Part II
United States

4 Describing and analyzing variability in Spanish /s/

A case study of Caribbeans in Boston and New York City

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4.1 Introduction

Systematic variation in speech has proven to be a rich source of insight into human language. In particular, patterns of phonetic variability have illuminated the sounds of speech as physical phenomena produced by human vocal tracts, as psychological phenomena stored in human minds, and as social phenomena distributed across and within human societies (Ladefoged 1980; Ohala 1989; Foulkes & Docherty 2006; among others). With respect to phonetic variation in the Spanish-speaking world, perhaps no speech sound has figured more prominently than /s/, the voiceless alveolar fricative. In addition to its importance in major diachronic shifts in the organization of Spanish phonology (see Nuñez, this volume), /s/ also played an early and important role in the emergence and recognition of patterns of social and regional linguistic variation within the Iberian peninsula. As early as the end of the fifteenth century, /s/ already constituted a site of synchronic variability, manifesting in "*aspiración… caída total… y ultracorreciones*," "aspiration… complete loss… and hyper-correction" (Lapesa 1942: 387). Later, as Iberian ways of speaking spread across the Atlantic, the distribution of the phonetic variants of /s/ became an important tool for philologists and dialectologists interested in tracking the development of Spanish in the Americas (Marden 1896; Ureña 1921; Granda 1994; Hammond 2001).

Such dialectology initiatives subsequently informed more contemporary approaches to sociophonetic variation in the Spanish of the Americas (Resnick 1975; Canfield 1981), which in turn paved the way for deeper study of Spanish /s/ in its social context as well as further investigation of the linguistic factors that condition its realization. Indeed, a host of studies carried out in the tradition of variationist sociolinguistics have focused on /s/, resulting not only in an increased understanding of the phenomenon itself, but also in the refinement of theories of language variation and change (Cedergren 1974; Poplack 1980; Hochberg 1986; Cepeda 1995; Erker 2010; File-Muriel & Brown 2011; Chappell 2014). In other domains of contemporary linguistic inquiry, Spanish /s/ variation has played a number of important roles, featuring prominently in the development of exemplar-theoretic models of

linguistic representation (Bybee 2000, 2002; Fox 2006), in furthering our understanding of the dynamics of sociolinguistic perception of speaker identity (Walker et al. 2014), and in accounting for the outcomes of language and dialectal contact (Lamboy 2004; Aaron & Hernández 2007; Lynch 2009; Waltermire 2011; Erker & Otheguy 2016).

On account of this long and rich research tradition, contemporary scholars are well-situated to pursue further study of Spanish /s/ from a position of substantial understanding. However, this enviable vantage point is not optimal in all respects. It requires researchers to navigate an extant literature that is vast, with relevant studies easily numbering in the hundreds if not thousands (this is to say nothing of the extensive crosslinguistic research on the phonetics of fricatives more generally). More problematic than its sheer volume, however, is the wide-ranging descriptive and methodological variation present in the research on Spanish /s/. This is due, in large part, to the time depth of inquiry into /s/, which extends from our present smartphone era back to the dawn of the printing press. Lapesa's observations dating systematic /s/ variation to at least as far back as the last decade of the fifteenth century are based on a letter written by the son of Christopher Columbus. While Ureña and other pioneering dialectologists had shifted their attention away from written data and towards speech, there are, of course and unfortunately, no audio recordings of the people whose voices served as the basis for the earliest attempts at the dialectal zonification of Latin America. The relatively recent emergence of low-cost audio recording technology that coincided with the development of variationist sociolinguistics radically improved the quality and reliability of observations of variability in speech, a development whose benefits extended to the study of Spanish /s/. However, because sprectrographic or other means of detailed acoustic-phonetic analysis remained unwieldy and expensive, most of the early variationist work on Spanish /s/ relied on descriptions that were based exclusively on analysts' perceptions of segmentally coded alternations. In the last couple of decades, as it has became possible to extract fine-grained acoustic measurements of the sounds of speech from any laptop, shifts in the best practices of sociophoneticians have led scholars of Spanish /s/ to explore its spectrotemporal properties from a gradient, subsegmental perspective. But technological advance comes with its own problems, namely, a potentially overwhelming array of acoustic measures to choose from when describing /s/.

How then to best synthesize the methodologically diverse literature, especially in the context of carrying out future research? Specifically, how can we capitalize on existing studies to operationalize a method for describing and analyzing /s/ that is robust, reliable, revealing and reproducible? Answering these questions is the first task of this chapter, one that we will approach methodically, empirically motivating each aspect of the descriptive protocol that we settle upon. In the end, it will consist of a combination of measures, some of which are discrete and others that are continuous, some of which are measured using acoustic-phonetic software and others that are based on perceptual impressions.

Once the proposed protocol is laid out in full, we will take it out for a test drive, illustrating how it can be used to explore a research question in the context of a case study. Specifically, we will ask whether patterns of /s/ variation among Spanish speakers of Caribbean origin are either intergenerationally stable or undergoing change in a setting characterized by dialectal and language contact. The appropriate motivation and context for this question will be provided in due course. For now, it suffices to say that we will see our descriptive protocol (configured to reflect the primary insights of the research literature on Spanish /s/ as well as current understanding of the acoustic-phonetic properties of fricatives) does a very good job of capturing the kind of data needed to seriously engage the research question. It also leads to a clear answer, namely, that patterns of /s/ variation present in the speech of recent arrivals from the Caribbean to two US cities, New York City and Boston, are conserved both among immigrants who have spent many years living in the United States as well as among US-born Spanish speakers of Caribbean ancestry. In other words, results reveal a trend of intergenerational structural continuity in /s/ variation among the study participants. As a first stop on the way to this conclusion, let us ask a simple question: What kind of phenomenon is Spanish /s/ variation?

4.2 /s/ variation as reduction

In his remarkable book *Latin American Spanish*, Lipski (1994) includes observations about /s/ in each one of his country-based descriptions of Spanish as it is spoken in several nations of Central, North and South America. In describing /s/ variation, he uses a number of terms, including *weakening*, *loss*, *elision*, *deletion*, *aspiration*, *erosion* and *effacement*. These are contrasted with the phrase *retention of sibilant [s]*. These descriptions get to the heart of the matter, which is that /s/ variation in Spanish is routinely seen to belong to the broader category of *phonetic reduction* phenomena that are prevalent in human speech. The basic idea is encapsulated in the *faithful* relationship between /s/ and [s]. The first of these symbols is used to represent a speech sound as an abstract object included in the phonological representation of words, as in /son/ "they are" or /mísmo/ "same." The second symbol, [s], is used to represent the speech sound as a phonetic object, that is, a concrete articulatory/acoustic event that occurs when a person utters a word whose phonological representation is presumed to contain /s/. However, it is often the case that there is variability in the phonetic implementation of /s/, such that its articulation results in sounds that cannot accurately be described with [s]. The most common alternative segmental descriptions in the literature, what in the variationist sociolinguistic tradition would be called other *variants* of /s/, are [h], the *voiceless glottal fricative*, and *deletion*, which refers to cases in which the /s/ that is presumed to be part of the phonological representation of a form has no phonetic reflex in the actual utterance of that form.

These variants are thought to be reduced in that they are *underarticulated* with respect to the phonological features that define /s/. In the case of [h], articulatory undershoot leads to loss of the place of articulation of /s/. That is, the phonetic object corresponding to /s/ remains a voiceless fricative, but one that has a glottal rather than oral constriction. For this reason, in addition to its frequent description as *aspiration*, the realization of /s/ as [h] is also sometimes referred to as *debuccalization*, a more general process by which the oral features of a speech sound are suppressed. At the extreme end of undershoot are cases of deletion, in which none of the features of /s/ specified in the lexical representation of a form are realized. That is, when /s/ is deleted, there is no phonetic substance to which it corresponds in the speech signal. From this perspective, non-sibilant realizations of /s/ constitute a continuum of *local hypo-speech events within an utterance*, ranging from partial to complete reduction. Such phenomena – which in addition to debuccalization and deletion also include the centralization of vowels, the spread of residual features from elided segments, assimilation of place, temporal reduction, and simplification of consonant clusters– are crosslinguistically widespread, and they are typically thought to result from the "tug-of-war between the need to convey the desired message and a principle of articulatory economy" (Barry & Andreeva 2001: 51).

This conception of phonetic variation, and of phonetic reduction in particular, is often formulated in terms of the spontaneous, real-time speech of an individual under different circumstances, with the aim of understanding what conditions (physiological, social, linguistic, etc.) favor the production of hyper- and hypo-articulated forms, respectively (Lindblom 1990; Kohler 1990). Aligning this perspective with the study of variation in a specific community in a particular time and place raises interesting questions about the phenomenology of /s/ reduction, especially because its status as either an instance of stable variation, change in progress, or completed change remains incompletely understood. For instance, should we think of all instances of [h] or deletion occurring in speech as online deviations from mental representations that contain /s/?[1] Or, are such articulations faithful realizations of representations that have themselves undergone reduction? In other words, is an instance of [míh.mo] a faithful articulation of the form /míh.mo/ or an unfaithful articulation of the form /mís.mo/? In a community in which [h] occurs at extremely high rates, the former possibility seems at least plausible. Indeed, some researchers have proposed that certain individuals who exhibit near categorical deletion rates have undergone lexical restructuring so as to exclude /s/ from phonological representations (Terrell 1979; Chappell 2014). However, such arguments are relatively rare in the literature, and with the exception of scholars working in a Usage-Based framework, with its exemplar model of memory storage for linguistic units, few studies of Spanish /s/ prioritize the task of relating mental representations to the phonetic substance of speech (though see Bullock, Almeida Toribio, & Amengual 2014 for a critique of generative phonological discussions of /

s/ reduction and phonological representation among Dominicans). Instead, most research proceeds by presuming that reduction represents an unfaithful, or under-articulated realization of canonical forms. This is a useful stipulation, especially when it is the distribution of phonetic variants in a community that is of primary interest, as is usually the case in the variationist sociolinguistic literature dedicated to /s/.

In recent years, scholars have expanded the conception of Spanish /s/ reduction to include continuously varying properties. (Fox 2006; Erker 2010, 2016; File-Muriel & Brown 2011). Such research has demonstrated that wide-ranging *sub*segmental variation occurs within segmental categories, especially with respect to the temporal and spectral properties of /s/. That is, there is strong evidence of a continuum of reduction even among segmentally identical realizations of /s/, namely, some are longer/shorter than others and have turbulent noise concentrated at higher/lower frequencies and intensities. Furthermore, variation along these dimensions has been shown to correlate with linguistic and social factors *within* segmental categories. For example, Erker (2010) reports that among cases classified as retention of sibilant [s], there is an effect of word position and following segment: in data collected from five Dominican residents of New York City, cases of [s] that occur word-finally were significantly longer than those that occurred word-internally, and those that occurred before pauses were significantly longer than those that occurred before vowels and consonants.

In addition, Erker found that the effect of following segments was more robust in the temporal domain compared to the spectral domain. He concludes that analyses of /s/ that include continuous, subsegmental measures "will more accurately identify patterns of variation and also better exploit the explanatory power of social and language-internal factors that condition /s/ weakening throughout the Spanish-speaking world" (24). This conclusion is echoed by File-Muriel: "Capturing the acoustic variation in different manifestations of /s/ is not possible using the traditional transcription approach, as it limits the representation of this gradient phenomenon to symbolic units of the International Phonetic Alphabet (IPA)" (2011: 225).

Despite the obvious benefits afforded by a shift towards instrumentally-based descriptions of sociophonetic variation (e.g. increased descriptive and explanatory power, greater reliability, increased precision, higher resolution, and more efficient and rapid calculation of measurements), it is probably unwise to entirely jettison categorical/segmental considerations from our conception of Spanish /s/ reduction. At minimum, there is overlap between the impressionistic category of deletion and the acoustically verified absence of speech-based frication in the audio signal. That is, the presence vs. absence of frication, or, put another way, of non-deletion vs. deletion, is a categorical distinction, and it is one that language users clearly attend to.

Consider, for instance, the folk-linguistic prohibition against *comerse las eses*, "eating one's s's" (Mason 1994) and also the soft mockery of hypercorrection in the phrase *hablar fisno*, "talking finely," which includes an

inserted /s/ in the word *fino* (Bullock et al. 2014). While continuous measures will be required for establishing the temporal and spectral thresholds at which listeners tend to perceive very reduced fricatives as instances of deletion, the perceptual difference between hearing and *not* hearing a fricative is itself categorical in nature. While it will likely require the fine-grained precision of instrumental measures to identify the temporal and spectral thresholds below which reduced realizations of /s/ are typically perceived as deleted vs. not-deleted. Relatedly, while there is clearly category-internal variation among segmentally identical realizations (among cases unambiguously classified as [s], for instance), it is unclear how such variation interacts with listeners' perceptions. It may, in fact, be the case that some amount of structured acoustic variation in /s/ production falls below the threshold of human auditory perception, making it highly unlikely to figure in sociolinguistic patterns. Conversely, some socially conditioned patterns of variation may in fact be opaque at the subsegmental level. Indeed, recent research indicates that a methodology that relies exclusively on acoustic-instrumental measures can fail to identify significant patterns of socially constrained variation that are successfully illuminated by perceptually-based segmental descriptions (Brogan & Bolyanatz 2018).

Another problem with relying solely on acoustic measures is that they are not immune to error. The task of segmenting fricatives in accordance with the spectrographic and waveform displays of acoustic phonetic software programs is frequently difficult, especially in the context of rapid, spontaneous speech. In addition, there is extensive debate among phoneticians (discussed in some detail in the next section) about which spectral measures are most appropriate for describing /s/, especially in light of the likelihood that some variation in the acoustic profile of fricatives is due to physiological factors such as speaker sex and vocal tract shape and length. These issues make even harder the already serious challenge of drawing inferences about articulation on the basis of acoustic properties, since some measures are arguably more reliable paths of inference from sound back to constriction location and vocal tract configuration than are others. Therefore, for various reasons (some having to do with the production and perception of the phenomenon and others relating to methodological strengths and weaknesses), our position is that it is wisest to adopt a broad perspective on /s/. Doing so is not only prudent, it also facilitates maximal synthesis of the research literature. From such a perspective, we can describe Spanish /s/ variation as an articulatory reduction phenomenon that manifests in categorical/discrete as well as continuous/gradient ways.

4.3 A descriptive protocol for Spanish /s/ variation

The following proposal for describing and analyzing Spanish /s/ variation is theoretically framed by the principles and practices of variationist

sociolinguistics (Weinreich, Labov, & Herzog 1968; Labov 1972). With respect to principles, this scholarly tradition maintains that inherent variability is a defining feature of human language, and that the variable use of language in social contexts is orderly and systematic. Moreover, the structured nature of linguistic variation arises through the interaction of members of a *speech community*, or some other unit of social organization whose boundaries and inner workings are, at least in part, linguistically defined; for example, a *community of practice* (see Bucholtz 1999) or *social network* (see Milroy & Milroy 1985).

A primary goal of the variationist researcher is to understand the mechanisms that underly speakers' behavior in regards to *sociolinguistic variables*, which are phonological, morphological, lexical, or syntactic features whose expression manifests as a series of variants that "mean the same thing,"[2] at least truth-conditionally and referentially speaking. Among the many strategies employed by variationist linguistics to understand the underlying structure of variant choice among language users, the most well-established is the quantitative modeling of the distribution of variants in relation to sets of linguistic and social factors hypothesized to constrain the use of the feature in question. Such models provide an empirical basis for describing the norms of a community and also act as windows into the knowledge that language users deploy in linguistically-mediated interaction. This is related to the primary research practice of variationist sociolinguistics that is relevant here, namely that the data should be collected in accordance with Labov's (1972: 72) *Principle of Accountability*, meaning that researchers should "report values for every case where the variable element occurs in the relevant environments as we have defined them." With respect to Spanish /s/, this means that (a) all instances of /s/ presumed to be part of the lexical representation of forms occurring in the relevant speech samples are eligible for description and should be included in the data set, and (b) that there are sufficient numbers of cases across the contexts defined by the set of linguistic and social factors included in the study to reliably assess their potential conditioning effects on /s/ realization.

In addition to these assumptions related to quantitative variationist sociolinguistics, the descriptive protocol offered here also makes several assumptions about the speech data and the researcher. In terms of the speech data to be analyzed, it is assumed that speech samples have been digitally recorded using a high-quality microphone and at an appropriate sampling rate, and also that the recording was carried out in a quiet space and in a similar manner across different speakers (see Ladefoged (2003) for a book-length treatment of best practices). It also assumes that the researcher is familiar with interpreting the details of spectrograms and waveforms and with segmenting fricatives and extracting acoustic measurements using *Praat* (Boersma 2002).

With these considerations as context, we propose that for a rich and flexible characterization of sociolinguistic variation in Spanish /s/, researchers should include (at least) the following descriptors:

a) Perceptual coding of segmental alternations
b) Spectrographic and waveform assessment of frication presence vs. absence
c) Temporal and spectral acoustic measures of fricative events

4.3.1 Perceptual coding of segmental alternations

The majority of studies of Spanish /s/, from the early dialectology surveys to the first wave of variationist research, classify realizations according to three variants: [s], [h], and deletion, the last of which has frequently been represented with the symbol ∅[3]. Other segmental variants of /s/ that have been proposed in the literature include the voiced alveolar fricative, [z], the glottal stop, [ʔ], the voiced glottal fricative, [ɦ], and also a combined sibilant+glottalized realization, [sʔ] (Cedergren 1974; File-Muriel & Brown 2011; Chappell 2014) as well as combined sibilant+interdental fricative realization [s$^{\theta}$], (Brogan & Bolyanatz 2018). In our experience with the data we have collected in Boston and New York City (NYC), the most frequently occurring segmental variants beyond [s], [h] and deletion are [z] and [ʔ]. We thus adopt a segmental coding schema consisting of these five variants, though it is certainly reasonable to utilize a more fully elaborated schema if the data call for it.

With respect to coding cases in accordance with a segmental schema, there is of course a range from what would be optimal to what is practical given researchers' resources and aims. If perception of variation is itself of primary interest, then impressionistic segmental classification of recorded /s/ realizations would likely need to involve multiple listeners of diverse sociolinguistic backgrounds, since prior linguistic experience can affect perception of Spanish /s/ variation (Poplack 1980). In addition, researchers would also likely want to carefully track listeners' confidence in their perceptual classification of tokens, especially those cases that were determined by other descriptors to be non-sibilants/reductions, as these realizations are the ones likeliest to give rise to differences in speaker perception (File-Muriel & Díaz-Campos 2003). When perception of variation is not a central research focus, but rather one among a set of ways to account for the distribution of variants in the spontaneous speech of a group of individuals, then fewer listeners are necessary for the classification of segmental alternation. We recommend at least two listeners, along with an assessment of inter-rater reliability, as well as a means for keeping track of tokens that are difficult to confidently classify according to the schema.

4.3.2 Spectrographic and waveform assessment of frication presence

Experimental analyses of fricatives in Spanish (Manrique & Massone 1981) and English (Jongman, Wayland, & Wong 2000) observe that sibilant

[s] has a number of stable acoustic correlates. Chief among these is the presence of high-frequency turbulent noise, above 4 kHz, with peaks between 5–8 kHz. These features have a clear visual signature when examined via the spectrographic and waveform displays in a computer program such as Praat. Spectrally, the energy associated with [s] appears as a dark cloud concentrated in the higher frequency range, typically centered around 6kHz, with the possibility of lower amplitude energy spanning across a wide range, from 1–11 kHz. In the waveform, the aperiodic energy of [s] manifests in a saw-like shape, which is low in intensity relative to flanking vowels. The acoustic and corresponding visual correlates of [z] are similar to those of [s], with the difference that the former is typically shorter in duration, in addition to co-occurring with voicing. This latter property is evidenced by the presence of low-frequency periodic energy in the spectrum and waveform. Non-sibilant realizations of /s/ range widely in their acoustics, and, as mentioned, it is not always obvious what segmental classification is most appropriate. For the purpose of the this descriptor, however, classification of the *type* of fricative event is not of primary importance. Rather, the aim is to determine, by inspecting spectrographic and waveform displays, whether there is evidence of speech-based frication in the speech stream where one would expect it to occur on the basis of the presumed lexical representation of the form in question. The literature provides numerous spectrographic and waveform illustrations of [s] and [z] as well as non-canonical realizations of /s/ produced by Spanish speakers (Klatt 1976; File-Muriel & Brown 2011; Erker 2012; Brogan & Bolyanatz 2018).

4.3.3 Acoustic measures

Once a determination has been made about whether or not an /s/ token has an acoustic-phonetic reflex – that is, whether it is a case of deletion or not – the fricative event corresponding to a non-deleted token should be segmented, making possible the extraction of acoustic measures. While some forced alignment programs can reduce the time needed to get a rough segmental boundary around fricatives, obtaining reliable measurements requires manual boundary placement (though this could of course change as automatic alignment technologies continue to improve). Because segmentation amounts to a discretization of a continuous phenomenon, there is no single "correct" boundary placement. However, both the spectrogram and waveform can provide reliable cues for better or worse segmentation of fricative events. Ladefoged's (2003) text summarizes the extensive research on the acoustic correlates of speech sounds and provides detailed descriptions of how these correlates can be identified in spectrograms and waveforms for the purpose of segmentation.

Segmented fricatives can be automatically measured for a broad range of acoustic properties by using Praat's scripting functionality. The most straightforward of the measures we recommend taking is the overall *duration of the*

segmented fricative event, typically reported in milliseconds. Additionally, it is important to report measures that characterize the spectral properties of the fricative event. There is a wide range of options available to researchers along this dimension, including (i) spectral center of gravity (the measure we recommend); (ii) frequency of the most prominent peak in the spectrum (i.e. peak frequency); (iii) spectral skewness; (iv) spectral kurtosis; and (v) percentage of voicing during frication, as well as other measures that are not part of the default functionality of Praat. Among phoneticians, there is ongoing debate about the reliability and utility of these and other measures. Summarizing the state of affairs, Fuchs and Toda (2010) remark, in describing their study of /s/ among English speakers, that "Choosing among the potential acoustic parameters for describing interspeaker variation of /s/ was a challenging task, since there is no generally accepted parameter in the literature, and some of the parameters studied so far are partially redundant" (289). The lack of consensus is due, in large part, to the potential for various acoustic measurements of spectral properties to be impacted by (i) physiological differences between speakers; (ii) crosslinguistic variation in the articulatory realization of the "same" segmental category; and (iii) static vs. dynamic properties of fricative events.

As is the case with a number of other acoustic properties of speech, systematic differences between speakers can arise from differences in physiology. These include not only gross differences in the size and shape of the vocal tract but also, specifically with respect to /s/, variation in palatal and dental morphology anterior to lingual constriction (Fuchs and Toda 2010). This suggests that the reported sex-related spectral differences between men and women in /s/ – for example, several studies observe that women produce /s/ with higher frequencies than men (Flipsen et al. 1999; Heffernan 2004) – are due to average male-female differences in post-pubescent vocal tract anatomy. That is, lower frequency spectral properties of /s/ are associated with larger vocal tracts and longer palates, which men are more likely on average to have than women. However, there is also evidence that spectral variation in /s/ is socially conditioned. For example, Munson et al. (2006) found significant differences between hetero- and homosexual men with respect to /s/ skewness, both in terms of their speech production as well as their likelihood to be rated as straight- or gay-sounding by listeners. Fuchs and Toda, whose study involved electropalatographic (EPG) data simultaneously recorded with acoustics, report a "mixture of effects" (299), observing both shorter palates *and* a fronter constriction among women than men.

Other important issues in discussions about spectral characterizations of sibilants concern crosslinguistic variation and dynamic change. In their experimental analysis of sibilant fricatives in English, Japanese and Mandarin, Li, Edwards, and Beckman (2007) observe that fricatives can contrast in terms of tongue posture as well as place of constriction. With respect to English, the alveolar and palatal fricatives, for example, differ primarily in terms of place

of articulation (plus the addition of lip rounding in the palatal fricative). This has implications for acoustic measurements.

> This generalization about a difference in energy distribution between /s/ and /ʃ/ can be captured effectively by the centroid frequency, the first moment or mean frequency when the power spectrum is treated as a probability distribution. This is a measure that negatively correlates with the length of the front resonating cavity, and thus roughly describes where the constriction is made relative to the length of the oral cavity.
>
> (Li 2007: 917)

According to Li et al., this approach to sibilant fricatives does not work, however, when they are differentiated by tongue posture, such as in Mandarin or Japanese. The authors thus propose alternative measurements, one of which (something they call *CentHigh*) is a center of gravity measure designed to filter out spectral energy in the low frequency range that can reflect a coupled back cavity resonance.

With respect to temporal variation in the acoustics of fricatives, Reidy (2016) reports that in both English and Japanese, the sibilant fricatives differ acoustically in terms of their static as well as dynamic properties. That is, while fricatives do have stable acoustic properties, their acoustic profile also varies over time. Reidy urges researchers to adopt descriptions of fricatives that reflect their dynamic nature, stating plainly that "static spectral features are insufficient to characterize /s/" (2016: 2519). His alternative approach involves taking numerous measurements across fricative events of a parameter that is the psycho-acoustic analogue of peak frequency, which he labels *peak ERBn*. Using this measure he shows that English /s/ achieves maximum peak frequency at roughly two-thirds of the way through fricative duration, and that it has a generally concave shape over the course of the fricative. This contrasts with /ʃ/, which changes less over time and has a flatter peak ERBn contour. Reidy's results were similar, but not identical for Japanese data, indicating that not only do the contours differ between fricatives within one language, the "same" segments have different contours in different languages.

Given these issues, our proposal is to take *three center of gravity measurements per fricative event*, one at the 1/4, 1/2, and 3/4 point of frication. This descriptor is not without its limitations, and more fully elaborated spectral descriptions might be called for if one is especially interested in relating acoustics to articulation, particularly constriction location. That said, while filtered measures can increase the reliability of inference regarding place of oral constriction for /s/, we know that a great many Spanish /s/ tokens *do not have* an oral constriction. So a blanket filtering process would not be equally useful for all tokens and may in fact introduce error into any such measure. Another concern with our proposal might be that any phonation co-occurring with frication could drive down COG values. One approach to

this problem is to also report percentage voicing, in line with File-Muriel and Brown (2011). However, to the extent that voicing is interpreted as a kind of reduction, via assimilation of the voicing of flanking segments, then it is not incoherent to take COG measurements across the entire spectrum, including the frequency ranges characteristic of voicing energy. From this perspective, a lower COG due to phonation meaningfully reflects the reduced nature of the fricative. Finally, and with respect to physiologically based differences, we recommend including *indiviual speaker* as a random effect in multivariate regression models of variation in COG. In summary, despite some limitations, COG does provide meaningful information about a fricative's spectral properties. In addition, it is easy to measure and does not require researchers to have the resources or expertise to collect EPG data. Moreover, variation in the spectral domain is, in the proposed protocol, one among several dimensions of variability. While no single descriptor proposed here is individually perfect, together they provide researchers with a very strong empirical base from which to investigate their questions.

4.3.4 Linguistic and social conditioning factors

The social and linguistic factors that have been shown to shape variation in Spanish /s/ production are many and also well-documented. Here we provide a list of the most frequently investigated factors and a brief description of the nature of their covariation with /s/ reduction. These descriptions are not meant to be the final word on any of these factors, and we direct the reader interested in a more thorough and nuanced discussion to one of the many summaries of the literature along these lines (Mason 1994; Lynch 2009; Erker 2017).

4.3.4.1 Linguistic factors

- **Syllable position**. Most studies find that /s/ is more likely to be reduced syllable-finally compared to syllable-initially, which is consistent with crosslinguistic research that finds syllable coda to be an intrinsically reduction-promoting position (Ohala & Kawasaki 1984; Recasens 2004). There are, however, also well-established patterns of Spanish /s/ reduction in syllabic onset position (Brown & Torres Cacoullos 2002; Brown 2005; Brogan & Bolyanatz 2018). Note also that while most studies consider syllable position to be defined lexically, others assume that in continuous speech a lexical coda /s/ can be resyllabified in word-final prevocalic position.
- **Following sound**. Studies vary in terms of how they operationalize descriptions of following phonetic context. The widest generalization is that following consonants favor /s/ reduction compared to following vowels and pauses. Among following consonants and vowels, certain

classes (i.e. obstruents) as well as individual segments are more reduction-favoring than others.

- **Preceding sound**. Similarly to following sounds, preceding phonetic context is operationalized at varying levels of detail across studies, for example the identification of individual segments, sound classes, and, in the case of vowels, acoustic-phonetic measurements. The broadest generalization with respect to this factor is that greater articulatory distance between /s/ and the preceding sound favors reduction, though this factor is routinely weaker in effect than is the following phonetic context.
- **Speech rate**. Once again, studies vary in terms of the details of how this factor is operationalized, but a clear trend emerges: Faster talking promotes reduction.
- **Stress**. Reduction of /s/ is more likely to occur in unstressed syllables.
- **Word position**. Reduction of /s/ is more likely in word-final compared to word internal-position, for example *hablas* "you speak" vs. *mismo* "same."
- **Lexical frequency**. Reduction is more likely in higher frequency words.
- **Length of carrier word**. Whether counted in terms of number of syllables or number of phones, there is evidence that increased word length correlates with reduction.
- **Morphological role**. Of all the linguistic factors listed here, this is the most controversial. While some studies find that morphemic /s/ is less likely to be reduced than non-morphemic /s/ (e.g. the /s/ of *hablas* vs. that of *entonces*), many other studies have found an opposite pattern or have failed to find any evidence that this factor significantly covaries with reduction.

4.3.4.2 Social factors

- **Individual**. As with all variable phenomena, individual speakers vary in comparison to other members of their communities. To account for this, most recent research includes *Speaker* or *Individual* as a (random) variable in multivariate quantitative analysis.
- **Sex**. Men are routinely reported to have higher rates of reduction than women in the same communities.
- **Age**. Younger speakers are more likely to weaken /s/ than older speakers (though see Brogan & Bolyanatz 2018 for the opposite pattern).
- **Regional origin**. Higher rates of reduction are typically reported for communities in Caribbean locales, as well as in coastal and lowland areas of Mainland Latin America compared to residents of the interior and highlands of Latin America. Among Spanish-speaking Iberians, rates of /s/ reduction are typically higher among those who reside in Southern as opposed to Central Northern regions.
- **Socioeconomic status**. Whether measured through general social class measures, levels of education, occupation, or area/location of residence,

the vast majority of studies that have examined this factor report higher rates of reduction among speakers of lower socioeconomic status.

- **Formality/Register**. Rates of reduction are higher in less formal contexts.

4.4 Case study: Caribbeans in Boston and New York City

To test the utility of the descriptive protocol we have proposed, we will examine how /s/ realization varies across each of the descriptors in a sample of 9,125 tokens of /s/ collected from the speech of 63 individuals. After describing variation in the data along each descriptor, we consider their relationship with each of two factors known to robustly constrain /s/ variation, *Syllable-position* and *Speaker regional origin*. This will motivate the specific case study, which is an investigation of intergenerational stability or change in the production of syllable-final /s/ among speakers of Caribbean origin who reside in Boston, MA and New York, NY.

The data for the present analysis are drawn from sociolinguistic interviews included in two corpora[4] of spoken Spanish, the *Boston Spanish Corpus* (BSC) and the *Otheguy-Zentella Corpus of Spanish in New York* (OZC). Forty-three interviews in the current study come from the BSC and 20 come from the OZC. The corpora were developed to explore the linguistic outcomes of *language contact* and *dialectal contact*. In the settings being studied, these terms refer, respectively, to the regular linguistic interaction between (a) the Spanish-speaking and English-speaking communities of Boston and NYC, whose members are in many cases one and the same and (b) Spanish speakers of diverse regional origins, for example the Caribbean, Central and South America, and Europe.

Previous analysis of the corpora has produced a substantial body of variationist research, which finds that: (1) among Spanish speakers in Boston and NYC, language and dialectal contact have promoted intergenerational change in the variable use of a range of linguistic features, including subject personal pronouns (Otheguy & Zentella 2012), grammatical subjects (Erker, Ho-Fernández, Otheguy, & Shin 2017), loan words (Varra 2013), subjunctive verbal morphology (Bookhamer 2013), and filled pauses (Erker & Bruso 2017); (2) the evidence for change in the corpora is broadly consistent with interpretations of (a) *structural convergence*, where the direction of change increases structural similarity with analogous structures of English, and/or (b) *dialectal leveling*, whereby regional differences present among recent arrivals to these cities are diminished among those with more US life experience; and (3) insofar as change has been observed in the OZC and BSC, it occurs in the broader context of prevailing intergenerational structural continuity, such that the linguistic behavior of newcomers to these cities is, overall, very similar to that of those with greater life experience in the United States. Indeed, most of the changes that have been observed are changes in rates of use of particular features, rather than changes in the underlying structure of variant choice. Evidence of the latter is the gold standard for contact-induced change

from the perspective of *comparative variationist linguistics* (Poplack, Walker, & Malcolmson 2006; Poplack & Levey 2010; Torres Cacoullos & Travis 2011), the leading framework for investigating the outcomes of linguistic contact.

Prior studies of /s/ in these corpora have discovered evidence of dialectal leveling, such that regional origin is a less robust predictor of patterned variation among speakers with more US life experience compared to recent arrivals (Erker 2012; Erker & Otheguy 2016). However, these studies worked with smaller samples and relied on descriptive protocols that are less robust and flexible than the one proposed here. An additional advantage of the current data set is that it is large enough to permit analysis of just Caribbean speakers, who are of special interest in the contact settings, for two reasons. First, with respect to language contact, the comparatively higher rates of reduction reported in the literature for Caribbeans makes this group, among Spanish speakers, the most different from English speakers in the United States, who do not routinely weaken /s/. That is, the realization of /s/ among Spanish speakers in Bogotá, for example, where /s/ is frequently realized as [s], is more like the realization of /s/ among English speakers in Boston or New York. In contrast, there is a larger degree of difference between English speakers' production of /s/ and that of the residents of Santo Domingo (Dominican Republic), for instance, whose use of Spanish is characterized by higher rates of /s/ reduction on average. In other words, the crosslinguistic difference between Spanish and English with respect to /s/ is at its greatest in the speech of those with origins in the Hispanophone Caribbean. This makes the speech of Caribbeans in the United States a site of special interest in assessing the the potential influence of the grammatical norms of English on the use of Spanish. In addition, with respect to dialectal contact, Caribbeans who migrate to large and diverse urban centers in the United States are, compared to their home country counterparts, much more likely to interact with other Spanish speakers who reduce [s] far less often than they do. This opens the door to potential dialectal leveling via prestige-motivated shifts, or, alternatively the amplification or entrenchment of dialectal differences as an expression of local regional solidarity. Our hypothesis is that the dual pressures of language contact and dialectal contact will align to promote change in the realization of [s] among Caribbeans in Boston and NYC. Specifically, we predict that increased US life experience will correspond to lower rates of /s/ reduction among Caribbeans in the form of (i) fewer non-[s] realizations, (ii) lower rates of deletion, and (iii) fricatives events with longer duration and higher COG.

4.4.1 Speakers, data and predictors

The speakers include 34 women and 29 men. Twenty-four participants migrated from or have ancestry in *Caribbean* locales, including Cuba (1 speaker), Dominican Republic (7), Puerto Rico (14), and Coastal Venezuela (3). Fourteen have origins in the *Andean* region of South America, including (non-coastal) Colombia (5), Ecuador (4), Peru (4), and (non-coastal)

Venezuela (1). Twenty-four have origins in what we call the *Central* region, which includes El Salvador (14), Guatemala (1), and Mexico (9).

With respect to differences in US life experience we adopt Otheguy and Zentella's (2012) method of grouping speakers into one of three *Immigration Categories*: (1) *Newcomers*, those who arrived in the United States after age 16 and who had spent less than six years in NYC or Boston at the time of their interview; (2) *Established Immigrants*, those who arrived in the United States after age 16 and had spent more than six years there at the time of their interview; and (3) *US Born*, those either born in the United States or brought as children before the age of three. The present study includes 25 *Newcomers*, 26 *Established Immigrants*, and 11 *US Born*. The final social factor included in the study – that is, in addition to speaker *Sex*, *Regional Origin*, and *Immigration Category* – was *Education Level*.

Tokens of /s/ were collected from interviews according to the protocol proposed in the previous section. An average of 144 tokens were collected from each speaker, with a minimum of 93 and a maximum of 200. Tokens were coded for the following linguistic factors: *Speech Rate*, *Syllable Position*, *Preceding Sound*, *Following Sound*, *Word Position*, *Stress*, *Lexical Frequency of the Carrier Word*, *Number of Syllables in the Carrier Word*, and *Morphemic Status of /s/*.

4.5 Results

All of the tokens from both corpora were inspected for frication presence vs. absence, and all non-deleted tokens were measured for duration and COG. Only the Boston data were impressionistically coded for segmental identity because the OZC data were collected prior to the development of the present study's descriptive protocol. They are undergoing perceptual coding at the time of writing this analysis.

- *Segmental identity*: Of the 4,325 tokens impressionistically coded for segmental identity, namely, all of the data collected from the BSC, 2,738 were perceptually identified as [s], 722 as deletion, 401 as [h], 363 as [z], and 19 as glottal stop. Sixty-four cases were labeled *can't tell*. The first and second authors' ratings were identical in 91% of cases.
- *Presence vs. absence of frication*: Visual inspection of spectrographic and waveform displays revealed evidence of frication in 7,099 cases, or 78 percent of the sample overall. The other 2,026 tokens showed no such evidence, for an overall deletion rate of 22 percent in the data.
- *Duration*: The 7,099 non-deleted cases ranged from from 11.4 to 750.2 ms long, with a mean of 98.7, and a standard deviation of 53.8.
- *COG*: Recall that three measurements were taken for each (non-deleted) fricative, one each at the one-quarter, one-half, and three-quarters points during the fricative. A one-way ANOVA comparing COG at the three points returned a significant main effect for measurement location ($F(2, 21273) = 89.2$, $p < .001$). Bonferroni post hoc tests showed that COG was

significantly higher at the midpoint of frication (M = 2923, sd = 2367) than at both the one-quarter (p <.001) and three-quarters points (p <.001). However, COG at the one-quarter (M = 2456, sd = 2172) and three-quarters points (M = 2523, sd = 2194) did not significantly differ (p <.22). These results are consistent with Reidy's (2016) argument that the spectral properties of fricatives vary dynamically, and that something like a steady state for frication does not emerge immediately at the onset of frication, but near to the midpoint, before diminishing towards the offset. From here on we will report the average of the three COG measures for each case as *Mean COG*. On this measure, the 7,099 non-deleted cases ranged from 34.7 Hz to 11243 Hz, with a mean of 2634, and a standard deviation of 2083. Figure 4.1 summarizes variation across the four descriptors.

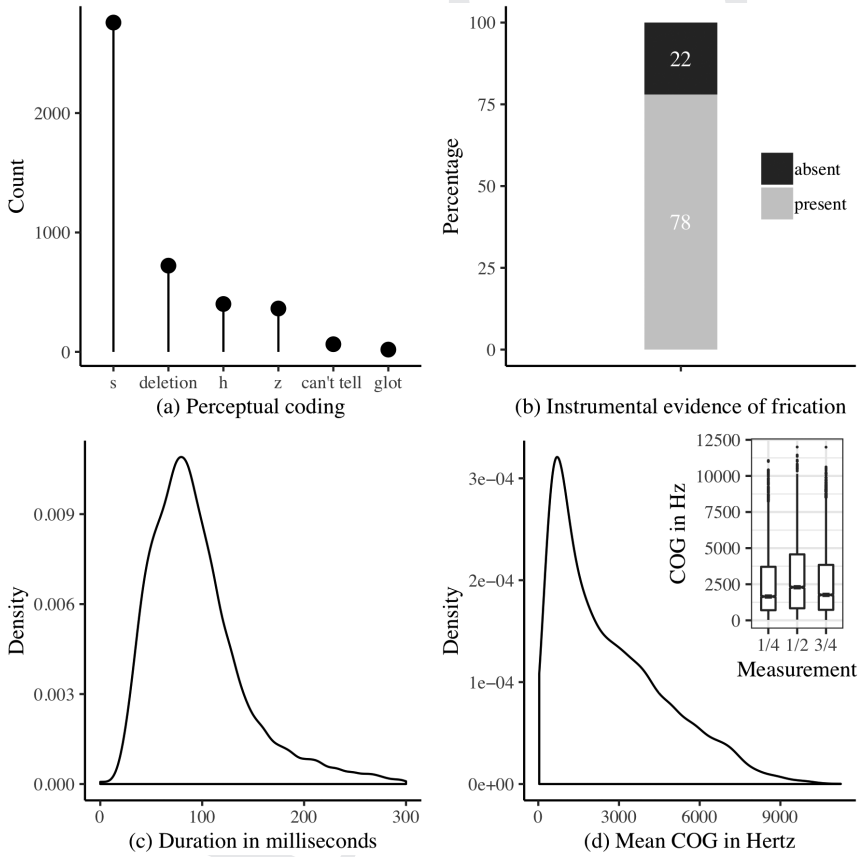

Figure 4.1 Variation across descriptors. 1a, n = 4,325 (Boston data only). 1b, n = 9,125 (Boston and NYC data combined). 1c-d, n = 7,099 (combined data, non-deleted tokens only).

4.5.1 Reduction and syllable-position

There is overwhelming evidence in these data that /s/ is more likely to be reduced syllable-finally than initially.

- *Segmental identity*: The overwhelming majority of non-[s] realizations occurred in syllable coda position. Of the 1,068 tokens in onset position, only 1 was deleted, 951 were realized as [s], and 116 were realized as [z]. A chi-square test comparing observed vs. expected values for the distribution of segmental variants returned a significant effect for syllable position (x = 546, df = 5, p-value <.001).
- *Presence vs. absence of frication*: Of the 2,026 tokens that showed no spectrographic or waveform evidence of frication, all but one occurred in coda position (x = 668, df = 1, p-value <.001).
- *Duration*: Frication duration was significantly shorter (t = -7.4, p-value <.001) in coda position (n = 4950, *M* = 88.2, *sd* = 41.8) than in onset position (n = 1848, *M* = 95.1, *sd* = 29.7); *nb*: outliers, those with a duration of greater than 215 ms were excluded from this and subsequent analyses of duration.
- *COG*: Mean COG was significantly lower (t = -18.2, p-value <.001) in coda position (n = 5223, *M* = 2370, *sd* = 2035) than in onset position (n = 1869, *M* = 3370, *sd* = 2040). Figure 4.2 summarizes these results.

4.5.2 Reduction and regional origin

Considerably higher levels of reduction were observed among Caribbeans compared to participants of Central and Andean origin.

- *Segmental identity*: Among Andeans, the most frequent variant was [s] (660 tokens, or 73% of their data), followed by [z] (101, 11%), deletion (83, 9%), [h] (44, 5%), can't tell (15, 2%) and glottal stops (3, 1%). Among participants of Central origins, the order was somewhat different, with deletion as the second most frequent category after [s]. The Central segmental ordering, in terms of decreasing frequency was as follows: [s] (1434 tokens, or 71% of their data), followed by deletion (317, 16%), [z] (135, 7%), [h] (107, 5%), can't tell (17, 1%), and glottal stops (1, < 1%). Among Caribbeans, [s] was also the most frequently occurring variant (664 tokens), but it occurred at much lower rate, 48%. This was followed by deletion (322, 23%), [h] (250, 18%), [z] (127, 9%), can't tell (32, 3%), and glottal stops (15, 1%). A chi-square test comparing observed vs. expected values for the distribution of segmental variants returned a significant effect for Regional Origin (x = 363, df = 10, p-value <.001).
- *Presence vs. absence of frication*: Of the 2,106 /s/ tokens collected from Andeans, 330, or 16%, were determined via spectrographic and waveform

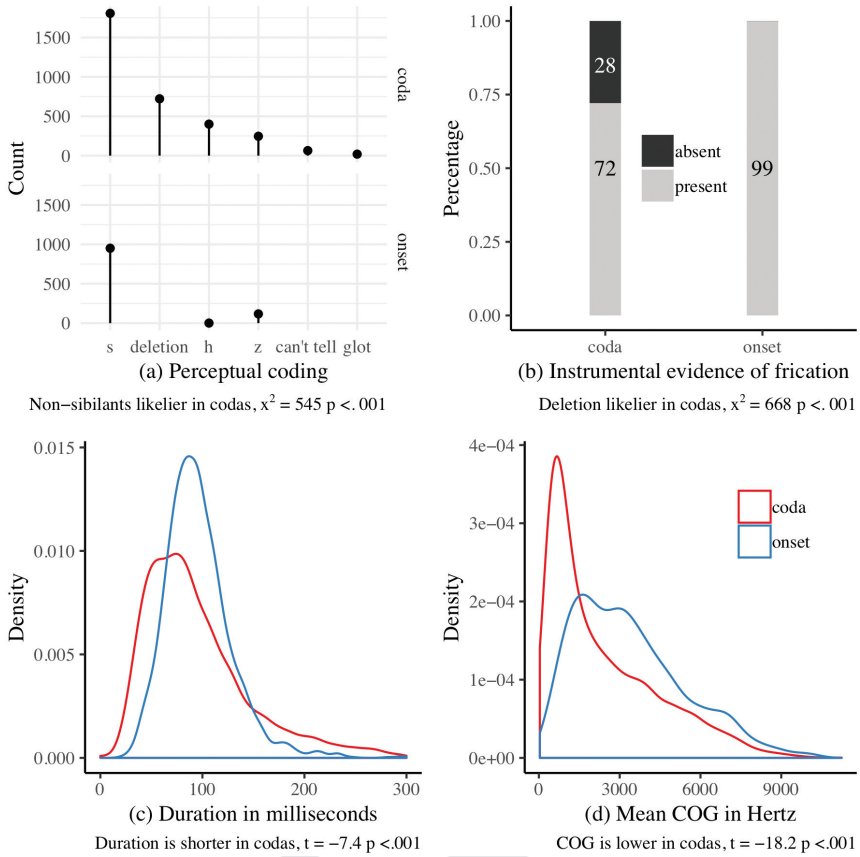

Figure 4.2 More reduction occurrs among codas compared to onsets across all descriptors. 1a, n = 4,325 (Boston data only). 1b, n = 9,125 (Boston and NYC data combined). 1c-d, n = 7,099 (combined data, non-deleted tokens only).

assessment to be deleted. Of the 3,210 tokens collected from participants of Central origin, 339, or 12%, were deleted. The highest deletion rate, 34%, was observed among Caribbeans, who deleted 1,303 of 3,809 total tokens. A chi-square test comparing observed and expected values for presence vs. absence of frication (i.e. deletion) returned significant results (x = 554, df = 2, p-value <.001).

- *Duration*: A one-way ANOVA comparing duration across the regional groups returned significant results (F(2, 6795) = 134.9, p <.001). Bonferroni post hoc tests showed that duration was three-ways distinct, with Caribbeans producing /s/ with a significantly shorter duration (M = 81 ms, sd = 37) than both Andeans (p <.001) and Centrals (p <.001).

The latter two groups also significantly differed from each other (p <.001), with Andean speakers producing shorter /s/ (M = 89.2 ms, sd = 2172) than Centrals (M = 98.9 ms, sd = 39.6).

- *COG*: A one-way ANOVA comparing mean COG across the regional groups returned significant results (F(2, 6788) = 592, p <.001). Bonferroni post hoc tests showed that COG was three-ways distinct, with Caribbeans producing /s/ with a significantly lower COG (M = 1784 Hz, sd = 1548) than both Andeans (p <.001) and Centrals (p <.001). The latter two groups also significantly differed from each other (p <.001), with Andean speakers producing /s/ with lower COG (M = 2308 Hz, sd = 1615) than Centrals (M = 3593 Hz, sd = 2351). Figure 4.3 summarizes these results.

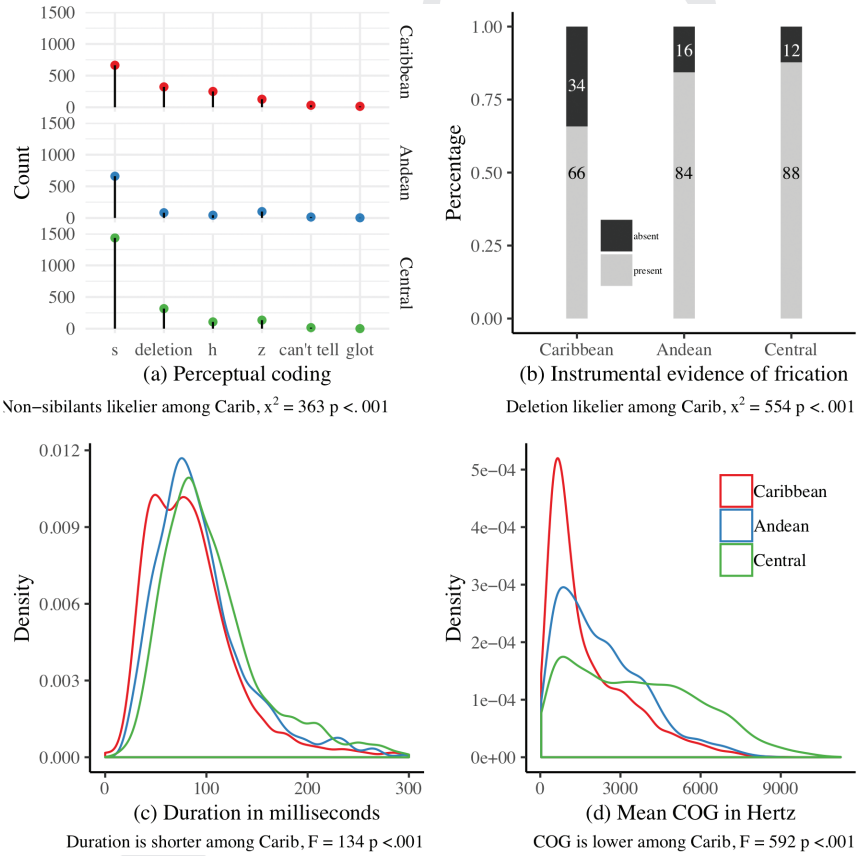

Figure 4.3 More reduction is observed among Caribbean compared to Central and Andean groups. 1a, n = 4,325 (Boston data only). 1b, n = 9,125 (Boston and NYC data combined). 1c-d, n = 7,099 (combined data, non-deleted tokens only).

4.5.3 Coda /s/ among Caribbeans only

Having established that in these data /s/ is most likely to be reduced (a) syllable-finally and (b) in the speech of Caribbeans, let us now address our hypothesis about intergenerational change – that increased US life experience will correspond to lower rates of /s/ reduction – by examining just the coda tokens produced by study participants with origins in either the Dominican Republic, Puerto Rico, Cuba and Coastal Venezuela (leaving for future research a comparison of potential differences between speakers with origins in these four areas). Recall that each speaker was grouped according to Immigration Category. Also recall that within the comparative variationist framework that guides our work, assessing the possibility of linguistic change requires a multivariate analysis of the underlying structure of variation. That is, while it is important to determine whether variation in each descriptor covaries with Immigration Category, the more important question is whether Immigration Category makes a significant contribution to regression models when its influence is considered alongside that of other potential conditioning factors. First consider the univariate results, which show a clear pattern of diminished reduction with increased US life experience.

- *Segmental identity*: Among Caribbean newcomers, the most frequent variant was deletion (122 tokens, or 32% of their data), which was followed, in decreasing order of frequency, by [h] (115, 31%), [s] (77, 20%), [z] (31, 8%), can't tell (20, 5%) and glottal stops (11, 3%). Among Caribbean Established Immigrants, the order was notably different, with deletion emerging as the second most frequent category after [s]. The Caribbean Established Immigrants' segmental ordering, in terms of decreasing frequency was as follows: [s] (164, or 44% of their data), followed by deletion (118, 31%), [h] (50, 13%), [z] (33, 9%), and can't tell (12, 3%). This group produced no glottal stops. Among Caribbean US-born participants, [s] was, similarly to the Established Immigrants, the most frequently occurring variant (131 tokens, or 44%). This was followed by [h] (84, 28%), deletion (82, 27%), and glottal stops (4, 1%). The US born did not produce any [z] or can't tell tokens. A chi-square test comparing observed vs.= expected values for the distribution of segmental variants returned a significant effect for Immigration Category ($x = 117.8$, $df = 10$, p-value $<.001$).
- *Presence vs. absence of frication*: Of the 1,574 /s/ tokens collected from Caribbean newcomers, 796, or 51%, were determined to be cases of deletion. Of the 1,177 tokens collected from Caribbean Established Immigrants, 425, or 36%, were deleted. The lowest deletion rate, 27%, was observed among US-born Caribbeans, who deleted 82 of 301 total tokens. A chi-square test comparing observed and expected values for presence vs. absence of frication (i.e. deletion) returned significant results ($x = 90$, $df = 2$, p-value $<.001$).

- *Duration*: A one-way ANOVA comparing duration across Immigration Category returned significant results ($F(2, 1693) = 91.2$, $p < .001$). Bonferroni post hoc tests showed that duration was three-ways distinct, with newcomers producing /s/ with a significantly shorter duration ($M = 65.5$ ms, $sd = 36$, n = 749) than both Established Immigrants ($p < .001$) and US-born participants ($p < .001$). The latter two groups also significantly differed from each other ($p < .001$), with Established Immigrants producing shorter /s/ ($M = 76.3$ ms, $sd = 38$, n = 735) than the U.S. born ($M = 104.6$ ms, $sd = 37$, n = 212).
- *COG*: A one-way ANOVA comparing mean COG across Immigration Category also returned significant results ($F(2, 1739) = 44.2$, $p < .001$). Bonferroni *post-hoc* tests showed that COG was three-ways distinct, with Caribbean newcomers producing /s/ with a significantly lower COG ($M = 1057$ Hz, $sd = 1081$, n = 778) than both Established Immigrants ($p < .001$) and US-born participants ($p < .001$). The latter two groups also significantly differed from each other ($p < .001$), with Established Immigrants producing /s/ with lower COG ($M = 1430$ Hz, $sd = 1197$, n = 746) than the US born ($M = 1921$ Hz, $sd = 1936$, n = 218). Figure 4.4 summarizes these results.

4.5.3.1 Multivariate analysis

To assess the effect of Immigration Category in the context of other social and linguistic predictors, we ran three[5] mixed effects regressions using the *lme4* package implemented in R (Bates et al. 2015). We ran a mixed effects binomial logistic regression for *Presence vs. Absence* of frication, and linear mixed effects regression for both *Duration* and *Mean COG*. In all three models, *Speaker* and *Carrier Word* (the word in which the /s/ occurred) were included as random effects. The following linguistic factors were included as fixed effects in each model: *Speech Rate* in log-transformed milliseconds, *Following Sound*, coded as *pause*, *vowel*, or *consonant*, *Word Position*, coded as *internal* or *final*, *Stress* of the syllable in which /s/ occurred, *Lexical Frequency of the Carrier Word* in log rank, based on a frequency dictionary of Spanish (Davies 2017), and *Morphemic Status of /s/*, coded as *non-morphemic*, *plural marker*, or *person marker*. The social factors included in each model were *Immigration Category*, *Sex*, *Age*, and highest *Education Level* attained, which included as values *primary school*, *high school*, *community college*, *university*, and *postgraduate*.

The results of the logistic regression for *Presence vs. Absence* of frication are given in Table 4.1. The reference levels for the categorical variables are *word-final position*, *stressed host syllable*, and *following consonant*. The "estimate" column in the statistical output (also referred to as) is the likelihood of change in log odds as compared to the reference levels. Negative estimates indicate that the relevant independent variable decreases the likelihood of frication, while positive estimates increase its likelihood. These results show

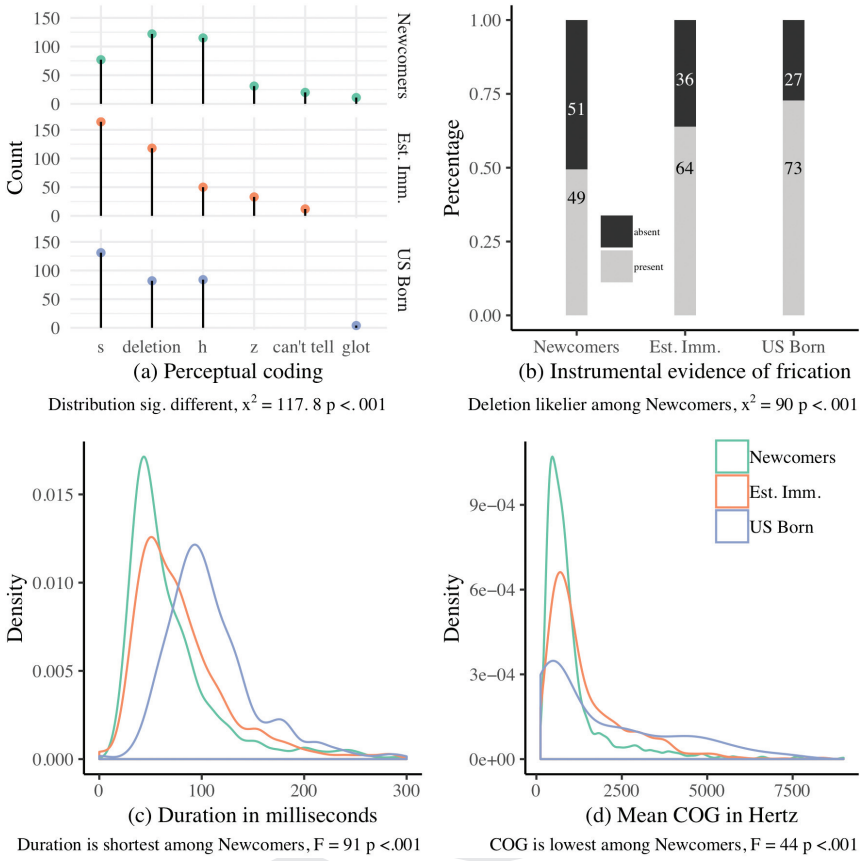

Figure 4.4 Reduction of coda /s/ among Caribbeans diminishes with increased U.S. life experience. 1a, n = 1,054 (Boston data only). 1b, n = 3,052 (Boston and NYC data combined). 1c-d, n = 1,749 (combined data, non-deleted tokens only).

that frication is significantly more likely to be produced when /s/ occurs (a) in slower speech (i.e. when the duration of host syllables is longer), (b) word-internally, and (c) before a pause. It is significantly less likely to occur when /s/ occurs in an unstressed syllable. None of the social variables, including Immigration Category, had a significant effect in the model. Non-significant linguistic predictors included *Lexical frequency*, *Morphological role*, and *Following vowel*.

The results for the linear regression run on Duration are presented in Table 4.2. Here the *estimate* corresponds to the amount of change in /s/ duration for each independent variable with respect to the reference values in the model, which are the same across all three regressions. A positive value means

Table 4.1 Mixed effects logistic regression results. Frication present

	Estimate	*Std. Error*	*z-value*	*Pr(>|z|)*
Significant results				
SpeechRate (log ms per syllable)	1.42	0.12	11.3	.001***
Word Position: internal	1.05	0.13	7.6	.001***
Stress: unstressed	-0.65	0.13	-4.9	.001***
Following: pause	0.39	0.16	2.5	.01**
Non-significant results				
Immigration Category: newcomer	-0.72	0.46	-1.6	0.11
Lexical Frequency (log Rank)	-0.03	0.03	-0.96	0.34
Age	-0.01	0.02	-0.73	0.47
Education: secondary	0.83	1.35	0.61	0.54
Following: vowel	0.06	0.12	0.47	0.64
Education: university	0.46	1	0.46	0.64
Sex: male	-0.17	0.38	-0.44	0.66
Immigration Category: U.S. born	-0.17	0.56	-0.3	0.76
Education: primary	0.44	1.34	0.25	0.8
Education: postgrad	0.11	0.97	0.16	0.9
Morphological: plural marker	0.02	0.19	0.09	0.93
Morphological: person marker	0.01	0.26	0.03	0.97

Table 4.2 Mixed effects linear regression results. Duration ms.

	Estimate	*Std. Error*	*t-value*	*Pr(>|z|)*
Significant results				
Following: pause	39.17	3.71	10.56	.001***
Speech Rate (log ms per syllable)	44.04	2.88	15.28	.001***
Following: vowel	10.09	2.96	3.4	.001***
Sex: male	-30.99	11.01	-2.81	.01**
Age	0.96	0.52	1.85	.06ns
Non-significant results				
Immigration Category: U.S. born	24.42	16.45	1.48	0.14
Education: postgrad	37.3	25.42	1.47	0.14
Education: university	21.53	26.29	0.82	0.41
Morphological: person marker	-4.54	5.75	-0.79	0.43
Education: primary	24.53	35.15	0.7	0.49
Stress: unstressed	-1.77	3.14	-0.56	0.57
Immigration Category: newcomer	5.93	11.85	0.5	0.62
Education: secondary	-17.76	35.68	-0.5	0.62
Lexical Frequency (log Rank)	0.22	0.67	0.33	0.74
Morphological: plural marker	-1.26	4.1	-0.31	0.76
Word Position: internal	-0.55	4.01	-0.14	0.89

the variable promotes an increase in the dependent variable (e.g. *following pause* leads to an increase in /s/ duration of 39 milliseconds), whereas a negative value indicates a decrease in the amount of the dependent variable. To calculate p-vales for the estimates (the lme4 packages does not calculate them), we used the *z* distribution. In addition, we used the MuMin package (Barton 2009) to calculate R values, which quantify the amount of variance that is accounted for by the model. Results indicate that frication duration is significantly longer when /s/ is (a) followed by a pause or a vowel compared to a consonant, (b) produced in slower speech, (c) produced by women, and (d) older speakers. The R for the fixed effects was .32, and for random effects it was .15. *Immigration Category* was, once again, not significant. Other non-significant variables were *Education level*, *Morphological role*, *Stress*, *Word position* and *Lexical frequency*.

The results for the linear regression run on Mean COG are presented in Table 4.3. Results indicate that COG is significantly higher (i.e. /s/ is less spectrally reduced) when it is (a) followed by a pause or a vowel compared to a consonant, (b) produced in slower speech, (c) produced by women, (d) and by those with postgraduate and university educations. In addition, COG is significantly lower when /s/ is a person marker. We will comment further on this counter-functional result in the next section. Once more, Immigration Category was not significant in the model. Other non-significant variables were *Stress*, *Age*, *Lexical frequency*, and *Word position*. In addition, the estimates for *primary* and *secondary* education as well as *plural marking /s/* did not significantly differ from the reference levels.

Table 4.3 Mixed effects linear regression results. COG

	Estimate	*Std. Error*	*t-value*	*Pr(>|z|)*
Significant results				
Following: vowel	529.82	72.56	7.3	.001***
SpeechRate (log ms per syllable)	512.46	70.65	7.25	.001***
Following: pause	440.05	91.05	4.83	.001***
Morphological: person marker	-518.52	142.73	-3.63	.001***
Education: postgrad	2224.72	733.47	3.03	.001***
Sex: male	-727.26	317.97	-2.29	.02*
Education: university	1552.75	759	2.05	.04*
Non-significant results				
Education: primary	1275.59	1014.29	1.26	0.21
Stress: unstressed	96.82	78.05	1.24	0.21
Immigration Category: newcomer	-393.65	342.88	-1.15	0.25
Immigration Category: U.S. born	483.16	475.45	1.02	0.31
Morphological: plural marker	-100.85	102.53	-0.98	0.33
Age	13.63	14.96	0.91	0.36
Lexical Frequency (log Rank)	12.74	16.6	0.77	0.44
Word Position: internal	-65.51	100.17	-0.65	0.51
Education: secondary	502.45	1032.15	0.49	0.63

4.5.4 Summary of results

The study's results support the view that Spanish /s/ reduction is a multimodal variable phenomenon, systematically manifesting along segmental/categorical as well as subsegmental/continuous dimensions. Variation along these dimensions tends to, but doesn't always, run in parallel. That is, the linguistic and social factors that promote reduction in one dimension often do so uniformly. One prominent site of parallelism in the data is the uniformly reduction-promoting effect of syllable coda position. When /s/ occurs in syllable-final rather than syllable-initial position, it is significantly more likely to be (1) realized as something other than [s], (2) deleted, (3) shorter in duration, and (4) lower in COG. Another parallel lies at the intersection of reduction and speakers' regional origins. The results presented here are highly consistent with the oft-reported observation that speakers of Caribbean origin are, among regionally delineated groups in the Hispanophone world, more likely to delete /s/ and also to produce it as a spectrotemporally reduced non-sibilant.

In addition to reaffirming the conditioning effects of syllable position and regional origin on /s/ reduction, the study's results also shed light on the integenerational status of coda /s/ among Caribbeans in the United States. We hypothesized that, under the pressures of language and dialectal contact, rates of coda /s/ reduction would diminish with increased US life experience. At the level of rates, we found evidence to support this hypothesis. In all four descriptors we observed significant differences between newcomers, established immigrants and the US born such that realizations of non-[s] segments declined in frequency, rates of deletion decreased and duration and COG increased with US life experience. However, in the context of multivariate analysis, the predictive power of Immigration Category was outmatched by that of other predictors. Indeed, when considered alongside other conditioning factors, Immigration Category failed to significantly contribute to any of the regressions that we ran. So, while there might be evidence in our data of intergenerationally shifting rates of /s/ reduction (and in the hypothesized direction of diminished amounts of reduction), the underlying structure of variant choice in our Caribbean participants' realization of coda /s/ remains primarily shaped by social and linguistic factors other than Immigration Category.

Additionally, the multivariate results highlighted several important instances of non-parallelism between dimensions of /s/ reduction. That is, the set of factors that emerged as significant was not identical across the three regressions. Only *Speech Rate* and *Following pause* were significant predictors in all three regressions. The effect of these two factors is clear: /s/ is less likely to be deleted and also less likely to be spectrotemporally reduced in slower speech and when there is no other sound occurring after /s/ in an utterance. In contrast, we found that while deletion is significantly more likely in unstressed syllables and also word-finally, *Stress* and *Word position*

are unpredictive of the spectrotemporal properties of /s/ when it is indeed realized. That is, knowing where a token appears in a word and whether it occupies a stressed syllable in that word are good predictors of whether it will be deleted or not, but bad predictors of its spectrotemporal properties if /s/ isn't deleted. And while no social factors were significantly predictive of deletion, *Sex* was similarly predictive for both *Duration* and *COG* in that /s/ was significantly more likely to be shorter and lower in COG in the speech of males. While increased *Age* was significantly predictive of longer Duration, age-graded differences failed to emerge for COG. Conversely, while *Education level* was predictive of differences in COG (those with more education produce /s/ with higher COG), no evidence was found for significant covariation between education and Duration. Finally, we observed significant covariation between COG and *Morphological role* such that person-marking /s/ was significantly *lower* in COG than non-morphemic /s/. We are inclined not to put too much stock into this result, as there are a number of potential alternative explanations for this counter-functional result, the most obvious being the co-occurrence of second-person singular verbs forms with overt subject pronouns. Investigating this possibility is beyond the scope of the present analysis.

4.6 Conclusions

The goals of this chapter were to (1) propose a methodology for the study of Spanish /s/ variation that drew from the best insights of the extensive literature on the topic and captured the different ways in which /s/ can be thought of as subject to reduction, and (2) to use that method to investigate the potential for intergenerational change among Spanish speakers in the United States. With respect to the first goal, the descriptive protocol offered and illustrated in the present chapter has clear advantages over a solely impressionistic coding of segmental variants and also over entirely instrumentally based descriptions. The most important benefit of adopting a multidimensional approach is the ability to demonstrate that different kinds of reduction are shaped by similar but not identical factors. That is, while there is some overlap in the insights offered by each of the protocol's descriptors, it is nonetheless clear that predicting the presence vs. absence of frication is a different task than predicting the spectrotemporal properties of non-deleted tokens. We encourage scholars interested in variationist approaches to Spanish /s/ reduction to try our approach and to continue improving upon it.

With respect to the topic of linguistic innovation or change, this study fits well with other research on Spanish in the United States in general and with previous study of the OZC and BSC in particular. In general, our results are consistent with variationist evidence of strong intergenerational structural continuity in the use of Spanish in the United States. More specifically, our results align with other research on Spanish in New York and Boston that reports shifting rates of use of variable phenomena but intergenerational

continuity in the underlying structure of variant choice. That is, while we found evidence of an intergenerationally diminished tendency towards / s/ reduction among Caribbeans in Boston and NYC, the set of factors that give rise to patterns of structured variation does not include Immigration Category. In other words, like others who have explored these corpora, we find that the prevailing trend in our data is one of intergenerational maintenance of sociolinguistic norms and the persistence of dialectal differences.

Notes

1 We continue to use the traditional brackets to represent phonemic segments. But the question of the relationship between phonetic substance and phonological form remains regardless of how we formalize phonological primitives, e.g. as clusters of distinctive features, gestural scores, etc.
2 Scholars of language in its social context have extensively debated this approach to variation, challenging not only its coherence in relation to non-phonological phenomena (Lavandera 1978) but also its limited appreciation of the dynamic, multidimensional, and socially-contingent nature of linguistic meaning in interaction (Eckert 2008).
3 Because that symbol is used in the IPA to represent a mid front rounded vowel, we will simply opt for the word "deletion" here.
4 The authors gratefully acknowledge the support of the *National Science Foundation* (BCS-1423840) and thank Otheguy and Zentella for generously sharing their data.
5 Because the descriptor *Segmental* has multiple values, it requires a more complex analysis, namely multinomial regression. Given the associated complexities, and the fact that the results of the other three analyses are themselves rather illuminating, we will not consider the *Segmental* descriptor in the multivariate analysis.

Glossary

Center of gravity: an acoustic measure that is a weighted average of the energy in the spectrum. It is calculated with the equation $COG = \Sigma fI/fI$, where I is the amplitude in decibels and f the frequency in Hertz of the spectral components.

Debuccalization: reduction process by which the oral features of a speech sound are suppressed.

Dialectal contact: the regular linguistic interaction of groups of speakers of the same language whose geographic origins vary, and whose respective origins are associated with systematically different ways of speaking along a range of linguistic dimensions.

Dialectal leveling: diminished regional differentiation, often as an outcome of dialectal contact.

Estimate: a statistic associated with the results of a regression model that quantifies the effect of a predictor variable on a dependent variable.

Together with its associated standard error, *t* or *z* statistic, and p-value, the estimate tells you the direction and magnitude of the predictor's effect.

Phonetic reduction: the systematic under-articulation of linguistic forms relative to their specification in mental representations.

Sociolinguistic variable: a phonological, morphological, lexical, or syntactic feature whose expression systematically varies in relation to linguistic and social conditioning factors. This is the chief analytical tool of linguists who work in the field known as *Variationist Sociolinguistics*.

Structural convergence: increased structural similarity between two linguistic systems, especially with respect to analogues structures and often as the result language contact.

References

Aaron, Jessi Elana, & Hernández, José Esteban (2007). Quantitative evidence for contact-induced accommodation. In K. Potowski & R. Cameron (Eds.), *Spanish in Contact: Policy, Social and Linguistic Inquiries* (pp. 327–341). New York: University of New York.

Barry, William, & Andreeva, Bistra (2001). Cross-language similarities and differences in spontaneous speech patterns. *Journal of the International Phonetic Association*, 31(1), 51–66.

Barton, Kamil (2009). MuMIn: Multi-model inference, R Package version 0.12.0. Available online at /http://r-forge.r-project.org/projects/mumin/,%202009 Accessed December 8, 2020.

Bates, Douglas , Mächler, Martin et al. (2015). Fitting linear mixed-effects models using lme4. *Statistical Software*, 67(1), 1–48.

Boersma, Paul (2002). Praat, a system for doing phonetics by computer. *Glot International*, 5(9/10), 341–345.

Bookhamer, Kevin (2013). *The Variable Grammar of the Spanish Subjunctive in Second-Generation Bilinguals in New York City*. New York: University of New York.

Brogan, Franny, & Bolyanatz, Mariška (2018). A sociophonetic account of onset /s/ weakening in Salvadoran Spanish: Instrumental and segmental analyses. *Language Variation and Change*, 30(2), 203–230.

Brown, Esther L. (2005). New Mexican Spanish: Insight into the variable reduction of "la ehe inihial"(/s-/). *Hispania*, 88(4), 813–824.

Brown, Esther L., & Torres Cacoullos, Rena (2002). Que le vamoh her? Taking the syllable out of Spanish /s/ reduction. *University of Pennsylvania Working Papers in Linguistics*, 8(3), 3.

Bucholtz, Mary (1999). Why be normal? Language and identity practices in a community of nerd girls. *Language in Society*, 28(2), 203–223.

Bullock, Barbara E, Almeida Toribio, Jaqueline, & Amengual, Mark (2014). The status of s in Dominican Spanish. *Lingua*, 143, 20–35.

Bybee, Joan (2000). Alternating environments. *Papers in Laboratory Phonology V: Acquisition and the Lexicon*, 5, 250.

Bybee, Joan (2002). Word frequency and context of use in the lexical diffusion of phonetically conditioned sound change. *Language Variation and Change*, 14(3), 261–290.

Canfield, D. Lincoln (1981). *Spanish Pronunciation in the Americas*. Chicago, IL: University of Chicago Press.

Cedergren, Henrietta C. Jonas (1974). *The Interplay of Social and Linguistic Factors in Panama*. (Unpublished PhD Dissertation). Ithaca, NY: Cornell University.

Cepeda, Gladys (1995). Retention and deletion of word-final /s/ in Valdivian Spanish (Chile). *Hispanic Linguistics*, 6, 329–354.

Chappell, Whitney (2014). Reanalysis and hypercorrection among extreme /s/ reducers. *University of Pennsylvania Working Papers in Linguistics*, 20(2), 5.

Davies, Mark (2017). *A Frequency Dictionary of Spanish: Core Vocabulary for Learners*. New York: Routledge.

Eckert, Penelope (2008). Variation and the indexical field 1. *Sociolinguistics*, 12(4), 453–476.

Erker, Daniel (2017). The limits of named language varieties and the role of social salience in dialectal contact: The case of Spanish in the United States. *Language and Linguistics Compass*, 11(1), doi: 10.1111/lnc3.12232

Erker, Daniel (2012). *An acoustically based sociolinguistic analysis of variable coda /s/ production in the Spanish of NYC*. (Unpublished PhD dissertation). New York University.

Erker, Daniel (2010). A subsegmental approach to coda /s/ weakening in Dominican Spanish. *Sociology of Language*, 203, 9–26.

Erker, Daniel, & Joanna Bruso (2017). Uh, bueno, em: Filled pauses as a site of contact- induced change in Boston Spanish. *Language Variation and Change*, 29(2), 205–244.

Erker, Daniel, & Ho-Fernández, Eduardo, Otheguy, Ricardo, & Shin, Naomi Lapidus (2017). Continuity and change in Spanish among Cubans in NY: A study of placement of subjects of finite verbs. In A. Cuza (Ed.), *Cuban Spanish dialectology: Variation, Contact and Change* (pp. 63–82). Washington, DC: Georgetown University Press.

Erker, Daniel, & Otheguy, Ricardo (2016). Contact and coherence: Dialectal leveling and structural convergence in NYC Spanish. *Lingua*, 172, 131–146.

File-Muriel, Richard, & Brown, Earl (2011). The gradient nature of s-lenition in Caleño Spanish. *Language Variation and Change*, 23(2), 223–243.

File-Muriel, Richard, & Díaz-Campos, Manuel (2003). Grammatical judgments and phonetic reality: A study of internal constraints in phonological variation. *Acoustical Society of America*, 114(4), 2335–2336.

Flipsen, Peter, Shriberg, Lawrence et al. (1999). Acoustic haracteristics of /s/ in adolescents. *Speech, Language, and Hearing Research*, 42(3), 663–677.

Foulkes, Paul, & Docherty, Gerard (2006). The social life of phonetics and phonology. *Phonetics*, 34(4), 409–438.

Fox, Michelle (2006). *Usage-based effects in Latin American Spanish syllable-final-/s/-lenition*. (Unpublished PhD dissertation). University of Pennsylvania, Philadelphia.

Fuchs, Susanne, & Toda, Martine (2010). Do differences in male versus female /s/ reflect biological or sociophonetic factors. In S.Fuchs, M. Toda, & M. Zygis (Eds.), *Turbulent Sounds: An Interdisciplinary Guide* (pp. 281–302.). Berlin: De Gruyter.

Granda, Germán de (Ed.) (1994). Sobre la etapa incial en la formación del español de América. In *Español del América, español en Africa y hablas criollas hispánicas: cambios, contactos, y contextos* (pp. 13–48). Madrid: Gredos.

Hammond, Robert M. (2001). *The Sounds of Spanish*. Somerville MA: Cascadilla Press.

Heffernan, Kevin (2004). Evidence from Hnr that /s/ is a social marker of gender. *Toronto Working Papers in Linguistics*, 23. Available online at https://twpl.library.utoronto.ca/index.php/twpl/article/view/6208. Accessed on December 8, 2020.

Hochberg, Judith G. (1986). Functional compensation for /s/ deletion in Puerto Rican Spanish. *Language*, 62(3), 609–621.

Jongman, Allard, Wayland, Ratree, & Wong, Serena (2000). Acoustic characteristics of English fricatives. *Acoustical Society of America*, 108(3), 1252–1263.

Klatt, Dennis H. (1976). Linguistic uses of segmental duration in English: Acoustic and perceptual evidence. *Acoustical Society of America*, 59(5), 1208–1221.

Kohler, Klaus J. (1990). Segmental reduction in connected speech in German: Phonological facts and phonetic explanations. In W.J. Hardcastle & A. Marchal (Eds.), *Speech Production and Speech Modelling* (pp. 69–92). Dordrecht: Kluwer Academic.

Labov, William (1972). *Sociolinguistic Patterns*. Philadelphia, PA: University of Pennsylvania Press.

Ladefoged, Peter (2003). *Phonetic Data Analysis: An Introduction to Fieldwork and Instrumental Techniques*. Malden, MA: Blackwell.

Ladefoged, Peter (1980). What are linguistic sounds made of? *Language*, 56, 485–502.

Lamboy, Edwin M. (2004). *Caribbean Spanish in the Metropolis: Spanish Language among Cubans, Dominicans, and Puerto Ricans in the NYC Area*. New York: Routledge.

Lapesa, Rafael (1942). *Historia de la lengua española*. Madrid: Gredos.

Lavandera, Beatriz R. (1978). Where does the sociolinguistic variable stop? *Language in Society*, 7(2), 171–182.

Li, Fangfang, Edwards, Jan, & Beckman, Mary (2007). Spectral measures for sibilant fricatives of English, Japanese, and Mandarin Chinese. In *Proceedings XV International Congress of Phonetic Sciences Vol. 4* (pp. 917–920). doi: 10.1017/S0025100316000062

Lindblom, Björn (1990). Explaining phonetic variation: A sketch of the H&H theory. In W.J. Hardcastle & A. Marchal (Eds.), *Speech Production and Speech Modelling* (pp. 403–439). Dordrecht: Kluwer Academic.

Lipski, John M. (1994). *Latin American Spanish*. London: Longman.

Lynch, Andrew (2009). A sociolinguistic analysis of final /s/ in Miami Cuban Spanish. *Language Sciences*, 31(6), 766–790.

Manrique, Ana Maria B. de, & Massone, María Ignacia (1981). Acoustic analysis and perception of Spanish fricative consonants. *Acoustical Society of America*, 69(4), 1145–1153.

Marden, Charles C. (1896). *The Phonology of the Spanish Dialect of Mexico City. Vol. 11*. Baltimore, MD: Modern Language Association of America.

Mason, Keith W. (1994). *Comerse las eses: A selective bibliographic survey of /s/ aspiration and deletion in dialects of Spanish* (Unpublished PhD dissertation). University of Michigan, Ann Arbor.

Milroy, James, & Milroy, Lesley (1985). Linguistic change, social network and speaker innovation. *Linguistics*, 21(2), 339–384.

Munson, Benjamin, McDonald, Elizabeth C. et al. (2006). The acoustic and perceptual bases of judgments of women and men's sexual orientation from read speech. *Phonetics*, 34(2), 202–240.

Ohala, John J. (1989). Sound change is drawn from a pool of synchronic variation. In L. E. Breivik & E. H. Jahr (Eds.), *Language Change: Contributions to the Study of its Causes* (pp. 173–198). Berlin: Mouton de Gruyter.

Ohala, John J. & Kawasaki, Haruko (1984). Prosodic Phonology and Phonetics. *Phonology*, 1, 113–127.

Otheguy, Ricardo, & Zentella, Ana C. (2012). *Spanish in NY: Language Contact, Dialectal Leveling, and Structural Continuity. Vol. 203*. Oxford: Oxford University Press.

Poplack, Shana (1980). The notion of the plural in Puerto Rican Spanish: Competing constraints on /s/ deletion. *Locating Language in Time and Space*, 1, 55–67.

Poplack, Shana, & Levey, Stephen (2010). Contact-induced grammatical change: A cautionary tale. *Language and Space: An International Handbook of Linguistic Variation*, 1, 391–419.

Poplack, Shana, Walker, James, & Malcolmson, Rebecca (2006). An English like no other: Language contact and change in Quebec. *Canadian Journal of Linguistics*, 51(2), 185–213.

Recasens, Daniel (2004). The effect of syllable position on consonant reduction (evidence from Catalan consonant clusters). *Phonetics*, 32(3), 435–453.

Reidy, Patrick F. (2016). Spectral dynamics of sibilant fricatives are contrastive and language specific. *Acoustical Society of America*, 140(4), 2518–2529.

Resnick, Melvyn C. (1975). *Phonological Variants and Dialect Identification in Latin American Spanish. Vol. 201*. The Hague: Mouton & Co.

Terrell, Tracy D. (1979). Final /s/ in Cuban Spanish. *Hispania*, 62(4), 599–612.

Torres Cacoullos, Rena, & Travis, Catherine (2011). Testing convergence via code-switching: Priming and the structure of variable subject expression. *Bilingualism*, 15(3), 241–267.

Ureña, Henríquez (1921). Observaciones sobre el español en América. *Revista de Filología Española*, 8, 357–390.

Varra, Rachel Marie (2013). *The social correlates of lexical borrowing in Spanish in New York City* (Unpublished PhD dissertation). City University of New York.

Walker, Abby, García, Christina et al. (2014). Comparing social meanings across listener and speaker groups: The indexical field of Spanish/s. *Language Variation and Change*, 26(2), 169–189.

Waltermire, Mark (2011). Frequency effects on the morphological conditioning of syllable-final /s/ reduction in border Uruguayan Spanish. *Language Contact*, 4(1), 26–55.

Weinreich, Uriel, Labov, William, & Herzog, Marvin (1968). Empirical foundations for a theory of language change. In W. Lehmann & Y. Malkiel (Eds.), *Directions for Historical Linguistics*. Austin, TX: University of Texas Press.

Topics for discussion

(1) Discuss the pros and cons of various methods for describing Spanish /s/ variation.
(2) In what ways is *Center of Gravity* an imperfect acoustic measure?
(3) The descriptive protocol proposed here is designed to capture variation in the production of /s/. How well do you think it would work in the context of a perception study? In what ways might it be modified?
(4) How important is it to take a position on the nature of phonological representations when studying variation in Spanish /s/ production? How might the answer to this question vary depending on a researcher's goals?
(5) Are there any segmental variants of /s/ beyond those listed in the preceding chapter? In what communities are these variants found?
(6) Identify three other variable sound phenomena in Spanish. How might the typical ways in which these sounds are described be reconsidered or refined?
(7) Describe the relationship between *rates of use* of a variable feature and *the underlying structure of variant choice* in the feature. Why is the latter more important than the former when it comes to assessing change in a speech community?