The Scope of Stop Weakening in Argentine Spanish

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1. Approaches to weakening or lenition

Recent experimental studies have documented the weakening of both voiceless (e.g. Lewis, 2000: 2001) and voiced Spanish stops in intervocalic position (e.g. Cole, Hualde & Iskarous, 1999; Ortega-Llebaria, 2004). In addition, synchronic and diachronic studies have repeatedly proposed the existence of a correlation between weakening of voiced and voiceless stops (e.g. Lloyd, 1993). However, very few studies have systematically analyzed both weakening processes in the same variety (Lavoie, 2001), and even fewer have presented experimental evidence demonstrating the existence of such a correlation. In this paper, we analyze the status of both processes in Argentine Spanish in order to motivate hypotheses that would account for diachronic changes in Spanish as well as in other Romance languages.

In particular, we evaluate three competing approaches to lenition. The first approach, henceforth Hypothesis A, predicts a positive correlation between an increasing rate of approximantization and deletion of voiced stops and increasing voicing of voiceless stops across places of articulation (e.g. Martinet, 1952; Lloyd, 1993; Wireback, 1997). This approach, which is basically diachronic in nature, sees lenition as a stage towards deletion. The second approach, or the effort-based hypothesis – Hypothesis B -, (Kirchner, 2004; Blevins, 2004) analyzes lenition as effort reduction. As such lenition involves a decrease in the degree of constriction of a given gesture as well as a decrease in duration. Thus, this approach predicts that more effortful gestures should lenite more than less effortful ones, and that the degree of lenition should be affected by the vocalic context. Consequently, we expect to find (i) weakening of voiceless stops; (ii) a higher rate of weakening with more open vowels; (iii) no effect of place of articulation. Finally, the third approach, namely the perception-based hypothesis – Hypothesis C - (Kingston, 2008), stipulates that lenition is an index of the degree of perceptual separation between two constituents. As such, this hypothesis predicts: (i) that the vocalic environment should not affect the degree of weakening; and (ii) more lenition of voiced than of voiceless stops.

2. Intervocalic stop lenition in Spanish

Diachronic stop weakening is documented at various stages in the evolution from Latin to Romance languages, as evidenced in processes like degemination, approximantization, deletion and voicing of voiceless stops (Wireback, 1997). A recurrent problem has been to establish which of these processes initiated the change in Spanish, in which order the change proceeded, and whether these processes influenced each other.

Lloyd (1993) views stop weakening as a chain shift; thus acknowledging correlations among degemination, voicing of voiceless stops and approximantization of voiced stops. Specifically, Lloyd reports instances of voicing of intervocalic voiceless stops (LUPU> *lobo* 'wolf') alternating with voiceless stops at different stages of the evolution, and across regions of the Iberian Peninsula. Since the 'newly' voiced intervocalic voiceless stops may have overlapped with the original voiced stops and produced confusions in meaning, the latter were fricativized, weakly articulated, or, in some cases, deleted (as the alveolars, CRUDELE > *cruel* 'cruel'). So, according to Lloyd's approach, the voicing of intervocalic voiceless stops implied the fricativization of voiced stops. Also, as a result of the voicing processes, geminate stops simplified to voiceless singletons (CUPPA > *copa* 'glass';

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Wireback, 1997: 99) thus, filling the gap left in the phonological structure by the voiceless stops that became voiced. Under this approach, deletion is viewed as the final stage of weakening. However, in contrast with the other weakening processes, deletion is more context-sensitive and affects voiced spirantized stops differently, with more deletion for alveolars and the least for labials (Lloyd, 1993: 237).

Other approaches to diachronic lenition have focused on strength hierarchies involving place and manner of articulation. In such hierarchies (e.g. Wireback, 1997), velars and voiced continuants are the weakest segments, whereas labials and (voiceless) geminate stops are the strongest. However, as Escure (1977) notes, strength hierarchies rank consonants based on their articulatory properties but disregard the fact that weakening patterns crucially depend on the consonant's position in the phonological phrase. The author thus proposes three different (implicational) hierarchies that attempt to capture weakening and deletion diachronically and cross-linguistically: (i) a hierarchy of major class and manner, (ii) a hierarchy of environment and (iii) a hierarchy of cavity. According to this 3-dimensional hierarchy, weakening and deletion affects first voiceless stops and fricatives, followed by voiced stops. The most vulnerable environment is word final position followed by word medial. Back consonants (i.e. velars) are more likely to weaken and delete than anterior consonants.

Few experimental studies have focused on the synchronic weakening of voiced and voiceless stops. In particular, Lewis (2001) points out that lenition should be viewed as a gradient process affecting each of the intervocalic stops differently and to different extents. Thus, the weakening processes found in Spanish are not ordered (i.e. one process feeding another as implied in the chain shift proposal) but rather the weakened realizations of stops can be found along a fortis - lenis continuum. Lewis shows that two different Spanish dialects are consistently situated at different stages in the lenition process, with more lenited forms in Peninsular Spanish than in Colombian Spanish.

With regard to the motivations underlying the lenition process, three proposals have been put forward (see §1 & §3). Lenition has been interpreted as an articulatory effort-reduction strategy (Kohler, 1994; Kirchner, 2004), a perceptual enhancement strategy (Kingston, 2008) or an aerodynamically constrained process (Recasens, 2002). Independently of the approach adopted, there is consensus regarding the manifestation of lenition in stops: in Spanish, lenited voiceless stops become partially or totally voiced (e.g. Lewis, 2001; Martínez Celdrán, 2008), lenited voiced stops become approximants (Santagada & Gurlekian, 1989; Martínez Celdrán, 1991), and some are deleted. Additionally, stop lenition is signaled by specific acoustic cues: shorter closure durations, and increased relative intensity, among other characteristics. Synchronic experimental studies (Romero, 1995; Lavoie, 2001; Lewis, 2001) show that in Spanish lenition affects stops differently. Voiceless velars weaken more than alveolars and labials with respect to closure duration (Lewis, 2001:153ff), whereas voiceless labials weaken more than alveolars and velars with respect to VOT. The percentage of voicing during closure is higher for alveolars making them more lenited than labials and velars. Intervocalic lenited stops become more similar in sonority to adjacent vowels. The relative consonant-vowel intensity ratio decreases. If lenition has a perceptual motivation (Kingston, 2008), that of differentiating between the edges of the prosodic constituents (less lenited) and the body of the prosodic constituents (more lenited), then, within the prosodic constituent, consonants lenite in order to become more sonorous. Phonological voiceless stops are produced with partial or total voicing and phonological voiced stops, which are articulated with a more open constriction show a vowel-like formant structure. According to Lewis (2001:160) the place of articulation of voiceless stops does not statistically influence the relative intensity, whereas in Lavoie's data (2001) the intensity ratios are the lowest (i.e., more lenition) for voiceless labials and voiced alveolars as compared to the rest of the stops in their corresponding series.[1]

Conditioning factors often discussed as directly related to stop lenition are the environment (i.e. flanking segments, position in the word and in the prosodic phrase), the speech style (conversation, paragraph and word list reading) and the dialect. Researchers have reported that greater openness of

[1] Articulatory measurements are also used to quantify lenition in different contexts. In Spanish, there is more linguo-palatal contact in utterance-initial position but the amount and location of contact shows no systematic distribution with respect to other positions in the prosodic phrase (Lavoie, 2001: 155).

flanking segments as well as faster and more casual speech favor lenition (Kirchner, 2004; Lewis, 2001). In Spanish, there is more lenition for /b, g/ in post-tonic than in tonic syllables (Ortega Llebaria, 2004). Similar findings (Cole et al., 1999) show that voiced velars lenite more in contexts following a stressed vowel and with flanking vowels /o, u/. However, contrary to the general predictions on the influence of openness of flanking vowels, both studies cited above found that voiced velars actually weaken less in the context of the open vowel /a/ than when flanked by the close vowels /u, i/. In this respect, Kingston (2008:17) notes that the difference in openness between close and open vowels is so small that it is unlikely to find more intervocalic consonant lenition in the context of open vowels than in the context of less open vowels. If weakening is viewed as an aerodynamically constrained process (Recasens, 2002), then all preceding sounds that favor airflow (i.e. not only open vowels) should contribute to stop lenition.

3. Current study: goals and hypotheses

This study has an empirical and a theoretical goal. First, we seek to determine the degree of lenition in voiced and voiceless stops in Argentine Spanish, through the acoustic analysis of a corpus of dialectological interviews. Second, based on the experimental evidence obtained, we want to test the specific predictions of the three competing approaches to lenition that were introduced in §1. Hypothesis A, or the system-oriented hypothesis, predicts that there will be a correlation between an increasing rate of approximantization and deletion of voiced stops and voicing of voiceless stops. Proponents of this hypothesis (e.g. Wireback, 1997; Recasens, 2002) have also made specific predictions, which do not necessarily derive from the general prediction just mentioned. In particular, they have observed that velars weaken first but coronals delete first, followed by velars and labials. Hypothesis B, or the effort-based hypothesis, predicts that consonants involving more effortful gestures should lenite first. From this general hypothesis, more specific predictions can be derived. First, it is expected that voiceless stops should lenite first. Second, a higher rate of lenition is expected when a given consonant is flanked by open vowels (Kirchner, 2004:316). Third, no place asymmetries are expected (Kirchner 2004:315). Lastly, no stress effects are predicted. The last hypothesis to be considered in this paper is Hypothesis C, or the perception-based hypothesis (Kingston, 2008). This hypothesis is based on the assumption that lenition is an index of separation between two prosodic constituents. As such, it predicts a higher degree of lenition within prosodic constituents than across constituents. This general prediction, however, will not be tested here, since we are only analyzing word-internal intervocalic stops. Crucially, this hypothesis makes the specific prediction that lenition will not be affected by the degree of constriction of the flanking vowels, given that lenition does not involve a reduction of effort. Finally, this hypothesis also specifically predicts that voiced stops will lenite first. Although this latter prediction is not fully motivated by the proponent of the perception-based hypothesis, this voicing asymmetry is probably justified by the fact that voiced stops have already weakened, and thus, the degree of perceived separation is smaller than with voiceless stops.

In summary, these three hypotheses make contrasting predictions for any given data set, since it is assumed that lenition is governed by different forces, such as system-internal constraints, articulatory patterns or perceptual differences. In the following section, we present the data that we will use to test the general and the specific predictions outlined by the three hypotheses.

4. Methodology

4.1. Stimuli & Participants

Target words containing instances of intervocalic /b,d,g,p,t,k/ were extracted from two-hour long dialectological interviews recorded by the first author for the Linguistic-Anthropologic Atlas of Argentina. For each of the participants a minimum of 20 tokens per stop was extracted (i.e. 20 words x 6 consonants = 120).

We analyzed here the speech of six male speakers native of two Argentine provinces (Corrientes and San Juan). Three speakers, representing three different locations in each province, were selected. These speakers were all native and lifelong residents of the locations under study; and their age ranged

between 25-50. Speakers from two different provinces were included specifically to analyze data representing varieties with different degrees of lenition. Indeed, previous studies reported a more advanced stage in the weakening of voiced stops in Corrientes than in San Juan (Vidal de Battini, 1964)

4.2. Data Analysis

All target words were coded for the following variables: (1) underlying stop; (2) surface realization; (3) preceding and following vowel; (4) stress; (5) location and province. In addition, the following acoustic measurements were taken using Praat 4.0.41. First, the total duration (in ms), the relative intensity (in dB) and the percentage of the consonant duration in which a visible F0 contour was present were measured. The duration of the following vowel and its average relative intensity were also measured. Finally, the relative CV intensity-ratio was calculated by subtracting the highest intensity value in the following vowel from the lowest intensity value in the consonant. All the measurements are illustrated in Figure 1(a,b). Figure 2 summarizes how each of the individual acoustic parameters will be used to indicate the degree of lenition.

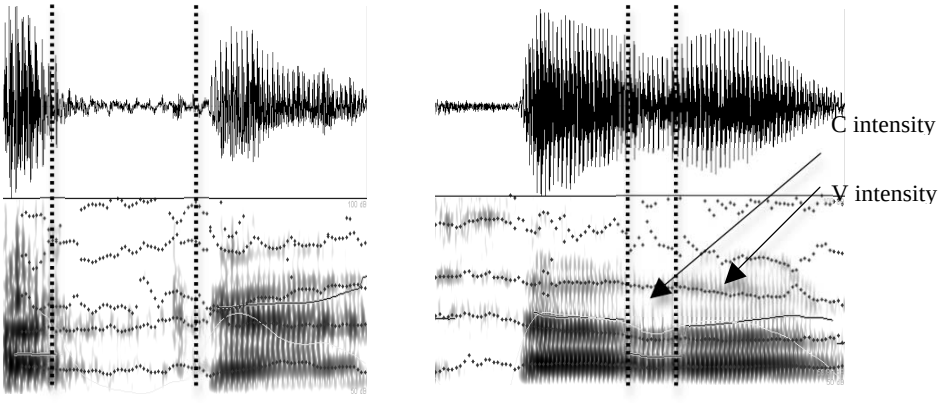

Figure 1: (a) stop realization of [k] extracted from the word *acá* 'here'; (b) approximant realization [ð] extracted from the word *alisador* 'filing tool' (AP, Corrientes). The vertical dotted lines indicate the duration of both consonants. The measurement of the relative CV intensity-ratio is illustrated in (b)

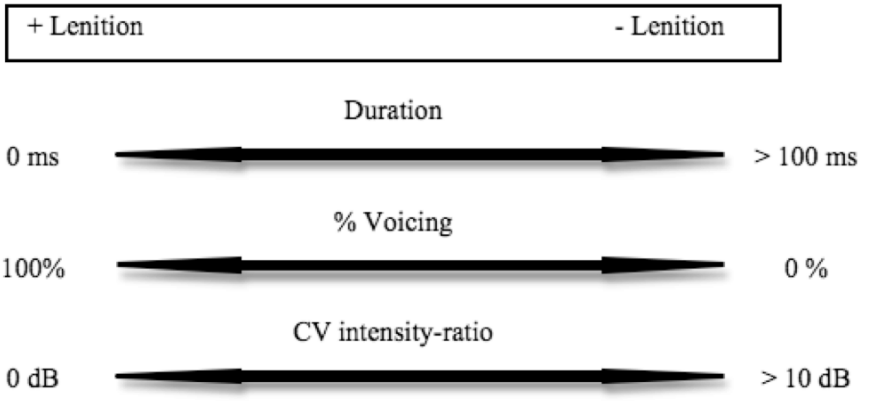

Figure 2: Schematization of how the three acoustic parameters measured will be used to assess the different degrees of lenition. Note that the upper values for duration and relative intensity are presented only for the purpose of illustration.

All the measurements were entered into a spreadsheet and statistics, which included repeated-measures ANOVAs, correlations and χ^2, were calculated with SAS 9.2. In all cases, significance was set at .05.

5. Results

5.1. Lenition of voiced and voiceless stops

Given that the first goal of the paper is to determine the degree of lenition of both voiceless and voiced stops in these Argentine Spanish varieties, in this first section we report results on the surface realization of the target structures (Figure 3) and their acoustic properties (Figures 4 & 5).

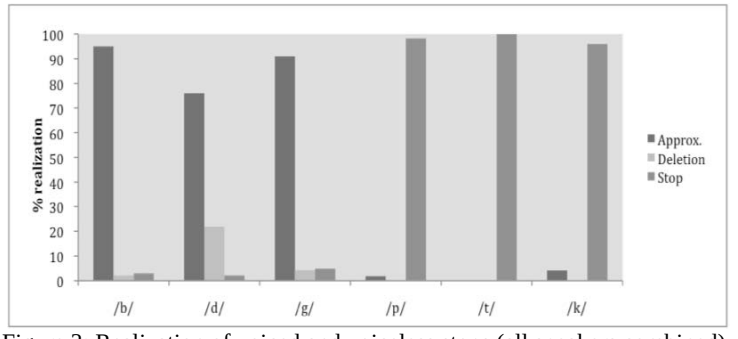

Figure 3: Realization of voiced and voiceless stops (all speakers combined).

Results presented in Figure 3 indicate that voiceless stops showed almost no signs of weakening. Only labials and velars had some approximant realizations, but in less than 5% of the cases. On the other hand, the underlying voiced stops[2] were almost categorically realized as approximants; and /d/ showed additional signs of weakening with 20% of deletions. These overall results suggest that voiced stops are, indeed, becoming weaker, but voiceless stops are not displaying the same trend. However, results presented in Figure 3 only reflect variation in manner, as suggested by the visual inspection of spectrograms. In order to determine more accurately whether there is a connection between the weakening of voiced and voiceless stops, we also analyzed the duration, %voicing and relative CV intensity-ratio of voiced and voiceless stops. Figure 4 displays the duration of voiced and voiceless stops for the six speakers included in the study.

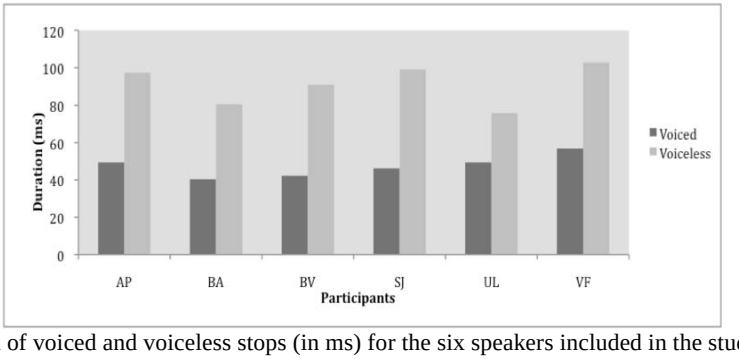

Figure 4: Duration of voiced and voiceless stops (in ms) for the six speakers included in the study. Speakers AP, BA & BV represent the variety spoken in Corrientes, whereas SJ, UL and VF are from San Juan.

If the weakening of voiced stops were accompanied by the weakening of voiceless stops, as predicted by Hypothesis A, we would expect that speakers who produced short voiced stop realizations

[2] The underlying representation of Spanish voiced stops has been the object of an extensive debate. For the purpose of our analysis, we are assuming that historically, they were voiced stops.

(e.g. BA, BV, SJ) would have also produced the shortest voiceless stops. Although BA and BV seemed to be following this trend, this was not the case for all the other speakers. Indeed, stops had similar durations across speakers, and no significant correlation was found between the duration of voiced and of voiceless stops (r=0.3; p=n.s).

The second parameter that we analyzed was the percentage of the consonant duration that was voiced. Again, if voiceless stops were weakening, we would expect a higher percentage of the segment to be voiced. However, this is not the general tendency reported in Figure 5. The overall results indicate that, although underlying voiced stops were realized as fully voiced by all speakers, voiceless stops showed very little signs of voicing, with the exception of one speaker (UL) whose voiceless stops were variably voiced for 60% of their duration. However, the correlation between the voicing of voiced and voiceless stops, again, did not turn out to be significant (r=0.1; p=n.s.).

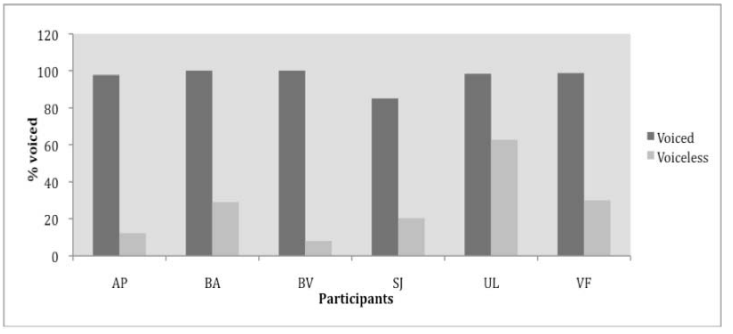

Figure 5: Percentage of the consonant showing a visible F0 contour for the six speakers included in the study. Speakers AP, BA & BV are from Corrientes, whereas, SJ, UL and VF are from San Juan.

The last variable that we examine in this section is the relative CV intensity-ratio. As mentioned in §4.2, a CV intensity-ratio close to '0' suggests that the consonant is more vowel-like, and, consequently, has a less constricted articulation. Figure 6 displays the results obtained.

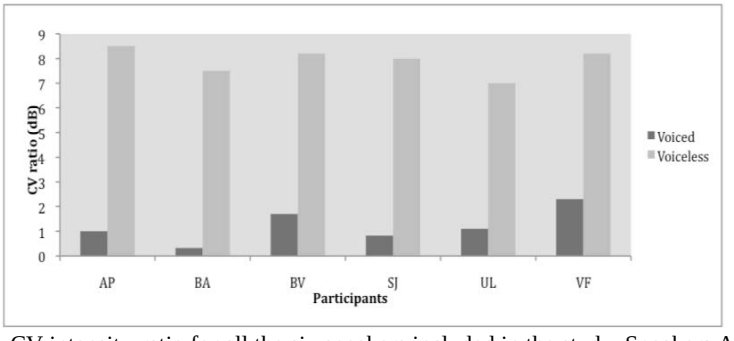

Figure 6: Relative CV intensity-ratio for all the six speakers included in the study. Speakers AP, BA & BV are from Corrientes, whereas SJ, UL and VF are from San Juan.

Results in Figure 6 confirmed the general trends observed for the other two acoustic parameters; namely, voiced stops are realized like vowel-like segments but voiceless stops showed no clear signs of weakening. The CV intensity-ratio of voiceless stops was consistently high across speakers, and once again, the correlation between the CV intensity-ratio in voiced and voiceless stops turned out not to be significant (r=0.2; p. ns.).

Thus, to summarize our results, there was not enough evidence to support the existence of a correlation between the weakening of voiced and of voiceless stops in these Argentine varieties. Voiced stops are becoming weaker; they are relatively short segments articulated with a wide constriction; and coronals show a relatively higher rate of deletion. Voiceless stops, on the other hand, are consistently realized as stops; are relatively long, show very few signs of voicing and are

articulated with a narrow constriction. In the next section, we turn to the analysis of the factors that favor lenition, particularly in the case of voiced stops.

5.2. Variables that affect lenition

In this subsection we analyze how several independent variables, such as the type of consonant, the quality of the flanking vowels and stress, affect stop weakening, in particular as concerns two of the parameters measured: duration and relative intensity. Here, we have decided to leave the analysis of % voicing aside, given the quasi-categorical patterns reported in the previous section; namely voiced stops were categorically voiced, whereas voiceless stops showed almost no signs of voicing. Figures 7 & 8 summarize the effects of consonant place & voicing on duration and CV relative intensity, respectively.

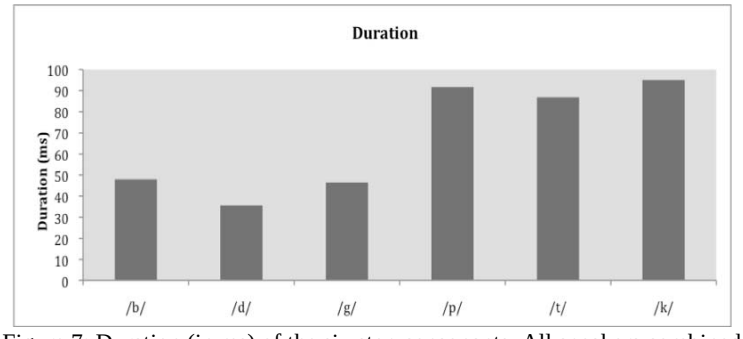

Figure 7: Duration (in ms) of the six stop consonants. All speakers combined

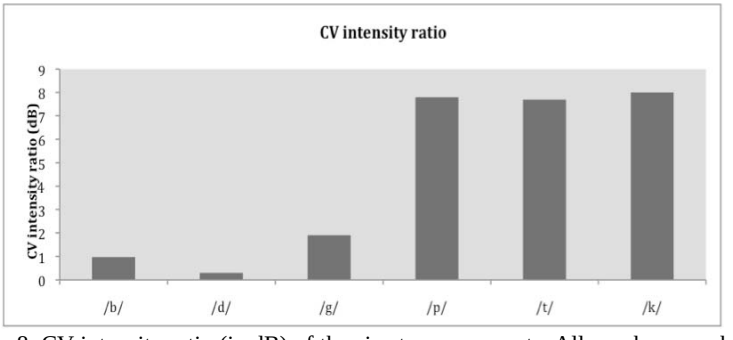

Figure 8: CV intensity ratio (in dB) of the six stop consonants. All speakers combined

Results presented in Figures 7 & 8 revealed some place asymmetries, in particular in voiced stops. Consonant place and voicing has a significant effect on duration as indicated by repeated-measures ANOVAs ($F_{(5,5)}$=235.74; p<.0001). Results of a post-hoc Tukey test showed that (a) voiced velars and labials were significantly longer than coronals (/b/ vs. /d/: t=5.88; p<.0001; /d/ vs. /g/: t=-4.49; p<.0001); (b) /t/ was significantly shorter than /k/ (t=-2.68; p=.0074). Differences, however, were not significant between /p/-/k/ and /b/-/g/. As for CV intensity-ratio (Figure 8), repeated-measures ANOVAs,[3] revealed a significant overall effect of consonant place and voicing ($F_{(5,5)}$=405.06; p<.0001). Results of a post-hoc Tukey test were in line with those reported for duration; namely, coronals have the lowest CV intensity-ratio (/b/ vs. /d/: t=2.88; p=.004; /d/ vs. /g/: t=-3.99; p<.0001), suggesting that they lenited the most. Among voiceless stops, differences were not significant, and place asymmetries were not found.

The second independent variable that we analyzed was the effect of the preceding and following vowels. As mentioned above, Hypothesis B predicts that consonants flanked by more open vowels will

[3] In both cases, location was the between-group factor and consonant place & voicing the within-group factor.

show the highest degree of lenition. The effect of the flanking vowels was tested on two dependent variables: consonant duration (Figure 9 & 10) and CV intensity-ratio (Figures 11 & 12).

Results of repeated-measures ANOVAs showed that there was no significant overall effect of the preceding vowel on the duration of each of the consonants ($F_{(5,4)}$=21.13; p=n.s.). The following vowel, however, had a significant effect on the duration of the consonant ($F_{(5,4)}$=2.85; p=0.014). However, no clear patterns regarding vowel-type emerged; namely, it was not always the case that consonants were significantly shorter when followed by more open vowels. We believe that the effects observed were more likely related to compensations for differential intrinsic vowel duration plus effects of stress and final lengthening.

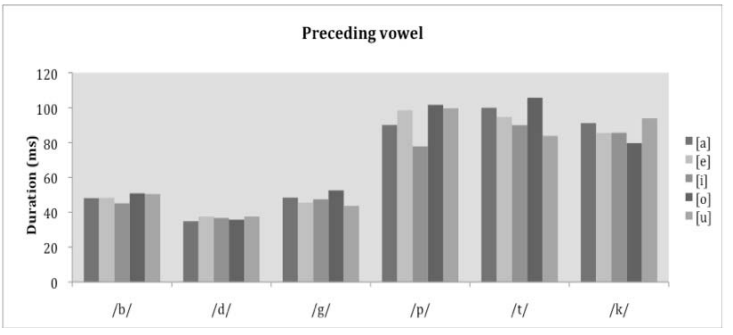

Figure 9: Consonant duration according to preceding vowel. All speakers combined

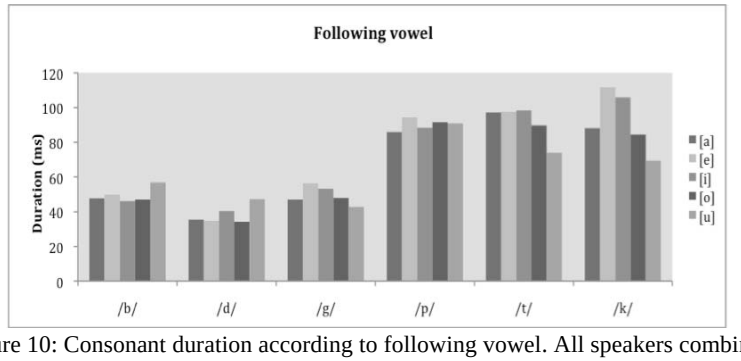

Figure 10: Consonant duration according to following vowel. All speakers combined

The second dependent variable that we analyzed here was the CV intensity-ratio. A smaller CV intensity-ratio value reflects a more vowel-like articulation, and thus a more lenition. Thus, if lenition is affecting voiced and voiceless stops, we expect to see small ratios across the board. In particular, if the predictions of Hypothesis B hold, we expect the smallest CV intensity ratio in the sequence [a]C[a], and the highest with high vowels.

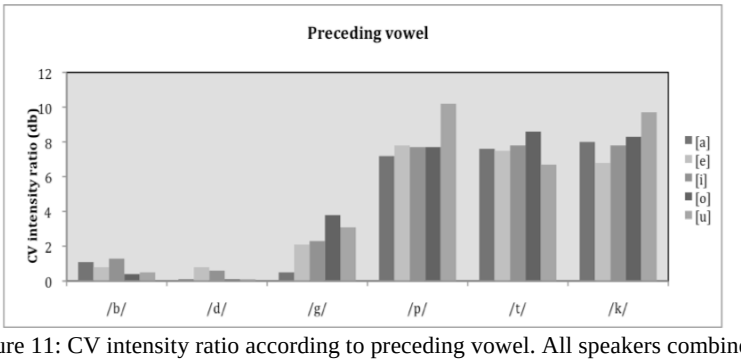

Figure 11: CV intensity ratio according to preceding vowel. All speakers combined

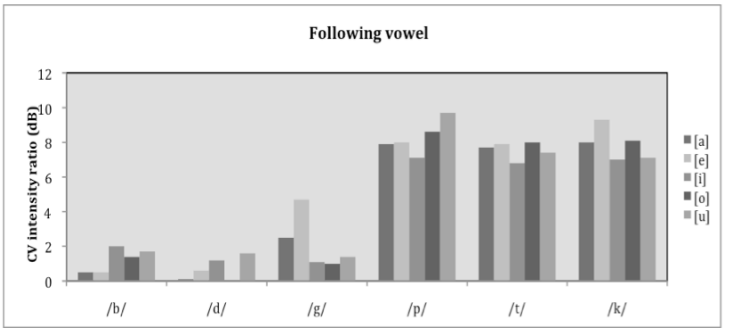

Figure 12: CV intensity ratio according to following vowel. All speakers combined

The patterns that emerged, however, did not clearly support the effort-based hypothesis. The preceding vowel (Figure 11) had a significant overall effect ($F_{(5,4)}$=3.88; p=.0074) on consonant lenition. Post-hoc Tukey tests revealed that (1) /b/ was more lenited when preceded by back vowels (although differences were not statistically significant, especially when compared to the vowel /i/); (2) /g/ was more lenited when preceded by [a] than when preceded by [i] (t=-2.19; p=.03) and [o] (t=-2.08; p=.03); and (3) a preceding [a] or [o] vs. a preceding [i] favored the lenition of /d/ (t=-3.56; p=.0004; t=2.29; p=.02, respectively). The following vowel (Figure 12) also had a significant overall effect on the CV intensity ratio ($F_{(5,4)}$=3.81; p=.002); as did the interaction of the following vowel*type of consonant ($F_{(5,21)}$=2.53; p=.0020). In particular, in the case of voiced stops, /g/ was lenited the least when followed by [e] and [a] (see a similar pattern for /k/), but no significant effects were observed for the other voiced consonants. Voiceless stops showed significant differences for all vowels; however, the only consistent pattern across places of articulation was that lenition was higher when the consonant was followed by [i].

The last independent variable that we analyze in this section is 'stress'. Figure 13 displays the duration of the six consonants under different stress conditions.

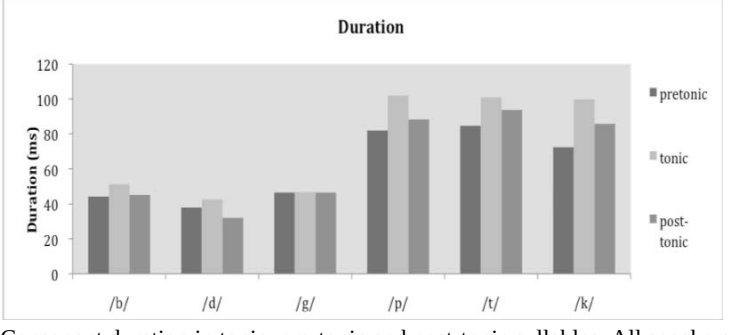

Figure 13: Consonant duration in tonic, pre-tonic and post-tonic syllables. All speakers combined

As in previous studies (e.g. Cole et al., 1999; Ortega-Llebaria, 2004), 'stress' inhibited lenition ($F_{(5,2)}$=22.12; p<.0001); consonants were overall significantly longer in tonic syllables than in unstressed syllables, either pre-tonic (t=-5.96; p<.0001) or post-tonic (t=5.19; p<.0001). Additional post-hoc Tukey tests revealed that the effect of stress was stronger for voiceless than for voiced consonants. Indeed, /d/ and /g/ did not significantly differ in duration across stress conditions. Results for the effect of stress on CV intensity-ratio confirmed the tendencies observed for duration (see Figure 14).

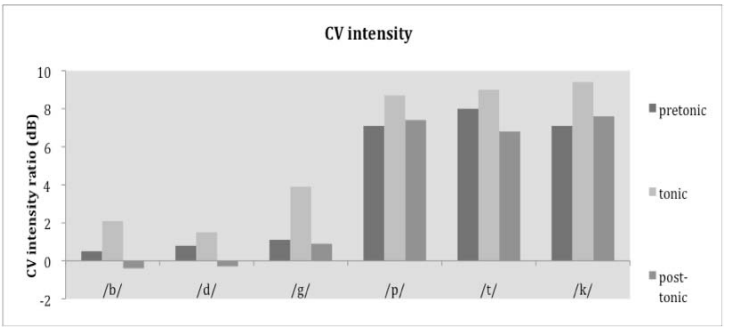

Figure 14: CV intensity ratio in tonic, pre-tonic and post-tonic syllables. All speakers combined

The variable 'stress' significantly affected the CV-intensity ratio ($F_{(5,2)}$=66.8; p<.0001). Moreover, there was significantly less lenition in stressed than in either pre-tonic (t=-7.56; p<.0001) or post-tonic syllables (t=11.15; p<.0001). Indeed, both voiced and voiceless consonants showed a significantly higher CV intensity-ratio in tonic than in unstressed syllables.

In summary, of all the three independent variables analyzed here, namely 'place', 'flanking vowels' and 'stress', we have shown that 'stress' had the strongest effect in inhibiting lenition across places of articulation, which was particularly evident in the CV intensity-ratio values. Results also showed that the flanking vowels had an overall effect on consonant duration and on the CV intensity-ratio. These effects, however, were not always consistent with the predictions of the effort-based hypothesis. In particular, the quality of the preceding vowel affected differently the CV intensity ratio of /b,d,g/. As for the following vowel, the most systematic pattern observed was that [i] promoted the lenition of voiceless stops. Finally, clear place asymmetries emerged from the results; coronals (/d/ in particular) lenited the most. As such, in the next section, we will focus only on voiced consonants, since those are the consonants that witnessed the most advanced stage of lenition, i.e. deletion.

5.3. Variables that affect deletion of voiced stops

In this section, as in the previous one, we analyzed the role that three variables (i.e. place of articulation, stress and flanking vowels) play on the rate of deletion of voiced stops. Figure 15 shows the results for 'place'.

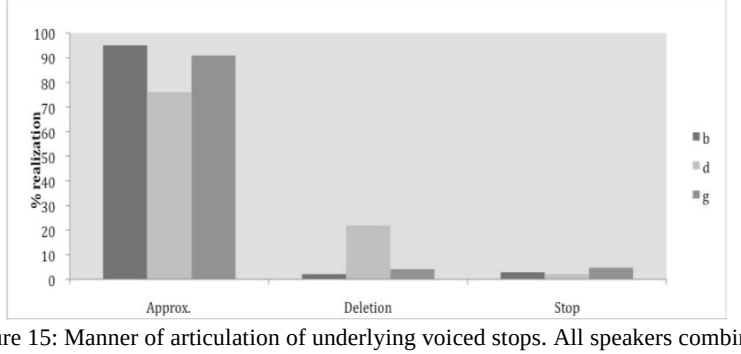

Figure 15: Manner of articulation of underlying voiced stops. All speakers combined

Results displayed in Figure 15 indicate clear place asymmetries. Coronals were deleted at a significantly higher rate (18.4%) than labials and velars (4.1% and 4.6%, respectively), as indicated by the results of a Cochran-Mantel-Haenszel test (row-mean scores = 930.6; p<0.0001). As concerns the second variable, namely, the effect of the flanking vowels, there was no significant overall effect of the

preceding vowel on the rate of deletion of each of the voiced consonants (see Figure 16). However, /d/ had a higher rate of deletion when preceded by [a, e].

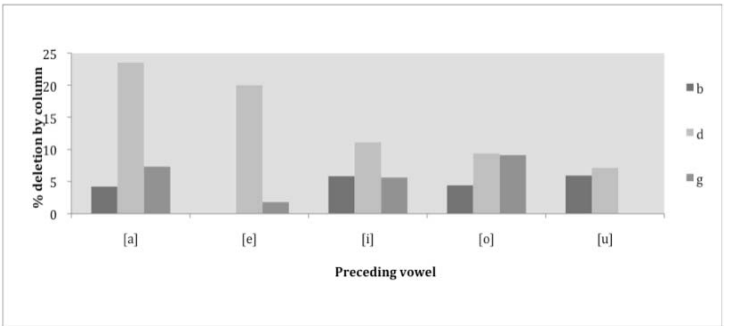

Figure 16: Percentage of deletion according to preceding vowel. All speakers combined

The following vowel did not affect equally the rate of deletion of each of the voiced consonants (Figure 17). /d/ showed the highest rates of deletion when followed by [o], whereas labials and velars were deleted more frequently when followed by both back vowels.

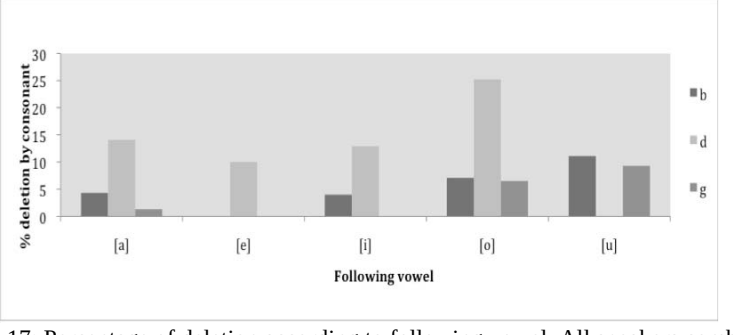

Figure 17: Percentage of deletion according to following vowel. All speakers combined

Finally, Figure 18 presents the results for 'stress'. As shown, deletion was overall more frequent in unstressed syllables, but this frequency was only significantly higher for /d/ ($\chi 2_{(4,283)}$=19.7; p=0.0016).

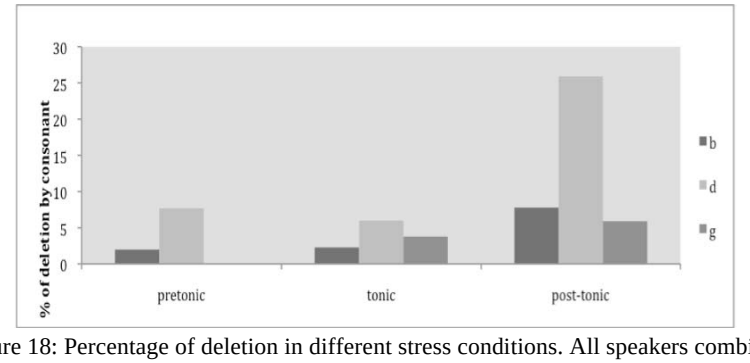

Figure 18: Percentage of deletion in different stress conditions. All speakers combined

In summary, the variables affecting deletion were similar to those affecting lenition in general. Stress played the most significant role in promoting deletion; the rate of deletion was higher in post-tonic syllables, and this was particularly true for /d/. There was a clear place asymmetry in the deletion

patterns; coronals deleted the most. As concerns the flanking vowels, /d/ deleted the most when preceded by [a,e] and followed by [o]. This latter result is consistent with those obtained in previous studies that had observed a high frequency of deletion in past participles (e.g. Bybee, 2001). In particular, Bybee attributes this pattern to the relatively high frequency of past participles, ending in –*ado*. Although we do not deny the role of either token or type frequency, we believe, as we will argue in §7, that the highest rate of deletion in this sequence is the result of specific coarticulatory patterns. Indeed, alveolars are relatively unconstricted segments and are affected by anticipatory and carry-over effects more than labials or velars (Recasens, 2007: 32).

6. Hypotheses evaluation

The results presented here offered no support for Hypothesis A. In these varieties of Argentine Spanish, there is no correlation between the lenition of voiced and of voiceless stops. In addition, we found no support for the velar asymmetry (e.g. Escure, 1977; Wireback, 1997); i.e. in these varieties velars do not weaken first. Our results only confirmed, in part, the deletion hierarchy proposed; namely coronals deleted more.

The general prediction derived from Hypothesis B was not supported by our results either. Voiceless stops did not show any clear signs of lenition. However, in order to determine whether our results disproved Hypothesis B, we would need to both define 'effort' more precisely and to find clear metrics to quantify it (see Kingston, 2008: 2-4). For example, if 'effort' were defined on aerodynamic terms, as opposed to on constriction terms, the patterns observed here would not be surprising. Indeed, voiceless stops are optimal stops in aerodynamic terms (e.g. Kohler, 1994; Recasens, 2002). Additionally, the general prediction about the role of articulatory effort results in specific prediction about effort in a given vocalic context. As mentioned, proponents of this hypothesis suggest that a higher rate of lenition is expected when more open vowels precede and follow the target consonant. As such, effort is mostly interpreted in terms of the vertical displacement of the articulators. As we mentioned, our results were not always consistent with the specific predictions derived from Hypothesis B. Some findings were indeed consistent; specifically, we found no evidence that a high vowel preceding the consonant would favor lenition. We also found that /d/ deleted at a higher rate when preceded by the vowel [a]. However, some results were inconsistent with the predictions derived from this hypothesis. For example, a lower CV intensity-ratio was observed for voiceless stops followed by [i]. As for voiced stops, a following [a] did not always promote lenition.

The third hypothesis, Hypothesis C, was partially confirmed by our results. As predicted by this hypothesis, lenition was not consistently promoted by more open flanking vowels, as the effort-based hypothesis would predict. Also, as predicted by Hypothesis C, voiced stops lenited the most. However, against the predictions of Hypothesis C, we observed some effect of the flanking vowels in the direction predicted by Hypothesis B. We also showed that there were clear place asymmetries that are not predicted by this hypothesis.

7. Discussion

7.1. Lenition patterns in Argentine Spanish

Table 1 summarizes our findings for each of the parameters studied and compares our results against those obtained by Lavoie (2001). As shown, our results were consistent with previous studies on other Spanish varieties, especially in what concerns lenition patterns of voiced stops. As previously observed, we found a clear place asymmetry in the lenition of voiced stops. Coronals showed a high percentage of lenition, were relatively short in duration and showed a wide constriction. As per voiceless stops, our results showed some differences with Lavoie's findings, in particular referring to duration. Duration, however, was not normalized in our study. As such, we only interpret durational differences as indicative of lenition, but not as the main phonetic correlate of the process. Against other previous studies (e.g. Lewis, 2001; Martínez Celdrán, 2008), however we found no clear signs of lenition of voiceless stops.

Parameter	+ lenition…….. – lenition
Manner	• /p,k/ /t/, categorically realized as stop ☑
	• /d b g/ ☑
Duration	• /p t k/ ☒
	• /d/ /b g/ ☑
Relative Intensity	• /p t/ /k/ ☑
	• /d/ /b/ /g/ ☑

Table 1: Comparison of present results against Lavoie's (2001) results. Similar results are marked with ☑, and differences are marked with ☒

Thus, it can be said that in theses varieties of Argentine Spanish we have a clear difference in the lenition patterns of voiced and voiceless stops. Although voiceless stops show very little signs of weakening, labials seem to lenite the most. This is indeed consistent with Lavoie's (2001) and Lewis's (2001) findings. However, the initial signs of weakening observed in voiceless labials are not consistent with the weakening hierarchy proposed by Escure's (1977) or with some diachronic accounts of weakening of voiceless stops (e.g. Wireback, 1997). As for voiced stops, coronals lenite the most. This finding is, again, consistent with both Lavoie's (2001) previous results and the diachronic tendency observed in the evolution from Latin to Romance (e.g. Wireback, 1997; Recasens, 2002; Sánchez Miret, 2007).

7.2. Lenition patterns in Romance

If we try to place now our findings in the evolution of stop consonants from Latin to Romance, we conclude that in these Argentine varieties as well as in Romance varieties more generally, there is a clear asymmetry in the evolution of voiceless and voiced stops. From Latin to Romance, voiceless stops had a fairly consistent evolution across varieties; namely either they were all maintained (e.g. standard Italian) or they were all voiced (e.g. Castilian, Portuguese). In addition, in the evolution from Latin to Romance, even if velar asymmetries were sometimes present at different stages, they are not apparent in the inventories of most Romance varieties. Indeed, there are no clear examples of Romance varieties that show weakening of velars, without showing weakening either labials, alveolars or both (see Sánchez Miret, 2007:240).

On the other hand, the evolution of voiced stops showed more variation across Romance varieties. In some varieties, such as Italian or Romanian, alveolars and velars were maintained. In other varieties, such as Castilian, they were approximantized. Finally, in another group of varieties, labials underwent fricativization but coronals and velars were deleted (e.g. French).

It is important to keep in mind, however, that Latin had also a system of geminate voiceless stops that was either maintained, as in some Italo-Romance varieties, or that resulted in a series of singleton voiceless stops, as in most Romance varieties. Varieties that kept the geminates (e.g. Italian), also maintained the Latin singleton voiceless stops and for the most part, they also retained the Latin voiced stops. As such, the role that the system plays in lenition should be further explored. We sketch some hypotheses in the following section.

7.3. Phonetics and phonological factors that account for lenition

To conclude our discussion, we propose that phonological and phonetic factors should be taken into account in models of lenition. Among the phonological factors, the size of the inventory plays a crucial role. In systems with a three-way length contrast, such as Classical Latin, or the Italo-Romance varieties studied by Kirchner (2004), there seems to be evidence supporting Hypotheses A & B.[4] Indeed, in the evolution from Latin to some Romance varieties, such as Castilian or Portuguese, geminates became singletons, and singleton voiceless stops became voiced. However, in systems with

[4] As for Hypothesis B, this applies at least to the effort-hierarchy.

a two-way contrast, such as the one attested nowadays in most Spanish varieties, lenition is affecting only the weakest or more lenited variants, i.e. the surface realization of voiced stops.

As for the phonetic factors, we found evidence supporting the importance of both perceptual and articulatory variables. Indeed, we found less lenition in perceptually prominent positions such as stressed syllables (see Ohala & Kawasaki, 1984; Wright, 2004). Additionally, we have also suggested that perceptual factors are not enough to account for the patterns observed in Argentine Spanish. In particular, the clear coronal asymmetry observed cannot be explained by such factors. However, this asymmetry can be explained if we take into account the predictions of models of coarticulation, such as the DAC model (Recasens, Pallarès & Fontdevila, 1997), which is based on the assumption that the size and direction of coarticulatory patterns vary according to the articulatory requirements involved in the production of different vowels and consonants (Recasens, 2007). Thus, different coarticulatory patterns are predicted for different places and manners of articulation and for different preceding and following vowels. Specifically, anticipatory and carryover effects in VC and CV sequences should be larger for alveolars than for labials, given the tongue involvement in the production of the former, which is absent in the latter. Moreover, this model also predicts that a vowel like [a] exerts more anticipatory and carryover effects on alveolars than high vowels (Recasens, 2007:32). If alveolars are more sensitive to effect of flanking vowels, we expect more weakening in intervocalic position, including more deletion with mid and low vowels. Thus, it is not only the degree of vertical displacement of the articulators that should be taken into account when predicting the degree of lenition, as the Hypothesis B seems to suggests, but also the different patters of tongue-coarticulation as suggested by Cole et al. (1999).

8. Conclusion

This work was conceived as a contribution to recent experimental and theoretical work on lenition. It contributed to recent experimental work by exploring some acoustic correlates of lenition in Argentine Spanish, in particular the relative CV intensity-ratio, duration and percentage voicing. Building up on previous work, we showed that that there are clear place asymmetries in lenition, and that stress plays a role in blocking lenition. Against previous works, however, we found no evidence of lenition of voiceless stops in these varieties. As concerns the theoretical approaches to lenition, this work was primarily inspired by John Kingston's presentation at the third edition of the Conference on Spanish Laboratory Phonology (Kingston, 2008). Thus, we explored further the perceptual and articulatory motivations that may promote lenition. We found some support for perceptual accounts of lenition but we also found a more complex picture that points out to the need of integrating articulatory constraints into a model of lenition. In particular, we have presented evidence supporting the role of tongue-coarticulation, as opposed to constriction degree, in accounting for lenition in these Argentine Spanish varieties.

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