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The Gradient Nature of S-Lenition in Caleño Spanish

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Abstract

Previous studies of s-weakening in Spanish have relied almost exclusively on the impressionistic coding of /s/. Not only is auditory transcription invariably influenced by the transcriber's background, but temporal and gradient acoustic details about the sound are concealed when tokens are represented symbolically. The present study examines the production of /s/ by eight females from Cali, Colombia during informal sociolinguistic interviews. We propose a metric for quantifying s-realization by employing three scalar dependent variables: s-duration, centroid, and voicelessness. The results of linear regressions indicate that the dependent variables are significantly conditioned by local speaking rate, lexical frequency, stress, word position, and the preceding and following phonological contexts. This study sheds light on how each independent variable impacts s-realization acoustically. For example, as local speaking rate increases, duration, centroid, and voicelessness decrease, indicative of lenition. We discuss the advantages of opting for instrumental measurements over symbolic representation.

The Gradient Nature of S-Lenition in Caleño Spanish

Richard J. File-Muriel and Earl K. Brown*

1 Introduction: Previous Studies and their Methodologies

S-lenition in Spanish is perhaps the most studied phenomenon in Romance Linguistics. Ferguson (1990:64) goes so far as to state that "the aspiration and deletion of /s/ in dialects of Spanish may be the most extensively treated of all sound changes being investigated from an empirical, variationist perspective." A likely reason for the plethora of studies detailing this phenomenon is that it is fairly wide-spread in the Spanish-speaking world, occurring in the southern part of Spain (Andalusia), the Canary Islands, and throughout Latin America, excepting the Mexican highlands and the Andean regions of South America. Specifically concerning Spanish-speaking Latin America, Lipski (1994) reports that s-lenition is found in the Caribbean zone, including coastal Mexico, Colombia, and Panama, and throughout Central America (excepting Costa Rica and Guatemala), the Pacific coast of Colombia and Ecuador, coastal Peru, Chile, Paraguay, Eastern Bolivia, Uruguay, and most of Argentina. In addition to geographic origin, it has been shown that a multitude of other factors influence the production of /s/, including linguistic, sociolinguistic, stylistic, and functional factors. The following only samples the abundance of work on s-lenition in Spanish.

Variation in the distribution of /s/ has been explained in terms of varying sociolinguistic characteristics of the speakers, such as socioeconomic status and education level, age, gender, and whether the speaker resides in an urban or rural location. Aspiration and deletion are generally considered markers of social class, with upper-class and more-educated speakers tending towards less weakening, while lower-socioeconomic class and less-educated speakers favor more lenition. Terrell (1981) examined the distribution of /s/ in Santo Domingo, finding that education level, task, and gender were significant in explaining the realization of /s/. Guillen Sutil (1992), Cedergren (1973), and Poplack (1979) found that the age of the speaker can also affect the rate of /s/ lenition, with younger speakers displaying more weakening than older speakers. Furthermore, in general, male speakers show higher levels of lenition than female speakers, as the latter are more likely to retain /s/ when lenition is stigmatized (Fontanella de Weinberg 1973). Interestingly, Rodriguez-Castellano and Palacio (1948) observed that rural speakers tend to conserve the word-final /s/ as a voiced aspirate, while urban speakers favor complete deletion.

The variants of /s/ (i.e., [s], [h], and Ø) co-vary with register such that the frequency of retention increases in formal speech styles and in reading tasks (Alba 2004, File-Muriel 2009). Increasing the rate of speech has profound effects on the duration of all segments and, not surprisingly, tends to occasion higher incidences of reduction in the form of lenition and assimilatory processes. Segment weakening results because the need for efficiency in coordinating articulatory gestures outweighs the need for precision. Bybee (2002) claims that this is universally true with all segments that undergo lenition. Accelerated speech rates will increase the frequency of stop lenition in Spanish, vowel harmony in Brazilian Portuguese, and flapping in American English, among other phenomena. Lipski (1985) found that style or speed of delivery figure into explaining /s/ variation. By comparing sports commentaries with other forms of broadcasting, Lipski argues that increased speed of delivery favors aspiration and deletion, while more deliberate speed favors retention. It is unclear, however, whether speed of delivery, style, or a combination of both factors contributed to the variation.

The majority of the existing quantitative studies that examine s-lenition have relied exclusively on transcription via auditory analysis (cf. Minnick Fox 2006, Erker forthcoming for exceptions). Terrell (1979) suggests that a fine-grained phonetic transcription of /s/ is possible, but would hinder the replicability of results for future investigations. For this reason, most sociolinguists and phonologists have adopted a tripartite system for distinguishing between the innumer-

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able phonetic manifestations of /s/ with the three IPA symbols [s], [h], and Ø. Based on this categorization of /s/, two varieties of Spanish have been identified in the Hispanic Linguistics literature:

1. Retention: Speakers tend to produce /s/ as [s] in all contexts, whereas aspiration (i.e., [h]) and deletion (i.e., Ø) are almost non-existent. This is the standard variety spoken in the capital of Colombia (Bogotá).
2. Aspiration/deletion: Speakers tend to produce /s/ as [h] or Ø. Although [s] appears in some formal registers, it is not very frequent in informal speech. This is the standard variety spoken in the Atlantic coastal region of Colombia.

2 Justification for this Study

The inherently subjective nature of audio transcription, which to date has been the preferred approach, has not gone unnoticed in the literature. Poplack (1979:66) adequately described what she saw as a methodological concern: "Researchers looking at similar Caribbean dialects have reported grossly different proportions of the same variants. These discrepancies are more likely due to [one researcher] counting the assimilated variants as instances of deletion, while [another researcher] considered them aspiration." In short, researchers make subjective decisions about what they hear (or think they hear), which becomes highly arbitrary due to the gradient nature of lenition.

The fact that transcription is subject to bias based on the expectations and experience of the transcriber is well documented in the literature (cf. Boucher 1994, Erker forthcoming, Mann and Repp 1980, Pouplier and Goldstein 2005). Several studies show that the surrounding phonetic context can influence the perception and categorization of segmental phenomena. For example, vowel durations affect the perception of voicing of syllable-final stop consonants (Repp and Williams 1985). Specific to /s/, the surrounding phonetic context has also been shown to influence perception and categorization. File-Muriel and Díaz-Campos (2003) examined the perception and categorization of different variants of /s/ using synthesized speech. They found that in pre-pausal position listeners categorized the aspirated and deleted variants at only 46-percent accuracy, which indicates the great difficulty of distinguishing between these two phonetic realizations.

Secondly, capturing the subtle (but vital) acoustic variation that exists in different manifestations of /s/ is not possible using the transcription approach, as it limits the representation of this gradient phenomenon to the symbolic units of the IPA. Widdison (1991, 1994, 1995) has shown conclusively that subtle acoustic properties influence perception in lexical decision tasks, even if the listeners are not conscious of the material in the signal that influences such decisions. Erker (forthcoming) demonstrates that, in the Spanish of Dominicans in New York, a strictly segmental description of coda /s/ productions groups together tokens that are significantly different from one another acoustically, thus concealing important patterns present in speech. He reports that, within the class of tokens that were coded as [s], significant differences existed in both of the acoustic measurements used in the study. Furthermore, these differences were correlated with several of the independent variables in the study and several of the conditioning factors only promote weakening in one dimension of the subsegmental description.

In light of these methodological concerns, we opt to abandon symbolic representation and instead analyze s-realization in gradient terms, thus removing subjectivity as much as possible, while at the same time capturing the subtle acoustic information that could be relevant to our understanding of the lenition process. We intend to address the following questions: (1) Which independent variables significantly condition s-realization when viewed as gradient? (2) Are these independent variables the same ones that have been reported in the previous studies, which are based on IPA transcription? (3) Do the independent variables have the same magnitude of effect in each of the three dependent variables? (4) What advantages, if any, are there to considering lenition in gradient terms as opposed to categorical ones?

3 Methods

3.1 Data Collection/Corpus

The data used in the present study come from sociolinguistic interviews conducted in Cali, Colombia. The participant pool in this study deliberately represents a relatively homogeneous group of speakers: Eight female residents of Cali, between 20 and 26 years of age. The participants were natives of Cali and reported no speech or hearing disorders. All of the participants in the study pertained to approximately the same socioeconomic class (i.e., all had the equivalent of a bachelors degree or were currently enrolled in university courses).[1] The interviews (approx. 30 minutes each) were conducted by a native of Cali, Colombia, who met the same criteria as the participants she interviewed. The interviews adhered to standard sociolinguistic methodology: Topics included vacation and travel plans, diversions, schooling, food, dangerous situations, local shopping, etc. The interviews took place in a quiet setting and were recorded using a solid-state Marantz PMD 670 compact flash recorder with a head-mounted unidirectional mic.

3.2 Dependent Variables

In order to code the three dependent variables (s-duration, center of gravity, and percent voiceless), the following procedures were applied. A sequential set of at least 200 tokens, whether word-initial, word-medial, or word-final, was selected, starting at least ten minutes into each interview. The decision to exclude tokens from the first ten minutes of each interview is based on the fact that speakers tend to be most conscious of their speech early on in a recorded conversation, and are therefore more likely to display hypercorrection and style-shifting at the beginning. The total number of tokens in this study is 1,777.

The researchers used Praat (v. 5.0.31 for Mac) to assist in coding the tokens and to take all of the acoustic measurements. The first of the three dependent variables, s-duration, was coded by manual delimitation. Attending to both the waveform and the spectrogram, the researchers delimited the left and right boundaries of the visible aperiodic, high-frequency (4,000-11,000 Hz) noise. Ladefoged suggests that "spectrograms cannot give such precise information in the time domain as expanded scale waveforms, which readily permit measurements in milliseconds" (Ladefoged 2003).

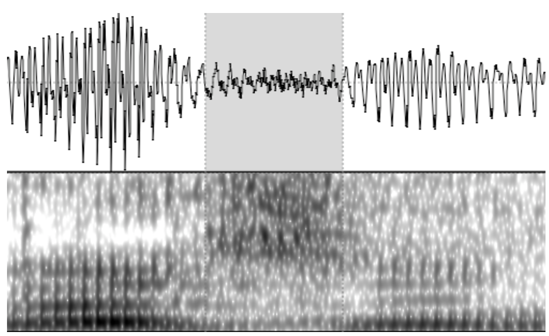

Figure 1: Waveform and spectrogram of /s/ in *la señora* 'the woman'.

The boundaries were placed at the zero-intercept in the waveform. Specifically, the onset of /s/ sequences was delineated at the zero-intercept point closest to the first sign of aperiodic noise in the waveform. Similarly, the offset was set at the zero-intercept point closest to the cessation of the aperiodicity associated with the /s/ sound (during the closure of a following voiceless stop there is often aperiodic ambient noise, which is visible in the waveform, but which shows no high-

[1]The present study focuses on the linguistic factors involving s-lenition and the advantages of instrumental measurement over symbolic representation; future research will look at a more representative sample of Caleño speakers, including a diverse sample of gender, socioeconomic classes, and age.

frequency noise in the spectrogram, hence the utility of viewing both the waveform and the spectrogram).[2] See Figure 1.

Tokens of /s/ that displayed no visible high-frequency noise in the spectrogram nor aperiodicity in the waveform were coded as having a duration of 0 milliseconds. See Figure 2. The band of low peaks and valleys in the waveform and the lighter shades of gray in the spectrogram represent the closure for the word-initial approximant in *dejó*.

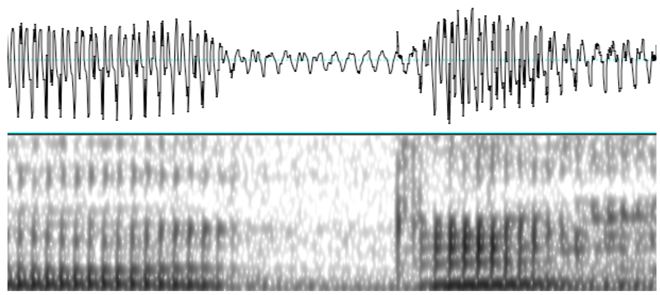

Figure 2: Waveform and spectrogram of the deleted /s/ in *nos dejó* 's/he left us'.

Due to the fact that fricative consonants produce highly variable noise, statistical techniques are quite useful in investigating the variation in fricative spectra. The second dependent variable in this study includes one of the spectral moments (Forrest et al. 1988), namely, center of gravity (henceforth centroid), which measures the central tendency (i.e., the mean) of the spectrum. The centroid measurement was taken from the middle 60-percent of the duration measurement in order to avoid the transitional boundaries. The transitional boundaries were intentionally excluded in order to reduce the influence of surrounding segments.[3] Following Silbert and de Jong (2008:2772), the centroid was limited to frequencies above 750 Hz with a pass Hann band filter, as this was intended to capture the noise component of the fricatives; energy produced by glottal pulsing is located predominantly in the frequency range below 750 Hz.

Finally, the third dependent variable, percent voicelessness, was taken from the "Voice Report" in Praat. This measurement was taken when the marked duration of /s/ filled exactly two-thirds of the Editor Window.

Aside from the initial manual delimitation of the duration boundaries by these researchers, the procedures described above were performed automatically using a Praat script. In our view, there are several advantages of using a script. First, in terms of efficiency, it is quicker to have Praat carry out the measurements automatically. Secondly, and more importantly, using a script creates uniformity in the coding process. For example, the script pulled exactly 60 percent of each token to measure the centroid and zoomed into the token so that it filled exactly two-thirds of the Editor Window before obtaining the voicing report, regardless of whether the duration was 20 or 120 milliseconds.

3.3 Independent Variables

This study analyzes the conditioning effect of eleven independent variables: (1) local speaking rate, (2) prosodic stress, (3) word position, (4) syllabic position, (5) preceding phonological context, (6) following phonological context, (7) word length, (8) lexical frequency, (9) bigram-one frequency, (10) bigram-two frequency, and (11) informant.

The local speaking rate was calculated by dividing the number of phonemes in the three-word phrase surrounding /s/ by the duration of that phrase, which produced a scalar measurement of

[2]Inter-rater reliability was tested by the independent coding of 25 tokens (selected at random) by both researchers; independent measurements all fell within 10 ms, indicating a high degree of precision, reliability, and replicability of the stated procedure.

[3]This decision is not meant to imply that the transitional boundaries do not contain important information (cf. Widdison 1994); the transitional boundaries were included in the duration measurements.

phonemes-per-second. When a pause preceded or followed the word in which /s/ occurred, the number of words in the surrounding phrase decreased accordingly, so that only two words, or occasionally one, were employed in the calculation of the local speaking rate. The prosodic stress was coded as either tonic (e.g., *per**s**ona* 'person') or atonic (e.g., *pare**c**en* 'they appear'). When word-final /s/ was followed by a vowel (with no intervening pause), resyllabification was assumed (e.g., *do**s** años* 'two years' > *do-**s**a-ños*) and stress was coded accordingly. Word position was coded as initial, medial, or final, as in ***s**eñora* 'woman/ma'am', *ha**s**ta* 'until' or *ca**s**a* 'house', and *vamo**s*** 'let's go', respectively. Similarly, syllabic position was coded as either initial or final. In only word-initial position is there overlap between word position and syllable position, as word-initial /s/ is always in syllable-initial position, but word-medial and word-final /s/ can be in either syllable position. Both the preceding and following phonological contexts were coded as: pause, high vowel (/i, u/), non-high vowel (/a, e, o/), coronal consonant, or non-coronal consonant. Word length was measured by the number of phonemes in the word, which created an ordinal variable with a range between two and eighteen phonemes. Lexical frequency was measured by calculating the number of instances each s-word occurs in a specific corpus. Bigram-one frequency measures the number of occurrences of the two-word string in which the s-word is preceded by another word (e.g., *no **s**abía* 's/he didn't know'). Bigram-two frequency measures the number of occurrences of the two-word string in which the s-word is followed by another word (e.g., ***s**abía que* 's/he knew that').

In order to calculate the lexical frequency and the bigram frequencies, a combined corpus of Cali speech was employed. The open source programming language R was used to calculate the number of occurrences of the individual words and the bigrams. The combined corpus consists of the corpus from which the tokens for this study were extracted as well as a corpus of spontaneous conversations from 38 speakers between the ages of 21 and 55 (cf. Travis 2005). The total number of words in the combined frequency corpus is 177,722. Finally, the informant was entered into the statistical analyses to control for inter-speaker variation caused by stylistic and physiological differences.

4 Results

Linear regressions were run with SPSS (v. 16.0 for Mac) for each of the three dependent variables (s-duration, centroid, and voicelessness) using a forward stepwise selection procedure in which the independent variables are sequentially entered into the model based on which ones have the largest correlation with the dependent variable. The results in Table 1 exclude the bigram frequencies, as their inclusion excluded the several hundred tokens in which the s-word was either preceded or followed by a pause, as a pause followed by a word or a word followed by a pause are not bigrams. Therefore, the bigram frequencies were not included in the linear regressions reported in Table 1, but their influence will be addressed in Table 2.

The coefficients given in Table 1 indicate that the corresponding independent variable significantly contributes (at an alpha level of $p<0.05$) to the dependent variable under investigation. These numbers can be used to interpret the strength and direction of influence. Furthermore, the order of each variable's inclusion in the model precedes the coefficient, and indicates the degree of correlation with the dependent variables. Coefficients furthest away from zero, as either a positive or a negative number, indicate a strong influence on the dependent variable. For example, the independent variable "local speaking rate" was selected first in all three regressions and has coefficients relatively far from zero, which seems to indicate that it is the most influential independent variable in s-realization. On the other hand, "informant" was selected fifth for s-duration, fourth for centroid, and sixth for voicelessness, indicating significant influence, but less than that attested for local speaking rate. The order of selection of each variable is indicated by the number to the left of each coefficient.

The results in Table 1 allow us to make several fundamental observations. First, several independent variables are powerful predictors of s-realization. They are: local speaking rate, word position, following phonological context, stress, and the specific informant. Each of these variables was selected as significant for all three dependent variables and shows virtually the same direction of influence. For example, as local speaking rate increases, s-duration, centroid, and voicelessness decrease. Similarly, when /s/ occurs in word final position or is followed by a non-high vowel, the same weakening tendency is apparent across all three dependent variables. On the other hand, when /s/ is realized in a tonic syllable or is followed by a pause, the opposite effect holds: s-duration, centroid, and voicelessness increase, indicating that these factors strongly favor s-retention. A second important result is that, in this study, word length and syllable position were not selected as significant predictors of s-realization, something which contradicts previous research (cf. Terrell 1979, Lipski 1999).

Variables	S-Duration	Centroid	%-Voiceless
Local speaking rate	1) -0.344	1) -0.267	1) -0.169
Informant	5) -0.116	4) -0.123	6) -0.061
Stress (tonic)	9) 0.051	5) 0.077	9) 0.057
Word position (initial)			
Word position (final)	4) -0.220	2) -0.393	4) -0.214
Word position (medial)	ns	7) -0.085	ns
Following (non-coronal)			
Following (pause)	2) 0.344	9) 0.051	5) 0.158
Following (non-high vowel)	7) -0.101	3) -0.263	3) -0.153
Following (high vowel)	3) 0.099	6) -0.113	ns
Following (coronal)	ns	ns	8) 0.063
Lexical frequency	6) 0.106	ns	ns
Preceding (non-coronal)	ns	ns	7) 0.060
Preceding (non-high vowel)	8) -0.101	ns	ns
Preceding (high vowel)	10) -0.062	ns	ns
Preceding (pause)	ns	ns	2) 0.231
Preceding (coronal)	ns	8) 0.053	ns
Word length	ns	ns	ns
Syllable position (initial)	ns	ns	ns
R-Squared	0.364	0.241	0.198

Table 1: Coefficients from three linear regressions (bigram frequencies excluded).

As alluded to above, s-realization varies significantly among the eight speakers. The fact that there are differences in centroid measurements between the speakers is not surprising, as these are likely due to the fact that the characteristics of frication noise depend (to an unknown degree) on the unique shape of a speaker's vocal tract. For example, Silbert and de Jong (2008:2771) show that the source spectrum for coronal fricatives depends, in part, on the shape and position of the lower teeth.

With regard to s-duration and voicelessness, a one-way ANOVA was used to test speaking rate differences between the eight participants. Local speaking rate differed significantly between the participants ($F(7,1769)=31.767$, $p=0.000$). Several Tukey post-hoc comparisons of the participants indicate that informant Two (M=20.475, 95% Cl [19.796, 21.154]) and informant Eight (M=20.780, 95% Cl [19.687, 21.873]) had significantly higher local speaking rates than the other informants. They can be contrasted with informants One (M=15.141, 95% Cl [14.337, 15.946]), Three (M=14.512, 95% Cl [13.919, 15.105]), and Four (M=16.124, 95% Cl [15.519, 16.729]), who employed a more deliberate local speaking rate. The local speaking rates of informants Five, Six, and Seven are located between the two extremes. Figure 3 below elucidates these differences visually with box plots.

While this figure clearly illustrates the differences in local speaking rates between the eight speakers, the assumption that the local speaking rate is only a consequence of the *overall* speaking rate of a given speaker is not supported in these data. A series of linear regressions individually analyzed the tokens from each speaker. The results show that the local speaking rate is, indeed, a highly significant predictor of s-duration in all eight speakers. With concern to centroid and voicelessness, the local speaking rate again shows a strong conditioning effect, as it is significant in the speech of seven of the eight speakers.

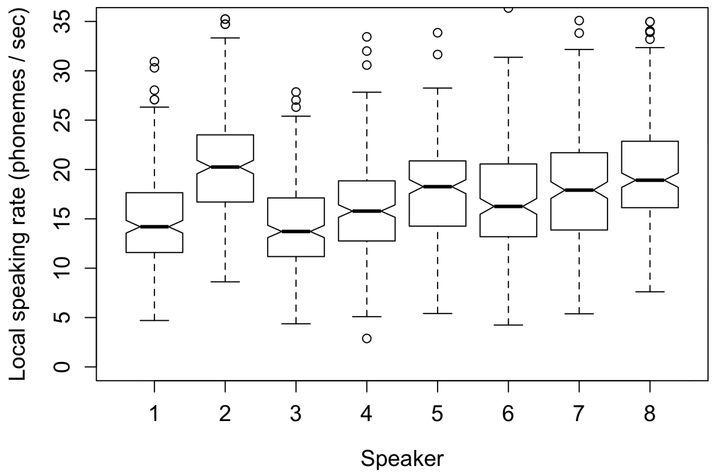

Figure 3: Distribution of local speaking rate according to speaker.

As mentioned above, the linear regressions reported in Table 1 exclude the bigram frequencies to allow the inclusion of all the tokens in this study (N=1,777). In order to address the influence of the bigram frequencies, three more linear regressions were run in which these frequency measures were included, even though it meant the exclusion of several hundred tokens. As was the case in the original linear regressions, the lexical frequency of the word in which /s/ occurs was selected as significantly contributing to s-duration, but not to centroid or voicelessness. Although the bigram two frequency (e.g., *sabía que* 's/he knew that') was selected as a significant predictor of both centroid and voicelessness, bigram one was not selected as significant, as seen in Table 2 below.

Variables	S-Duration	Centroid	%-Voiceless
Local speaking rate	1) -0.345	2) -0.249	3) -0.201
Informant	4) -0.149	5) -0.137	ns
Stress (tonic)	ns	6) 0.083	ns
Word position (initial)			
Word position (final)	2)-0.246	1) -0.356	1) -0.259
Word position (medial)	ns	ns	ns
Following (non-coronal)			
Following (non-high vowel)	ns	3) -0.180	2) -0.166
Following (high vowel)	3) 0.224	ns	ns
Following (coronal)	ns	ns	4) 0.119
Lexical frequency	8) 0.072	ns	ns
Lexical frequency bigram 1	ns	ns	ns
Lexical frequency bigram 2	ns	4) 0.149	7) 0.077
Preceding (non-coronal)	ns	ns	5) 0.085
Preceding (non-high vowel)	5) -0.143	ns	ns
Preceding (high vowel)	7) -0.088	ns	ns
Preceding (coronal)	ns	7) 0.073	6) 0.089
Syllable position (initial)	6) -0.132	ns	ns
R-Squared	0.278	0.250	0.145

Table 2: Coefficients from three linear regressions (bigram frequencies included).

5 Discussion

When viewed in gradient terms, the results suggest that s-realization in Caleño Spanish is influenced by a variety of factors, including local speaking rate, word position, informant, lexical frequency, bigram two frequency, stress, and surrounding phonological context. Of all the factors examined, local speaking rate appears to be the most significant predictor of s-realization in these data, as it was selected first in the three regressions reported in Table 1 and the coefficients indicate a strong influence. These findings provide more evidence that an increased rate of speech tends to occasion higher incidences of lenition and assimilatory processes (cf. Bybee 2002, Lipski 1985). In accelerated speech, the need for efficiency in coordinating articulatory gestures outweighs the need for precision.

Concerning the surrounding phonological context, the tendency for /s/ to weaken in word-final position is an illustrative example of phonological asymmetries across positions; certain word positions (e.g., word final) are more vulnerable to weakening processes than others (e.g., word initial) due to the differential role that such positions play in lexical retrieval (cf. Beckman 1999 for the importance of positional faithfulness in explaining phonological asymmetries). The fact that s-weakening occurs when followed by a non-high vowel in these data supports results from studies of initial s-reduction in New Mexican Spanish (Esther Brown 2005). With regard to stress and following pause, our results are interpreted as supportive of previous studies that report the strengthening effect of tonic stress (Alba 1982, Beckman 1999) and following pause (Poplack 1979). Although the preceding context is significant and relevant to s-realization, its influence is substantially less than that exerted by the following phonological context, which supports the broad general claim that Spanish is a language characterized more by regressive assimilatory processes than progressive ones (Schwegler et al. 2010:243–246).

This study highlights a few of the advantages of using instrumental acoustic measurements in lieu of traditional auditory analysis. The gradient approach allows us to make detailed observations regarding the temporal, spectral, and energy properties of /s/ that are affected during the lenition process. The acoustic correlates are not affected equally by all the factors and may in fact go in opposite directions, which, to our knowledge, is a novel finding regarding s-lenition in Spanish. For example, the presence of a following high vowel tends to increase s-duration (indicator of fortition), lower the centroid (indicator of lenition), and not affect the voicing (neutral effect). Similar observations regarding the preceding phonological context provide us with another example in which important generalizations would otherwise be overlooked within a symbolic account of s-realization. Some variables only affect certain aspects of s-realization, but do not affect others. An illustrative example of this is when /s/ follows a pause (e.g., [#] ***s****ea también* 'like also'). The preceding pause creates an environment relatively resistant to sonorization, while neither the centroid nor the duration are affected. The explanation is clearly articulatory: Following a pause, the vocal chords are inactive, making the target sound impervious to voicing assimilation. Such information is impossible to capture using traditional IPA categories, which collapse all relevant acoustic cues into several categorical labels (i.e., [s, h, Ø]).

Similarly, by employing gradient measurements of both dependent and independent variables we gain a more accurate account of the conditioning factors previously reported in the literature. For example, Terrell (1979) proposes that word length significantly conditions s-realization in Cuban Spanish. Specifically, he employs a binary distinction of word length and shows that polysyllabic words are more likely than monosyllabic words to have a lenited /s/. However, when analyzed as a gradient variable by the number of phonemes (which in these data range from two phonemes (e.g., *es* 'be') to eighteen (e.g., *internacionalizado* 'internationalized'), word length was not selected as a significant predictor of the three linear regressions reported in Table 1 above.

In conclusion, we have proposed that scalar acoustic measures (when available) are preferred to symbolic representation. First, scalar variables allow the researcher to address the actual acoustic parameters that are immeasurable with categories, making possible the detailed study of gradient phenomena. Second, by analyzing s-realization in terms of three dependent variables, we are able to observe the variable influence of the independent factors that have long been studied in the literature. Third, scalar measures analyzed with software (such as Praat) are less vulnerable to transcriber bias, as transcription encourages the researcher to impose segmentation on inherently gradient phenomena.

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