to the southwest of Spain in the province of Badajoz. The author claims that the glottal stop emerges in this dialect mainly before voiceless stops, principally before the dental /t/, e.g. [eʔtraperlo] for *estaperlo* ‘black market’, [eʔtaka] for *estaca* ‘post’ or [eʔtendé] for *extender* ‘extend/spread’ (29). While
not explicitly stated, the glottal stop in the Higuera de Vargas dialect seems to serve as an allophone of /s/ or the /ks/ cluster. Cortés Gómez also refers to another author who has found the presence of the glottal stop in Peninsular Spanish: Lorenzo Criado (1948) describes the glottal stop in Albalá as occurring word-finally before a pause.\(^{18}\)

While the data in Cortés Gómez (1979) and Lorenzo Criado (1948) are entirely impressionistic, they demonstrate that the glottal stop may be utilized for different ends within a single region: the glottal stop in the dialect described by Cortés Gómez seems to be an allophone of highly-reduced /s/, while in Lorenzo Criado’s dialect the [ʔ] may serve as an interruption of the speech stream (Kingston 2008) marking the utterance’s end (Henton and Bladon 1987).

Similar to Cortés Gómez’s analysis of [ʔ] in Higuera de Vargas, Terrell (1977) presents the glottal stop in Puerto Rican Spanish as a reduced variant of /s/ in syllable-final position, e.g. esconder ‘to hide’ [eʔkonder], and, considering the high levels of /s/-lenition in this dialect (Lipski 1994), this suggests that the glottal stop could be due to extreme reduction of /s/ and not be due to language contact with English (see the discussion of Valentín-Márquez 2006 below). Unfortunately, Terrell does not discuss the variant in more depth.

Tellado González (2007) also refers to the glottal stop as an allophone of /s/ in Puerto Rican Spanish along with [s], [h], ø and assimilation\(^{19}\). Contra Terrell (1977), she finds that [ʔ] never occurs word-externally, e.g. [eʔte] for este ‘this’, but rather, only

\(^{18}\) Aspiration and deletion of syllable- and word-final /s/ is characteristic of these two Extremaduran dialects (Lipski, n.d.).

\(^{19}\) Tellado González (2007) does not give a detailed account of assimilation, which is exceedingly rare in her data, and this form will not be discussed in the present analysis.
occurs word-finally in intervocalic coda position, with a slightly heightened rate of glottal stop use when a stressed vowel follows the underlying /s/ over an unstressed vowel, e.g. [laʔon.se] las once ‘eleven o’clock’ over [maʔaβjer.to] más abierto ‘more open’. She also notes that the occurrence of [?] does not depend on whether the word-final /s/ serves as a grammatical marker. Tellado González argues that the glottal stop serves as a means of avoiding diphthongization, but the author offers no phonetic or articulatory explanations of the glottal stop’s appearance.

While Tellado González (2007) discusses the glottal stop as an allophonic surface-level manifestation of an underlying /s/, she does note one instance of the glottal stop’s occurrence that does not correspond to an underlying /s/: one participant said a laʔ una ‘at one o’clock’, an example of glottal stop use without an underlying /s/. While the author does not explore the issue further, I posit that the glottal stop in this case serves as an extension of underlying /s/ from other, similar structures, e.g. a las dos. The glottal stop, with or without an underlying /s/, continues to serve the same phonetic purpose of maximally demarcating between the adjacent, heterosyllabic vowels, and I found a similar extension of the glottal stop to V#V environments in Nicaraguan Spanish (see section 6.4.2). This extension in Puerto Rican Spanish will have to be investigated in the future, as no other examples were found in Tellado González’s (2007) analysis.

Offering the most thorough analysis of the glottal stop in Puerto Rican Spanish, Valentín-Márquez (2006) argues that language contact with English, which variably inserts a glottal stop before a vowel-initial word after a pause, initiated the use of the allophone in Puerto Rican Spanish. Valentín-Márquez is quick to label the glottal stop in
all dialects of Spanish a contact feature: he goes as far as to suggest that Arabic may have played a role in the emergence of the segment in Spain.

Valentín-Márquez argues that the use of the glottal stop in coda position at the word boundary between vowels also eschews lexical ambiguity, preventing the ambiguity that would arise from *las aves* and *la sabes* with a retained sibilant, *las untas* and *la juntas* with aspiration and *unas ideas* and *una idea* with elision\(^{20}\). In other words, Valentín-Márquez claims that the use of the glottal stop prevents lexical ambiguity that cannot be avoided by retention, aspiration or elision while simultaneously upholding universal tendencies: the glottal stop creates a default onset consonant and maintains the preferred open syllable structure (CV).

Based on a comparison of older data collected in San Juan (López Morales 1983) and Valentín-Márquez’s data collected in 2004, Valentín-Márquez suggests a movement away from elision and towards aspiration and glottal stop insertion. He suggests that Puerto Ricans’ desire to differentiate themselves from the influx of Dominican immigrants who tend to fully elide /s/ might have instigated this movement away from elision. The author claims that elision is the most stigmatized variant of /s/, and aspiration and glottal stop insertion serve as a means of approximating a more perceived “standard”

\(^{20}\) See section 2.3.1 for a discussion of why this claim is controversial and has been contested in Spanish.
dialect, avoiding the stigmatized pronunciation. The author suggests that this is a change in progress, driven by the younger generation and, in particular, by women.  

Tellado González (2007) and Valentín-Márquez’s (2006) descriptions of the glottal stop’s use in Puerto Rico seems to closely approximate the use of the glottal stop in pacific Nicaragua. However, not much information is available on the glottal stop in Nicaraguan Spanish, and only a few mentions of the variant can be found in the literature. Rosales Solís (2010) notes that the glottal stop exists alongside [s], [h], and ø as a variant of /s/ (144), and Quesada Pacheco (1996) explains that the glottal stop can be found in both Nicaragua and Guanacaste, a western province of Costa Rica that was once part of Nicaragua and still retains linguistic features characteristic of Nicaragua (Lipski 1994, 2008). Quesada Pacheco (1996) claims that the glottal stop occurs in different environments in Guanacasteco and Nicaraguan Spanish, with the glottal stop appearing in word-final, intervocalic position before stressed vowels in Guanacaste, e.g. [loʔ’indjoh] for los indios ‘the Indians’, and aspiration appearing in the same environment before unstressed vowels, e.g. [lohani’maleh] for los animales ‘the animals’ (104). Citing Lipski (1984), Quesada Pacheco alleges that the glottal stop appears before a sonorous consonant in Nicaragua, e.g. [’miʔmo], but the author seems to have misread Lipski (1984), who notes that it is voiced glottal aspiration that occurs before a sonorant consonant in Nicaragua, e.g. [mífimo].

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21 Valentín-Márquez also claims that the increasing use of glottal stops is propagated by reggaetón music, in which glottal stop does not occur solely where there is an underlying /s/ but may appear in environments such as hacer [ʔ] el [ʔ] amor ‘to make love’. Valentín-Márquez asserts that this may be influencing the linguistically rebellious identity of the younger generation of caborrojeños. The problem with this claim, of course, is that the young women in his study who seem to be driving the change express a dislike for reggaetón music, making their alleged approximation to its pronunciation doubtful.
The existing literature only makes mention of the glottal stop in Nicaraguan Spanish, and no information beyond brief descriptions, which are sometimes incorrect, is currently available to explain the social and linguistic factors influencing the variant. In the following chapters I will fill this void in the literature and propose that the glottal stop is internally motivated in Nicaraguan Spanish. In addition to the explanation I provide for the glottal stop in Nicaraguan Spanish, the fact that all the glottal stop-using dialects discussed in this section also show extreme reduction of coda /s/ suggests that there may be similar linguistic processes at work in other dialects where contact is not as convincing an explanation for glottal stop use.

3.4 Conclusion

This chapter has focused on hiatus resolution strategies including diphthongization, vocalic elision, coalescence, and epenthesis across languages and in dialects of Spanish. The chapter then focused on dialects of Spanish that use the glottal stop, which is often inserted between vowels to resolve adjacent, heterosyllabic vowel sequences. Most dialects of Spanish that use the glottal stop are contact dialects, existing in close proximity to another language with the glottal stop in its phonological inventory or as a phonetic reflex. However, Nicaraguan Spanish is more difficult to explain with a contact hypothesis, as no other languages have recently coexisted with Spanish in western Nicaragua. Instead, I propose that the glottal stop is language internal in
Nicaraguan Spanish, influenced by both linguistic and social factors and not simply affected by language contact.

In order to explore this hypothesis, I conducted a study consisting of a sociolinguistic interview, an image identification task, and a reading task with 36 participants in Managua, Nicaragua. I designed the study to include an equal distribution of males and females, three age ranges, and three educational levels to determine the effect of social factors on glottal stop production, and I targeted specific linguistic environments to determine where the glottal stop would occur the most. Chapter 4 explains the methodology and data collection of this experiment in Managua, Nicaragua.
Chapter 4: Methodology and data collection

In order to fill the void in the literature on the glottal stop’s appearance in Managua and explain the factors conditioning its occurrence, I conducted a three-part experiment in the summers of 2011 and 2012, designed to elicit naturally-occurring realizations in an informal sociolinguistic interview, target specific environments predicted to condition the glottal stop’s occurrence in a reading task, and target specific environments while removing the influence of the orthographic <s> in an image identification task. The present chapter details the methodology used with the participants, recording environment, stimuli materials and tasks, and the data analysis, which explains the coding of the independent variables and an acoustic analysis of the different realizations. A statistical analysis and discussion of the results will be presented in chapters 5 and 6, respectively.

The present chapter is divided into three sections. Section 4.1 provides a brief introduction to the study, in which I discuss the participants and recording conditions, 4.2 introduces the stimuli and three tasks in the experiment, and 4.3 discusses the data analysis, including the coding of the independent variables and the classification of the dependent variables, providing examples of the all the realizations observed in the data. Section 4.4 provides a conclusion to the chapter.
4.1 Introduction to the study

After impressionistically observing the glottal stop variant in Nicaragua in the summer of 2010, I returned in the summers of 2011 and 2012 to conduct a three-part study with 36 adult participants, all born and raised in Managua. While a random sample of the population would have been ideal to provide a cross-section of the community, personal safety issues prevented such a design. Instead, I used the snowball sampling method to recruit new participants through friends, colleagues, and those who had already participated in the study. In order to maintain a relatively quiet environment, the recordings were made in the participants’ homes or places of employment, and efforts were made to minimize background noise to allow for an acoustic analysis of the data. In total, over 26 hours of data were recorded in Audacity using a unidirectional microphone connected to a PC, resulting in the acoustic analysis and independent variable coding of 7,132 tokens.

The glottal stop was found in two environments, both of which are described in this chapter. First, the glottal stop occurred in word-final, intervocalic environments where there is an underlying /s/, e.g. *das otro* ‘you give another’ as [daʔo.tɾo], which I call the V/s/#V environment. Second, the glottal stop occurred in word-final, intervocalic environments where there is no underlying /s/, e.g. *la otra* ‘the other (fem.)’ as [laʔo.tɾa], which I call the V#V environment. The combination of 3,701 tokens of V/s/#V realizations and 3,431 tokens for V#V environments leads to the total of 7,132 realizations analyzed in the study.
The research design of the study involved recruiting 36 participants, allowing for 18 men, 18 women, 12 participants from each age group, and 12 participants from each education range as well. Table 3 below shows the even division of subjects recruited for participation in the study.

<table>
<thead>
<tr>
<th></th>
<th>Youngest Age Group (18-29)</th>
<th>Middle Age Group (30-49)</th>
<th>Oldest Age Group (50+)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
</tr>
<tr>
<td>No High School Diploma</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>High School Diploma</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>College Degree</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total Participants in the Study: 36**

Table 3: Breakdown of participants recruited and analyzed by age, gender, and education level.

Previous studies on /s/ lenition have found differences based on gender, age, and education level (see chapter 2), and the literature on glottal stop insertion in Spanish has found differences based on age and education as well (refer to chapter 3). In my study, I recruited an even number of participants from these different social categories to determine the extralinguistic factors’ potential influence on glottal stop realizations in my data.

In order to acquire the desired 36 interviews with an even distribution of gender, age, and education level, 46 interviews were conducted before eliminating the problematic or unnecessary interviews. There were three primary reasons for exclusion: first, the sound quality of three interviews was compromised by heavy rainfall on the tin roofs of the participants’ homes, which introduced a great deal of background noise in the
recordings and inhibited my ability to correctly identify the variants in question. Accordingly, these compromised interviews were excluded from analysis and other participants falling within the same extralinguistic categories were later recruited for the study. Secondly, some participants’ social groups were incorrectly identified by others before the interview. In other words, several participants were initially identified as falling within a certain age range or educational group by close friends or family members, and when those participants were actually interviewed they expressed membership in a different age range or educational group. To avoid an uneven cross-section of the population, additional interviews falling within a certain social group cell beyond those allowed in my research design were excluded from analysis, accounting for five exclusions. One other participant was excluded from analysis when she explained that she considered herself Managuan but was actually born and raised in León, as the introduction of a non-Managüense could lead to confounding variables. Finally, one participant chose to abandon the study prematurely due to health problems.

4.2 Tasks

The 36 participants who were not excluded from analysis based on one of the reasons listed in section 4.1 completed three tasks. In this section, I discuss first the sociolinguistic interview, followed by the reading task, and finally the image identification task.
4.2.1 Sociolinguistic interview

The participants began with a sociolinguistic interview that lasted for approximately 30-45 minutes\textsuperscript{22}, in which topics such as family, work, travel, personal interests, and the social and financial problems within Nicaragua were discussed. Throughout the sociolinguistic interviews, I would introduce a broad topic and then ask more specific, guided questions based on my participants’ responses. I generally started these interviews with a series of questions to elicit personal information, allowing me to find out more about my participants’ occupation, interests, daily life, and hobbies. These series of questions were often based around the broad topics shown in (5).

(5)

1. Work

Example questions:

¿A qué te dedicás? ¿Qué hacés en el trabajo? ¿Qué es lo mejor y lo peor de ese trabajo? ¿Cuáles otros trabajos has tenido y cómo eran? ¿Cuál sería tu profesión ideal?

‘What do you do for a living? What do you do at work? What is the best and worst part of that job? What other jobs have you had? What would your ideal profession be?’

2. Daily activities

Example questions:

¿Cómo es un día normal para vos? ¿Cuáles son las actividades que hacés todos los días?
¿Cómo es el horario durante el fin de semana diferente de la semana? ¿Qué hacés cada fin de semana? ¿Adónde sales? ¿Con quién?

\textsuperscript{22} These interviews occasionally lasted longer, depending on how much the participant wanted to talk.
‘What is a normal day like for you? What are the activities you do every day? How is your schedule different during the weekend than workdays? What do you do every weekend? Where do you go out? With whom?’

3. Hobbies and interests

Example questions:

¿Qué te gusta hacer en tu tiempo libre? ¿Cuáles son tus pasatiempos o pasiones? Explicáme cómo es/son. ¿Por qué te llamó la atención eso?

‘What do you like to do in your free time? What are your hobbies or passions? Tell me what it is/they are like. Why did this catch your attention?’

I would base the next broad topics I asked about on each participant’s responses to these personal questions, trying to ask about the areas of the most interest to each person.

One topic that generated a great deal of debate was the current state of Nicaragua, including its educational system, problems with poverty or corruption, violence, and political intervention to assuage these issues. Sample questions are shown below in (6).

(6) Example questions:

¿Cuáles son los problemas más graves hoy en día de Nicaragua? ¿Aquí en Managua? ¿En las otras zonas del país? ¿Te han afectado personalmente estos problemas? ¿Cómo? ¿Los políticos hacen algo para mejorar la situación? ¿Qué pensás que podemos hacer nosotros para resolver el problema?

‘What are the most serious problems in Nicaragua? Here in Managua? In other areas of the country? Have these problems personally affected you? How? Are politicians doing something to improve the situation? What do you think we can do to resolve the problem?’

In these sociolinguistic interviews, I did my best to direct the conversation toward topics of particular interest to the participant and to make my participants feel comfortable and relaxed in the hopes of obtaining a more casual speaking style.
However, I recognize the inherent level of formality introduced by the presence of a headset with a microphone. For this reason, the first ten minutes of each sociolinguistic interview were excluded from analysis to avoid including more formal or stilted utterances in the analysis. I generally noticed that my participants began to feel more comfortable chatting with me after a few minutes of conversation, as indicated by the decreasing levels of formal sibilance in their speech as the interview progressed.

Accordingly, coding for V/s/#V environments, e.g. *mis amigos* ‘my friends’ and V#V environments, e.g. *la una* ‘one (def.)’, began at the 10 minute mark and continued until 40-50 realizations of V/s/#V and 40-50 realizations of V#V had been coded for each participant23 (see section 4.3 for more information about coding across the tasks). Depending on the duration and content of the sociolinguistic interview, some participants did not fully reach 40 realizations of V/s/#V. If 40 realizations were not reached, all available tokens from the participant within the selected time frame were included in the analysis. The few participants who did not fully reach 40 realizations reached a total number of realizations in the high twenties or thirties; there was only one participant who only reached 23 realizations of word-final intervocalic /s/.

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23 In my coding for the sociolinguistic interview, I wanted to code at least 40 realizations for V/s/#V or V#V environments per participant when possible. If in my coding I later realized that I had included a few additional tokens beyond 40, I kept the additional tokens in the analysis.
4.2.2 Reading task

The second task completed by the participants was a reading task, which involved reading aloud 45 sentences designed by the researcher. While this task was unproblematic for the more educated participants, three participants, all of whom fell into the lowest educational level, were illiterate and unable to provide data for this particular task. Fortunately for this study, while all illiterate participants fell into the lowest education level, each illiterate participant fell into a different age group, ensuring that data were available for each social group in the reading task. In other words, the fact that three participants could not complete the reading task did not leave any blank cells in Table 3 that could pose problems for the statistical analysis\textsuperscript{24}. Table 4 below shows the breakdown of participants based on age, gender, and educational level who were able to complete the reading task.

<table>
<thead>
<tr>
<th></th>
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</tr>
<tr>
<td>College Degree</td>
<td>2</td>
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<td>2</td>
</tr>
</tbody>
</table>

**Total Participants in the Reading Task: 33**

Table 4: Participants, shown by age, gender, and education level, who completed the reading task.

\textsuperscript{24} As chapter 5 shows, gender is never a significant predictor of a variant in any model, meaning the data come from at least three different speakers within a certain age range and educational level.
In this reading task, the participants read 45 sentences\(^{25}\) out loud that targeted two environments. While my pilot study in 2011 only targeted V/s/#V environments, e.g. *vas a ‘you go to’*, an analysis of the pilot study data revealed that while the glottal stop does appear the most with intervocalic /s/ at the word boundary, there were also many tokens of the glottal stop or creaky voice in the reading task between vowels where there was no underlying /s/, e.g. *el científico habló ‘the scientist talked’* as [el.sjen.ti.fi.ko.?a.ʔlo]. In order to explore both of these environments in more detail in the 2012 continuation of my study, my stimuli targeted both environments in the data collected in 2012. That is, after discovering the potential importance of the V#V environment in the reading task, I targeted vowel-vowel environments at the word boundary without underlying /s/, e.g. *la hormiga ‘the ant’*, in addition to environments of intervocalic /s/ at the word boundary, e.g. *los otros ‘the others’*, varying the levels of independent variables throughout the task.

This section first discusses the factors manipulated for the V/s/#V environment, followed by an explanation of the factors manipulated for the V#V environment based on the preliminary results from the pilot study.

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\(^{25}\) In 2011 only 44 sentences were used, but one additional sentence was added to the stimuli in 2012 to more specifically target the vowel-vowel environment at the word boundary where there was no underlying /s/. Some target words were also modified based on participants’ feedback, e.g. I discovered that *aguafiestas extremo ‘serious party-pooper’*, used in my 2011 stimuli, is seldom used in Nicaragua, and this was replaced with *hembras heridas ‘injured females’*, maintaining the same preceding and following vowels, preceding and following stress, and preceding and following word classes. All utterences produced fluidly from my 2011 recordings were included in the analysis even if they were removed in the 2012 stimuli; if the utterance was produced choppily it was excluded from analysis.
4.2.2.1 V/s/#V environments in the reading task

Below, examples of the reading task stimuli targeting the V/s/#V environment are shown across the factors that were expected to potentially be significant. As mentioned above, these expectations were largely based on the significant factors found in previous Spanish /s/ lenition studies and glottal stop insertion studies (refer to chapters 2 and 3).

First, for the V/s/#V environment, preceding vowel, or the vowel directly before word-final /s/, was manipulated in the reading task and included the five Spanish vowels /a/, /e/, /i/, /o/, and /u/\(^{26}\). Preceding vowel variation is shown below in (7) with the targeted /s/ underlined.

(7)  
\begin{itemize}
  \item a. Preceding /a/: \textit{Prefiero las casas entre las montañas.}  
  \begin{flushright}
  ‘I prefer houses between the mountains.
  \end{flushright}
  \item b. Preceding /e/: \textit{Ese día fue un lunes amargo, un lunes educacional.}  
  \begin{flushright}
  ‘That day was a bitter Monday, an educational Monday.’
  \end{flushright}
  \item c. Preceding /i/: \textit{Él escribe esa tesis obscena con un lapicero algunos días y un lápiz otros días.}  
  \begin{flushright}
  ‘He writes that obscene thesis with a pen some days and a pencil other days.’
  \end{flushright}
  \item d. Preceding /o/: \textit{Me molesta esa voz áspera.}  
  \begin{flushright}
  ‘That rough voice bothers me.’
  \end{flushright}
  \item e. Preceding /u/: \textit{El avestruz ordinario corre muchas veces al día.}  
  \begin{flushright}
  ‘The average ostrich runs many times a day.’
  \end{flushright}
\end{itemize}

The same preceding vowel manipulation was not included for V#V environments, as a preliminary analysis of the uncontrolled V#V data in my pilot study showed that preceding vowel was not a significant predictor of glottal stop insertion.

\(^{26}\) One caveat is that the number of stimuli with preceding /i/ and /u/ are limited due to the scarcity of words with final /i/ or /u/ vowels in Spanish, particularly when these vowels are stressed.
Following vowels for V/s/#V environments, or the word-initial vowel directly after the word-final /s/, were also varied in the reading task stimuli, again incorporating /a/, /e/, /i/, /o/, and /u/. Below, (8) illustrates the following vowel variation with the targeted /s/ underlined.

(8) a. Following /a/: *Los aplausos para la hermana son bien merecidos.* ‘The applause for the sister is well deserved.’
   b. Following /e/: *Los enanos cantan bien en el teatro.* ‘The dwarfs sing well in the theater.’
   c. Following /i/: *Los hipotecarios te van a robar.* ‘The mortgages will rob you.’
   d. Following /o/: *Los ogritos no te van a molestar en la isla.* ‘The little ogres will not bother you on the island.’
   e. Following /u/: *Los utensilios están baratos allí pero el alcohol es caro.* ‘The utensils are inexpensive here, but the alcohol is expensive.’

Because preliminary analyses of the pilot study data found following stress to be a statistically significant predictor of glottal stop use, the stress (either stressed or unstressed) of the word-initial vowel directly following the word-final /s/ was controlled for across following vowels. This is briefly illustrated in (9) for the following vowel /e/,

27 Four stimulus sentences with different preceding and following stress were used given each following vowel as illustrated in (9). This allowed for a comparison of following stressed and unstressed syllables when the preceding syllable was unstressed and a comparison of following stressed and unstressed syllables when the preceding syllable was stressed.
(9) a. Following stressed vowel (with preceding stressed vowel):
   \( Vos \ te \ casá\s \) \( este \) \( sá\)\( bado \).
   ‘You get married this Saturday.’

b. Following unstressed vowel (with preceding stressed vowel):
   \( Vos \ te \ casá\s \) \( en \) la \( iglesia \).
   ‘You get married in the church.’

c. Following stressed vowel (with preceding unstressed vowel):
   \( Prefiero \) \( las \) \( casas \) entre las \( montañas \).
   ‘I prefer houses between the mountains.’

d. Following unstressed vowel (with preceding unstressed vowel):
   \( Me \) encantan \( las \) casas enormes de esta ciudad.
   ‘I love this city’s enormous houses.’

As you can see above in (9), preceding stress was also manipulated, allowing for inclusion of both preceding unstressed and preceding stressed vowels.

For V/s/#V environments, word class was manipulated for both the preceding word (the word containing /s/) and the following, vowel-initial word to include adverbs, e.g. antes ‘before’, determiners, e.g. los ‘the’ or muchas ‘many (fem.)’, nouns and pronouns, e.g. hembras ‘females’, prepositions, e.g. en ‘in/on’, verbs (and verbal elements like gerunds or participles), e.g. te casá\( s\) ‘you get married’, conjunctions, e.g. y ‘and’ or o/u ‘or’, and adjectives, e.g. heridas ‘injured (pl. fem.)’. Variations on preceding word class, or the word that contains the word-final /s/, are shown below in (10). It should be noted that no conjunctions or prepositions are available in (10), as these word classes are rare or nonexistent with word-final /s/ in Spanish.
(10) a. Preceding adjective: *Ella siempre lleva los tutús ordinarios en el escenario.*
   ‘She always wears the ordinary tutus on stage.’

b. Preceding adverb: *Antes de ese día era un secreto, pero después el escocés humilde se enteró.*
   ‘Before that day it was a secret, but afterwards the humble Scotsman found out.’

c. Preceding determiner: *Los egos de ellos están bien inflados.*
   ‘Their egos are very inflated.’

d. Preceding noun: *Nos dio un análisis ignorante y fue un análisis inmensamente caro.*
   ‘He/she gave us an ignorant analysis and it was an immensely expensive analysis.’

e. Preceding verb: *Vamos a los Palís u otros supermercados este año.*
   ‘We’re going to the Palís or other supermarkets this year.’

The variations for following word class in V/s/#V environments, following the same criteria as preceding word class, are presented in (11).

(11) a. Following adjective: *Prometen mucho los análisis híbridos del científico.*
   ‘The hybrid analyses of the scientist are very promising.’

b. Following adverb: *El científico habló de sus análisis humildemente.*
   ‘The scientist spoke of his analysis humbly.’

c. Following conjunction: *Vamos a los Palís u otros supermercados este año.*
   ‘We’re going to the Palís or other supermarkets this year.’

d. Following determiner: *Ella lee la historia del avestruz otra vez.*
   ‘She reads the story about the ostrich again.’

e. Following noun: *Los años aquí pasan rápidamente.*
   ‘The birds here have many colors.’

f. Following preposition: *Vos te casás en la iglesia.*
   ‘You get married in the church.’

g. Following verb: *Es que esa tos amenaza la salud.*
   ‘It’s that that cough threatens one’s health.’

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28 This particular sentence was removed from the data in 2012, as some participants were unfamiliar with the word *tutús* ‘tutus’. Fluid productions of this sentence were coded and included in the statistical analyses, while choppy or irregular productions were excluded.
Finally, I accounted for the lexical or plural/verbal nature of /s/ in V/s/#V environments, incorporating lexical /s/, /s/ as a plural marker for nominal elements, and /s/ as a verbal marker into the task, illustrated in (12).

(12)  

a. Lexical /s/:  
Ese día fue un lunes amargo, un lunes educacional.29  
‘That day was a bitter Monday, an educational Monday.’

b. Plural marker:  
Ella no busca animales insomiso para la granja.  
She isn’t looking for disobedient animals for the farm.

c. Verbal marker:  
Parece que vos ya tenés historia con ellos.  
‘It seems that you already have history with them.’

4.2.2.2 V#V environments in the reading task

The discussion above details the factors manipulated for V/s/#V environments to determine which, if any, significantly influence the use of the glottal stop. However, as I was analyzing the data from my pilot, I also discovered some uses of the glottal stop in a V#V environment. In order to investigate this environment in addition to the V/s/#V environment, I amended the reading task to include different factor levels for the V#V environment; these factors are briefly discussed in this section.

As I had already conducted a pilot study with numerous uncontrolled V#V environments in the reading task, I was able to focus on the factors that emerged as significant in this pilot study when developing my controlled stimuli for the V#V

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29 All sentences have at least one target and some sentences have more than one target. Refer to appendix A for all the targets.
environment. This allowed me to limit the number of independent variables in the stimuli expected to influence glottal stop insertion in the V#V environment based on the preliminary results from the pilot study. While the V/s/#V stimuli targeted a wide range of potentially important factors based on previous literature (see chapters 2 and 3), the V#V stimuli, as explained below, specifically controls only for following vowel and following stress, the factors that appeared to condition the glottal stop’s appearance the most for both V/s/#V and V#V environments in the pilot study.

My preliminary analysis suggested the statistical significance of the following environment for glottal stop insertion in V#V environments. Therefore, following vowel and following stress were controlled for in the revised stimuli\(^{30}\), illustrated in (13) below.

\(^{30}\) The preceding vowel was not kept constant in these sentences.
Muchas amas siguen las telenovelas, pero la ama flaca no.
‘Many homemakers follow soap operas, but the skinny homemaker doesn’t.’

Los usos de ese producto son variados,” dijo la artista.
‘The uses of that product are varied,” said the artist.

Los egos de ellos están bien inflados.
‘Their egos are very inflated.’

Antes de ese día era un secreto, pero después el escocés humilde se enteró.
‘Before that day it was a secret, but after the humble Scotsman found out.”

Los ogritos no te van a molestar en la isla.
‘The little ogres won’t bother you on the island.’

Me encantan todas las isletas, pero la isleta grande es la mejor.
‘I love all the islets, but the big islet is the best.’

La osa con la uña larga come la uvita.
‘The bear with the long fingernail eats the little grape.’

Aquí viene otra fila de las hormigas rojas con la hormiga amarilla.
‘Here comes another line of the red ants with the yellow ant.’

La osa con la uña larga come la uvita.
‘The bear with the long fingernail eats the little grape.’

La osa con la uña larga come la uvita.
‘The bear with the long fingernail eats the little grape.’

As preceding vowel and preceding stress were not selected as statistically significant in the results from my pilot study, the V#V stimuli did not control for preceding vowel or

31 In Nicaraguan Spanish, feminine words beginning with a stressed vowel maintain their feminine article, e.g. la agua ‘the water’ instead of el agua or la ama ‘the homemaker’ instead of el ama, as is standard in other dialects of Spanish.
preceding stress. However, I did keep preceding stress constant as a monosyllabic,
unstressed word, e.g. *la* ‘the’, *de* ‘of’, *se* ‘himself/herself’, etc.

Before the participants began the reading task, they were given brief directions. Participants were asked to read each sentence aloud and as fluently as possible. Additionally, in order to achieve the most fluent reading possible, participants were asked to read each sentence two times. This allowed the participants who struggled with the reading task an opportunity to produce the sentence more naturally. If neither the first nor the second reading was fluent, additional readings were requested from the participant until the desired fluidity was achieved. Only one production of each sentence was analyzed for each speaker, and the most fluent production with the fewest hesitations or corrections was selected for analysis. See section 4.3 for more information about the coding procedure.

4.2.3 Image identification task

Finally, the participants completed an image identification task to remove the visual influence of orthographic <$s$> in the reading task. They were presented with ten images that represented animals, objects, or people, and the target words varied in following vowel and following vowel stress. When presented with an image, the participants were asked to identify what they saw in each picture with a quantifier, e.g. *En esta figura observo muchas olas* ‘In this image I see many waves’, *varios ingleses* ‘various Englishmen’, or *las águilas* ‘the eagles’. If the participants’ response deviated
from my anticipated response, I would ask clarification questions to elicit the desired response, e.g. ¿Podrías llamarlo otra cosa? ‘Could you call it something else?’ If the participant failed to include a quantifier in his or her response, I would ask, ¿Y cuántos hay? ‘And how many are there?’ In my own word-final intervocalic /s/ production in this task, I made an attempt to approximate the glottal frication most common for word-final intervocalic /s/ in the Managuan dialect to avoid biasing my respondents’ productions in favor of more formal sibilance.

To illustrate the image identification process in my study, one of the images used is shown below.

![Example image identification stimulus](image)

**Figure 2:** Example image identification stimulus.

When the participants were shown figure 2, they were to respond that they saw los/unos/muchos/varios/tres elefantes ‘the/some/many/various/three elephants.’
As previously mentioned, there were ten images to be identified in total. The anticipated identifications of these images included a quantifier + one of the nouns shown in (14).

(14) 1. ovejas ‘sheep’
2. olas ‘waves’
3. águilas ‘eagles’
4. aguacates ‘avocados’
5. elefantes ‘elefants’
6. equis ‘X’s’
7. utensilios de cocina ‘kitchen utensils’
8. uvas ‘grapes’
9. islas ‘islands’
10. ingleses ‘Englishmen’

Most participants did not struggle with this task, but one male from the lower education group seemed to have the most difficult time producing the desired phrase. I believe his lack of exposure to schooling is associated with his unfamiliarity with the concept of producing a desired response in an unnaturalistic task. However, after much repetition he did complete the image identification task.

4.3 Data analysis

In the analysis of the recorded data, certain exclusionary principles were followed to prevent inappropriate coding. For example, unintelligible utterances or parts of recordings obscured by background noise were always excluded from analysis. Any realizations affected by interruptions in the steam stream, i.e. realizations interrupted by pauses, hesitations or false starts, were also excluded from analysis. Additionally, only
one realization of each sentence in the reading task was coded per participant: the more fluent reading of the sentence was selected for coding, and in the case of equal fluency, the second reading was selected. While fluency was not explicitly measured, selecting the reading with fewest hesitations, restarts, or pauses was not a difficult task. Once the more fluent reading was chosen for analysis, all realizations of V/s/#V and V#V in that sentence were analyzed. Similarly, all realizations of V/s/#V and V#V in the image identification task were analyzed. I coded all realizations instead of simply the target words in the image identification task in order to increase the number of realizations, as both the reading task and sociolinguistic interview included thousands of tokens while the image identification task would only have a few hundred should only the target words be coded. Additionally, the reason for inclusion of the image identification case was to increase the level of formality compared to the sociolinguistic interview and also remove the orthographic <s> found in the more formal reading task. The inclusion of non-target tokens at the same level of formality would not be expected to alter the outcome in any way.

4.3.1 Independent variables

Before discussing the phonetic realizations, I first address the independent variables coded for in the study. I coded each token for the factors expected to influence glottal stop realization based on previous research and my own expectations, shown below in table 5.
<table>
<thead>
<tr>
<th>Category</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Task</td>
<td>Image Identification</td>
</tr>
<tr>
<td></td>
<td>Reading</td>
</tr>
<tr>
<td></td>
<td>Sociolinguistic Interview</td>
</tr>
<tr>
<td>Age</td>
<td>18-29</td>
</tr>
<tr>
<td></td>
<td>30-49</td>
</tr>
<tr>
<td></td>
<td>50+</td>
</tr>
<tr>
<td>Education</td>
<td>Did not finish high school</td>
</tr>
<tr>
<td></td>
<td>High School Degree</td>
</tr>
<tr>
<td></td>
<td>College Degree</td>
</tr>
<tr>
<td>Type of /s/</td>
<td>Verbal Marker</td>
</tr>
<tr>
<td></td>
<td>Plural Marker</td>
</tr>
<tr>
<td></td>
<td>Lexical /s/</td>
</tr>
<tr>
<td>Preceding Word Class</td>
<td>Adverb</td>
</tr>
<tr>
<td></td>
<td>Determiner</td>
</tr>
<tr>
<td></td>
<td>Noun</td>
</tr>
<tr>
<td></td>
<td>Verb</td>
</tr>
<tr>
<td></td>
<td>Adjective</td>
</tr>
<tr>
<td>Following Word Class</td>
<td>Adverb</td>
</tr>
<tr>
<td></td>
<td>Determiner</td>
</tr>
<tr>
<td></td>
<td>Noun</td>
</tr>
<tr>
<td></td>
<td>Preposition</td>
</tr>
<tr>
<td></td>
<td>Verb</td>
</tr>
<tr>
<td></td>
<td>Conjunction</td>
</tr>
<tr>
<td></td>
<td>Adjective</td>
</tr>
<tr>
<td>Preceding Vowel</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>e</td>
</tr>
<tr>
<td></td>
<td>i</td>
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<tr>
<td></td>
<td>o</td>
</tr>
<tr>
<td></td>
<td>u</td>
</tr>
<tr>
<td>Following Vowel</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>e</td>
</tr>
<tr>
<td></td>
<td>i</td>
</tr>
<tr>
<td></td>
<td>o</td>
</tr>
<tr>
<td></td>
<td>u</td>
</tr>
<tr>
<td>Preceding Vowel Stress</td>
<td>Unstressed</td>
</tr>
<tr>
<td></td>
<td>Stressed</td>
</tr>
<tr>
<td>Following Vowel Stress</td>
<td>Unstressed</td>
</tr>
<tr>
<td></td>
<td>Stressed</td>
</tr>
<tr>
<td>Sameness of Preceding and Following Vowel</td>
<td>Same vowel</td>
</tr>
<tr>
<td></td>
<td>Different vowels</td>
</tr>
<tr>
<td>Preceding and Following Word Pairs</td>
<td>Determiner + Noun</td>
</tr>
<tr>
<td></td>
<td>Noun + Adjective</td>
</tr>
<tr>
<td></td>
<td>Verb + X</td>
</tr>
<tr>
<td></td>
<td>Other pairing</td>
</tr>
<tr>
<td>Preceding Word Length (Syllables)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4+</td>
</tr>
</tbody>
</table>

Table 5: Independent variables coded for in my analysis of the data.

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32 Preceding word class refers to the word containing the /s/.

33 Boroff (2007) notes that some languages require sameness of the vowels preceding and following a glottal stop. While this factor has not been discussed at length in studies on Spanish, I coded each token for this factor to determine whether it does, in fact, play a role in the language.
Table 5 shows that the social factors of age (18-29, 30-49, and 50+), gender (male or female), and education (no high school degree, high school degree, and college degree) were predicted to be significant factors influencing glottal stop realization\(^{34}\). Task, also assumed to impact glottal stop use, was divided into the sociolinguistic interview, reading task, and image identification task in the coding process.

Linguistic variables were expected to constrain glottal stop use as well, including the number of syllables in the preceding word (1 through 4+), the lexical or plural/verbal status of the /s/, the preceding and following word class (adverb, determiner, noun, preposition, verb, conjunction, and adjective), pairings of preceding and following word classes (Determiner + Noun, Noun + Adjective, Verb + Any Word Class, and other combinations)\(^{35}\), the preceding and following vowel (/a/, /e/, /i/, /o/, /u/), the sameness of this preceding and following vowel\(^{36}\), and the preceding and following vowel stress (stressed or unstressed). These factors were selected for coding based on their importance in previous studies on /s/ realizations and glottal stop insertion (see chapters 2 and 3), and an analysis of the importance of each factor will be discussed in chapter 5. One realization of the glottal stop in an environment other than V/s/#V and V/#V was coded separately for the same factors and will be discussed in more detail in chapter 6.

\(^{34}\) These social predictors are explored because of their importance in previous studies (see section 2.3.5). The speakers’ neighborhoods were also coded, but there is not enough neighborhood diversity in this preliminary analysis to include the factor here. Speakers’ ages were coded for continuously but binned into the groups of “18-29”, “30-49”, and “50+” for the statistical analysis in chapter 5.

\(^{35}\) See section 5.3.1 for further explanation of the paired word class variable.

\(^{36}\) Refer to section 5.3 for a justification of this partial interaction.
4.3.2 Dependent variable

In addition to coding for independent variables, an acoustic analysis was performed on the recorded data. This acoustic analysis involved analyzing the waveform and spectrogram associated with each potential glottal stop environment in Praat and following predetermined criteria for classification (see the discussion below). Below, I explain the different realizations found in V/s/#V environments and V#V environments and explain how these variants were classified.

For V/s/#V environments, eight different realizations of /s/ occurred in this position, including the glottal stop, creaky voice, deletion, amplitude change, aspiration, sibilance, sibilance + glottal stop and sibilance + creaky voice, all of which are discussed in the following paragraphs. Each token of word-final, intervocalic /s/ was coded for its realization, shown below in table 6.

<table>
<thead>
<tr>
<th>Class</th>
<th>Levels of the Variant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glottal Activity</td>
<td>Glottal stop</td>
</tr>
<tr>
<td></td>
<td>Creaky voice</td>
</tr>
<tr>
<td>Deletion or Near-Deletion</td>
<td>Amplitude change</td>
</tr>
<tr>
<td></td>
<td>Deletion</td>
</tr>
<tr>
<td>Frication</td>
<td>Aspiration (Voiced, occasionally voiceless)</td>
</tr>
<tr>
<td></td>
<td>Sibilant</td>
</tr>
<tr>
<td>Frication + Glottal Activity</td>
<td>Sibilant + Glottal Stop</td>
</tr>
<tr>
<td></td>
<td>Sibilant + Creaky Voice</td>
</tr>
</tbody>
</table>

Table 6: Variants of /s/ in Managua, Nicaraguan Spanish.

Eight variants were identified in the data: glottal frication occurs commonly in the data (voiced and voiceless) as does sibilance. Deletion or near-deletion is also frequent, and this category includes both null realizations and realizations that would be considered
null based on an analysis of the spectrogram but are accompanied by a change in amplitude between the two vowels in the waveform. Glottal activity may also take place, with either full glottal closure or glottal constriction (creaky voice), in which the glottal pulses separate but no period of extended silence can be observed in the spectrogram, which is characteristic of creaky voice (Gordon and Ladefoged 2001: 6). Finally, sibilance followed by a glottal stop and sibilance followed by creaky voice have been noted in the data as well, but these variants were generally found in the formal reading task with the orthographic influence of <s>.

Unlike the V/s/#V environment, where an underlying segment /s/ may be associated with eight different phonetic realizations, there are only three possible realizations for V#V environments: insertion of a glottal stop, insertion of creaky voice, or no insertion. Accordingly, V#V realizations were simply coded for the absence of insertion, insertion of a glottal stop, or insertion of creaky voice. These V#V variants are illustrated alongside the V/s/#V variants for comparison in Table 7 below.

<table>
<thead>
<tr>
<th>Observed V/s/#V Realizations</th>
<th>Observed V#V Realizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Glottal stop</td>
<td>1. Glottal stop</td>
</tr>
<tr>
<td>2. Creaky voice</td>
<td>2. Creaky voice</td>
</tr>
<tr>
<td>3. Amplitude change</td>
<td>3. No insertion</td>
</tr>
<tr>
<td>4. Deletion</td>
<td></td>
</tr>
<tr>
<td>5. Aspiration (Voiced and voiceless)</td>
<td></td>
</tr>
<tr>
<td>6. Sibilant</td>
<td></td>
</tr>
<tr>
<td>7. Sibilant + Glottal Stop</td>
<td></td>
</tr>
<tr>
<td>8. Sibilant + Creaky Voice</td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Variants found in V/s/#V and V#V environments, respectively.
In total, 3,701 tokens of V/s/#V and 3,431 tokens for V#V, yielding a total of 7,132 tokens of the variants within the envelope of variation, were analyzed. In this section, examples of all the variants are provided, and the acoustic criteria for coding these realizations are also detailed here.

First, I provide examples of deletion and near-deletion, the variants that give rise to dispreferred postlexical hiatus. I then show examples of the glottal stop and creaky voice, which I argue is a reduced version of the glottal stop produced in less prominent prosodic positions (see Pierrehumbert and Talkin 1992 for a similar analysis). Next, I present examples of the fricatives, starting with voiced glottal frication followed by sibilance. Finally, I provide examples of sibilance followed by a glottal stop and sibilance followed by creaky voice.

Rather than classifying each realization in a completely impressionistic manner, I opened each token word and determined the proper variant based on acoustic analysis of the spectrogram and waveform in Praat. Conducting an acoustic analysis removes potential researcher bias and decreases potential auditory confusion between similar realizations, resulting in a more objective and more replicable analysis of the tokens. I followed the following coding system for deletion and near deletion: if no interruption to the periodic waveform occurred and no division between the vowels could be established in the spectrogram, the token was coded as deletion. If no division between the vowels could be observed in the spectrogram but a change in amplitude occurred between the vowels in the waveform, the token was coded as near deletion. These variants are shown below in figures 3 and 4.
Figure 3: Speaker WT’s production of *las iras son malas para la salud*\(^{37}\) ‘Wrath is bad for one’s health’.

Figure 3 shows no silence or frication in the spectrogram corresponding to the /s/ of *las* and no interruption to the periodic waveform. The intervocalic /s/ token was therefore counted as deletion.

\(^{37}\) The final /d/ of *salud* ‘health’ is deleted.
Figure 4: Close-up of speaker S’s production of near deletion for the /s/ in *muchas islas* ‘many islands’.

The lack of silence or frication in the spectrogram in figure 4 indicates deletion, but the transition between vowels is accompanied by a decrease in amplitude in the waveform. The realization was therefore coded as near deletion. As there are few acoustic differences between deletion and near deletion and the two variants behave similarly in the data, the variants are conflating in the statistical analyses in chapter 5.

Figures 5 and 6 below provide examples of the glottal stop and creaky voice. If a period of silence occurred in the spectrogram corresponding with a flattening of the waveform, indicating a lack of energy, for more than 30 milliseconds (ms) between the vowels, the token was coded as a glottal stop. Irregular glottal pulses were sometimes visible before or after the period of silence, indicating glottal activity and aiding in the variant’s identification. If, on the other hand, the glottal pulses did not cease in the spectrogram and the wave did not fully flatten, but instead the glottal pulses were more
distant from one another and each cycle in the waveform was noticeably separated, the
token was deemed a creaky voice realization. Figures 5 and 6 below illustrate
realizations of the glottal stop and creaky voice, respectively.

![Waveform and spectrogram](image)

Figure 5: Speaker WT’s production of a glottal stop in *Levantan las olas*\(^{39}\) ‘The waves rise up’.

Figure 5 shows a period of silence in the spectrogram and lack of energy in the waveform
corresponding to the glottal closure for the /s/ of *las*, and is classified as a glottal stop
realization.

---

\(^{38}\) 30 ms is actually much shorter than the average duration of a glottal stop realization, but it was selected
as the appropriate duration to help distinguish between a glottal stop and creaky voice. In my observations,
if the separation between two glottal pulses lasted for more than 30 milliseconds, the glottal pulses were not
occurring at regular intervals, which is the criteria I used to operationalize my coding of creaky voice.
When glottal pulses were separated by 30 ms or more, the glottal pulses were not occurring in regular
intervals and could not be classified as creaky voice.

\(^{39}\) The final /n/ of *levantan* ‘they rise’ is deleted.
In figure 6 above the glottal pulses separate but do not cease for a period of 30 milliseconds or more for the intervocalic /s/ realization in casas. The token was consequently coded as a realization of creaky voice.

Figures 3, 5, and 6 also provide an example of the classification used for non-insertion, glottal stop insertion, or creaky voice insertion in the V#V environment, as the same acoustic criteria were required to make the determination. The lack of silence in the spectrogram, lack of separation of the glottal pulses, or lack of energy in the waveform indicated non-insertion in a V#V environment, while a period of silence in the spectrogram and lack of energy in the waveform greater than 30 ms indicated glottal stop insertion. Finally, separation of the glottal pulses without a period of silence in the
spectrogram greater than 30 ms corresponded to the classification of creaky voice insertion.

Figures 7 shows an example of voiced frication, a very common realization in casual speech. If noise could be observed throughout the spectrogram and was accompanied by low amplitude aperiodic energy in the waveform, the token was classified as a case of glottal frication, illustrated in the waveform and spectrogram below.

![Figure 7](image.png)

Figure 7: Speaker GM’s production of [ɾi] for the /s/ of las in Odio las alturas ‘I hate heights’.

Figure 7 above shows noise throughout the spectrogram, indicative of glottal frication. The glottal frication produced for /s/ at the word boundary between vowels was almost exclusively voiced, but it did occasionally appear without voicing. However, word-final
intervocalic voiceless glottal frication was generally only produced when there was hesitation between the two words and was no longer considered as falling within the V/s/#V environment. Therefore, this voiceless glottal frication followed by a pause was not included in the analysis.

The last realizations addressed in this section, [s], [sʔ], and [s] followed by creaky voice, were almost entirely reserved for the reading task, as sibilance represents a highly formal, standard speech style in Nicaraguan Spanish. Examples of these three realizations are shown below in Figures 8, 9, and 10, respectively.

Figure 8: Speaker L’s sibilant production on the /s/ of *Vamos a*… “We go to…”.

In figure 8 the high frequency noise in the spectrogram and the aperiodic wave correspond to the speaker’s production of [s], and the realization was coded as such. This realization was taken from the reading task, where rates of sibilance production were much higher.
The same high frequency noise is visible in figure 9 below, but the sibilant is followed by glottal closure, indicative of [sʔ].

Figure 9: Speaker SH’s production of [sʔ] in *museos altos* ‘tall museums’.

In figure 9 above the period of high frequency noise corresponding to the final /s/ in *museos* is followed by brief silence in the spectrogram. Note that some glottal activity is visible directly after the sibilant, showing glottal closure before the following vowel. Realizations like these were coded as [sʔ].

Finally, a similar realization is shown below in figure 10. A period of high frequency noise in the spectrogram indicates sibilance, and glottal constriction takes place following the sibilance.
Figure 10: Speaker L’s production of sibilance + creaky voice for the word-boundary /s/ of *análisis humildemente* ‘analyses humbly’.

Figure 10 shows part of speaker L’s production of the phrase *El científico habló de sus análisis humildemente* ‘The scientist spoke of his analyses humbly’. After a period of high frequency noise indicative of sibilance, the spectrogram shows the glottal pulses separating in the first half of the /u/ but there is not silence in the spectrogram for a period of 30 milliseconds or more, which is required in my coding for a glottal stop classification. This realization was coded as sibilance followed by creaky voice.
4.4 Conclusion

This chapter has explained the methodology involved in the data design, the collection of the data, and the classification of the variants in the V/s/#V and V#V environments. The following chapter investigates the raw frequencies and distributions of the variants found in the V/s/#V environment as well as the frequencies and distributions of glottal stop insertion, creaky voice insertion, and non-insertion in the V#V environment. After exploring the distribution of the V/s/#V and V#V variants, statistical models are fit to the data, and the most important factors are investigated and discussed.
Chapter 5: Results from the statistical analysis of the data

This chapter presents the results of the statistical analyses conducted to determine what factors condition the occurrence of the glottal stop in Nicaraguan Spanish. In order to explore these factors, several analyses were conducted in the statistical packages R and SPSS on 7,132 fully-coded tokens from the study’s 36 participants, consisting of 3,701 tokens in the V/s/#V environment and 3,431 tokens in the V#V environment. In addition to discussing the analyses that determine the predictors of glottal stop realizations, the other variants occurring in the V/s/#V and V#V environment are also discussed to explain their relationship with the glottal stop in Nicaraguan Spanish. This chapter discusses the raw data and the results of the statistical analyses. Due to the multiple environments that allow for glottal stop insertion, large models are presented across tasks along with smaller, task-specific models for deletion (the variant leading to postlexical hiatus) and the glottal stop, which allows for a comparison among the interview, reading, and image identification tasks.

In this chapter, section 5.1 introduces the descriptive statistics for the V/s/#V environment for the dependent variable (5.1.1) and the independent variables under consideration (5.1.2), including the frequencies and general distribution of the variants,

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40 These numbers reflect the total number of tokens across all types of realizations. The different realizations were later conflated into binomial categories according to the goal of each statistical model.
along with an explanation of the changes in frequency each variant undergoes based on task. Section 5.2 discusses the descriptive statistics for the V#V environment for both the dependent variable (5.2.1) and the relevant independent variables (5.2.2). After the introduction of the descriptive statistics, sections 5.3-5.8 present and discuss the statistical models that best fits the data at hand based on a binomial logistic regression model with mixed effects.

Section 5.3 discusses the glottal stop. First, in section 5.3.1 a binomial mixed-effects logistic regression model is created for the glottal stop in the V/s/#V environment to determine the factors that are predictive of the glottal stop with an underlying /s/. The model presented in section 5.3.1 is across all tasks in the V/s/#V environment, and sections 5.3.1.1-5.3.1.3 discuss models for the glottal stop fitted only to one particular task: the sociolinguistic interview, the reading task, and the image identification task, respectively. These task-specific models were created to avoid unwanted aggregation of the tokens across different tasks and levels of formality (see section 5.3.1.1 for a discussion). In section 5.3.2, the same statistical approach is applied for the glottal stop in the V#V environment, allowing for a comparison between [ʔ] production with and without an underlying /s/. Due to the low number of glottal stop realizations in the V#V environment, the glottal stop in the V#V environment could not be analyzed by individual task.

In section 5.4 the factors influencing creaky voice realizations are investigated, beginning with the V/s/#V environments (5.4.1) and followed by the V#V environment (5.4.2). Section 5.5 discusses the factors influencing deletion, beginning with deletion in
the V/s/#V environment (5.5.1), followed by task-specific models for V/s/#V deletion in the sociolinguistic interview, reading task, and image identification task, respectively, in sections 5.5.1.1-5.5.1.3. This section concludes with a discussion of non-insertion in the V#V environment (5.5.2). The factors conditioning aspiration are explained in 5.6, the significant predictors of sibilance are introduced in 5.7, and 5.8 addresses the most important factors for predicting sibilance followed by glottal constriction: 5.8.1 deals with sibilance followed by a glottal stop, and 5.8.2 discusses sibilance followed by creaky voice. Sections 5.6-5.8 only discuss the V/s/#V environment, as this is the only place where these variants occur. Section 5.9 provides a conclusion to the chapter.

5.1. Descriptive Statistics for the V/s/#V Environment

The first section of this chapter presents the raw counts and percentages of each dependent and independent variable in the data. First, in 5.1.1 the frequencies of all the dependent variable’s levels in the V/s/#V environment are presented, followed by frequency tables for all the independent variables in the V/s/#V environments in 5.1.2.
5.1.1 Descriptive statistics for the dependent variable in the V/s/#V environment

Table 8 presents the raw frequencies and percentages of the different variants that occur in the V/s/#V environment, including the glottal stop, creaky voice, amplitude change, deletion, aspiration, sibilance, sibilant followed by glottal stop, and sibilant followed by creaky voice. See chapter 4 for more detailed descriptions of each realization.

<table>
<thead>
<tr>
<th>Dependent Variable (Across All Tasks)</th>
<th>Glottal Constriction</th>
<th>Deletion (or Near Deletion)</th>
<th>Frication (Glottal)</th>
<th>Frication + Glottal Constriction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Glottal Stop</td>
<td>Amplitude Change</td>
<td>Aspiration</td>
<td>Sibilant + Glottal Stop</td>
</tr>
<tr>
<td></td>
<td>Creaky Voice</td>
<td>Deletion</td>
<td></td>
<td>Sibilant + Creaky Voice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>347</td>
<td>85</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>211</td>
<td>710</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.4%</td>
<td>2.3%</td>
<td>13.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8: Realizations (including N and percentages) of the dependent variable in V/s/#V environments.

As shown in table 8, glottal stops account for a total of 9.4% (N=347) of the tokens, and creaky voice realizations account for 5.7% (N=211) of the data, meaning 15.1% of the tokens were realized with some closure of the glottis. A decrease in amplitude between vowels accounts for 2.3% (N=85) of the tokens, and deletion is found in 19.2% of the tokens (N=932): therefore, deletion or an amplitude change (considered a subcategory of deletion) occurs in 21.5% of the data overall. Glottal aspiration is found in 25.2% of the data (N=932) and sibilance in 21.1% (N=782). Finally, sibilance followed by a glottal stop accounts for 13.5% (N=500) and sibilance followed by creaky voice accounts for 3.6% (N=134) of the data.
In table 8 above I constructed broad categories for the variants based on their production and perception. For example, the glottal stop and creaky voice fall under the category of glottal constriction as some degree of glottal closure is involved for both. Deletion and amplitude change fall under the broad category of deletion/near deletion, as both variants are perceptually elided and acoustically very similar. Finally, both sibilance followed by a glottal stop and sibilance followed by creaky voice fall under the broader category of sibilance followed by glottal constriction because both realizations involve oral frication followed by some degree of glottal closure. These broad categories are intended to help illustrate the similarities in production and perception of these variants.

However, I would like to point out that the variants placed within a certain broad category do not necessarily behave the same way in the data. When two variants within the same broad category seem to behave differently and are predicted by different factors in the models, I contend that the two should not be analyzed together as one dependent variable in the following models. For this reason, the variants that behave differently, even if they are similar in production or perception, were analyzed as separate binary dependent variables. Because of their divergent behavior, the glottal stop and creaky voice, although produced similarly, were separated as two different dependent variables in the following models. The same separation was done for sibilance followed by the glottal stop and sibilance followed by creaky voice: because of their different linguistic behavior, the two were analyzed as different dependent variables. However, deletion and amplitude change behave quite similarly in the data, and are therefore conflated.
throughout the rest of this dissertation. In the models fitted to the data in this chapter and
in the discussion in chapter 6, “deletion” refers to both deletion and amplitude change.

Table 8 above provided a broad overview of the distribution of the variants, but it
should be kept in mind that task heavily dictated the realization of some of the variants.
Table 9 below shows the distribution of /s/ variants based on task.

<table>
<thead>
<tr>
<th>Phonetic Realization</th>
<th>Sociolinguistic Interview</th>
<th>Image Identification</th>
<th>Reading Task</th>
<th>Total N across tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% in task : N</td>
<td>% in task : N</td>
<td>% in task : N</td>
<td></td>
</tr>
<tr>
<td>Glottal Stop</td>
<td>4.5% : 73</td>
<td>16.6% : 72</td>
<td>12.4% : 202</td>
<td>347</td>
</tr>
<tr>
<td>Creaky Voice</td>
<td>4.9% : 81</td>
<td>6.2% : 27</td>
<td>6.3% : 103</td>
<td>211</td>
</tr>
<tr>
<td>Deletion</td>
<td>31.5% : 515</td>
<td>13.9% : 60</td>
<td>8.3% : 135</td>
<td>710</td>
</tr>
<tr>
<td>Amplit. Change</td>
<td>4% : 66</td>
<td>1.4% : 6</td>
<td>0.8% : 13</td>
<td>85</td>
</tr>
<tr>
<td>Aspiration</td>
<td>44.9% : 734</td>
<td>16.6% : 72</td>
<td>7.7% : 126</td>
<td>932</td>
</tr>
<tr>
<td>Sibilance</td>
<td>9.8% : 161</td>
<td>25.4% : 110</td>
<td>31.3% : 511</td>
<td>782</td>
</tr>
<tr>
<td>Sib + Glottal Stop</td>
<td>0.2% : 3</td>
<td>15.7% : 68</td>
<td>26.3% : 429</td>
<td>500</td>
</tr>
<tr>
<td>Sib + CV</td>
<td>0.2% : 4</td>
<td>4.2% : 18</td>
<td>6.9% : 112</td>
<td>134</td>
</tr>
<tr>
<td>Total realizations for each task</td>
<td>100% : 1,637</td>
<td>100% : 433</td>
<td>100% : 1,631</td>
<td>3701</td>
</tr>
</tbody>
</table>

Table 9: Frequency breakdown of the realizations in the V/s/#V environment based on task.

As shown by table 9, the tasks greatly affected the production of the variants. For
example, aspiration, deletion, and a decrease in amplitude between adjacent vowels
account for over 80% of the realizations in the sociolinguistic interview, but these three
variants account for under 40% of the realizations in the image identification task and
less than 20% in the reading task. In other words, in more formal tasks, speakers opt to
use aspiration and deletion less than in casual speech.

On the other end of the spectrum, sibilance followed by a glottal stop, sibilance
followed by creaky voice, and sibilance alone accounted for nearly 65% of the data in the
reading task. However, the use of these sibilant variants drops to approximately 10% in the sociolinguistic interview task. The use of glottal stop and creaky voice is the lowest in the casual sociolinguistic interview, but the use of these variants does not increase as much as the sibilant variants with increased formality. The use of creaky voice only increases from 4.9% to 6.3% from the least formal to most formal tasks, and instead of gradually increasing or decreasing from the least to most formal tasks, the use of the glottal stop is actually highest in the image identification task (16.6%).

Table 10 shows the task-specific frequencies and counts of table 9 with the percent difference across tasks. The % Difference Across Tasks column shows the positive or negative change associated with each variant by task, comparing the rates for the informal sociolinguistic interview task to the more formal reading task (or image identification task in the case of the glottal stop). In other words, a positive % Difference Across Tasks indicates that use of the variant increases with an increase in formality, and a negative number indicates a decrease in variant usage as formality increases.

<table>
<thead>
<tr>
<th>Phonetic Realization</th>
<th>% Difference Across Tasks</th>
<th>Sociolinguistic Interview %</th>
<th>Image Identification %</th>
<th>Reading %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspiration</td>
<td>-37.2%</td>
<td>44.9% (734)</td>
<td>16.6% (72)</td>
<td>7.7% (126)</td>
</tr>
<tr>
<td>Deletion</td>
<td>-26.4%</td>
<td>35.5% (581)</td>
<td>15.3% (66)</td>
<td>9.1% (148)</td>
</tr>
<tr>
<td>Sibilance + Glottal Stop</td>
<td>+26.1%</td>
<td>0.2% (3)</td>
<td>15.7% (68)</td>
<td>26.3% (429)</td>
</tr>
<tr>
<td>Sibilance</td>
<td>+21.5%</td>
<td>9.8% (161)</td>
<td>25.4% (110)</td>
<td>31.3% (511)</td>
</tr>
<tr>
<td>Glottal Stop</td>
<td>+12.1%</td>
<td>4.5% (73)</td>
<td>16.6% (72)</td>
<td>12.4% (202)</td>
</tr>
<tr>
<td>Sibilance + Creaky Voice</td>
<td>+6.7%</td>
<td>0.2% (4)</td>
<td>4.2% (18)</td>
<td>6.9% (112)</td>
</tr>
<tr>
<td>Creaky Voice</td>
<td>+1.4%</td>
<td>4.9% (81)</td>
<td>6.2% (27)</td>
<td>6.3% (103)</td>
</tr>
</tbody>
</table>

Table 10: Differences across tasks, listed from greatest difference to smallest.

Even without any perceptual measures, e.g. matched-guise tests or participant observations, tables 9 and 10 still provide some insight into the perceived formality or
prescriptive “correctness” of a sibilant realization, rarely found in less formal tasks, based on the higher degree with which these variants are used in formal tasks. Similarly, the tables indicate that some realizations are dispreferred in formal speech, particularly deletion and aspiration. While the use of the glottal stop and creaky voice increase in more formal tasks, their percent change is smaller than the other major variants. This suggests that realizations with glottal constriction may not be as imbued with prescriptive associations, like sibilant variants, on the one hand, or associations with very casual speech, like [h] and ø, on the other, an idea that will be explored in section 6.6.

5.1.2 Descriptive statistics for the independent variables in the V/s/#V Environment

Table 11 presents a frequency breakdown of the different independent variables showing the raw counts and percentages of the levels within each variable for the V/s/#V environment, with the levels of all the explanatory variables presented below in table 11. Refer to chapter 4 for descriptions of the independent variables.
<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1812</td>
<td>49%</td>
</tr>
<tr>
<td>Male</td>
<td>1889</td>
<td>51%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Task</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Image Identification</td>
<td>433</td>
<td>11.7%</td>
</tr>
<tr>
<td>Reading</td>
<td>1631</td>
<td>44.1%</td>
</tr>
<tr>
<td>Sociolinguistic interview</td>
<td>1637</td>
<td>44.2%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>1240</td>
<td>33.5%</td>
</tr>
<tr>
<td>30-49</td>
<td>1210</td>
<td>32.7%</td>
</tr>
<tr>
<td>50+</td>
<td>1251</td>
<td>33.8%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not finish high school</td>
<td>1076</td>
<td>29.1%</td>
</tr>
<tr>
<td>High School Degree</td>
<td>1382</td>
<td>37.2%</td>
</tr>
<tr>
<td>College Degree</td>
<td>1343</td>
<td>36.6%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Type of /s/</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Marker</td>
<td>671</td>
<td>18.1%</td>
</tr>
<tr>
<td>Pausal Marker</td>
<td>2234</td>
<td>60.4%</td>
</tr>
<tr>
<td>Lexical /s/</td>
<td>796</td>
<td>21.5%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Preceding Word Class</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adverb</td>
<td>280</td>
<td>7.6%</td>
</tr>
<tr>
<td>Determiner</td>
<td>1374</td>
<td>37.1%</td>
</tr>
<tr>
<td>Noun</td>
<td>1380</td>
<td>37.1%</td>
</tr>
<tr>
<td>Verb</td>
<td>671</td>
<td>18.1%</td>
</tr>
<tr>
<td>Adjective</td>
<td>36</td>
<td>0.9%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Following Word Class</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adverb</td>
<td>263</td>
<td>7.1%</td>
</tr>
<tr>
<td>Determiner</td>
<td>352</td>
<td>9.5%</td>
</tr>
<tr>
<td>Noun</td>
<td>1382</td>
<td>37.2%</td>
</tr>
<tr>
<td>Preposition</td>
<td>447</td>
<td>12.1%</td>
</tr>
<tr>
<td>Verb</td>
<td>671</td>
<td>18.1%</td>
</tr>
<tr>
<td>Adjective</td>
<td>36</td>
<td>0.9%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Paired Word Class</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determiner + Noun</td>
<td>1354</td>
<td>36.6%</td>
</tr>
<tr>
<td>Noun + Adjective</td>
<td>492</td>
<td>13.2%</td>
</tr>
<tr>
<td>Verb + Any Word Class</td>
<td>671</td>
<td>18.1%</td>
</tr>
<tr>
<td>Other Pairings</td>
<td>1185</td>
<td>32%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Preceding Vowel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same Vowel</td>
<td>805</td>
<td>21.8%</td>
</tr>
<tr>
<td>Different Vowels</td>
<td>2896</td>
<td>78.2%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Following Vowel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same Vowel</td>
<td>805</td>
<td>21.8%</td>
</tr>
<tr>
<td>Different Vowels</td>
<td>2896</td>
<td>78.2%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Preceding Stress</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstressed</td>
<td>3060</td>
<td>82.7%</td>
</tr>
<tr>
<td>Stressed</td>
<td>641</td>
<td>17.3%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Following Stress</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstressed</td>
<td>2478</td>
<td>67%</td>
</tr>
<tr>
<td>Stressed</td>
<td>1223</td>
<td>33%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Preceding Word Length (Syllables)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1562</td>
<td>42.2%</td>
</tr>
<tr>
<td>2</td>
<td>1195</td>
<td>32.8%</td>
</tr>
<tr>
<td>3</td>
<td>489</td>
<td>13.2%</td>
</tr>
<tr>
<td>4+</td>
<td>455</td>
<td>12.3%</td>
</tr>
<tr>
<td>Total</td>
<td>3701</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 11: Frequency table of all independent variables by individual level for the V/s/#V environment.
Table 11 illustrates the distribution of the independent variables, showing where the data is not evenly distributed. Information about these distributions will be helpful to the analyses beginning in section 5.3, where I will show that multiple comparisons cannot be conducted on the factor groups with particularly lopsided data.

5.2 Descriptive statistics for the V#V environment

This section illustrates the raw counts and percentages associated with the 3,401 tokens found in the V#V environment. First, I present the figures associated with the dependent variable, which includes non-insertion (as there is no underlying /s/ to delete) and glottal insertion. Following the presentation of the data for the dependent variable, I provide a table illustrating the distribution for all the individual levels of the independent variables as well.

5.2.1 Descriptive statistics for the dependent variable in the V#V environment

Table 12 shows the raw counts and percentages associated with each level of the dependent variable, including the glottal stop, creaky voice, amplitude change, and non-insertion.
Table 12: Realizations (including N and percentages) of the dependent variable in V#V environments.

The most common realization by far in the V#V environment is non-insertion: 96.8% (N=3,320) of realizations fall into the broad deletion category. Full glottal closure only accounts for 0.9% of the data (N=31), and creaky voice, the reduced glottal stop, accounts for 2.3% (N=80) of the data. Compared to table 8, which showed that 9.4% of all realizations in the V/s/#V environment consisted of a full glottal stop and 5.7% of creaky voice, table 12 demonstrates that fewer glottal realizations are produced in the V#V environment.

Due to the dominance of non-insertion and the lower number of glottal stops in the V#V environment, a comparison across tasks is less informative and statistical predictions less reliable. With this caveat in mind, table 13 presents the raw counts and frequencies of the variants appearing in the V#V environment by task. Keep in mind that less variation occurs in this environment: the two broad options include non-insertion of a segment, as there is no underlying segment between vowels at the word boundary, or the insertion of a glottal gesture, be it full glottal closure with the glottal stop or the separation of glottal pulses with creaky voice.
Table 13: Frequency breakdown of the realizations in the V#V environment based on task.

Table 13 indicates that while the number of glottal realizations is lower in the V#V environment than in the V/s/#V environment, a trend is still visible, made more explicit below in table 14, which compares the two broad categories of non-insertion and insertion. Again, a positive % Difference Across Tasks indicates a higher use of the variant as formality increases, while a negative % Difference Across Tasks indicates a decrease of variant use with increased formality.

Table 14: Differences across tasks, listed from greatest difference to smallest.

As illustrated above, non-insertion decreases as formality increases, while insertion of a glottal realization increases as formality increases. In other words, in both the V/s/#V environment and the V#V environment, the tendency to resolve hiatus through glottal insertion increases in more formal settings.
5.2.2 Descriptive statistics for the independent variable in the V#V environment

Table 15 below illustrates the levels of each independent variable in the V#V environment, noting both the raw count within each category and the percentage each level makes up of the factor as a whole.
<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1,662</td>
<td>48.4%</td>
</tr>
<tr>
<td>Male</td>
<td>1,769</td>
<td>51.6%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Task</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Image Identification</td>
<td>628</td>
<td>18.3%</td>
</tr>
<tr>
<td>Reading</td>
<td>1,197</td>
<td>34.9%</td>
</tr>
<tr>
<td>Sociolinguistic</td>
<td>1,666</td>
<td>48.8%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>1,089</td>
<td>31.7%</td>
</tr>
<tr>
<td>30-49</td>
<td>1,101</td>
<td>32.2%</td>
</tr>
<tr>
<td>50+</td>
<td>1,239</td>
<td>36.1%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not finish high school</td>
<td>1,030</td>
<td>29.7%</td>
</tr>
<tr>
<td>High School Degree</td>
<td>1,167</td>
<td>34%</td>
</tr>
<tr>
<td>College Degree</td>
<td>1,244</td>
<td>36.3%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Preceding Word Class</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adverb</td>
<td>428</td>
<td>12.5%</td>
</tr>
<tr>
<td>Determiner</td>
<td>681</td>
<td>19.2%</td>
</tr>
<tr>
<td>Noun</td>
<td>684</td>
<td>19.2%</td>
</tr>
<tr>
<td>Preposition</td>
<td>506</td>
<td>14.7%</td>
</tr>
<tr>
<td>Verb</td>
<td>637</td>
<td>18.6%</td>
</tr>
<tr>
<td>Conjunction</td>
<td>477</td>
<td>13.9%</td>
</tr>
<tr>
<td>Adjective</td>
<td>59</td>
<td>1.7%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Following Word Class</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adverb</td>
<td>189</td>
<td>5.5%</td>
</tr>
<tr>
<td>Determiner</td>
<td>668</td>
<td>19.5%</td>
</tr>
<tr>
<td>Noun</td>
<td>1,103</td>
<td>32.1%</td>
</tr>
<tr>
<td>Preposition</td>
<td>388</td>
<td>11%</td>
</tr>
<tr>
<td>Verb</td>
<td>956</td>
<td>27.7%</td>
</tr>
<tr>
<td>Conjunction</td>
<td>76</td>
<td>2.2%</td>
</tr>
<tr>
<td>Adjective</td>
<td>107</td>
<td>3.1%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Paired Word Class</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determiner + Noun</td>
<td>582</td>
<td>17%</td>
</tr>
<tr>
<td>Noun + Adjective</td>
<td>59</td>
<td>1.7%</td>
</tr>
<tr>
<td>Verb + Any Word Class</td>
<td>637</td>
<td>18.6%</td>
</tr>
<tr>
<td>Other Pairings</td>
<td>1,153</td>
<td>34.1%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Preceding Vowel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>1,113</td>
<td>32.4%</td>
</tr>
<tr>
<td>e</td>
<td>1,240</td>
<td>35.1%</td>
</tr>
<tr>
<td>i</td>
<td>319</td>
<td>9.2%</td>
</tr>
<tr>
<td>o</td>
<td>716</td>
<td>20.6%</td>
</tr>
<tr>
<td>u</td>
<td>43</td>
<td>1.3%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Following Vowel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>913</td>
<td>26.6%</td>
</tr>
<tr>
<td>e</td>
<td>1,056</td>
<td>30.6%</td>
</tr>
<tr>
<td>i</td>
<td>494</td>
<td>14.1%</td>
</tr>
<tr>
<td>o</td>
<td>306</td>
<td>8.9%</td>
</tr>
<tr>
<td>u</td>
<td>395</td>
<td>11.5%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Sameness of Preceding and Following Vowel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same Vowel</td>
<td>913</td>
<td>26.6%</td>
</tr>
<tr>
<td>Different Vowels</td>
<td>2,518</td>
<td>73.4%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Preceding Stress</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstressed</td>
<td>3,104</td>
<td>90.5%</td>
</tr>
<tr>
<td>Stressed</td>
<td>327</td>
<td>9.5%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Following Stress</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstressed</td>
<td>3,082</td>
<td>90.7%</td>
</tr>
<tr>
<td>Stressed</td>
<td>349</td>
<td>10.3%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Preceding Word Length (Syllables)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1,735</td>
<td>50.6%</td>
</tr>
<tr>
<td>2</td>
<td>1,056</td>
<td>30.6%</td>
</tr>
<tr>
<td>3</td>
<td>402</td>
<td>12.2%</td>
</tr>
<tr>
<td>4+</td>
<td>224</td>
<td>6.6%</td>
</tr>
<tr>
<td>Total</td>
<td>3,431</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 15: Frequency table of all independent variables by individual level for the V#V environment.
The factors presented in table 15 are largely the same as those presented in table 11 with one exception: the type of /s/ (lexical, plural, or verbal) is not included in this model, as there is no /s/ in the underlying form for the V#V environment. Again, the lumpiness of the data can be observed in table 15. For example, preceding /u/ accounts for only 1.3% of the preceding vowels, while preceding /a/ and /e/ account for 32.4% and 36.1% of the data, respectively. Very low frequency realizations pose a problem to multiple comparisons in a statistical analysis, as will be addressed in section 5.3.

5.3 The glottal stop

In order to investigate the realizations in more detail, several binomial logistic regression models with mixed effects were fitted to the data. These models were all fit in R using the package lme4 (Bates, Maechler, and Bolker 2012). The packages multcomp (Hothorn, Bretz, and Westfall 2008) and car (Fox and Weisberg 2011) were also used to perform pairwise comparisons and analyses of deviance, respectively.

In this section I first discuss the factors conditioning the glottal stop in the V/s/#V environment (5.3.1) and then discuss the factors conditioning the glottal stop in the V#V environment. In the models fitted to the data in section 5.3 (and in sections 5.4-5.8), I used speaker and word (both preceding and following) as random effects, the independent variables listed in table 5 (including gender, task, age, education level, type of /s/, preceding word class, following word class, paired preceding and following word class, preceding vowel, following vowel, sameness of the preceding and following vowel, sameness of the preceding and following vowel,
preceding stress, following stress, and preceding word length), and the binary dependent variable of glottal stop realization vs. all other realizations. In other words, creaky voice, amplitude change, deletion, aspiration, sibilance, sibilance followed by a glottal stop and sibilance followed by creaky voice were conflated into one category (non-glottal stop) and compared to glottal stop realizations. The same binary dependent variable analysis will be conducted for the other variants in the following sections to determine which factors predict their use.

To explain my use of both preceding and following word as random effects and paired word class as a main effect, I offer the following: the purpose of this model is to capture the true effect of the preceding and following word on glottal stop likelihood, which is captured by the paired word class variable, as well as the random chance of having a glottal stop given the preceding and following word. Including both of these elements makes my model more accurate because I account for both fixed and random effects. The randomness part considers the subtle deviance for each individual word, e.g. *muchos* ‘many’ or *casas* ‘houses’, while the fixed part considers the deviance inside each category for paired word class, e.g. determiner – noun or noun – adjective pairings. If the paired word class is truly significant, the deviance inside each individual category should be much smaller than the deviance across different categories. These randomness and fixed parts do have some overlap, but the random deviance is subtle and the removal of preceding and following word as random effects does not alter the results of the model. For example, the estimate of glottal stop likelihood with a verb followed by any word class (with a reference level of determiner – noun) only changes from -1.825767 to
-1.84857 when the random effect of preceding and following vowel is removed, and the p-value is less than 0.001 in both cases. Other estimates and p-values are minimally affected by their removal as well. Because of this very subtle effect of random deviance, the random factors of preceding and following word are maintained in the models for consistency. Again, their inclusion did not alter the results. See section 5.3.1 for further explanation of the paired word class variable.

My use of the sameness of the preceding and following vowel variable in addition to the variables preceding vowel and following vowel could also be questioned. Why did I not build an interaction into the model between preceding and following vowel instead of including a new variable? By including this variable I actually simplify the full interaction between preceding and following vowel into a two-level variable. Using the full interaction model, there would be 25 levels, and we need to use 24 degrees of freedom to estimate the categories. In the following models I consider both preceding and following vowel for main effects and an incomplete interaction between the two in the sameness of preceding and following vowel. Instead of using 24 degrees of freedom in the full model, I use 9 degrees of freedom for both main effects of preceding and following vowel and the incomplete interaction, which is the sameness of the preceding and following vowel. Given that the required degrees of freedom in the full model is very high and my sample size is limited, it would be costly to consider the full interaction, and my model would be unnecessarily overcomplicated. This reduction of degrees of freedom makes the model more reliable, allowing me to use only motivated variables from previous studies.
Finally, as explained in section 5.1.1, while I have referred to creaky voice as a variant similar to the glottal stop due to its similar production with varying degrees of glottal constriction, I discovered that the glottal stop and creaky voice behave quite differently in the data, as illustrated by sections 5.3 and 5.4. Conflating the realizations neutralized significant predictors of the glottal stop, on the one hand, and creaky voice, on the other, masking some of the independent variables important to one realization or the other. For this reason, the glottal stop and creaky voice are treated as separate binomial dependent variables in the following models. The same separation was applied to sibilance followed by a glottal stop and sibilance followed by creaky voice, as these variants also behave differently in the data. The only variants that were conflated in the following models are deletion and near deletion; these variants do behave very similarly.

5.3.1 Results from the binary logistic regression model for the glottal stop in the V/s/#V environment

This section explains the procedure I used to create the relevant statistical models. Using word (both preceding and following) and speaker as random effects, I began with a

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41 In the model I created combining the glottal stop and creaky voice, only preceding word length (p < 0.001), paired word class (p < 0.001), and following stress (p < 0.001) emerged as significant predictors of glottal constriction. However, in the model constructed using only the glottal stop as the dependent variable, task (p < 0.05) and following vowel (p < 0.05) emerge as significant factors in the model in addition to preceding word length, paired word class, and following stress, as shown in section 5.3.1. In the model fitted only to creaky voice realizations, shown in section 5.4.1, preceding stress emerges as the most predictive factor (p < 0.001), a factor not selected as significant in the model fitted to the glottal stop alone. Significant differences are also found in the model fitted only to creaky voice between the levels of preceding vowel, with /a/ more likely to precede creaky voice than /o/.
saturated model in R, incorporating all the independent variables, and stepped down until only significant factors were included in the model. In other words, I ran the saturated mixed effects model and then hand-selected one factor that did not significantly improve the predictive ability of the model to remove. In this initial model created in R, a treatment contrast was used, comparing one base level of a variable to the other levels. Before removing this independent variable, I releveled the factor to explore all the direct comparisons between its levels. This ensured that no significant differences occurred between the levels of a variable that was to be removed from the model.

When the releveling verified that the levels of the variable were not statistically significant, the variable was removed from the model. However, if any direct comparisons between the levels were significant, the factor was maintained in the model. This procedure was followed until only factors that significantly improved the model as a whole or factors with significant differences between two levels or more remained in the model. I also checked for motivated interactions in each model. If the interaction was significant it was kept in the model. However, if the interaction was not significant it was removed from the model.

For each individual model fitted to the data throughout this chapter, I first present an analysis of deviance table to illustrate the significance of each factor to the model as a whole. Included in these analysis of deviance tables are the factors with significant differences between levels, even if the p-value for the factor as a whole does not reach significance. In other words, each model retains all the independent factors found to be
significant to the model overall as well as all the predictors with at least one significant difference between two levels of the predictor.

In addition to an analysis of deviance table for each model fitted to the data, I also present a multiple comparison of means for the different levels of each independent factor retained in the model. This multiple comparison of means shows the relationships between the levels of the factor and illustrates the effect of each level on the likelihood of the variant in question. It should be noted that the p-value for each level in the multiple comparison of means is higher, or more conservative, than the p-value for each level in the original model with treatment contrasts.\(^4\) Rather than comparing one level of the variable to another, as is the case in the original model, the multiple comparison of means considers more than one test simultaneously. In other words, the multiple comparison of means takes more than one comparison within a factor into account. To guarantee that the overall confidence level is 95% for the test as a whole, the p-values of each level of the factor are adjusted to be more conservative, while the model with treatment contrasts simply compares one level of a factor to another level of that factor, without adjusting the p-value to account for the additional comparisons between other levels of the factor.

Due to these differences in p-values, significant differences between levels in this initial model with treatment contrasts are not always found to be significant in the multiple comparison of means presented in this chapter. With the more conservative p-values in the multiple comparison of means, some comparisons simply approach significance, meaning their p-value is below 0.1 but above 0.05, or barely miss near

\(^4\) In the original model with treatment contrasts I used an alpha value of 0.05 to determine statistical significance.
significance. However, in order to present and discuss all the patterns and tendencies found in the data, all the variables with statistically significant differences between levels in my preliminary model are included in the discussion below, even if these variables only approach statistical significance when multiple comparisons are taken into account. This inclusion allows for a more thorough discussion of the directionality of all the factors predictive of the glottal stop and the other variants falling within the envelope of variation.

In the construction of each model, I investigated covariance and generally found little overlap among the factors. However, an overlap in the data between type of /s/ and preceding word class was quickly identified: when the preceding word class was a verb, the /s/ in question was also a verbal /s/. That is, preceding word class and type of /s/ were confounded because they were actually predicting the same thing. Models were run with each factor separately to determine which better accounted for the data. However, I discovered that incorporating paired word class into the model, or the pairing of certain preceding and following word classes, actually yielded more statistically significant differences among the levels than the type of /s/ or preceding word class factors. These paired word class levels include 1) determiner-noun, e.g. la artista ‘the artist’, 2) noun-adjective, e.g. museos altos ‘tall museums’, 3) verbs + any word class, e.g. volvemos ese... ‘we return that…’, and 4) any other word class pairings, e.g. antes ella... ‘beforehand she…’. Therefore, paired word class was the factor included in the final model, while preceding word class and following word class were excluded. The
important similarity across all these factors is that verbal /s/ (or a preceding verb) is significantly less likely to show glottal stop insertion than other word classes (p < .01).

In order to establish the statistical significance of each factor as a whole within the model, I used the statistical package car (Fox and Weisberg 2011), which allows for a generalization of analysis of variance for generalized linear mixed effects models (GLMM) in an analysis of deviance. In table 16 below, I show the results of the analysis of deviance table using Wald’s Chi-square test for the generalized linear mixed effects model fitted to the glottal stop against all other realizations in the V/s/#V environment across tasks, showing the test statistics’ χ², degrees of freedom, and p-values. A significant p-value (< 0.05) indicates that the factor as a whole significantly improves the model, and the intercept is presented in the table below to give the reader a complete picture of the model. Refer to chapter 6 for a more detailed discussion of all the independent variables that compares expectations based on prior research and the results of the present statistical analyses.
Table 16: Analysis of deviance table for the model fitted to the glottal stop in the V/s/#V environment.

Table 16 shows that following stress, paired word class, preceding word length, following vowel, and task are all significant predictors in the V/s/#V model (p < .05), meaning that these factors significantly affect the realization of the glottal stop. Interestingly, none of the factors selected as significant to this model are social factors. While this table broadly illustrates the factors that are significant predictors in the model, it fails to show a comparison of the individual levels for each significant factor. As previously mentioned, a pairwise test with Tukey’s adjustment on each significant factor does show the differences among levels taking the multiple comparisons conducted into account in the adjusted p-value. Tables 17-21 show the statistically significant differences among the levels in each factor significant to the V/s/#V model across all tasks.

---

43 The p-value (Pr(>Chisq) in the analysis of deviance tables and p-value in the multiple comparison of means tables) is labeled with asterisks to ease interpretation of the results. Three asterisks indicate that the p-value falls between 0 and 0.001, two asterisks indicate that the p-value falls between 0.001 and 0.01, and one asterisk indicates that the p-value falls between 0.01 and 0.05. In other words, one asterisk or more indicates significance. A period indicates that the p-value falls between 0.05 and 0.1, meaning that the factor is approaching significance, and the lack of any symbol indicates that the p-value is above 0.1.
Table 17 below compares the means of following stressed vowels with following unstressed vowels: a positive estimate indicates that the glottal stop is more likely in the environment of the first level presented, while a negative estimate indicates that the glottal stop is more likely in the environment of the second presented level. The table also includes the standard deviation, z-value, and p-value.

<table>
<thead>
<tr>
<th>Stressed V – Unstressed v</th>
<th>Estimate</th>
<th>Std.</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.4703</td>
<td>0.1622</td>
<td>9.065</td>
<td>&lt;2e-16 ***</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Adjusted p-values reported -- single-step method)

Table 17: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for following stress.

As the above table shows, glottal stops are much more likely when there is a following stressed vowel (p <0.001). As models in the following sections will show for each individual task and V#V environments, following stress is a consistently significant predictor of the glottal stop in that a following stressed vowel favors glottal stop production, illustrating this particular factor’s importance regardless of environment or task.

Table 18 presents the multiple comparison of means for paired word class, which involves combinations of preceding and following words that appeared frequently in the data. The categories include word pairings that fall within a syntactic constituent, such as preceding determiner and following noun, e.g. *las olas* ‘the waves’, and preceding noun and following adjective, e.g. *museos altos* ‘tall museums’. The categories also include
word pairings that do not maintain such a close syntactic relationship as determiner-noun and noun-adjective, such as preceding verb followed by any word class, e.g. *volvemos ese... ‘we return this…’* and any other preceding and following word class pairings, e.g. *antes ella... ‘beforehand she…’.*

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb-X – Det.-Noun</td>
<td>-1.8258</td>
<td>0.3656</td>
<td>-4.994</td>
<td>&lt; 0.001 ***</td>
</tr>
<tr>
<td>Other Pairs – Det.-Noun</td>
<td>-1.0584</td>
<td>0.2559</td>
<td>-4.136</td>
<td>&lt; 0.001 ***</td>
</tr>
<tr>
<td>Verb-X – Noun-Adj.</td>
<td>-1.5189</td>
<td>0.4030</td>
<td>-3.770</td>
<td>0.00103 **</td>
</tr>
<tr>
<td>Other Pairs – Noun-Adj.</td>
<td>-0.7516</td>
<td>0.2667</td>
<td>-2.818</td>
<td>0.02359</td>
</tr>
<tr>
<td>Verb-X – Other Pairs</td>
<td>-0.7674</td>
<td>0.3563</td>
<td>-2.154</td>
<td>0.13189</td>
</tr>
<tr>
<td>Noun-Adj. – Det.-Noun</td>
<td>-0.3068</td>
<td>0.2989</td>
<td>-1.026</td>
<td>0.72761</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 1
(Adjusted p-values reported -- single-step method)

Table 18: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for paired word class.

As I had found in prior models using only preceding word class or type of the /s/ instead of paired word class, glottal stop realizations are least likely following verbs. As table 18 shows, glottal stops are much less likely between verbs and any following word than between determiners and nouns (p < 0.001) or between nouns and adjectives (p = 0.00103). Determiner-noun pairs and noun-adjective pairs are both more likely than other word combinations to involve a glottal stop (p < 0.001 and p = 0.02359, respectively). In other words, glottal stop realizations are most likely between determiner-noun pairs and are second most likely between noun-adjective pairs. On the opposite end of the
spectrum, the glottal stop is least likely between preceding verbs and any following word class.

Table 19 presents a multiple comparison of means for the different levels of preceding word length.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+ - 2</td>
<td>0.88018</td>
<td>0.27777</td>
<td>3.169</td>
<td>0.00801 **</td>
</tr>
<tr>
<td>4+ - 1</td>
<td>0.96399</td>
<td>0.31224</td>
<td>3.087</td>
<td>0.01080 *</td>
</tr>
<tr>
<td>4+ - 3</td>
<td>0.83808</td>
<td>0.33132</td>
<td>2.530</td>
<td>0.05357 .</td>
</tr>
<tr>
<td>3 - 1</td>
<td>0.12591</td>
<td>0.32486</td>
<td>0.388</td>
<td>0.97965</td>
</tr>
<tr>
<td>2 - 1</td>
<td>0.08381</td>
<td>0.22152</td>
<td>0.378</td>
<td>0.98102</td>
</tr>
<tr>
<td>3 - 2</td>
<td>0.04210</td>
<td>0.29389</td>
<td>0.143</td>
<td>0.99892</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1  
(Adjusted p-values reported -- single-step method)

Table 19: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for preceding word length.

In table 19, the comparisons between preceding words of 4+ syllables and preceding one-syllable words, on the one hand, and preceding words of 4+ syllables and preceding two-syllable words, on the other, show significant differences between the two (p = 0.0108 and p = .00801, respectively.) In other words, glottal stop realizations are more common following longer words than shorter words.

Table 20 presents a multiple comparison of means based on task, comparing the sociolinguistic interview, reading, and image identification tasks.
As shown in table 20, the sociolinguistic interview is the task in which glottal stop realizations are the least likely. Glottal stops are significantly more likely in the reading task than in the sociolinguistic interview ($p = 0.0273$), and while not statistically significant, the likelihood of a glottal stop is higher in the image identification task than the sociolinguistic interview as well, with the $p$-value approaching significance ($p = 0.091$). In other words, the glottal stop is least likely in the most informal task. In chapter 6, I demonstrate that this is due to the tendency to decrease deletion and aspiration in the more formal reading and image identification tasks (see table 10) while also increasing the use of less socially stigmatized variants and more phonetically salient markers of the underlying segment.

Finally, table 21 provides another multiple comparison of means to illustrate the differences found among the individual vowels following /s/.

---

The percentage of glottal stop use is highest in the image identification task. However, due to the small sample size in the image identification task its predictive ability is lower in these statistical models. The most important difference here is that the glottal stop is least likely in the informal sociolinguistic interview, a point that will be discussed in section 6.1.5.
Table 21: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for following vowel.

Table 21 shows an effect of following /o/: glottal stop is more likely with a following /o/ than with a following /a/ (p = 0.0469). As can be seen from the consistency of the negative estimates in comparisons between /a/ and all other vowels, /a/ is the vowel that is least likely to occur following a glottal stop. Correspondingly, the estimates show that /o/ is the vowel most likely to occur following a glottal stop. Additionally, a comparison between following /o/ and following /i/ approaches statistical significance (p = 0.0948), suggesting that /i/ is somewhat less likely to occur following a glottal stop than /o/ as well. Other potentially significant groupings of the vowels were checked in the model, such as high, low, front, and back vowels as well as combinations based on vowel frequency, but such groupings were not statistically significant.
Section 5.3.1.1 Results from the binary logistic regression model for the glottal stop with mixed effects in the V/s/#V environment in the sociolinguistic interview task

In this chapter I not only construct a model based on all observations, I also construct models based on each task individually. The reason I chose to provide task-specific models is that focusing on a subset of the data set shows subtle changes in the models, particularly when task and age ($p < 0.01$), on the one hand, and task and education ($p < 0.01$), on the other, showed interactions in the full model including all tasks. While neither age nor education were significant on their own in the full model, the interaction suggests that these factors behave differently in different tasks. Looking at the whole data set, the effects of different levels of age or education are aggregated across different tasks, which is why these variables are not significant in the full model. By focusing on one task only, I avoid this undesired aggregation. This gives us the opportunity to detect possible but significant differences between different age groups or education levels within a particular task.

In order to explore the potential differences in the significant factors in the sociolinguistic interview, reading, and image identification task, separate analyses were conducted for each task. Like the model presented for V/s/#V environments across all tasks, the following tables discuss the same binomial logistic regression model with mixed effects using only the data from one particular task. I first present the results for the sociolinguistic interview, the task least likely to lead to glottal stop insertion, as shown above in table 20. In table 22 below, I present the analysis of deviance table based
on the binomial logistic regression model with mixed effects for /s/ realizations exclusively in the sociolinguistic interview task.

| Analysis of Deviance Table (Type III tests) |
|--------------------------------------------|----------------|----------------|
|                                             | Chisq         | Df            | Pr(>Chisq)   |
| Intercept                                  | 45.0897       | 1             | 1.882e-11 ***|
| Following Stress                           | 33.7606       | 1             | 6.233e-09 ***|
| Paired Word Class                          | 14.9033       | 3             | 0.001901 **  |
| Age                                        | 4.7419        | 2             | 0.093392 .   |

Significance codes: 0 '****' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 22: Analysis of deviance table for the model fitted to the glottal stop in the V/s/#V environment in the sociolinguistic interview.

Table 22 illustrates that the significant predictors of glottal stop realization in the V/s/#V environment in the sociolinguistic interview task are paired word class and following stress. Age is included in the analysis above because of its significance between levels in the initial model I created, in which two levels of the variable were directly compared with a treatment contrast. When directly compared, the youngest speakers use the glottal stop in the sociolinguistic interview significantly more than the oldest speakers (p = 0.03035), and the middle age group falls between the two. However, the p-value in the analysis of deviance only approaches significance because this p-value represents the entire variable and not simply the one significant comparison between levels. The comparisons between the middle and older age groups and between the younger and middle age groups are not significant, which results in a p-value of 0.093392.
Table 23 shows the age-based trend described above. I reiterate that the p-value below is more conservative than in the original model as multiple comparisons are taken into account.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older – Young</td>
<td>-1.0947</td>
<td>0.5055</td>
<td>-2.165</td>
<td>0.0769</td>
</tr>
<tr>
<td>Older – Mid</td>
<td>-0.6097</td>
<td>0.5272</td>
<td>-1.157</td>
<td>0.4782</td>
</tr>
<tr>
<td>Mid – Young</td>
<td>-0.4850</td>
<td>0.4521</td>
<td>-1.073</td>
<td>0.5300</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ‘ 1

Table 23: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for age in the sociolinguistic interview.

While the conservative, adjusted p-values in table 23 miss the significant difference between the oldest and youngest speakers, the numbers presented in the estimate verify the directionality of the difference. The negative estimate in the Older-Younger comparison shows that younger speakers are more likely to use glottal stops in the sociolinguistic interview compared to the study’s oldest age group (p = 0.0769), and the negative estimate in the Mid-Young comparison tells us that, while not statistically significant, the younger speakers use glottal stops in the sociolinguistic interview more than the study’s middle age group.

Table 24 shows the results of the multiple comparison of means for following stress, echoing the results already seen for the model across all tasks.
Estimate | Std. Error | z-value | p-value |
--- | --- | --- | --- |
**Stressed V – Unstressed v** | 2.5209 | 0.4339 | 5.81 | 6.23e-09 *** |

Signif. codes: 0 ‘****’ 0.001 ‘***’ 0.01 ‘**’ 0.05 ‘.’ 0.1 ‘ ’ 1  
(Adjusted p-values reported -- single-step method)

Table 24: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for following stress in the sociolinguistic interview.

As previously shown, the glottal stop is significantly more likely with a following stressed vowel (p = 6.23e-09).

Similar to the results presented for the model fitted across all tasks, paired word class emerged as a significant predictor for the sociolinguistic interview task as well, shown below in table 25.

<table>
<thead>
<tr>
<th>Other Pairs – Det.-Noun</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb-X – Det.-Noun</td>
<td>-1.8385</td>
<td>0.6256</td>
<td>-2.939</td>
<td>0.01581 *</td>
</tr>
<tr>
<td>Verb-X – Noun-Adj.</td>
<td>-1.3374</td>
<td>1.0326</td>
<td>-1.295</td>
<td>0.54980</td>
</tr>
<tr>
<td>Other Pairs – Noun-Adj.</td>
<td>-1.1609</td>
<td>0.9455</td>
<td>-1.228</td>
<td>0.59350</td>
</tr>
<tr>
<td>Noun-Adj. – Det.-Noun</td>
<td>-0.5010</td>
<td>0.9733</td>
<td>-0.515</td>
<td>0.95281</td>
</tr>
<tr>
<td>Verb-X – Other Pairs</td>
<td>-0.1765</td>
<td>0.5775</td>
<td>-0.306</td>
<td>0.98943</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘****’ 0.001 ‘***’ 0.01 ‘**’ 0.05 ‘.’ 0.1 ‘ ’ 1  
(Adjusted p-values reported -- single-step method)

Table 25: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for paired word class in the sociolinguistic interview.

When restricted to the sociolinguistic interview, significant differences emerged when determiner-noun pairings were compared with verbs followed by any word class and with any other word pairings (p = 0.00228 and p = 0.01581, respectively). Based on the data,
determiner-noun pairings are the most predictive of the glottal stop, while the glottal stop is again least likely to surface following a verb.

Section 5.3.1.2 Results from the binary logistic regression model with mixed effects in the reading task

The tables presented above in section 5.3.1.1 illustrated the significant factors in the model fitted to the sociolinguistic interview task’s realizations, and we now turn to the reading task. Tables 26-31 introduce and explore the predictive factors for the glottal stop found in the reading task. First, in table 26, I present the results of an analysis of deviance conducted on the best model fitted to the reading task in order to establish the p-values of each factor as a whole.

<table>
<thead>
<tr>
<th>Analysis of Deviance Table (Type III tests)</th>
<th>Chisq</th>
<th>Df</th>
<th>Pr(&gt;Chisq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>33.5955</td>
<td>1</td>
<td>6.785e-09 ***</td>
</tr>
<tr>
<td>Following Stress</td>
<td>30.6140</td>
<td>1</td>
<td>3.148e-08 ***</td>
</tr>
<tr>
<td>Paired Word Class</td>
<td>19.5490</td>
<td>3</td>
<td>0.0002105 ***</td>
</tr>
<tr>
<td>Preceding Word Length</td>
<td>11.9459</td>
<td>3</td>
<td>0.0075706 **</td>
</tr>
<tr>
<td>Education</td>
<td>5.9259</td>
<td>2</td>
<td>0.0516651 .</td>
</tr>
<tr>
<td>Age</td>
<td>5.8681</td>
<td>2</td>
<td>0.0531818 .</td>
</tr>
<tr>
<td>Following Vowel</td>
<td>6.5640</td>
<td>4</td>
<td>0.1607998</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 26: Analysis of deviance table for the model fitted to the glottal stop in the V/s/#V environment in the reading task.
As table 26 shows, following stress, paired word class, and preceding word length are all significant predictors of the glottal stop in the analysis of deviance above. Education and age are both approaching significance; as before, the factors are retained in the model due to statistically significant comparisons between two levels in the original model with treatment contrasts: this original model shows that college-educated participants are less likely to use the glottal stop than participants who only finished high school (p = 0.026402), and older participants are more likely to use glottal stops than younger participants (p = 0.022699). Finally, the glottal stop is more likely with a following /o/ than with a following /a/ in the original model as well (p < 0.05).  

To explore the factors found to be either statistically significant in the model or statistically significant between individual levels of the factor, I present the results of a multiple comparison of means for each of the predictors above. First, a recurring trend is the importance of a following stressed vowel, the directionality of which is illustrated below in table 27.

---

45 Following vowel is included in this analysis of deviance due to its significance in the original model with treatment contrasts. When /o/ is directly compared to /a/ not taking into account the numerous other comparisons between vowels, a statistical difference emerges: glottal stops are more likely with a following /o/ than with a following /a/ (p < 0.05). However, there are too many comparisons and too few tokens for the difference to be statistically significant when the multiple comparisons are taken into account. For this reason, the following vowel difference is maintained in the model and mentioned in the analysis, but it will not be discussed in great detail.
Table 27: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for following stress in the reading task.

This table again shows that the glottal stop is much more likely when followed by a stressed vowel than when followed by an unstressed vowel (p = 3.15e-08). This holds true not only for the reading task, but also for the sociolinguistic interview model and in the model combining all tasks.

The importance of paired word class in the data again emerges for the reading task, and the trend is shown below in table 28.

Table 28: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for paired word class in the reading task.

As previously illustrated, the same broad patterns emerge in the reading task data: determiner-noun pairs, e.g. *las olas* ‘the waves’, are more likely to show a glottal stop
between them than combinations in the other pairs category, e.g. *antes ella...* ‘beforehand she...’ (p = 0.00912) or verbs followed by any word class, e.g. *volvemos a* ‘we return to’ (p = 0.00115). Glottal stops are also more likely between noun-adjective pairs, e.g. *amigos altos* ‘tall friends’, than between verbs and any other word class, e.g. *viaja en* ‘he/she travels in’ (p = 0.01352), but there is no statistical difference between determiner-noun pairings and noun-adjective pairings. As shown in the previous models across tasks and for the sociolinguistic interview, glottal stops are least likely when preceded by a verb.

Similar to the results for the model across all tasks, preceding word length is a predictive factor in the reading task as well. Table 29 below shows the multiple comparison of means results.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+ - 1</td>
<td>1.4841</td>
<td>0.4596</td>
<td>3.229</td>
<td>0.00625 **</td>
</tr>
<tr>
<td>2 - 1</td>
<td>0.8751</td>
<td>0.4192</td>
<td>2.088</td>
<td>0.15027</td>
</tr>
<tr>
<td>4+ - 2</td>
<td>0.6090</td>
<td>0.3114</td>
<td>1.955</td>
<td>0.19678</td>
</tr>
<tr>
<td>4+ - 3</td>
<td>0.8631</td>
<td>0.4566</td>
<td>1.890</td>
<td>0.22320</td>
</tr>
<tr>
<td>3 - 1</td>
<td>0.6209</td>
<td>0.5732</td>
<td>1.083</td>
<td>0.69017</td>
</tr>
<tr>
<td>3 - 2</td>
<td>-0.2542</td>
<td>0.4575</td>
<td>-0.556</td>
<td>0.94261</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’  0.001 ‘**’  0.01 ‘*’  0.05 ‘.’  0.1 ‘ ’ 1

(Adjusted p-values reported -- single-step method)

Table 29: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for preceding word length in the reading task.

As was the case across all tasks, glottal stops are more likely to occur following words consisting of four or more syllables than following monosyllabic words (p = 0.00625).
That is, glottal stops tend to occur following the longest words more often than following the shortest words. The same tendency holds in a comparison between words of four or more syllables and words of two (and three) syllables, but this difference is not statistically significant.

Two social factors also emerged as significant predictors of the glottal stop in the V/s/#V environment, including education and age. The interaction between education and age was tested in the model, but it was not significant. Comparisons between the levels of these factors are shown below in tables 30 and 31.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. Degree – HS Diploma</td>
<td>-1.32310</td>
<td>0.59592</td>
<td>-2.220</td>
<td>0.0678  .</td>
</tr>
<tr>
<td>Univ. Degree – No HS Diploma</td>
<td>-1.27782</td>
<td>0.64286</td>
<td>-1.988</td>
<td>0.1151</td>
</tr>
<tr>
<td>No HS Diploma – HS Diploma</td>
<td>-0.04528</td>
<td>0.61578</td>
<td>-0.074</td>
<td>0.9970</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Adjusted p-values reported -- single-step method)

Table 30: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for education in the reading task.

Interestingly, the biggest difference of note is that the lower education levels use the glottal stop more in the reading task than the college-educated participants. This idea will be explored in more depth in chapter 6: this is actually due to college-educated participants’ tendency to produce [s] for /s/ in formal tasks due to increased access to education and a heightened influence of Standard Spanish, reducing the number of glottal stops produced in their speech.
Table 31 below presents a multiple comparison of means of the study’s three age groups.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std.</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older – Young</td>
<td>1.3951</td>
<td>0.6123</td>
<td>2.278</td>
<td>0.0589</td>
</tr>
<tr>
<td>Older – Mid</td>
<td>1.0820</td>
<td>0.6036</td>
<td>1.793</td>
<td>0.1720</td>
</tr>
<tr>
<td>Mid – Young</td>
<td>0.3131</td>
<td>0.6274</td>
<td>0.499</td>
<td>0.8717</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 1
(Adjusted p-values reported -- single-step method)

Table 31: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for age in the reading task.

The results, while again only approaching significance due to the conservative, adjusted p-value, indicate that older speakers are more likely to use glottal stops in the reading task than younger speakers (p = 0.0589). This age difference is of particular interest: remember that in the sociolinguistic interview task, younger speakers were actually more likely than older speakers to use the glottal stop. While the model fitted to the data across tasks did not select age as a significant predictor, these more specific task-based analyses show that age-based differences are taking place in Managua and that these differences vary across tasks.

Finally, as previously mentioned, the conservative p-value from the numerous comparisons between following vowels leaves the factor above the cutoff of statistical significance, but if we look exclusively at the comparison between /a/ and /o/ in the
original model with treatment contrasts, the difference is statistically significant, with the glottal stop more likely to occur with a following /o/ than a following /a/ (p < 0.05).

Section 5.3.1.3 Results from the binary logistic regression model with mixed effects in the image identification task

Fewer factors emerge as significant predictors of the glottal stop in the model fitted to the image identification task, likely due to the lower number of tokens available in this task. The significant factors are presented below in table 32.

<table>
<thead>
<tr>
<th>Analysis of Deviance Table (Type III tests)</th>
<th>Chisq</th>
<th>Df</th>
<th>Pr(&gt;Chisq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>30.948</td>
<td>1</td>
<td>2.65e-08 ***</td>
</tr>
<tr>
<td><strong>Following Stress</strong></td>
<td>14.459</td>
<td>1</td>
<td>0.0001433 ***</td>
</tr>
<tr>
<td>Education</td>
<td>4.784</td>
<td>2</td>
<td>0.0914460 .</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘****’ 0.001 ‘***’ 0.01 ‘**’ 0.05 ‘*’ 0.1 ‘.’ 1

Table 32: Analysis of deviance table for the model fitted to the glottal stop in the V/s/#V environment in the image identification task.

As shown in table 32, following stress continues to be a significant predictor of glottal stop realizations (p < 0.001) in the image identification task, and education approaches significance (p = 0.091446). If we look at the comparison between the high school and college educated in the original model, the difference is significant, but this difference is
not big enough to make the whole factor statistically significant in the analysis of deviance above.

Table 33 below presents the multiple comparison of means for education to illustrate this difference.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. Degree – HS Diploma</td>
<td>-1.3029</td>
<td>0.6315</td>
<td>-2.063</td>
<td>0.0972</td>
</tr>
<tr>
<td>Univ. Degree – No HS Diploma</td>
<td>-1.1565</td>
<td>0.6364</td>
<td>-1.817</td>
<td>0.1635</td>
</tr>
<tr>
<td>No HS Diploma – HS Diploma</td>
<td>-0.1463</td>
<td>0.5678</td>
<td>-0.258</td>
<td>0.9640</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 33: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for education in the image identification task.

As shown in table 33, those with a university degree are less likely to use the glottal stop in the image identification task than those with a high school diploma, although the p-value only approaches statistical significance. When compared in the original model, the college-educated do use the glottal stop significantly less than those with a high school diploma (p = 0.039097).

Finally, the comparisons between levels of following stress are shown below in table 34.
Like previous models have shown, glottal stops are more likely preceding stressed vowels than preceding unstressed vowels (p < 0.001). Chapter 6 will explore the reasons behind this factor’s perpetual importance across tasks.

Table 34: Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for following stress in the image identification task.

<table>
<thead>
<tr>
<th>Stressed V – Unstressed v</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.6201</td>
<td>0.4261</td>
<td>3.802</td>
<td>0.000143 ***</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)
5.3.2 Results from the binary logistic regression model for the glottal stop in the V#V environment

This section presents the logistic regression model with mixed effects fitted exclusively to the V#V environment, which will enable a comparison between the factors that influence the glottal stop when there is an underlying /s/ and when there is not an underlying /s/. As shown in section 5.2.1, there are fewer full glottal stops in V#V environments than in V/s/#V environments: there were 347 glottal stop realizations in the V/s/#V environment and only 31 glottal stop realizations in the V#V environment, accounting for 9.4% vs. 0.9% of the overall data, respectively. A binomial logistic regression model with mixed effects combining both environments and using the presence or absence of underlying /s/ as a new independent variable shows that the /s/ is a significant predictor of the model: p < 0.001. In other words, glottal stops are much more likely in the V/s/#V environment than in the V#V environment. Furthermore, an interaction between underlying /s/ and task emerges in this model (p < 0.02), motivating the separate analyses.

With only 31 realizations of the glottal stop in the V#V environment, any model fitted to the data will not have a great deal of predictive power. However, in order to

\[46\] The factors selected as significant in the model combining both V/s/#V and V#V environments are largely the same as the model for V/s/#V environments: based on an analysis of deviance using Wald’s Chi-square test for the generalized linear mixed effects model, the significant predictors include preceding word length (p < 0.001), paired word class (p < 0.001), following stress (p < 0.001), and underlying /s/ (p < 0.001). The factors of education and following vowel were included in the model as both are approaching significance, but the p-values are not below 0.05. Again, the similarity between this model fitted to both V/s/#V and V#V environments and the model fitted only to the V/s/#V environment is due to the much higher number of [ʔ] realizations in the V/s/#V environment.
paint a general picture of the factors at work, I present here the best model found for these realizations. Table 35 presents the results of the model fitted to the V#V data.

<table>
<thead>
<tr>
<th></th>
<th>Chisq</th>
<th>Df</th>
<th>Pr(&gt;Chisq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>50.988</td>
<td>1</td>
<td>9.291e-13 ***</td>
</tr>
<tr>
<td>Preceding Word Length</td>
<td>15.289</td>
<td>3</td>
<td>0.001585 **</td>
</tr>
<tr>
<td>Task</td>
<td>10.432</td>
<td>2</td>
<td>0.005429 **</td>
</tr>
</tbody>
</table>

Table 35: Analysis of deviance table for the model fitted to the glottal stop in the V#V environment across all tasks.

As shown in Table 35, preceding word length and task are significant predictors of glottal stop realizations in the V#V environment across tasks. Tables 36 and 37 below present the multiple comparison of means for these factors to illustrate the directionality of the trends.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+ - 1</td>
<td>2.4712</td>
<td>0.6699</td>
<td>3.689</td>
<td>0.00122 **</td>
</tr>
<tr>
<td>4+ - 2</td>
<td>1.8362</td>
<td>0.7486</td>
<td>2.453</td>
<td>0.06720 .</td>
</tr>
<tr>
<td>3 - 1</td>
<td>1.6053</td>
<td>0.7315</td>
<td>2.195</td>
<td>0.12444</td>
</tr>
<tr>
<td>3 - 2</td>
<td>0.9703</td>
<td>0.7766</td>
<td>1.249</td>
<td>0.59455</td>
</tr>
<tr>
<td>4+ - 3</td>
<td>0.8660</td>
<td>0.7392</td>
<td>1.171</td>
<td>0.64428</td>
</tr>
<tr>
<td>2 - 1</td>
<td>0.6350</td>
<td>0.7480</td>
<td>0.849</td>
<td>0.83057</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Affected p-values reported -- single-step method)

Table 36: Tukey HSD Linear Hypotheses of glottal stop in the V#V environment for
preceding word length.

The positive estimates in table 36 above show that the longest words, those of four or
more syllables, are more likely to have a following glottal stop than shorter words of only
one syllable (p < 0.01) in the V#V environment, which was also observed in the V/s/#V
environment. The comparison between words of four or more syllables and words of only
two syllables is approaching significance (p < 0.07), showing the same directionality:

Table 37 below presents the multiple comparison of means for task in the V#V
environment.
The negative estimate in the comparison between the sociolinguistic interview and reading task indicates that the glottal stop is less likely to occur in the sociolinguistic interview task than it is in the reading task. In other words, the glottal stop in the V#V environment is most likely in the reading task.

Unfortunately, there were too few realizations to conduct an analysis by individual task in the V#V environment as was conducted in the V/s/#V environment, but in the combined analysis that I was able to conduct, two trends similar to those occurring in the V/s/#V environment appear: the glottal stop is more likely following longer words than following shorter words, and the glottal stop is more likely in the most formal task than in the least formal task. Table 36 shows that the glottal stop is significantly more likely following the longest words (4+ syllables) than following one-syllable words ($p = 0.00122$), and table 37 illustrates that the glottal stop is significantly more likely in the reading task than in the sociolinguistic interview ($p = 0.0107$).

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std.</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview – Reading</td>
<td>-1.7179</td>
<td>0.5984</td>
<td>-2.871</td>
<td>0.0107 *</td>
</tr>
<tr>
<td>Reading – Image Ident.</td>
<td>1.9646</td>
<td>0.9735</td>
<td>2.018</td>
<td>0.1028</td>
</tr>
<tr>
<td>Interview – Image Ident.</td>
<td>0.2468</td>
<td>1.0372</td>
<td>0.238</td>
<td>0.9683</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 37: Tukey HSD Linear Hypotheses of glottal stop in the V#V environment for task.
5.4 Creaky Voice

In order to establish which factors condition creaky voice realizations, separate models were created following the same parameters used for the glottal stop models, this time with a binomial dependent variable of creaky voice versus all other realizations, e.g. aspiration, deletion, sibilance, etc.\textsuperscript{47} Using the packages lme4 (Bates, Maechler, and Bolker 2012), multcomp (Hothorn, Bretz, and Westfall 2008), and car (Fox and Weisberg 2011), a mixed effects binomial logistic regression model with treatment contrasts was first fitted to the data in the V/s/#V environments in R to determine the significance of direct comparisons between levels of a variable. Then, in order to assess the significance of a factor as a whole to the overall model, an analysis of deviance was conducted, as shown in sections 5.4.1. Factors with significant differences between individual levels within the variable are maintained in the analysis of deviance, even if their overall p-value is not significant, to show the directionality of the differences among levels.

\textsuperscript{47} I recognize that the construction of this model comparing creaky voice to all other variants (including the glottal stop) may mask the similar factors conditioning both creaky voice and the glottal stop, as they are given different values for the dependent variable. In future analyses glottal stop realizations should be removed from the analysis of creaky voice to more accurately determine the factors that predict creaky voice independently of the glottal stop. Refer back to section 5.1 to see an explanation of the model fitted to the data for both the glottal stop and creaky voice, which avoids this issue, as well as my justification for separating the glottal stop from creaky voice in the first place.
5.4.1 Results from the binary logistic regression model for creaky voice in the V/s/#V environment

Table 38 below presents the results of an analysis of deviance showing the significant predictors of creaky voice in the V/s/#V environment across all tasks. Again, the factors with statistical significance between levels of the factor when a direct comparison is conducted with treatment contrasts in R are maintained in the model to illustrate the directionality of the results, even though the more conservative p-value means they miss significance.

<table>
<thead>
<tr>
<th>Analysis of Deviance Table (Type III tests)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Chisq    Df      Pr(&gt;Chisq)</td>
</tr>
<tr>
<td>134.9694  1      &lt; 2.2e-16 ***</td>
</tr>
<tr>
<td>Preceding Stress</td>
</tr>
<tr>
<td>Chisq    Df       Pr(&gt;Chisq)</td>
</tr>
<tr>
<td>12.5528   1       0.0003956 ***</td>
</tr>
<tr>
<td>Preceding Word Length</td>
</tr>
<tr>
<td>Chisq    Df      Pr(&gt;Chisq)</td>
</tr>
<tr>
<td>5.2017    3       0.1576122</td>
</tr>
<tr>
<td>Preceding Vowel</td>
</tr>
<tr>
<td>Chisq    Df      Pr(&gt;Chisq)</td>
</tr>
<tr>
<td>6.1793    4       0.1861517</td>
</tr>
<tr>
<td>Significance codes:  0   ‘<em><strong>’  0.001 ‘</strong>’  0.01 ‘</em>’  0.05 ‘.’  0.1 ‘ ’  1</td>
</tr>
</tbody>
</table>

Table 38: Analysis of deviance table for the model fitted to creaky voice in the V/s/#V environment across all tasks.

Creaky voice realizations appear to be more conditioned by the preceding environment than following environment. As shown above in table 38, preceding stress is the most significant predictor of creaky voice realizations. The multiple comparison of means for preceding stress is shown below in table 39. The negative estimate shows that
creaky voice is significantly more likely following an unstressed vowel than following a stressed vowel.

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.2149</td>
<td>0.3429</td>
<td>-3.543</td>
<td>0.000396 ***</td>
</tr>
</tbody>
</table>

Table 39: Tukey HSD Linear Hypotheses of creaky voice realizations in the V/s/#V environment for preceding stress.

While preceding word length and preceding vowel do not emerge as significant in the above analysis of deviance table due to the low number of tokens across multiple comparisons and more conservative p-value taking these multiple comparisons into account, a direct comparison of the individual levels in the original model constructed in R with treatment contrasts shows a significant difference between /o/ and /a/: creaky voice realizations tend to occur more after a preceding /a/ than after a preceding /o/. This directionality can still be observed in the pairwise comparisons for preceding vowel shown below in table 40.
Table 40: Tukey HSD Linear Hypotheses of creaky voice in the V/s/#V environment for preceding vowel.

Table 41 below also shows the directionality observed for creaky voice realization given preceding word length. The patterns conditioning creaky voice follow the same pattern observed to condition glottal stop realizations, with creaky voice more likely following longer words.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+ - 1</td>
<td>0.58999</td>
<td>0.27902</td>
<td>2.115</td>
<td>0.145</td>
</tr>
<tr>
<td>2 - 1</td>
<td>0.32772</td>
<td>0.20205</td>
<td>1.622</td>
<td>0.361</td>
</tr>
<tr>
<td>3 - 1</td>
<td>0.27664</td>
<td>0.27275</td>
<td>1.014</td>
<td>0.737</td>
</tr>
<tr>
<td>4+ - 3</td>
<td>0.31335</td>
<td>0.31785</td>
<td>0.986</td>
<td>0.753</td>
</tr>
<tr>
<td>4+ - 2</td>
<td>0.26227</td>
<td>0.27183</td>
<td>0.965</td>
<td>0.766</td>
</tr>
<tr>
<td>3 - 2</td>
<td>-0.05108</td>
<td>0.26741</td>
<td>-0.191</td>
<td>0.997</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 .’ 0.1 ‘ ’ 1

(Adjusted p-values reported -- single-step method)

Table 41: Tukey HSD Linear Hypotheses of creaky voice in the V/s/#V environment for preceding word length.

As table 41 shows, creaky voice realizations are more likely following longer words, much like glottal stop realizations. The difference is most noticeable between 4+-syllable words and 1-syllable words, the comparison selected as significant in the direct comparison between levels conducted in the initial R model (p < 0.05).

### 5.4.2 Results from the binary logistic regression model for creaky voice in the V#V environment

In order to investigate creaky voice realizations in the V#V environment, a new, saturated model with treatment contrasts was created in R pairing creaky voice realizations against all other realizations, i.e. glottal stop insertion and non-insertion, in the V#V environment, and factors that did not significantly improve the model were
eliminated. The analysis of deviance results presented below in table 42 show that three factors significantly improve the model.

<table>
<thead>
<tr>
<th>Analysis of Deviance Table (Type III tests)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chisq</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>Task</td>
</tr>
<tr>
<td>Preceding Word Length</td>
</tr>
<tr>
<td>Same Vowel</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 42: Analysis of deviance table for the model fitted to creaky voice in the V#V environment across all tasks.

The three significant factors include task, preceding word length, and the sameness of the preceding and following vowel, all with p-values below .01. The multiple comparison of means below show the comparisons between levels for each factor.

First, the multiple comparison of means for preceding word length is presented below in table 43.
Table 43: Tukey HSD Linear Hypotheses of creaky voice in the V#V environment for preceding word length.

Table 43 above illustrates that creaky voice is more likely to be inserted following longer words in the V#V environment. Words of four or more syllables are significantly more likely to be followed by creaky voice insertion than one-syllable words (p < 0.001) or two-syllable words (p < 0.05) like the glottal stop in this environment.

Unlike what has already been reported for the glottal stop and creaky voice realizations in V/s/#V environments, a new factor emerges as a significant predictor of creaky voice realizations in the V#V environment: the sameness of the preceding and following vowel. Table 44 below provides the multiple comparison of means between same preceding and following vowels and different preceding and following vowels.
Table 44: Tukey HSD Linear Hypotheses of creaky voice in the V#V environment for sameness of preceding and following vowel.

As shown above by the positive estimate, if the vowels preceding and following the word boundary are the same, a creaky voice realization is significantly more likely (p < 0.01).

On the other hand, creaky voice realizations are less likely when the preceding and following vowels are different.

The final predictive factor of creaky voice realizations in the V#V environment is task. The multiple comparison of means for task is shown below.

Table 45: Tukey HSD Linear Hypotheses for creaky voice in the V#V environment based on task.

Based on the negative estimates for the first and second comparison in table 45, we observe that creaky voice realizations are more likely in the more formal tasks of image identification and reading when compared to the more informal sociolinguistic interview.

There is not a significant difference between the formal tasks of reading and image
identification. Unfortunately, the number of creaky voice realizations in the V#V environment when divided by task is too low to conduct a meaningful statistical analysis, so we are unable here to explore the factors conditioning creaky voice realizations in each task.

5.5 Deletion

This dissertation proposes that the creation of hiatus across the word boundary as the result of /s/ lenition in Nicaraguan Spanish leads to glottal stop insertion to resolve the hiatus created in this environment. In order to investigate the relationship between deletion and glottal stop/creaky voice realizations, this section discusses the factors that condition deletion in Nicaraguan Spanish. First, I explore the V/s/#V environment in section 5.5.1, presenting the analysis of deviance tables and multiple comparisons of means to illustrate the phenomena at work, followed by an analysis of non-insertion in the V#V environment in section 5.5.2.

5.5.1 Results from the binary logistic regression model for total deletion in the V/s/#V environment

The analysis of deviance for deletion of /s/ in the V/s/#V environment is presented below in table 46, showing the factors that significantly predict deletion.
Table 46: Analysis of deviance table for the model fitted to deletion in the V/s/#V environment across all tasks.

<table>
<thead>
<tr>
<th></th>
<th>Chisq</th>
<th>Df</th>
<th>Pr(&gt;Chisq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>59.9307</td>
<td>1</td>
<td>9.826e-15 ***</td>
</tr>
<tr>
<td>Task</td>
<td>87.3166</td>
<td>2</td>
<td>&lt; 2.2e-16 ***</td>
</tr>
<tr>
<td>Paired Word Class</td>
<td>28.9009</td>
<td>3</td>
<td>2.349e-06 ***</td>
</tr>
<tr>
<td>Preceding Word Length</td>
<td>19.7861</td>
<td>3</td>
<td>0.0001880 ***</td>
</tr>
<tr>
<td>Following Vowel</td>
<td>20.5447</td>
<td>4</td>
<td>0.0003897 ***</td>
</tr>
<tr>
<td>Following Stress</td>
<td>7.9238</td>
<td>1</td>
<td>0.0048788 **</td>
</tr>
<tr>
<td>Preceding Vowel</td>
<td>14.6604</td>
<td>4</td>
<td>0.0054599 **</td>
</tr>
<tr>
<td>Same Vowel</td>
<td>4.1519</td>
<td>1</td>
<td>0.0415877 *</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

As anticipated, task is a highly significant predictor of deletion. In addition to task, paired word class, preceding word length, following vowel, following stress, preceding vowel, and same vowel are selected as significant predictors of deletion as well. In order to explore the directionality of the conditioning, multiple comparison of means for these factors are presented below.

First, I present the multiple comparison of means for task, shown below in table 47.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview – Reading</td>
<td>1.6480</td>
<td>0.1777</td>
<td>9.274</td>
<td>&lt; 1e-04 ***</td>
</tr>
<tr>
<td>Reading – Image Ident.</td>
<td>-0.8694</td>
<td>0.2612</td>
<td>-3.328</td>
<td>0.00246 **</td>
</tr>
<tr>
<td>Interview – Image Ident.</td>
<td>0.7786</td>
<td>0.2375</td>
<td>3.279</td>
<td>0.00287 **</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Applied p-values reported -- single-step method)

Table 47: Tukey HSD Linear Hypotheses for deletion in the V/s/#V environment based on task.

The estimate of the first comparison shows that deletion is much more likely in the sociolinguistic interview than it is in the reading task. Both the orthographic influence of $<s>$ in the reading task and the increased formality inherent to a reading task likely contribute to this difference. Deletion is also more likely in the image identification task than the reading task, which removes the orthographic influence of $<s>$, but deletion is less likely in the image identification task than in the sociolinguistic interview. Formality and the oral or written nature of the task both seem to influence the rate of deletion. See chapter 6 for further discussion.

Table 48 below shows the multiple comparison of means for paired word class, finding three significant differences between levels of the factor.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb-X – Other Pairs</td>
<td>-0.77979</td>
<td>0.20644</td>
<td>-3.777</td>
<td>&lt; 0.001 ***</td>
</tr>
<tr>
<td>Other Pairs – Det.-Noun</td>
<td>0.92702</td>
<td>0.24889</td>
<td>3.725</td>
<td>0.00104 **</td>
</tr>
<tr>
<td>Other Pairs – Noun-Adj.</td>
<td>0.95855</td>
<td>0.28492</td>
<td>3.364</td>
<td>0.00423 **</td>
</tr>
<tr>
<td>Verb-X – Noun-Adj.</td>
<td>0.17877</td>
<td>0.32140</td>
<td>0.556</td>
<td>0.94250</td>
</tr>
<tr>
<td>Verb-X – Det.-Noun</td>
<td>0.14723</td>
<td>0.29266</td>
<td>0.503</td>
<td>0.95652</td>
</tr>
<tr>
<td>Noun-Adj. – Det.-Noun</td>
<td>-0.03153</td>
<td>0.34011</td>
<td>-0.093</td>
<td>0.99970</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 1
(Adjusted p-values reported -- single-step method)

Table 48: Tukey HSD Linear Hypotheses for deletion in the V/s/#V environment based on paired word class.

As table 48 shows, deletion is most likely between two words that do not share a particularly close syntactic relationship: deletion is more likely for these “other” word pairings than for verb and any following word class pairs, determiner-noun pairs, and noun-determiner pairs (p < 0.01). This effect is the opposite of the glottal stop results.

As shown in previous studies (refer to chapter 2), preceding word length tends to affect deletion rates across dialects of Spanish. Table 49 shows the effect of preceding word length in Nicaraguan Spanish.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 1</td>
<td>0.98986</td>
<td>0.25226</td>
<td>3.924</td>
<td>&lt; 0.001 ***</td>
</tr>
<tr>
<td>4+ - 1</td>
<td>0.92873</td>
<td>0.27251</td>
<td>3.408</td>
<td>0.00366 **</td>
</tr>
<tr>
<td>3 - 2</td>
<td>0.59508</td>
<td>0.20240</td>
<td>2.940</td>
<td>0.01674 *</td>
</tr>
<tr>
<td>4+ - 2</td>
<td>0.53395</td>
<td>0.22668</td>
<td>2.356</td>
<td>0.08444 .</td>
</tr>
<tr>
<td>2 - 1</td>
<td>0.39478</td>
<td>0.22797</td>
<td>1.732</td>
<td>0.30387</td>
</tr>
<tr>
<td>4+ - 3</td>
<td>-0.06112</td>
<td>0.23507</td>
<td>-0.260</td>
<td>0.99375</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 49: Tukey HSD Linear Hypotheses for deletion in the V/s/#V environment based on preceding word length.

The same effect appears in Nicaraguan Spanish: deletion is significantly more likely at the end of words consisting of three, four, or more syllables than shorter words consisting of only one or two syllables.

Table 50 below presents the multiple comparison of means for following vowel, showing the significant comparisons between levels of the factor.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>e - a</td>
<td>0.79941</td>
<td>0.19806</td>
<td>4.036</td>
<td>&lt; 0.001 ***</td>
</tr>
<tr>
<td>i - e</td>
<td>-0.87122</td>
<td>0.26505</td>
<td>-3.287</td>
<td>0.00861 **</td>
</tr>
<tr>
<td>o - e</td>
<td>-0.66954</td>
<td>0.28009</td>
<td>-2.390</td>
<td>0.11379</td>
</tr>
<tr>
<td>u - e</td>
<td>-0.52339</td>
<td>0.28384</td>
<td>-1.844</td>
<td>0.34021</td>
</tr>
<tr>
<td>u - a</td>
<td>0.27602</td>
<td>0.28685</td>
<td>0.962</td>
<td>0.86815</td>
</tr>
<tr>
<td>u - i</td>
<td>0.34783</td>
<td>0.32419</td>
<td>1.073</td>
<td>0.81548</td>
</tr>
<tr>
<td>o - i</td>
<td>0.20168</td>
<td>0.32349</td>
<td>0.623</td>
<td>0.97034</td>
</tr>
<tr>
<td>o - a</td>
<td>0.12987</td>
<td>0.28216</td>
<td>0.460</td>
<td>0.99043</td>
</tr>
<tr>
<td>u - o</td>
<td>0.14615</td>
<td>0.34360</td>
<td>0.425</td>
<td>0.99292</td>
</tr>
<tr>
<td>i - a</td>
<td>-0.07181</td>
<td>0.26616</td>
<td>-0.270</td>
<td>0.99879</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 50: Tukey HSD Linear Hypotheses for deletion in the V/s/#V environment based on following vowel.

The above table shows that deletion is significantly more likely with a following /e/ than with a following /a/ or /i/ (p < 0.01). While not significant, there is also a directionality towards greater deletion with a following /e/ than with a following /o/.

Following stress is also a significant predictor of deletion, and table 51 below illustrates the multiple comparison of means for the variable.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stressed V – Unstressed v</td>
<td>-0.4793</td>
<td>0.1703</td>
<td>-2.815</td>
<td>0.00488 **</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 51: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment based on following stress.
Contrary to the results shown for the glottal stop variant in the V/s/#V environment, which showed that a glottal stop is more likely with a following stressed vowel, table 51 shows the opposite: deletion is more likely with a following unstressed vowel (p < 0.01).

In addition to following vowel, illustrated in table 50, preceding vowel was also selected as a significant predictor of deletion, shown below in table 52.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>o - a</td>
<td>0.63662</td>
<td>0.20767</td>
<td>3.066</td>
<td>0.0154 *</td>
</tr>
<tr>
<td>o - e</td>
<td>0.55019</td>
<td>0.20076</td>
<td>2.741</td>
<td>0.0407 *</td>
</tr>
<tr>
<td>i - a</td>
<td>0.70451</td>
<td>0.39715</td>
<td>1.774</td>
<td>0.3571</td>
</tr>
<tr>
<td>i - e</td>
<td>0.61808</td>
<td>0.39244</td>
<td>1.575</td>
<td>0.4808</td>
</tr>
<tr>
<td>u - o</td>
<td>-0.92020</td>
<td>0.61505</td>
<td>-1.496</td>
<td>0.5329</td>
</tr>
<tr>
<td>u - i</td>
<td>-0.98810</td>
<td>0.68862</td>
<td>-1.435</td>
<td>0.5739</td>
</tr>
<tr>
<td>u - a</td>
<td>-0.28359</td>
<td>0.62466</td>
<td>-0.454</td>
<td>0.9899</td>
</tr>
<tr>
<td>u - e</td>
<td>-0.37001</td>
<td>0.62353</td>
<td>-0.593</td>
<td>0.9727</td>
</tr>
<tr>
<td>e - a</td>
<td>0.08643</td>
<td>0.21726</td>
<td>0.398</td>
<td>0.9939</td>
</tr>
<tr>
<td>o - i</td>
<td>-0.06789</td>
<td>0.39334</td>
<td>-0.173</td>
<td>0.9998</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 52: Tukey HSD Linear Hypotheses for deletion in the V/s/#V environment based on preceding vowel.

Based on the positive estimate for the first two comparisons, the multiple comparison of means for preceding vowel shows that preceding /o/ is more likely to be followed by deletion than preceding /a/ or preceding /e/ (p < 0.05).

Finally, including the ‘same vowel’ factor significantly improves the model as well, shown below in table 53.
Table 53: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment for sameness of preceding and following vowel.

<table>
<thead>
<tr>
<th>Same Vowels – Different Vowels</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.3441</td>
<td>0.1689</td>
<td>-2.038</td>
<td>0.0416 *</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Table 53 indicates that deletion is more likely if there are different preceding and following vowels (p < 0.05). In other words, if the same vowel precedes and follows the /s/ before the word boundary, e.g. las amigas ‘the female friends’, one of the variants other than deletion is more likely than if the vowels are different, e.g. los amigos ‘the male friends’.

5.5.1.1 Results from the binary logistic regression model for deletion in the V/s/#V environment in the sociolinguistic interview task

As shown above in table 47, task itself is a significant predictor of deletion, and table 10 showed that there is a large decrease in deletion use as the formality of tasks increases. I have also hypothesized that where higher rates of deletion occur, a higher rate of glottal stop will be used to resolve the postlexical hiatus created by this /s/ deletion. For this reason, it is important to analyze the factors that condition deletion in each task to conduct a thorough comparison between deletion and glottal stop use. In order to
investigate the different ways the independent variables influence deletion in each task, three smaller models were fitted to the data corresponding to the sociolinguistic interview, the reading task, and the image identification task. This section provides the results of the model fitted to the sociolinguistic interview. Table 54 below presents the analysis of deviance table with the factors that significantly improve the model for deletion.

<table>
<thead>
<tr>
<th></th>
<th>Chisq</th>
<th>Df</th>
<th>Pr(&gt;Chisq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>37.413</td>
<td>1</td>
<td>9.558e-10  ***</td>
</tr>
<tr>
<td>Paired Word Class</td>
<td>22.504</td>
<td>3</td>
<td>5.123e-05  ***</td>
</tr>
<tr>
<td>Following Vowel</td>
<td>25.373</td>
<td>4</td>
<td>4.231e-05  ***</td>
</tr>
<tr>
<td>Preceding Word Length</td>
<td>24.824</td>
<td>3</td>
<td>1.680e-05  ***</td>
</tr>
<tr>
<td>Preceding Vowel</td>
<td>9.896</td>
<td>4</td>
<td>0.04221    *</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘’ 1  

Table 54: Analysis of deviance table for the model fitted to deletion in the V/s/#V environment in the sociolinguistic interview.

As shown above, the factors of paired word class, following vowel, preceding word length, and preceding vowel are significant predictors for deletion in the sociolinguistic interview. Multiple comparison of means are presented for each factor below.

Table 55 below shows the multiple comparison of means for paired word class in the sociolinguistic interview with comparisons between all the levels of the factor.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Pairs – Det.-Noun</td>
<td>1.12480</td>
<td>0.29155</td>
<td>3.858</td>
<td>&lt;0.001 ***</td>
</tr>
<tr>
<td>Verb-X – Other Pairs</td>
<td>-0.63817</td>
<td>0.24155</td>
<td>-2.642</td>
<td>0.038 *</td>
</tr>
<tr>
<td>Other Pairs – Noun-Adj.</td>
<td>1.09849</td>
<td>0.43132</td>
<td>2.547</td>
<td>0.0487 *</td>
</tr>
<tr>
<td>Verb-X – Det.-Noun</td>
<td>0.48663</td>
<td>0.34495</td>
<td>1.411</td>
<td>0.4747</td>
</tr>
<tr>
<td>Verb-X – Noun-Adj.</td>
<td>0.46032</td>
<td>0.45193</td>
<td>1.019</td>
<td>0.7251</td>
</tr>
<tr>
<td>Noun-Adj. – Det.-Noun</td>
<td>0.02631</td>
<td>0.49985</td>
<td>0.053</td>
<td>0.9999</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 1
(Adjusted p-values reported -- single-step method)

Table 55: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment for paired word class in the sociolinguistic interview task.

The multiple comparison of means above shows that other word pairings are significantly more likely to have deletion of /s/ between them than determiner-noun pairings (p < 0.001), verbs followed by any word class (p = 0.038), and noun-adjective pairings (p = 0.0487). These findings parallel the results across tasks discussed in section 5.5.1.

Table 56 below provides the multiple comparison of means for following vowel in the sociolinguistic interview task.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>e - a</td>
<td>0.7525330</td>
<td>0.1781279</td>
<td>4.225</td>
<td>&lt;0.001 ***</td>
</tr>
<tr>
<td>i - e</td>
<td>-1.0345224</td>
<td>0.2537053</td>
<td>-4.078</td>
<td>&lt;0.001 ***</td>
</tr>
<tr>
<td>u - e</td>
<td>-0.5609152</td>
<td>0.2575379</td>
<td>-2.178</td>
<td>0.179</td>
</tr>
<tr>
<td>o - e</td>
<td>-0.5610966</td>
<td>0.2831423</td>
<td>-1.982</td>
<td>0.264</td>
</tr>
<tr>
<td>u - i</td>
<td>0.4736071</td>
<td>0.3201447</td>
<td>1.479</td>
<td>0.563</td>
</tr>
<tr>
<td>o - i</td>
<td>0.4734258</td>
<td>0.3319583</td>
<td>1.426</td>
<td>0.598</td>
</tr>
<tr>
<td>i - a</td>
<td>-0.2819894</td>
<td>0.2475403</td>
<td>-1.139</td>
<td>0.777</td>
</tr>
<tr>
<td>u - a</td>
<td>0.1916177</td>
<td>0.2650575</td>
<td>0.723</td>
<td>0.949</td>
</tr>
<tr>
<td>o - a</td>
<td>0.1914364</td>
<td>0.2811027</td>
<td>0.681</td>
<td>0.958</td>
</tr>
<tr>
<td>u - o</td>
<td>0.0001814</td>
<td>0.3444591</td>
<td>0.001</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 56: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment for following vowel in the sociolinguistic interview task.

The preceding table shows that deletion is significantly more likely to be accompanied by a following /e/ than a following /a/ (p < 0.001) or a following /i/ (p < 0.001). While not significant, the same directionality is observed for following /u/ and /o/: deletion is more likely with a following /e/.

Preceding word length was also selected as a significant predictor of deletion in the sociolinguistic interview in table 54 above, and comparisons between the levels of this factor are shown below in the multiple comparison of means.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+ - 1</td>
<td>1.44337</td>
<td>0.35090</td>
<td>4.113</td>
<td>&lt;0.001 ***</td>
</tr>
<tr>
<td>3 - 1</td>
<td>1.43096</td>
<td>0.31643</td>
<td>4.522</td>
<td>&lt;0.001 ***</td>
</tr>
<tr>
<td>3 - 2</td>
<td>0.64696</td>
<td>0.24729</td>
<td>2.616</td>
<td>0.0436 *</td>
</tr>
<tr>
<td>2 - 1</td>
<td>0.78401</td>
<td>0.30169</td>
<td>2.599</td>
<td>0.0453 *</td>
</tr>
<tr>
<td>4+ - 2</td>
<td>0.65936</td>
<td>0.29075</td>
<td>2.268</td>
<td>0.1040</td>
</tr>
<tr>
<td>4+ - 3</td>
<td>0.01241</td>
<td>0.29168</td>
<td>0.043</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 57: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment for preceding word length in the sociolinguistic interview task.

Table 57 demonstrates that deletion is more likely following longer words than following shorter words. Words of four or more syllables are significantly more likely to have their final /s/ deleted than words of one syllable (p < 0.001), and deletion is more likely following words of three syllables than words of only one syllable as well (p < 0.001). Three-syllable words are also more likely to be followed by deletion than two-syllable words (p = 0.0436), and the trend continues with two-syllable words, which are more likely to be followed by deletion than one-syllable words (p = 0.0453). The effect here is somewhat larger for three-syllable words over shorter words than for four-syllable words over shorter words.

Finally, in the multiple comparison of means for preceding vowel in the sociolinguistic interview, preceding /o/ tends to be followed by deletion more than other preceding vowels, and this difference approaches significance in the comparison between preceding /o/ and preceding /a/ (p = 0.0968): deletion is more common following /o/ than following /a/.
5.5.1.2 Results from the binary logistic regression model for deletion in the V/s/#V environment in the reading task

A binomial logistic regression model with mixed effects was also fit to the reading task data in the V/s/#V environment to determine the factors that influence deletion in this more formal task. The analysis of deviance conducted on this model is presented below, showing the factors that significantly improve the model.

<table>
<thead>
<tr>
<th>Analysis of Deviance Table (Type III tests)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>Following Stress</td>
</tr>
<tr>
<td>Following Vowel</td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td>Preceding Word Length</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 58: Analysis of deviance table for the model fitted to deletion in the V/s/#V environment in the reading task.

As table 58 demonstrates, following stress is the most significant factor conditioning deletion in the reading task, and following vowel, education, and preceding word length all approach significance. The multiple comparison of means for each of these factors are shown below.

In table 59 the multiple comparison of means for following vowel is presented.
Table 59: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment for following stress in the reading task.

Table 59 demonstrates that in the reading task, deletion is more likely before following unstressed vowels than before following stressed vowels ($p < 0.001$).

Table 60 below presents the results from the multiple comparison of means for following vowel in the reading task.

Table 60: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment for following vowel in the reading task.
One comparison between levels emerges as significant in this multiple comparison of means: deletion is significantly more likely before a following /e/ than before a following /i/. The same effect of following /e/ was found in the sociolinguistic interview: deletion is more likely when that particular vowel follows the /s/.

Table 61 below shows the multiple comparison of means for education.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No HS Diploma – Univ. Degree</td>
<td>1.7056</td>
<td>0.7546</td>
<td>2.260</td>
<td>0.0614</td>
</tr>
<tr>
<td>HS Diploma – No HS Diploma</td>
<td>-0.8820</td>
<td>0.7287</td>
<td>-1.210</td>
<td>0.4468</td>
</tr>
<tr>
<td>HS Diploma – Univ. Degree</td>
<td>0.8236</td>
<td>0.7178</td>
<td>1.147</td>
<td>0.4848</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported – single-step method)

Table 61: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment for education in the reading task.

As the table above shows, the difference between the college-educated participants and those without a high school diploma approaches significance: the less educated participants delete /s/ more than the most educated participants, with participants with a high school education falling between the two groups.

Finally, the comparisons between levels of preceding word length are presented below.
<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+ - 1</td>
<td>0.9958</td>
<td>0.4271</td>
<td>2.331</td>
<td>0.0862</td>
</tr>
<tr>
<td>3 - 1</td>
<td>0.9587</td>
<td>0.5965</td>
<td>1.607</td>
<td>0.3634</td>
</tr>
<tr>
<td>3 - 2</td>
<td>0.4911</td>
<td>0.6082</td>
<td>0.807</td>
<td>0.8454</td>
</tr>
<tr>
<td>2 - 1</td>
<td>0.4676</td>
<td>0.3671</td>
<td>1.274</td>
<td>0.5688</td>
</tr>
<tr>
<td>4+ - 2</td>
<td>0.5282</td>
<td>0.3902</td>
<td>1.354</td>
<td>0.5172</td>
</tr>
<tr>
<td>4+ - 3</td>
<td>0.0371</td>
<td>0.6514</td>
<td>0.057</td>
<td>0.9999</td>
</tr>
</tbody>
</table>

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
(Adjusted p-values reported -- single-step method)

Table 62: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment for preceding word length in the reading task.

As shown in the multiple comparison of means in table 62, the difference between the longest words (words of four or more syllables) and the shortest words (one-syllable words) approaches significance, with deletion occurring more following the longer words.

5.5.1.3 Results from the binary logistic regression model for deletion in the V/s/#V environment in the image identification task

One final task-specific model was fitted to the data in the V/s/#V environment for deletion, this time in the image identification task. Keep in mind that fewer tokens are available for this shorter task, but certain factors did emerge as significant predictors of deletion in this task, shown below in the analysis of deviance.
Table 63: Analysis of deviance table for the model fitted to deletion in the V/s/#V environment in the image identification task.

Table 63 shows that preceding vowel and paired word class are significant predictors of deletion in the image identification task, and education is retained in the model due to near-significance between two levels of the variable.

In order to explore the directionality of the individual levels, the following tables show multiple comparison of means. First, a multiple comparison of means is shown for preceding vowel in table 64.

Table 64: Tukey HSD Linear Hypotheses of deletion in the V/s/#V environment for preceding vowel in the image identification task.
Table 64 shows an effect of preceding /o/: deletion is significantly more likely in the image identification task when preceded by /o/ than when preceded by /a/ \( p = 0.0136 \) or /e/ \( p = 0.0208 \).

Differences between levels of paired word class are also found, shown in the multiple comparison of means below.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Pairs – Det.-Noun</td>
<td>1.5767</td>
<td>0.5457</td>
<td>2.889</td>
<td>0.0177 *</td>
</tr>
<tr>
<td>Verb-X – Det.-Noun</td>
<td>1.3165</td>
<td>0.7054</td>
<td>1.866</td>
<td>0.2240</td>
</tr>
<tr>
<td>Other Pairs – Noun-Adj.</td>
<td>1.7716</td>
<td>1.3207</td>
<td>1.341</td>
<td>0.5134</td>
</tr>
<tr>
<td>Verb-X – Noun-Adj.</td>
<td>1.5114</td>
<td>1.4039</td>
<td>1.077</td>
<td>0.6848</td>
</tr>
<tr>
<td>Verb-X – Other Pairs</td>
<td>-0.2602</td>
<td>0.6674</td>
<td>-0.390</td>
<td>0.9780</td>
</tr>
<tr>
<td>Noun-Adj. – Det.-Noun</td>
<td>-0.1949</td>
<td>1.2467</td>
<td>-0.156</td>
<td>0.9985</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Adjusted p-values reported -- single-step method)

Table 65: Tukey HSD Linear Hypotheses for paired word class in the model fitted to deletion in the V/s/#V environment in the image identification task.

Table 65 demonstrates that word pairings other than determiner-noun pairs, verbs followed by any word class, or noun-adjective pairs tend to show more deletion between the two words: deletion is significantly more likely between these other words pairings than between determiner-noun pairs \( p = 0.0177 \).

Finally, a direct comparison between participants with a college degree and participants without a high school diploma approaches significance: Those without a high school diploma are more likely to delete /s/ in the image identification task than those with a college education \( p = 0.07599 \). However, when the other comparisons within this
factor are taken into account in a more conservative p-value, the comparison misses near-significance in the multiple comparison of means.

5.5.2 Results from the binary logistic regression model for non-insertion (equivalent to total deletion for /s/) in the V#V environment

In this section, I present the statistical results of non-insertion in the V#V environment, e.g. *la otra* ‘the other one’ realized as [la.o.tra], without any glottal stop or creaky voice insertion between the two vowels at the word boundary. This realization is similar to deletion in its lack of acoustic properties, but with non-insertion, there is no underlying segment as is the case of deletion in V/s/#V environments. While this section repeats some of the results found for glottal stop insertion alone (5.3.2) and creaky voice insertion alone (5.4.2), I chose to include these findings due to a larger sample size when both glottal stop and creaky voice insertion are combined, which allows for a more reliable analysis. Table 66 below presents the analysis of deviance table for non-insertion in the V#V environment.
Table 66: Analysis of deviance table for the model fitted to non-insertion in the V#V environment across all tasks.

The above table indicates the factors that significantly improve the model, which include task and preceding word (p < 0.001). Preceding vowel and education are maintained in the model due to significant comparisons between two levels of the original model constructed in R with treatment contrasts; the directionality of these factors will be illustrated below.

Table 67 shows the task factor’s multiple comparison of means for non-insertion in the V#V environment.

Table 67: Tukey HSD Linear Hypotheses for non-insertion in the V#V environment based on task.
What table 67 demonstrates is that non-insertion is significantly more likely in the less formal sociolinguistic interview task than in the reading and image identification task \((p < 0.001)\). As we saw earlier in sections 5.3 and 5.4, in the more formal tasks, insertion of a glottal stop or creaky voice is more likely to occur.

Preceding word length is also a significant predictor of non-insertion in the V#V environment, and table 68 below shows the factor’s multiple comparison of means.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+ - 1</td>
<td>-1.57476</td>
<td>0.37103</td>
<td>-4.244</td>
<td>&lt;0.001 ***</td>
</tr>
<tr>
<td>4+ - 2</td>
<td>-1.66750</td>
<td>0.41162</td>
<td>-4.051</td>
<td>&lt;0.001 ***</td>
</tr>
<tr>
<td>4+ - 3</td>
<td>-0.87898</td>
<td>0.42638</td>
<td>-2.061</td>
<td>0.164</td>
</tr>
<tr>
<td>3 - 2</td>
<td>-0.78852</td>
<td>0.38651</td>
<td>-2.040</td>
<td>0.172</td>
</tr>
<tr>
<td>3 - 1</td>
<td>-0.69578</td>
<td>0.37156</td>
<td>-1.873</td>
<td>0.238</td>
</tr>
<tr>
<td>2 - 1</td>
<td>0.09274</td>
<td>0.33783</td>
<td>0.275</td>
<td>0.993</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Adjusted p-values reported -- single-step method)

Table 68: Tukey HSD Linear Hypotheses of non-insertion in the V#V environment for preceding word length.

The negative estimate in the first two comparisons above demonstrates that non-insertion is much more likely following shorter words of one or two syllables than it is following longer words of four or more syllables \((p <0.001)\). That is, the glottal stop or creaky voice is inserted after longer words more than after shorter words, as was shown earlier in sections 5.3 and 5.4.

Table 69 below is presented to illustrate the directionality of V#V non-insertion trends for education. The multiple comparison of means is below.
Table 69: Tukey HSD Linear Hypotheses for non-insertion in the V#V environment for education.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. Degree – No HS Diploma</td>
<td>0.6642</td>
<td>0.3365</td>
<td>1.974</td>
<td>0.119</td>
</tr>
<tr>
<td>Univ. Degree – HS Diploma</td>
<td>0.3380</td>
<td>0.3298</td>
<td>1.025</td>
<td>0.561</td>
</tr>
<tr>
<td>No HS Diploma – HS Diploma</td>
<td>-0.3262</td>
<td>0.3287</td>
<td>-0.992</td>
<td>0.582</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

The comparison selected as significant in the original model with treatment contrasts was the comparison between participants with a university degree and those who lacked a high school education ($p < 0.05$). Non-insertion in the V#V environment is more likely for the most educated group than for the least educated group, which means that the group with the lowest education level was more likely to insert a glottal stop or creaky voice than the highest education group when it does not correspond to an underlying segment.

There are too many comparisons and too few tokens to successfully conduct a multiple comparison of means for preceding vowel, but a direct comparison between levels of the variable in the original model I created in R shows that preceding /e/ conditions non-insertion; that is, glottal stop or creaky voice insertion in the V#V environment is least likely when there is a preceding /e/. The binomial logistic regression model with mixed effects shows that glottal insertion is most likely with a preceding /a/, and the difference between preceding /e/ and /a/ is significant ($p = 0.014755$).
5.6 Aspiration

While not explicitly the focus of this dissertation, the glottal stop occurs in the same environment as other variants of /s/. Because a complex interplay exists among all the variants, the relationship between the glottal stop use and the use of other variants should be explored. In the following sections, I present the results of a binomial logistic regression model with mixed effects comparing realizations of aspiration against all other variants of /s/.

Table 70 presents the results of an analysis of deviance, showing the factors that influence the realization of [h], which only occurs in the V/s/#V environment.

<table>
<thead>
<tr>
<th>Analysis of Deviance Table (Type III tests)</th>
<th>Chisq</th>
<th>Df</th>
<th>Pr(&gt;Chisq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.0557</td>
<td>1</td>
<td>0.8133628</td>
</tr>
<tr>
<td>Following Stress</td>
<td>79.5673</td>
<td>1</td>
<td>&lt; 2.2e-16 ***</td>
</tr>
<tr>
<td>Task</td>
<td>250.6463</td>
<td>2</td>
<td>&lt; 2.2e-16 ***</td>
</tr>
<tr>
<td>Paired Word Class</td>
<td>17.4186</td>
<td>3</td>
<td>0.0005796 ***</td>
</tr>
<tr>
<td>Preceding Word Length</td>
<td>14.4587</td>
<td>3</td>
<td>0.0023428 **</td>
</tr>
<tr>
<td>Preceding Vowel</td>
<td>12.9479</td>
<td>4</td>
<td>0.0115334 *</td>
</tr>
<tr>
<td>Education</td>
<td>4.2739</td>
<td>2</td>
<td>0.1180150</td>
</tr>
<tr>
<td>Following Vowel</td>
<td>5.4603</td>
<td>4</td>
<td>0.2432454</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 70: Analysis of deviance table for the model fitted to aspiration across all tasks.

Numerous factors condition the production of [h] in Nicaraguan Spanish, the most important being following stress, task, paired word class, preceding word length, and
preceding vowel. Education and following vowel will also be discussed, as individual comparisons among two of their levels emerged as significant when treatment contrasts were used in the original model.

The importance of following stress is presented first in the multiple comparison of means in table 71 below.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std.</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stressed V – Unstressed v</td>
<td>-1.6268</td>
<td>0.1824</td>
<td>-8.92</td>
<td>&lt;2e-16  ***</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Adjusted p-values reported -- single-step method)

Table 71: Tukey HSD Linear Hypotheses for following stress in the aspiration model.

As shown in table 71, glottal frication is significantly less likely to occur before a stressed vowel than before an unstressed vowel. Glottal frication appears to function in this regard like deletion, occurring more frequently before an unstressed vowel, while the glottal stop occurs more frequently before a following stressed vowel.

Task was also a significant predictor of glottal aspiration, and the multiple comparison of means below illustrates the differences between the levels.
As table 72 illustrates, aspiration is significantly less likely in the reading task than in the oral tasks (the sociolinguistic interview and the image identification task), and between the oral tasks, aspiration is more likely in the sociolinguistic interview than the image identification task. As aspiration is not the focus of my hypothesis, instead of providing individual analyses based on task, I summarize any task-based differences that exist following the presentation of the factors important to aspiration across tasks.

Table 73 below presents the multiple comparison of means for paired word class to illustrate which paired word classes are most predictive of aspiration.

Table 72: Tukey HSD Linear Hypotheses for aspiration based on task.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reading – Image Ident.</strong></td>
<td>-2.0751</td>
<td>0.2767</td>
<td>-7.501</td>
<td>&lt; 1e-04  ***</td>
</tr>
<tr>
<td><strong>Interview – Reading</strong></td>
<td>2.9999</td>
<td>0.1899</td>
<td>15.796</td>
<td>&lt; 1e-04  ***</td>
</tr>
<tr>
<td><strong>Interview – Image Ident.</strong></td>
<td>0.9248</td>
<td>0.2381</td>
<td>3.884</td>
<td>0.000308 ***</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 1
(Adjusted p-values reported -- single-step method)

Table 73: Tukey HSD Linear Hypotheses for aspiration based on paired word class.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Verb-X – Det.-Noun</strong></td>
<td>1.1831</td>
<td>0.3099</td>
<td>3.817</td>
<td>&lt;0.001   ***</td>
</tr>
<tr>
<td><strong>Verb-X – Noun-Adj.</strong></td>
<td>1.0064</td>
<td>0.3361</td>
<td>2.994</td>
<td>0.0137   *</td>
</tr>
<tr>
<td><strong>Other Pairs – Det.-Noun</strong></td>
<td>0.6877</td>
<td>0.2598</td>
<td>2.648</td>
<td>0.0385   *</td>
</tr>
<tr>
<td><strong>Verb-X – Other Pairs</strong></td>
<td>0.4954</td>
<td>0.2248</td>
<td>2.204</td>
<td>0.1174</td>
</tr>
<tr>
<td><strong>Other Pairs – Noun-Adj.</strong></td>
<td>0.5111</td>
<td>0.3015</td>
<td>1.695</td>
<td>0.3172</td>
</tr>
<tr>
<td><strong>Noun-Adj. – Det.-Noun</strong></td>
<td>0.1767</td>
<td>0.3548</td>
<td>0.498</td>
<td>0.9580</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 1
(Adjusted p-values reported -- single-step method)
Aspiration is more likely to occur between verbs and any other word class than between determiners and nouns \( (p < 0.001) \), and aspiration is also more likely between verbs and any other word class than between nouns and adjectives \( (p < 0.05) \). Finally, aspiration is more likely between other word class pairings than between determiners and nouns, suggesting that aspiration is less likely overall between members of the same syntactic constituent.

The length of the preceding word is yet another significant factor predictive of aspiration. The multiple comparison of means is presented below in table 74.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 1</td>
<td>-1.0222</td>
<td>0.2816</td>
<td>-3.630</td>
<td>0.00175 **</td>
</tr>
<tr>
<td>4+ - 1</td>
<td>-0.7788</td>
<td>0.3026</td>
<td>-2.574</td>
<td>0.04872 *</td>
</tr>
<tr>
<td>3 - 2</td>
<td>-0.5621</td>
<td>0.2225</td>
<td>-2.527</td>
<td>0.05456 .</td>
</tr>
<tr>
<td>2 - 1</td>
<td>-0.4600</td>
<td>0.2535</td>
<td>-1.815</td>
<td>0.26296</td>
</tr>
<tr>
<td>4+ - 2</td>
<td>-0.3188</td>
<td>0.2514</td>
<td>-1.268</td>
<td>0.57967</td>
</tr>
<tr>
<td>4+ - 3</td>
<td>0.2433</td>
<td>0.2634</td>
<td>0.924</td>
<td>0.78959</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Augusted p-values reported -- single-step method)

Table 74: Tukey HSD Linear Hypotheses for preceding word length in the aspiration model.

Table 74 shows that aspiration is less likely following longer words than it is following shorter words: aspiration is significantly less likely following words of three syllables or four syllables than words of only one syllable \( (p < 0.05) \), and words of three syllables are nearly significantly less likely to show following aspiration than words of only two syllables \( (p = 0.05456) \).
Table 75 below shows the multiple comparison of means for education. As previously explained, while these p-values do not reach significance, the comparisons are included because a direct comparison between participants with a college degree and participants with a high school diploma is statistically significant when the two are compared with treatment contrasts (p < 0.05). The multiple comparisons of means test below has a more conservative p-value.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. Degree – HS Diploma</td>
<td>-1.4366</td>
<td>0.7053</td>
<td>-2.037</td>
<td>0.103</td>
</tr>
<tr>
<td>No HS Diploma – HS Diploma</td>
<td>-0.9247</td>
<td>0.7043</td>
<td>-1.313</td>
<td>0.388</td>
</tr>
<tr>
<td>Univ. Degree – No HS Diploma</td>
<td>-0.5119</td>
<td>0.7092</td>
<td>-0.722</td>
<td>0.751</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 75: Tukey HSD Linear Hypotheses for aspiration based on education.

Although not statistically significant here, the directionality is clear: those with a high school degree tend to aspirate more than those with a university degree, a difference that is significant when the two levels are compared in the original model with treatment contrasts in R.

Finally, while the numerous comparisons among following vowels increase their p-values above 0.05, the direct comparison of following /o/ and /a/ in the original model with treatment contrasts in R shows that aspiration is significantly more likely before /a/ than it is before /o/ (p = 0.020779). However, the difference between two levels of the preceding vowel factor retain significance even with the multiple comparisons: note the /o/ /e/ comparison below in table 76.
Table 76: Tukey HSD Linear Hypotheses for aspiration based on preceding vowel.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>o - e</td>
<td>-0.69496</td>
<td>0.21646</td>
<td>-3.211</td>
<td>0.00944 **</td>
</tr>
<tr>
<td>o - a</td>
<td>-0.51037</td>
<td>0.22268</td>
<td>-2.292</td>
<td>0.12817</td>
</tr>
<tr>
<td>i - e</td>
<td>-0.86006</td>
<td>0.49255</td>
<td>-1.746</td>
<td>0.37205</td>
</tr>
<tr>
<td>i - a</td>
<td>-0.67547</td>
<td>0.50027</td>
<td>-1.350</td>
<td>0.62917</td>
</tr>
<tr>
<td>u - i</td>
<td>0.68844</td>
<td>0.75343</td>
<td>0.914</td>
<td>0.87801</td>
</tr>
<tr>
<td>u - o</td>
<td>0.52334</td>
<td>0.62321</td>
<td>0.840</td>
<td>0.90738</td>
</tr>
<tr>
<td>e - a</td>
<td>0.18459</td>
<td>0.23704</td>
<td>0.779</td>
<td>0.92817</td>
</tr>
<tr>
<td>o - i</td>
<td>0.16510</td>
<td>0.49178</td>
<td>0.336</td>
<td>0.99683</td>
</tr>
<tr>
<td>u - e</td>
<td>-0.17162</td>
<td>0.63017</td>
<td>-0.272</td>
<td>0.99860</td>
</tr>
<tr>
<td>u - a</td>
<td>0.01297</td>
<td>0.63522</td>
<td>0.020</td>
<td>1.00000</td>
</tr>
</tbody>
</table>

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
(Among adjusted p-values reported -- single-step method)

Table 76 shows that aspiration is more likely with a preceding /e/ than with a preceding /o/ (p < 0.01). The same general trend is seen in the comparison between /a/ and /o/, and while not statistically significant, /o/ is again less likely to precede aspiration.

The models fitted to the individual task are not presented in their entirety as aspiration is not the focus of the present dissertation. However, I do present the notable differences here found in the models fitted to the sociolinguistic interview, the reading task, and the image identification task to illustrate the differences that exist. First, the results from the model fitted to the sociolinguistic interview are largely the same as the results from the model across all tasks, with following vowel as the only factor departing from the larger model: in the sociolinguistic interview model, there are no significant differences between the levels of the following vowel factor.
The reading task shows one small difference from the overall model presented early in this section. While paired word class continues to be significant to the overall model in the reading task alone, it is other word class pairings that are more likely to have intervening aspiration than verbs followed by any word class. In the multiple comparison of means, the difference is significant (p = 0.0127), and the difference between other pairings and noun-adjective pairings approaches significance (p = 0.0617), with aspiration more likely between other word pairings.

Finally, one additional linguistic and one additional social factor emerge as significant in the image identification task not observed for the model across tasks or the other task-specific models: first, aspiration is significantly more likely following preceding stressed vowels than following preceding unstressed vowels (p < 0.001). Second, in addition to education, in which the college-educated participants are again less likely to use aspiration than high school-educated participants (p = 0.0282 in the direct comparison with treatment contrasts) and those with no high school education (p = 0.0484), significant differences are observed between different age groups. The oldest speakers are significantly more likely than the youngest participants to use aspiration (p = 0.0161), and the middle age group falls between the oldest and youngest age groups’ aspiration use. In other words, while aspiration is generally associated with the middle education group across tasks, it is also associated with older speakers in the image identification task.

48 The possible interaction between age and education was tested in the model. However, the interaction was not significant and was removed from the model.
5.7 Sibilance alone

This section addresses the factors predictive of sibilance alone in the data. As in previous sections, an analysis of deviance table is presented below in table 77 followed by the multiple comparison of means to investigate the relationship between the levels of the significant factors.

<table>
<thead>
<tr>
<th>Analysis of Deviance Table (Type III tests)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Chisq</strong></td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>Task</td>
</tr>
<tr>
<td>Preceding Word Length</td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td>Following Stress</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 77: Analysis of deviance table for the model fitted to sibilance across all tasks.

As table 77 shows, task is the most predictive factor of sibilance, an unsurprising result considering the rarity of sibilance in casual conversation in Nicaragua. Preceding word length, education, and following stress also significantly improve the model.

Table 78 below shows the multiple comparison of means for task.
The table demonstrates that sibilance is significantly more likely in the reading task than in the sociolinguistic interview (p < 0.001) and significantly more likely in the image identification task than in the sociolinguistic interview (p < 0.001). There is also a significant difference between the more formal reading and image identification tasks: sibilance is more likely in the reading task than in the image identification task (p < 0.05).

Table 79 below shows the relationship between levels in the preceding word length factor.

Table 78: Tukey HSD Linear Hypotheses for sibilance based on task.
As indicated above, longer words are significantly less likely than shorter words to end with sibilance: words of four of more syllables are less likely than words of only one syllable to have word-final sibilance (p < 0.05), and the comparison between words of four or more syllables and words of two syllables follows the same trend approaching significance (p < 0.1).

In section 5.6 we saw that aspiration is more likely in the speech of the high school-educated than in the speech of the college-educated, but another difference emerges between the two groups shown below.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. Degree – HS Diploma</td>
<td>1.2862</td>
<td>0.4808</td>
<td>2.675</td>
<td>0.0205 *</td>
</tr>
<tr>
<td>Univ. Degree – No HS Diploma</td>
<td>0.9162</td>
<td>0.4711</td>
<td>1.945</td>
<td>0.1262</td>
</tr>
<tr>
<td>No HS Diploma – HS Diploma</td>
<td>0.3699</td>
<td>0.4822</td>
<td>0.767</td>
<td>0.7232</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 80: Tukey HSD Linear Hypotheses for sibilance based on education.

Contrary to the trend observed for aspiration, the most educated group uses sibilance significantly more than the high-school educated group (p < 0.05), and while not significant, the same trend is observed in the comparison between the most and least educated groups.

Finally, following stress plays a role as well, shown in the multiple comparison of means in table 81 below.
Interestingly, sibilance is statistically more likely when followed by an unstressed vowel (p < 0.05), the opposite of many other dialects well-known for their lenition of /s/ (refer to chapter 2 for more details about /s/-lenition in other dialects of Spanish). It appears that the [s] in Nicaraguan Spanish does not behave as the [s] in other aspirating dialects of Spanish in this respect.

5.8 Sibilance followed by glottal constriction

The production of sibilance alone has been discussed in section 5.7, and the following section discusses sibilance followed by a glottal stop or creaky voice. These realizations were common in the more formal tasks as a variant of /s/, and sections 5.8.1 and 5.8.2 will discuss the [sʔ] and [s] followed by creaky voice, respectively.

5.8.1 Results from the binary logistic regression model for sibilance + glottal stop

This section presents the results from the binary logistic regression model with mixed effects for sibilance followed by a glottal stop. The analysis of deviance table

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Err</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stressed V – Unstressed v</td>
<td>-0.4736</td>
<td>0.2335</td>
<td>-2.028</td>
<td>0.0426 *</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 81: Tukey HSD Linear Hypotheses for following stress in the sibilance model.
presented below illustrates the factors significant to the model as a whole. Again, following and preceding vowel are included due to a significant comparison between individual levels of the variant in the analysis with treatment contrasts. The preceding and following vowels will be discussed to illustrate the directionality of the trends within the factor.

<table>
<thead>
<tr>
<th>Analysis of Deviance Table (Type III tests)</th>
<th>Chisq</th>
<th>Df</th>
<th>Pr(&gt;Chisq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>59.4312</td>
<td>312</td>
<td>1.266e-14  ***</td>
</tr>
<tr>
<td><strong>Following Stress</strong></td>
<td>65.5997</td>
<td>1</td>
<td>5.525e-16  ***</td>
</tr>
<tr>
<td>Task</td>
<td>76.8894</td>
<td>2</td>
<td>&lt; 2.2e-16  ***</td>
</tr>
<tr>
<td>Paired Word Class</td>
<td>7.3498</td>
<td>3</td>
<td>0.06154 .</td>
</tr>
<tr>
<td><strong>Following Vowel</strong></td>
<td>6.0179</td>
<td>4</td>
<td>0.19782</td>
</tr>
<tr>
<td><strong>Preceding Vowel</strong></td>
<td>5.4150</td>
<td>4</td>
<td>0.24730</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 82: Analysis of deviance table for the model fitted to sibilance + glottal stop across all tasks.

Table 82 shows that following stress and task are the most predictive factors of [sʔ] as a variant of /s/ (p < 0.001). Paired word class approaches significance as a factor (p < 0.07), and one direct comparison is significant within the preceding and following vowel factors that will be addressed below.

Table 83 presents the multiple comparison of means for task, showing the significant comparisons between levels of the factor.
Unsurprisingly, [sʔ] is most common in the more formal tasks. [sʔ] is significantly more likely in the reading task than in the interview task \( (p < 0.001) \), and it is also significantly more likely in the image identification task than the interview task \( (p < 0.001) \). When the more formal tasks are compared, sibilance followed by a glottal stop is more likely in the reading task than in the oral image identification task \( (p < 0.001) \).

Following stress also plays a role in the [sʔ] realization, illustrated below in the multiple comparison of means for the predictor.

Unsurprisingly, [sʔ] is most common in the more formal tasks. [sʔ] is significantly more likely in the reading task than in the interview task \( (p < 0.001) \), and it is also significantly more likely in the image identification task than the interview task \( (p < 0.001) \). When the more formal tasks are compared, sibilance followed by a glottal stop is more likely in the reading task than in the oral image identification task \( (p < 0.001) \).

Following stress also plays a role in the [sʔ] realization, illustrated below in the multiple comparison of means for the predictor.

Table 84 demonstrates the importance of following stress: [sʔ] is significantly more likely with a following stressed syllable than with a following unstressed syllable \( (p < 0.001) \).

Again, I must mention that the comparisons in table 85 below do not reach significance when multiple comparisons are taken into account. However, a direct
comparison between two levels of the factor does show significance, and the multiple comparison of means table is presented below to clarify the directionality of the trends.

<table>
<thead>
<tr>
<th>Other Pairs – Det.-Noun</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Pairs – Noun-Adj.</td>
<td>-1.006599</td>
<td>0.457289</td>
<td>-2.201</td>
<td>0.121</td>
</tr>
<tr>
<td>Verb-X – Other Pairs</td>
<td>-0.808469</td>
<td>0.375260</td>
<td>-2.154</td>
<td>0.134</td>
</tr>
<tr>
<td>Noun-Adj. – Det.-Noun</td>
<td>0.802705</td>
<td>0.470395</td>
<td>1.706</td>
<td>0.316</td>
</tr>
<tr>
<td>Verb-X – Det.-Noun</td>
<td>-0.198130</td>
<td>0.464479</td>
<td>-0.427</td>
<td>0.974</td>
</tr>
<tr>
<td>Verb-X – Noun-Adj.</td>
<td>-0.005764</td>
<td>0.491012</td>
<td>-0.012</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p-values reported -- single-step method)

Table 85: Tukey HSD Linear Hypotheses for paired word class in the model predicting sibilance followed by glottal stop.

Table 85 shows that while not significant, [sʔ] occurs more frequently between determiners and nouns than between other word class pairs, and the variant occurs more between noun-adjective pairs than between other pairs as well. These two comparisons, when conducted individually, show p-values below 0.05, suggesting that the [sʔ] realization is more common between parts of the same syntactic constituent than between word pairs with a weaker syntactic relationship.

Finally, I should note that when directly compared, [sʔ] is significantly more likely with a following /i/ than with a following /a/ (p = 0.0467), and the variant is nearly significantly more likely when preceded by an /o/ than when preceded by an /e/ (p = 0.0678). In other words, the factors preceding and following vowel are not very
significant on their own, but a few differences do occur with individual vowel comparisons.

5.8.2 Results from the binary logistic regression model for sibilance + creaky voice

This section investigates the realizations of sibilance followed by creaky voice across all tasks to determine what factors predict the variant’s use. Table 86 below presents the analysis of deviance table to show the most important predictors’ significance as a whole to the model.

<table>
<thead>
<tr>
<th></th>
<th>Chisq</th>
<th>Df</th>
<th>Pr(&gt;Chisq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>82.3952</td>
<td>1</td>
<td>&lt; 2.2e-16 ***</td>
</tr>
<tr>
<td>Task</td>
<td>42.1135</td>
<td>2</td>
<td>7.164e-10 ***</td>
</tr>
<tr>
<td>Preceding Stress</td>
<td>7.7991</td>
<td>1</td>
<td>0.005227 **</td>
</tr>
<tr>
<td>Preceding Vowel</td>
<td>6.2592</td>
<td>4</td>
<td>0.180606</td>
</tr>
<tr>
<td>Paired Word Class</td>
<td>3.8561</td>
<td>3</td>
<td>0.277424</td>
</tr>
</tbody>
</table>

Table 86: Analysis of deviance table for the model fitted to sibilance + creaky voice across all tasks.

Sibilance followed by creaky voice is primarily conditioned by task (p < 0.001) and preceding stress (p < 0.01). Preceding vowel and paired word class are not significant predictors to the model as a whole, but are maintained due to significance between direct
comparisons of two levels of the variants. These differences will be discussed after
presenting multiple comparison of means for task and preceding stress.

In table 87, I present the multiple comparison of means for task.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview – Reading</td>
<td>-3.4403</td>
<td>0.5408</td>
<td>-6.361</td>
<td>&lt;0.001 ***</td>
</tr>
<tr>
<td>Interview – Image Ident.</td>
<td>-2.8914</td>
<td>0.5950</td>
<td>-4.859</td>
<td>&lt;0.001 ***</td>
</tr>
<tr>
<td>Reading – Image Ident.</td>
<td>0.5489</td>
<td>0.2996</td>
<td>1.832</td>
<td>0.149</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 87: Tukey HSD Linear Hypotheses for sibilance followed by creaky voice based on task.

The above table demonstrates that sibilance followed by creaky voice is significantly
more likely in the reading task than in the interview task (p < 0.001) and significantly
more likely in the image identification task than in the interview task (p < 0.001). In other
words, sibilance followed by creaky voice is most likely in the more formal tasks and less
likely in the casual interview task.

Table 88 shows the multiple comparison of means for preceding stress.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stressed V – Unstressed v</td>
<td>1.0471</td>
<td>0.3749</td>
<td>2.793</td>
<td>0.00523 **</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 88: Tukey HSD Linear Hypotheses for preceding stress predictive of sibilance
followed by creaky voice.
Table 88 shows that a preceding stressed vowel predicts sibilance followed by creaky voice significantly more than a preceding unstressed vowel (p < 0.01). That is, the sibilant + creaky voice realization is less likely when preceded by an unstressed vowel.

Finally, I would like to note the relevant individual comparisons for preceding vowel and paired word class. A direct comparison between the preceding vowels /i/ and /e/ shows that the sibilant followed by creaky voice is more likely when preceded by an /i/ than when preceded by an /e/, but this is likely due to the lack of words with /i/ as the final vowel. Additionally, a comparison between verbs followed by any word class and other word pairings approaches significance (p = 0.052), and a comparison between verbs followed by any word class and determiner-noun pairs approaches significance as well (p = 0.08087), with pairings of verbs and any following word class less likely to have intervening sibilance followed by creaky voice in both comparisons. Again, task and preceding stress are the most significant factors to the model, but I mention the preceding vowel and paired word class factors for transparency.

5.9 Conclusion

This chapter has provided the statistical analysis necessary to understand the behavior of the different variants in the V/s/#V environment and the V#V environment in Nicaraguan Spanish, offering descriptive statistics for both environments and a discussion of the best models for the glottal stop, creaky voice, deletion, aspiration, sibilance, and sibilance followed by glottal constriction. The variants most crucial to the
dissertation, the glottal stop and deletion, were also explored in task-specific models to see how their use changes in more formal and less formal oral and written settings. Chapter 6 discusses the significance of these statistical models in relation to the theories introduced in chapters 2 and 3 about /s/-lenition and glottal stop insertion in Spanish, referring to both linguistic and social conditioning factors.
Chapter 6: Discussion

Chapter 5 provided statistical analyses of the data, and in chapter 6 these analyses are examined and discussed in light of the theoretical claims and previous studies detailed in chapters 2 and 3. Chapter 6 first explores the linguistic (internal) factors that condition the glottal stop in section 6.1 with all tasks combined. While the focus of this dissertation is on the glottal stop in Nicaraguan Spanish, it is impossible to thoroughly explain the glottal stop’s behavior without also taking into account the other variants that occur in the same environment. These variants exist in inverse or direct relationships with the glottal stop, conditioned by the same factors in different ways. For that reason, section 6.2 explores the glottal stop in relation to other variants found in the same environment.

Section 6.3 provides a task-based analysis of the variants’ uses in each task, exploring the social (extralinguistic) factors of age and education in the tasks. Then, section 6.4 discusses the extension of the glottal stop in Nicaraguan Spanish to the V#V environment, section 6.5 explores the reanalysis of the phonological system, and section 6.6 addresses the neutrality of the glottal stop. Finally, section 6.7 explores local vs. global formality strategies, section 6.8 offers a summary and conclusions about the glottal stop in Nicaraguan Spanish, and section 6.9 suggests areas for future research.
6.1 Linguistic factors conditioning the glottal stop across all tasks

As shown in the statistical analysis of the data in chapter 5, several linguistic factors condition the occurrence of the glottal stop. This section details those predictive factors across all tasks, enabling a discussion of the factors that condition the glottal stop regardless of level of formality or task. Section 6.3 will provide a more detailed analysis of the predictive factors’ behavior in each task. In addition to merely laying out the glottal stop’s predictive factors, this section also addresses the deeper question of why these particular factors work to condition the glottal stop over other factors.

In this section I discuss the V/s/#V environment, or the intervocalic environment at the word boundary with an underlying /s/. As shown in table 1 of chapter 5, several variants occur in this environment, including glottal constriction, deletion, glottal frication, oral frication, and oral frication followed by glottal constriction. The following discussion refers to the likelihood of the glottal stop alone in relation to all other realizations.

6.1.1 Following stress

As shown in chapter 5, following stress is a factor that is consistently significant across the models constructed, illustrating the importance of this particular factor in conditioning glottal stop realizations. Table 89 below simplifies the relationship shown in chapter 5, ranking the levels’ likelihood to increase glottal stop use. A rank of 1 indicates
that the level increases glottal stop likelihood the most, and the rank decreases in order as the factors predict the glottal stop less and less. The highest number indicates that the glottal stop is least likely given that level.

<table>
<thead>
<tr>
<th>Following Stressed Vowel</th>
<th>Most Likely to Increase Glottal Stop Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Following Unstressed Vowel</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 89: Effect of following stress across tasks on glottal stop in the V/s/#V environment.

As shown above, the glottal stop is more likely when followed by a stressed vowel, but the question that remains is why following stress conditions the glottal stop. A review of the literature and previous claims about the word-initial, stressed vowel position merits a review to answer this question.

First, as noted in chapter 3, Casali (1998) explains that there exist certain special positions that are particularly resistant to reduction or deletion in hiatus: (a) word-initially, (b) in a lexical word/morpheme and (c) in a stressed syllable (refer to section 3.3.2). As word-initial, stressed vowels fall under not one but two of these special categories, the vowel is highly stable, meaning it 1) is not frequently reduced or deleted, and 2) it requires an onset more than atonic vowels in word-initial positions.

Casali explains that word-initial vowels tend to change less synchronically, being elided less when hiatus is formed, and diachronically as well, with word-initial vowel loss a rarer phenomenon than word-internal or word-final vowel loss. The same maintenance is observed for word-initial consonants: while word- or syllable-final consonants undergo voicing neutralization frequently, voicing differences are generally
maintained in word-initial position in spite of the fact that articulatory considerations favor neutralization as much in onset position as in coda position (Westbury and Keating 1986).

Casali (1998) also notes that the greater duration and amplitude found word-initially increase the salience of segments in this position, which helps them avoid reduction, deletion, or neutralization (Jun 1995 and Steriade 1995). Preservation and fortition of word-initial segments serves a cognitive purpose as well: MacEachern (1995) shows that word-initial segments are particularly important in aiding word recognition as native speakers seem to store words by first phoneme in their mental lexicon and more lexical information is needed earlier in the word to identify it.

In regards to this fortition before word-initial, stressed vowels Borroff (2007) argues that there is “a cross-linguistic tendency for strengthening of elements in initial position of prosodic units” (172). In other words, segments in initial position are stronger than segments in final position, and Borroff explains that prosodically more prominent domains, e.g. initial position, accented positions, and stressed positions (Pierrehumbert and Talkin 1992; Dilley et al. 1996), show higher degrees of strengthening than less prominent domains (Fougeron 2001). Such strengthening in prosodically strong positions could be beneficial to a listener for the reasons outlined below in (15).
1. Segmentation: “strengthening could help with segmentation of the signal into words and higher domains.”

2. Identify Boundaries: “the degree of strengthening could possibly tell the listener about the strength of the prosodic boundaries.”

3. Lexical Access: “if initial strengthening enhances the segment-specific articulations of consonants and vowels, then it could enhance cues that aid in identifying each segment.”

(Fougeron and Keating 1997: 3738)

Borroff (2007) adds that fortition through glottal stop epenthesis could also prevent coarticulatory effects from other neighboring segments, helping in both the vowel target’s and word’s identification.

Word-initial and stressed positions are also special positions in Spanish, as the same tendencies of preservation and fortition hold true in Spanish-specific studies. In an analysis of hiatus maintenance and resolution through diphthongization in Spanish, Chitoran and Hualde (2007) argue that both word-initial vowel sequences and stressed/pretonic vowel sequences are strong positions particularly unlikely to undergo reduction through diphthongization. That is, Chitoran and Hualde contend that in these strong positions, hiatus is maintained much more than in other environments. For example, words with stressed or pretonic vowel sequences, e.g. diálogo ‘dialogue’, are more likely to maintain the hiatus than words with vowel sequences farther from stress, e.g. dialogó ‘he/she dialogued’ (Hualde 1997, 1999, 2005, and Colina 1999), and the first
vowel sequences of the word, e.g. biólogo, are also more likely to maintain hiatus over other vowel sequences later in the word, e.g. radiólogo ‘radiologist’.

Chitoran and Hualde (2007) also note that hiatus maintenance is higher when a morphological boundary comes between two adjacent vowels, e.g. boquiancho ‘widemouthed’ (Navarro Tomás 1948, Hualde 1997, and Hualde 1999), and the authors posit that these strong positions may be more resistant to diphthongization because of their duration: initial and stressed/pretonic vowel sequences were measured as longer than other vowel-vowel sequences, which may decrease their chances of reduction. This durational account also helps to explain the special behavior of word-initial stressed vowels in my data. Vowel sequence reduction preferences are illustrated below in (16).

(16) hiatus > reduction\textsuperscript{49} > diphthongization > deletion (Monroy 1980)

While the reductionist processes used to resolve hiatus in (16) are unlikely in strong positions, fortition processes are more likely: in strong positions, hiatus may be resolved through consonantal epenthesis, which strengthens rather than reduces the division between the adjacent vowels. This fortition relationship is illustrated below in (17).

(17) $V_1V_2$ (hiatus) > $V_1CV_2$

Other tendencies also point to the specialness of word-initial position and stressed position across dialects of Spanish. First, word-initial vowels are regularly maintained if postlexical hiatus is resolved with deletion in Mexican Spanish, e.g. la iglesia ‘the church’ becomes [liɣle.sja] (Hernández 2009), not [laɣle.sja], regardless of the stress of

\textsuperscript{49} Barberia (2012) explains that vowel reduction as a hiatus resolution strategy involves a shortening of one of the vowels in the vowel-vowel sequence and a loss of some acoustic cues, resulting in monosyllabification (Aguilar 2003). Centralization is not necessarily involved in this reduction.
the word-initial vowel. Second, in /s/-reducing dialects of Spanish, intervocalic, word-final /s/ is maintained much more before a word-initial stressed vowel than before an unstressed vowel (Poplack 1979, Terrell 1979, López Morales 1980, Alba 1982, and Dohotaru 1998). For example, the intervocalic /s/ in las olas ‘the waves’, with a stressed /o/, is more likely to be produced with unreduced sibilance than in las olitas ‘the little waves’, with an unstressed /o/. In Spanish, this word-final intervocalic /s/ resyllabifies from coda to onset position, and the [s] is more stable before a stressed vowel.

The tendency to find more unreduced [s] before a word-initial stressed vowel is echoed by the tendency for a glottal stop to be found more commonly in this position as well (Lope Blanch 1987, Sanicky 1989, Tellado González 2007), supporting the notion that consonantal fortition is more likely through [s] retention or glottal stop use in this particularly stable position than lenition. In these strong positions in Spanish, lenition (or hiatus resolution through diphthongization) is unlikely, but fortition ([s] maintenance or glottal stop use) is more likely.

The preceding discussion on word-initial and stressed vowels’ resistance to lenition paired with the linguistic tendency to strengthen word-initial, prosodically prominent domains helps to explain the effect of a following stressed vowel on glottal stop realizations. The use of a glottal stop before a word-initial, stressed vowel not only protects this special position from postlexical hiatus, it also serves as an onset, strengthening the prosodically prominent position.
6.1.2 Paired word class

Paired word class, or the combination of a particular preceding and following word class, also emerged as a significant predictor of the glottal stop realization in the model that pitted the glottal stop against other realizations across all tasks. Table 90 below shows the effect of different word pairings on the glottal stop’s likelihood, showing the ranking of the pairings in influencing glottal stop likelihood. 1 indicates that the pairing increases glottal stop likelihood the most, and the highest number indicates that the glottal stop is least likely with that pairing. Intermediate ratings, i.e. 2 and 3, indicate that the glottal stop is the second-most and third-most likely with those pairings, respectively. These rankings were determined based on the statistical analyses presented in chapter 5.

<table>
<thead>
<tr>
<th>Word Pairing</th>
<th>Most Likely to Increase Glottal Stop Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determiner + Noun</td>
<td>1</td>
</tr>
<tr>
<td>Noun + Adjective</td>
<td>2</td>
</tr>
<tr>
<td>Other pairs</td>
<td>3</td>
</tr>
<tr>
<td>Verb + Any word class</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 90: Effect of paired word class across tasks on glottal stop in the V/s/#V environment.50

As table 90 illustrates, a glottal stop is the most likely between a determiner and a noun, e.g. las ostras ‘the oysters’, and least likely between a verb and any word class, e.g. caminamos a ‘we walk to’. Glottal stop use is also more likely when a noun is followed

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50 These tables are for data visualization purposes and not all the differences among the levels of each factor are significant. Refer to chapter 5 to see all the significant differences.
by an adjective, e.g. amigos altos ‘tall friends’ than it is between any other word pairings, e.g. cosas hacen ‘things they make’.

Based on the results shown in table 90 above, it seems to be the case that some high frequency strings like determiner-noun are more conducive to glottal stop use than less frequent word pairings, such as noun-preposition, e.g. cosas en ‘things in’. However, the glottal stop is not particularly likely between verb-any word class pairings, even those this string is also high frequency: approximately 70% of the words following verbs are prepositions, and Alba (2006) refers to both determiner-noun and verb-preposition strings as high frequency groupings. In order to understand the difference in glottal stop likelihood in high frequency determiner-noun and verb-preposition pairings, we must first look at deletion rates. An important observation is that full deletion is less common between more common word pairs in my data, shown below in table 91.

<table>
<thead>
<tr>
<th>Other pairs</th>
<th>Most Likely to Increase Deletion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noun + Adjective</td>
<td>2</td>
</tr>
<tr>
<td>Determiner + Noun</td>
<td>3</td>
</tr>
<tr>
<td>Verb + Any word class</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 91: Effect of paired word class across tasks on deletion in the V/s/#V environment.

Verbs followed by prepositions were not separated from verbs followed by other word classes in these analyses for several reasons. First, the vast majority of words following verbs were prepositions (approximately 70%). Secondly, even those following words that were not prepositions showed similar variant behavior to the verb-preposition pairing. That is, the most common variant between verbs and prepositions is aspiration, and aspiration is also the most common variant for the few examples of other following word classes. I contend that speakers are less likely to use a glottal stop following verbs because of their high frequency collocation with an unstressed preposition, which creates a tendency to aspirate postverbally. Only 13 realizations of the glottal stop following a verb occur: two of these precede an unstressed preposition while three precede an unstressed non-preposition. There is some increase in glottal stop use before a stressed vowel in a non-preposition: eight glottal stop realizations take place before a stressed vowel in these verb + non-preposition pairings.
Tables 90 and 91 demonstrate that full deletion is least likely between verbs followed by any word class, which are overwhelmingly prepositions, and between determiners and nouns. Both determiner-noun and verb-preposition pairings are high frequency strings in Spanish (Alba 2006), and both tend to undergo reduction to the point of deletion in Nicaraguan Spanish less than other, less frequent strings. Noun-adjective pairings, which are less common than determiner-noun and verb-preposition pairings, are the third least likely to undergo full deletion, while infrequent “other” pairings show the highest likelihood of deletion. In other words, the most frequent strings show full /s/ deletion the least, while the least frequent strings show /s/ deletion the most.

Other studies on /s/-reducing dialects of Spanish help explain the results for Nicaraguan Spanish, and several have shown that /s/ retention is highest after a determiner (Ma and Herasimchuk 1971; Cedergren 1973). This supports Bybee (2000a, 2000b, 2001, 2002a, 2002b, 2006), who suggests that determiner + noun pairings and other high frequency strings may be stored in the mind as a single entity and are therefore subject to phonetic reduction as whole units. In the dialects investigated by Ma and Herasimchuk (1971) and Cedergren (1973), Puerto Rican and Panamanian Spanish, word-internal, prevocalic /s/ reduction is uncommon; the same is true of Nicaraguan Spanish. Rather, in these dialects the prevocalic /s/-weakening that occurs is word-final, not word-internal. However, if high frequency strings are stored in the mind as a single unit, a reanalysis of the boundaries may also be taking place, with speakers viewing what is word-final intervocalic /s/ as a unit-internal intervocalic /s/ in these high frequency strings. Such a mental organization may play an important role in limiting full deletion.
when an /s/-final verb is followed by a vowel-initial preposition or an /s/-final determiner is followed by a vowel-initial noun.

Other studies have suggested that high frequency pairings behave differently than low frequency pairings in regards to hiatus resolution as well. In New Mexican and Colorado Spanish Alba (2006) finds that there are higher rates of diphthongization in high frequency strings than in low frequency strings. In his GoldVarb analysis, Alba shows that strings containing two word classes that are likely to commonly co-occur, e.g. article + noun or verb + preposition, are also more likely to show hiatus resolution (occurring in 86% of the utterances) than all other strings (67%). He also shows that high frequency words, or the 30% most frequently uttered words in Spanish, show hiatus resolution more frequently (86%) than less common words (70%). Alba concludes that these frequency effects support Bybee’s (2001) argument that strings appear to be stored in memory as chunks rather than as individual lexical units, as high frequency strings behave differently than lower frequency strings.

To summarize, previous research has indicated that /s/ retention is highest between determiner-noun pairings in /s/-reducing dialects of Spanish and that high frequency determiner-noun and verb-preposition pairings show higher rates of hiatus resolution through diphthongization than less frequent word pairings. I have shown that in Nicaraguan Spanish deletion rates are lowest between high frequency determiner-noun pairings and between verb-preposition pairings. But why is there not more [s] retention between these high frequency pairings and why do we see a difference in variant use between determiner-noun and verb-preposition pairings if they are both high frequency
strings? An exploration of glottal frication likelihood, shown below in table 92, helps to answer this question.

<table>
<thead>
<tr>
<th>Most Likely to Increase Glottal Frication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb + Any word class</td>
</tr>
<tr>
<td>Other pairs</td>
</tr>
<tr>
<td>Noun + Adjective</td>
</tr>
<tr>
<td>Determiner + Noun</td>
</tr>
</tbody>
</table>

Table 92: Effect of paired word class across tasks on aspiration in the V/s/#V environment.

Table 92 shows that glottal frication is the most likely following verbs and the least likely between determiner-noun pairings, exactly the opposite of the patterning of the glottal stop. In section 6.5 I argue that the word-final, intervocalic segment in question is not /s/ for Nicaraguan speakers but rather /h/, which explains the lack of sibilant retention between high frequency strings in Nicaraguan Spanish: the speakers are retaining their underlying segment more between these high frequency strings, but this underlying segment is actually glottal frication.

The answer as to why the high frequency determiner-noun and verb-preposition pairings behave differently has to do with the effect of another predictor entirely: following stress. While both pairings are high frequency and both avoid full deletion more than less frequent word pairings, there are stress differences between the first vowel in nouns and the first vowel in prepositions. An initial stressed syllable is commonly observed in nouns, e.g. las olas ‘the waves’, unas horas ‘some hours’, mis uñas ‘my nails’.

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Following Spanish stress rules, word-initial stress is the norm with following two-syllable words, and word-initial stress may also occur with three-syllable words, e.g. *mis ídolos* ‘my idols’. As shown in section 6.1.1, a glottal stop is more likely when the following vowel is stressed, which serves to strengthen this special initial position. When the following vowel is stressed, the glottal stop occurs in 73.3% of determiner-noun pairs compared to 42.6% for noun-adjective pairs, 46.7% for other pairings, and 61.5% for verb-any word class pairings. In other words, the rate of glottal stop use is higher between determiners and nouns than between other any combination of word pairings when the following vowel is stressed. However, the seemingly different behavior of the determiner-noun environment can be explained by the tendency for higher rates of following stressed vowels in the data: a following stressed vowel occurs in 45.2% of determiner-noun pairings compared to only 28.7% in noun-adjective pairings, 24.3% of other word pairings, and 27.3% of verb-any word class pairings. Speakers recognize the likelihood of a stressed vowel after /s/ in determiner-noun pairings and strengthen their production accordingly.

On the other hand, prepositions tend to be unstressed function words (Navarro Tomás 1977), and the unstressed prepositions *a* ‘to’ or *en* ‘in’ most commonly follow verbs. As shown in section 6.1.1, the glottal stop is less likely before these unstressed vowels. Rather than fortition with a glottal stop, the underlying segment is maintained in production without strengthening.52

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52 Scott Schwenter (p.c. April 14, 2013) notes that in future studies a more fine-grained classification of collocations could reveal more details, e.g. differences between grammatical vs. lexical distinctions for *vamos a* ‘we are going to’.
In both high frequency pairings (determiner-noun and verb-preposition), some intervocalic glottal realization is likely to be maintained, preserving the physical presence of the underlying segment in production. However, the variant that is produced depends on another linguistic factor: the stress of the following vowel. Fortition (use of the glottal stop) is more common when the following vowel is stressed, and unstrengthened use of [h], the underlying segment, is more common when that following vowel is unstressed. (See section 6.5 for a discussion of the underlying representation.) The fact that full deletion is less likely between high frequency pairings like determiner-noun, verb-preposition, and noun-adjective (refer to table 41) continues to support Bybee’s (2000a, 200b, 2001, 2002a, 2002b, 2006) argument that high frequency strings may be stored in memory as a single unit. Because these strings may be stored in memory as a single unit, full deletion occurs in these environments the least. In high frequency strings the intervocalic, word-final segment is viewed instead as unit internal, and deletion is less likely between vowels word-internally.

### 6.1.3 Preceding word length

Section 5.3.1 shows that preceding word length also conditions glottal stop realizations in the data. Table 93 below illustrates the effect of word length.
As shown above in table 93, the glottal stop is significantly more likely following words of four or more syllables than following shorter words of one or two syllables. The difference between preceding words of four or more syllables and preceding words of three syllables also approaches significance in the multiple comparison of means in chapter 5.

Previous studies have noted the importance of word length on /s/ retention rates: Terrell (1979) and Dohotaru (1998) note that /s/ retention is more likely with monosyllabic words in Cuban Spanish than polysyllabic words, and Ruiz-Sánchez (2004) finds the same trend in Venezuelan Spanish. Terrell (1979) also finds that full elision is more frequent following longer words, regardless of the type of /s/, i.e. lexical, plural, or verbal. The same results emerge in my study as well: in Nicaraguan Spanish, full deletion is significantly more likely following words of three, four, or more syllables than it is following shorter words of just one or two syllables. Higher rates of full elision following longer words seems to be a trend across multiple /s/-reducing dialects of Spanish.

File-Muriel (2007) explains the higher rates of deletion following longer words in dialects of Spanish through lexical accessibility. He argues that as more phonological material becomes available to the listener, the overall importance of each information-carrying unit decreases; given the additional phonological material earlier in the word,
the listener is able to access the lexical unit, recognizing the word without each individual sound. Méndez Dosuna (1985) notes that time constraints likely play a role in longer words as well: he finds that individual units become shorter in longer Spanish words, and Johnson (2004) shows that in English longer words undergo ‘massive reduction’. More reduction in longer words appears to be a trend across languages.

While deletion is more likely following longer words, aspiration is actually less likely in this exact environment: table 74 in chapter 5 shows that aspiration is significantly more likely following shorter words of one or two syllables than it is following longer words of three, four, or more syllables. In other words, aspiration tends to occur following shorter words, while full deletion and glottal stop use are more likely following longer words.

However, with more deletion following longer words comes more dispreferred hiatus in the same environment: it is more likely that following longer words two heterosyllabic vowels will be adjacent across the word boundary. Full deletion of a word-final segment creates hiatus, which, as noted by Alonso (1930), Quilis (1999) and Frago-Gracia and Franco-Figueroa (2001), is a dispreferred construction across almost all dialects of Latin American Spanish. In order to resolve postlexical hiatus where it is created the most, the glottal stop is inserted most following longer words in Nicaraguan Spanish, which maximally demarcates between these two adjacent, heterosyllabic vowels and resolves the postlexical hiatus.
6.1.4 Following vowel

In section 5.3.1 the following vowel factor appeared to condition the glottal stop as well: the glottal stop is significantly more likely with following /o/ than following /a/.

As shown below in table 94, the glottal stop is most likely before a following /o/, followed by a following /u/.

<table>
<thead>
<tr>
<th></th>
<th>Most Likely to Increase Glottal Stop Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>/o/</td>
<td>1</td>
</tr>
<tr>
<td>/u/</td>
<td>2</td>
</tr>
<tr>
<td>/e/</td>
<td>3</td>
</tr>
<tr>
<td>/i/</td>
<td>4</td>
</tr>
<tr>
<td>/a/</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 94: Effect of following vowel across tasks on glottal stop in the V/s/#V environment.\( ^{53} \)

Regardless of the grouping of vowels into categories like place, e.g. high vs. low or front vs. back, or frequency, e.g. the frequent following /a/ and /e/ vs. the less frequent /i/, /o/, and /u/, no significant differences emerged in the analysis. However, the effect of following /o/ is consistent.

As discussed in section 6.1.1, the glottal stop is more likely before a stressed vowel than an unstressed vowel as a fortition strategy, and the vowels that are stressed most commonly in word-initial position are also the vowels that are most likely to condition the glottal stop. When I investigated the relationship between following /o/ and

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\( ^{53} \) Keep in mind that the only statistically significant difference found in the model created in chapter 5 is between the /o/ and /a/ (p < 0.05), and the difference between /o/ and /i/ approaches significant (p < 0.1).
following stress, I found more overlap in the data between following stressed vowels and following /o/ than with any other vowel, shown below in the table 95 cross-tab.

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>e</th>
<th>i</th>
<th>o</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unstressed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75% (N = 865)</td>
<td>71% (N = 729)</td>
<td>63% (N = 372)</td>
<td>53% (N = 245)</td>
<td>57% (N = 267)</td>
</tr>
<tr>
<td><strong>Stressed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25% (N = 289)</td>
<td>29% (N = 294)</td>
<td>37% (N = 223)</td>
<td>47% (N = 215)</td>
<td>43% (N = 202)</td>
</tr>
<tr>
<td><strong>Total N</strong></td>
<td>1,154</td>
<td>1,023</td>
<td>595</td>
<td>460</td>
<td>469</td>
</tr>
</tbody>
</table>

Table 95: Cross-tab for following stress and following vowel.

As table 95 shows, following /o/ is a stressed vowel more frequently than any other vowel, followed by following /u/.

In other words, it is not the case that the glottal stop is more likely before certain following vowels depending on their quality; it is simply the distribution of the data that brings about this result. Because this effect is simply the result of confounded data, the effect of following vowel will not be discussed further in this chapter.

6.1.5 Task

Task also emerged as a significant predictor of the glottal stop, which means that the use of the glottal stop is not necessarily the same in each task. Table 96 below shows the tasks in which the glottal stop is the most and least likely.
<table>
<thead>
<tr>
<th>Task</th>
<th>Most Likely to Increase Glottal Stop Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>1&lt;sup&gt;54&lt;/sup&gt;</td>
</tr>
<tr>
<td>Image Identification</td>
<td>1</td>
</tr>
<tr>
<td>Sociolinguistic Interview</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 96: Effect of task on glottal stop use in the V/s/#V environment.

Table 96 shows that the glottal stop is the most likely in the image identification and the reading task, and it is the least likely in the sociolinguistic interview. It should be noted that the glottal stop likelihood appears to be related to the formality of each task: the glottal stop is most common in the more formal tasks that require the participant to complete a specified activity, and the glottal stop is the least common in the most naturalistic, conversational task.

Table 10 from chapter 5, repeated below in table 97 for convenience, shows the changes in the glottal stop’s frequency across tasks in relation to the other variants.

<table>
<thead>
<tr>
<th>Phonetic Realization</th>
<th>% Difference Across Tasks</th>
<th>Sociolinguistic Identification %</th>
<th>Image Identification %</th>
<th>Reading %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspiration</td>
<td>-37.2%</td>
<td>44.9% (734)</td>
<td>16.6% (72)</td>
<td>7.7% (126)</td>
</tr>
<tr>
<td>Sibilant + Glottal Constriction</td>
<td>+32.8%</td>
<td>0.4% (7)</td>
<td>19.9% (86)</td>
<td>33.2% (541)</td>
</tr>
<tr>
<td>Deletion</td>
<td>-26.4%</td>
<td>35.5% (581)</td>
<td>15.3% (66)</td>
<td>9.1% (148)</td>
</tr>
<tr>
<td>Sibilance</td>
<td>+21.5%</td>
<td>9.8% (161)</td>
<td>25.4% (110)</td>
<td>31.3% (511)</td>
</tr>
<tr>
<td>Glottal Stop</td>
<td>+12.1%</td>
<td>4.5% (73)</td>
<td>16.6% (72)</td>
<td>12.4% (202)</td>
</tr>
<tr>
<td>Creaky Voice</td>
<td>+1.4</td>
<td>4.9% (81)</td>
<td>6.2% (27)</td>
<td>6.3% (103)</td>
</tr>
</tbody>
</table>

Table 97: Differences across tasks with increasing formality, listed from greatest difference to smallest.

<sup>54</sup> Looking at percentages alone, the glottal stop is more frequent in the image identification task than in the reading task. However, the small sample size from the image identification task decreases its predictive ability in the statistical models. In the binomial logistic regression models with mixed effects the glottal stop is significantly more likely in both the reading task and the image identification task than in the sociolinguistic interview, but the p-value is smaller for the reading task than for the image identification task. For this reason, both the image identification and reading task are rated as most predictive of the glottal stop. The most important point is that the glottal stop is less common in the informal task than it is in the formal tasks.
The above table shows that aspiration and deletion rates decrease with increasing rates of formality, going from the most frequent variants in the informal sociolinguistic interview (44.9% and 35.5% of the data, respectively) to the two least frequent variants in the more formal reading task (7.7% and 9.1% of the data, respectively). On the other hand, the glottal stop patterns with sibilance and sibilance followed by glottal constriction: as formality increases, the frequency of these variants increases as well. Sibilance and sibilance followed by glottal constriction increase from 9.8% and 0.4% of the data in the sociolinguistic interview, respectively, to 31.3% and 33.2% of the data in the reading task.

The difference in the frequency of the glottal stop from the less formal to more formal tasks is not as extreme as the differences found for the other variants: while aspiration, deletion, sibilance, and sibilance followed by glottal constriction exhibit % differences of 37.2%, 26.4%, 21.5%, and 26.4% from the sociolinguistic interview to the reading tasks, respectively, the use of the glottal stop only increases by 12.1% from the sociolinguistic interview to the image identification task. It is also the only variant that does not progressively increase or decrease from the sociolinguistic interview to the reading task; the use of the glottal stop is the lowest in the sociolinguistic interview and highest in the image identification task, with its use in the reading task falling between these two extremes.\(^{55}\) In other words, while deletion and aspiration are strongly associated with the more informal tasks and sibilance and sibilance followed by glottal

\(^{55}\) It should be noted that the statistical analysis in section 5.3.1 finds a greater statistical difference between the sociolinguistic interview and the reading task than between the sociolinguistic interview and the image identification task, but both comparisons are statistically significant in the original model. This crossover is likely due to the overall low number of realizations in the image identification task.
constriction are strongly associated with the more formal tasks, the glottal stop is not as clearly linked to more formal or more informal registers as these other variants. The same is true of creaky voice, which exhibits the least change from the sociolinguistic interview to the reading task, increasing in use by only 1.4%. Glottal constriction’s relationship with extralinguistic factors such as task, age, and education levels will be explored in greater detail in section 6.3.

6.2 The glottal stop in relation to the other variants by factor

In this section we discuss the behavior of all the variants in relation to each other by exploring the factors’ effect on each variant. How do these complex variant relationships unfold in the participants’ speech? The following sections discuss the influence of all of the factors significant to more than one variant in the V/s/#V environment in order to show the directionality of all these variants in relation to one another.

6.2.1. Following stress

Section 6.1.1 showed the significance of following stress in glottal stop realizations, but following stress impacts the other variants as well. Table 98 below rates the levels of the factors based on which levels increase the variant’s likelihood the most
and which increase the variant’s likelihood the least. The number 1 means the variant is most likely with that level of the independent variable, and the highest number means the variant is least likely with a certain level. If no numbers are provided for a variant, the factor is not significant in the model and therefore the levels of the variant are not discussed.

Table 98: Effect of following stress on glottal stop, creaky voice, deletion, aspiration, sibilance alone, sibilance followed by a glottal stop, and sibilance followed by creaky voice in the V/s/#V environment.

<table>
<thead>
<tr>
<th>Following Stress</th>
<th>Glottal Stop</th>
<th>Creaky Voice</th>
<th>Deletion</th>
<th>Asp.</th>
<th>Sib.</th>
<th>Sib. + GS</th>
<th>Sib. + CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stressed</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstressed</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Table 98 shows that the glottal stop and sibilance followed by a glottal stop follow the same pattern: when the following vowel is stressed, both variants are more likely to occur. However, the other variants affected by following stress, including deletion, aspiration, and sibilance, show the opposite trend: the use of these variants increases when the following vowel is unstressed. As discussed in section 6.1, the glottal stop is a fortition device in strong positions, and it appears that sibilance followed by a glottal stop behaves in the same way. Unsurprisingly, deletion and aspiration occur in weak environments, appearing more before unstressed vowels. The only unexpected result in the table above is the behavior of [s]. In other /s/-reducing dialects of Spanish, sibilance is retained more before stressed vowels than before unstressed vowels (Terrell 1979, Dohotaru 1998), but the opposite takes place in the Nicaraguan data: [s] is more likely
with a following unstressed vowel, much like aspiration and deletion. This suggests that
sibilance in Nicaraguan Spanish behaves differently in this environment than sibilance in
other dialects of Spanish, likely due to the presence of other variants in Nicaraguan
Spanish, i.e. the glottal stop and sibilance followed by the glottal stop. In Nicaraguan
Spanish, [s] followed by a glottal stop appears to be the speakers’ fortition strategy
involving sibilance, while [s] alone patterns more like glottal frication and elision in
relation to stress.

6.2.2. Task

Task is another factor selected as significant in several models fitted to the
variants. In table 99 below, each level of the factor is ranked by how much it increases a
variant’s likelihood in the data.

<table>
<thead>
<tr>
<th>Task</th>
<th>Glottal Stop</th>
<th>Creaky Voice</th>
<th>Deletion</th>
<th>Asp.</th>
<th>Sib.</th>
<th>Sib. + GS</th>
<th>Sib. + CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview</td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ident.</td>
<td>1</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Reading</td>
<td>1&lt;sup&gt;26&lt;/sup&gt;</td>
<td></td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 99: Effect of task on glottal stop, creaky voice, deletion, aspiration, sibilance alone, sibilance followed by a glottal stop, and sibilance followed by creaky voice in the V/s/#V environment.

<sup>26</sup> Refer to table 96 for an explanation of the glottal stop’s ranking based on task.
Table 99 shows which variants are more likely in the informal tasks and which variants are more likely in the formal tasks. Unsurprisingly, all variants involving sibilance are much more likely in the more formal reading task and least likely in the casual sociolinguistic interview. On the other hand, aspiration and deletion are much more common in the casual sociolinguistic interview than in the formal reading task. The glottal stop is more likely in the more formal reading task than the casual sociolinguistic interview. A more detailed discussion including task-specific analyses and explanations for these task-based differences will be provided in section 6.3, which focuses entirely on the linguistic and social differences across tasks.

6.2.3. Preceding word length

The number of syllables in the preceding word, i.e. the word containing final /s/, was a significant predictor for all the variants except the complex sibilant variants. The ranking of the levels most predictive to a variant’s use are shown below in Table 100.

<table>
<thead>
<tr>
<th>Preceding Word Length</th>
<th>Glottal Stop</th>
<th>Creaky Voice</th>
<th>Deletion</th>
<th>Asp.</th>
<th>Sib.</th>
<th>Sib. + GS</th>
<th>Sib. + CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+ Syll.</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Syll.</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Syll.</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Syll.</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 100: Effect of preceding word length on glottal stop, creaky voice, deletion, aspiration, sibilance alone, sibilance followed by a glottal stop, and sibilance followed by creaky voice in the V/s/#V environment.
While the directionality of the levels’ effect is not perfectly ascending or descending for each variant, a pattern does emerge: the glottal stop, creaky voice, and deletion tend to be more likely following longer words, while aspiration and sibilance tend to be more common following shorter words. I argue in section 6.1.3 that where deletion is more likely and consequently where more postlexical hiatus is created, i.e. following longer words, the glottal stop will also be more likely to maximally demarcate between adjacent, heterosyllabic vowels and resolve the dispreferred hiatus. Following shorter words where postlexical hiatus is not as likely, other variants are more common.

6.2.4. Paired word class

The pairing of certain preceding and following word classes also influences the likelihood of several variants, as shown below in table 101.

<table>
<thead>
<tr>
<th>Paired Word Class</th>
<th>Glottal Stop</th>
<th>Creaky Voice</th>
<th>Deletion</th>
<th>Asp.</th>
<th>Sib.</th>
<th>Sib. + GS</th>
<th>Sib. + CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Det. + Noun</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Noun + Adj.</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Verb + Any</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Other Pairs</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 101: Effect of paired word class on glottal stop, creaky voice, deletion, aspiration, sibilance alone, sibilance followed by a glottal stop, and sibilance followed by creaky voice in the V/s/#V environment.
Particularly of note in table 101 is the relationship between the variants and the high frequency pairings. The variants associated thus far with fortition, namely the glottal stop and sibilance followed by a glottal stop, are more likely between high frequency determiner-noun pairings with a high rate of stressed vowels following the word boundary, and aspiration is most likely between verbs and any word class, namely prepositions, with a high rate of unstressed vowels following the word boundary. See section 6.1.2 for a more detailed discussion of the role of paired word class (and stress) in relation to the variants. On the other hand, deletion is more likely between word pairings that are less frequent, i.e. other word pairings and noun-adjective pairings. Interestingly, paired word class is not a significant predictor of sibilance, which again suggests that [s] does not pattern like it does in other varieties of /s/-reducing Spanish, where [s] is most likely to be preserved between high frequency determiner-noun pairings (Ma and Herasimchuk 1971; Cedergren 1973).

6.2.5 Summary

This section has demonstrated that a complex interplay is at work among all the variants. With respect to following stress, the glottal stop and sibilance followed by a glottal stop serve as a fortition strategy before stressed vowels, while deletion, aspiration, and sibilance are more likely to appear before unstressed vowels. Formality also affects most of the variants, with deletion and aspiration occurring more frequently in the casual tasks, while sibilant realizations and the glottal stop are more likely in the more formal
tasks. The length of the preceding word is also a common predictor of the variants: deletion, creaky voice, and glottal stop use are more likely following longer words, while aspiration and sibilance are more likely following shorter words. Finally, paired word class also influences most variants: the glottal stop and sibilance followed by the glottal stop are more likely in high frequency strings with following stressed vowels at the word boundary, i.e. determiner-noun pairings, while aspiration is more likely in high frequency strings with a following unstressed vowel at the word boundary, i.e. verb-preposition pairings. Deletion is more likely in less frequent pairings.

Before moving on, I would like to point out that linguistically the glottal stop and sibilance followed by the glottal stop behave very similarly: both are more likely with a following stressed vowel and between high frequency determiner-noun pairings. In other dialects of Spanish with /s/ lenition including Cuban, Puerto Rican, and Panamanian Spanish, sibilance (without a following glottal stop) is most likely to be maintained before a following stressed vowel (Terrell 1979; Dohotaru 1998) and between determiner-noun pairings (Ma and Herasimchuk 1971; Cedergren 1973). However, in Nicaraguan Spanish sibilance alone is actually less likely with a following stressed vowel and paired word class is not a significant predictor of the variant. Based on these facts, it appears that the fortition strategy at work in Nicaraguan Spanish involves variants other than sibilance, namely the glottal stop and sibilance followed by the glottal stop.

Up to this point in chapter 6, the analysis of the glottal stop and the other variants occurring in the same environment has included their appearance across all tasks. In an analysis combining a variant’s realizations across all tasks, we assume that the variant in
question behaves similarly in all the tasks, regardless of the task’s formality or the oral or written nature of the task. However, as shown in chapter 5, new factors emerge as significant predictors of the glottal stop in task-specific models that were neutralized in the model including all tasks, particularly social factors. In order to tease apart these task-based differences, a more detailed discussion is needed. In section 6.3, the linguistic and social factors that condition the variants differently based on level of formality are discussed across the study’s three tasks.

6.3 Task-based differences in the V/s/#V environment

In this section I explore the differences in glottal stop use based on task. Section 6.3.1 investigates language internal differences based on task, and section 6.3.2 addresses the interesting social differences observed when the tasks are analyzed separately. More specifically, 6.3.2.1 explores age-based differences and 6.3.2.2 details the differences based on education.
6.3.1 Linguistic differences based on task

Few interesting internal differences are found when the data are analyzed by task individually. The most notable differences are what factors do not emerge as significant within each task, but this is rather unsurprising due to the lower number of tokens available when the tasks are separated.

One factor is consistently significant in each task: the stress of the following vowel conditions the glottal stop in the sociolinguistic interview, the image identification task, and the reading task. In each of these tasks, the glottal stop is always more likely when the following vowel is stressed. As the glottal stop serves to strengthen the special position of word-initial, stressed vowel, this consistency is expected.

Some differences are found in a comparison of the tasks. For example, while paired word class is a significant predictor of the glottal stop in the sociolinguistic interview and reading task, this factor is not significant in the image identification task. However, this is likely due to the low number of tokens in the image identification task: there are the fewest tokens available from the image identification task, as it was the shortest task with only ten images to identify. Finally, preceding word length is only significant in the reading task and does not emerge as a significant predictor of the glottal stop in the sociolinguistic interview or image identification task, likely due to the high number of longer words available in the reading task. Preceding words of four or more syllables in the interview or image identification task were relatively rare.
6.3.2 Social differences in each task

More interesting comparisons can be made among the social factors in the individual tasks. While no social factors emerged as significant in the model combining all three tasks, we see in the models broken down by task that the differences that do exist are simply disguised when all three tasks are combined: because the social groups use the glottal stop differently in the three tasks, their effects are neutralized when combined.

Two social factors show significant differences in these task-based analyses: age and education, and a discussion of these two factors will take place in this section. An interaction between age and education was tested in the models presented in chapter 5, but it was not significant, which indicates that there are not differences within each age group based on different education levels and vice versa. In order to show the distribution of glottal stop use given these social factors, the cross tabulation based on both age and education is provided below in table 102.

<table>
<thead>
<tr>
<th></th>
<th>No HS Diploma</th>
<th>HS Diploma</th>
<th>College Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9.5% (N = 33)</td>
<td>12.4% (N = 43)</td>
<td>7.8% (N = 27)</td>
</tr>
<tr>
<td>Mid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.1% (N = 35)</td>
<td>11% (N = 38)</td>
<td>6.9% (N = 24)</td>
</tr>
<tr>
<td>Older</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13.3% (N = 46)</td>
<td>21% (N = 73)</td>
<td>8.1% (N = 28)</td>
</tr>
</tbody>
</table>

Table 102: Cross tabulation of glottal stop use (N) by age and education.
Table 102 shows that glottal stop use is higher for both the older and non-college educated participants. That is, glottal stop use is higher for older speakers within each of the three education levels as well as for the non-college educated participants within each of the age groups. Based on this distribution and the lack of interaction in the models constructed in chapter 5, the two social variables will be discussed separately throughout this section.\footnote{The inclusion of more speakers would help reveal an interaction between age and education if an interaction exists. However, no interaction seems to be present in my current data.}

In spite of the gender differences commonly found in /s/-reducing dialects of Spanish (Cedergren 1973, López Chavez 1977, Cepeda 1995, Dohotaru 1998), gender does not condition the glottal stop in Nicaragua. In fact, gender does not condition any realization of /s/: gender was not selected as a significant predictor of sibilance, aspiration, or even deletion. In the case of Nicaraguan Spanish, women are not more likely to opt for the conservative variant than men. Rather, the social factors of age and education are the only ones that condition variant selection in the dialect.
6.3.2.1 Social differences based on age

Age emerges as a significant predictor of glottal stop use in the models restricted to the sociolinguistic interview and to the reading task, but the age groups behave differently in these two tasks. Tables 103 and 104 below show the relationship between age groups and glottal stop likelihood in the sociolinguistic interview and the reading task, respectively.

<table>
<thead>
<tr>
<th>Sociolinguistic Interview</th>
<th>Age Group</th>
<th>Most Likely to Increase Glottal Stop Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Youngest</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Middle</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Oldest</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 103: Effect of age on glottal stop use in the sociolinguistic interview.

<table>
<thead>
<tr>
<th>Reading Task</th>
<th>Age Group</th>
<th>Most Likely to Increase Glottal Stop Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oldest</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Middle</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Youngest</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 104: Effect of age on glottal stop use in the reading task.

As table 103 shows, in the more informal sociolinguistic interview, the youngest group uses the glottal stop more than the oldest group. However, in the more formal reading task above, it is actually the oldest group that uses the glottal stop more than the youngest group, with the middle age group falling between the two. These age-related differences
based on task can actually be explained by the influence of other variants in formal speech.

Younger speakers have more recently been in contact with prescriptive norms in the school system, while older speakers are more removed from these prescriptive influences (Labov 1972). Instead of exposing students to local norms, educational systems teach the global, prescriptive norms of Standard Spanish, which includes sibilance in coda position instead of aspiration or deletion. My youngest participants showed the greatest prescriptive influence: only in the youngest age group did participants actually use distinción in the reading task, producing the Peninsular Spanish [θ] for /θ/, a phoneme that has merged with /s/ in Latin American Spanish. Distinción is not found in Nicaraguan Spanish or in Latin America (Lipski 1994). Their use of this allophone was not regular, and when asked why they were approximating distinción, my younger participants told me that that is what they had been taught was correct in school. The fact that the youngest speakers approximated this Peninsular norm and speakers from other age groups did not supports the notion that those individuals most recently in the school system are more affected by the global, prescriptive Spanish norms taught in school.\footnote{I would like to note that these notions of “standard” or “prescriptive” Spanish have more to do with what is perceived to be globally prestigious or correct by the speakers of Nicaraguan Spanish.}

The effect of prescriptive influences becomes clearer when different age groups’ use of all the variants is explored in each task. Table 105 below shows the different age groups’ use of the variants in the sociolinguistic interview, the image identification task, and the reading task.
<table>
<thead>
<tr>
<th>Phonetic Realization</th>
<th>Age Groups in Socio Interview</th>
<th>Age Groups in Image Identification</th>
<th>Age Groups in Reading Task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Young : Mid : Old</td>
<td>Young : Mid : Old</td>
<td>Young : Mid : Old</td>
</tr>
<tr>
<td>Glottal Stop</td>
<td>6.8% : 4.1% : 2.3%</td>
<td>18.3% : 15.1% : 17.1%</td>
<td>8% : 9.6% : 20%</td>
</tr>
<tr>
<td>Creaky Voice</td>
<td>6.8% : 5.7% : 2.3%</td>
<td>2.9% : 11.9% : 2.9%</td>
<td>4.8% : 7.6% : 6.7%</td>
</tr>
<tr>
<td>Deletion59</td>
<td>34.7% : 26.7% : 44.3%</td>
<td>8.7% : 13.8% : 20.6%</td>
<td>8% : 6.8% : 12.6%</td>
</tr>
<tr>
<td>Aspiration</td>
<td>39.4% : 54% : 42%</td>
<td>6.7% : 14.5% : 24.7%</td>
<td>6.9% : 4.1% : 12.4%</td>
</tr>
<tr>
<td>Sib Alone</td>
<td>11.6% : 8.8% : 9%</td>
<td>35.6% : 29.6% : 15.3%</td>
<td>36.1% : 33.2% : 24.2%</td>
</tr>
<tr>
<td>Sib + Gl Stop</td>
<td>0.4% : 0.2% : 0%</td>
<td>21.2% : 13.8% : 14.1%</td>
<td>31% : 30.4% : 17%</td>
</tr>
<tr>
<td>Sib + Cr Voice</td>
<td>0.4% : 0.4% : 0%</td>
<td>6.7% : 1.3% : 5.3%</td>
<td>5.3% : 8.3% : 7.1%</td>
</tr>
</tbody>
</table>

Table 105: Use of the variants (in %) based on age group in each task.60

As has already been addressed in tables 103 and 104 above, table 105 again shows that the age groups use the glottal stop differently across tasks. To illustrate these differences even more clearly, figure 11 below provides a line graph showing the age group’s use (%) of the glottal stop across tasks.

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59 Deletion conflates fully deleted tokens and the small number of amplitude changes found in the data.
60 Columns may not equal exactly 100%, as percentages were rounded to the nearest tenth.
Figure 11: The age groups’ use of the glottal stop in each task.\textsuperscript{61}

As shown in figure 11 above, the youngest speakers use the glottal stop more than the older speakers in the informal sociolinguistic interview (p = 0.03035), while older speakers use the glottal stop more than the youngest speakers in the more formal reading task (0.022693). The difference between the older and middle age groups’ use of the glottal stop approaches significance in the reading task (0.073021). Interestingly, all groups’ use of the glottal stop increases in the image identification task, and the glottal stop is the only variant to follow this pattern. This pattern, however, goes hand in hand with differences in the use of other variants, which are discussed below.

The biggest difference in variant use from one task to another is found for aspiration, and all age groups follow a similar pattern of use. While aspiration is a very

\textsuperscript{61} Figures 11-23 use different scales to ensure visibility of the groups’ behaviors from one task to another. Please make note of the range of each Y-axis as you read each figure.
common realization in the sociolinguistic interview task for all groups, accounting for 39.4%-54% of all realizations in these three age groups, its use decreases to 4.1%-12.4% of all realizations in the formal reading task. Figure 12 shows the age groups’ similar use of aspiration in the three tasks.

![Aspiration by Age and Task](image)

Figure 12: The age groups’ use of aspiration in each task.

Interestingly, it is the middle age group that uses aspiration the most in casual speech (54%), but these speakers’ use of aspiration decreases quite a bit in the image identification task, even dipping below the other age groups’ use in the reading task. In task-specific models fitted to aspiration, no differences among age groups are significant in the sociolinguistic interview, the middle age group is significantly more likely to use
aspiration than the older age group in the reading task \((p = 0.02738)\), and the older group is significantly more likely to use aspiration than the youngest group in the image identification task \((p = 0.015745)\). The difference between the youngest age group and the middle age group only approaches significance in the image identification task \((p = 0.086629)\), with the middle age group using aspiration the least.

Deletion behaves similarly, decreasing in use with increased formality for all age groups, as illustrated below in figure 13. Again, all age groups follow a similar trajectory across the tasks.

![Deletion by Age and Task](image)

Figure 13: The age groups’ use of deletion in each task.
Of particular importance to the behavior of these different age groups is the fact that the oldest speakers consistently use deletion the most in all tasks. In other words, while deletion rates decrease for all groups in more formal tasks, older Nicaraguans continue to delete more than younger speakers even in the reading task. However, none of the task-based models found significant differences among age groups. Only in the reading task did the difference between the youngest and oldest age groups approach significance (0.0751), with older speakers more likely to delete.

On the other hand, sibilance use follows a very different trajectory: all the age groups use sibilance more as the tasks become increasingly formal, illustrated below in figure 14.

![Sibilance by Age and Task](image)

Figure 14: The age groups’ use of sibilance in each task.

Unlike the age patterning observed with deletion, it is the youngest group that uses sibilance more in all tasks. In the task-specific models fitted to the data the difference
between younger speakers and older speakers was significant in the image identification task (p = 0.01855), with younger speakers more likely to use sibilance. No other comparisons among the levels in the other tasks were significant.

Although there is a clear increase in sibilant use from the sociolinguistic interview to the image identification task and finally the reading task for the middle and older age groups, the youngest group’s sibilant use is approximately the same in both guided tasks, standing at 35.6% in the image identification task and 36.1% in the reading task. This larger jump from the sociolinguistic interview to the image identification task signals the younger speakers’ increased familiarity with formal registers and tasks. The youngest speakers, having more recently gone through the school system, are less removed from school environment expectations, in which they are asked to perform guided tasks such as responding formally to a teacher’s question or presenting a paper for the class. The more recent exposure to oral formal registers may explain the relative stability of younger speakers’ sibilance use in the image identification and reading tasks, while the older speakers only reach their peak sibilance use in the reading task where there is an explicit orthographic <s>.

My younger participants also emphasized “correctness” in my conversations with them more than older speakers, telling me that they were often corrected in school. For example, when asked in an electronic correspondence after participating in my experiment about her educational experience, one of my younger participants wrote the following: “Sobre la S me hicieron pronunciarla correctamente y a no comermela x
ejemplo en la calle no te dice sino puej no la pronuncian”.

‘About the /s/, they made me pronounce it correctly and not eat it. For example, not in the street—one says si no puej ‘if not, well’—they don’t pronounce it.’ This participant observes that there is a difference between casual speech spoken in the street and formal speech spoken in the classroom, and she has been taught that in a formal environment one should use sibilance.

Even the production of distinción, or the differentiation between the /θ/ and /s/ phonemes that have been merged in Latin American Spanish, was enforced in class to help with spelling. One young participant wrote the following, explaining how she was taught to pronounce orthographic <z>: “la z se pronuncia como cuando en ingles pronuncias /th/ de think.” ‘The <z> is pronounced like when you pronounce <th> in English’. Another wrote, “Si nos hacian pronunciar la z y mos [sic] corregian si lo haciamos mal.” ‘Yes, they made us pronounce the z and they corrected us if we did it wrong.’ These comments demonstrate that the standard these speakers have been taught to approximate in formal speech is not a local standard; distinción is not found in any Latin American dialect of Spanish, as the phonemes responsible for the distinct [s] and [θ] production have merged into /s/.

Karen López Alonzo, a Nicaraguan graduate student at The Ohio State University who has both studied and taught in Managua, corroborated the pervasiveness of Nicaraguans’ belief that they speak “bad” Spanish, with Nicaraguan instructors strongly emphasizing prescriptive Spanish norms in their classes (p.c. March 28, 2013). Renowned Nicaraguan scholar Róger Matus Lazo even wrote a book entitled Mejoremos

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62 The participant comments in this section are exactly as they appear in the original.
nuestro idioma (1997) ‘Let’s improve our language’ and dedicates an entire chapter to Los vicios idiomáticos y el buen uso ‘Idiomatic vices and proper use’. In another widely used textbook in Nicaraguan schools, Nuestra Ortografía (2004), Matus Lazo calls aspiration “[un] fenómeno del habla popular o descuidada” (87) ‘[a] phenomenon of popular or careless speech’ and contends that “Es necesario ejercitarse en la correcta pronunciación de los sonidos para evitar problemas de escritura” (87). ‘It is necessary to practice the correct pronunciation of the sounds to avoid writing problems’. Prescriptive influences in Nicaragua propagate the notion that Nicaraguan Spanish is careless and incorrect, and my younger participants appear keenly aware of this view.

The written comments of my younger speakers demonstrate that these speakers have recently been taught that there is a proper way to speak Spanish and draw upon this knowledge in formal settings, whether or not an explicit orthographic <s> is present. This is why the youngest speakers tend to use sibilance at the same rate in both the image identification and reading tasks. While the explicit orthographic <s> increases [s] production for speakers in the middle and older age groups, the perceived formality of the task influences younger speakers’ production to a greater extent.

Sibilance followed by a glottal stop follows a pattern similar to that observed for sibilance alone: as formality increases, so does the use of the variant, shown below in figure 15.
Figure 15: The age groups’ use of sibilance followed by the glottal stop in each task.

As figure 15 shows, sibilance followed by the glottal stop hardly ever occurs in the sociolinguistic interview, ranging from only 0%-0.4% of use in casual speech, but its use increases for all age groups in the reading task, accounting for 17-31% of the data per group. The middle age group uses sibilance followed by a glottal stop significantly more than the older speakers in the reading task (p = 0.038807), and this difference approaches significance for the younger and older speakers as well (p = 0.0626).

Like sibilance followed by a glottal stop, sibilance followed by creaky voice is found the most in the more formal image identification and reading tasks, illustrated below.
Figure 16: The age groups’ use of sibilance followed by creaky voice in each task.

For the middle and older age groups, the use of sibilance progressively increases from the less formal to more formal tasks, but again, the youngest age group uses sibilance followed by creaky voice with approximately the same frequency in both the image identification task and the reading task, once again signaling the decreased orthographic influence of <s> for this age group. That is, the middle and older age groups adjust their speech to include more sibilance when they see a written <s>, and speakers in the middle age group use [s] almost as much as the youngest speakers with the presence of a written <s>. However, the youngest group seems to operate under a different strategy: these younger speakers who have more recently been exposed to prescriptive influences use standard Spanish sibilance at similar rates whenever they perceive formality, while the other age groups gradually use more sibilance followed by creaky voice as the tasks’ formality increases. I should point out, however, that none of the differences between age
groups are significant in any task for sibilance followed by creaky voice, likely due to the lower frequency of this variant.

Before moving on, I would like to mention that the age-based differences for creaky voice realizations in each task do not seem to follow any clear patterns and for this reason, no line graph is provided. Rather, all age groups’ use of creaky voice is unremarkable, with the exception being the middle age groups’ higher percentage of creaky voice use in the image identification task: the likelihood of creaky voice for this age group is significantly higher than the younger (p = 0.0211) and older (p = 0.0124) age groups. However, the fact that the fewest tokens are available from the image identification task could account for this apparent deviation.

6.3.2.2 Social differences based on education

Different education levels also condition the glottal stop in a task-based analysis: particularly in the more formal tasks, the more educated speakers use the glottal stop less than the less educated speakers. Table 106 below shows the education levels’ percentages of use for each variant in the three tasks.
As shown in table 106, the speakers’ rates of glottal stop use are similar in casual speech across education levels. However, differences emerge in the more formal tasks, illustrated by figure 17 below.

As shown in table 106, the speakers’ rates of glottal stop use are similar in casual speech across education levels. However, differences emerge in the more formal tasks, illustrated by figure 17 below.

<table>
<thead>
<tr>
<th>Phonetic Realization</th>
<th>Education Groups in Sociolinguistic Interview</th>
<th>Education Groups in Image Identification</th>
<th>Education Groups in Reading Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glottal Stop</td>
<td>4.4%</td>
<td>4.1%</td>
<td>4.9%</td>
</tr>
<tr>
<td>Creaky Voice</td>
<td>4%</td>
<td>3.3%</td>
<td>7.9%</td>
</tr>
<tr>
<td>Deletion⁶³</td>
<td>47.7%</td>
<td>25.9%</td>
<td>34.4%</td>
</tr>
<tr>
<td>Aspiration</td>
<td>34.9%</td>
<td>59.5%</td>
<td>37.6%</td>
</tr>
<tr>
<td>Sib Alone</td>
<td>8.6%</td>
<td>6.9%</td>
<td>14.6%</td>
</tr>
<tr>
<td>Sib + Gl Stop</td>
<td>0.4%</td>
<td>0.2%</td>
<td>0%</td>
</tr>
<tr>
<td>Sib + Cr Voice</td>
<td>0%</td>
<td>0.2%</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

Table 106: Use of the variants (in %) based on education group in each task.⁶⁴

Figure 17: The education groups’ use of glottal stop in each task.

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⁶³ Like table 10, deletion here conflates fully deleted tokens and the small number of amplitude changes found in the data.

⁶⁴ Again, columns may not be exactly equal to 100%. Percentages were rounded to the nearest tenth.
As shown above, the most educated speakers use glottal stops less in the more formal image identification and reading tasks than the other two groups, who have similar rates of glottal stop use. The differences are significant between the most educated level and the middle and lower education levels in the reading task ($p = 0.026403$ and $p = 0.046841$, respectively) and between the highest and middle education levels in the image identification task ($p = 0.039097$). The difference between the most and least educated levels in the image identification task approaches significance ($p = 0.069194$).

Creaky voice in the reading task behaves similarly to glottal stop use, with the most educated deviating from the other groups in the most formal task, shown below in figure 18.
Figure 18: The education groups’ use of creaky voice in each task.

Figure 18 shows that the least educated group uses creaky voice more in the reading task than the more educated groups, paralleling glottal stop use, and the difference is significant in the model fitted to creaky voice (p = 0.0338). While the difference is not significant, the most educated group actually uses creaky voice more than the other two groups in the informal interview task, which differs from the educational levels’ use of the glottal stop.

Some similarities across all the educational groups are apparent when considering use of aspiration, as shown in figure 19 below.
In all tasks, the middle education level uses aspiration the most, and this group uses aspiration significantly more than the most educated group in the sociolinguistic interview ($p = 0.04328$). However, the percentage difference between speakers with a high school diploma and the two other groups decreases in the more formal tasks; all groups greatly decrease their use of aspiration. In the image identification task the most educated level uses aspiration significantly less than the middle and lower education groups ($p = 0.030074$ and $0.044012$, respectively). The middle education level continues to use aspiration significantly more than the most educated level in the reading task ($p = 0.03732$).

Figure 19: The education groups’ use of aspiration in each task.
The same consistency of patterning appears with deletion, shown below in figure 20.

Figure 20: The education groups’ use of deletion in each task.

As shown by figure 20, the lowest education level uses deletion the most in each task. When compared with the most educated level, this difference is significant in the reading and identification tasks (p = 0.0167 and p = 0.07880, respectively). Again, like aspiration, rates of deletion steadily decrease for all groups as the level of formality increases.

Just as aspiration is consistently used more by the middle education level and deletion is used more by the lowest education level, sibilance alone is consistently used more by the highest education level, shown below in figure 21.
In all three tasks, the most educated group uses sibilance alone more than the other groups, significantly more so than the least educated in the reading and image identification tasks (p = 0.01952 and p = 0.00891, respectively) and the middle education group in the reading and image identification tasks (p = 0.05574 and p = 0.03539, respectively). Contrary to the pattern observed for deletion and aspiration, all three education levels increase their use of sibilance as the formality of the task increases, but the highest education level’s use of sibilance remains the highest.
Finally, patterns similar to those observed in figure 21 above emerge for other variants involving sibilance, illustrated by figures 22 and 23 below. However, the differences among the levels of education are not significant.
Figure 22: The education groups’ use of sibilance + glottal stop each in task.

Figure 23: The education groups’ use of sibilance followed by creaky voice in each task.
Figures 22 and 23 show that the most educated group uses sibilance followed by a glottal stop more than any other group in the reading and image identification tasks, but use of the variant is minimal in casual speech. The more educated speakers also use sibilance followed by creaky voice more than the other education levels in the image identification and reading tasks, but paralleling sibilance followed by a glottal stop, the use of this variant by all education levels in the casual sociolinguistic interview is minimal. While the least educated speakers’ use of sibilance followed by creaky voice decreases from the image identification task to the reading task, keep in mind that the variant is less common than other variants involving sibilance and the scale is smaller; the group’s use of the variant only decreases slightly, from 4.8% to 3.7%.

6.3.3 Conclusions

While the V/s/#V environment is rich with variation, section 6.3 has demonstrated that patterning can be observed for the variants across the three different tasks based on the social factors of age and education.

Age-related patterns include the following: the younger speakers lead glottal stop use in the informal sociolinguistic interview, and while all speakers increase their glottal stop use in the image identification task, the oldest speakers pull ahead of the other two age groups in the formal reading task, increasing their use of the glottal stop to 20%, while the younger speakers decrease their glottal stop use. The older group leads in deletion rates across all three tasks and has the lowest percentage of variants involving
sibilance across the tasks as well while the younger speakers tend to lead in sibilance use across all tasks. The middle age group uses aspiration the most in the interview but decreases its use in the formal reading task, falling below the other two groups.

Education-related patterns also emerged. First, the most educated speakers lead the other education levels in sibilant-based variant use in all tasks, and they decrease their use of the glottal stop, creaky voice, aspiration, and deletion the most in the formal reading task in favor of sibilance. The middle education level uses aspiration more than the other levels across all tasks, and the least educated participants lead deletion across all tasks. The associations between variants and social groups will be explored more in section 6.6.

6.4 Glottal insertion in the V#V environment

Up to the present section in chapter 6, the variants have been discussed in the V/s/#V environment, occurring where there is an underlying /s/, e.g. [daʔo.tɾo] for das otro ‘you give another’. However, I also observed glottal constriction in between vowels where there is no underlying /s/, e.g. [laʔo.la] for la ola ‘the wave’. This section discusses the factors that condition the use of the glottal stop and creaky voice in section 6.4.1 and section 6.4.2 addresses the social and phonetic motivations behind glottal constriction’s extension into the V#V environment.
6.4.1 Factors conditioning glottal constriction in the V#V environment

As shown at the beginning of chapter 5, glottal insertion is much less frequent in the V#V environment than the V/s/#V environment, illustrated below in table 107, which is repeated from table 12 for convenience.

<table>
<thead>
<tr>
<th>Dependent Variable in V#V Environments (Across All Tasks)</th>
<th>Glottal Constriction</th>
<th>Non-Insertion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Glottal stop</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Creaky voice</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Amplitude change</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Non-Insertion</td>
<td>3,306</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3,431</td>
</tr>
</tbody>
</table>

Table 107: Realizations (including N and percentages) of the dependent variable in V#V environments.

While the glottal stop accounts for 9.4% of the data and creaky voice accounts for 5.7% of the data in the V/s/#V environment, full glottal closure only accounts for 0.9% of the data and creaky voice accounts for 2.3% of the data in the V#V environment. In other words, glottal constriction is less common in the V#V environment. In order to test the statistical significance of underlying /s/, a model was created in chapter 5, which showed that underlying /s/ is a significant predictor of glottal stop realizations in the model (p < 0.001).

While glottal constriction is less common in the V#V environment than in the V/s/#V environment, a trend is still noticeable across the tasks: more glottal constriction occurs in the more formal tasks, with a positive difference of 5.7% from the casual
sociolinguistic interview to the formal reading task. Table 108 is repeated from table 14 below to show this increase based on task.

<table>
<thead>
<tr>
<th>Phonetic Realization</th>
<th>% Difference Across Tasks</th>
<th>Sociolinguistic Interview %</th>
<th>Image Identification %</th>
<th>Reading %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Insertion</td>
<td>-5.7%</td>
<td>99.1% (1,592)</td>
<td>97.1% (610)</td>
<td>93.4% (1,118)</td>
</tr>
<tr>
<td>Insertion</td>
<td>+5.7%</td>
<td>0.9% (14)</td>
<td>2.9% (18)</td>
<td>6.6% (79)</td>
</tr>
</tbody>
</table>

Table 108: Difference in % use of insertion across tasks.

Table 108 shows that insertion of a glottal gesture increases as formality increases, meaning that both glottal constriction in the V/s/#V and V#V environments follow the same path, increasing in frequency in more formal settings. In the models fitted to the glottal stop in the V#V environment, task emerged as a significant predictor: the glottal stop is more likely in the reading task than the sociolinguistic interview (p < 0.02), with the likelihood of glottal constriction in the image identification task falling between the two extremes. This result parallels the results for the V/s/#V environment: there is a higher rate of glottal stop use in more formal tasks.

Preceding word length also significantly improved the model: insertion of the glottal stop is more likely after longer words of four or more syllables than after shorter words of only one syllable (p < 0.01). The patterning of creaky voice is the same: creaky voice is more common following longer words and in more formal tasks.

One additional factor emerges as significant in the model fitted to creaky voice in the V#V environment: sameness of the preceding and following vowel. Creaky voice is more likely when the preceding and following vowels are both the same. It remains to be
seen if this result is due to the low number of overall tokens of glottal constriction in the 
V#V environment or if the sameness of the preceding and following vowel consistently 
influences glottal insertion, but future studies should attempt to shed light on this factor’s 
predictive abilities.

6.4.2 Social and phonetic factors behind glottal constriction’s extension into the V#V 
environment

In the previous section I discussed the factors conditioning the glottal stop and 
creaky voice in the V#V environment, and in this section I argue that glottal constriction 
in this environment constitutes an extension from the V/s/#V environment. I contend that 
this extension is phonetically and socially motivated, driven by the less educated 
speakers.

First, the spread of glottal constriction from the V/s/#V environment with an 
underlying /s/ to the V#V environment with no underlying /s/ is supported by the number 
of realizations in the data. In the V/s/#V environment, glottal constriction (either the 
glottal stop or creaky voice) accounts for 15.1% of the data. In the V#V environment, 
however, glottal constriction accounts for only 3.2% (N=111) of the data, and of that 
3.2%, 71.2% (N=79) of the tokens occur in the formal reading task. In other words, the 
number of glottal constrictions found in the V#V environment, especially in unread 
speech, is much lower than the number of glottal constrictions found in the V/s/#V 
environment.
Secondly, the least educated group tends to use glottal constriction in the V#V environment more than other groups, shown below in figure 24.

![Glottal Constriction in V#V by Education and Task](image)

Figure 24: Glottal constriction in V#V environments by education and task.

In the binomial logistic regression model fitted to non-insertion (the acoustic equivalent of deletion when there is no underlying /s/), which pairs non-insertion against glottal stop or creaky voice insertion in the V#V environment, the results indicate that the least educated speakers, or those without a high school diploma, insert glottal constriction significantly more than the most educated participants, or the college-educated (p < 0.05), with high school diploma recipients falling between the two. The same is apparent in figure 24 above, which shows that the least educated tend to insert glottal constriction
more than the other education levels. These less educated speakers also use the glottal stop more than other education levels in the V/s/#V environment in formal tasks and may therefore associate the realization with formal, careful speech, whether there is an underlying segment or not (see section 6.7).

In addition to social factors there is a phonetic motivation for the extension of the glottal stop into the V#V environment. In the V#V environment the insertion of glottal constriction strengthens the special position of word initial vowels and maximally demarcates between adjacent vowels, serving a similar phonetic purpose to the glottal stop in the V/s/#V environment, only without an underlying segment. Additionally, glottal constriction is more likely following longer words in the V#V environment, which mirrors the glottal stop’s use in the V/s/#V environment. This similarity shows that speakers are applying glottal constriction in the V#V environment like they apply it in the V/s/#V environment, indicative of an analogical extension into this V#V environment.

As discussed in section 3.3, the glottal stop serves as a means of resolving hiatus in several contact dialects of Spanish (Sanicky 1989, Lipski 2000, Tellado González 2007, Hernández 2009), and the glottal stop serves the same purpose in other languages as well (Borroff 2007). In other words, the use of the glottal stop to resolve hiatus is certainly not unprecedented in other dialects of Spanish and languages of the world, and such an explanation accounts for both the V/s/#V and V#V glottal stop in Nicaraguan Spanish.

One other innovative use of the glottal stop emerged in the data as well. During the image identification task, a young, male participant with a college degree introduced
a picture with “En esta figura vemos…” “In this figure we see…” However, instead of producing figura vemos ‘figure we see’ as [fi.yu.ra.βe.moh], as one would expect, he pronounced it as [fi.yu.ra.?e.moh]. Interestingly, deletion of intervocalic /β ð y/ is common in casual Nicaraguan speech, which creates dispreferred postlexical hiatus. The use of a glottal stop in this environment continues to serve the same purpose of marking the underlying segment, maximally demarcating between adjacent vowels, and strengthening the prosodically prominent stressed, word-initial position (Casali 1998). In other words, the glottal stop may even be extending to other environments of consonantal reduction at the word boundary to resolve postlexical hiatus created in those environments.

This section has argued that the glottal stop in the V/s/#V environment serves phonetically to strengthen the onset in strong positions and to prevent hiatus caused by deletion of the underlying segment. In the V#V environment, hiatus is not simply one possible realization from deletion of an underlying segment; rather, postlexical hiatus is always produced in this environment. The speakers, and in particular the least educated speakers, are using a realization found in the V/s/#V environment to serve a similar, phonetic role in the V#V environment. Extending glottal constriction to a comparable position at the word boundary allows for maximal demarcation between adjacent vowels to resolve the hiatus. The most educated speakers are less likely to incorporate this strategy due to prescriptive influences; their output is the closest to Standard Spanish, in which no realization is inserted between vowels at the word boundary.
6.5 The underlying representation in Nicaraguan Spanish

Lipski (1984) concludes that preconsonantal coda /s/ in Nicaraguan Spanish is rewritten as [h] before a consonant or pause, shown below in (18).

\[(18) \ s \rightarrow \ h / \{C \#\} \ (177)\].

Lipski (1984) then concludes that this rule has, by analogy, been extended to prevocalic contexts as well, illustrated below in (19).

\[(19) \ s \rightarrow \ h / \_\_ \#V \ (178)\].

In other words, Lipski (1984) argues that /s/ is realized as [h] before a consonant, pause, or a vowel. This debuccalization of coda /s/ at the lexical level was “nearly absolute in application” (Lipski 1984: 177) in all environments in Nicaraguan Spanish thirty years ago, giving Nicaraguan Spanish its “breathy quality” (Lipski 1994). The rates of aspiration were extreme in Lipski’s studies, and “reduction of syllable- and word-final /s/ occurs to a greater extent… than in any other Central American variety, with frequencies comparable to Caribbean dialects” (Lipski 1994: 291). Nearly 30 years have passed since Lipski’s study, and my data suggest that this weakening is even more extreme in Nicaraguan Spanish today, leading me to postulate that coda /s/ at the lexical level has actually been reanalyzed as /h/ in this dialect.
Several factors indicate that the underlying segment in Nicaraguan Spanish is not the same as in other more standard dialects of Spanish. First, it is important to note that in casual speech my participants’ most common realization is aspiration, occurring in 44.9% of all tokens, followed by deletion, which takes place in 35.5% of the realizations. The rates of deletion observed in my data are much greater than the rates observed by Lipski in 1984: deletion only accounted for 2.1%-13.1% of the V/s/#V realizations in his data, with only the speakers from the lowest socioeconomic status reaching 13.1%. In other words, deletion appears to be more widespread three decades later in Nicaragua.

Also of note is the fact that sibilance occurs with less than 10% frequency in the sociolinguistic interviews I recorded, and most of the sibilants in casual speech are produced by highly educated speakers who are more exposed to prescriptive Spanish influences that promote sibilance. I noticed that in my casual interactions with the participants when the microphone was turned off, sibilance was almost never used. Even in the recordings when sibilance is used, [s] does not always behave like sibilance in other dialects. For instance, sibilance in Nicaraguan Spanish is most likely with a following unstressed vowel, while the opposite is true in other dialects with /s/ reduction (Terrell 1979, Dohotaru 1998). In Nicaraguan Spanish, the glottal stop is the variant more likely to occur before a stressed vowel where sibilance is retained in other dialects, indicating that the glottal stop serves the purpose of strengthening strong prosodic environments that [s] strengthens in other dialects. Another difference between Nicaraguan Spanish and other /s/-reducing dialects is that in other dialects sibilance is maintained more between high frequency word pairings (Ma and Herasimchuk 1971;
Cedergren 1973); however, the same is not true of Nicaraguan Spanish. In Nicaraguan Spanish, glottal frication and the glottal stop are more likely to be used between high frequency word pairings. These dialectal differences demonstrate that Nicaraguan Spanish sibilance does not behave like sibilance in other dialects of /s/-leniting Spanish, and Nicaraguan Spanish uses another variant, the glottal stop, to serve the linguistic purpose of retained coda sibilance in other dialects.

In addition to sibilance by itself, previously undocumented variations of sibilance emerge in Nicaragua as well: sibilance is often followed by a glottal stop or creaky voice in formal tasks, and while sibilance alone is not more likely to be retained before stressed vowels, sibilance followed by a glottal stop is more likely to occur before a stressed vowel in Nicaraguan Spanish. That is, while the speakers use sibilance for social reasons to approximate a perceived global standard, these speakers simultaneously incorporate the glottal stop for linguistic reasons, which is their linguistic fortition strategy. These [sʔ] realizations suggest that local linguistic strategies to strengthen word-initial, stressed vowels, i.e. the glottal stop, exist alongside social strategies, i.e. sibilance, to increase formality in Nicaraguan Spanish, resulting in a mixture of the global and local norms (see section 6.7).

Finally, anecdotal evidence from my recording sessions supports this line of thought. During my recording sessions, a female participant occasionally used sibilance where there was no underlying /s/, similar to hablar fisno ‘talk fancy’ in the Dominican Republic (Morgan 1998), in which speakers hypercorrect and produce [s] in non-standard

\[\text{Interestingly enough, this speaker fell into the highest educational level, having earned a college degree, but she was also one of the oldest speakers and had not been in the educational system for some time.}\]
environments. These errors generally occurred during the image identification task, which involved a higher level of formality but did not provide text to indicate the position of /s/.

At first, I thought these occasional [s] insertions were simple production errors, but this speaker produced [ok.ser.bos] for observo ‘I observe’ for every image she identified. The speaker’s consistency suggests that this erroneous [s] use is not a sporadic production error but rather represents a reanalysis of the phonological inventory: the speaker in question was not certain where [s] should be produced because she was uncertain where there was an underlying /s/ in the phonological system. While most speakers did not hypercorrect, the speaker discussed in the preceding paragraphs does seem to be reanalyzing the phonological system similar to Dominicans who hablan fisno ‘talk fancy’.

The distribution of the variants, the unusual behavior of sibilance in Nicaraguan Spanish, and the fact that hypercorrection with [s] insertion takes place in innovative places lead me to posit that the phonological system of Nicaragua actually has an underlying /h/ in coda position where other dialects have /s/.

My explanation of coda reanalysis in Nicaraguan Spanish follows Terrell (1986), Núñez Cedeño (1988; 1989; 1994), and Harris (2002), who argue that /s/ deletion is so advanced in Dominican Spanish, /s/ in coda position (but not in onset position) is lost in the lexical representations of less educated speakers. At the same time, these speakers understand that their speech is stigmatized and in formal situations attempt to approximate what they perceive to be prescriptive Spanish with coda sibilance. However,
this norma culta ‘educated norm’ is out of many speakers’ reach (Morgan 2000), and in this Dominican coda /s/ hypercorrection the speakers are ultimately “missing the target as often as not” (Harris 2002: 97). My data point to a similar reanalysis in Nicaraguan Spanish, but instead of the loss of coda /s/ it is the reanalysis of coda /s/ as /h/.

The production of the glottal stop in this dialect is more easily explained if we posit an underlying coda /h/ as well: the place of articulation of the glottal stop is identical to the place of articulation for glottal frication, and both lack an oral gesture. Additionally, while glottal frication tends to occur in weak environments, before an unstressed vowel, the glottal stop tends to occur in strong positions, before a stressed vowel. Considering 1) that the low amplitude frication of [h], often auditorily indistinguishable from elision, may not maximally demarcate between the vowels and 2) that the insertion of an oral gesture for an underlying segment involving no oral gesture may be too effortful, the use of the glottal stop is not unexpected. The glottal stop realization can be explained as a fortition process that provides full gestural closure, particularly in strong positions to provide a greater interruption to the speech stream (Kingston 2008) between two vowels. The glottal stop is also relatively easy to produce articulatorily. Ferguson (1990) notes that that glottal stop is common across languages and that children are able to produce the sound even without an adult model.

Based on these facts, I conclude that the glottal stop is incorporated in Nicaraguan speech for several reasons. First, the glottal stop is a means of marking an underlying segment, /h/, in production. Secondly, it is a process of fortition that strengthens the underlying /h/, particularly before stressed vowels. Finally, it resolves hiatus by clearly
demarcating between two adjacent vowels at the word boundary, particularly following longer words where deletion (and consequently, postlexical hiatus) is most common. The less educated speakers’ higher rate of glottal stop use in the V/s/#V environment suggests that these speakers associate the glottal stop with careful, hyperarticulated speech, which may lead to the extension of the glottal stop where there is no underlying segment in more formal styles.

The reanalysis of coda /s/ at the lexical level to /h/ is a bold proposal and does not perfectly account for all speakers. As is the case in the Dominican Republic, more educated speakers in Nicaragua are likely to maintain a correspondence between the underlying segment and surface-level sibilance due to greater prescriptive influence and a more regular use of [s] in formal speech. For these educated speakers, signs of phonological reanalysis are less likely.

Another problematic aspect of my argument (and any argument dealing with underlying representations) is the necessity of using production data to answer questions about the speakers’ underlying segments. However, I believe the data provided in this dissertation presents a strong case in favor of this reanalysis. Future production and perception studies in western Nicaragua are needed to shed more light on these speakers’ phonological inventories.

The phonological inventory in Puerto Rican Spanish should also be explored; there appear to be similarities in /s/ realizations in both dialects, with extreme levels of aspiration, high rates of deletion, and the incorporation of a glottal stop in similar environments. It is entirely possible that the reanalysis I have proposed for coda /s/ in
Nicaraguan Spanish has also occurred in Puerto Rican Spanish. These future studies will also need to address the impact of this proposed reanalysis on the Nicaraguan phonological inventory, which would involve a merger of /h/, e.g. [hi.ɾa.ɾa] jirafə ‘giraffe’ and what was once coda /s/, e.g. [ba.ɾa] vas a ‘you go to’, into a single /h/ phoneme.

6.6 Neutrality of the glottal stop

Sections 6.4 and 6.5 argued that there are several linguistic reasons to use the glottal stop in the V/s/#V and V#V environments, and there are also social reasons to use the glottal stop. Section 6.3 demonstrated that the variants, including the glottal stop, are used by all age ranges and all education levels to different degrees in each task. The question, then, is which variants correspond most to each age group and education level. The symmetric maps below are provided as a means of illustrating the social groups’ correspondences with the variants. That is, the variants are situated next to the social groups with which they most correspond, and more distant variants have a weaker correspondence.

The symmetric maps below are generated in the R package ca (Nenadic and Greenacre 2007) by first calculating a distance (or similarity) matrix using all the column and row labels. The distance between all column labels and row labels (and the distance from each other) is measured based on the chi-squared statistic of the two-way contingency table, which is used to calculate if the row variable is independent from the
column variable. A larger chi-squared statistic in one cell indicates that the two labels occur together more often, measuring the strength of the relationship between the two.

The second step involves matrix decomposition techniques. In the case of symmetric map generation, CA uses singular value decomposition to find coordinates for the row labels and column labels in a two-dimensional graph that are approximately the same as the original distance matrix. Consequently, there is no concrete interpretation of the X-axis and Y-axis; they simply represent the constructed two-dimensional space within which the row labels and column labels are arranged to illustrate the distance among them in the data.

In order to visualize the changing behavior of social groups in different tasks, six symmetric maps are provided below showing the correspondences of age groups and education levels in each task. The age groups are presented first, and, following a discussion of age, the same progression is then shown for the different education levels.

The first symmetric map below shows the age groups’ correlation with the variants in the less formal sociolinguistic interview. Note that in the maps below sibilance followed by a glottal stop and sibilance followed by creaky voice are conflated due to their infrequent use in certain tasks.
As figure 25 shows, the youngest group correlates with sibilance, the middle group falls next to aspiration, and the older group patterns with deletion. Sibilance followed by glottal constriction is the farthest away from all groups, as it is almost never used in the more casual sociolinguistic interview. The most noteworthy placement is that of the glottal stop and creaky voice in the symmetric map: neither variant is clearly associated with any age group at all.

Next, I present the symmetric map of the age groups’ relationship with the variants in the image identification task, shown below in figure 26.
The middle age group patterns noticeably differently in the image identification task: instead of correlating with aspiration, as the group did in the sociolinguistic interview, there are no strong correlations in this more formal task. The closest variant to the group is now sibilance, which falls between the middle and youngest age groups. Aspiration and deletion now pattern with the oldest age group, suggesting that the middle age group distances itself from aspiration in more formal tasks. The youngest group continues to pattern with variants involving sibilants, but the relationship is not as strong as in the casual sociolinguistic task, as other groups have started to use sibilance more as well. Particularly of note is the glottal stop and creaky voice: again, the two variants do not correlate with any particular age group.
These correlations continue to evolve in the most formal reading task, shown in the symmetric map in figure 27 below.

![Age Group and Variant Correspondences in Reading Task](image)

Figure 27: Symmetric map of the age groups’ relationship with the variants in the reading task.

In the most formal task, both the youngest and middle age groups pattern with sibilance, and are placed far from any other variants in the symmetric map. In the reading task, only the older group patterns with non-sibilant variants, while creaky voice does not appear to correlate with any particular group. Only in the formal reading task do both the young and middle age groups eschew all non-sibilant variants, including the glottal stop. Here, the glottal stop patterns somewhat with the older age group, the only group that falls near the non-sibilant variants.
The evolving correlations between the age groups and the variants from less formal to more formal tasks show an interesting progression. The patterning of certain age groups with specific variants is clear in the sociolinguistic interview: younger speakers pattern with [s], speakers in the middle age group pattern with [h], and older speakers pattern with elision, with the glottal stop and creaky voice not clearly patterning with any one group. In the image identification task, the middle age group dissociates itself from aspiration and moves toward the use of a variant involving sibilance, meaning the oldest group patterns with both deletion and aspiration, with glottal stop falling between all the groups. Finally, in the reading task, both the younger and middle group pattern strongly with sibilant variants, while older speakers fall closer to deletion, glottal stop use, and aspiration at the other extreme of the map.

Similar progressions can be observed between the education levels and variant use as well, shown in the following three symmetric maps. First, the symmetric map for the sociolinguistic interview is presented in figure 28.
An interesting similarity emerges between education levels and age groups’ use of the variants: just as the youngest speakers corresponded with sibilance in the sociolinguistic interview, so do the most educated speakers: the college-educated fall closest to [s] use. As the middle age group patterned with aspiration in the sociolinguistic interview, so does the middle education level: the high school educated fall closely in line with [h] use. Finally, just as the oldest age group patterned with deletion in the sociolinguistic interview, so does the least educated group: those who did not finish high school pattern with deletion. In other words, the older and less educated, the younger and most educated, and the middle age and education groups use the variants similarly in the sociolinguistic interview. As with age groups, the glottal stop and creaky voice not pattern strongly with any particular education level.
Below the symmetric map is included for the image identification task, showing the education levels’ relationship with the variants in a more formal setting.

![Education Levels and Variant Correspondences in Identification Task](image)

Figure 29: Symmetric map of the education groups’ relationship with the variants in the image identification task.

In the image identification task the three education levels behave similarly in relation to the variants, although the associations between the education levels and the variants are not as strong. As shown in section 6.3.2, all age and education levels tend to decrease their use of aspiration and deletion in more formal tasks, opting increasingly for sibilance, and this move weakens the association of any particular variant to an age or education level. Also of note is the fact that the college-educated group falls farther from the other two groups on this symmetric map than in the map for the sociolinguistic interview, showing the most educated group’s higher sensitivity to a task they perceive to
be formal. Given the most educated group’s increased use of sibilance over other variants, the glottal stop now falls between the middle and lower education groups.

In the reading task, the correlation between education levels and the variants is maintained more strongly than the correlations between age and variant use, shown below in figure 30.

![Education Levels and Variant Correspondences in Reading Task](image)

Figure 30: Symmetric map of the education groups’ relationship with the variants in the reading task.

Even in the most formal task, the relationships are the same: the college-educated continue to pattern with [s], the middle education group falls closest to aspiration, and the least educated still corresponds with deletion. As was the case with the image identification task, the most educated group is still situated the farthest from the other two groups, showing that their variant use is the most dissimilar from other education groups.
in these more formal tasks. Once again, the glottal stop and creaky voice do not pattern with any particular education level in the reading task.

In addition to illustrating the evolving relationships of the age groups and education levels with the variants given differing levels of formality, the symmetric maps above serve to illustrate an important tendency of the glottal stop and creaky voice: in nonread speech, i.e. the interview and image identification tasks, the glottal stop and creaky voice never pattern strongly with a particular social group. In other words, glottal constriction shows itself to be remarkably neutral, and it does not correspond to social groups as much as the variants with sibilance, aspiration, and deletion. The glottal stop and creaky voice are the least socially marked variants in unread speech, indexing the least about the speakers’ age and education levels.

To expand upon what I mean by the ‘neutrality’ of the glottal stop, I refer to Eckert (2008), who argues that “the meanings of variables are not precise or fixed but rather constitute a field of potential meanings – an indexical field, or constellation of ideologically related meanings, any one of which can be activated in the situated use of the variable” (454). Here, Eckert suggests that variants have a field of potential meanings, and, based on my participants’ observations and the symmetric maps shown above, sibilance in Nicaraguan Spanish may indicate intelligence, a certain degree achieved in school, youthfulness, or snobbery. Similarly, aspiration may index blue-collar professions, a local identity, or a down to earth attitude. Finally, deletion may index old age, poverty, or low education levels.
However, the glottal stop (and creaky voice) are the only variants that do not have a firmly established indexical field in the V/s/#V environment, and for this reason the glottal stop has become a versatile variant. Nicaraguan speakers are able to call upon the glottal stop to mark an underlying segment, provide fortition before strong environments, and maximally demarcate between adjacent vowels without simultaneously evoking a barrage of social meanings. The absence of an activated indexical field also allows speakers to use this variant as a local formality strategy, discussed in section 6.7.

6.7 Local vs. global formality strategies

The progression of glottal stop use across tasks speaks to the formality strategies employed by Nicaraguan speakers of different social categories. Some similarities emerge for all age groups: use of the glottal stop is higher in the image identification task than in the sociolinguistic interview for all age groups, and for all age groups other than the oldest speakers, this rate of glottal stop use decreases in the reading task but is still higher than the rates of use in the sociolinguistic interview. The same pattern emerges for the three education levels: first, rates of use are very similar for all education groups in the sociolinguistic interview, and all education levels increase their use of the glottal stop in the more formal image identification task. All education levels also decrease their use of the glottal stop in the reading task, but the rate is still higher for all groups than their rate of glottal stop use in the sociolinguistic interview.
With this in mind, what do these task-based changes tell us about the glottal stop’s use in relation to education levels? First, they suggest that the glottal stop is not a stigmatized variant for any education level. Unlike deletion and aspiration, whose rates consistently decrease as formality increases, the glottal stop’s use is highest in the formal image identification task and is higher in the most formal reading task than in the casual sociolinguistic interview. These differences also suggest that the glottal stop is a formality strategy when decorum is required, creating the impression of more careful speech. Many of my participants remarked to me that in Nicaragua “Nos comemos la s” ‘we eat our s’, and many proceeded to tell me that Nicaraguans were very ‘lazy’ speakers. The salient, complete closure of the glottal stop may be a way to distance themselves from this generalization about their own speech, producing a variant that better demarcates between adjacent vowels and is consequently viewed as more deliberate, or less ‘lazy’.

Next, what do these task-based differences tell us about the different age groups’ use of the glottal stop? First, it is important to note that we observe less uniformity in age groups than we do across education levels. While all education levels used the glottal stop at similar rates in the sociolinguistic interview task and followed the same trajectory of use across tasks, there are two statistical differences of note for speakers of different ages: younger speakers use the glottal stop significantly more than older speakers in the casual sociolinguistic interview, and older speakers use the glottal stop significantly more than younger speakers in the formal reading task. This suggests that different formality strategies are being employed by the youngest and oldest age groups. While the youngest
group opts to increase its use of sibilance and decrease its use of the glottal stop in the formal reading task, with the middle age group following suit, the older group increases both its sibilance and glottal stop use. The oldest group’s use of a variant containing sibilance is only 48.3% in the formal reading task, compared to 72.4% and 71.9% for the youngest and middle age groups, respectively. In the most formal settings involving reading, the oldest group applies all its strategies associated with formality, while the younger and middle age groups use a sibilant-specific strategy.

Based on the results discussed in this chapter, there appears a clear continuum from hypo- to hyper-articulation in Nicaraguan Spanish. In the sociolinguistic interview, several participants indicated their conscious awareness of this continuum when they told me that typical Nicaraguan Spanish is “lazy” and that Nicaraguans pronounce their /s/’s “badly”. The results of this study indicate that there is also an unconscious understanding of this continuum: the use of the hypoarticulated variants [h] and ø decrease and the use of the hyperarticulated variants [ʔ], [s], and sibilance followed by glottal constriction increase as formality increases in Nicaraguan Spanish.

In section 6.2.5 I argued that the glottal stop and sibilance followed by the glottal stop both appear to serve as fortition strategies in Nicaraguan Spanish: they are both more likely to occur with a following stressed vowel and between high frequency determiner-noun pairings. In other /s/-reducing dialects of Spanish, sibilance serves this purpose. Sibilance in Nicaraguan Spanish, on the other hand, seems to be produced more for extralinguistic reasons. The use of sibilance followed by a glottal stop increases from 0.2% in the sociolinguistic interview to 26.3% in the reading task, moving from a nearly
unused variant in casual speech to the second most common realization in the formal reading task. This two-part realization serves a dual purpose in Nicaraguan Spanish: the glottal stop serves a linguistic function, working as a fortition strategy for the underlying /h/ in prominent prosodic positions, while the sibilance that precedes the glottal stop is inserted to increase social prestige. That is, the glottal stop corresponds to the underlying representation and sibilance is inserted at the surface level to approximate what is perceived to be prescriptively “correct” Spanish.

Bucholtz (2001) points out that a “precisely enunciated speech style has semiotic connections to literacy” (92), and Eckert (2008) furthers this notion, arguing that the “attention to the continuum of articulation level thus can be seen as part of a broader national ideology that links hyperarticulation to clarity and clarity to education and power” (470). The youngest and most educated speakers of Nicaraguan Spanish hyperarticulate the most, even in informal settings, to align themselves with an identity imbued with education and power. Because they have had more recent exposure to a prescriptive education emphasizing Standard Spanish sibilance, the variants most commonly called upon to construct this powerful and educated identity involve sibilance. However, when older and less educated individuals hyperarticulate to align themselves with a more powerful and educated identity in formal tasks, they tend to hyperarticulate more with a glottal stop, strengthening the underlying /h/ of Nicaraguan Spanish.

In addition to greater prescriptive influence, I found that the younger and more educated speakers who participated in my experiments also seemed to have more exposure to sibilant-using external dialects of Spanish. These social groups spent more
time on the internet, watched international movies, and some had even traveled to areas of the word that use coda sibilance in Spanish, such as Mexico and the United States. Multiple factors appear to contribute to the younger and more educated speakers’ greater use of sibilance.

These different hyperarticulation strategies are actually due to two different standards at work in creating a more formal, educated, and powerful identity. While the younger and middle age groups are approximating to a greater extent Standard Spanish sibilance, which is a global convention not found in local speech, the oldest group relies more heavily on a local strategy to hyperarticulate and increase formality, illustrated below in figure 31.

![Venn diagram showing the different formal targets of the oldest speakers and other age groups.](image)

Figure 31: Venn diagram showing the different formal targets of the oldest speakers and other age groups.

Sibilance, which is overwhelmingly the target for the young and middle age groups in the reading task and, to a lesser degree for the older group, is very uncommon in informal
speech. My participants also commented on how unnatural and pretentious excessive sibilance sounds in casual speech, suggesting that sibilance is not considered a local realization. On the other hand, my participants simply noted that individuals who use the glottal stop in their speech simply sound like local Managuans, highlighting the fact that the glottal stop is considered a local realization.

Another key point is that in Nicaraguan Spanish the glottal stop’s use increases in formal speech, and it does not appear to be a stigmatized realization. In fact, the oldest age group seems to be hyperarticulating in formal speech by aiming for a different target than the two younger groups: the older speakers continue to use local standards of hyperarticulation, i.e. the glottal stop, rather than global standards, i.e. sibilance. Some speakers in the older group do use some sibilance, of course, but overall the group acquiesces less to the non-local standard, which is why the older and less educated speakers’ formality target lies closer to the Local Standard side of the Venn diagram.

6.8 Conclusion

Throughout this dissertation I have investigated the glottal stop in Nicaraguan Spanish, and this chapter has proposed several arguments to explain the use of the glottal stop in Nicaraguan Spanish. I concluded that the glottal stop is conditioned by both linguistic and extralinguistic factors. Linguistically speaking, the glottal stop is most likely in the V/s/#V environment before a following stressed vowel, in between high frequency word class pairings, and after longer words. The glottal stop is used in
Nicaraguan Spanish for several reasons. First, the glottal stop serves to saliently mark the underlying segment. Secondly, the glottal stop is used to strengthen the position of word-initial, stressed vowels, which are particularly resistant to synchronic reduction and deletion in vowel-vowel sequences and diachronic deletion; the glottal stop maximally demarcates between these adjacent vowels, preventing dispreferred hiatus in this special phonological environment. Finally, the glottal stop serves to resolve postlexical hiatus in environments with particularly high rates of deletion, i.e. following longer words.

When all tasks were combined no significant social differences were found to predict glottal stop use, and even in the task-based analyses where significant differences do occur, the rate of change for the glottal stop is not as drastic from informal to more formal tasks as it is for deletion, aspiration, or sibilance. I also found that the glottal stop is used by all genders, age groups, and education levels, and in the symmetric maps provided in section 6.6, the glottal stop does not pattern strongly with any social category. Because of these factors, I argued that the glottal stop is the most ‘neutral’ variant. That is, the glottal stop is not as imbued with social meaning as aspiration, deletion, and sibilance, which are correlated much more strongly with particular social groups.

As I mentioned, a task-based analysis proved particularly enlightening for the social predictors of the glottal stop in the V/s/#V environment, because the age groups and education levels do behave differently in different tasks. I found that the youngest age group uses the glottal stop significantly more than the oldest group in casual speech, but the oldest group uses the glottal stop significantly more than the youngest speakers in
the formal reading task. Educational differences emerged as well: the most educated
speakers use the glottal stop less than the other groups in the more formal tasks, opting
for sibilance over the glottal stop. I proposed that these age groups’ and education levels’
different rates of glottal stop and sibilance use actually indicate two formality strategies
at work, one local and one global.

The global formality strategy involves sibilance, and this strategy is utilized more
by the youngest speakers and the most educated groups. Coda sibilance is not considered
a Nicaraguan variant, and several participants commented to me that they resent
Nicaraguans who use a great deal of sibilance in casual speech. According to the
participants, these speakers are snobbish, presenting themselves as too good to speak like
a Nicaraguan, because Nicaraguans do not use coda [s] informally. That means speakers
who use sibilance are aspiring to a different, non-local target, aligning themselves with
perceived prescriptive Spanish norms more than local norms. On the other hand, less
educated speakers and older speakers tend to use the glottal stop more in formal tasks.
The complete gestural closure and salience of the glottal stop clearly signal the presence
of an underlying segment while also maximally demarcating between the word-final and
word-initial vowels. The use of the glottal stop serves as a local formality strategy for the
less educated and older, allowing the speakers to strengthen the segment and move up on
the hypo/hyper-articulation scale, associated with education and power (Eckert 2008).

Interestingly, this same formality strategy appears to be at work for the least
educated speakers in the V#V environment as well, where the less educated are inserting
glottal constriction between vowels, e.g. [miʔa la] mi ala ‘my wing’, more than the most
educated. Glottal constriction in the V#V environment is not underlingly motivated, as there is no underlying segment between the vowels, but the insertion of glottal constriction is just as motivated phonetically. The glottal closure still maximally demarcates between adjacent, heterosyllabic vowels, allowing for a preferred CVCV structure, and the insertion also helps to strengthen prosodically prominent positions, such as a word-initial or stressed vowel.

Finally, based on the high frequency of glottal frication in the data and the fact that the glottal stop, with the same place of articulation, tends to occur in strong positions, I proposed a reanalysis of the phonological system in Nicaraguan Spanish: I contended that the underlying segment for Managuan speakers in coda position is actually /h/.

Supporting this argument, some speakers who participated in my study never used [s] or misused [s], hypercorrecting to use sibilance in an environment without underlying /s/. This lack of use and misuse of sibilance certainly suggest that /s/ is not the underlying segment, as some speakers are not entirely sure where sibilance is supposed to occur in their production.

An analysis of the V/s/#V environment, or as I should say, the V/h/#V environment, is a thorny issue, given the multiplicity of variants coexisting in the position. In order to accurately describe and explain the variation, an acoustic analysis was crucial; the acoustic analysis enabled me to disentangle the many realizations occurring in the same environment and show that there is more variation in production than would be identified with impressionistic analysis. The systematic approach followed
in this dissertation allows us to reach more robust conclusions regarding the use of these different production strategies.

In addition to the multiplicity of variants, the analysis is complicated by the numerous linguistic and social factors that contribute to the variants’ realizations across the tasks. In spite of the complexity involved in the analysis, several linguistic and social patterns emerged in my data, enabling an explanation of where and why the glottal stop occurs in Nicaraguan Spanish. I conclude that the glottal stop in western Nicaragua is not a contact feature, but rather a language internal process that works to 1) mark the underlying segment in production, 2) strengthen prosodically salient positions, and 3) resolve hiatus with maximal gestural closure. In addition, the glottal stop serves as the most socially neutral of the variants and fills the role of local formality strategy, demonstrating its incredible versatility in Nicaraguan Spanish.

This dissertation has contributed to several areas of linguistic study, including dialectology, phonetics/phonology, and sociolinguistics. Within dialectology, I have provided the first detailed analysis of the glottal stop in Nicaragua, a previously unanalyzed realization, and increased our understanding of a highly understudied variety of Spanish. In terms of phonetics and phonology, I have explained the glottal stop as a language internal, phonetically motivated variant that is not caused by language contact. Instead, I argued that the glottal stop serves a linguistic purpose in Nicaraguan Spanish, working as a fortition and hiatus resolution strategy.

My results also contribute to phonological theory. The analysis presented here situated the different productions of word-final, intervocalic /s/ (or /h/, as I argue) within
a continuum of fortition (or a continuum of hyperarticulation), illustrated below in (20). Sibilance is not included in the fortition continuum below because it is more stylistically conditioned in Nicaraguan Spanish and does not correspond to the reanalyzed underlying coda /h/.


(20) above emphasizes that fortition is not simply present or absent, but is rather a more fined-grained process. Crucially, the fortition continuum interacts with other linguistic factors. That is, the degree of variant fortition interacts with a hierarchy of phonological positions or environments that require more or less fortition: there is a tendency for vowels in hiatus (created by high deletion rates) to be separated through hyperarticulation, and there is an even stronger tendency for word-initial, stressed vowels to be separated through hyperarticulation. The different strengthened variants correlate with this hierarchy of environments where fortition is preferred: the glottal stop, situated at the extreme end of the fortition continuum, is reserved for the phonological environment that most requires the hyperarticulation, i.e. word-initial stressed vowels.

Finally, this dissertation has contributed to sociolinguistics by examining the correlations of the word-final intervocalic /s/ (/h/) variants with social factors, exploring which age groups and education levels are more likely to use a variant across several tasks. I also explained how different social groups develop formality strategies, using either socially neutral “local” linguistic strategies (the glottal stop) or stylistically calling
upon what are perceived to be globally prestigious standards (sibilance) to achieve a more formal speech style. With that said, it is my hope that this dissertation will inspire new studies to delve into the rich and fascinating variation that exists in Nicaragua.

6.9 Future research

This dissertation has been the first effort in the literature to provide an analysis and explanation of the glottal stop in Nicaraguan Spanish, and a great deal of research still needs to be done. First, I have relied on statistical analyses, participant observations, and correlations to explain the relationship between social factors and the glottal stop, but a more detailed investigation of the social meaning associated with the glottal stop is needed. Matched-guise tests, for example, would be a very promising means of exploring the subtleties of the glottal stop’s indexical field (Eckert 2008). In such tests, informants would listen to Nicaraguans’ speech and rate each speaker on a series of personal qualities, such as intelligence, kindness, political affiliations, leadership skills, etc. The Nicaraguans’ speech would be manipulated to include one word-final, intervocalic /s/ variant, and if the informants’ ratings of that individual’s personal qualities change based on the variant inserted in the recording, it suggests that the variant is triggering the difference in listener perceptions. For example, this test could reveal a relationship between increased glottal stop use and a higher rating of perceived speaker kindness, indicating that kindness is among the qualities indexed by the use of the glottal stop. In addition to revealing relationships between personal/social factors and the variants, the
matched-guise test also allows for a much deeper exploration of the indexical field beyond broad and monolithic categories like gender, education, and age.

In addition to a deeper investigation of the social meaning associated with the glottal stop in Nicaraguan Spanish, a comparison of the social factors at work in Nicaraguan Spanish and Puerto Rican Spanish would be enlightening, as the two dialects appear to be using the glottal stop in similar ways linguistically. Valentín-Márquez (2006) argues that young speakers and, in particular, young females are driving the change in Puerto Rico, and the use of the glottal stop may be a local, socially neutral hyperarticulation strategy in Puerto Rican Spanish, much like Nicaraguan Spanish.

Another study that could prove interesting to the social analysis of the glottal stop would entail an in-group/out-group perception comparison. After exploring local perceptions of the glottal stop, it would be fascinating to investigate what the glottal stop indexes about an individual to native Spanish speakers from other, external dialects. Such a study could include speakers from other Nicaraguan Spanish dialects that do not use the glottal stop but are familiar with its use and speakers of external dialects that are unfamiliar with the glottal stop’s use to determine how familiarity influences its perception.

Finally, I have concluded that the glottal stop is a postlexical hiatus resolution strategy, but future studies should also aim to determine what other hiatus resolution strategies are at work in Nicaraguan Spanish, particularly word-internally. Based on casual observations, I believe that diphthongization is quite common word-internally and deletion may also be employed, but I never heard the glottal stop used word-internally.
The field would benefit from an analysis of how these different strategies work together in Nicaraguan Spanish to resolve hiatus, clarifying the complex relationship among several strategies serving the same purpose in a single dialect.
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Appendix A: Stimuli used in the image identification task (with anticipated responses)

1. “En esta imagen, observo unas/las/muchas/varias ovejas.”
   ‘In this picture, I see some/the/many/various sheep.’

2. “En esta imagen, veo/observo unas/las/muchas/varias olas.”
   ‘In this picture, I see some/the/many/various waves.’
3. “En esta imagen, observo unas/las/muchas/varias águilas.”
   ‘In this picture, I see some/the/many/various eagles.’

4. “En esta imagen, observo unos/los/muchos/varios aguacates.”
   ‘In this picture, I see some/the/many/various avocados.’

5. “En esta imagen, observo unos/los/muchos/varios elefantes.”
   ‘In this picture, I see some/the/many/various elephants.’
6. “En esta imagen, observo unas/las/muchas/varias equis.”
   ‘In this picture, I see some/the/many/various X’s.’

7. “En esta imagen, observo unos/los/muchos/varios utensilios.”
   ‘In this picture, I see some/the/many/various utensils.’

8. “En esta imagen, observo unas/las/muchas/varias uvas.”
   ‘In this picture, I see some/the/many/various grapes.’
9. “En esta imagen, observo unas/las/muchas/varias islas.”
   ‘In this picture, I see some/the/many/various islands.’

10. “En esta imagen, observo unos/los/muchos/varios ingleses.”
    ‘In this picture, I see some/the/many/various Englishmen.’
Appendix B: Stimuli used in the reading task

1. Vos te casás este sábado. ‘You get married this Saturday.’
2. Vos te casás en la iglesia. ‘You get married in the church.’
3. Me encantan las casas enormes de esta ciudad. ‘I love this city’s enormous houses.’
4. Prefiero las casas entre las montañas. ‘I prefer houses between the mountains.’
5. Me molesta esa voz áspera. ‘That rough voice bothers me.’
6. Es que esa tos amenaza la salud. ‘It’s that that cough threatens one’s health.’
7. Veo los edificios altísimos del país. ‘I see the country’s very tall buildings.’
8. Me impresionan los museos altos. ‘The tall museums impress me.’
9. Creo que comés hígados. ‘I believe you eat liver.’
10. Parece que vos ya tenés historia con ellos. ‘It seems that you already have history with them.’
11. Ella no busca animales insumisos para la granja. ‘She isn’t looking for disobedient animals for the farm.’
12. No entiendo a los animales híbridos. ‘I don’t understand hybrid animals.’
13. Los Palís usan mucha plata en su publicidad. ‘Palís use a lot of money on their advertising.’
14. Vamos a los Palís u otros supermercados este año. ‘We’ll go to Palís or other supermarkets this year.’
15. El científico habló de sus análisis humildemente. ‘The scientist spoke of his analysis humbly.’
16. Prometen mucho los análisis híbridos del científico. ‘The scientist’s hybrid analyses are very promising.’
17. Ella lee la historia del aveSTRUZ otra vez. ‘She reads the story about the ostrich another time.’
18. El aveSTRUZ ordinario corre muchas veces al día. ‘The average ostrich runs many times a day.’
19. Estamos rodeados de espíritus obedientes todos los días. ‘We’re surrounded by obedient spirits every day.’
20. Pensó que los espíritus ogros lo perseguían. ‘He thought the ogre spirits were following him.’
21. Antes del accidente ellas estaban bien pero después ambas estaban confundidas. ‘Before the accident they were fine but afterwards both were confused.’
22. Ese día fue un lunes amargo, un lunes educacional. ‘That day was a bitter Monday, an educational Monday.’

23. Él escribe esa tesis obscena con un lapicero algunos días y un lápiz otros días. ‘He writes that obscene theses with a pen some days and a pencil other days.’

24. Nos dio un análisis ignorante y fue un análisis inmensamente caro. ‘He/she gave us an ignorant analysis and it was an extremely expensive analysis.’

25. Muchas hembras heridas se mejoran, pero la hembra gordita no. ‘Many females (animals) get better, but the fat female (animal) does not.’

26. Antes de ese día era un secreto, pero después el escocés humilde se enteró. ‘Before that day it was a secret, but afterwards the humble Scotsman found out.’

27. Algunas chicas se preocupan por las obras de otras. ‘Some girls worry about the works of others (fem).’

28. Aquí viene otra fila de las hormigas rojas con la hormiga amarilla. ‘Here comes another line of the red ants with the yellow ant.’

29. ¿Me das las uvas para probarlas? ‘Would you give me the grapes to try them?’

30. Me gustan las urbanidades en el campo. ‘I like urban things in the country.’

31. Muchas amas siguen las telenovelas pero la ama flaca no. ‘Many homemakers follow soap operas, but the skinny homemaker does not.’

32. Todavía está enferma, pero las aflicciones son menos graves. ‘He/she is still sick, but the afflictions are not as serious.’

33. Me encantan todas las isletas pero la isleta grande es la mejor. ‘I love all the islands, but the big island is the best.’

34. Las iras son malas para la salud. ‘Wrath is bad for one’s health.’

35. Los otros sí saben nadar. ‘The others do know how to swim.’

36. Los ogritos no te van a molestar en la isla. ‘The ogres will not bother you on the island.’

37. Los hígados y la albahaca son buenos para la salud. ‘Liver and basil is good for one’s health.’

38. Los hipotecarios te van a robar. ‘The mortgages will rob you.’

39. Los años aquí pasan rápidamente. ‘The years here pass quickly.’

40. Los aplausos para la hermana son bien merecidos. ‘The applause for the sister is well-deserved.’

41. Los enanos cantan bien en el teatro. ‘The dwarfs sing well in the theater.’

42. Los egos de ellos están bien inflados. ‘Their egos are very inflated.’

43. Los utensilios están baratos allí pero el alcohol es caro. ‘The utensils are cheap here, but the alcohol is expensive.’

44. ‘Los usos de ese producto son variados’, dijo la artista. ‘‘The uses of that product are varied”, said the artist.’

45. La osa con la uña larga come la uvita. ‘The bear with the long fingernail eats the little grape.’

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