The Phonetics and Phonology of S-Lenition and Vowel Laxing in Eastern Andalusian Spanish

by

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Contents

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Abstract

This thesis will examine the interaction of laxing and s-lenition in Eastern Andalusian Spanish. The first experiment will confirm that laxing of vowels, always seen in closed syllables in EAS, occurs even in syllables where the coda has been deleted by s-lenition The second experiment will provide an answer to why this is the case, and why this phenomenon does not represent a case of opacity for Optimality Theory. A set of constraint rankings will be proposed to govern laxing and s-lenition, and the effects of s-lenition on the surrounding sounds.

Chapter 1: Introduction

§1.1 Features of Eastern Andalusian Spanish

Andalusia is the southernmost and second-most populated autonomous community in Spain, stretching across the southern portion of the country from coast to coast and including the provinces of Huelva, Granada, Córdoba, Cádiz, Málaga, Jaén, Sevilla, and Almeria. The Andalusian dialect, spoken by close to eight million people, is quite distinct from Standard Peninsular Spanish (SPS), which is mainly spoken in the central regions of Spain. Although there are linguistic traits typical of the Andalusian region as a whole, such as the weakening of obstruents in codas and the pronunciation of a voiceless [h], there is a significant distinction in moraic phonology between the eastern and western halves of Andalusia, specifically involving the interaction of two phonological phenomena.

The first phenomenon is characteristic not only of Andalusian Spanish as a whole, but also exists generally in SPS: the laxing of non-low vowels in closed syllables. In

Andalusian Spanish, the environment governing laxing is not straightforward, because obstruents are not tolerated in the codas of syllables, and are either aspirated or deleted. This is especially noticeable in the case of /s/, because of its morphological significance. In Spanish, /s/ is not only a way to mark plurals, but also to conjugate verbs for the second person singular. In Western Andalusian Spanish this lenition of coda obstruents leads to a re-tensing of the vowels, retaining laxed vowels only in syllables closed by sonorants, which would not have been deleted. In EAS however, all laxed vowels remain so, even if the environment for laxing has been removed through deletion of the coda segment.

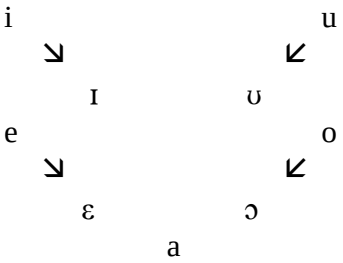
As was mentioned before, this EAS phenomenon of the retention of laxed vowels in syllables with deleted codas has special implications for /s/, since unlike other obstruents, it has a morphological significance. In WAS, the distinction between singulars and plurals may be lost in cases where /s/ is the only mark of a plural (/es/ is used in some cases). In EAS, because of its retention of the lax vowels, this difference is preserved. Both laxing and s-lenition are discussed in more depth below.

§1.2 Laxing

In its underlying form, Spanish has a typical 5-vowel system: /i e a o u/. In the output however, each of the four non-low vowels has two allophones: one tense and one lax. The only low vowel in Spanish, /a/, only has the lax form, likely due to the physical difficulty of tensing such a low vowel (see Chapter 5 for more details). The tense allophones appear in open syllables, and the lax allophones appear in closed syllables. The laxing of a vowel is characterized by centralization. This causes a lowering of the vowel, which translates into higher first formants. In front vowels, centralization also

causes backing of the vowels, leading to lower second formants. Back vowels experience fronting, and thus their second formants raise. The fronting and backing are less robust changes than the lowering, however. Figure 1 below demonstrates these changes:

Figure 1: Laxing of Spanish Vowels



As Figure 1 illustrates, as each of the four non-low Spanish vowels centralize, /i/ becomes [ɪ], /e/ becomes [ɛ], /o/ becomes [ɔ], and /u/ becomes [ʊ]. To illustrate the effects of laxing, Table 1 lists possible formant values for each of these vowels.

Table 1: Example Formants of Spanish Tense and Lax Vowels

Vowels	Tense		Lax	
	F1 (Hz)	F2 (Hz)	F1 (Hz)	F2 (Hz)
i	350	2500	450	2400
e	500	2000	650	1900
a	-	-	750	1650
o	500	1350	650	1450
u	350	1350	450	1450

Below are sample words used in the experiments in this thesis which show each of these vowel allophones in their expected environments:

[i]	*ni̱ño*	/ni̱ɲo/	[ni̱ɲo]	‘boy’
[ɪ]	*difíci̱l*	/difiθi̱l/	[difiθɪ̱l]	‘difficult’
[e]	*ve̱o*	/be̱o/	[be̱o]	‘I see’
[ɛ]	*ve̱rde*	/be̱rde/	[bɛ̱rðe]	‘green’
[a]	*hija̱*	/iha̱/	[iha̱]	‘daughter’
[a]	*usa̱n*	/usa̱n/	[usa̱n]	‘they use’
[o]	*ojo̱*	/oho̱/	[oho̱]	‘eye’
[ɔ]	*ho̱mbre*	/o̱mbre/	[ɔ̱mbre]	‘man’
[u]	*u̱na*	/u̱na/	[u̱na]	‘a’ (feminine form)
[ʊ]	*u̱n*	/u̱n/	[ʊ̱n]	‘a’ (masculine form)

§1.3 S-Lenition in Codas

Another feature of EAS is the weakening of /s/ in codas. This lenition is due to a dislike for having unlicensed obstruents in codas. All obstruents in codas are lenited in EAS, however the argument was made by Chip Gerfen (2001a, to appear) that differences exist that distinguish s-lenition from the weakening of other moraic obstruents. His research studied the effects of obstruent-lenition on the lengths of preceding vowels and following consonants, and found a statistically significant difference between the effects of moraic s-lenition versus those caused by the weakening of other obstruents in the coda of a syllable. Since this thesis also seeks to study the effect of lenition on surrounding sounds, it is logical to focus on the weakening of the moraic /s/ only, and not try to combine two different phenomena.

The lenition of /s/ causes it to be either aspirated or deleted. For example, *mes* ('month') might be realized as either [mɛ^{h}] or [mɛ]. In aspiration, the place features of the /s/ are deleted, and the segment assimilates the place features of the preceding vowel. This leaves an apparently lengthened vowel with a period of voiceless at the end where the lenited /s/ had been. This can be seen in the spectrograms in Figure 2 and Figure 3. Figure 2 shows the spectrogram of *hombre usa*, and Figure 3 shows the spectrogram of the plural form of the phrase, *hombres usan*, in which the /s/ in *hombres* has been aspirated.

Figure 2: /om.bre.u.sa/ [ɔm.bre.u.sa] 'man uses'

ɔ m b r e u s a

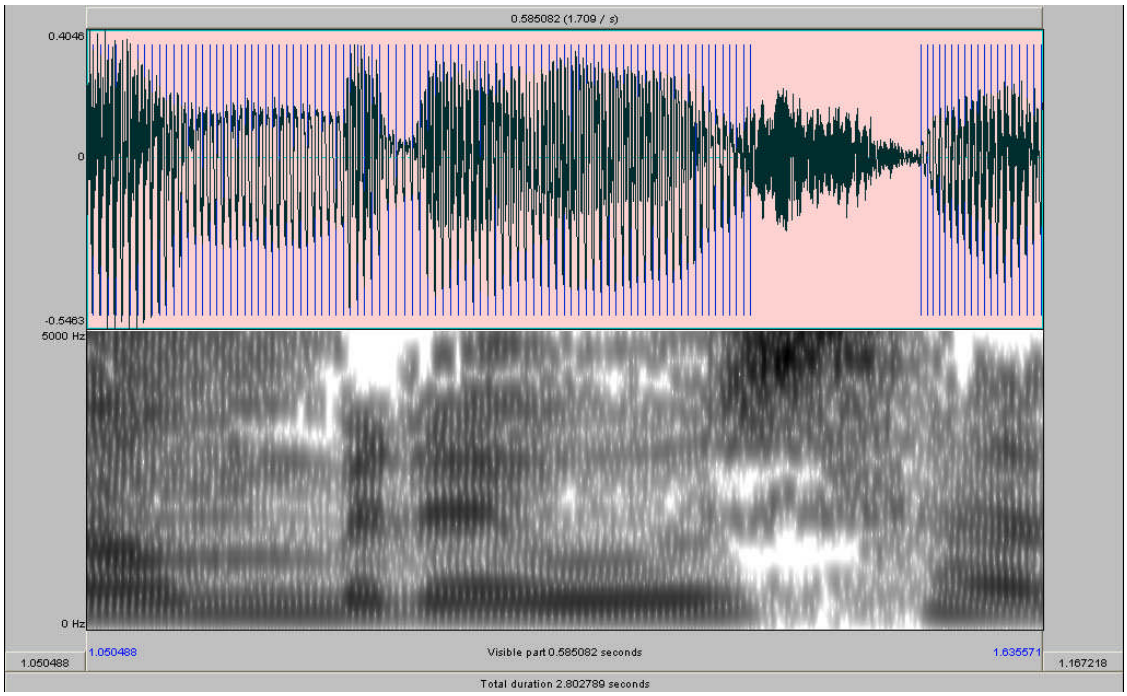
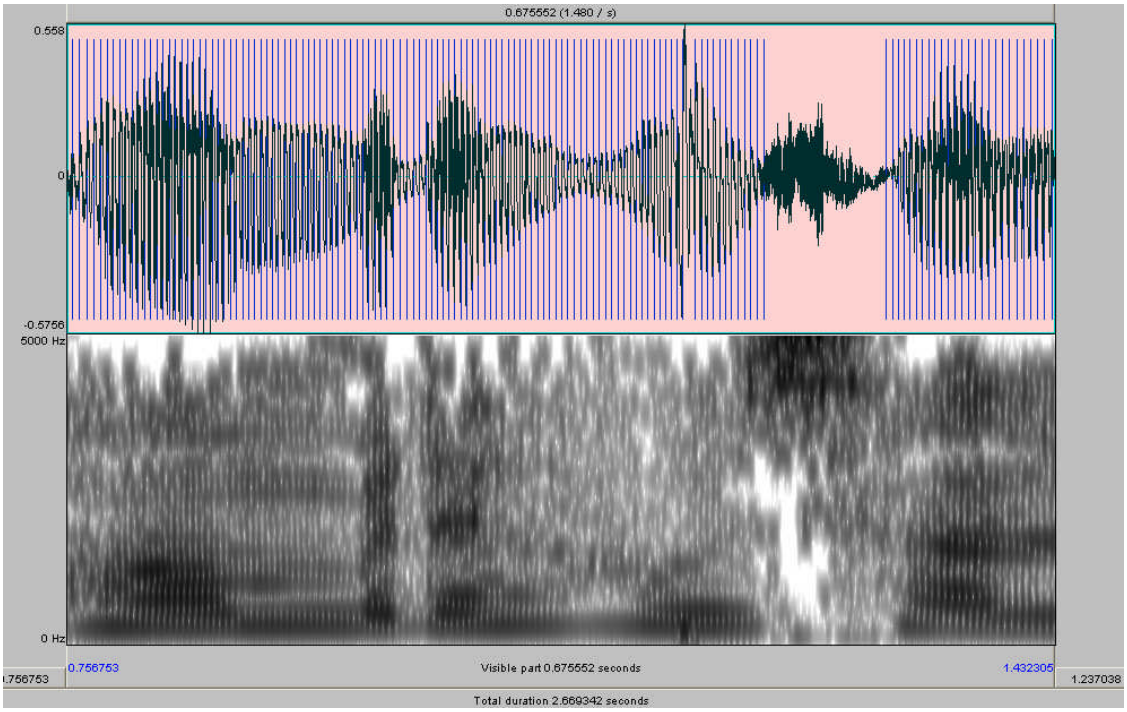


Figure 3: /om.bres.u.san/ [ɔm.brɛ^{h}.u.san] ‘men use’

ɔ m b r ɛ ^{h} u s a n



In deletion, the entire segment is deleted, as in the figures below. Figure 4 shows the spectrogram of *andaluz pide*, and Figure 5 shows the plural version of this phrase, *andaluces piden*, in which the /s/ in *andaluces* undergoes deletion.

Figure 4: /an.da.luθ.pi.de/ [an.ða.lʊθ.pi.ðe] ‘Andalusian asks for’

a n ð a l ʊ θ p i ð e

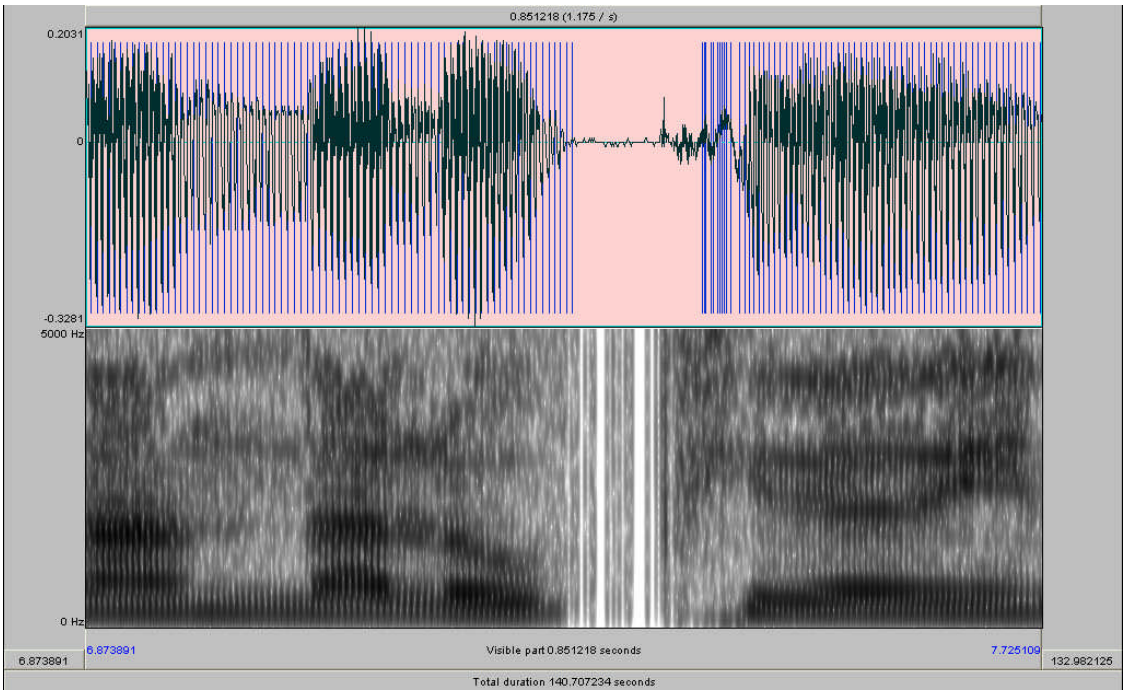
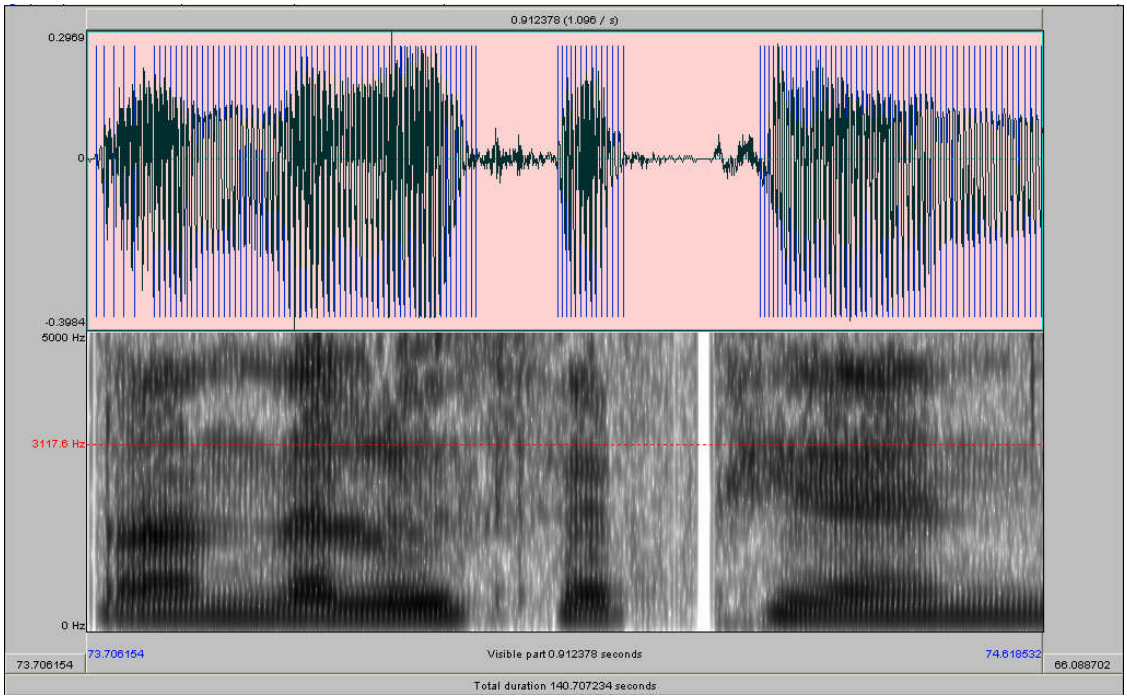


Figure 5: /an.da.lu.θes.pi.den/ [an.ða.lu.θɛ.pi.ðɛn] ‘Andalusians ask for’

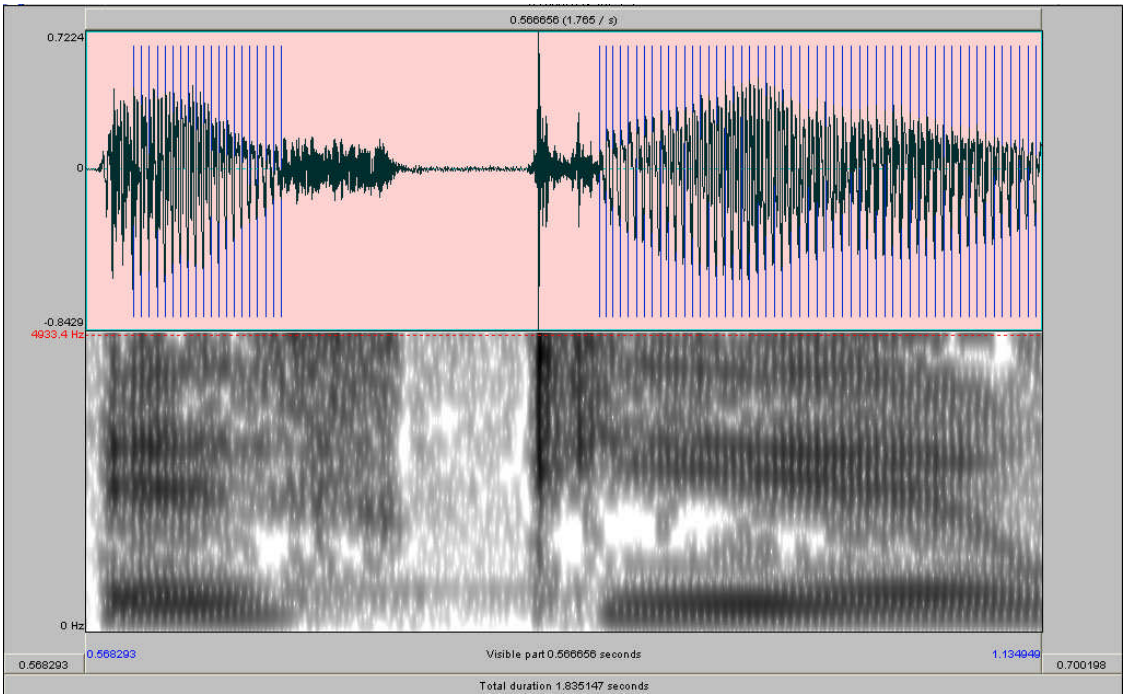
a n ð a l u θ e p i ð e n



Occasionally the /s/ may be fully realized in a coda, but this is more likely to occur in formal speech, since the Andalusian dialect is relatively low prestige compared to the Castilian accent, where /s/ is always pronounced. There is much variation even within the speech of an individual speaker, however, and even in casual speech the degree of s-lenition will often vary between complete deletion and the occasional fully formed [s]. Figure 6 shows the spectrogram of *esquié*, in which the /s/ was fully pronounced.

Figure 6: /es.kie/ [ɛs.kie] ‘I skied’

ɛ s k i e



§1.4 Traditional Analysis

Traditional rule-based analysis of these phenomena would create two rules, one for laxing and one for s-lenition:

1) Laxing

[-low, +ATR] > [-ATR]/_C.

2) S-Lenition

[s] > [Ø]/_.
[^{h}]

In order to produce an output that contains a laxed vowel, laxing would have to be ordered before s-lenition. If s-lenition were ordered first, and complete deletion of the /s/ occurred, the syllable would no longer be closed, and the environment for laxing would disappear. Since the speech of native speakers of EAS exhibits laxed vowels even when the /s/ is deleted however, the laxing must occur first. This is an example of a counterbleeding relationship (Kiparsky 1973), meaning that if the ordering of the rules were reversed, the first rule would rob the second rule of its environment so that the second rule would not apply. This ordering of the rules requires the existence of an abstract intermediate form besides the input and the output, which would occur after laxing and before lenition. As we will see in the next section, requiring an intermediate form causes a problem when we try to analyze these phenomena using Optimality Theory.

§1.5 Optimality Theory

Optimality Theory uses language-specific rankings of universal constraints to produce speech output from the underlying input. Rather than relying on ordered rules, as in the traditional analysis discussed above in §1.4, constraints in OT apply simultaneously, and there are no intermediate forms. A single input is acted upon by the ranked constraints, and a single output is produced. This means that an analysis of laxing and lenition that requires an intermediate form defies an OT explanation of ranked constraints (Kiparsky 1973).

This need for an intermediate form could be abolished however, if it could be shown that the environment for laxing is not actually eliminated by s-lenition. Cases of s-lenition in which the /s/ is aspirated already do not pose a problem for OT, because the

aspiration occupies the coda mora, meaning that the syllable is still closed. Therefore, if it can be shown that the deletion of the /s/ segment from the coda does not lead to the deletion of the coda mora, and thus to the opening of the syllable, the phenomena would no longer be opaque for OT. Both Gerfen (2001a, 2001b, to appear) and Morris (2000) found evidence that gemination of the following onset frequently accompanies s-lenition. If this is the case, and the moras left empty by the deletion of /s/ are in fact linked to the onsets of the following syllables through gemination, then there is no longer any need for an intermediate form in the analysis, and these phenomena would be transparent to OT. That is what this thesis will attempt to prove.

In Chaper 2, the laxness of vowels in syllables where a moraic /s/ has been lenited will be verified, and a tentative search for gemination will be attempted. In Chapter 3, the presence of gemination will be confirmed, and there will be an in-depth look into the distribution of aspiration and gemination in s-lenition. In Chapter 4, an OT analysis of laxing and lenition will be offered, and Chapter 5 will draw some general conclusions based on this research and discuss any problems that have surfaced.

Chapter 2: Phonetic Analysis of S-Lenition and Laxing

§2.1 Methods

§2.1.1 *Participants*

The single participant in this experiment was a native speaker of Eastern Andalusian Spanish in her early twenties, who was born and raised in Málaga. At the time of the experiment she had been living in the United States for three months. Although she has some awareness of the phonology of her particular dialect, she does not have extensive knowledge of linguistics in general, or phonology specifically.

§2.1.2 *Equipment*

Sound data was gathered in this experiment using a Marantz Solid State digital recorder and microphone. The recording was made in mono at a sample rates of 44 kHz. The sound files were edited using the video-editing software Vegas 6.0, and were analyzed spectrally using Praat (Boersma and Weenink 2006), a speech-analysis program. The acoustic measurements were then analyzed using the statistical package SPSS 13.0 for Windows. All computer work was done on Dell PCs running Windows XP.

§2.1.3 *Procedure*

The experimental items were a series of forty-nine sentences (see Appendices A and B), each with a singular and a plural version, excepting three sentences, which could not be pluralized under the guidelines of the experiment. The sentences were constructed with the purpose of providing a diverse set of environments in which /s/ would be present

in the coda of the underlying representation. Thus, there were multiple cases of /s/ which appeared both in word-internal and word-final coda position, and which were preceded by each of the five phonemic vowels of Spanish. A series of sentences rather than individual words was used with the expectation that a more natural pronunciation might be produced while repeating a cohesive sentence than when reading individual words out of context. Altogether, the sentences contained 213 instances of /s/ in a coda, 64 of which were word-internal and 149 of which were in word-final position, including 32 which were also sentence-final. 56 of these /s/s followed /a/, 84 followed /e/, 20 followed /i/, 43 followed /o/, and 10 followed /u/.

The sentences were presented in singular form and in English to the participant in order to avoid a pronunciation prejudiced by the orthography. The participant was instructed to speak as she would with family members or friends, in as natural a fashion as possible. In order to put her at her ease, the experiment was preceded by a discussion about Andalusia, where the examiner had spent a semester living with a family the previous year. When the experiment began, the participant was asked to read aloud each sentence, not in English, but in Spanish, giving both the singular version, and the plural version of the sentence, using the vocabulary which came naturally to her. When formulating the sentences, the words were chosen in order to make the Spanish translation straight-forward. She was instructed to pluralize only nouns and not pronouns, in order to make the task easier, and to make any necessary changes to verbs. She was given a few moments before she began in order to study the words and to ask any questions she might have. She was not, however, told the purpose of the experiment. When she was asked before the start of the experiment if she had guessed its purpose, she

replied that she had not. The participant took about eight minutes to recite all the sentences, speaking into a microphone. She was then thanked for her help, and was asked again if she thought she knew the experiment's purpose, but she replied once more in the negative.

The sound files were transferred from the recorder to the computer via the memory chip onto which they had been recorded. Using Vegas 6.0, the large sound files were cropped in order to eliminate excess dead space between the sentences, and then each sentence was rendered as a .wav file and saved separately. The new .wav files were opened in Praat, and Praat's speech analysis tools were used in order to study the spectrograms and measure the formants of the vowels in the speech samples. Among the features measured were the lengths of each vowel in the sentence, as well as its first and second formants, and the realization of each /s/ in coda position (whether there was deletion, aspiration, or a fully articulated [s]).

§2.2 Data

The data was analyzed in terms of three categories: (1) realization of /s/ in a coda (2) F1 and F2 of vowels preceding a moraic /s/, and (3) length of vowels preceding a moraic /s/. The first category has to do with the distribution of possible s-realizations and the second and third are related to the effect and results of laxing. As well, a tentative foray was made into searching for gemination, although the relevant data for that from this experiment was extremely limited. Each of these data sets was segmented further by vowel type, consonant type, realization type, and whether or not the /s/ occurred at a word boundary or not.

§2.2.1 *Realization Distributions*

Out of 176 instances of /s/ in codas, 74 were aspirated, 72 were deleted, and 30 were pronounced as a fully realized [s]. A chi-square test was performed, and the observed distributions did differ significantly from an equal distribution (χ= (32.045, 2), p= 0.00). This would seem to disprove the idea that the selection of a particular realization is a random event. Randomness would predict that the frequencies of each the three realizations would be roughly equal, but the chi-square test results indicate that the actual frequencies differ significantly from equal distributions. The next step therefore, was to search for patterns in the data.

A chi-square test was run to assess whether realizations patterned differently according to whether the moraic /s/ was on a word boundary or not. This did not produce significant results (χ= (1.127, 2), p= 0.569).

Table 2: Distributions of Realizations by Word-Internal or Word-Final Position

	Word-internal /s/	Word-final /s/
Ø	26	46
h	22	52
s	8	22
Total	56	120

No tests were run during this experiment to determine whether or not the distributions were affected by whether the following sound was a consonant or a vowel; however this is investigated in Chapter 3.

Next, the effect of affix vs. root was investigated. It was hypothesized that a moraic /s/ that was part of the root of the word would be more likely to be lenited than an /s/ that was part of a morphological affix. The lenition of a single sound in the coda of a

portion of the word root would likely not affect recognition or comprehension in any way. However, the lenition of a moraic /s/ that is a morphological affix may result in the loss of important information. A chi-square test was run to investigate this, but no significant relationship was found between the morphological role of an /s/ and its realization (χ= (0.544, 2), p= 0.762). Therefore, it appears that a moraic /s/ is just as likely to be lenited when it is part of the root of the word as it is when it is part of a morphologically significant affix.

None of the above tests were able to find any significant relationships between the choice of realization of /s/ and either its morphological significance or its position in the word (word-internal vs. word-final). In Chapter 3, we will focus on examples of moraic /s/ that appear at word boundaries only, and examine whether or not realizations distributions are affected by the whether the first syllable of the following word contains an onset.

§2.2.2 *Laxing*

The argument that a description of s-lenition requires ordered rules is based on that fact that although Spanish vowels lax only in a closed syllable, in EAS lax vowels appear in syllables whose underlying structure was closed, but whose surface structure is open due to s-lenition. If the environment for laxing was removed and yet the vowels are still pronounced as lax, it seems that the rules governing these phenomena must be ordered. In order to determine the validity of this argument, it was first necessary to verify that vowel laxing was indeed taking place. To investigate the appearance of lax vowels in open syllables, the data was segmented by two sets of characteristics: (1) vowel type and (2) realization type.

For vowel type: the vowels were divided by height and backness into the familiar five vowel system used by Spanish, i e a o u, and also by whether or not they were expected to lax (in the case of an underlying syllable with a filled coda, /i/ should lax to [ɪ], /e/ to [ɛ], /o/ to [ɔ], and /u/ to [ʊ]; /a/ was not expected to lax). A one-way ANOVA was run on the data to determine whether or not there was a significant difference for the first and second formants between vowels that were expected to lax and those that were expected to remain tense. Data was excluded from the test if the vowel was either shorter than 0.05 seconds or showed formants whose shape was not either flat or a plateau (trough, peak, rising, falling, erratic), because these vowels either had not had enough time to reach their target formants or were experiencing interference from a neighboring sound. These vowels tended to produce extremely erratic results, introducing undesirable sources of variation into the experiment and skewing the results. The test results are summarized in Table 3 below:

Table 3: Results of Formants for Tense vs. Lax Formants

	F1		F2	
	F	p	F	p
i	$F(1,56)= 147.775$	$p= 0.00$	$F(1,56)= 3.031$	$p= 0.087$
e	$F(1,112)= 149.022$	$p= 0.00$	$F(1,112)= 3.630$	$p= 0.059$
a	$F(1,121)= 0.088$	$p= 0.767$	$F(1,121)= 0.002$	$p= 0.961$
o	$F(1,61)= 161.401$	$p= 0.00$	$F(1,61)= 0.360$	$p= 0.551$
u	$F(1,19)= 94.741$	$p= 0.00$	$F(1,19)= 3.372$	$p= 0.082$

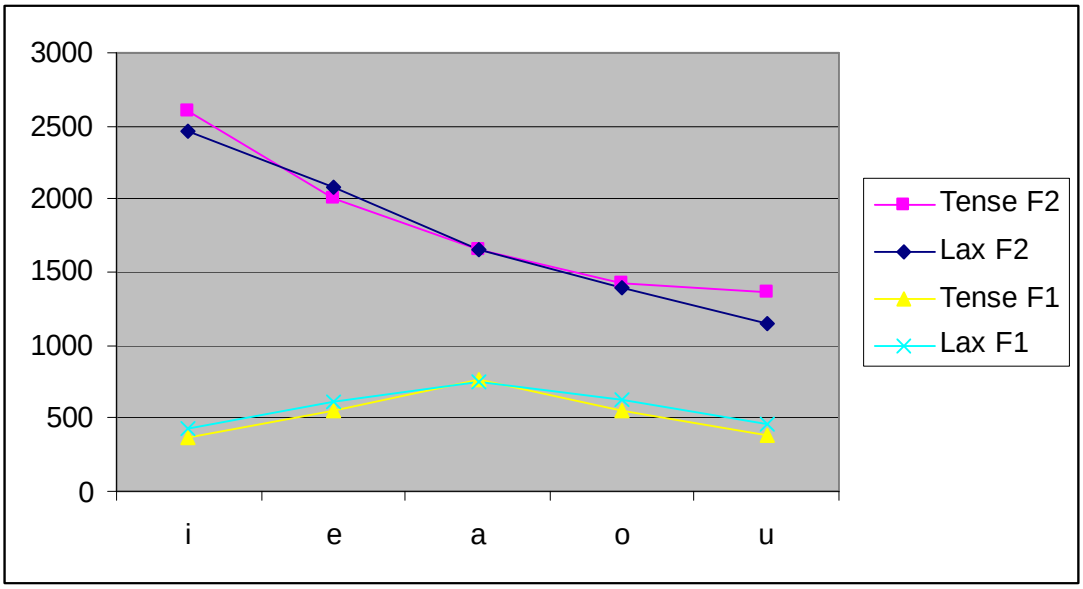
Although lax vowels are centralized vowels, the essential portion of their movement is the lowering, so even though the vowels in closed syllables did not consistently change their front/back position, the fact that they were all lowered allows us

to determine that laxing is indeed occurring. As expected, all of the vowels except for /a/ showed significant lowering effects when they appeared in an underlyingly closed syllable. Average F1 and F2 values for each vowel are listed in Table 4 and displayed in Graph 1:

Table 4: Average Formant Values by Vowel

Vowels	Tense		Lax	
	F1	F2	F1	F2
i	368	2600	429	2460
e	544	2010	616	2080
a	758	1660	755	1660
o	554	1420	630	1390
u	376	1360	459	1150

Graph 1: Average Formant Values by Vowel



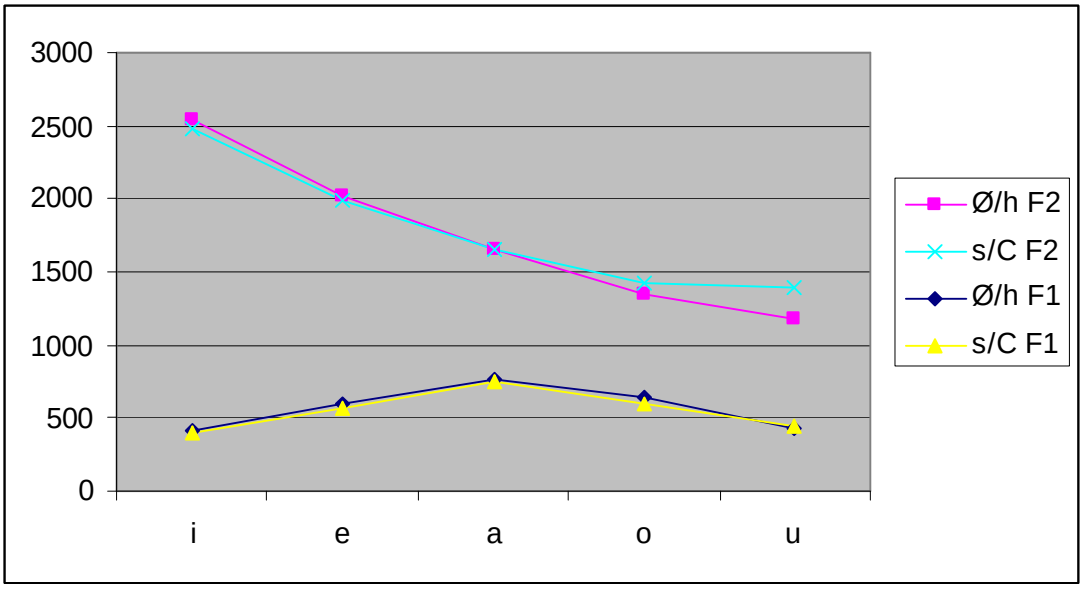
A test was also run to determine whether or not there was a significant difference in formant values for vowels in syllables where the coda had been lenited and where it

had remained intact. In both of these cases, a lax vowel would be expected to appear, but since the environment for laxing was no longer present, it was hypothesized that possibly some vowels would have experienced different degrees of laxing, or perhaps some re-tensing. A one-way ANOVA was run to investigate this, but no significant result was found for any of the vowels ($p > 0.05$). Since the non-low vowels experienced the same degree of laxing in an underlyingly closed syllable regardless of whether the coda had been lenited, it appears that syllables with lenited codas must be treated as closed syllables for the purposes of laxing. Table 5 lists the average formants values for the two different categories: (1) deletion or aspiration and (2) full /s/ realization or other consonant. In the first category, some re-tensing effects might have been expected to appear, since s-lenition had occurred. In the second category, there was no s-lenition, and no re-tensing was expected.

Table 5: Average Formant Values for Syllables with Lenited Codas/Preserved Codas

	Ø/h		s/C	
	F1	F2	F1	F2
i	420	2540	404	2480
e	599	2020	566	1990
a	773	1650	753	1650
o	646	1350	597	1430
u	431	1180	439	1390

Graph 2: Average Formant Values for Syllables with Lenited Codas/Preserved Codas

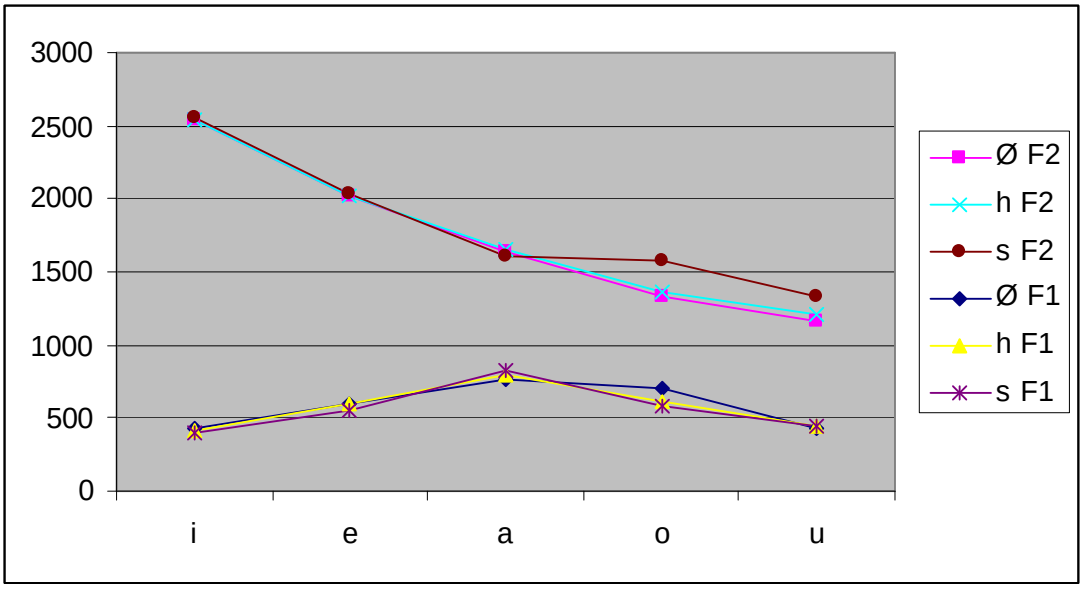


Next, a test was run to determine if there were any significant differences between each of the three types of realizations of /s/. Theoretically, no differences should exist, since for all of these realizations, the underlying form of the syllable is closed, and a one-way ANOVA was able to verify this experimentally as again, no significant differences were found for any vowels ($p \leq 0.05$), indicating that no re-tensing occurred after the initial laxing.

Table 6: Average Formants For Each Realization

	Ø		h		s	
	F1	F2	F1	F2	F1	F2
i	424	2540	415	2540	393	2560
e	597	2020	601	2020	552	2040
a	758	1640	791	1660	826	1610
o	708	1330	618	1360	584	1580
u	427	1170	445	1210	438	1324

Graph 3: Average Formants For Each Realization

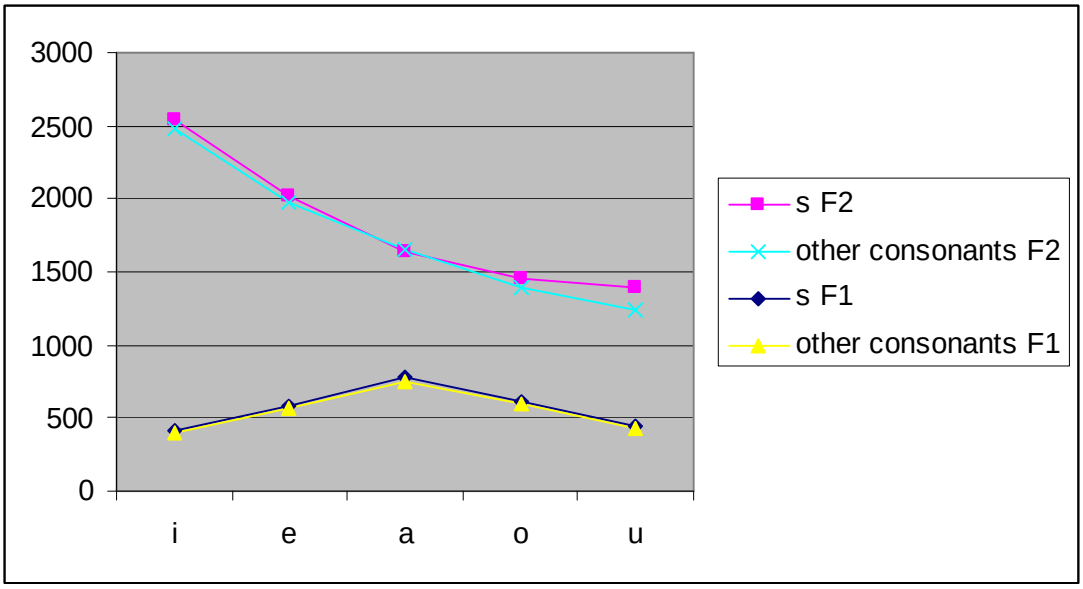


Finally, a test was run to see if the vowel formants in syllables containing all three possible /s/ realizations would produce an average distinct from vowels in syllables closed by other consonants. This was meant to test whether an underlying moraic /s/ produces the same, lesser, or greater degrees of laxing in the vowel. A one-way ANOVA showed that the degree of laxing did not differ significantly between the two groups ($p > 0.05$).

Table 7: Average Formant Values for Syllables: Moraic S vs. Other Consonants

	s		other consonants	
	F1	F2	F1	F2
i	416.2593	2540.741	404.2895	2472.132
e	580.4138	2027.598	570.0762	1977.524
a	782.88	1638.211	747.53	1651.60
o	616.8889	1458.148	599.7115	1389.952
u	439.0625	1395.604	434.0667	1246.6

Graph 4: Average Formant Values for Syllables: Moraic S vs. Other Consonants



Based on the tests conducted on the data, it appears that the crucial factor in determining whether a vowel laxes is whether or not the coda position of the syllable in the underlying structure is filled. There was no significant difference between the formants of vowels in syllables whose codas had been deleted and those in syllables whose codas had not been deleted. The realization of /s/ in a particular case, therefore, does not affect the height or backness of a vowel, and each underlying /s/ in a coda results in vowel formants similar to those that would be found in a syllable closed with a consonant other than /s/.

§2.2.3 *Gemination*

Much of the data gathered during this experiment was not useful for an investigation of gemination, since it wasn't designed with that goal in mind, but a few tentative tests were run in order to determine if a second, larger experiment focusing on

gemination might be useful. Out of the 963 syllables examined in the previous tests, only 29 were used for this test, and these had to be segmented by moraic consonant, since different types of consonants could not be expected to have the same length. The consonants examined for possible gemination after s-lenition were p, t, k, n, and θ. Table 9 below details the number of examples of each consonant used in this little mini test, as well as the number of each type of consonant that is expected to geminate or not to geminate. It was expected that consonants in open syllables would not geminate, and that consonants in syllables whose moraic /s/ had been deleted or aspirated would geminate. There is a discussion of why this is the case in the beginning of Chapter 3.

Table 8: Frequencies of Consonants

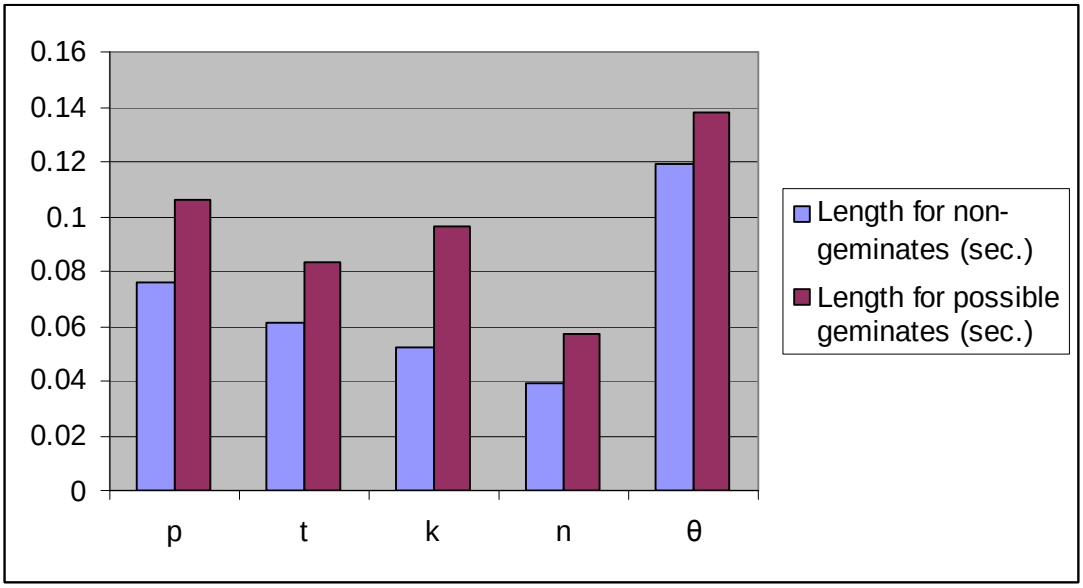
Consonant	# occurrences	# not expected to geminate	# expected to geminate
p	9	4	5
t	8	5	3
k	8	3	5
n	2	1	1
θ	2	1	1

Although the data sample is so small that variation could easily erase any effect that might be seen, this initial test did indicate that gemination might be occurring. All of the consonants except for /θ/ showed an average increase in length of at least 37%. However, there was not enough data for a statistical test to produce a significant result for any of the consonants except for /k/, which showed the most dramatic length increase ($p \leq 0.05$). Table 9 and Graph 5 below list the average measured lengths of the consonants.

Table 9

Consonant	Length for non-geminates (sec.)	Length for possible geminates (sec.)	% length increase
p	0.076	0.106	40.46
t	0.061	0.0833	36.61
k	0.052	0.096	83.44
n	0.039	0.057	46.15
θ	0.119	0.138	15.97

Graph 5



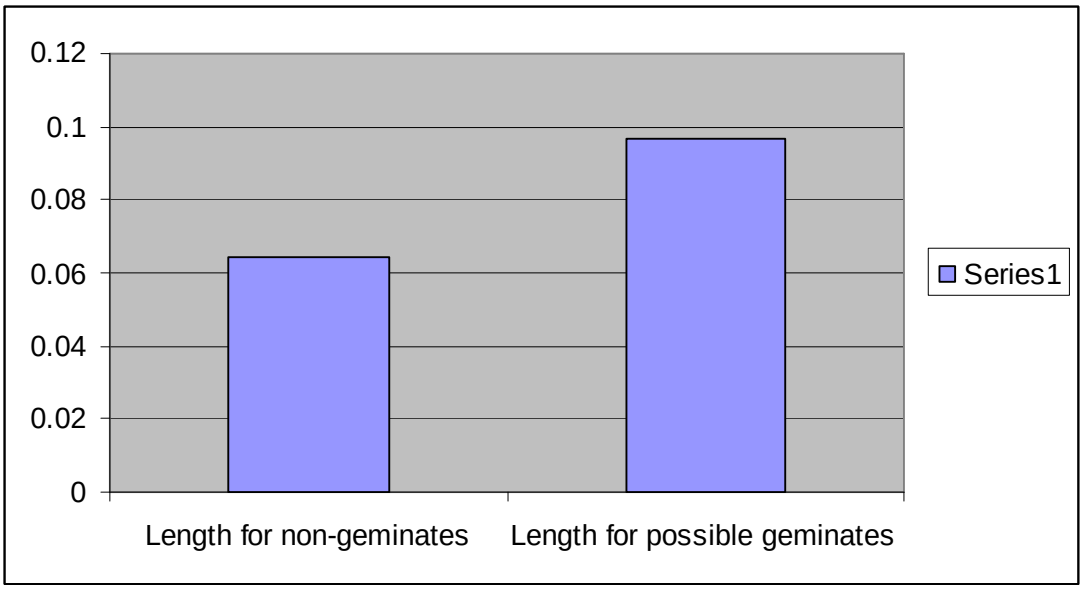
In an attempt to combine data and possibly produce results that were significant, the test was run again, this time treating p, t, k as one group. It is reasonable to assume that the three voiceless stops would have similar lengths in similar environments, and indeed a one-way ANOVA showed no significant difference between their average lengths ($p \leq 0.05$), although with such a small data set, this may not be accurate. Treating the voiceless stops as one group provided enough data that a second one-way ANOVA

produced significant results, indicating that for voiceless stops at least, gemination does occur as a result of s-lenition ($p \leq 0.05$). Table 10 and Graph 6 summarize these results.

Table 10: Average Lengths for Possible Geminates and Non-geminates

	Length for non-geminates	Length for possible geminates	% increase
Voiceless Stops	0.064	0.097	34.33

Graph 6: Average Lengths for Possible Geminates and Non-geminates



Gemination was studied more in-depth in the second full experiment, which is discussed in Chapter 3.

§2.3 Summary of Results

This experiment demonstrated that the four non-low vowels in EAS all experience laxing when they occur in a syllable whose underlying structure is closed, with laxing realized as increase in F1 (and either an increase or a decrease in F2). It found no

difference for the degree of laxing for vowels in syllables which remained closed versus those which are opened due to lenition of a moraic /s/. Nor were there any differences related to the particular realization of the lenited /s/ ([Ø], [h], and [s]). No pattern to describe the distributions of these realizations was discovered. The possible patterns investigated involved whether the /s/ was word-internal or word-final, and whether the /s/ was part of an affix or the root word, but these both produced negative results. In chapter 3, the effects of s-lenition at word boundaries will be examined in depth, and a pattern to describe the occurrence of these effects will be proposed.

Chapter 3: Gemination

§3.1 Description of Gemination

Gemination refers to the lengthening of sound by spreading to an extra timing slot. Gemination is a frequent occurrence after the deletion of a sound, since deletion leaves behind an unfilled timing slot, which then can be appropriated by the sound preceding or following the deleted segment. Both Gerfen (2001a, 2001b, to appear) and Morris (1999) mention gemination of the following consonant as a possible consequence of s-lenition. The first experiment, discussed in Chapter 2, included a small investigation into gemination and found proof that gemination does occur for voiceless stops. The second experiment was designed in order to verify this gemination, and also to examine whether other groups may also experience gemination after s-lenition.

Gemination is of interest because it solves the problem of how OT can account for the retention of laxed vowels in syllables whose moraic /s/ has been deleted. The relationship between laxing and lenition appears to be one of counter-bleeding, since an ordering of lenition before laxing would eliminate the environment for laxing (Kiparsky 1973). Situations of counter-bleeding are difficult for OT to explain, because they demand an ordering of the rules and an intermediate form, which is impossible in OT, since it relies on ranked constraints that all apply at once to an input to produce an output. Both §1.5 and §4.1 describe OT more in-depth.

In the cases of lenition where /s/ is aspirated instead of deleted, ordered rules are not necessary because the aspiration is able to fill the coda position left by the deleted /s/, closing the syllable. This would seem to leave no explanation for those cases in which /s/ appears to be deleted, but a third possibility exists: that of gemination of the onset

following the deleted /s/. Gemination was not fully discussed in chapter 2, which was focused more heavily on examining laxing on its own, but if gemination were occurring in all the cases where aspiration is not, the coda position of the syllable would again be filled, and the laxing environment would be retained. As the experiment below demonstrates, this is in fact the case. Gemination sometimes occurs in conjunction with aspiration after s-lenition, but more often in the absence of aspiration. Moreover, a pattern describing the occurrences of aspiration and gemination will be proposed later.

§3.2 Methods

§3.2.1 *Participants*

The participant in this study was the same as in the previous one: a native speaker of EAS in her mid-twenties, originally from Málaga. Because of the time difference between this and the previous experiment, at the time of this experiment she had been in living in the United States for six months, during which time she used SPS when speaking to students. Again, as in the first study, however, she made an effort to use EAS during the experiment.

§3.2.2 *Equipment*

Sound data was gathered in this experiment was a Marantz Solid State digital recorder and microphone. The recording was made in mono sound at a sampling frequency of 44 kHz. The sound files were edited using Vegas 6.0, a video editing software, and were analyzed spectrally using Praat, a speech-analysis program (Boersma and Weenink 2006). The acoustic data gathered was organized in Microsoft Excel and analyzed using the statistical package SPSS 13.0.

§3.2.3 *Procedure*

The experiment involved pairing nouns with conjugated verbs (and objects when necessary). Each of the eighteen different nouns (either proper names or regular nouns) was paired with one half of a list of 32 verb phrases. Each of the nine nouns ended with either /r/, /l/, /n/, /θ/, or one of the five possible Spanish phonemic vowels. Of the 30 verbs used, two began with each of the three voiceless stops /p/, /t/, /k/, two with the liquids /r/ and /l/, and twenty with each of the five vowels. Of the verbs which began with vowels, there were ten which began with each of the orthographic vowels, and ten in which the orthography contained an *h* before the vowel (ex. *hacer* /aθer/ 'to do'). Duplicate types of verbs (ex. two beginning with /p/) never appeared together in the same list. Altogether there were eight actual lists, because there were four orderings of two halves of the master list. Different orderings were used in order to help prevent ordering effects.

The participant was asked to read each noun aloud, and pair it with each verb phrase on a given list. So for instance, she would read, *La gitana hunde el plan. La gitana echa la pelota, La gitana une los ingredientes*…. Each of these sequences would then be repeated a second time after she had finished the list. Finally, the list would be read twice more, pluralizing both the noun and the verb. Then the participant would move onto the next noun. Two or three items were accidentally not read a second time in the plural form, so altogether the participant read 544 sentences, which took about an hour and a half, including a break halfway through.

By having the participant read a plural version of the lists, an /s/ was added to the coda of each noun, e.g. *el niño* 'the child' → *los niños* 'the children'. Since a moraic /s/

is expected to either aspirate or delete, which leads to a gemination of the following sound word internally (Gerfen 2001a, 2001b, to appear), the goal of the experiment was to discover if this same phenomenon occurred across word boundaries. The purpose of the lists was to create an environment in which each type of sound to be studied would be present in a situation where it would be expected to geminate (following a deleted/aspirated /s/ in a coda) and a nearly identical situation in which it would not be expected to geminate (following a syllable without an underlying /s/). Thus, one sentence might be

José usa el ordenador
'José uses the computer'

/ho.se.u.sa.el.or.de.na.dor/
[ho.se.u.sa.el.or.ðe.na.ðor]

The plural version would then be:

Los Josés usan el ordenador
'The Josés use the computer'

/los.ho.ses.u.san.el.or.de.na.dor/
[loh.ho.se^{h}.u.san.el.or.ðe.na.ðor]

Only the initial noun phrase and the verb in each sentence were pluralized, while all other words remained unchanged, including any pronouns, in order to decrease the complexity of the task. The variety in noun endings was meant to try to eliminate unusual results by minimizing the effect that one particular type of sound might have. A complete list of nouns and verb phrases used can be found in Appendices C and D.

After the experiment, the sound files were edited in Vegas 6.0 in order to divide up each sentence into its own .wav file. The .wav files were then analyzed using Praat.

Specifically, the realization of each /s/ in the plural nouns was noted, and the length of the initial sound of each verb was measured to search for gemination.

§3.3 Data

§3.3.1 *Occurrence of Gemination*

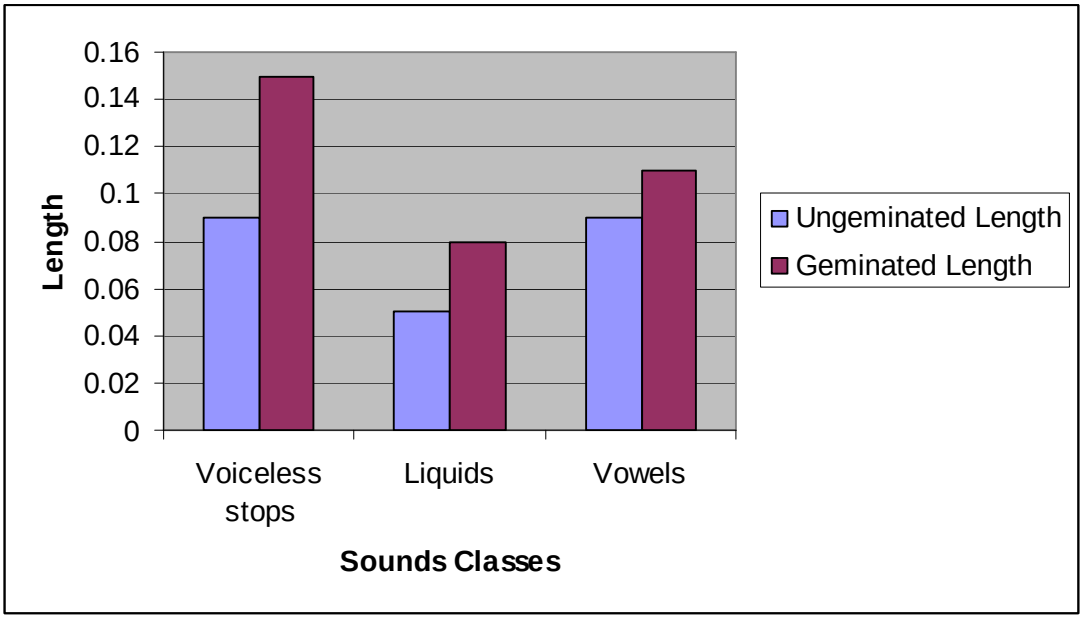
A one-way ANOVA was run to check for gemination. Since it is only when /s/ is deleted that it leaves a timing slot to be filled by gemination, the two groups tested were the sounds following a lenited /s/, ignoring the presence or absence of aspiration for the moment, and sounds following open syllables where deletion had not taken place. Following sounds that were measured included a, e, i, o, u, p, t, k, l, r. For the purposes of the test, these sounds were divided into three groups: (1) vowels (a, e, i, o, u), (2) voiceless stops (p, t, k), and (3) liquids (l, r). The length values for three sounds were thrown out because they were each more than twice the maximum length of any other sound, and a clear pause in the participant's speech could be heard.

The test demonstrated that gemination occurs for voiceless stops ($F(1, 49)=128.499$, $p= 0.00$), as well as for the liquids ($F(1, 31)= 41.307$, $p= 0.00$), after a lenited /s/. In vowels, there was a significant increase in length from vowels ($F(1, 152)= 8.519$, $p= 0.004$), but it is not enough to be considered gemination, since it is an average increase of only 22.2%. Both voiceless stops and liquids show a length increase of well over 50%. Nevertheless, there is a statistically significant length increase for all three types of sounds.

Table 11: Average Length for Geminated/Ungeminated Sounds

	Ungeminated Length	Geminated Length	% Increase
Voiceless stops	0.09	0.15	66.7
Liquids	0.05	0.08	60.0
Vowels	0.09	0.11	22.2

Chart 7: Average Length for Geminated/Ungeminated Sounds



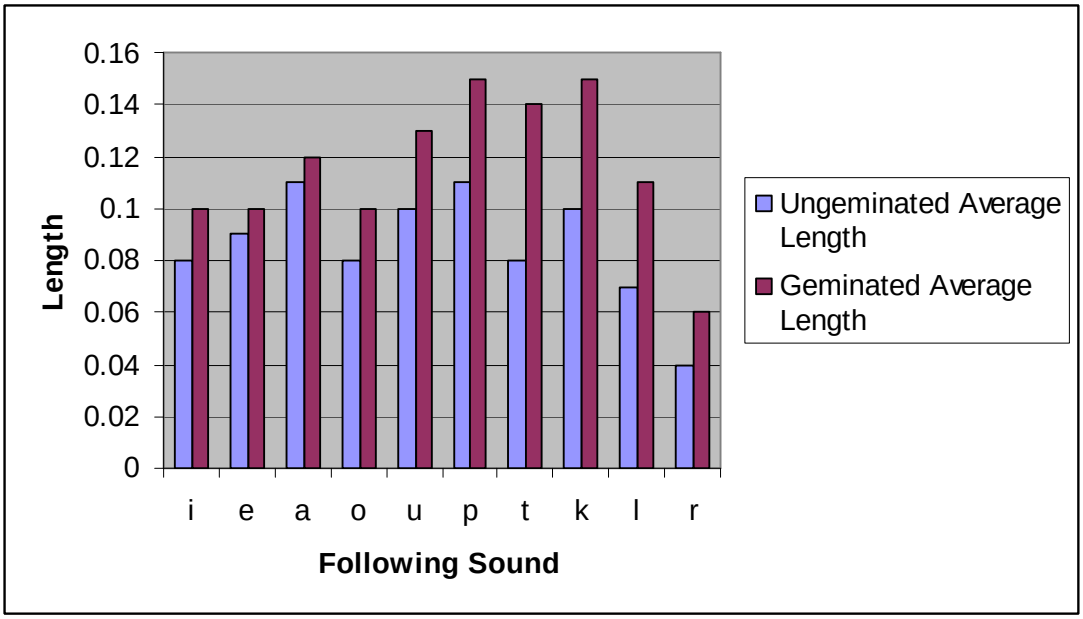
Average values for each type of sound are presented in Table 12. Clearly, there is some variation between the lengthening experienced by each type of sound. For instance, % length increases in the voiceless stops ranges from 36.% and 75%, and between 9.1% and 30% for the vowels. The liquids were more consistent, with /l/ increasing an average of 57.1% in length, and /r/ increasing an average of 50.0%. It is not clear what these differences can be attributed to. Certain preceding sounds (from the nouns which preceded the verbs in the sentence) seemed to have different effects on the length of the sounds which followed them. The effects seemed to be fairly consistent, producing

longer segments than usual for both following ungeminated and ungeminated sounds, but it is possible that this is not the case, and that some sounds were affected differently from the others, therefore introducing some variation.

Table 12: Average Length for Geminated/Ungeminated Sounds

Following Sound	Ungeminated Average Length	Geminated Average Length	% Increase
i	0.08	0.10	25.0
e	0.09	0.10	11.1
a	0.11	0.12	9.1
o	0.08	0.10	25.0
u	0.10	0.13	30.0
p	0.11	0.15	36.7
t	0.08	0.14	75.0
k	0.10	0.15	50.0
l	0.07	0.11	57.1
r	0.04	0.06	50.0

Chart 8: Average Length for Geminated/Ungeminated Sounds



§3.3.2 *Patterning of Lenition Effects*

The spread of % length increases for sounds expected to geminate and those not expected to geminate appears in Table 13. Graph 9 displays this information in a boxplot. After determining that gemination generally occurs only when the following sound has a consonant (when the following syllable has an onset), further investigation was made into the relationship between the aspiration and gemination. Table 14 lists the frequencies of the result of aspiration only, gemination only, both, and neither. Gemination was defined as a length increase of at least 35.0%, since the 25th quartile for the length increase for expected geminates was 35%, while the 75th quartile increase in length for non-geminates was 12.6% and the maximum was 25.0%.

Table 13: Spread for % Length Increases

	Minimum (%)	25th percentile (%)	Average (%)	75th percentile (%)	Maximum (%)
Gemination expected	25.0	35.0	44.6	53.4	89.0
Gemination not expected	-117	-14.8	6.0	12.6	25.0

Graph 9: Spread for % Length Increases

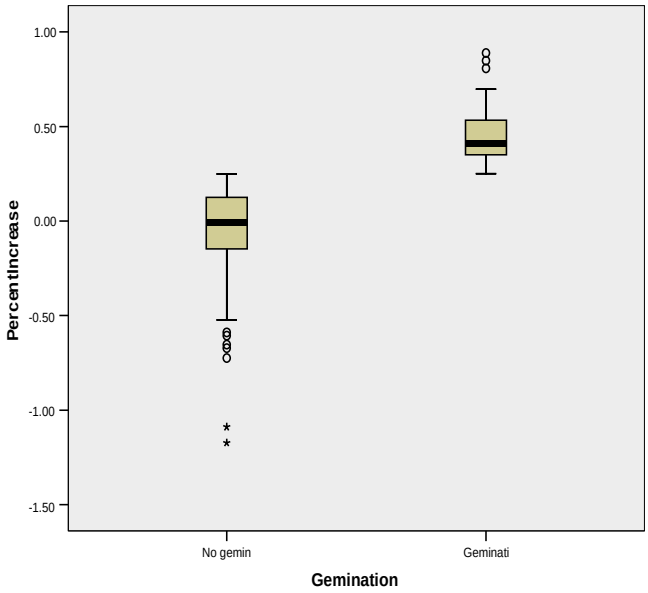


Table 14: S-Lenition Effect Frequencies

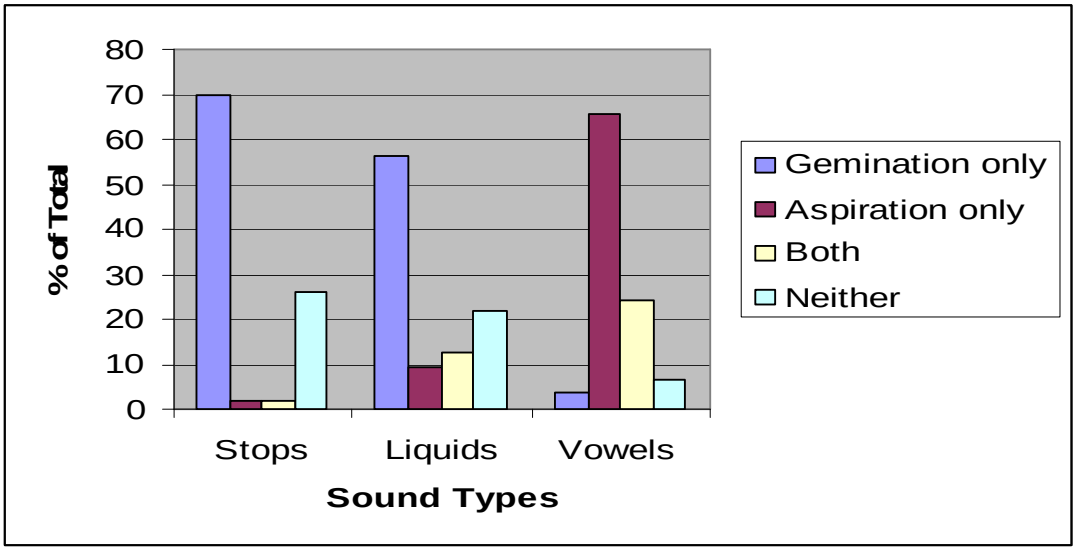
	Number of Occurrences	% of Total
Aspiration Only	112	46.5
Gemination Only	58	24.1
Both	34	14.1
Neither	37	15.4

From Table 14, it appears that aspiration only is the clear winner in terms of effect preference, occurring 46.5% of the time. However, a more in-depth examination of the occurrences of each type of effect, displayed in Table 15, reveals that aspiration is only the preferred effect when there is no following onset, and the majority of the time there is only gemination when liquids and voiceless stops are in a following onset. The results are by no means absolute, and there is clearly a lot of variation, but the overall trend appears to be aspiration when the following syllable has no onset, and gemination when it does.

Table 15: Effect Frequencies by Sound Type

	Gemination		Aspiration		Both		Neither	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
Stops	35	70.0	1	2.0	1	2.0	13	26.0
Liquids	18	56.3	3	9.4	4	12.5	7	21.9
Vowels	6	3.9	100	65.4	37	24.2	10	6.5

Graph 10: Effect Frequencies by Sound Type



There were a number of cases in which both gemination and aspiration occurred, and in fact Gerfen (2001b, to appear) always describes the effect of word-internal lenition as including both gemination and lenition. He found that there is an inverse relationship between the length of the gemination and the length of the period of aspiration when they appear together. Each phonological group also had a significant minority of cases in which neither aspiration nor gemination appeared to occur. It might be the case that due to natural variations in speech, in rhythm and speed etc,. the geminated sounds were shorter than they normally would be, and so did not reach the 35.0% increase in length

that defined gemination in this experiment. It might also be that the method used to detect aspiration was not sensitive enough. This subject will be discussed more in §5.1.

§3.4 Summary of Results

The goals of this chapter were twofold: (1) determine if gemination was occurring and (2) try to find a pattern for the effects of s-lenition. For the first part, the results of the experiment made it clear that gemination is occurring some of the time, although not all of the time. Several patterns were also found in the data. Gemination is most likely to occur when the syllable after a lenited /s/ contains an onset. Aspiration is usually the result of s-lenition when the following syllable does not have an onset. Aspiration and gemination can both occur for the same syllable, although infrequently, and cases were also found in which neither occurred. It was clear however, that gemination is the "winner" when a consonant follows the lenited /s/, and that aspiration wins when a vowel follows.

Chapter 4: Optimality Theory

§5.1 Optimality Theory

As was discussed in previous chapters, Optimality Theory explains the production of specific outputs from specific inputs by means of a language-specific ranking of universal constraints (Prince and Smolensky 1993). There are two types of constraints: faithfulness constraints and markedness constraints. Faithfulness constraints restrict the amount of change from the input to the output. Thus for the example, the faithfulness constraint IDENT states that nothing about the output may be changed from the input. Markedness constraints force outputs that are phonologically unmarked. For instance, an example of a markedness constraint is *ObsCoda, which does not allow obstruents in the coda.

Faithfulness and markedness constraints are frequently in conflict, because if an input contains sequences of sounds which are not natural. For instance if an obstruent appears in a coda in the input, markedness constraints will try to force a change in the output, while faithfulness constraints will oppose any changes. If an input contains an obstruent in a coda therefore, either IDENT or *ObsCoda must be violated. The ranking of these constraints will determine which one of these that will be. If IDENT is ranked above *ObsCoda (IDENT >> *ObsCoda), then the output will be identical to the input, and the obstruent will remain in the coda, violating *ObsCoda. If however *ObsCoda is ranked above IDENT, the output must be changed in some way, by deleting the obstruent, by epenthesizing a vowel after the obstruent to make it an onset, by turning the obstruent into a sonorant, etc. Each of these changes may be allowed or blocked by other

faithfulness constraints or markedness constraints. The exact ranking of constraints will lead to the output which is pronounced by a native speaker.

OT relies only on the ranking of constraints in order to produce output, so there are no intermediate forms, as in a rule-based system. This is why the possibility of a counter-bleeding relationship existing between laxing and lenition was so problematic for OT. If laxing must occur before lenition, then there must be an intermediate form where laxing has occurred, but lenition has not yet. Since such an intermediate form would not be possible in OT, and therefore the surface form would be opaque (Kiparsky 1973, McCarthy 2002). If no counter-bleeding relationship exists, then no intermediate form is necessary, and, it becomes possible to explain the phenomena in terms of ranked constraints, which will be outlined in this chapter.

§5.2 Laxing in Closed Syllables

There are three constraints involved in the tense/laxing rule in Eastern Andalusian Spanish. The first two relate to the respective environments in which tense and lax vowels are found. *ClosedTense refers to the fact that tense vowels are not permitted in closed syllables. It only applies to non-low vowels, however, as was mentioned in §1.2. Applied without restrictions, *ClosedTense would cause the laxing of all non-low vowels in closed syllables.

(1) *Closed Tense

*[+tense, -low]C.

*OpenLax refers to the fact that no non-low, lax vowels are allowed in open syllables: [-tense, -low]. The application of *OpenLax would cause the tensing of all non-low vowels in open syllables.

(2) *OpenLax

*[-tense, -low]C.

Finally, since these rules have the capacity to cause a change in the tenseness of vowels from the input to the output, a third constraint is needed: Ident-[tense].

(3) IDENT-[tense]

αtense → αtense

The tense value may not change from input to output.

Since IDENT-[tense] would prevent any changes in the tense value of the values, *ClosedTense and *OpenLax must be ranked above it.

Tableaux 1-4: Domination of *ClosedTense and *OpenLax by IDENT-[tense]

Tableau 1

/el/ *el* 'the'

candidates	*ClosedTense	*OpenLax	IDENT-[tense]
[el]	*!		
→ [ɛl]			*

Tableau 2

/ɛl/ *el* 'the'

candidates	*ClosedTense	*OpenLax	IDENT-[tense]
[el]	*!		
→ [ɛl]			

Tableau 3

/le/ *le* dative pronoun

candidates	*ClosedTense	*OpenLax	IDENT-[tense]
→ [le]			
[lɛ]		*!	

Tableau 4

/lɛ/ *le* dative pronoun

candidates	*ClosedTense	*OpenLax	IDENT-[tense]
→ [le]			*
[lɛ]		*!	

As is clear from the four tableaux above, when *ClosedTense and *OpenLax are ranked above IDENT-[tense], vowels will become tense in open syllables and lax in closed syllables, no matter what the tense value was of the input. This agrees with the Richness of the Base theory proposed by Smolensky (1996).

§5.3 S-Lenition

Examining the results of the second experiment, it appears that EAS s-lenition is achieved by gemination or aspiration. Gemination occurs when the following syllable contains an onset, and aspiration occurs when it does not. In the case of s-lenition, the

initiator of the change is the markedness of obstruents in codas in Spanish. Therefore, the obstruent must either be eliminated from the coda or licensed by gemination from the following onset. Below are cases in which aspiration or gemination would be expected to occur.

/Vs.C/: Gemination

/es.blan.ko/	[ɛb.blan.ko]	'it is white'
/mis.bra.θos/	/mɪb.bra.θɔ^{h}]	'my arms'

s].V/: Aspiration

/es.a.θul/	[ɛ^{h}.a.θʊl]	'it is blue'
/mis.o.hos/	[mɪ^{h}.o.ho^{h}]	'my eyes'

§5.3.1 *Gemination*

To follow the example of McCarthy and Prince (1993) in creating a specific criteria for allowing consonants in the coda, the constraint CODA-COND can prevent the pronunciation of a moraic obstruent which is unlicensed by a following onset. Since CODA-COND is the impetus for both gemination and aspiration, it must be highly ranked.

(1) CODA-COND

Obstruents must be licensed by a following onset in order to appear in a coda.

If CODA-COND is forcing changes to the input, it must outrank IDENT (Prince and Smolensky 1993, McCarthy and Prince 1995, McCarthy and Prince 1999).

(2) IDENT

All features of the input must remain intact and appear in the output.

Tableau 5: Domination of CODA-COND over IDENT

/mes.ke/ *mes que* 'month that'

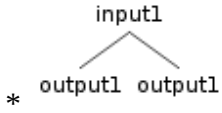
candidates	CODA-COND	IDENT
→[mɛk.ke]		*
[mɛs.ke]	*!	

This ranking of CODA-COND over IDENT means that some change must be made in the output so that CODA-COND is not violated. Since CODA-COND allows moraic obstruents to be licensed by following onsets, one possibility for dealing with the obstruent is to delete the segment and then link the empty mora to the following onset to create a geminate. This would be violated by three constraints: MAX-seg, Integrity, and *Gem (Prince and Smolensky 1993, McCarthy and Prince 1995, McCarthy and Prince 1999).

(3) MAX

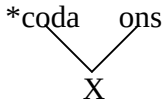
No input may be deleted.

(4) Integrity



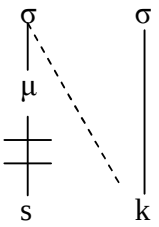
One input can produce only one output.

(5) *Gem



One segment may not be linked to both a coda and an onset.

In order to produce the correct output [mek.ke], which satisfies CODA-COND, from the input /mes.ke/, which does not satisfy CODA-COND, the /s/ must be deleted, and the /k/ must link to the mora vacated by the /s/.



This output violates the three constraints MAX, Integrity, and *Gem, but as Tableau 6 demonstrates, [mek.ke] is the chosen output. Therefore, CODA-COND must outrank these three constraints.

Tableau 6: Domination of CODA-COND over MAX-seg, Integrity, and *Gem

/mes.ke/ *mes que* 'month that'

candidates	CODA-COND	MAX-seg	Integrity	*Gem
[mɛs.ke]	*!			
→[mɛk.ke]		*	*	*

If a segment can be deleted, can a mora be deleted? Deleting the entire coda would certain be simpler than deleting a segment and then geminating the following onset. Deletion of the coda would produce [me.ke]. This is not a possible output of /mes.ke/, however, and must therefore be blocked by MAX-μ.

(6) MAX-μ.

Any mora that is present in the input must appear in the output.

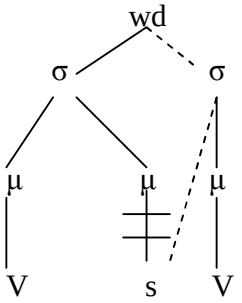
If MAX-μ may not be violated to satisfy CODA-COND, it must be ranked more highly than MAX-seg, Integrity, and *Gem, as Tableau 7 demonstrates.

Tableau 7: Domination of MAX-μ over MAX-seg, Integrity, and *Gem

/mes.ke/ *mes que* 'month that'

candidates	MAX-μ	MAX-seg	Integrity	*Gem
[me.ke]	*!	*		
→[mɛk.ke]		*	*	*

Another possible solution that would satisfy CODA-COND would be to epenthesize a vowel after the /s/, which would resyllabify the /s/ as an onset, rather than a coda. A new syllable would be inserted, and the /s/ would detach from its coda mora and reattach to the new syllable:



Since [me.sV.ke] is not a possible output of /mes.ke/, it must be prevented by DEP_{ons} (Prince and Smolensky 1993, McCarthy and Prince 1995, McCarthy and Prince 1999). Since epenthesis is not permitted, DEP_{ons} must outrank MAX-seg, Integrity, and *Gem.

(7) DEP_{ons}

No onset not present in the input may appear in the output.

Tableau 8: Domination of DEP_{ons} over MAX-seg, Integrity, and *Gem

/mes.ke/ *mes que* 'month that'

candidates	DEP_{ons}	MAX-seg	Integrity	*Gem
[me.sV.ke]	*!			
→[mɛk.ke]		*	*	*

A constraint is also needed that can prevent aspiration. According to the results of the experiment described in Chapter 3, aspiration should be the result only when there is no following onset. When there is a following onset, the ranking of the constraints must assure that gemination is more optimal than aspiration. Aspiration can be prevented

by MAX-[place], which must be ranked above MAX-seg, Integrity, and *Gem, as demonstrated in Tableau 9.

(8) MAX-[place]

No place features may be deleted from the input.

Tableau 9: Domination of MAX-[place] over MAX-seg, Integrity, and *Gem

/mes.ke/ *mes que* 'month that'

candidates	MAX-[place]	MAX-seg	Integrity	*Gem
[mɛ^{h}.ke]	*!			
→[mɛk.ke]		*	*	*

Finally, the preservation of the [-son] feature of /s/ must be maintained so that the /s/ is not turned into a sonorant in the output. This can be accomplished with IDENT-[son], which must be high ranking.

(9) IDENT-[son]

Sonorant values must be the same in the input and the output.

Tableau 10: Domination of IDENT-[son] over MAX-seg, Integrity, and *Gem.

/mes.ke/ *mes que* 'month that'

candidates	IDENT-[son]	MAX-seg	Integrity	*Gem
mɛ[C, +son].ke	*!			
→mɛk.ke		*	*	*

The final rankings necessary to produce gemination, listed below, are demonstrated in Tableau 11:

CODA-COND		MAX-seg
MAX-μ		Integrity
DEP_{ons}	>>	*Gem
IDENT-[son]		IDENT
MAX-[place]		

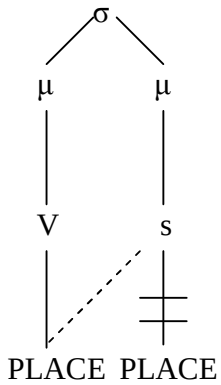
Tableau 11: Final Ranking for Gemination

/mes.ke/ *mes que* 'month that'

candidates	CODA COND	MAX-μ	DEP_{ons}	MAX-[place]	IDENT-[son]	MAX-seg	Integrity	*Gem	IDENT
mɛs.ke	*!								
me.ke		*!							
me.sV.ke			*!						
me.ske			*!						
$mɛ^{h}$.ke				*!					
mɛ [C, +son].ke					*!				*
→mɛk.ke						*	*	*	*

§5.3.2 *Aspiration*

In order to produce aspiration, we must get the output [V^{h}.V] from the input /Vs.V/. The /s/ must undergo debuccalization, losing its place features, and then assimilate the place features of the preceding vowel.



This would be prevented by MAX-[place], which is currently too highly ranked to be violated in favor of CODA-COND. Therefore, MAX-[place] must be ranked below CODA-COND (see Tableau 12) but still remain above MAX-seg, Integrity, and *Gem so that aspiration does not occur when there is a following onset (see Tableau 9).

Tableau 12: Domination of CODA-COND over MAX-[place]

/a.blas.a/ *hablas a* 'you talk to'

candidates	CODA-COND	MAX-[place]
a.blas.a	*!	
a.bla^{h}.a		*

Tableaus 13 and 14 demonstrate how the overall rankings (below) conform to CODA-COND by gemination when there is a following onset, and by aspiration when there is not.

CODA-COND				MAX-seg
MAX-μ	>>	MAX-[place]	>>	Integrity
DEP_{ons}				*Gem
IDENT-[son]				IDENT

Tableau 13: Final Ranking for Gemination

/mes.ke/ *mes que* ‘month that’

candidates	CODA COND	MAX-μ	DEP_{ons}	IDENT-[son]	MAX-[place]	MAX-seg	Integrity	*Gem	IDENT
mɛs.ke	*!								
me.ke		*!							
me.sV.ke			*!						
me.ske			*!						
mɛ [C, +son].ke				*!					*
$mɛ^{h}$.ke					*!				
→mɛk.ke						*	*	*	*

Tableau 14: Final Ranking for Aspiration

/a.blas.a/ *hablas a* ‘you talk to’

candidates	CODA COND	MAX-μ	DEP_{ons}	IDENT-[son]	MAX-[place]	MAX-seg	Integrity	*Gem	IDENT
a.blas.a	*!								
a.bla.a		*!							
a.bla.sV.a			*!						
a.bla.sa			*!						
a.bla[C, +son].a				*!					*
→$a.bla^{h}$.a					*				

Chapter 5: Conclusion

The experiments discussed above provide evidence that deletion of /s/ at word boundaries in Eastern Andalusian Spanish can either be accompanied by aspiration of the preceding vowel or by gemination of the following consonant. Aspiration is favored when the following word has no onset, and gemination is favored when it does have an onset. On average, gemination results in a length increase of between 60 and 70%, although there is a lot of variation.

This discovery, that deletion of moraic /s/ in EAS is always accompanied by either aspiration or gemination, means that the relationship between s-lenition and vowel laxing in EAS is not opaque. Vowel laxing occurs only in closed syllables. The syllable need only be closed in its underlying representation however, to produce laxing in the vowel. If the moraic /s/ had been entirely deleted in EAS, therefore, without any accompanying aspiration or gemination, laxing and lenition would have formed a counterbleeding relationship (Kiparsky 1973). In other words, if lenition were ordered before laxing, laxing would not occur, therefore laxing must occur first. This ordering can only exist in a rule-based interpretation, since it requires an intermediate form when laxing has occurred, but lenition has not. The constraints of OT act on an input to produce an output, so this kind of intermediate form is not possible for OT (Kiparsky 1973, McCarthy 2002). The opacity in the surface form that this caused was eliminated by the discovery that either aspiration or gemination appears in conjunction with s-lenition. Thus, the coda mora remains filled, and the laxing environment is preserved, abolishing the need for an ordered set of rules and an abstract intermediate form.

The phenomena discussed in this thesis, laxing and lenition followed by gemination or aspiration, are natural changes and can be explained by markedness constraints. Laxing occurs in closed syllables (those that have codas), and since closed syllables have an extra mora, unless the length of other moras in the syllable were shortened, closed syllables would necessarily be longer than open syllables. Lax vowels tend to be shorter, therefore laxing vowels in closed syllables is probably a way of maintaining a consistent vowel length. Laxing only occurs for the non-low vowels however. Bakovic (2001) notes that in some languages low vowels can only be [-ATR], which appears to be the case in EAS. This likely has to do with the physical difficulty pronouncing a sound with an advanced tongue root when the mouth is open wide (as in low vowels), which is a position which tends to pull the tongue back in the mouth. Also, it is not the case that the [a] in EAS is on average shorter than the tense vowels, even though it is lax. In fact, lower vowels tend to be longer than higher vowels, a trend which is in conflict with the shortness of lax vowels, which by definition are lower than their tense counterparts. Although [a] does not have the mechanism of laxing to shorten it in closed syllables, it is possible that it is shortened anyway, in order to preserve a consistent syllable length. Further study would be needed to determine this.

The purpose of lenition is to solve the markedness complaint of unlicensed obstruents in the coda. NoCoda has long been treated as a universal constraint, (McCarthy and Prince 1993), and can be explained by the theory of licensing by cue proposed by Steriade (1997, 1999). According to licensing by cue, this universal aversion to codas is due to the dearth of cues for licensing segments in that position. This has led to the creation of a number of coda condition constraints that stipulate how a

particular type of sound can be licensed in the coda in a particular language. For instance, McCarthy and Prince (1993) define CODA-COND in Axininca Campa to allow nasals with the same place as a following consonant to appear in coda position. The CODA-COND created by Ito and Mester (1994) allows codas which are licensed through being linked to following onsets.

In EAS, there is a similar situation to the one proposed by Ito and Mester. Instead of a general ban on moraic consonants however, it is only obstruents which must be licensed in coda position by linking to a following consonant (Gerfen 2001a, to appear). There are of course ways of removing unlicensed codas, such as deletion of the mora or resyllabification as an onset, but a number of faithfulness constraints in EAS are ranked relatively highly, so EAS chooses to license the coda through gemination when possible. When this is not possible, aspiration is used to assimilate the place values of the preceding vowel and change the segment's consonant value from [+] to [-], which does not violate CODA-COND.

Although CODA-COND necessitates the deletion of moraic /s/, which in Spanish is used to mark plurals, EAS still maintains the distinction between singular and plural nouns. It does this by preserving vowel laxing in syllables whose /s/ has been deleted, and by length increases in either the vowel preceding lenition or the consonant following it. Both aspiration and gemination serve to fill the empty mora in the syllable left by the deleted /s/, maintaining the closed environment and triggering laxing. This is similar to the argument made by Campos-Astorkiza (1991) that this gemination after segment deletion in EAS is a example of compensatory lengthening which serves to preserve the number of segments in the input. The aspiration and gemination effects therefore, in

addition to the laxed vowel, allow speakers to continue to distinguish singulars from plurals in the absence of semantic or other markers, even after the morphological marker for plurals has been deleted. This raises an interesting question: is *s* truly the plural marker in EAS, if it is never pronounced? If asked how to form the plural, any EAS speaker would likely respond that you add an *s* to the end of a noun; if it is not pronounced, however, can it really be considered part of the morphology? Is /s/ truly the underlying segment? The answer is probably still yes, because speakers of EAS are aware that there should be an *s*, and in formal situations may even pronounce an [s]. Further research into this issue might be indicated, however.

One other interesting result of this analysis, is that it provides some evidence in the ongoing debate on the nature of /h/. Is /h/ an obstruent or not? Although it is usually described to introductory linguistics students as a fricative, which is a type of obstruent, this question has not yet been decided one way or the other. /h/ sometimes behaves like an obstruent, and sometimes not. The fact that it involves constriction and is not "singable" would seem to argue for it being an obstruent, but there is no oral constriction (only glottal), which makes it more vowel-like. Right now, /h/ is usually described as [-cons, -son], so that it is not considered a consonant, but since it is not sonorant, it cannot be a vowel. One analysis based on the experiments laid out in this thesis is that /h/ appears to act less like an obstruent and more like a sonorant, since it is allowed to appear in coda position, where unlicensed obstruents are not permitted. Another analysis however, would be that /h/ is acting like an obstruent, but is allowed in the coda because it is homorganic with the preceding vowel, since it has assimilated its place features. This explanation would require a modification to CODA-COND to allow licensing by

preceding vowels, and ranking of the other constraints would still assure that aspiration would occur only when there is no following onset. However, this would raise the question of why the assimilation of only the place features is enough to license [h], while in gemination, the entire root-node must spread to the empty mora. Therefore, although the results of these experiments don't offer any definitive answer as to the nature of [h] in aspiration, there is some evidence that it should not be treated as an obstruent.

One worrisome problem with the data is that although gemination occurred the majority of the time when a syllable with an onset followed the lenited /s/, and aspiration occurred when the syllable was onsetless, there were still a few cases in which both aspiration and gemination occurred, and a number in which neither aspiration nor gemination occurred. The cases when both occurred were few, but the cases in which neither occurred formed a significant minority. This is troublesome because it seems to deny the constraints that were ranked in Chapter 4. It is possible, however, that either normal variation in speech patterns led to some geminated consonants falling below the 35.0% increase stipulated for gemination in Chapter 3, or that the measure for detecting aspiration was not sensitive enough.

In fact, Gerfen's (2001a, 2001b, to appear) extensive research on EAS, shows that aspiration always accompanies s-lenition. Therefore, the possibility that the mechanism for detecting aspiration was not sensitive enough is a strong one. Gerfen himself suggested examining spectral slices in order to check the vowel for breathy voicing (personal communication), which could be done in future experiments. Therefore, it is possible that the pattern that seems to have been found from the data in these experiments is not as clear as it seems, and that not only should not there be any cases where neither

aspiration nor gemination occurred, but that there should be more in which both were present.

Another slight problem regards aspiration. Although for the purposes of the OT analysis, the [h] was assumed to stay in the coda where the s-lenition had taken place, instead of moving into the onset of the following word, it often sounds as if that [h] has moved into the onset. For instance, /los.o.hos/ might sound like [lɔ.ho.hɔ^{h}]. Often this [h] can be very clearly heard, and it does sound as though it has been resyllabified to form the onset of the following syllable. If this is the case however, there is a problem with the analysis. If [h] can move into the onset of a following word, why can't /s/ do it too, and escape deletion? Unfortunately, there is no way to determine once and for all how the two words are syllabified, but further experimentation could investigate whether native speakers also perceive the [h] to have entered the onset of the following word. It may, however, be the case that it only sounds as if [h] has entered the onset because that is the form the syllable is expected to take.

Future experiments could follow up on Gerfen's work (2001b) with s-lenition as well. He studied s-lenition that was occurring word internally, and found a trade-off in length between aspiration and gemination (which his research indicated co-existed with each other at places of s-lenition). The experiment performed for this thesis examined s-lenition at word boundaries, but did not look for this same trade-off, because aspiration and gemination were not found to occur simultaneously to a significant degree. As was mentioned earlier in this chapter however, there remains the possibility that the vowel experiences some breathy voicing even in the presence of the gemination of a following consonant. If this is the case, then a future experiment might also involve investigating

the same kind of length trade-off between aspiration and gemination at word boundaries that Gerfen found to occur word internally.

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Appendix A: Experiment 1 Participant Copy

This banana is not ripe enough.

The lawn is very green.

The boy opens the door.

This Slavic language is difficult to learn.

The bathroom here is very clean.

I saw the abandoned house.

The grade disappointed me.

Did she know him?

This statue depicts a hero of the war.

My daughter is ten years old.

I tried to smooth out the wrinkles.

The sky is blue.

He told me his erroneous idea.

I see the hippopotamus.

The eye is green.

He is a very fussy man.

The mask will be ready for Halloween.

That Egyptian pyramid is marvelous.

I sat down in the chair.

My teacher is very sad.

I bought a potato.

This is a chocolate donut.

She gave me a lovely basket of fruit.

He is developing a new idea.

The man uses the computer.

I bought a kaki at the supermarket.

His attitude displeases me.

Love is wonderful.

My interview is on Thursday.

I watched the agile monkey.

Did you buy me an apricot?

He hit me!

The search is not going well.

Yesterday I found a pen on the floor.

This clue didn’t help me.

After the party I took my make-up off.

His speech unbalanced me.

It has not rained and the tree is very thirsty.

That joke is not very funny.

I said good-bye and left.

She is always gossiping.

His beard is very long.

The roller coaster disoriented me.

The tribe has always lived here.

I gave my friend a peach.

The boy always plays in front of his house.

This tutu is pink, but that one is white.

I have lived here for a month.

I skied once**.**

Appendix B: Experiment 1 Master Sheet

1. Este plátano no está lo suficientemente maduro
Estos plátanos no están lo suficientemente maduros
This banana is not ripe enough.

2. El césped está muy verde
Los céspedes están muy verdes
The lawn is very green.

3. El niño abre la puerta
Los niños abren las puertas
The boy opens the door.

4. Esta lengua eslava es difícil de aprender
Estas lenguas eslavas son difíciles de aprender
This Slavic language is difficult to learn.

5. El cuarto de baño aquí está muy limpio
Los cuartos de baño aquí están muy limpios
The bathroom here is very clean.

6. Vi la casa abandonada
Vi las casas abandonadas
I saw the abandoned house.

7. La nota me decepcionó
Las notas me decepcionaron
The grade disappointed me.

8. Le conoció?
Did she know him?

9. Esta estatua representa a un héroe de guerra
Estas estatuas representan a unos héroes de guerra
This statue depicts a hero of the war.

10. Mi hija tiene diez años
Mis hijas tienen diez años
My daughter is ten years old.

11. Intenté quitar la arruga
Intenté quitar las arrugas
I tried to smooth out the wrinkle.

12. El cielo es azul
Los cielos son azules
The sky is blue.

13. Me dijo su idea errónea
El me dijo sus ideas erróneas
He told me his erroneous idea.

14. Veo el hipopótamo
Veo los hipopótamos
I see the hippopotamus.

15. El ojo es verde
Los ojos son verdes
The eye is green.

16. El es un hombre muy tiquismiquis
Ellos son unos hombres muy tiquismiquis
He is a very fussy man.

17. La máscara estará lista para Halloween
Las máscaras estarán listas para Halloween
The mask will be ready for Halloween.

18. Esa pirámide egipcia es maravillosa
Esas pirámides egipcias son maravillosas
That Egyptian pyramid is marvelous.

19. Me senté en la silla
I sat down in the chair.

20. Mi profesor está muy triste
Mis profesores están muy tristes
My teacher is very sad.

21. Compré una patata
Compré unas patatas
I bought a potato.

22. Este es un donut de chocolate
Estos son unos donuts de chocolate
This is a chocolate donut.

23. Ella me dio una cesta de fruta fantástica
Ella me dio unas cestas fantásticas de fruta
She gave me a lovely basket of fruit.

24. Está desarrollando una nueva idea
Ellos están desarrollando unas nuevas ideas
He is developing a new idea.

25. El hombre usa el ordenador
Los hombres usan los ordenadores
The man uses the computer.

26. Compre un kaki en el supermercado
Compre unos kakis en el supermercado
I bought a kaki at the supermarket.

27. Su actitud me molesta
Sus actitudes me molestaron
His attitude displeases me.

28. El amor es maravilloso
Love is wonderful.

29. Mi entrevista es el jueves
Mis entrevistas son los jueves
My interview is on Thursday.

30. Observé a el mono ágil
Observé a los monos ágiles
I watched the agile monkey.

31. Me compraste un albaricoque
Me compraste unos albaricoques
Did you buy me an apricot?

32. El me golpeó
He hit me!

33. La búsqueda no está yendo bien
Las búsquedas no han ido bien
The search is not going well.

34. Ayer encontré un boli en el suelo
Ayer encontré unos bolis en el suelo
Yesterday I found a pen on the floor.

35. Esta pista no me ayudó
Estas pistas no me ayudaron
This clue didn’t help me.

36. Después de la fiesta me quite el maquillaje
Después de la fiesta me quite el maquillaje
After the party I took my make-up off.

37. Su discurso me descoloco
Sus discursos me descolocaron
His speech unbalanced me.

38. No ha llovido y el árbol necesita agua
No ha llovido y los árboles necesitan agua
It has not rained and the tree needs water.

39. Esa broma no es muy graciosa
Esas bromas no son muy graciosas
That joke is not very funny.

40. Dije adios y me marché
I said good-bye and left.

41. Ella siempre está cotilleando
Ellas siempre están cotilleando
She is always gossiping.

42. Su barba es muy larga
Sus barbas son muy largas
His beard is very long.

43. Esquié una vez
Esquié varias veces
I skied once**.**

44. La montaña rusa me desorientó
Las montañas rusas me desorientaron
The roller coaster disoriented me.

45. La tribu siempre ha vivido aquí
Las tribus han vivido siempre aquí
The tribe has always lived here.

46. Di a mi amigo un melocotón
Di a mis amigos unos melocotones
I gave my friend a peach.

47. El niño siempre juega delante de su casa
Los niños siempre juegan delante de sus casas
The boy always plays in front of his house.

48. Este tutú es rosa pero ese es blanco
Estos tutús son rosas, pero esos son blancos
This tutu is pink, but that one is white.

49. He vivido aquí durante un mes
He vivido aquí durante varios meses
I have lived here for a month.

Appendix C: Experiment 2 Noun List

La gitana/las gitanas

José/los Josés

Pili/las Pilis

El profesor/los profesores

El chico/los chicos

Matu/los Matus

Juan/los Juanes

Manuel/los Manueles

La actriz/las actrices

Appendix D: Experiment 2 Verb Phrases

Ordering 1:

hundir el plan

echar la pelota

unir los ingredientes

hablar

heder

imitar la actriz

resistir el ataque

hipar

subir las escaleras

arrancar las páginas

crear problemas

lavar la ropa

traer los libros

orear la ropa

hornear el pan

probar la comida

abrir la puerta

hacer el trabajo

impedir el paso

hervir el agua

honrar a sus padres

salir

hurgar el fuego

pedir dinero

caer

entrar

oír el sonido

usar el ordenador

hinchar el globo

recibir el mensaje

torcer la ropa

levantar la mesa

Ordering 2:

probar la comida	hablar
impedir el paso	salir
usar el ordenador	hipar
hacer el trabajo	recibir el mensaje
hurgar el fuego	honrar a sus padres
resistir el ataque	caer
arrancar las páginas	unir los ingredientes
orear la ropa	oír el sonido
lavar la ropa	pedir dinero
crear problemas	abrir la puerta
hervir el agua	heder
entrar	torcer la ropa
subir las escaleras	echar la pelota
traer los libros	hundir el plan
hornear el pan	imitar la actriz
hinchar el globo	levantar la mesa

Ordering 3:

honrar a sus padres	abrir la puerta
unir los ingredientes	hablar
arrancar las páginas	usar el ordenador
pedir dinero	hinchar el globo
crear problemas	orear la ropa
recibir el mensaje	hornear el pan
echar la pelota	hurgar el fuego
impedir el paso	subir las escaleras
hipar	caer
oír el sonido	entrar
hundir el plan	probar la comida
torcer la ropa	levantar la mesa
lavar la ropa	heder
hervir el agua	traer los libros
hacer el trabajo	imitar la actriz
salir	resistir el ataque

Ordering 4:

usar el ordenador

orear la ropa

hundir el plan

hacer el trabajo

pedir dinero

heder

abrir la puerta

entrar

caer

honrar a sus padres

hipar

lavar la ropa

salir

resistir el ataque

torcer la ropa

impedir el paso

hinchar el globo

hablar

unir los ingredientes

hornear el pan

oír el sonido

hervir el agua

hurgar el fuego

arrancar las páginas

echar la pelota

imitar la actriz

levantar la mesa

crear problemas

traer los libros

probar la comida

recibir el mensaje

subir las escaleras

Appendix E: Complete List of Constraints Used

(1) *Closed Tense

*[+tense, -low]C.

(2) *OpenLax

*[-tense, -low]C.

(3) IDENT-[tense]

αtense → αtense

The tense value may not change from input to output.

(4) CODA-COND

Obstruents must be licensed by a following onset in order to appear in a coda.

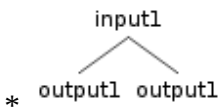
(5) IDENT

All features of the input must remain intact and appear in the output.

(6) MAX

No input may be deleted.

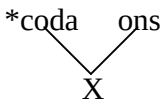
(7) Integrity



*

One input can produce only one output.

(8) *Gem



One segment may not be linked to both a coda and an onset.

(9) MAX-μ.

Any mora that is present in the input must appear in the output.

(10) DEP_{ons}

No onset not present in the input may appear in the output.

(11) MAX-[place]

No place features may be deleted from the input.

(12) IDENT-[son]

Sonorant values must be the same in the input and the output.