Unstressed Vowel Reduction in Andean Spanish

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1. Introduction

A continuum of vowel weakening processes ranging from shortening and devoicing to elision commonly referred to as unstressed vowel reduction (UVR) is a salient characteristic of two Spanish speaking regions: the Andean highlands and the central and northern areas of Mexico (Lipski 1990). To date, Spanish UVR has been described in only a limited number of studies: four investigations examine the process in dialects of the central plateau region of Mexico (Boyd-Bowman 1952, Canellada & Zamora Vicente 1960, Lope Blanch 1963, Matluck 1952) while three focus on the characteristics of UVR in different zones of the Andes (Gordon 1980 on Bolivia, Hundley 1983, 1986 on Cusco, Peru and Lipski 1990 on Ecuador). Several of these (Boyd-Bowman, Canellada & Zamora Vicente, and Matluck) are impressionistic reports primarily based on examples obtained through the informal observation of speech in everyday contexts. Others (Gordon 1980, Lipski 1990) offer very brief and general descriptions of the phenomenon or present data collected from a small group of informants (Hundley 1983). In reality, Lope Blanch's work on UVR in the Spanish of Mexico City is the only study that provides detailed information about the process, including descriptions of different degrees of vowel reduction as well as quantitative data regarding the relative frequency of UVR in various consonantal contexts. However, as Lope Blanch did not have access to spectrography, his results await confirmation by acoustic analysis and Spanish UVR thus invites further, instrumentally based investigation. More information is needed about Andean Spanish in particular although, as will be indicated in Section 2, Spanish UVR appears to be a relatively homogeneous process, exhibiting the same basic characteristics in Mexico and the Andes.

The present study provides a detailed description of unstressed vowel reduction in the Spanish of Cusco, a mid-sized city located in the Southern Peruvian Andes. The phonetic results of the process are delineated based on spectrographic analysis and the contexts in which UVR is most likely to occur are specified, including vowels typically affected as well as the consonantal and prosodic environments most conducive to reduction. A potential explanation of these results within the framework of Articulatory Phonology (Browman & Goldstein 1989 et seq) is also explored.

The remainder of this paper is organized as follows. Section 2 reviews the findings of previous studies on Spanish UVR, Section 3 describes the methods employed in the current study and findings are reported in Section 4. Section 5 discusses the results, comparing unstressed vowel reduction in Andean Spanish to cross-linguistic trends in vowel devoicing and also provides an analysis of Andean UVR in terms of gestural overlap. Section 6 summarizes major findings and concludes.

2. Results of previous studies on Spanish UVR

Despite their limitations, previous studies on both Mexican and Andean UVR do show substantial agreement with regard to several features of the process, including its gradient effects and variable occurrence, its tendency to target the mid-vowels /e/ and /o/ adjacent to /s/ and its association with word-final syllables. These observations will guide the present study of UVR which seeks to verify their accuracy.

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*Acknowledgements: Many thanks to Travis Bradley and two anonymous reviewers whose comments helped to greatly improve this paper. I am solely responsible for any remaining flaws, inaccuracies or otherwise objectionable content.

2.1. Gradience

All studies emphasize the variable nature of UVR, reporting that affected unstressed vowels can exhibit reduced duration, weakened voicing, complete devoicing and, in the most extreme cases, appear to be deleted. Deletion is the only controversial category among UVR's purported range of effects; Canellada and Zamora Vicente as well as Hundley assume that vowels are sometimes completely elided and argue that novel consonant clusters which violate the phonotactic rules of Spanish result from such deletion. Lope Blanch, on the other hand, emphasizes the subjectivity involved in attempting to distinguish between complete deletion and extreme reduction by ear and contends that brief, transitional vocalic elements are present even in cases of apparent elision. Lipski notes that even if vowels are sometimes actually deleted in production they must be retained in the underlying representation as consonants that would be placed in the rhyme by the elision of unstressed vowels do not undergo the weakening and assimilatory processes they would be expected to exhibit in coda position.

Although descriptions of weakened voicing and devoicing predominate in characterizations of UVR, several authors do employ terms suggestive of quality changes. For example, Matluck (p.13) states that unstressed vowels may become *reducida* 'reduced' and *relajada* 'relaxed' in Mexican Spanish. Canellada and Zamora Vicente (p.228) also use the term *relajación* 'relaxation' and Lipski mentions "centralization" (p.1) as a potential though not especially common outcome of UVR. These comments raise questions regarding the nature of Spanish UVR; could it more accurately be termed vowel devoicing or are quality changes also a significant part of the process?

2.2. Variation

Previous studies characterize UVR as a process that is subject to considerable inter and intra-personal variation. Not all speakers of the dialects characterized as exhibiting UVR actually reduce unstressed vowels. Both Lope Blanch and Gordon found vowel reduction in the speech of approximately half their informants. Moreover, those whose speech is characterized by UVR reduce vowels occasionally and inconsistently, with particular vowels being affected in some productions of a word but not in others. For example, Lope Blanch reports that one of his informants devoiced the final vowel in *tesis* 'thesis' in one sentence but pronounced the word with a fully voiced vowel several seconds later in the following utterance.

2.3. Target vowels

The mid-vowels /e/ and /o/ are consistently mentioned as the primary targets of UVR. Lope Blanch found that /e/ was the vowel most likely to undergo UVR in his study on Mexico City Spanish, accounting for 42% of reduced tokens in his sample. Gordon and Hundley report similar results for Andean varieties. Only Lipski observes that the vowels targeted by UVR differ according to word position: he notes that /e/ and the high vowels were the most common targets word-internally while /e/ was the vowel most frequently affected in word-final position.

2.4. Consonantal context: the role of /s/

All previous studies note that UVR most frequently affects unstressed vowels that are adjacent to voiceless consonants. They also unanimously associate UVR with one voiceless consonant in particular, the alveolar sibilant /s/. Boyd-Bowman suggests that the Mexican /s/ is produced with particularly strong frication that sometimes overwhelms nearby unstressed vowels. Lope Blanch also emphasizes the role of /s/ in UVR, claiming that 90% of the reductions in his data occurred next to this phoneme. However, this result is undoubtedly due in part to his decision to include the very frequent filler words *pues* 'well then' and *entonces* 'then', which were often pronounced as [ps] and [tons], in his sample.

There is some disagreement regarding the relative configuration of unstressed vowels and /s/ most likely to induce reduction. Lope Blanch finds that unstressed vowels followed by /s/ show a stronger tendency to undergo UVR. Hundley reports that, in the data he collected in the Peruvian Andes, unstressed vowels were just as likely to be reduced by a preceding /s/ as a following /s/. This discrepancy might also be due to Hundley's decision to exclude the fillers *pues* and *entonces* as tokens from his reduction counts. However, it might also indicate one point of divergence between Mexican and Andean UVR.

2.5. Word position

All previous research identifies word-final syllables ending in /s/ as the most common locus for UVR. As the majority of Spanish word-final syllables are also post-tonic syllables due to the preponderance of paroxytones in the lexicon (Nuñez Cedeño & Morales Front 1999) and as word-final /s/ is often part of the plural morpheme, multiple factors potentially condition the strong tendency to reduce unstressed vowels in this environment. Not surprisingly, there is disagreement as to which factor is primarily responsible for UVR in word-final position, with some (Boyd-Bowman and Lope Blanch) attributing this pattern to the presence of /s/ and others (Canellada & Zamora Vicente, Matluck) arguing for the importance of post-tonic position. Lipski suggests that the effect is due in part to the predictability of plural morphemes and the first person plural verbal affix *mos*. No study presents conclusive evidence in support of any of these hypotheses.

2.6. Speech rate

There is some indication that UVR, especially deletion, is more likely to occur in fast speech. Boyd-Bowman (p.139) states that UVR is most common in *el habla rápida y nerviosa* 'rapid, nervous speech' and that the complete elision of unstressed vowels is typical only in the fast speech of residents of the Mexican Central Plateau. Canellada and Zamora Vicente also note that unstressed vowels which seem to be deleted in rapid speech are usually restored in slow, careful speech.

Hundley's study on Andean Spanish provides the only quantitative data available regarding the relationship between rate and UVR. Following Lehiste's (1970) description of 4.4 to 5.9 syllables per second as an average or neutral speech rate, he defined slow speech as 4.0 to 4.4 syllables per second and fast speech as 6.0 to 6.4 syllables per second. Twenty-nine slow and twenty-three fast five-second intervals of speech which he describes as containing one or two pauses were selected from the recordings of three subjects containing a total of 216 vowels. The results support the claim that UVR occurs more frequently in fast speech. However, as Hundley does not state how pauses affected his rate calculations and a relatively limited amount of data was analyzed, this finding must be considered preliminary.

3. Methods

3.1. Informants

The present study is based on an analysis of the unstressed vowels in ten-minute-long samples of conversational speech selected from individual interviews with 16 residents of Cusco, Peru. These informants are part of a group of 180 participants in a larger project designed to examine the sociolinguistic correlates of UVR in Cusco Spanish. Their interviews were chosen for use in this study because they exhibit the highest rates of unstressed vowel reduction in the total sample and were therefore likely to yield a large corpus of reduced tokens that could be used to formulate a thorough description of the phenomenon.[1]

The age, gender and language background of the informants whose speech was analyzed are presented in Table 1. The inclusion of only two women in this group of "frequent vowel reducers"

[1] Based on the spectrographic analysis of 120 interviews, it appears that the UVR encountered in the speech of "frequent vowel reducers" such as the 16 subjects discussed here and the unstressed vowel reduction found in the speech of those who less frequently exhibit the effect possess essentially the same characteristics. Thus, it is assumed at this point that the descriptions contained in this paper hold true for Cusco UVR in general and not just for "frequent vowel reducers". This assumption will be evaluated empirically when all data have been examined.

reflects the strong association of UVR with male speech evident in the larger sample of 180 persons while the preponderance of subjects over the age of fifty represents the high rate of occurrence of UVR in the speech of older individuals.[2] The fact that 9 of these informants speak both Quechua and Spanish is indicative of the prevalence of bilingualism in Cusco. It should be noted, however, that great care was taken to avoid including individuals who spoke Spanish as a second language in this study. Informants were questioned extensively about their language background and those who reported that they had not learned to speak primarily in Spanish were excluded from the sample.

Subject	Age	Gender	Language Background	Subject	Age	Gender	Language Background
1	78	M	Spanish/Quechua	9	70	M	Spanish/Quechua
2	42	M	Spanish/Quechua	10	75	M	Spanish
3	24	M	Spanish	11	74	M	Spanish
4	90	M	Spanish/Quechua	12	55	M	Spanish/Quechua
5	64	M	Spanish	13	34	M	Spanish
6	43	F	Spanish	14	65	M	Spanish/Quechua
7	41	F	Spanish/Quechua	15	44	M	Spanish/Quechua
8	53	M	Spanish	16	45	M	Spanish/Quechua

Table 1. Informant characteristics.

3.2. Data collection

Informants were told that the researcher was conducting a study on attitudes toward the Quechua language in the city of Cusco and interviewing a large number of people representing a range of ages and occupations. The actual purpose of the interviews was not mentioned as the knowledge that their speech was being evaluated would most likely have caused participants to speak in their most formal and standard register. Quechua was chosen as a "cover" topic for two reasons. Firstly, when several possible topics were piloted before the study actually began this subject elicited the most interest and greatest amount of conversation from Cusco residents, probably as a result of current strong, widespread enthusiasm for the recovery and revitalization of Andean culture in the area. Secondly, the topic facilitated in depth questioning about informants' language background that was used to determine whether or not Spanish was their first language. Interviews lasted a minimum of thirty minutes with approximately the first 10 minutes being devoted to collection of demographic information. During the rest of the time, the researcher asked a series of open-ended questions that required subjects to express opinions and recount personal anecdotes. Whenever possible, subjects were encouraged to digress and discuss other topics of interest to them in order to generate a larger sample of more spontaneous speech. Interviews were generally conducted at informants' homes or places of business in a quiet environment and recorded on a Sony MZ-RH910 mini disc recorder with a Sony ECM-MS907 unidirectional microphone. They were subsequently digitized at 22,050 Hz and 16 bit.

3.3. Data analysis

Ten-minute sections of recordings were chosen from the middle or later parts of the interviews when subjects were answering open-ended questions and had, hopefully, become accustomed to the interview situation and presence of a recording device. Spectrographic analysis of the selected speech samples was conducted using SIL Speech Analyzer software, version 2.

Of a total of 16,581 unstressed vowels in the sample, 1,648 (9.9%) were identified as reduced. The high frequency filler words *pues* 'well', *entonces* 'then' and *digamos* 'let's say' which are typically

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[2] Potential older potential participants who lacked intact dentition, displayed voice quality problems or suffered from obvious respiratory difficulties were excluded from the study in order to avoid potential confusion of the effects of these conditions on articulation and the strength of vowel voicing with actual UVR.

reduced to [ps:], [tons:] and [ms:] in this dialect, were not included in the sample in order to avoid overestimating the frequency of reduction in the contexts [p_s], [s_s] and [m_s]. In an additional attempt to limit the potential biasing of the sample by frequent words, only the first three occurrences of any word in an individual subject's sample were included in the corpus (Wolfram 1993).

Spectrographic analysis of the unstressed vowels in the current sample confirmed previous observations that UVR is a gradient and variable phenomenon, producing a range of phonetic outcomes and occurring on an occasional and inconsistent basis. Affected tokens were divided into several groups which are intended to serve a heuristic function, arranging them along a continuum of reduction for descriptive purposes. It is in no way implied that they constitute mutually exclusive categories. Following criteria employed in several previous studies on vowel devoicing (Cedergren 1986, Dauer 1980, Jun et al. 1997), vowels were labeled as partially devoiced/shortened when the length of their voice bar was 30ms or less as with the /u/ of *los escuchaba* (Figure 1b). Vowels like the /e/ in Figure 1b with a slightly longer but faint voice bar and lacking clear formant structure were classified as "weakly voiced". In cases such as Figure 1a where no glottal tone was present but some energy could be observed in the first and second formants and the syllable did not appear to be temporally reduced, vowels were considered "completely devoiced".

(a) (b)

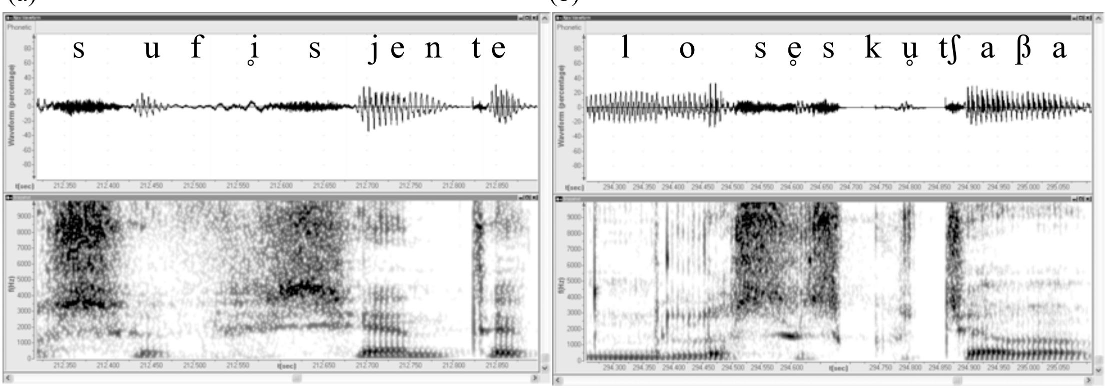

Figure 1. (a) Complete devoicing of /i/ in *suficiente* 'sufficient'; (b) Weakened voicing of /e/ and partial devoicing/shortening of /u/ in *los escuchaba* 'listened to them'.

(a) (b)

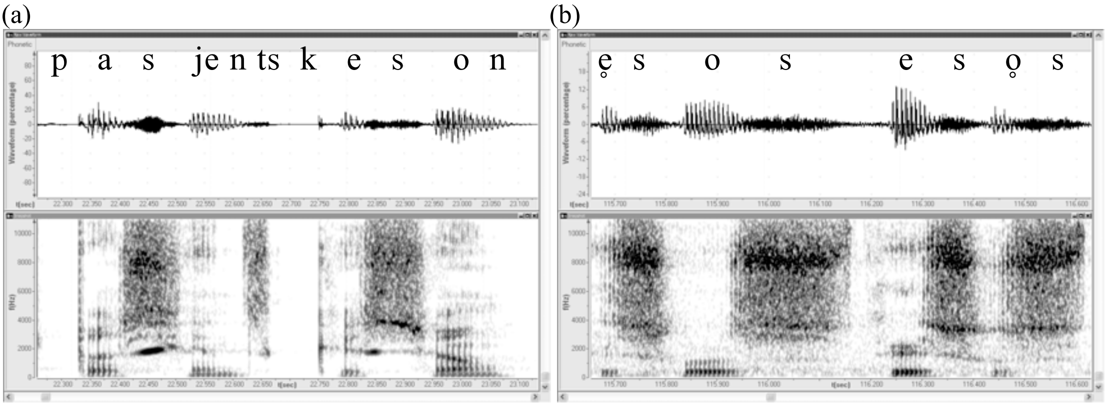

Figure 2. (a) Apparent elision of /e/ in *pacientes* 'patients'; (b) Devoicing of /e/ in the first token of *esos* 'those' and devoicing of /o/ the subsequent production of the same word.

When neither formants nor voice bar were present and the syllable did seem to be shortened as in the final syllable of *pacientes* 'patients'(Figure 2a), vowels were classified as "apparently elided". This designation reflects the tentative status of vowel deletion as a category in a study based exclusively on acoustic data. Although spectrographic evidence seems to point in the direction of deletion, only techniques providing information about movements of the articulators which were not available for this study could distinguish between a combination of severe shortening of articulatory trajectories and devoicing versus actual deletion of vocalic segments. In the absence of such evidence, the "apparently deleted" tokens are viewed only as constituting the most extreme point on the devoicing continuum. These data cannot, therefore, contribute to the resolution of the controversy over the phonetic reality of unstressed vowel elision raised by past investigations.

The idiolectal variability observed in unstressed vowel devoicing in this study is exemplified in Figure 2b which shows one informant's successive productions of *esos* 'those'. In the first production, the initial /e/ is devoiced (a rare instance of stressed vowel devoicing) while the /o/ in the final syllable is devoiced in the next pronunciation.

4. Results

4.1. Phonetic characteristics: UVR is gradient, variable unstressed vowel devoicing

A majority (56%) of the 1648 affected tokens identified in the sample fell into the "completely devoiced" category, 25% were classified as weakly voiced, 10% as partially devoiced or shortened and 9% as apparently elided. Given that 65% of "reduced" vowels (devoiced + apparently elided) had no voice bar and virtually no formant structure while only a handful of the weakly voiced and partially voiced/shortened tokens gave the auditory impression of centralization, the label "unstressed vowel reduction" employed in previous studies seems somewhat misleading. Since the "reduced vowels" in this sample actually appear to exhibit varying degrees of devoicing rather than quality changes and previous research also emphasizes the prevalence of devoicing as opposed to centralization in this process, I propose that the phenomenon is more accurately described as "unstressed vowel devoicing" and will use this term in the remainder of the present article.

An anonymous reviewer suggested that the distance between the first and second formants in stressed and unstressed vowels in the sample be compared as a rough empirical test of the claim that unstressed vowel reduction is really predominantly unstressed vowel devoicing rather than centralization. To this end, F1 and F2 were measured in 100 stressed vowels, 100 unstressed, unreduced/fully voiced vowels (20 per each vowel type for both stress conditions) for each subject, yielding a total number of 1600 stressed vowels and 1600 unstressed, unreduced tokens. For each subject, F1 and F2 were also measured in all reduced/devoiced tokens that had sufficient formant structure to allow for such calculations (a total of 361 vowels in the data of all 16 subjects). Formants were measured near the center of the vowels in an attempt to minimize the influence of consonantal context, which obviously could not be held constant in conversational data, using the formant tracking function of SIL Speech Analyzer version 2. The difference between F1 and F2 values for stressed versus unstressed vowels (including the 361 reduced/devoiced tokens) were then compared using an ANOVA with repeated measures for subjects. Results, given in Table 2, indicate that F1-F2 distance did not differ significantly for any of the vowels, thus providing preliminary support for the claim that centralization is not prevalent in Cusco Spanish. Statistical comparison of F1 to F2 distance in unstressed unreduced/devoiced vowels to that occurring in the other classes of tokens was not possible due to the small number of such vowels with measurable formant structure. However, mean distances for unstressed reduced/devoiced vowels are presented in Table 2.

	$\bar{x}$ distance F1 – F2					
	stressed	unstressed, unreduced	unstressed, reduced	F	df	p
/i/	1886 Hz	1864 Hz	1850 Hz	2.16	1,700	.0917
/e/	1537 Hz	1512 Hz	1497 Hz	2.18	1,775	.1402
/a/	931 Hz	916 Hz	900 Hz	1.67	1,659	.1971
/o/	593 Hz	575 Hz	584 Hz	1.75	1,705	.1888
/u/	543 Hz	552 Hz	550 Hz	2.53	1,669	.1124

Table 2. Mean distance F1-F2.

The potential for centralization in Andean unstressed vowels should certainly be reexamined in the future using more controlled speech as numerous factors including flanking consonants, speech rate and position in the intonational phrase may affect F1 and F2 in conversational speech. A more precise measure of centralization should probably also be employed. However, it seems reasonable to conclude for the time being that "unstressed vowel devoicing" is a more appropriate label for the process examined in this study than "unstressed vowel reduction".

4.2. The segmental context of vowel devoicing
4.2.1. Target vowels

When the percentages of devoiced tokens corresponding to each vowel are calculated, the results of the present study appear to agree with previous reports that the mid-vowels /e/ and /o/ are most frequently affected by this process. /e/ accounts for 37% percent of devoiced tokens and /o/ for 26% (See Table 3). However, /e/ is the most frequently-occurring vowel in Spanish and the high vowels, especially /u/, are fairly infrequent (Quilis & Esgueva 1980). It is therefore important to consider devoicing rate, or the number of devoiced tokens of a particular vowel divided by the total number of times it occurs in unstressed syllables, as well as percentages. Table 3 shows that the high vowels and /e/ have the highest devoicing rates in the sample while the rates for /o/ and /a/ are relatively low.

Vowel	Number of Devoiced Tokens	Percentage of Devoiced Tokens	Devoicing Rate
/e/	606	37%	20%
/o/	432	26%	13%
/i/	232	14%	13%
/a/	206	13%	8%
/u/	172	10%	5%

Table 3. Percentage of devoicing and devoicing rates.

Further examination of the data indicates that the vowels most frequently targeted by devoicing vary by word position. As noted previously by Lipski, the high vowels and the front mid-vowel /e/ are often devoiced in word-medial syllables (e.g., [ku̥skéɲa] *Cusqueña* 'Cusqueña beer', [paɾti̥sípa] *participa* 'participates', [aɾte̥sanía] *artesanía* 'crafts') with /o/ and /a/ being affected only to a negligible degree in this context (see Table 3).

Vowel	Devoicing rate	
	Word-Medial	Word-Final
/u/	22%	19%
/i/	13%	20%
/e/	13%	20%
/o/	1.5%	18%
/a/	1%	15%

Table 4. Devoicing rates by word position.

However, his observation that /e/ is most likely to be targeted in word-final syllables is not corroborated. It is the case that sandhi devoicing (1a), in which the voiceless consonant following the devoiced vowel forms the onset of the following word, follows the same pattern as word-medial devoicing, primarily affecting the high vowels and /e/. However, in word-final syllables closed by /s/ (1b), the primary locus for devoicing, and in open, pre-pausal syllables (1c) all vowels are affected at relatively high rates (Table 4).

(1) Devoicing in Word-Final Syllables

a. Sandhi:	[tɾáxe̥ típiko]	*traje típico*	'typical costume'
	[komplétamente̥ korékto]	*completamente correcto*	'completely correct'
	[kási̥ tóðo]	*casi todo*	'almost all'
b. Closed by /s/:	[bjáxe̥s]	*viajes*	'trips'
	[los íŋkḁs]	*los incas*	'the Incas'
	[ésto̥s]	*estos*	'those'
	[kóɾpu̥s kɾísti]	*Corpus Christi*	'Corpus Christi'
	[aɾkoíɾi̥s]	*arcoiris*	'rainbow'
c. Open pre-pausal:	[espesjálmente̥]#	*especialmente*	'especially'
	[gɾamátikḁ]#	*gramática*	'grammar'
	[kúsko̥]#	*Cusco*	'Cusco'
	[ínti̥]#	*Inti*	'god of the sun'

4.2.2. Consonantal context

As noted in previous studies, unstressed vowels are most likely to be devoiced when adjacent to voiceless consonants, particularly the voiceless sibilant /s/. However, the claim that virtually all devoicing affects vowels flanked by an /s/ is not born out. In contrast to Lope Blanch's finding that 90% of reduction (devoicing) occurred next to an /s/, only 69% of devoiced tokens are contiguous with /s/ in the current study. Devoicing also occurs adjacent to the voiceless stops /p t k/, the affricate /tʃ/, the cluster [tř̥] which frequently forms an affricate in Andean Spanish, the other fricatives /x/ and /f/ and the voiceless assibilated rhotic /ř̥/ that often occurs in this dialect (See Table 5). As 83% of devoicing occurs between two voiceless consonants and 14% affects unstressed vowels that follow voiceless consonants and precede a pause, it can be concluded that devoicing is limited to contexts in which voicelessness predominates and that both preceding and following contexts contribute to the process. Thus, devoicing cannot be entirely attributed to the presence of the voiceless sibilant /s/ on one side of the target vowel.

Consonant		Devoicing Rate	
		C_	_C
Affricates	tʃ	18%	15%
	tř̥	61%	16%
Stops	p	9%	8%
	t	27%	17%
	k	16%	15%
Fricatives	s	28%	26%
	f	25%	13%
	x	29%	14%
	ř̥	37%	16%

Table 5. The consonantal context of devoicing.

The position of /s/ relative to an unstressed vowel did not appear to affect the probability of devoicing; 28% percent of unstressed vowels were devoiced when preceded by an /s/ while 26% were devoiced when followed by an /s/. Not surprisingly, these results agree with those obtained by Hundley (1983) who also collected data in Cusco and omitted *pues* and *entonces* from his reductions counts. Moreover, as in the case of Hundley's findings, the discrepancy between these percentages and those obtained by Lope Blanch (1963) in Mexico City based on a sample that includes *pues* and *entonces* might indicate a difference between reduction contexts in two dialects or simply follow from the decision to exclude filler words from the sample. In any case, it can be said that /s/ is the only voiceless consonant in this sample that is as likely to devoice a preceding unstressed vowel as a following one.

While the likelihood of devoicing does not increase when an unstressed vowel is followed rather than preceded by /s/, a close inspection of the data does reveal an unexpected effect of the syllabic affiliation of a following /s/ on devoicing rate. Unstressed vowels show a much stronger tendency to devoice when followed by a tautosyllabic (i.e. coda) /s/ than when followed by an /s/ that forms the onset of the next syllable. This difference between devoicing rates occurs both word-medially (2a) and word-finally where a final /s/ may become the onset of a following vowel-initial word (2b). Chi square tests shown in Table 6 indicate that the effect is statistically significant in both cases ($\chi^2 = 5.25$, $p<.05$, df = 1, n= 1088 for medial tokens and $\chi^2 = 5.81$, $p<.05$, df = 1, n= 1742 for word-final position).

(2)	a.	/s/ in coda	[ek.si̥s.tíɾ]	*existir*	'to exist'
		/s/ in onset	[pɾo.fe.sóɾ]	*professor*	'teacher'
	b.	/s/ in coda	[kwán.tḁs.pa.lá.bɾas]	*cuantas palabras*	'how many words'
		/s/ in onset	[kó.sa.sin.te.ɾe.sán.tes]	*cosas interesantes*	'interesting things'

	Position in Word			
	Medial		Final	
Syllabic Affiliation of /s/	Devoiced Vowels	Voiced Vowels	Devoiced Vowels	Voiced Vowels
Following /s/ in coda	197 (42%)	271 (58%)	495 (40%)	742 (60%)
Following /s/ in onset	74 (12%)	546 (88%)	56 (11%)	449 (895)

Table 6. Percentage vowel devoicing by position of /s/ and position in word.

4.3. Prosodic domains
4.3.1. Word position

As reported in previous studies, devoicing is much more common in word-final position than word-medially or initially, and accounts for 60% of devoicing in the sample. Devoicing also tends to be more severe in word-final position with a higher percentage of affected tokens in this context being classified as "completely devoiced" or "apparently deleted" rather than "partially voiced/shortened" and "weakly voiced".

In word-initial syllables, only 5% of unstressed vowels exhibit any type of devoicing. Of these, 48% percent were judged to be either completely devoiced or apparently elided while 52% were assigned to the categories "partially voiced/shortened" and "weakly voiced". Sixteen percent of all devoiced tokens in the sample are located in unstressed vowels in word-initial syllables.

Nine percent of unstressed vowels in word-medial syllables were devoiced, with 60% falling into the "completely devoiced" and "apparently deleted" categories. Devoicing in word-medial position accounts for 24% of all devoiced tokens in the sample.

Three distinct patterns of devoicing are observed in word-final syllables: sandhi devoicing, devoicing in open, pre-pausal syllables and devoicing in final-syllables closed by /s/. Sandhi devoicing exhibits the same patterns found in word-medial syllables; 9% of unstressed vowels are devoiced in sandhi and 53% of the affected tokens were rated as completely devoiced or apparently elided. As mentioned in Section 2.3, only the high vowels and /e/ are devoiced to an appreciable extent in word internal syllables and in sandhi. This context accounts for 13% of all devoiced tokens in the sample. Thirteen percent of unstressed vowels in word-final, open, pre-pausal syllables are devoiced. Most devoicing is severe in this context, with 87 % being classified as completely devoiced or apparently deleted. This environment produced 14% of all devoiced tokens in the sample. In word-final syllables closed by /s/, 22% of unstressed vowels are devoiced and this context accounts for one third of all devoiced tokens. Seventy-six percent of affected vowels were classified as completely devoiced or apparently elided.

4.3.2. Larger prosodic domains

The effects of intonational phrase and utterance boundaries on devoicing were also examined. Intonational phrases were identified by the presence of boundary tones in the waveform portion of spectrographic displays and, optionally, shorter pauses. Long pauses, the ends of conversational turns and topic shifts were used to demarcate utterances. Generally, higher devoicing rates were found at the edges of these larger prosodic domains than at word boundaries.

When word-initial syllables were the first elements of intonational phrases or utterances, unstressed vowels were more frequently devoiced and also were more often classified as either completely devoiced or apparently deleted. Twelve percent of word-initial syllables that were also intonational phrase-initial contained devoiced vowels while 15% of utterance-initial syllables exhibited devoicing.

The three word-final contexts interacted differently with the final position in larger prosodic constituents. As sandhi devoicing requires close juncture between words, this process naturally never occurred in intonational phrase or utterance-final position. Open, pre-pausal word-final syllables, on the other hand, were necessarily in the final position of either intonational phrases or utterances. The devoicing rate in this type of word-final syllable increased in utterance-final position (21%) versus intonational phrase-final position (13%). The percentage of devoiced vowels in word-final syllables closed by /s/ was inversely related to the final position in larger prosodic domains. The devoicing rate in this context decreased from 22% to 17% in intonational phrase-final position. In utterance-final position, the rate dropped even further to 15%.

4.4. Speech rate

Given the lack of consensus regarding measurements of the rate of conversational speech (Laver 1993), strong claims about the relationship between unstressed vowel devoicing and speech velocity in Andean Spanish cannot be made using the speech samples collected for this study. However, these data do at least suggest that the devoicing process is not strongly correlated with fast speech. Devoicing was commonly observed in very slow speech during these interviews, even at rates between 2 and 3 syllables per second which are far below the 4.4 to 5.9 syllables per second described as average rate by Lehiste (1970). Furthermore, an examination of the relationship between speech rate in syllables per second in 560 intonation phrases (35 for each of the 16 informants, reflecting a range of speech velocity for each person) and the percentage of unstressed vowels devoiced yielded a Pearson Product Moment correlation coefficient of -.078, suggesting little relationship between rate and devoicing.

In a study on vowel devoicing in Greek, Dauer (1980) noted large differences between the speeds at which individual subjects spoke and found that when standard speech rates were used for comparison, vowel devoicing showed no relationship with speech velocity. However, when samples corresponding to the slow and fast rates for each individual speaker were contrasted, a definite tendency for vowel devoicing to occur in more rapid speech emerged. The same approach was applied to the current data set and considerable differences between subjects' habitual speaking rates were observed. However, as the largest positive correlation coefficient obtained for the relationship between an individual informant's speech rate and percentage of unstressed vowel devoicing was .28, it cannot be said that these calculations revealed a significant degree of rate dependence for vowel devoicing in Andean Spanish.

In the future, the effect of speech rate on vowel devoicing in this dialect should be tested using controlled speech samples, such as a word list reading, the type of task that has most often been used to study the rate dependence of vowel devoicing in other languages.

5. Discussion

5.1. Comparison with vowel devoicing patterns in other languages

The recognition that unstressed vowel reduction in Andean Spanish is primarily unstressed vowel devoicing invites comparison with other languages in which the same type of devoicing process occurs. These include Japanese (Beckman & Shoji 1984, Fujmoto et al 2002, Tsuchida 1997, Varden 1999, inter alia), Korean (Jun & Beckman 1993, Jun, Beckman & Lee 1998, Jun, Beckman, Niimi & Tiede 1997), Greek (Arvaniti 1994, Dauer 1980), Montreal French (Cedergren 1985, 1986) and Turkish (Jannedy 1995). Gordon (1998) presents information about vowel devoicing in a number of less-frequently-studied languages.

As in Andean Spanish, vowel devoicing in other languages is described as a variable and gradient process affecting vowels located next to voiceless consonants. Voiceless consonants produced with particularly large glottal openings or with glottal opening gestures timed to occur near an adjacent vowel are most likely to be associated with devoicing. For example, Jun et al (1997) report that Korean aspirated word-initial stops as well as fricatives, both of which have especially large and late-occurring glottal opening gestures, show a stronger tendency to devoice following vowels than other voiceless consonants. Devoicing in Andean Spanish also seems to reflect the glottal opening patterns of voiceless consonants; devoicing more commonly affects the vowels that follow voiceless stops and affricates rather than vowels that precede them (see Table 5), as would be expected given that the peak opening of these consonants occurs at the release of their oral closure. As the glottal opening gestures of fricatives usually occur simultaneously with the formation of their oral constrictions (Silverman 1997), following vowels would be most likely to be devoiced by the egressive airflow of these sounds as appears to be the case for the fricatives /f/, /x/ and /ř̥/ which are all associated with more devoicing of following versus preceding vowels. The approximately equivalent devoicing rates of vowels preceded and followed by an /s/ require further explanation.

The frequent devoicing of non-high vowels in Andean Spanish represents a significant departure from cross-linguistic trends as the process targets high vowels almost exclusively in other languages (Gordon 1998). High vowels are thought to be most vulnerable to devoicing as a result of two articulatory characteristics, their limited duration and the relatively high tongue position involved in their production. Because high vowels are inherently shorter than low or mid-vowels (Lehiste 1970), there is a greater probability that the glottal abductions of adjacent voiceless consonants will prevent full realization of the glottal adduction required for their voicing. Also, as noted by Jaeger (1978), the relatively close oral constriction associated with the high vowels raises air pressure in the oral cavity and thus has an inhibitory effect on transglottal airflow, making these vowels more susceptible to devoicing than those produced with lower tongue positions. In addition, research on Japanese high vowel devoicing suggests that perceptual factors may reinforce the tendency to devoice high vowels bordered by fricatives. Beckman and Shoji (1984) and Tsuchida (1994) found that the acoustic cues produced by the coarticulation of devoiced high vowels and preceding fricatives are sufficient for listeners to distinguish between [ʃi] and [ʃu] at greater than chance levels.

The devoicing of /e/, a mid-vowel of intermediate duration, along with the high vowels /i/ and /u/ word-internally and word-finally in sandhi as well as the devoicing of all vowels word-finally in open pre-pausal syllables and syllables closed by /s/ in Andean Spanish cannot be attributed either to durational factors or close articulations. Presumably, the perceptual effects of the low and mid-vowel devoicing are not counteracted by the effects of these vowels produced with lower tongue positions on spectral properties of adjacent fricatives.

The effects of prosodic position on unstressed vowel devoicing in Andean Spanish are partially in agreement with cross-linguistic trends. Gordon (1998) reports that, with the exception of languages with word-final stress, vowel devoicing is strongly associated with word-final position. He also finds that the final position of larger prosodic domains is even more conducive to devoicing than word-final position, probably due to aerodynamic factors. As subglottal pressure drops over the course of an utterance, it is likely to fall to levels that propitiate devoicing at the right edges of larger prosodic constituents. Andean Spanish vowel devoicing occurs much more frequently in word-final position than word-medially or initially as in other languages. Moreover, the increased devoicing rate observed for word-final, open pre-pausal syllables when these elements also occupy utterance-final position agrees with the trends noted by Gordon. However, the decrease in devoicing rate that occurs when word-final syllables ending in /s/ are placed in the final position of larger prosodic domains is contrary to cross-linguistic patterns.

Finally, the apparent lack of a strong correlation between speech rate and vowel devoicing sets Andean Spanish apart from most other languages that exhibit this process. High vowel devoicing has been shown to be strongly rate-dependent in all languages in which it has been studied systematically, with the exception of Japanese. Japanese high vowel devoicing is described as regularly occurring in slow speech (Kondo 1997,Varden 1999).

5.2. Vowel devoicing as the result of gestural overlap

5.2.1. Explanations of vowel devoicing in other languages

The devoicing effect of voiceless consonants on unstressed high vowels was initially described as the result of a feature changing, assimilatory process by which vocalic segments were transformed from [+voice] to [-voice] in order to agree with the voicing specifications of adjacent sounds (e.g. McCawley 1968 on Japanese). However, more recent studies employing the theoretical framework of Articulatory Phonology attribute vowel devoicing to gestural overlap. As devoicing is associated with fast speech in most languages, it can readily be ascribed to a rate-based decrease in distance between gestures that causes the glottal abductions of voiceless segments to impinge upon adjoining vowels. The Articulatory Phonology approach successfully explains the major characteristics of vowel devoicing; the gradience and variability of the process as well as the restriction of its effects to the short high vowels, its occurrence near consonants with large or late occurring glottal opening gestures, and connection with increased speech rate all follow naturally from this account.

Because Japanese high vowel devoicing occurs not only at fast rates but also in slow speech when all gestures should have ample time to reach their targets and be fully realized, it cannot be easily attributed to gestural overlap. Varden (1999) attempts to reconcile the rate independence of Japanese devoicing with an Articulatory Phonology approach, arguing that devoicing during fast speech in Japanese is comparable to devoicing in other languages and results from gestural overlap which causes the glottal spreading associated with voiceless consonants to encroach upon neighboring vowels. However, he ascribes devoicing in slow speech to a phonologically based shift in alignment of the glottal opening gestures of voiceless consonants toward adjacent high vowels. In his study of single word productions, he found that when voiceless fricatives or affricates preceded a voiceless vowel, the center of their frication shifted, moving to the midpoint between them and the vowel. Varden argues that this realignment represents the phonologization of a process that was initially phonetic in nature and limited to fast speech. He compares the timing of frication in these fricative or affricate devoiced vowel pairs to the single, aggregate glottal opening gesture observed at the midpoint of clusters composed of /s/ plus a voiceless stop in several languages (Kingston 1990). As he accepts Tsuchida’s (1997) claim that devoiced Japanese high vowels are specified [+spread glottis],Varden interprets the timing of frication observed in his data as evidence that adjacent voiceless consonants and devoiced vowels share this feature.

Vowel devoicing in Andean Spanish proves to be even more problematic for the gestural overlap approach than does Japanese high vowel devoicing. Not only does Andean devoicing occur in slow speech, but it also affects non-high vowels which do not have especially short durations. However, as an approach that makes explicit reference to the overlap between articulatory gestures appears particularly well-suited to address a process characterized by gradience and variable occurrence, it seems advantageous to pursue an explanation of the process within the framework of Articulatory Phonology in spite of these challenges.

The vowel devoicing during slow speech that occurs in Andean Spanish can plausibly be addressed by an explanation similar to that given by Varden for rate-independent devoicing in Japanese, but translated into Articulatory Phonology terms. Varden’s hypothesis that the glottal spreading associated with voiceless consonants is timed to occur in greater proximity to neighboring vowels can easily be expressed as changes in the phasing relationships governing consonant vowel coarticulation.

Based on the results of X-ray pellet studies, Browman and Goldstein (1990) have proposed consonant-vowel and vowel-consonant phasing relationships for English (Figure 3).[3] Andean vowel

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[3] Figures use the schematic representation and gestural landmarks proposed by Gafos (2002). This representational system generally employs a single drawing to represent each consonantal and vocalic segment. However, a segment is in reality the product of several individual articulatory gestures (glottal gestures, tongue tip

devoicing could be modeled via phasing relationships that allow for greater proximity between vowels and bordering consonants, thus increasing the likelihood that the glottal opening gestures of voiceless consonants would affect the glottal adduction gestures associated with adjacent vowels. However, simply trading one static set of phasing relationships for another does not provide an adequate means of representation either for the variable occurrence of vowel devoicing or for its gradient effects. A more satisfactory formulation of CV and VC timing in Andean Spanish is achieved by framing phasing relationships in terms of phase windows (Byrd 1996b), which align gestures with reference to a range of points rather than only with regard to two discrete moments in each movement's trajectory. As unstressed vowels adjoined by voiceless consonants are fully voiced at least 90% of the time, the phase windows aligning unstressed vowels and voiceless consonants would necessarily include the points corresponding to the canonical coordination relationship as well as points allowing for sufficient overlap to cause vowel devoicing (Figure 4). Of course, without articulatory data of the type collected by Browman and Goldstein, this account of Andean vowel devoicing is admittedly speculative.

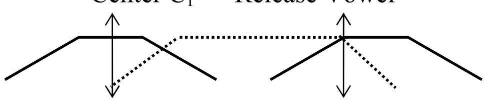

Figure 3. Canonical consonant-vowel, vowel-consonant phasing relationships.

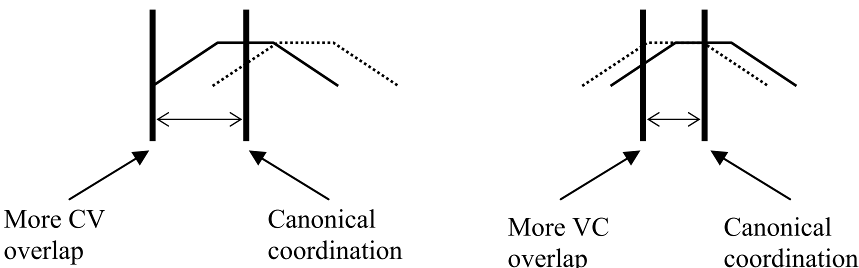

Figure 4. CV and VC phasing relationships with more overlap, incorporating phase windows.

5.2.2. Devoiced /e/: a result of consonant-vowel homorganicity?

As discussed in Section 5.2.1, it has been argued that devoicing most often affects high vowels as a result of their limited duration which allows the glottal opening gestures of adjacent voiceless consonants to more readily interfere with the glottal adduction required for full voicing. Duration is thus considered to be a key factor in determining which vowels in a given language may become devoiced. However, the devoicing of /e/ at a rate comparable to that of the high vowels word-medially and in sandhi position in Andean Spanish cannot be readily attributed to duration alone and an explanation must be sought elsewhere. The 58.82 ms. mean duration of unstressed /e/ (Marín Gálvez 1994) is quite similar to those of the unstressed high vowels /i/ and /u/ which are 57.21 and 53.61 ms., respectively. But unstressed /o/, with an essentially equivalent mean duration of 58.95 ms., does not devoice nearly as often as /e/. (The low vowel /a/, of course, has the greatest average duration of the unstressed vowels, 61.43 ms, and may well be exempted from devoicing as a result of its length).

The characteristic that sets /e/ apart from the other non high vowels and underlies its tendency to devoice may be its anterior place of articulation. Clements and Hume (1995) conclude, based on consonant-vowel interactions in a number of languages, that front vowels should be considered [+coronal] as they seem to form natural class with consonants bearing this specification. Since, according to a study of phoneme frequency in conversational speech (Quilis & Esgueva 1980), the

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gestures, velic gestures, etc.). While intra-segmental gestural coordination schemes still need to be fleshed out, Gafos suggests that oral gestures are the "head gestures" of segments and the points aligned in inter-segmental coordination relationships. Within a segment, he assumes that other gestures shift to follow the head gesture of the segment in which they occur.

most frequently-occurring voiceless phonemes in Spanish are /s/ (18.6%) and /t/ (8.6%), it seems plausible that the high devoicing rate of /e/ is a result of this anterior vowel's interaction with voiceless consonants articulated in the same general region of the oral cavity.[4]

In his study on unstressed vowel reduction in Ecuadorian Spanish, Lipski (1990) attributes the frequent devoicing of /e/ to its status as [+coronal] and its consequent similarity to /s/. He models the devoicing and deletion of /e/ within a feature geometry framework, claiming that the vowel first loses its [-consonant] specification due to a decrease in sonority. As both /e/ and an adjacent /s/ share the features [+coronal] and [+continuant], the place node of the vowel delinks from its root node and attaches to that of the consonant in order to avoid violation of the Obligatory Contour Principle.

Hall's (2004) recent analysis of vowel intrusion as the result of gestural overlap suggests a way to express the interaction of front vowels and coronal consonants as well as Lipski's argument that this relationship contributes to the tendency to devoice /e/, within the Articulatory Phonology framework. Based on the observation that consonant-vowel homorganicity affects the occurrence of intrusive vowels in some languages and also influences the probability of metathesis in others, Hall proposes that the amount of overlap between the gestures associated with adjacent segments is more limited in heterorganic consonant vowel combinations than in homorganic CV pairs. Under this view, the similar tongue positions involved in the production of /e/ and the frequently-occurring voiceless coronal consonants would allow these segments to occur in greater temporal proximity to one another than consonant vowel pairs involving /o/ or /a/ and coronal consonants as represented in Figure 5. The greater fusion between the oral gestures associated with the vowel and consonant gestures shown in 5(a) would presumably reduce the distance between the glottal gestures associated with the two segments, increasing the probability of vowel devoicing when the consonant is voiceless. The back mid-vowel /o/ would be allowed to overlap in a similar fashion only with the voiceless velar consonants /k/ and /x/ which, according to Quilis and Esgueva (1980), represent a meager 7.6% and 1% of consonants in conversational speech. Thus, the glottal adduction gestures of /e/ would be more likely to be impeded by the adduction gestures of adjoining voiceless consonants than the other non high vowels.

Figure 5. Overlap in homorganic and heterorganic CV sequences.

5.2.3. Indiscriminate devoicing in word-final syllables: the role of coda /s/

The relatively high devoicing rates for all vowels, including the back mid-vowel /o/ and the low vowel /a/, in open pre-pausal syllables and word-final syllables closed by /s/ cannot be ascribed to durational factors or increased overlap between homorganic vowels and consonants. The indiscriminate devoicing observed in these contexts must have a different origin.

Devoicing in open pre-pausal, and therefore intonational phrase-final syllables can most likely be attributed to aerodynamic factors and consequently does not require additional explanation in articulatory terms. Presumably, the drop in subglottal pressure that naturally occurs near the ends of phrases propitiates this type of devoicing (Gordon 1998), affecting all vowels in this environment to an equal extent. Myers (2005) also presents evidence that devoicing in intonational phrase-final position is automatic and phonetically motivated. The degree to which such a physiologically-based effect should be considered worthy of note and classified as equivalent to the more unusual types of devoicing found in Andean Spanish is questionable. However, the devoicing of phrase-final /u/ in Azorean Portuguese has been analyzed as a domain edge process rather than a consequence of changes in egressive airflow (Silva 1998). Furthermore, as Kariņš (1995) reports that the devoicing of short vowels in open syllables is inhibited pre-pausally in Latvian, it appears that devoicing in this context is

[4] This study was conducted in Madrid. Occurrences of the interdental /θ/ (2.77%) were combined with those of /s/ (15.87) to estimate frequencies for Peruvian Spanish.

subject to cross-linguistic variation and may not be the inevitable result of a universal phonetic tendency.

As mentioned in Section 2.5, devoicing in word-final syllables closed by /s/, which are also primarily plural morphemes and principally located in post-tonic position, can potentially be attributed to several causes. These include their location in word-final position, the articulatory properties of /s/, morphological conditioning and proximity to primary word stress. While previous studies of vowel devoicing in Spanish have not provided sufficient data to distinguish between these factors, several results obtained in this investigation suggest that the high rate of devoicing observed in this environment is mainly due to the characteristics of coda /s/ and amenable to explanation in terms of gestural overlap.

The potential contributions of word-final position and immediate post-tonic position on devoicing in this context are called into question by the finding that sandhi devoicing behaves like word-internal devoicing, affecting only the high vowels and /e/. Unstressed vowels in sandhi are by definition in word-final position and, like those in syllables closed by /s/, are overwhelmingly in immediately post tonic position. However, devoicing is not as frequent in sandhi as in word-final syllables ending in /s/ nor does it affect all vowels.

Evidence supporting the strong association of coda /s/ with devoicing comes from the finding reported in Section 3.3.1 that unstressed vowels followed by an /s/ in coda position rather than an /s/ that forms the onset of the next syllable are significantly more likely to devoice both word-internally and word-finally. One possible explanation for the devoicing effect of coda /s/ comes from the articulatory pattern known as the syllable position effect. Several studies on English nasals, stops and the lateral /l/ reviewed in Krakow (1999) have shown that these consonants exhibit a different type of articulatory organization when in coda position; the timing relationships between their component gestures become less stable and there is an overall tendency for secondary articulatory gestures, such as movements of the velum, tongue dorsum or changes in glottal aperture, to occur earlier in relation to the sound's primary oral gestures than when in onset. While the syllable position effect may not occur in all languages and its characteristics appear to vary cross-linguistically (Kochetov 2006), it is possible that the glottal opening gesture of coda /s/ in Andean Spanish displays the pattern associated with the syllable position effect and occurs prior to the formation of the sound's oral constriction. As vocal fold abduction normally occurs simultaneously with /s/'s oral gesture (Silverman 1997), the syllable position effect would cause the regressive shift of the sound's laryngeal abduction to sometimes devoice the preceding unstressed vowel (Figure 6a).

This explanation is supported by the observation that, as word-final syllables ending in /s/ are placed in the final position of progressively larger prosodic domains, the devoicing rate associated with them decreases. (Section 3.4). This reduction could be explained as the result of phrase-final lengthening, the stretching out and pulling apart of articulatory gestures that has been observed at the boundaries of prosodic units (Beckman, Edwards & Fletcher 1992, Byrd & Saltzman 1998, Wightman, Shattuck-Hufnagel, Ostendorf & Price 1992). Such a lengthening and separation of gestures could counteract the devoicing effect of coda /s/ by increasing the duration of vowels and moving them away from the following /s/, preventing devoicing at the ends of intonational phrases and utterances (Figure 6b).

Figure 6. (a) Word-final [V̥s]; (b) Intonation phrase-final [Vs].

The hypothesis that phrase-final lengthening might be antagonistic to devoicing has a precedent in Dauer (1980), who noted a similar decrease in devoicing rates at the right edges of larger prosodic elements in Greek and attributed this effect to the "stretching out" (p.25) of final syllables. Cedergren and Simoneau (1985) also report that, in Montreal French, the final syllable in a rhythm group is rarely devoiced because vowels are likely to be lengthened in that prosodic position.

Another possible explanation for the devoicing effects of coda /s/ comes from the observation that, cross-linguistically, vowels are often shorter in closed syllables (Maddieson 1985). Perhaps unstressed vowels in syllables closed by /s/ are more vulnerable to devoicing because the presence of a coda consonant decreases their duration and this, rather than the intrasegmental organization of coda /s/, makes them more vulnerable to overlap. The attribution of vowel devoicing to closed-syllable shortening would also be compatible with an Articulatory Phonology account of the process as it would relate devoicing to reduced vocalic duration. As increased gestural overlap due to the closed syllable effect would presumably be counteracted by phrase-final lengthening, a possible closed syllable shortening effect for Andean Spanish is also consistent with the reduced devoicing rates found for word-final syllables ending in /s/ in the final position of larger prosodic domains.

However, while vowel shortening in closed syllables has been documented in a variety of languages, there is evidence that it is not a cross-linguistic universal. Jannedy (1995) found that Turkish unstressed vowels are longer in closed versus open syllables. Furthermore the evidence for the existence of this effect in Spanish is debatable. An early study by Navarro Tomás (1917) shows that vowels are shorter in Spanish closed syllables, but this finding is not supported by a more recent and systematic study on vowel duration by Marín Gálvez (1994). In any case, this process would have to be observed in Andean Spanish before any conclusions regarding its contribution to vowel devoicing could be drawn. As controlled rather than conversational speech is needed to effectively compare the length of vowels in closed versus open syllables in this dialect, further examination of the issue is left to future research.

It is also difficult to draw conclusions with regard to the importance of the fourth potential cause of devoicing in word-final syllables ending in /s/, namely morphological conditioning. The fact that coda /s/ induces high rates of devoicing word-internally as well as word-finally suggests that phonetic factors play a greater role in devoicing than position in plural markers. However, it may still be the case that the often redundant nature of plural suffixes contributes to the high rate of devoicing in this context as suggested by Lipski (1990). Finally, the frequent occurrence of this affix may be related to its association with especially high rates of devoicing. According to Bybee (2001), high-frequency words tend to exhibit a great deal of reduction due to faster shifts in their lexical representation, as well as the fact that they are often used in casual speech.

6. Conclusion

This paper has described the process often referred to as “unstressed vowel reduction” in a dialect of Andean Spanish based on spectrographic analysis of 16,581 unstressed vowels extracted from the conversational speech of 16 residents of Cusco, Peru. Results suggest that the process is more accurately termed unstressed vowel devoicing because quality changes and centralization are not frequently observed in these data. As in other languages, most devoicing occurred between voiceless consonants and devoicing rates were highest for /i/ and /u/. Departures from cross-linguistic trends, including the frequent devoicing of /e/ word-medially and of all vowels in some types of word-final syllables as well as the apparent lack of a strong correlation between the process and speech rate prevent the straightforward application of the gestural overlap account of vowel devoicing in other languages to Andean Spanish. However, it has been argued that the anomalous aspects of this process can be addressed within the framework of Articulatory Phonology.

Given that many syntactic and some phonological characteristics of Andean Spanish have been attributed to the influence of Quechua, it is tempting to speculate that language contact may have played a role in the development of unstressed vowel devoicing in this dialect. The existence of vowel devoicing in Quechua documented in one published resource (Crothers 1979) as well as thus far unsubstantiated claims that Quechua is stress timed (Hundley 1983), suggest means by which contact with Quechua might be related to unstressed vowel devoicing in Andean Spanish. However, more specific information about the characteristics of Quechua must be obtained before such possibilities can be effectively evaluated.

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Selected Proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology

edited by Laura Colantoni and Jeffrey Steele

Cascadilla Proceedings Project Somerville, MA 2008

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ISBN 1-57473-424-9 library binding

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or:

Delforge, Ann Marie. 2008. Unstressed Vowel Reduction in Andean Spanish. In *Selected Proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology*, ed. Laura Colantoni and Jeffrey Steele, 107-124. Somerville, MA: Cascadilla Proceedings Project. www.lingref.com, document #1718.