

# Linguistic factors conditioning glottal constriction in Nicaraguan Spanish

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This paper provides the first quantitative exploration of the linguistic factors conditioning glottal constriction in Nicaraguan Spanish, an allophone of word-final, intervocalic /s/, e.g. [ma.'al.to] for *más alto* 'higher'. To date the variant has only been mentioned in passing in dialectal surveys (Quesada Pacheco 1996; Rosales Solís 2010) or described as a contact feature in other dialects of Spanish, i.e. Philipino (Lipski 2000), Yucatan (Lope Blanch 1987: 108-124), Argentinian/Paraguayan (Sanicky 1989; Thon 1989), and Puerto Rican Spanish (Valentín-Márquez 2006). However, the Spanish spoken in Managua is not in contact with any other languages, and I argue that glottal constriction in this dialect is a phonetically motivated, language-internal phenomenon. After a statistical analysis of 3,701 tokens from 36 Managuan participants, I conclude that glottal constriction serves to 1) strengthen prosodically strong positions due to its likelihood before word-initial, stressed vowels and 2) avoid postlexical hiatus, being more likely after longer words with high rates of /s/ deletion.

KEY WORDS: Nicaraguan Spanish, coda /s/, glottal constriction, glottal stop, fortition, hiatus resolution

## 1. Introduction

The reduction of syllable-final /s/, e.g. *esto* 'this' realized with aspiration ['eh.to] or deletion ['e.to], is one of the most widely discussed phonological variables in the literature on Hispanic linguistics (Brown & Torres Cacoullós 2003). Topics of particular interest include the historical evolution and dispersion of the reduction (Ferguson 1990; Lipski 1999; Méndez Dosuna 1996), the acoustic and articulatory factors driving the reduction (Guitart 1976; Seklaoui 1989) and affecting perception (Schmidt 2013), linguistic and social factors conditioning the variation in a particular dialect (Alba 1982; Alfara 2000; Brown & Torres Cacoullós 2002, 2003; Carvalho 2006; Cedergren 1973; Cepeda 1995; Dohotaru 1998; Gerfen 2001; Horn 2013<sup>1</sup>; Lafford 1986; Longmire 1976; López Chávez 1977; Lynch 2008; Ma & Herasimchuk 1971; Morgan 1998, 2000; Moya Corral 2007; Parrell 2011; Poplack 1980; Ranson 1991; Ruiz-Sánchez 2004; Ruch 2008; Tennant et al. 2008; Torreira 2007a, 2007b, 2012; Vallejo-Claros 1970; among many others), and cross-dialectal comparisons (Canfield

1981; Lipski 1994; Penny 2000; Terrell 1977; Terrell & Tranel 1978). Put simply, the production, perception, and extension of syllable-final /s/ in the Spanish-speaking world has generated a great deal of interest among linguists of various disciplines.

However, little has been published on /s/ reduction in Nicaraguan Spanish (henceforth NS) other than brief mentions in dialectal surveys (Canfield 1981; Lipski 1994; Quesada Pacheco 1996; Rosales Solís 2010) and Lipski's (1984a) article comparing percentages of [s], [h], and deletion among Nicaraguans from three different education levels in different registers. The consensus from these scarce publications is that NS is a dialect with very high levels of syllable-final /s/ reduction. In fact, Lipski (1994) notes that the rates of aspiration in NS approximate the rates found in Caribbean dialects, where aspiration is the norm. Lipski (1994) explains that before a consonant, syllable-final /s/ is nearly categorically realized as glottal frication, e.g. *hasta* 'until' as [ʔa.h.ta], giving NS its "breathy quality".

At the word boundary in intervocalic position, both aspiration and deletion occur, e.g. [ma.'ha.sja]<sup>2</sup> and [ma.'a.sja] for *más hacia* 'more toward'. Lipski (1984a) finds relatively low rates of deletion in this environment, with only 2.1%-13.1% of the realizations elided depending on the speaker's social class, and higher rates of sibilance at 35.1%. However, my experience in Nicaragua thirty years later diverged from Lipski's description (1984a), and I noticed an evolution of the variants (Chappell 2014). Rather than 35.1% sibilance, I observed rates lower than 10% for sibilant retention, e.g. *los amo* 'I love them' as [lo.'sa.mo], and I also noticed higher rates of deletion (35.5%) than the 2.1%-13.1% deletion rates found in Lipski (1984a), e.g. [lo.'a.mo]. In addition to the changing rates of sibilance and deletion, I observed that NS makes use of an innovative variant in the word-final, intervocalic environment. This variant, which I call glottal constriction,<sup>2</sup> has only been alluded to in previous work on NS (Quesada Pacheco 1996; Rosales Solís 2010), and outside of NS the glottal stop has been explained exclusively in terms of a language contact phenomenon. In Nicaragua, however, this argument holds less weight as no other languages are in contact with NS, and another account is needed.

This study is motivated by the radical reduction of coda /s/ in NS, the scarcity of studies on the variety, and the presence of an allophone (glottal constriction) that has never been examined as a non-contact feature. A great deal of research is needed on the glottal stop to more fully understand the phonetic motivation for the variant and the lin-

guistic factors that condition its use. In order to fill this gap, the present study seeks to answer the following two research questions:

1) What linguistic factors condition glottal constriction in Nicaraguan Spanish?

2) What is the phonetic motivation behind glottal constriction's use if it is not simply a language contact feature?

## *2. Literature Review*

### *2.1. /s/ lenition in Spanish*

As aspiration and deletion of syllable-final /s/ are found across numerous dialects of Spanish, including southern Spain, the Southern Cone, the Caribbean, and Central America (Lipski 1994), the variable provides fertile ground for cross-dialectal investigations in search of broader tendencies and universals in the Spanish lenition process. In fact, /s/ lenition affects approximately half of the Spanish-speaking world (Terrell 1981), but shows several cross-dialectal similarities. While not comprehensive, this section will present an introduction to /s/ lenition, specifically discussing the linguistic factors found to condition the process. I refer the reader to File-Muriel (2007) and Mason (1994) for a thorough review of /s/ in the Spanish-speaking world.

/s/ lenition represents a reduction process in Spanish that has been progressing for centuries and continues to progress today (Lipski 1984b; Seklaoui 1989: 13-16; Terrell 1981). Many linguists contend that syllable-final /s/ lenition is a step on the diachronic path to full deletion, following a tendency that favors syllable-final consonant reduction allowing for the open syllables favored by Romance languages (Calero 1990; Felix 1979; Lipski 1984a, 1984b, 1994; Mason 1994; Terrell 1979, 1981; Widdison 1995). Some linguists, on the other hand, point to instances of stable variation of /s/ lenition in the Spanish-speaking world that do not necessarily support a diachronic pathway to deletion (Barrios 2002; Cameron 2000). Yet other studies indicate that while /s/ lenition tends to progress diachronically, a reversal of /s/ reduction patterns may take place among younger speakers with increased access to education and contact with external /s/-retaining dialects of Spanish associated with prestige (Lafford 1986).

In terms of the emergence and spread of the reduction, /s/ lenition is widespread in southern Spain, and the weakening of syllable-final /s/ was also extended to Latin America (Penny 2000: 125). Some agreement has been established regarding the general pattern of diffusion /s/

lenition follows in the Spanish-speaking world. Ferguson (1990), Lipski (1999), and Méndez Dosuna (1996) argue that /s/ lenition begins before a consonant, e.g. ['ah.ta] for *hasta* ‘until’ or, at the word boundary, [lah.'me.sas] for *las mesas* ‘the tables’, and in more advanced dialects spreads to the prepausal environment, e.g. ['me.sah] for *mesas* ‘tables’. Finally, in even more advanced dialects /s/ lenition occurs word-finally before a vowel as well, e.g. *es así* ‘it is like that’ as [e.ha.'si]. As noted above, aspiration or elision occur in all of these environments in NS.<sup>3</sup>

## 2.2. Linguistic factors influencing /s/ lenition

Numerous studies have been conducted on the factors influencing /s/ lenition in different dialects of the Spanish-speaking world. In this section I aim to introduce the work most relevant to the present study and draw some cross-dialectal conclusions about the general principles at work behind /s/ lenition.

### 2.2.1. Phonological environment

There are certain predictors of /s/ lenition that are consistent across dialects, and phonological environment repeatedly emerges as one of these significant linguistic factors. The importance of phonological environment is evident in Cedergren’s “best-fit estimation” data on Panamanian Spanish: one of the most predictive factors of aspiration is a following consonant, and word-internal coda /s/ favors aspiration as well (1973: 42-43). The same tendency is described in Puerto Rican (Ma & Herasimchuk 1971) and Cuban Spanish (Tennant et al. 2008; Vallejo-Claros 1970).

Terrell and Tranel (1978) show a patterning of /s/ lenition across dialects of Caribbean Spanish, including Venezuelan, Puerto Rican, and Cuban Spanish, finding that aspiration in these dialects is least common before a pause, more common before a vowel, and most common before a consonant, illustrated below in figure 1.

/s/ retention-----	/s/ reduction
low aspiration-----	high aspiration
Pause	Vowel Consonant

**Figure 1.** The continuum of /s/ retention and aspiration in Caribbean Spanish given the following phonological environment based on Terrell and Tranel (1978).

Figure 1 shows that the likelihood of /s/ lenition increases if the following environment is a vowel and, to an even greater extent, if the following environment is a consonant. The opposite pattern is observable for /s/ retention: /s/ retention is more likely if the following environment is a vowel than if the following environment is a consonant,

and retention is most likely before a pause. One exception to this general rule has reoccurred in the literature: /s/ is retained to a much higher extent if the following vowel is stressed, e.g. *los otros* ‘the others’, and this exception will be discussed in greater detail in section 2.2.2. In Cuban Spanish, Dohotaru (1998) reaches similar conclusions about the phonological environments conditioning aspiration: she argues that aspiration is the norm word-internally before a consonant but that aspiration is unlikely before a pause. However, Dohotaru differs from Terrell and Tranel (1978) in finding that rather than retention before a pause, the most common realization is actually full elision, occurring in 75.3% of the realizations.<sup>4</sup>

Of particular importance to the present study are the phonological factors conditioning full elision: while Dohotaru (1998) finds that elision is most likely prepausally, deletion is also frequent word-finally before a consonant or a vowel (44.9% and 43.5%, respectively). Tennant et al. (2008) find in their GoldVarb analysis that elision is favored word-finally before a vowel in Cuban Spanish, e.g. *las amo* ‘I love them’ as [la.'a. mo], showing that full deletion resulting in hiatus is common postlexically in other advanced dialects, just as it is in NS (Chappell 2014).

### *2.2.2. Word length, Stress, and Word Class*

In addition to phonological environment, the role of target word length is a recurring theme across dialects of Spanish. Terrell (1979) argues that word length is the single most predictive factor of Cuban Spanish /s/ deletion, with monosyllabic words less likely to present full deletion than polysyllabic words. /s/ elision in Caracas, Venezuela follows the same pattern: /s/ elision is more common following polysyllabic words than following monosyllabic words (Ruiz-Sánchez 2004), with increasing rates of elision as the syllable number increases from two to six. This difference may be due to timing constraints, as longer words have shorter individual units (Méndez Dosuna 1985), and ‘massive reduction’ (Johnson 2004) of the segments in longer words has been documented in English as well. Along the same lines, File-Muriel & Brown (2011) have established a correlation between longer words and a faster speech rate.

Several studies have also commented on the importance of following stress in /s/ lenition processes. The existing studies have consistently found that before a stressed vowel /s/ is retained much more frequently than before an unstressed vowel (Alba 1982; López Morales 1980: 66-67; Poplack 1979; Terrell 1979). Some studies contend that these higher rates of retention occur exclusively between determiners and a following stressed vowel, e.g. *los únicos* ‘the only ones’ (Terrell 1979), and other studies have supported the notion that the determiner is the lexical category most likely to retain /s/ (Cedergren 1973: 51-55;

Guy & Braga 1976; Ma & Herasimchuk 1971). Dohotaru's (1998) data on Cuban Spanish highlight the importance of the following stressed vowel for sibilance rates: before unstressed vowels only 2.1% of word final /s/ realizations are retained, while 37.8% of /s/ realizations in this phonological environment are retained before a stressed vowel.

Alba (1982) argues that lexical accent of the target word in Dominican Spanish conditions /s/ deletion, with unaccented words, e.g. possessive adjectives, articles, and prepositions, retaining sibilance much more than lexically accented words. He argues that this is due to these words' proclitic nature, placing the target unaccented word in the same accentual unit as the following word, and the increased duration, pitch, and intensity of the following stressed syllable (Quilis 1971) decreases the likelihood of reduction. More recently, File-Muriel (2010) finds that lexical frequency plays a crucial role in /s/ reduction in *Barranquillero* Spanish, with high-frequency words showing greater rates of reduction. However, these different conclusions pose a methodological problem as it is difficult to establish whether it is the target word's i) word length, ii) lexical accent, iii) word class, or iv) frequency that truly conditions /s/ reduction. This study sheds some light on this issue, but separating high-frequency words, unaccented words, monosyllabic words, and determiners poses a challenge to the researcher as many of these values commonly co-occur.

### 2.2.3. Nicaraguan Spanish

Although very little research has been conducted on Nicaraguan Spanish, this section details the available information. Lipski (1985) notes that the variety reduces coda /s/ far more frequently than all other Central American dialects, paralleling the /s/-reduction frequencies found in radical Caribbean varieties (see Lipski 1994). Documenting the contexts in which /s/-reduction is most frequent among three social strata in casual conversations, Lipski (1984a) presents the following /s/-reduction data in the prevocalic environment.

**Table 1.** Prevocalic coda /s/ reduction rates in NS casual speech in the early 1980s (from Lipski 1984a).

	s#V'			s#V		
	[s]	[h]	Ø	[s]	[h]	Ø
Upper class	27.7%	70.2%	2.1%	7.4%	90.4%	2.2%
Middle class	29.0%	65.8%	5.3%	4.8%	88.4%	6.8%
Lower class	22.6%	62.8%	13.1%	1.6%	90.2%	8.2%

(V = unstressed vowel; V' = stressed vowel; # = word break)

Lipski’s data demonstrate the prevalence of glottal frication in the word-final, prevocalic context, both before a stressed and unstressed vowel, while deletion rates are limited and only reach 13.1% among members of the lowest social class. As is the case in other /s/-reducing dialects of Spanish (Alba 1982; López Morales 1980: 66-67; Poplack 1979; Terrell 1979), full retention in NS is limited before an unstressed vowel, but it is more frequent before a stressed vowel. While [s] production before an unstressed vowel falls between 7.4% and 1.6% for all social classes, [s] is retained with 22.6%-29% frequency before a stressed vowel.

More recently, Chappell (2014) has argued in favor of an advancement of the reduction: thirty years after Lipski’s data collection, NS speakers use sibilance much less, particularly before a following stressed vowel, and deletion much more in prevocalic contexts. Additionally, glottal constriction, which was not discussed in Lipski’s (1984a) work, accounts for nearly 25% of the realizations before a stressed vowel. The more recent distribution of prevocalic /s/ variants is presented below in table 2.

**Table 2.** Prevocalic coda /s/ reduction in NS casual speech from 2011-2012.

s#V´	s#V					TOTAL	s#V					TOTAL
	[s]	[ʔ]	[h]	∅			[s]	[ʔ]	[h]	∅		
Upper class	21% (24)	23.7% (27)	28.1% (32)	27.2% (31)		114	5.7% (20)	10% (35)	45% (157)	39.3% (137)		349
Middle class	12.2% (21)	17.4% (30)	44.2% (76)	26.2% (45)		172	4.8% (21)	3.5% (15)	65.8% (285)	25.9% (112)		433
Lower class	11.2% (13)	23.3% (27)	16.4% (19)	49.1% (57)		116	2.2% (7)	3.2% (10)	39% (123)	55.6% (175)		315

(V = unstressed vowel; V´ = stressed vowel; # = word break)

Whether Lipski’s (1984a) [h] rates are directly comparable to these data is unclear; Lipski (1984a) does not address glottal constriction in NS, and it is not known if (a) the realization did not occur in his data or (b) he conflated glottal constriction with [h]. Regardless, the [s] and ∅ variants can be less ambiguously compared, and the most notable difference between the data sets is the rates of full elision. Lipski (1984a) finds limited deletion in the early 1980s, while Chappell (2014) notes elision rates over 50% for the lowest social class. For all social classes, elision is a more common realization than retention in casual speech, demonstrating the extent of the reduction in NS. Sibilance appears to have undergone a shift as well. While the

most educated part of the population continues to retain [s] before a stressed vowel, following the pattern found by Lipski (1984a), the rates of [s] before a stressed vowel are markedly reduced in the middle and lower social classes, falling from 29% and 22.6% in the 1980s to 12.2% and 11.2% in 2011-2012, respectively. It seems that [s] production is eroding among the popular classes in NS casual speech and being supplanted by reduced variants.

### 2.3 *Hiatus Resolution*

The result of /s/ deletion in word-final, intervocalic environments, common in the aforementioned /s/-reducing dialects of Spanish, is hiatus, a heterosyllabic vowel-vowel sequence. Casali (1998: 3) writes, “many languages do not readily tolerate adjacent heterosyllabic vowels” and seek to resolve them rather than maintain adjacent vowels in separate syllables. Numerous authors argue that Spanish dialects demonstrate a tendency to eschew hiatus (Alonso 1930: 31-37; Frago-Gracia & Franco-Figueroa 2001: 99; Hernández 2009: 3-5; Quilis 1993: 190-192), particularly in Latin America where prescriptive influences are not as great (Alonso 1930: 36-37). The tendency to resolve hiatus may be related to the CV syllable structure’s unmarked nature cross-linguistically, as every known language allows for that syllable structure (Kager 1999: 95). There are several strategies described by Casali (1998) for resolving hiatus, and these strategies can be found in different dialects of Spanish, including vocalic elisions, e.g. [li.'yle.sja] for *la iglesia* ‘the church’ (Hernández 2009: 24); diphthong formation, e.g. [pe.'ljar] for *pelear* ‘to fight’; coalescence, e.g. [lɛs.'kwe.la] or [lɪs.'kwe.la] for *la escuela* ‘the school’ (Jenkins 1999: 127, 130), and epenthesis, e.g. [ka.'no.ɣa] for *canoa* ‘canoe’ (Garrido 2007: 30). Of course, these processes can co-occur in any given language or dialect (Barberia 2012: 174-176; Casali 1998: 5), meaning that both diphthong formation and elision may be found in a dialect of Spanish as the hiatus resolution processes are not mutually exclusive. Multiple factors condition hiatus resolution, including vowel quality, word position and proximity to stress, analogical change, speech style, socioeconomic status of the speaker, and word or string frequency (Garrido 2013).

The present discussion will not discuss in detail the vast body of literature that exists on types of hiatus resolution other than epenthesis, but I recommend Barberia (2012), Garrido (2013), and Hernández (2009) for excellent discussions of the subject. Instead, I will focus on epenthesis in Spanish, as this is the form of hiatus resolution of special importance to the present study on glottal constriction in Nicaragua.

As previously mentioned, epenthesis involves the insertion of a consonant between the two adjacent, heterosyllabic vowels found in hiatus. There is no single consonant employed across dialects of Spanish; rather, different sounds are inserted in different Spanish-speaking areas. In Mexican Spanish, for example, the spelling ‘mojo’ can be observed for *moho* ‘mildew/mold’ in online speech, indicating that the silent orthographic *h* is actually being produced as [x] between the two vowels (Hernández 2009: 5).<sup>5</sup> In addition to [x], a bilabial approximant has been reported as an epenthesized consonant between adjacent vowels in Mexican Spanish, e.g. [to.ʔβa.ja] for *toalla* ‘towel’ (Garrido 2013: 339; Hernández 2009: 12). In Colombian Spanish an inserted velar approximant has been noted, e.g. [ka.'no.ɣa] for *canoa* ‘canoe’ (Garrido 2007: 30), and Spanish-speaking children have been observed resolving hiatus in a similar way: at the approximate age of 1:11 Rebeke Campos-Astorkiza’s son, whose primary input is Spanish from the northern Bilbao region, began inserting a velar approximant between adjacent, heterosyllabic vowels, e.g. *leon* ‘lion’ produced as [le.'ɣon] (p.c. 11/30/2011). Bybee (2001: 72-73) notes that these epenthetic segments, or strengthenings, are often the result of the retiming of articulatory gestures that were already present before the consonantal insertion. For example, the bilabial approximant inserted in *toalla* above constitutes a retiming of the lip-rounding gesture already present in the production of [o] and the insertion of a velar approximant in *canoa* and *leon* involves a retiming of the tongue retraction involved in the production of the back vowel.

### 2.3.1. *Glottal Constriction*

Of particular importance to the present study is the insertion of a glottal segment between adjacent vowels, e.g. [pa.ra.'ʔi.so] for *paraíso* ‘paradise’ (Sanicky 1989, describing Misiones, Argentina), as has been observed in some dialects of Spanish. In articulatory terms, Esling et al. (2005) explain that the glottal stop is generally thought of as a constriction occurring exclusively at the glottis. However, the authors demonstrate that the glottal stop is actually a much more complex sound based on laryngeoscopic studies, produced 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). Several other studies support this conclusion (Esling 2002; Esling & Edmondson 2002; Carlson, Esling & Harris 2003; Esling & Harris 2003; Edmondson et al. 2005), and Esling et al. (2005) contend that this complex pro-

duction is necessary to stop vocal fold vibration. Without the additional supralaryngeal reinforcement, airflow would likely continue to flow through the glottis, facilitating a continuation of voicing because of subglottal and supralaryngeal pressure differences.<sup>6</sup> With the supralaryngeal constriction, however, the pressure difference decreases and full glottal closure is facilitated.

Unfortunately, linguistic analyses of the glottal stop in Spanish are scarce, and the use of a glottal stop is often glossed over as a result of languages in contact. For example, the glottal stop is one of the most salient features of Chabacano Spanish, a Spanish-based creole spoken in the Philippines, and is used to emphasize phonetic boundaries and resolve hiatus (Lipski 2000). In the western hemisphere, the glottal stop has also been described in Yucatan Spanish in contact with Mayan, occurring primarily between an atonic vowel and a following tonic vowel, e.g. [des.'kan.sa.'?u.no] *descansa uno* 'one rests' (Lope Blanch 1987: 115). Farther south, the glottal stop has been described in the Spanish of Paraguay and Argentina as a language contact feature as well (Alonso 1930: 18-21, 36; Thon 1989; Vidal de Battini 1964: 83), with the glottal stop of Guaraní entering the Spanish of the region due to widespread bilingualism. Like Yucatan Spanish, the glottal stop is most likely at the word boundary between vowels (Pruñonosa 2000), particularly when the second vowel is tonic (Sanicky 1989).

I would like to draw attention to the fact that all of the preceding dialects are dialects of Spanish in contact with other languages. In fact, the use of the glottal stop in these dialects appears to be directly linked with bilingualism and bilingual communities who are transferring the use of the glottal stop in an indigenous language into their Spanish. Mackenzie (n.d.) and Thon (1989) argue that older speakers in lower socioeconomic strata in Paraguay and Argentina show more Guaraní interference in their speech and incorporate the glottal stop more in their Spanish, while the speech of higher social classes parallels Southern Cone Spanish in non-contact zones (Mackenzie n.d.). Michnowicz (2006) and Thon (1989) indicate that in the Yucatan peninsula and Argentina, respectively, the glottal stop is used in Spanish much as it is used in the indigenous languages of these areas. In other words, bilingual speakers seem to be superimposing their use of the glottal stop in Mayan or Guaraní into their Spanish.

The situation is somewhat different in Spain, Puerto Rico, and Nicaragua. In Spain, scarce data are available about the use of the glottal stop, and only a few authors have even noted its presence in

dialectological surveys. Cortés Gómez (1979) explains that the glottal stop of Higuera de Vargas, a town in the province of Badajoz in southwest Spain, occurs mainly before a voiceless stop, particularly before the dental /t/, e.g. [eʔ.'ta.ka] for *estaca* ‘post’, and [eʔ.ten.'de] for *extender* ‘extend/spread’ (29). Terrell (1977) make similar claims about the glottal stop in Puerto Rico, indicating that the realization serves as a reduced variant of syllable-final /s/, e.g. *esconder* ‘to hide’ as [eʔ.kon.'del].

Tellado González (2007) and Valentín-Márquez (2006) also note the presence of the glottal stop in Puerto Rican Spanish; however, neither author finds a glottal stop in the word-internal environment described by Terrell (1977). Rather, Tellado González (2007) only describes cases of word-final, intervocalic glottal stop use, an environment where variation among [s], [h], [ʔ], and assimilation occurs. Interestingly, Tellado González notes a higher rate of glottal stop use before a word-initial stressed vowel, e.g. [la.'ʔon.se] *las once* ‘eleven o’clock’, than before a word-initial unstressed vowel, [ma.ʔa.'βjer.to] *más abierto* ‘more open’. Finally, she claims that the glottal stop does not show any correlation with the status of the /s/ as a grammatical marker, meaning there is no difference in glottal stop use if the word-final /s/ is a plural marker, e.g. *gatos* ‘cats’, person marker, e.g. *quieres* ‘you want’, or simply a part of the lexeme, e.g. *tesis* ‘thesis’. Tellado González (2007) concludes that the glottal stop is a means of avoiding diphthongization through synalepha, or the merging of two adjacent vowels across the word boundary into a single syllable. However, no phonetic or articulatory account is provided to explain why the glottal stop appears over any other realization.

An interesting exception emerges in Tellado González’s (2007) data: while the glottal stop almost exclusively emerges as a variant of word-final /s/ between vowels, the glottal stop also surfaced saliently between the adjacent vowels in *a la una* ‘at one o’clock’, i.e. [a.la.'ʔu.na]. Although Tellado González (2007) does not explore this exception in more detail, it appears to be an extension of the glottal stop from similar environments where it commonly occurs as a variant of word-final /s/, e.g. *a las ocho* ‘at eight o’clock’ as [a.la.'ʔo.ʃo] or a *las once* ‘at eleven o’clock’ as [a.la.'ʔon.se]. Regardless of the presence or absence of the underlying /s/, the glottal stop continues to maximally demarcate between two adjacent, heterosyllabic vowels.

In addition to supporting Tellado González’s (2007) description of the most common environments conditioning the glottal stop, Valentín-Márquez (2006) offers a theoretical explanation for the glot-

tal stop's appearance as well: he claims that the glottal stop in Puerto Rican Spanish emerged because of contact with the English language, given that glottal stops commonly occur between words in English. Valentín-Márquez (2006) even claims that the glottal stop found in parts of Spain is due to contact with Arabic, but such a generalization may sweep interesting dialectal similarities under the rug. If we compare dialects with a glottal stop, both the Spanish of Extremadura and the Spanish of Puerto Rico reduce coda /s/ to glottal frication. The place of articulation is the same for both glottal frication and the glottal stop with only a change in the manner of articulation. It is not necessarily a stretch to claim that the glottal stop is a language-internal change guided by similar reductionist processes in Spain and in Puerto Rico.

While limited information is available on the glottal stop in Puerto Rico, even less is available on the glottal stop in Nicaragua. At present, the existence of the glottal stop has only been briefly mentioned as a dialectal feature without any independent studies dedicated to an analysis of its use. The few authors who have mentioned the glottal stop include Rosales Solís (2010), who explains that the glottal stop occurs in variation with sibilance, aspiration, and deletion as an allophone of /s/ (144), and Quesada Pacheco (1996). Quesada Pacheco (1996) notes that the glottal stop is found in both Nicaragua and Guanacaste, which is the westernmost province of Costa Rica that formed part of Nicaragua until the early 19<sup>th</sup> century and continues to use dialectal features typical of Nicaraguan speech (Lipski 1994). Describing the environments in which the glottal stop occurs, Quesada Pacheco (1996) confirms the presence of the glottal stop in Guanacaste word-finally for /s/ between vowels, particularly when the second vowel is stressed, e.g. *los indios* 'the Indians' as [lo.'ʔin.djoh]. When the second vowel is unstressed, glottal frication is more common, e.g. *los animales* 'the animals' as [lo.ha.ni.'ma.leh] (104). Unfortunately, Quesada Pacheco (1996) misreads Lipski (1984a): he claims that Lipski (1984a) describes the glottal stop in Nicaragua as occurring before a sonorous consonant, e.g. ['miʔ.mo] for *mismo* 'the same', but Lipski (1984a) actually states that voiced glottal aspiration occurs in this position, e.g. ['mifi.mo]. My findings, detailed more thoroughly in section 5, indicate that the use of the glottal stop in Nicaragua is quite similar to the use of the glottal stop described by Quesada Pacheco (1996) in Guanacaste.

### *3. Methodology*

In order to answer the questions raised here about glottal constriction in NS, I conducted a study in Managua, Nicaragua, the capital city, during the summers of 2011 and 2012. In total, I analyzed the speech of 36 Managuans<sup>7</sup> who were recruited through the snowball sampling method. The study included 18 men, 18 women, 12 speakers from each age category, which included young (18-29), middle (30-49), and older (50+) speakers, and 12 speakers from each educational group, which consisted of those without a high school diploma, the high school educated, and the college educated. The social factors involved in the production of glottal constriction are discussed in Chappell (2015); the sole purpose of the present study is to document the linguistic factors most predictive of glottal constriction.

These 36 Managuans completed a 3-part study. First, the participants took part in a 30-45 minute sociolinguistic interview to determine where glottal constriction appears in naturally occurring speech. The topics of these interviews included family, hobbies, work, travels, and concerns about Nicaragua, and I attempted to keep the conversation as casual as possible. The second task involved reading a series of 45 sentences designed to elicit the glottal stop in a more formal context with the presence of an orthographic, word-final, prevocalic <s> by manipulating the factors previously found to be predictive of /s/ reduction in other studies (see section 2.2), including stress, vowel, word class, and word length (see Appendix B). The third task, an image identification task, removed this influence of the orthographic <s> while maintaining the more formal setting. In this final task, participants were given ten images of easily identifiable nouns, e.g. grapes or waves, and asked to describe what they saw in the picture (see Appendix A).

Depending on their availability, the participants were recorded in their homes, schools, or places of work. Attempts were made to minimize ambient noise: all recordings took place in a quiet room, and if excessive background noise interfered with the recordings, e.g. rain falling on a tin roof or dogs continually barking, they were excluded from analysis. During the interview, reading task, and image identification task each participant wore a unidirectional microphone, and their speech was recorded in Audacity on a PC and saved for later analysis.

In total, more than 26 hours of data were recorded from the participants. Instead of impressionistic classifications of glottal constriction, I opened the recordings in Praat and used the spectrogram and waveform to analyze every word-final, intervocalic token of /s/. If the waveform flattened corresponding to silence in the spectrogram for

a period of more than 30 milliseconds, the realization was classified as a glottal stop. In initial analyses, I categorized creaky voice separately, in which the glottal pulses separated in the spectrogram and the waveform flattened, indicative of partial glottal closure. However, because the two variants involve the same glottal production differing only in the degree of supraglottal constriction (Esling et al. 2005), the glottal stop and creaky voice were later conflated into the single category of glottal constriction. Any realization that did not meet these acoustic criteria was classified as “other”.

#### 4. Statistical Analysis of the Data

In order to determine which linguistic factors condition glottal constriction in NS, I used the package *lme4* (Bates et al. 2012) in R (R Core Team) to fit a binomial logistic regression model with random effects to the data and explore the results. Speaker was included as a random effect to account for individual differences, but word was not included as a random effect to avoid unnecessary overlap in the model with target and following word class, which are included as independent variables.

The dependent variable in this model is “glottal constriction vs. other realization”, and the independent variables include the task, preceding and following stress, preceding and following vowel, target word class and following word class, number of syllables in the target word, and the morphological status of the /s/.<sup>8</sup> The preceding and following vowels include the five Spanish vowels (/a/, /e/, /i/, /o/, /u/), preceding and following stress involves either stressed or unstressed vowels, and the number of syllables in the target word includes 1, 2, 3, and 4+ syllables. Finally, paired word class includes four pairs of target and following word classes based on the closeness of the syntactic constituents (Pak 2007), including determiner-noun, noun-adjective, verb-preposition, and ‘other’ pairings. Two of these pairings involve word class pairings with closely related syntactic constituents that commonly co-occur, i.e. determiner-noun pairs like *los otros* ‘the others’<sup>9</sup> and verb-preposition pairs like *vamos a* ‘we go to’. Word pairings without such a close syntactic relationship are considered ‘other pairs’, e.g. the adverb-pronoun pairing of *antes ella...* ‘beforehand she...’. The syntactic closeness of noun-adjective word pairs falls between these two extremes. The individual levels and their frequency breakdowns across all three tasks are shown below in table 3.

**Table 3.** Frequency breakdown for the individual levels considered in the statistical analysis.

CATEGORICAL INDEPENDENT VARIABLES		N	PERCENT
Task	Image Identification	433	11.7%
	Reading	1631	44.1%
	Sociolinguistic Interview	1637	44.2%
	Total	3701	100%
Type of /s/	Verbal Marker	671	18.1%
	Plural Marker	2234	60.4%
	Lexical /s/	796	21.5%
	Total	3701	100%
Paired Word Class	Determiner + Noun	1353	36.6%
	Noun + Adjective	492	13.3%
	Verb + Preposition	671	18.1%
	Other Pairings	1185	32%
	Total	3701	100%
Preceding Vowel	a	1027	27.7%
	e	948	25.6%
	i	195	5.3%
	o	1423	38.4%
	u	108	29.2%
	Total	3701	100%
Following Vowel	a	1154	31.2%
	e	1023	27.6%
	i	595	16.1%
	o	460	12.4%
	u	469	12.7%
	Total	3701	100%
Preceding Stress	Unstressed	3060	82.7%
	Stressed	641	17.3%
	Total	3701	100%
Following Stress	Unstressed	2478	67%
	Stressed	1223	33%
	Total	3701	100%
Target Word Length (Syllables)	1	1562	42.2%
	2	1195	32.3%
	3	489	13.2%
	4+	455	12.3%
	Total	3701	100%

In addition to the categorical variables analyzed above, the lexical frequency of the target word, the following word, and the string frequency were included as scalar independent variables in the model. These frequencies were calculated by tabulating the number of occurrences of each word or string in the spontaneous speech of the author’s corpus of NS.

In order to present the data from the mixed effects model more clearly, the packages *car* (Fox & Weisberg 2011) and *multcomp* (Hothorn et al. 2008) were used. First, an analysis of deviance table is provided to establish the significant factors as a whole for the model.<sup>10</sup> In the analysis of deviance the Wald’s Chi-square test shows the test statistics’  $\chi^2$  as well as the degrees of freedom and p-values. A p-value below 0.05 indicates the factor’s significance to the model as a whole. Table 5 below shows that four factors significantly improve the model overall: following stress, paired word class, target word length, and following vowel. Task, type of /s/, preceding and following vowel, preceding stress, target word frequency, following word frequency, and string frequency were not significant predictors of glottal constriction.

**Table 5.** Analysis of deviance table for the model fitted to the glottal stop in the V/s/#V environment.

ANALYSIS OF DEVIANCE TABLE (TYPE III TESTS)			
	$\chi^2$	Df	Pr(> $\chi^2$ )
Intercept	83.762	1	<0.001 ***
Following Stress	94.684	1	<0.001 ***
Paired Word Class	70.598	2	<0.001 ***
Target Word Length	74.968	3	<0.001 ***
Following Vowel	16.912	4	<0.01
Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1			

This analysis of deviance table is useful for determining which factors significantly improve the model, but a comparison among the individual levels of each factor is more revealing. To provide this more detailed comparison and account for the multiple comparisons conducted, a pairwise test with Tukey’s adjustment illustrates the behavior of each level with an adjusted p-value (Hothorn et al. 2008). Tables 6-9 provide these pairwise comparisons for each factor selected as significant within the model as a whole, including the estimate, standard error, z-value, and p-value. A negative estimate indicates that glottal constriction is less likely in the environment of the first level presented, while a positive estimate indicates that glottal constriction

is more likely given the first level. Table 6 shows the pairwise comparison for following stressed vs. following unstressed vowel, table 7 illustrates the comparison among levels for paired word class, table 8 provides the comparisons among target word length levels, and table 9 shows the pairwise comparisons for following vowel.

**Table 6.** Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for following stress.

	ESTIMATE	STD. ERROR	Z-VALUE	P-VALUE
Following Stressed V – Unstressed v	1.0146	0.1043	9.731	<0.001 ***
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 (Adjusted p-values reported -- single-step method)				

**Table 7.** Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for paired word class.

	ESTIMATE	STD. ERROR	Z-VALUE	P-VALUE
Det.-Noun – Verb-Prep	1.7418	0.4138	4.209	<0.001 ***
Other Pairs – Verb-Prep	0.7051	0.4049	1.741	0.172
Other Pairs – Det.-Noun	-1.0368	0.1291	-8.031	<0.001 ***
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 (Adjusted p-values reported -- single-step method)				

**Table 8.** Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for target word length.

	ESTIMATE	STD. ERROR	Z-VALUE	P-VALUE
4+ - 2	1.016773	0.167896	6.056	<0.001 ***
4+ - 1	1.548970	0.180789	8.568	<0.001 ***
4+ - 3	1.013010	0.204510	4.953	<0.001 ***
3 - 1	0.535960	0.199363	2.688	<0.001 ***
2 - 1	0.532197	0.127011	4.190	<0.001**
3 - 2	0.003763	0.188635	0.020	1.00
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 (Adjusted p-values reported -- single-step method)				

**Table 9.** Tukey HSD Linear Hypotheses of glottal stop in the V/s/#V environment for following vowel.

	ESTIMATE	STD. ERROR	Z-VALUE	P-VALUE
o - e	0.59597	0.15964	3.733	<0.01 **
o - a	0.54262	0.15603	3.478	<0.01 **
o - u	0.51878	0.18453	2.811	<0.05 *
o - i	0.45575	0.16770	2.718	0.05
u - a	0.02384	0.17243	0.138	0.99
i - a	0.08687	0.15614	0.556	0.98
u - e	0.07719	0.17546	0.440	0.99
e - a	-0.05335	0.14149	-0.377	0.99
u - i	-0.06303	0.18602	-0.339	0.99
i - e	0.14022	0.15760	0.890	0.89

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

Table 6 above indicates that glottal constriction is significantly more likely if a stressed vowel follows the /s/, e.g. *las olas* ‘the waves’ rather than *las olitas* ‘the little waves’. Table 7 shows that glottal constriction is the least likely between verbs and a following element (generally an unstressed preposition) and in the ‘other pairs’ category, while glottal constriction is significantly more likely in determiner-noun and noun-adjective pairings. Next, table 8 illustrates that glottal constriction is most likely following longer words and significantly less likely following shorter words of only one or two syllables.<sup>11</sup> Finally, table 9 demonstrates a following /o/ effect: glottal constriction is significantly more likely with a following /o/ than with another following vowel.

## 5. Discussion

### 5.1. Factors Conditioning Glottal Constriction

In this section I discuss the conclusions drawn from the statistical analysis presented in section 4 and propose a phonetic motivation for the patterns observed above. First, the effect of following stress will be addressed in section 5.1.1, 5.1.2 discusses the length of the target word, in 5.1.3 the paired word class category is explored and explained, and 5.1.4 details what appears to be a following /o/ effect. Finally, section 5.2 draws broader conclusions about the linguistic role of glottal constriction in NS before concluding in section 6.

5.1.1. *Following Stress*

As noted in section 4, following stress significantly improves the model fitted to glottal constriction in the V/s/#V environment. Across languages, stressed positions are considered prosodically prominent domains where higher rates of fortition processes and lower rates of lenition processes can be observed (Borroff 2007: 175-176; Fougeron 2001). In acoustic terms, the importance of following stress is likely due to the greater amplitude and duration of stressed vowels (Casali 1998: 33), increasing the acoustic prominence of segments in this position and decreasing the likelihood that said segments will undergo reduction, neutralization, or deletion (Jun 1995: 34-38; Steriade 1993, 1995, 1997). In addition to acoustic prominence, fortition in strong prosodic environments serves cognitive purposes as well. Fortition in prosodically prominent environments may decrease coarticulatory effects and aid in perception (Borroff 2007: 171-172), enabling listeners to more successfully identify prosodic boundaries, segment the signal into words and phrases, and decrease the processing load by facilitating lexical access (Fougeron & Keating 1997; MacEachern 1995).

Studies specific to the Spanish language support the notion that prosodically prominent domains are less likely to undergo lenition. More specifically, both word-initial and stressed positions have been found to disfavor reduction; Chitoran and Hualde (2007) find that word-initial and stressed or pretonic vowel sequences are especially unlikely to undergo diphthongization in Spanish. For example, maintenance of the hiatus is more likely in *diálogo* ‘dialogue’, where the vowel-vowel sequence occurs in initial and stressed position, than in *dialogó* ‘he/she dialogued’ or *radiólogo* ‘radiologist’, where the vowel-vowel sequence is in initial position but farther from the stressed syllable or stressed but not word-initial, respectively (Colina 1999; Hualde 1997, 1999).

This aversion to reduction in prosodically strong environments is supported by other dialects of Spanish where coda /s/-reduction commonly occurs: rather than reducing /s/ before a word-initial stressed vowel, sibilance is maintained much more frequently in this position (Alba 1982; Dohotaru 1998; López Morales 1980: 66-67; Poplack 1979; Terrell 1979), which amounts to a fortition strategy (File-Muriel & Brown 2011: 235), particularly in dialects where reduction is the norm. As shown earlier in table 2, a similar pattern of aspiration and elision evasion is found in this environment in NS: rates of aspiration and deletion decrease in stressed syllables, while rates of sibilance increase. In addition to sibilance, glottal constriction rates increase in stressed

syllables as well, indicating that glottal constriction is a second fortition strategy within the dialect. The average behavior of the variants is shown in table 10 below (based on table 2) to illustrate the decrease in aspiration and deletion, the lenited variants, and an increase in sibilance and glottal constriction.

**Table 10.** Average rates of the variants in unstressed and stressed syllables based on the data in table 2.

	UNSTRESSED	STRESSED
Average aspiration rates	51.5% (N = 565)	31.6% (N = 127)
Average deletion rates	38.6% (N = 424)	33.1% (N = 133)
Average sibilance rates	4.4% (N = 48)	14.4% (N = 58)
Average glottal constriction rates	5.5% (N = 60)	20.9% (N = 84)
Total	1097	402

Table 10 demonstrates that the stress of the following vowel impacts glottal constriction rates similarly to sibilance: their rates of use increase with syllable stress and heightened prominence. While aspiration and deletion continue to be the most common variants in stressed syllables, their rates of use decrease when compared to unstressed syllables, suggesting that while reduction is the norm in Nicaraguan Spanish, it is avoided more commonly before stressed vowels.

Based on the data outlined above from (i) cross-linguistic tendencies, (ii) other dialects of Spanish, and (iii) rates of use before unstressed and stressed vowels in NS, I argue that glottal constriction is a fortition in prosodically prominent domains, which include accented, stressed, or initial positions (Dilley et al. 1996; Pierrehumbert & Talkin 1992). Fortition is more common in these prosodically prominent domains than in less prominent ones (Fougeron 2001), which explains glottal constriction’s higher likelihood of occurrence before a stressed vowel. Glottal constriction can be found as a fortition before stressed vowels in other languages as well, e.g. Dutch (Booij 1995), which indicates that glottal closure may be used as a fortition tool even in typologically different languages.

#### 5.1.2. Target Word Length

The length of the target word also significantly improved the model discussed in section 4, and previous studies shed some light on the importance of word length. In other /s/-reducing dialects, i.e. Cuban and Venezuelan Spanish, /s/ is more likely to be retained following

shorter words, e.g. *tos* ‘cough’, and fully elided following longer words, e.g. *realizaciones* ‘realizations’ (Dohotaru 1998; Ruiz-Sánchez 2004; Terrell 1979). The same deletion results emerge in these data from NS: /s/ elision is most common following words of three or more syllables and least likely following one- or two-syllable words.

File-Muriel (2007) discusses these differing rates of elision based on lexical accessibility: the importance of each unit of phonological material becomes less important as the listener has more access to more information. That is, the listener is easily able to identify a longer word due to the additional lexical information, but this task is more challenging for the listener given shorter words with less phonological material. As mentioned in section 2.2.2, time constraints may also be important in /s/ elision rates following longer words: in longer words, individual units are durationally shorter (Johnson 2004; Méndez Dosuna 1985) and have been found to correlate with faster speech rates in Spanish as well (File-Muriel & Brown 2011).<sup>12</sup>

Given the increased access to lexical information and the durational reduction of phonological units in longer words, why does the rate of glottal constriction increase following longer words? I contend that the direct relationship between deletion and glottal constriction in this position can be explained through an analysis of the hiatus created in this environment. There are higher rates of full elision following longer words, which, in turn, creates more hiatus following longer words as well. As discussed in section 2.3, these heterosyllabic vowel-vowel sequences are dispreferred across nearly all Latin American dialects of Spanish (Alonso 1930: 31-37; Frago-Gracia & Franco-Figueroa 2001: 99; Quilis 1993: 190-192), and hiatus resolution strategies are commonly used to resolve the heterosyllabic V-V structure (Face & Alvord 2004). To avoid the heterosyllabic sequence, Nicaraguans utilize glottal constriction following longer words to maximally demarcate between the two adjacent, heterosyllabic vowels and prevent the hiatus created postlexically.

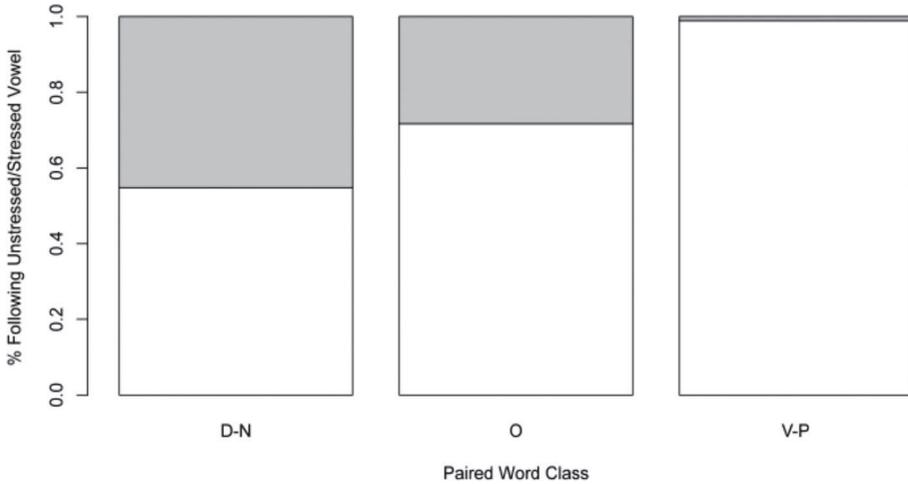
### *5.1.3. Paired Word Class*

In addition to following stress and target word length, certain pairings of target word class and following word class were found to significantly improve the model fitted to glottal constriction in the V/s/#V environment. Glottal constriction is the most likely between a determiner and a noun, e.g. *las ostras* ‘the oysters’, less likely between other word pairings, e.g. *cosas antes* ‘things before’, and least likely between verb-preposition pairings, e.g. *caminamos a* ‘we walk to’. An anonymous reviewer notes that the effect of paired word class may simply be an indirect measure of frequency, but my findings suggest

that frequency is not behind paired word class's significance. First, target word frequency, following word frequency, and string frequency were all incorporated into the model (avoiding overlap and testing for interactions) and none of these factors was selected as a significant predictor of glottal constriction. Second, both determiner-noun pairings and verb-preposition pairings are high-frequency strings (Alba 2006), but glottal constriction is most likely between determiner-noun pairings and least likely between verb-preposition pairings, with less frequent pairings falling between the two extremes. The factors' lack of significance and the differential behavior of two high-frequency strings suggest that frequency alone is not the best way to explain the patterning of the data in NS.<sup>13</sup>

Another possible explanation of the paired word effect could be an interaction between target word length, discussed in section 5.1.2 as a significant predictor of glottal constriction, and paired word class, as determiner target words tend to have fewer syllables than noun or verb target words. However, when tested in the model the interaction between the two factors did not reach significance, suggesting that the effects are independent. Additionally, if the paired word class effect were simply due to preceding word length, we would expect fewer cases of glottal constriction between determiner-noun pairings, as determiners tend to be somewhat shorter than other target words and section 4 finds lower rates of glottal constriction with shorter words. However, we observed the opposite effect in section 4; glottal constriction is more likely both (i) following longer words and (ii) between determiners and nouns. I contend that these apparently contradictory results are actually due to two different but related linguistic motivations governing the use of glottal constriction: a strategy to resolve hiatus where /s/ deletion is most likely and a fortition strategy in prosodically prominent environments.

As neither frequency nor preceding word length can adequately account for the paired word class effect, I argue that a combination of syntactic closeness and following stress can best explain the likelihood of the glottal stop based on paired word class. Both determiner-noun and verb-preposition pairings are strings that commonly co-occur compared with other word pairings, but the following word's initial vowel in these determiner-noun and verb-preposition pairings differs in stress: while prepositions are lexically unstressed (Navarro Tomás 1991: 185-194), a word-initial, stressed vowel is commonly found in nouns, e.g. *sus hipos* 'his/her hiccups', *las olas* 'the waves', or *unas horas* 'some hours'. Figure 2 below shows the frequency with which a pairing involves a second-word-initial unstressed (white)



**Figure 2.** Determiner-noun (D-N), other (O), and verb-preposition (V-P) word pairings by % following stressed vowel (gray).

or stressed (gray) vowel, demonstrating a tendency for following stressed vowels to occur most in determiner-noun pairings.<sup>14</sup>

The tendency for following stress to occur most frequently in determiner-noun pairings is generalized in speakers' production as well. In other words, when speakers are habitually exposed to these commonly co-occurring determiner-noun strings they recognize that a strong following environment is likely to occur, and they adjust their production of glottal constriction based on this generalization. When following stress is controlled and only those cases of second word-initial stressed vowels are analyzed, this generalization becomes apparent. Table 11 below shows that when the following vowel is stressed, glottal constriction is 23.2% more frequent between determiners and nouns than it is between any other pairing.

**Table 11.** Rates of glottal constriction for paired word class levels when the second word carries initial stress.

	DET.-NOUN	NOT DET.-NOUN
% glottal constriction when following vowel is stressed	65% (N = 189/291)	41.8% (N = 110/263)

Both figure 2 and table 11 demonstrate that it is a combination of the words' syntactic relationship and the likelihood of following stress

in the word pairing that cause the higher rates of glottal constriction between determiners and nouns. This line of reasoning suggests that variation plays an important role in speakers' mental grammar: based on the tendency for a stressed vowel to occur second-word initially in determiner-noun pairings, speakers generalize this tendency and use higher rates of glottal constriction (fortition) where strong prosodic environments are anticipated by the speaker, i.e. between determiner-noun pairs.

#### 5.1.4. *Following Vowel*

The final factor that emerged as a significant predictor of glottal constriction is the following vowel. Numerous groupings of the five Spanish vowels into different categories based on tongue position or frequency were tested, e.g. higher vowels vs. lower vowels, front vowels vs. back vowels, or more frequent following vowels (/a/ and /e/) vs. less frequent following vowels (/i/, /o/, /u/), but the following /o/ effect was consistent in the data analysis. However, I discovered that rather than an independent effect, the following /o/ effect is mostly due to the vowel's interaction with following stress. The cross-tabulation of the vowels and following stress is provided below in table 12, with following /o/ showing more overlap with following stress than the others.

**Table 12.** Cross-tab for following stress and following vowel.

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

An interaction between following vowel and following stress was written into the model, and the interaction between following /o/ and following stress approached significance ( $p < 0.084$ )<sup>15</sup>. Because the interaction did not meet the alpha value, it was not included in the model. However, the effect is clear: following /o/ tends to be a stressed vowel more often than the others, leading to what appears to be a following /o/ effect, but the effect is due mainly to stress patterns.

#### 5.2. *Glottal Constriction as a Language-Internal, Phonetically Motivated Variant*

An analysis of the factors that significantly improve the model fitted to glottal constriction demonstrates that the allophone serves

two key linguistic purposes in NS. First, glottal constriction appears most frequently in strong prosodic positions as a fortition strategy: the variant is most likely before a word-initial, stressed vowel, an environment highly resistant to both synchronic and diachronic reduction and deletion (Jun 1995; Steriade 1993, 1995, 1997). The use of glottal constriction before a word-initial, stressed vowel reduces coarticulatory effects (Borroff 2007: 171-172), clearly demarcating between heterosyllabic vowels, and aids listener perception where phonological material is most crucial for successful lexical retrieval (MacEachern 1995). Second, glottal constriction arises in environments with high rates of /s/ deletion, i.e. following longer words, to avoid cross-linguistically and cross-dialectally dispreferred hiatus (Alonso 1930: 31-37; Frago-Gracia & Franco-Figueroa 2001: 99; Hernández 2009: 3-5; Hualde 2005: 89-94; Quilis 1993: 190-192) in a special phonological environment: word-initially (Casali 1998: 30-34). While glottal constriction in NS serves different linguistic purposes, its production in both maximally demarcates between adjacent vowels without introducing the lingual activity needed to produce sibilance, which may be too costly articulatorily for speakers who eliminate tongue movement nearly categorically in all phonological contexts.

One important question remains to be answered about glottal constriction in NS. Did glottal constriction emerge as a variant of /s/ to prevent hiatus in environments where it is most likely or did the creation of postlexical hiatus lead to the epenthesis of glottal constriction? These possible evolutions are presented below in (1) and (2).

(1) [s] > [h]  $\left\{ \begin{array}{l} \emptyset \text{ (lenition)} \\ [ʔ] \text{ (fortition of [h] to maximally demarcate between vowels)} \end{array} \right.$

(2) [s] > [h] >  $\emptyset$  > [ʔ] ([ʔ] insertion to resolve hiatus)

While the question is a difficult one to answer without access to diachronic data, I propose that glottal constriction originally emerged as a fortition of [h], shown in (1) above. The factors most significant to the model fitted to glottal constriction are stress-based, which suggests that the realization originated as a fortition strategy in prosodically prominent environments and was only later extended to serve other linguistic purposes like resolving hiatus. As illustrated in table 2, the overwhelming majority of word-final, intervocalic /s/ realizations in modern NS are reduced across social classes, and the infrequent use of sibilance paired with the additional articulatory effort

required in its production decrease the likelihood of its use in casual NS.<sup>16</sup> Glottal constriction, on the other hand, maintains the same place of articulation as aspiration, the most common coda /s/ variant in the dialect, with a more salient division between the preceding and following vowel. No additional articulatory effort is added at the lingual level and potentially problematic social indices associated with sibilance are avoided (see Chappell 2015).

Following this line of reasoning, the use of glottal constriction as a hiatus resolution strategy, shown above in (2), serves as an extension of the initial fortition strategy. Borroff (2007: 173-176) notes that fortition prevents coarticulatory effects and aids listener perception, and the same point can be made of glottal constriction's occurrence in longer words where deletion of /s/, and subsequent creation of hiatus, is most likely. While the intervocalic /s/ that undergoes reduction in NS is word-final at the lexical level, it is word-initial at the post-lexical level, e.g. *los hipos* 'the hiccups' typically becomes [lo.'si.pos] after resyllabification (Morgan 2010). As word-initial segments are the most crucial for successful lexical identification (MacEachern 1995), /s/ deletion resulting in hiatus may actually increase the listener's cognitive processing load when identifying strings containing a word-final, intervocalic /s/. Glottal constriction, on the other hand, clearly marks the consonantal division between the neighboring vowels and indicates the presence of a word boundary.

The linguistic functions of glottal constriction may even be expanding beyond the word-final, intervocalic /s/ environment: Chappell (2014) argues that the variant is being extended to novel environments to resolve hiatus. This claim is supported by the percentages of glottal constriction in different environments in the data: in the V/s/#V environment glottal constriction accounts for 15.1% of all realizations, e.g. [lo.'ʔa.ta] for *los ata* 'he/she ties them', but Chappell (2014) documents a small percentage (3.2%, N = 111/3,431) of heterosyllabic V#V environments with epenthetic glottal constriction, e.g. [la.'ʔo.la] for *la ola* 'the wave', even though there is no underlying /s/. Although Chappell (2014) notes that there were not enough tokens to conduct a statistical analysis, the lower frequency of glottal constriction in this V#V environment suggests that the realization is being extended from the V/s/#V environment to the newer V#V environment. The extension to this V#V environment is consistent with the phonetic motivation for glottal constriction I have proposed in the presence of an underlying /s/. Although there is no underlying /s/ in the V#V environment, glottal constriction continues to maximally demarcate between heterosyllabic, adjacent vowels to resolve dispre-

ferred postlexical hiatus and reduce the listener's processing load by decreasing coarticulatory effects.

The linguistic distribution of glottal constriction demonstrates that it is a phonetically motivated variant working as both a fortition and hiatus resolution device and is not simply caused by transfer due to language contact. Rather, glottal constriction maintains the same place of articulation as the most common variant in the V/s/#V environment, glottal frication, but more maximally demarcates between vowels in prominent prosodic positions and prevents hiatus where deletion of the underlying segment is most likely.

## *6. Conclusion*

Unlike previous studies on glottal constriction in dialects of Spanish, this study is the first to propose that glottal constriction exists in some advanced /s/-reducing dialects of Spanish as a language-internal feature rather than a contact feature. Glottal constriction serves as a variant of word-final, intervocalic /s/ in NS and is conditioned by following stress, target word length, and certain paired word classes based on syntactic closeness and following stress. Glottal constriction is most likely before a word-initial stressed vowel, following longer words, and between determiner-noun word pairings, and I conclude that this versatile variant serves two primary purposes. First, it strengthens prosodically prominent positions, i.e. stressed, word-initial vowels. Second, it prevents dispreferred hiatus where deletion of /s/ between vowels is most likely, i.e. following longer words. While these two motivations are different, they work together to condition glottal constriction in Nicaraguan Spanish.

As this paper is the first to tackle glottal constriction in NS, a great deal of future work is needed. First, a detailed comparison between the behavior of the glottal stop in Puerto Rico and Nicaragua would be enlightening, as the two dialects behave similarly in regards to /s/ reduction and the glottal stop seems to serve a very similar role in the Spanish of both countries. Secondly, future studies should explore the other hiatus resolution strategies at work in NS to more thoroughly document the ways in which hiatus is avoided in the dialect. I have observed frequent word-internal diphthongization in the dialect and deletion of one vowel in postlexical hiatus, and an analysis of how these hiatus resolution strategies work together would expose the complex relationship among different hiatus resolution strategies in a single dialect.

An interesting theoretical point brought about by the results of this study should also be investigated in future work. File-Muriel (2010) finds string frequency to be the single most predictive factor of /s/ reduction in his data on *Barranquillero* Spanish, but string frequency was not found to affect the production of glottal constriction in Nicaraguan Spanish. Additional explorations of the factors conditioning deletion and /s/ retention indicate that deletion is not more likely in high-frequency strings, nor is retention more likely in low-frequency strings, contradicting File-Muriel's (2010) findings. Two explanations could account for this discrepancy. First, the difference may simply be a case of dialectal deviation, with /s/ reduction conditioned by discrete factors in *Barranquillero* Spanish and NS. Second, it may be the case that string frequency is only a significant predictor of /s/ lenition in dialects with incomplete diffusion of the reduction. However, when the degree of diffusion reaches nearly categorical levels in all phonological contexts, string frequency may cease to function as a significant predictor of /s/ reduction, and the most significant predictor may become stress-related, as I have found in NS. Comparisons of incipient and more advanced /s/-leniting dialects should investigate the effects of string frequency and stress to determine if and how the impact of independent variables shifts as the reduction becomes increasingly advanced.

This work has contributed to the fields of Hispanic dialectology by exploring a radical dialect of Spanish that is largely under-represented in the linguistic literature. Additionally, this paper expands upon the existing knowledge in Hispanic phonetics/phonology by explaining glottal constriction as a phonetically motivated, language-internal variant rather than a contact feature. Finally, it has expanded upon variationist studies by analyzing the factors that condition this novel coda /s/ realization and the intricacies of its behavior in NS.

### Notes

<sup>1</sup> More specifically, Horn (2013), Moya Corral (2007), Parrell (2011), Ruch (2008), and Torreira (2007a, 2007b, 2012) discuss aspiration in /st/ clusters in Seville and the evolution of pre-aspirated [ht] to post-aspirated [th] and to [ts].

<sup>2</sup> The transcriptions of /s/ in word-final, intervocalic environment show the resyllabified output at the postlexical level. That is, at the lexical level, /s/ is syllable-final and undergoes reduction, but at the postlexical level the /s/ is resyllabified to onset position of the following lexical unit.

<sup>3</sup> I use the term "glottal constriction" instead of "glottal stop" because an acoustic analysis of the variant showed variable production of either full glottal closure

(the glottal stop) or partial glottal closure (creaky voice).

<sup>4</sup> While most dialects appear to follow the pattern proposed by Ferguson (1990), Lipski (1999), and Méndez Dosuna (1996), Brown and Torres Cacoullós (2003) call into question this proposed diffusion of /s/ reduction based on contradictory data from Chihuahua, Mexico. Findings from New Mexico (E. L. Brown 2005) and Cali Spanish (E. K. Brown & E. L. Brown 2012) provide support.

<sup>5</sup> The distinction between Terrell and Tranel's (1978) and Dohotaru's (1998) conclusions illustrate one of the gravest problems in the literature on /s/ lenition in Spanish: different studies often operationalize the variants in divergent ways but continue to compare their results to other authors. For instance, Terrell and Tranel (1978) distinguish only between aspiration and full retention of /s/. Dohotaru makes a three-way distinction among complete retention, aspiration, and elision. Drawing comparisons from sources comparing variants operationalized in different ways is indeed a difficult task, and the presence of glottal constriction as an additional variant in Nicaraguan Spanish complicates the picture even further.

<sup>6</sup> The author is a native speaker of Mexican Spanish.

<sup>7</sup> Moisik and Esling (2011) propose a 'whole larynx' model that resolves the divide between (i) a glottal focus for laryngeal sounds and (ii) a lingual focus for pharyngeal sounds, focusing instead on the epilaryngeal closure that takes place in both to more globally account for the productions. Rather than the more traditional 'glottal constriction', the authors use 'ventricular incursion' (1408) to account for the supralaryngeal constriction needed to fully stop vocal fold vibration. I use the more traditional notion of glottal constriction in this analysis, as the glottal stop and creaky voice are not contrastive in Nicaraguan Spanish and behave similarly in the data, but I do acknowledge the importance of supralaryngeal constriction in the production of a full glottal stop.

<sup>8</sup> Forty-six interviews were conducted in total, but ten speakers were excluded from analysis due to poor sound quality of the recordings, an inability to complete the tasks due to illness or other obligations, or speakers being misidentified by others, i.e. some speakers were identified as Managuans but actually grew up in another part of the country.

<sup>9</sup> The morphological status of /s/ includes lexical, e.g. *análisis* 'analysis', in which the coda /s/ is simply part of the lexical unit, a number marker, e.g. *los ovarios* 'the ovaries', or a person marker. The final category of person marker always involves either second person singular, e.g. *escupes* 'you spit', or first person plural, e.g. *escupimos* 'we spit'.

<sup>10</sup> The determiners included definite and indefinite articles as well as possessives, e.g. *los* 'the', *unas* 'some', and *sus* 'his/hers', respectively. These determiners were conflated in this analysis to avoid an oversaturated model.

<sup>11</sup> The analysis of deviance table provides a generalization of analysis of variance for the generalized linear mixed effects model.

<sup>12</sup> While the effects of determiner-noun pairings, on the one hand, and longer words, on the other, initially appear to be at odds with one another, I argue that these different effects are actually due to two competing motivations for glottal constriction: (i) fortition and (ii) hiatus resolution. These two effects are shown to be independent, and I contend that they condition glottal constriction for different linguistic purposes. Refer to section 5 for this complete discussion.

<sup>13</sup> Future studies should investigate individual word and string frequency with larger corpora as well.

<sup>14</sup> The interaction between following stress and paired word class was tested but did not reach the alpha value. It was therefore not included in the final model, but the directionality of the trend is clear.

<sup>15</sup> When this interaction was written into the model the effect of following stress continues to be strongly predictive of glottal constriction while following /o/ is no longer significant, showing that the perceived following vowel effect is, in fact, primarily a following stress effect. Michnowicz (forthcoming), however, finds a following /o/ effect for glottalization in Yucatan Spanish that does not lose significance when an interaction between /o/ and following stress is written into his model, suggesting that a coarticulatory effect may be at work between /o/ and glottal constriction.

<sup>16</sup> Beyond the uncommonness of sibilance and the additional articulatory effort required in its production, the variant may also index several undesirable social cues, including elitism or a lack of nationalistic pride, making the realization even more infrequent in NS.

### *Bibliographical References*

- Alba, Matthew 2006. Accounting for variability in the production of Spanish vowel sequences. In Sagarra, Nuria & Toribio, Almeida J. (eds.), *Selected Proceedings of the Ninth Hispanic Linguistics Symposium*. Somerville, MA: Cascadilla Proceedings Project. 273-285.
- Alba, Orlando 1982. Función del acento en el proceso de elisión de la /s/ en la República Dominicana. In Alba, Orlando (ed.), *El español del Caribe: ponencias del VI Simposio de Dialectología*. Santiago, Dominican Republic: Universidad Católica Madre y Maestra. 15-26.
- Alfaraz, Gabriela 2000. *Sound Change in a Regional Variety of Cuban Spanish*. Ph.D. dissertation. Michigan State University, East Lansing, MI.
- Alonso, Amado 1930. *Problemas de dialectología hispanoamericana*. Buenos Aires: Facultad de Filosofía y Letras de la Universidad de Buenos Aires.
- Barberia Aurrekoetxea, Irene 2012. *The Gradient Nature of Hiatus Resolution in Spanish*. Ph.D. dissertation. University of Deusto, Bilbao, Spain.
- Barrios, Graciela 2002. Uso de -s final de palabra. Marcadores sociales en el lenguaje. In Barrios, Graciela & Orlando, Virginia (eds.), *Estudios sobre el español hablado en Montevideo*. Montevideo: Gráficos del Sur. 21-28.
- Bates, Douglas; Maechler, Martin & Bolker, Ben 2012. Package 'lme4'. Available at: <http://cran.stat.sfu.ca/web/packages/lme4/lme4.pdf>.
- Booij, Geert 1995. *The Phonology of Dutch*. Oxford: Clarendon Press.
- Borroff, Marianne L. 2007. *A Landmark Underspecification Account of the Patterning of Glottal Stop*. Ph.D. dissertation. Stony Brook University, Stony Brook.
- Brown, Earl K. & Brown, Esther L. 2012. Syllable-final and syllable-initial /s/ reduction in Cali, Colombia: One variable or two? In File-Muriel, Richard J. & Orozco, Rafael (eds). *Colombian Varieties of Spanish*. Frankfurt: Iberoamericana Vervuert Verlag. 89-106.
- Brown, Esther L. 2005. New Mexican Spanish: Insight into the variable reduction of 'la ehe inihial' (/s/). *Hispania* 88. 813-824.
- Brown, Esther L. & Torres Cacoullós, Rena 2002. ¿Qué le vamo aher?: Taking the syllable out of Spanish /s/ reduction. *University of Pennsylvania Working Papers in Linguistics: Papers from NWAV 30*. Philadelphia: University of Pennsylvania Press. 17-32.

- Brown, Esther L. & Torres Cacoulllos, Rena 2003. Spanish /s/: A different story from beginning (initial) to end (final). In Núñez-Cedeño, Rafael; López, Luis & Richard, Cameron (eds). *Proceedings from the 31st Linguistic Symposium on Romance Linguistics*. Amsterdam: John Benjamins. 21-38.
- Bybee, Joan 2001. *Phonology and Language Use*. Cambridge: Cambridge University Press.
- Calero Fernandez, María Angeles 1990. Distribution and social stratification of implosive /s/ and intervocalic /j/ within the speech community of Toledo. *Sintagma* 2. 29-44.
- Cameron, Richard 2000. Language change or changing selves? Direct quotation strategies in the Spanish of San Juan, Puerto Rico. *Diachronica* 17(2). 249-292.
- Canfield, D. Lincoln 1981. *Spanish Pronunciation in the Americas*. Chicago: University of Chicago Press.
- Carlson, Barry F.; Esling, John H. & Harris, Jimmy G. 2003. A laryngeoscopic phonetic study of N'aka'pamux (Thompson) Salish glottal stop, glottalized resonants, and pharyngeals. In Kinkade, M. Dale; Gerdts, Donna B. & Matthewson, Lisa (eds.). *Studies in Salish linguistics in honor of M. Dale Kinkade, Occasional papers in linguistics* 17. Missoula: University of Montana Press. 58-71.
- Carvalho, Ana Maria 2006. Spanish (s) aspiration as a prestige marker on the Uruguayan-Brazilian border. In Villa, Daniel J. & Rivera-Mills, Susana (eds.). *Spanish in Context* 3:1. Amsterdam: John Benjamins. 85-114.
- Casali, Roderic F. 1998. *Resolving Hiatus*. New York: Garland.
- Cedergren, Henrietta 1973. *The Interplay of Social and Linguistic Factors in Panama*. Ithaca. Ph.D. dissertation. Cornell University, NY.
- Cepeda, Gladys 1995. Retention and deletion of word-final /s/ in Valdivian Spanish. *Hispanic Linguistics* 6/7. 329-353.
- Chappell, Whitney 2014. Reanalysis and hypercorrection among extreme /s/ reducers. *University of Pennsylvania Working Papers in Linguistics* 20: 2.
- Chappell, Whitney 2015. Formality strategies in Managua, Nicaragua: A local vs. global approach. *Spanish in Context* 12: 2. 221-254.
- Chitoran, Ioana & Hualde, José Ignacio 2007. From hiatus to diphthong: the evolution of vowel sequences in Romance. *Phonology* 24(1). 37-75.
- Colina, Sonia 1999. Reexamining Spanish glides: Analogically conditioned variation in vocoid sequences in Spanish dialects. In Gutiérrez-Rexach, Javier & Martínez-Gil, Fernando (eds.). *Advances in Hispanic Linguistics*. Somerville, MA: Cascadilla. 121-134.
- Cortés Gómez, Eugenio 1979. *El habla de Higuera de Vargas (Badajoz)*. Badajoz: Diputación Provincial.
- Dilley, Laura; Shattuck-Hufnagel, Stefanie & Ostendorf, Mari 1996. Glottalization of vowel-initial syllables as a function of prosodic structure. *Journal of Phonetics* 24. 423-444.
- Dohotaru, Puica 1998. /s/ final de sílaba y de palabra en el habla juvenil habanera. *Anuario de Lingüística Hispana* XIV. 149-168.
- Edmondson, Jerold A.; Esling, John H.; Harris, Jimmy G. & Tung-Chiou, Huang 2005. A laryngoscopic study of glottal and epiglottal/pharyngeal

- stop and continuant articulations in Amis – an Austronesian language of Taiwan. *Language and Linguistics* 6(3). 381-396.
- Esling, John H. 2002. Laryngoscopic analysis of Tibetan chanting modes and their relation to register in Sino-Tibetan. *7<sup>th</sup> International Conference on Spoken Language Processing 2*. Denver: Causal. 1081-1084.
- Esling, John H. & Edmondson, Jerold A. 2002. The laryngeal sphincter as an articulator: Tenseness, tongue root and phonation in Yi and Bai. In Braun, Angelika & Masthoff, Herbert R. (eds), *Phonetics and its Applications: Festschrift for Jens-Peter Köster on the Occasion of his 60th Birthday*. Stuttgart: Franz Steiner Verlag. 38-51.
- Esling, John H.; Fraser, Katie & Harris, Jimmy G. 2005. Glottal stop, glottalized resonants and pharyngeals: A reinterpretation with evidence from a laryngeoscopic study of Nuuchahnulth (Nootka). *Journal of Phonetics* 33. 383-410.
- Esling, John H. & Harris, Jimmy G. 2003. An expanded taxonomy of states of the glottis. In Solé, Maria-Josep; Recasens, Daniel & Romero, Joaquín (eds), *Proceedings of the 15<sup>th</sup> International Congress of Phonetic Sciences*. Barcelona: Universitat Autònoma de Barcelona. 1049-1052.
- Face, Timothy & Alvord, Scott 2004. Lexical and acoustic factors in perceptions of the Spanish diphthongs vs. hiatus contrast. *Hispania* 87(3). 553-564.
- Felix, Sascha 1979. Anatomy of a sound change in Canarian Spanish (/s/ > h/ > Ø). *Zeitschrift für Romanische Philologie* 95. 358-381.
- Ferguson, Charles A. 1990. From esses to aitches. In Croft, William A.; Kemmer, Suzanne & Denning, Keith (eds.), *Studies in Typology and Diachrony, for Joseph H. Greenberg*. Philadelphia: John Benjamins Publishing Company. 59-78.
- File-Muriel, Richard 2007. *The Role of Lexical Frequency and Phonetic Context in the Weakening of Syllable-final Lexical /s/ in the Spanish of Barranquilla, Colombia*. Ph.D. dissertation. Indiana University, Bloomington, IN.
- File-Muriel, Richard 2010. Lexical frequency in the weakening of syllable-final lexical /s/ in the Spanish of Barranquilla, Colombia. *Hispania* 92. 348-360.
- File-Muriel, Richard & Brown, Earl K. 2011. The gradient nature of s-lenition in Caleño Spanish. *Language Variation and Change* 23. 223-243.
- Fougeron, Cécile 2001. Articulatory properties of initial segments in several prosodic constituents in French. *Journal of Phonetics* 29. 109-135.
- Fougeron, Cécile & Keating, Patricia A. 1997. Articulatory strengthening at edges of prosodic domain. *Journal of the Acoustical Society of America* 106(6). 3728-3740.
- Fox, John & Weisberg, Sanford 2011. *An {R} Companion to Applied Regression, Second Edition*. Thousand Oaks CA: Sage. Available at <http://socserv.socsci.mcmaster.ca/jfox/Books/Companion>.
- Frago-Gracia, Juan Antonio & Franco-Figueroa, Mariano 2001. *El español de América*. Cádiz: Servicio de Publicaciones Universidad de Cádiz.
- Garrido, Marisol 2007. Diphthongization of mid/low vowel sequences in Colombian Spanish. In Holmquist, Jonathan; Lorenzino, Augusto & Sayahi, Lotfi (eds). *Selected Proceedings of the Third Workshop on*

- Spanish Sociolinguistics*. Somerville, MA: Cascadilla Proceedings Project. 30-37.
- Garrido, Marisol 2013. Hiatus resolution in Spanish: Motivating forces, constraining factors, and research methods. *Language and Linguistics Compass* 7(6). 339-350.
- Gerfen, Chip 2001. A critical view of licensing by cue: The case of Andalusian Spanish. In Lombardi, Linda (ed.). *Segmental Phonology in Optimality Theory*. Cambridge: Cambridge University Press. 183-205.
- Guitart, Jorge 1976. *Markedness and a Cuban Dialect of Spanish*. Washington: Georgetown University Press.
- Guy, Gregory & Braga, Maria Luiza 1976. Number concordance in Brazilian Portuguese. Paper Presented at New Ways of Analyzing Variation V (NWAV-V) Conference, Georgetown University.
- Hernández, Edith 2009. *Resolución de hiatos en verbos -ear: un estudio sociofonético en una ciudad mexicana*. Ph.D. dissertation. The Ohio State University, Columbus, OH. Available at: <http://rave.ohiolink.edu/etdc/view.cgi?acc%5Fnum=osu1262231085>.
- Horn, Meagan E. 2013. *An Acoustic Investigation of Postaspirated Stops in Seville Spanish*. MA thesis. The Ohio State University, Columbus, OH. Available at: [http://kb.osu.edu/dspace/bitstream/handle/1811/54452/MeaganHorn\\_HayesForum2013\\_MAPaper.pdf?sequence=1](http://kb.osu.edu/dspace/bitstream/handle/1811/54452/MeaganHorn_HayesForum2013_MAPaper.pdf?sequence=1).
- Hothorn, Torsten; Bretz, Frank & Westfall, Peter 2008. Simultaneous inference in general parametric models. *Biometrical Journal* 50(3). 346-363.
- Hualde, José Ignacio 1997. Spanish /i/ and related sounds: An exercise in phonemic analysis. *Studies in the Linguistic Sciences* 27(2). 61-79.
- Hualde, José Ignacio 1999. Patterns in the lexicon: hiatus with unstressed high vowels in Spanish. In Gutiérrez-Rexach, Javier & Martínez-Gil, Fernando (eds). *Advances in Hispanic Linguistics*. Somerville, MA: Cascadilla Press. 182-197.
- Hualde, José Ignacio 2005. *The Sounds of Spanish*. Cambridge: Cambridge University Press.
- Kager, Rene 1999. *Optimality Theory*. Cambridge, MA: Cambridge University Press.
- Kingston, John 2008. Lenition. In Colantoni, Laura & Steele, Jeffrey (eds). *Selected Proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology*. Somerville, MA: Cascadilla Proceedings Project. 1-31.
- Jenkins, Devin L. 1999. *Hiatus Resolution in Spanish: Phonetic Aspects and Phonological Implications from Northern New Mexican Data*. Ph.D. dissertation. University of New Mexico, Albuquerque, NM.
- Johnson, Keith 2004. Massive reduction in conversational American English. Spontaneous speech: Data and analysis. In Yoneyama, Kakuzi & Kikuo, Maekawa (eds). *Proceedings of the 1st Session of the 10th International Symposium*. Tokyo: The National International Institute for Japanese Language. 29-54.
- Jun, Jungho 1995. *Perceptual and Articulatory Features in Place Assimilation: An Optimality Theoretic Approach*. Ph.D. dissertation. UCLA, Los Angeles, CA.
- Lafford, Barbara 1986. Valor diagnóstico-social del uso de ciertas variantes

- de /s/ en el español de Cartagena, Colombia. In Núñez Cedeño, Rafael A.; Páez Urdaneta, Iraset & Guitart, Jorge M. (eds), *Estudios sobre la fonología del español del Caribe*. Caracas: La Casa de Bello. 53-75.
- Lipski, John 1984a. /s/ in the Spanish of Nicaragua. *Orbis* 33. 171-181.
- Lipski, John 1984b. On the weakening of /s/ in Latin American Spanish. *Zeitschrift für Dialektologie und Linguistik* 51. 31-43.
- Lipski, John 1985. /s/ in Central American Spanish. *Hispania* 68. 143-49.
- Lipski, John 1994. *Latin American Spanish*. London: Longman.
- Lipski, John 1999. The many faces of Spanish /s/-weakening: (Re)alignment and ambisyllabicity. In Gutiérrez-Rexach, Javier & Martínez-Gil, Fernando (eds). *Advances in Hispanic Linguistics*. Somerville, MA: Cascadilla Press. 199-213.
- Lipski, John 2000. Chabacano/Spanish and the Philippine linguistic identity. Paper presented at the conference *Shedding Light on the Chabacano Language*, Instituto Cervantes, Ateneo de Manila University.
- Lipski, John n.d. The Spanish of Extremadura. Available at: <http://www.personal.psu.edu/jml34/Extremadura.htm>.
- Longmire, Beverly Jean 1976. *The Relationship of Variables in Venezuelan Spanish to Historical Sound Changes in Latin and the Romance Languages*. Ph.D. dissertation. Georgetown University, Washington D.C.
- Lope Blanch, Juan 1987. *Estudios sobre el español de Yucatán*. México, D.F.: Universidad Nacional Autónoma de México.
- López Chávez, Juan 1977. El fonema /s/ en el habla de La Cruz, Sinaloa. *Nueva Revista de Filología Hispánica* 26. 332-40.
- López Morales, Humberto 1980. *Estratificación social del español de San Juan*. MS.
- López Morales, Humberto 1983. *Estratificación social del español de San Juan de Puerto Rico*. México, D.F.: Universidad Nacional Autónoma de México.
- Lorenzo Criado, Emilio 1948. El habla de Albalá. Contribución al estudio de la dialectología extremeña. *Revista de Estudios Extremeños* 4. 398-407.
- Lynch, Andrew 2008. A sociolinguistic analysis of final /s/ in Miami Cuban Spanish. *Language Sciences* 31. 766-790.
- Ma, Roxana & Herasimchuk, Eleanor 1971. The linguistic dimensions of a bilingual neighborhood. In Fishman, Joshua A.; Cooper, Robert L. & Ma, Roxana (eds.). *Bilingualism in the barrio*. Bloomington: Indiana University. 349-464.
- MacEachern, Margaret 1995. Laryngeal similarity effects in Quechua and Aymara. MS, UCLA.
- Mackenzie, Ian n.d. Spanish in Paraguay. Newcastle University. Available at <http://www.staff.ncl.ac.uk/i.e.mackenzie/paraguay.htm>.
- Mason, Keith W. 1994. *Comerse las eses: A Selective Bibliographic Survey of /s/ Aspiration and Deletion in Dialects of Spanish*. Ph.D. dissertation. University of Michigan, Ann Arbor, MI.
- Méndez Dosuna, Julián 1985. La duración de -s en los grupos sp, st, sk: A propósito del orden regular de difusión en algunos cambios fonéticos. In Michelena, Luis & Melena, José L. (eds). *Symbolae Ludovico Mitxelena Septuagenario Oblatae*. Vitoria, Spain: Universidad del País Vasco. 647-655.

- Méndez Dosuna, Julián 1996. Can weakening processes start in initial position?. In Hurch, Bernhard & Rhodes, Richard A. (eds), *Natural Phonology: The State of the Art*. New York: Mouton de Gruyter. 97-106.
- Michnowicz, James Casimir 2006. *Linguistic and Social Variables in Yucatan Spanish*. Ph.D. dissertation. The Pennsylvania State University, State College, PA.
- Michnowicz, Jim & Kagan, Laura. In press. On glottal stops in Yucatan Spanish. To appear in Sessarego, S. & Tejedo, F. (eds). *Proceedings of WSS7*. Amsterdam: John Benjamins.
- Milroy, James 2001. Language ideologies and the consequences of standardization. *Journal of Sociolinguistics* 5. 530-55.
- Moisik, Scott R. & Esling, John H. 2011. The 'Whole Larynx' approach to laryngeal features. *Proceedings of the 17th International Congress of Phonetic Sciences*. 1406-1409.
- Morgan, Terrell A. 1998. The linguistic parameters of /s/-insertion in Dominican Spanish: A case study in qualitative hypercorrection. In Gutierrez-Rexach, Javier & del Valle, José (eds). *Proceedings of the First Hispanic Linguistics Colloquium*. Columbus, OH: The Ohio State University. 79-96.
- Morgan, Terrell A. 2000. Más allá de la norma culta: La ultracorrección en español. *ACIECMH* 2. Santiago: Universidad Bolivariana. 51-62.
- Morgan, Terrell A. 2010. *Sonidos en contexto: Una introducción a la fonética del español con especial referencia a la vida real*. New Heaven: Yale University.
- Moya Corral, Juan Antonio 2007. Noticia de un sonido emergente: La africada dental procedente del grupo -st- en Andalucía. *Revista de Filología* 25. 457-465.
- Navarro Tomás, Tomás 1991. *Manual de pronunciación española, 25th ed.* Madrid: Consejo Superior de Investigaciones Científicas.
- Pak, Marjorie 2007. Phrasal tone and syntax in San Mateo Huave. MS. Available at <http://marjoriepak.com/huave.pdf>
- Parrell, Benjamin 2011. The role of gestural phasing in Western Andalusian Spanish aspiration. *Journal of Phonetics* 40. 37-45.
- Penny, Ralph 2000. *Variation and Change in Spanish*. Cambridge: Cambridge University Press.
- Pierrehumbert, Janet & Talkin, David 1992. Lenition of /h/ and glottal stop. In Docherty, Gerard J. & Ladd, D. Robert (eds). *Papers in Laboratory Phonology II*. Cambridge: Cambridge University Press. 90-117.
- Poplack, Shana 1979. *Function and Process in a Variable Phonology*. Ph.D. dissertation. The University of Pennsylvania, Philadelphia, PA.
- Poplack, Shana 1980. Deletion and disambiguation in Puerto Rican Spanish. *Language* 56. 371-385.
- Pruñonosa, Manuel 2000. Algunos rasgos fónicos de interferencia del guaraní en el español del Paraguay. In Calvo Pérez, Julio (ed.), *Teoría y práctica del contacto: El español de América en el candelero*. Frankfurt and Madrid: Vervuert and Iberoamericana. 113-122.
- Quesada Pacheco, Miguel Ángel 1996. El español de América Central. In Alvar López, Manuel (ed.). *Manual de dialectología hispánica: El español de América*. Barcelona: Editorial Ariel. 101-115.

- Quilis, Antonio 1971. Caracterización fonética del acento en español. *Travaux de Linguistique et de Litterature* 9. 53-7.
- Quilis, Antonio 1993. *Tratado de fonología y fonética española*. Madrid: Gredos.
- R Core Team 2014. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing.
- Ranson, Diana 1989. *Change and Compensation: Parallel Weakening of [s] in Italian, French and Spanish*. New York: Peter Lang.
- Ranson, Diana 1991. Person marking in the wake of /s/ deletion in Andalusian Spanish. *Language Variation and Change* 3. 133-152.
- Rosales Solís, María Auxiliadora 2010. El español de Nicaragua. In Quesada Pacheco, Miguel Ángel (ed.), *El español hablado en América Central: Nivel fonético*. Madrid: Iberoamericana. 137-154.
- Ruch, Hanna 2008. *La variante [ts] en el español de la ciudad de Sevilla: Aspectos fonético-fonológicos y sociolingüísticos de un sonido innovador*. Ph.D. dissertation. The University of Zürich, Zürich, Switzerland.
- Ruiz-Sánchez, Carmen 2004. El comportamiento de la /s/ implosiva en el habla de Caracas. *Boletín de lingüística* 21. 48-65.
- Sanicky, Cristina Aurora 1989. Las vocales en contacto en el habla de Misiones, Argentina. *Hispania*. 72(3). 700-704.
- Schmidt, Lauren B. 2013. Regional variation in the perception of sociophonetic variants of Spanish /s/. In Carvalho, Ana M. & Beaudrie, Sara (eds). *Selected Proceedings of the 6th Workshop on Spanish Sociolinguistics*. Somerville, MA: Cascadilla Proceedings Project, 189-202.
- Steriade, Donca 1993. Positional neutralization. Paper Presented at the 23rd Meeting of the North East Linguistic Society. University of Ottawa, Canada.
- Steriade, Donca 1995. *Neutralization and the Expression of Contrast*. Manuscript, UCLA, Los Angeles.
- Steriade, Donca 1997. *Phonetics in Phonology: The Case of Laryngeal Neutralization*. Manuscript, UCLA, Los Angeles.
- Tellado González, Judith 2007. *Variación alofónica de /s/ implosiva en el español de Puerto Rico: El fenómeno de oclusión glotal*. MA thesis. University of Puerto Rico, Río Piedras, Puerto Rico.
- Tennant, Jeff; Heap, David; Faure, Ana & Fernández Leyva, Jesús 2008. Initial observations on variation of (s) in Holguín Cuban Spanish. Paper Presented at the Sixth International Conference on Foreign Language Teaching, Communication and Culture. Holguín, Cuba, April 23<sup>rd</sup>-25<sup>th</sup> 2008.
- Terrell Tracy 1977. Constraints on aspiration and deletion of final /s/ in Cuban and Puerto Rican Spanish. *Bilingual Review/La Revista Bilingüe* 4. 35-51.
- Terrell, Tracy 1979. Final /s/ in Cuban Spanish. *Hispania* 62(4). 599-612.
- Terrell, Tracy 1981. Diachronic reconstruction by dialect comparison of variable constraints: s-aspiration and deletion in Spanish. In Sankoff, David & Cedergren, Henrietta (eds). *Variation Omnibus*. Alberta: Carbondale and Edmonton. 115-124.
- Terrell, Tracy & Tranel, Bernard 1978. Parallelisms between liaison in French and /s/ aspiration and deletion in Caribbean Spanish dialects. *Études Linguistiques sur les Langues Romanes, Recherches Linguistiques Montreal* 10. 31-50.

- Thon, Sonia 1989. The glottal stop in the Spanish spoken in Corrientes, Argentina. *Hispanic Linguistics* 3(1-2). 199-218.
- Torreira, Francisco 2007a. Pre- and post-aspirated stops in Andalusian Spanish. In Prieto, Pilar; Mascaró, Joan & Solé, Maria-Josep. *Segmental and Prosodic Issues in Romance Phonology*. 67-82.
- Torreira, Francisco 2007b. Coarticulation between aspirated-s and voiceless stops in Spanish: An interdialectal comparison. In Sagarra, Nuria & Toribio, Almeida Jacqueline (eds), *Selected Proceedings of the 9th Hispanic Linguistics Symposium*. Somerville, MA: Cascadilla Press. 113-120.
- Torreira, Francisco 2012. Investigating the nature of aspirated stops in Western Andalusian Spanish. *Journal of the International Phonetic Association* 42. 49-63.
- Valentín-Márquez, Wilfredo 2006. La oclusión glotal y la construcción lingüística de identidades sociales en Puerto Rico. In Sagarra, Nuria & Toribio, Almeida Jacqueline (eds). *Selected Proceedings of the 9th Hispanic Linguistics Symposium*. Somerville, MA: Cascadilla Proceedings Project. 326-341.
- Vallejo-Claros, Bernardo 1970. La distribución y estratificación de /r/ /r/ y /s/ en el español cubano. Ph.D. dissertation. The University of Texas, Austin, TX.
- Vidal de Battini, Berta E. 1964. *El español de la Argentina*. Buenos Aires: Consejo Nacional de Educación.
- Widdison, Kirk 1995. An acoustic and perceptual study of the Spanish sound change s>h. *Rivista de Linguistica* 7(1). 175-190.

## 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 unos / los / muchos / varios utensilios.”*  
‘In this picture, I see some/the/many/various utensils.’



7. “*En esta imagen, observo unas / las / muchas / varias islas.*”  
‘In this picture, I see some/the/many/various islands.’



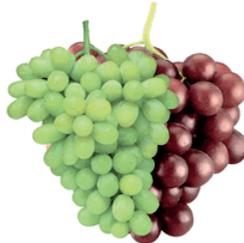
8. “*En esta imagen, observo unos / los / muchos / varios ingleses.*”  
‘In this picture, I see some/the/many/various Englishmen.’



9. “*En esta imagen, observo unas / las / muchas / varias equis.*”  
‘In this picture, I see some/the/many/various X’s.’



10. “*En esta imagen, observo unas / las / muchas / varias uvas.*”  
‘In this picture, I see some/the/many/various grapes.’



## 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 analyses 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 thesis 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.'