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An Acoustic and Perceptual Analysis of Compensatory Processes in Vowels Preceding Deleted Post-Nuclear /s/ in Andalusian Spanish*

Kristin M. Carlson
Purdue University

According to the Distinctiveness Conditions proposed by Kiparsky (1982), semantically relevant information tends to be retained in the surface structure. As a result, one would anticipate either the retention of /s/ or some compensatory mechanism to convey the information lost by its deletion in those dialects of Spanish that systematically weaken to the point of deletion said segment in syllable- and word-final positions. Following the methodologies of Hammond (1978) and Figueroa (2000), the objective of this study is to experimentally explore in Andalusian Spanish the possible existence of a phonological quantitative and/or qualitative compensatory mechanism, realized as either vowel lengthening or an open-closed vowel alternation, in an attempt to disambiguate those tokens rendered homophonous by the deletion of final /s/. Speech samples were elicited from six native speakers of Andalusian Spanish. These speech samples were then organized into a four-part perception test and administered to twenty-five participants who were also native speakers of this same dialect area. Finally, spectrographic analysis was performed on all tokens used in the perception test. This study found no systematic evidence of any compensatory mechanism at work in the vowels preceding /s/ → [ø] in word-final position. However, this investigation did find sufficient evidence for the phonemicization of vowel duration in syllable-final position within the word. An average increase of 24.4% in the length of the vowel preceding the [ø] allophone of /s/ provided the participants with adequate acoustic cues to correctly distinguish pairs such as buque [ˈβu.ke] 'ship' (n.) and busque [ˈβuø.ke] 'look for' (3SG.PRES.SUBJ) at a rate of 79.0%. The aforementioned findings concur with those of both Hammond (1978) for Miami-Cuban Spanish and Figueroa (2000) for Puerto Rican Spanish.

Key words: Andalusian Spanish, /s/ deletion, functional hypothesis, compensatory lengthening

1. Introduction

The dialects of southern Spain, the Canary Islands, and the Caribbean basin share a number of common linguistic traits which have led to their categorization into a larger linguistic community or macrodialect. One of the most salient of these phonological processes which has not only been the subject of an extremely large corpus of linguistic literature but also serves to differentiate coastal Spanish from the more conservative varieties is that of underlying /s/-weakening; specifically, the phonetic realization of the

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coronal sibilant /s/ as either the glottal fricative [h] or as phonetic zero [ø].[1] Speakers of these so-called radical or innovative dialects to which both Caribbean and Andalusian varieties pertain optionally, albeit consistently, aspirate and/or delete the phoneme /s/ in three very specific environments: syllable-final, word-final before another consonant or vowel, and absolute- or utterance-final positions.[2]

In standard Spanish, word-final /s/ denotes three prominent functions: lexical, verbal, and plural. However, only for the latter two does it bear functional weight. Word-final /s/ suffixally marks number on the elements of the noun phrase (i.e. articles, adjectives, pronouns, and nouns) and distinguishes between the second- and third-person singular verb forms in the majority of their aspectual and modal functions to the exclusion of the preterit, the preterit perfect, the affirmative imperative, and the present tense of the verb *ser*; e.g. *interesante~interesantes* 'interesting', *ella~ellas* 'she~they', *libro~libros* 'book~books', and *tiene~tienes* 'he has~you have' (2SG.PRES.IND).

Given that many phonologically radical dialects almost invariably delete the phoneme /s/ in word-final position, apart from contextual prompting such as a reported higher use of subject pronouns or some other linguistic and/or non-linguistic factors, how do these speakers compensate phonetically or phonemically to indicate number or person when context fails to do so? If we accept the Distinctiveness Conditions espoused by Kiparsky (1982:87) which maintain that "there is a tendency for semantically relevant information to be retained in surface structure" then we would naturally anticipate in these dialects either the retention of word-final /s/ where it carries a significant functional yield or some compensatory process to convey the information lost by its deletion. As a result, the deletion of this word-final morpheme is instrumental in determining the validity of the Functional Hypothesis.

The definitive work of Navarro Tomás (1939), *Dédoublement de phonèmes dans le dialecte andalou*, ignited a polemic that has lasted the better part of sixty years and which has spanned both sides of the Atlantic. Proponents of *desdoblamiento fonológico* 'phonemic doubling' suppositionally claim an expanded vocalic inventory (seven, eight, or ten) accompanied often times by a reconfiguration of the vocalic triangle proposed by Hellwag (1781) in those dialects that exhibit final consonant deletion: Cassano (1972a, 1972b), Honsa (1965) (Argentinian Spanish), Alarcos Llorach (1949,

[1] For ease of exposition, transcriptions exhibiting underlying syllable-final /s/-deletion and those which lack /s/ at the phonemic level, *pescado* [peø.ˈka.d̪o] 'fish' (n.) versus *pecado* [pe.ˈka.d̪o] 'sin' (n.), will be transcribed with phonetic zero [ø] within phonetic brackets. Said transcriptional notation should in no way be interpreted as the closed-mid front rounded vowel /ø/.

[2] It should be noted that /s/-weakening occurs before phrasal resyllabification lest the plural marker of a form like *frases* 'sentences' in the phrase *frases interesantes* 'interesting sentences' would resyllabify to the onset of the following syllable as in [ˈfra.se.si̪n.te.ɾe.ˈsa̪n.t̪es]; an environment not typically known for weakening of consonantal segments.

1958, 1964), Alonso et al. (1950), Alvar (1955), López Morales (1984), Mondéjar Cumpían (1962, 1970, 1979, 2001), Rodríguez-Castellano and Palacio (1948), Salvador (1957, 1964, 1977), Zamora Vicente (1960), (Eastern Andalusian Spanish), Navarro Tomás (1948) (Puerto Rican Spanish), and Lopez Morales (1979) (Cuban Spanish) to mention a few. Conceivably, *desdoblamiento* would serve to disambiguate those tokens rendered homophonous by the deletion of word-final /s/ since the morphological value expressed by said phoneme in standard Spanish would now be marked by vowel quality thereby potentially evincing the soundness of Kiparsky's functional assumptions. Therefore, speakers of a dialect that reportedly has *desdoblamiento* as a recuperatory mechanism for /s/ → [ø] in word-final position would be able to perceptually differentiate *libro* [ˈli.βɾo] 'book' (SG.) from *libros* [ˈli.βɾɔø] 'books' (PL.) and *vive* [ˈβi.βe] 'he/she lives' (3SG.PRES.IND) from *vives* [ˈβi.βɛø] 'you live' (2SG.PRES.IND).

Hammond (1978) pioneered and carried out the first comprehensive acoustic and perceptual analysis to empirically determine if any consistent phonetic or phonemic patterning was present in the quality of vowels directly preceding deleted /s/ in syllable- and word-final positions for bilingual native speakers of Miami-Cuban Spanish. For the acoustic portion of his study, four subjects were recorded reading a series of sentences containing specific instances in which nouns or verbs contrasted according to the presence or non-presence of the phoneme /s/ in the above-mentioned environments such as *Pablo mira tus fotos* 'Paul looks at your pictures' and *Pablo mira tu foto* 'Paul looks at your picture'. Spectrographically, he compared the qualitative and quantitative attributes of the vowels preceding /s/ → [ø] in words such as [ˈfo.toø], [ˈfo.to], and [ˈfo.tos]. With the same tokens he examined via spectrographic analysis, Hammond conducted a perception test on twenty native speakers of the Miami-Cuban dialect, two of which had also participated in the acoustic portion of his investigation.

Even though there were a few instances where the second and third formant frequencies clearly indicated a slight opening / laxing of the vowel concomitant to the [ø] allophone of word-final /s/, and although vowels in the same environment demonstrated minor quantitative differences, both of these findings were in no way systematic for word-final position. However, he did discover a significant quantitative increase of 36.3% in the vowels preceding /s/ → [ø] in word-internal position which adequately allowed the test subjects to correctly differentiate between identical sounding words such as *pescado* [peø.ˈka.ðo] 'fish' (n.) and *pecado* [pe.ˈka.d̪o] 'sin' (n.) 91.6% of the time. In summary, word-internal vowel length, not vowel opening, provided his subjects with enough acoustic information to correctly distinguish between the minimal pairs.

A study much like that of Hammond (1978) was performed by Alemán (1977).[3] She analyzed the speech samples of three native speakers of Puerto Rican Spanish and subsequently prepared a perception test with sentences and words which exhibited deleted post-nuclear /s/ in syllable- and word-final environments. This stimulus tape was played for twenty-five undergraduate students from the University of Puerto Rico. The investigator found that these students were unable to distinguish between word pairs that differed according to the presence or absence of the [ø] allophone of /-s/. However, upon spectrographic analysis of these tokens, Alemán did find that the vowels + /s/ → [ø] were repeatedly reduced in all examined syllabic and phonetic environments whereby the essence of the vowel became practically imperceptible. In marked contrast to Hammond (1978), Alemán did not find any instances of compensatory lengthening at work in syllable-final position within the word. Alemán's study empirically supports Hammond's in that they both found that vowel formant restructuring did not provide satisfactory perceptual information for native speakers of two insular Caribbean dialects of Spanish to reliably distinguish person and number when morphological /s/ was omitted. Regrettably, the spectrographic data from this study are not obtainable as the deposited copy of Alemán's thesis has been reported missing.

Following the methodology of Hammond (1978), yet expanding her research to another innovative dialect of the Caribbean, Figueroa (2000) experimentally tested the validity of vowel opening and lengthening triggered by deleted post-nuclear /s/ on six bilingual speakers of Puerto Rican Spanish. Although she did detect lengthening in approximately two-thirds of the vowel versus vowel + /s/ → [ø] pairs in sections I, III, and IV of the acoustic study, these data in no way contradict those of Hammond because despite an increase in vowel length, low correct response rates of 52.3%, 52.3%, and 62.2% respectively seem to suggest no positive correlation between the two; at least in word-final position. On the whole, her findings for Part II reinforce those of Hammond (1978) whereby a 46.7% increase in word-internal vowel length preceding deleted post-nuclear /s/ provided the participants of her perception test sufficient perceivable information to distinguish between minimal word pairs at an accuracy rate of 93.8%.

Inspired by these previous dialectal analyses and hopeful that the findings of this present research project provide inspiration for future work on the phenomenon of post-nuclear /s/-deletion in other non-conservative dialects of Spanish, this study attempted to acoustically and perceptually investigate the phenomenon of syllable-final /s/-deletion in Andalusian Spanish in order to determine the possible compensatory

[3] A personal communication between Alemán and Figueroa in 1997 is the sole source of information about the 1977 investigation.

effects this extreme process of lenition might have on the vowels immediately preceding the [ø] allophone of functional /s/.

2. Methodology

In order to make a direct comparison to Hammond (1978) and Figueroa (2000), their methodologies were adopted for this study. Speech samples were elicited from six subjects, all of whom were native speakers of Andalusian Spanish[4] between twenty-five and forty years of age. None had spent more than one year in the United States and all had completed their university education in Spain (equivalent to six years).

Two sets of sentences - Forms A and B[5] - were used to educe allophonic variants of /s/ in three specific environments: syllable-final position within a word, word-final position within a breath-group, and utterance- or absolute-final positions. The two groups of sentences provided test words that, whenever possible, contrasted phonemically according to the presence or absence of the phoneme /s/ in each of the previously mentioned environments. For instance, Form A, sentence 34 read: *Alicia sabe más que sus padres* 'Alice knows more than her/your parents' while Form B, sentence 34 read: *Alicia sabe más que su padre* 'Alice knows more than her/your father'.

Each subject was given a set of forty-eight test sentences typed on index cards, and then provided with the following oral and written instructions in Spanish: (1) look at each sentence until you can repeat it from memory; (2) place the index-card containing the sentence face-down; and (3) say the sentence. Each group of test sentences was read twice in order to allow for sufficient samples exemplifying both optional retention and deletion of final /s/. Form A was recorded on one day and Form B one to three days later so as to minimize the possibility of memorization and practice of the test sentences. The purpose of the experiment was never divulged to any of the subjects prior to the completion of all recordings.

After the recordings were completed, these collected speech samples (i.e. the words and sentences under investigation) were organized into a four-part perception test as follows:

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[4] Despite the fact that many accept the subdialectal division of Andalusia into eastern and western regions, depending upon the specific means of compensation for the information lost, I will subsume both dialect areas into one; since, to my knowledge, no acoustic studies have been carried out in western Andalusia and acoustic-based studies present for eastern Andalusia are rather scant. Nevertheless, in order to be able to carry out a comparative observation between these two subdialect areas, three of the six subjects that participated in the acoustic portion of this study are native speakers of western Andalusia.

[5] See Appendix.

Part I: Sentences with the test word in utterance-final position

1. Eleven contextually ambiguous sentences, each appearing twice, with /s/ → [ø] in word-final position; e.g. *Creo que la ves* [ˈβeø] 'I believe that you (2SG.PRES.IND) see her.'
2. Eleven contextually ambiguous sentences, each appearing twice, without /s/ → [ø] in word-final position; e.g. *Creo que la ve* [ˈβe] 'I believe that (s)he sees her.'
3. Five contextually ambiguous control sentences, each appearing twice, in which /s/ → [s] in word-final position; e.g. *Creo que la ves* [ˈβes] 'I believe that you (2SG.PRES.IND) see her.'

Part II: Isolated words, from within a sentence, with and without word-internal /-s/ → [ø]

1. Three minimal pairs, each appearing twice
   a. *pecado* [pe.ˈka.d̪o] 'sin' (n.) and *pescado* [peø.ˈka.ðo] 'fish' (n.)
   b. *patillas* [pa.ˈti.ʝas] 'sideburns' and *pastillas* [paø.ˈti.jas] 'pills'
   c. *buque* [ˈβu.ke] 'ship' (n.) and *busque* [ˈβuø.ke] 'look for' (3SG.PRES.SUBJ)
2. Two control words, each appearing twice, in which /s/ → [s]
   a. *pescado* [pes.ˈka.ðo]
   b. *busque* [ˈβus.ke]

Part III: Isolated words, from utterance-final position, with and without word-final /s/ → [ø]

1. Six words, each appearing twice, with /-s/ → [ø]; e.g. *pueblos* [ˈpwe.βloø] 'towns'
2. Six words, each appearing twice, without /-s/ → [ø]; e.g. *pueblo* [ˈpwe.βlo] 'town'
3. Three control words, each appearing twice, in which /-s/ → [s]; e.g. *fotos* [ˈfo.tos] 'photographs' (n.)

Part IV: Isolated words, from within a breath group, with and without word-final /s/ → [ø]

1. Five words, each appearing twice, with /-s/ → [ø]; e.g. *con mis sastres* [ˈmiø] 'with my tailors'
2. Five words, each appearing twice, without /-s/ → [ø]; e.g. *con mi sastre* [ˈmi] 'with my tailor'
3. Two control words, each appearing twice, in which /-s/ → [s]; e.g. *las frases* [ˈfra.ses] 'the sentences'

The completed sound-files for the perception test contained a total of forty-four

sentences, fifty-six words, and twenty-four control items which were administered to twenty-five participants, all of whom shared similar criteria for admissibility in this part of the study as did those subjects who participated in the acoustic study. It should be noted that two of the subjects from the acoustic study were also included in the set of participants for the perception test so as to ascertain how these speakers might perceive their own speech.

Each participant was provided with an electronic answer sheet that included written instructions for each section in Spanish and only two choices for each item: one containing /-s/ and the other without /-s/. Subsequently, each subject was then asked to select the word they perceived from the linked sound-files on the provided answer sheet. The most convenient method to administer the perception test taking into account the significant geographic distance between the researcher's assistant and the participants was by means of an interactive form accessible via the Internet.

3. Data analysis

3.1 Perception test

A preliminary examination of the data amassed from the entire perception test warrants two general remarks. To begin, the correct response rates of the twenty-five participants were relatively high for Part II of the perception test which analyzed lexical pairs exhibiting a word-medial contrast with respect to the presence or absence of deleted post-nuclear /s/. Conversely, however, their correct response rates were markedly lower for Parts I, III, and IV of the same test which investigated the aforementioned phonetic contrasts but in word-final position.

Table 1. Percentage of correct responses by participants to all items of the perception test (excluding control items)

Test Section	Total Number of Responses	Number of Correct Responses	Percentage of Correct Responses
I	1100	595	54.1
II	300	237	79.0
III	600	340	56.7
IV	500	275	55.0
I-IV	2500	1447	57.9

Table 1 summarizes the performance of all twenty-five participants on each of the four sections of the perception test as well as indicates the overall percentage of

correct responses for the test in its entirety.[6] The participants responded with the highest rate of accuracy to the test items in Part II at a percentage of 79.0 as compared to Parts I, III, and IV with percentages of 54.1, 56.7, and 55.0 respectively. Part II differed noticeably from the other three test sections in that it examined the participants' ability to distinguish isolated lexical pairs where word-internal, post-nuclear /s/ was either never present or deleted; e.g. *buque* ['βu.ke] 'ship' (n.) versus *busque* ['βuø.ke] 'look for' (3SG.PRES.SUBJ). Parts I, III, and IV, on the other hand, successively investigated pairs of complete sentences with and without post-nuclear /s/ in utterance-final position, isolated minimal pairs with and without deleted post-nuclear /s/ in word- and utterance-final positions, and isolated word pairs excised from within a breath-group with and without post-nuclear /s/ in word-final position. When compared against the higher percentage of correct responses from Part II, the results from the remaining three sections of the perceptual task conspicuously suggest that there is indeed some type of acoustic variation between the vowels preceding deleted word-medial /-s/ as opposed to those same vowels in word-and / or utterance-final positions.

Given that exactly half of the test items for all four parts of the perception test exhibited /-s/ → [ø], a participant unable to discern any phonemic distinction in the vowels preceding this deleted phoneme would roughly score 50.0% on each section. In light of this, low correct response rates of 54.1%, 56.7%, and 55.0%, corresponding to Parts I, III, and IV, not only imply that the participants had little, if any, ability to distinguish phonemic differences between the vowels of each minimal pair, but also that any deviation slightly greater than 50.0% can only be attributed to utter probability. In the subsection to follow, spectrographic evidence will be offered which not only substantiates the participants' notable success in the discrimination of word-medial contrasts from Part II but also these data will demonstrate a positive correlation with respect to their inability to distinguish lexical pairs with and without word-final /s/-deletion in Parts I, III, and IV.

A compilation of all of the data from Parts I through IV of the perception test with respect to the participants' ability to perceive items with /-s/ → [ø] versus those without final /s/ reveals that the participants responded with only 28.8% accuracy to test items manifesting /-s/ → [ø]. Particularly, out of 1250 occurrences of tokens exhibiting final /s/-deletion, only 360 were perceived correctly, yet from the 1250 occurrences of tokens lacking final /s/, 1087 were correctly identified. As a result, one can conclude that these native speakers of Andalusian Spanish rarely found adequate acoustic cues upon which to rely in order to successfully discern tokens without final

[6] In no instances did the participants fail to provide a usable response to any of the items on the perception test; namely, each participant completed all four parts of the test without leaving any entries blank.

/s/ and those with deleted final /s/. Even though exactly one-half of the lexical items exhibited the deletion of post-nuclear /s/, the test participants tended to more successfully identify lexical items lacking underlying /-s/ which seems to indicate a tendential preference towards the singular (pro)nominal and verbal forms when the sibilant [s] was not heard.[7]

Specific mention should be made that a number of other linguistic and extra-linguistic factors were taken into consideration as bearing possible influence on the participants' comprehensively better discriminatory performance on Part II of the perception test. These factors included the preceding vowel, the grammatical category of the lexemes under study (verbs versus non-verbs), own speech recognition by two test-subjects included in the participant pool, regional origin of the test-subjects and the participants, and gender of the test-subjects as well as that of the participants. It was found that none of these potential determinants above and beyond that of segmental environment, specifically that of word-internal position, provided enough supplemental audible information to aid participants in their ability to accurately and regularly make the distinction between tokens with /-s/ → [ø] and those without.

3.2 Acoustic study

[7] As previously mentioned in the introduction, word-final /s/ serves three principal functions- two of which are grammatical in nature: (1) the plural morpheme for nouns and their corresponding determiners and adjectival modifiers as in *las cosas pequeñas* 'the small/little things'; (2) the verbal morpheme marking 2nd person singular forms for most aspectual and modal functions as in *ves* 'you see' (2sg.pres.ind); and (3) an integral part of the lexical word as in *tenis* 'tennis'. On the other hand, syllable-final, word-internal /s/ bears a comparatively lower functional load in that there are relatively fewer minimal pairs distinguished by /-s/ and /-s/ → [Ø]. Furthermore, /-s/ in the word-internal position serves no other function than to form part of the lexeme. Though the potential for ambiguity and therefore general confusion is ever present between minimal pairs with final /s/ and those without, this is uncommon as other components of the grammar tend to compensate for the loss of /-s/. Terrell (1977, 1978, 1979) and Lafford (1989) suggest that within the noun phrase at least one constituent (most frequently a determiner) tends to retain some form of the non-lenited variant in word-final position. Moreover, others like Poplack (1979, 1980) and Hochberg (1986a, b) found a higher proportion of pronoun use in word-final /s/-deleting dialects thereby potentially resolving any ambiguity within the language's verbal morphology. Generally speaking, languages tend to accommodate phonological reduction by means of some type of grammatical / morphological compensation. In the case of post-nuclear /s/ → [Ø] in word-internal environments, it is not surprising to find a compensatory mechanism as well, that of lengthening of the preceding vowel, which disambiguates minimal pairs since the elements of the immediate noun phrase may not be enough to provide adequate or any contextual distinction; compare *un pescado* [peØ.ˈka.d̪o] *grande* 'a big fish' and *el pecado* [pe.ˈka.d̪o] *grande* 'a big sin'.

The minimal pairs under analysis from the perception test were spectrographically examined in order to determine two fundamental parameters: vowel length and vowel quality. As anticipated, the acoustic data empirically support the perceptual findings previously detailed in Section 3.1. Table 2 compares vowel length measurements of the pairs [a] versus [aø], [e] versus [eø], and [u] versus [uø] when they occur in word-internal, syllable-final position; i.e. from Part II. Corresponding spectrograms are provided as well. The data show that there was a marked increase in the length of the syllable exhibiting vowel + /s/ → [ø] over just the vowel alone, especially with respect to /a/ and /u/ thereby providing the listener with enough acoustic information to correctly distinguish between the test items. It is worth noting that the minimal pair most frequently missed on this section, *pecado* [pe.ˈka.d̪o] and *pescado* [peØ.ˈka.d̪o] exhibited the smallest increase in the duration of the vowel (7.0%).

Table 2. Comparison of vowel length on Part II of perception test: vowel versus vowel + /s/ → [ø]

Word	Length of V or V + [ø] of Initial Syllable	Total Length of Word	Length Ratio Syllable/Word	Increase in Length of Syllable with V + [ø] over V Alone
buque	129.9	420.8	30.9%	32.2%
buøque	191.7	485.4	39.5%	
patillas	82.6	561.0	14.7%	34.1%
paøtillas	125.3	623.8	20.1%	
pecado	91.2	351.9	25.9%	7.0%
peøcado	98.1	351.5	27.9%	
Average				24.4%

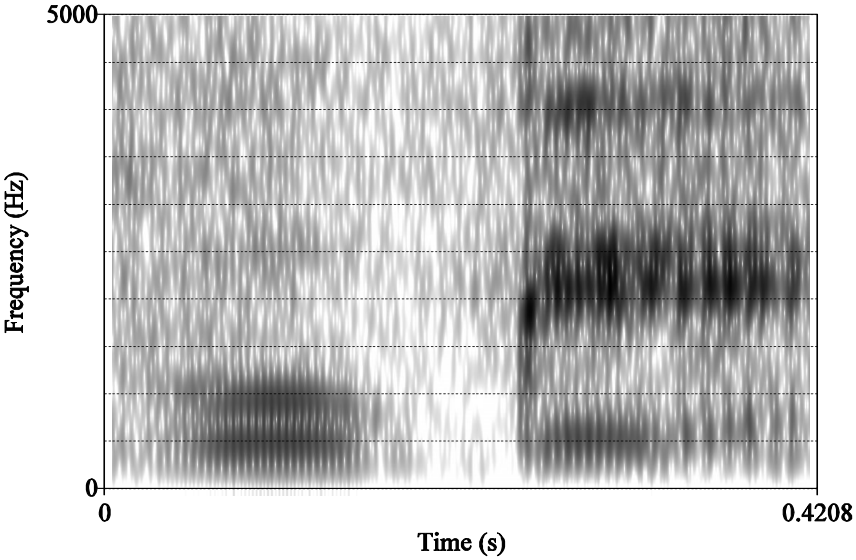

Figure 1. Spectrogram of *buque* [ˈβu.ke] 'ship' (n.)

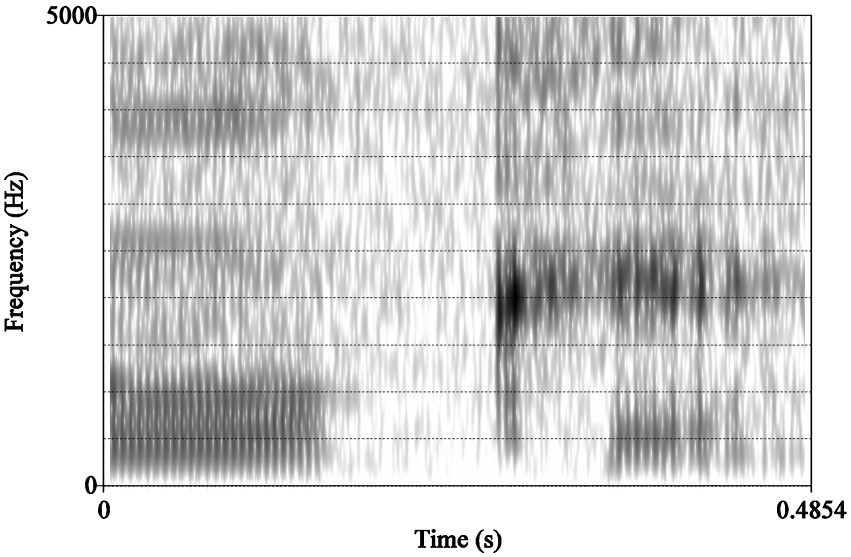

Figure 2. Spectrogram of *busque* [ˈβuø.ke] 'look for' (3SG.PRES.SUBJ)

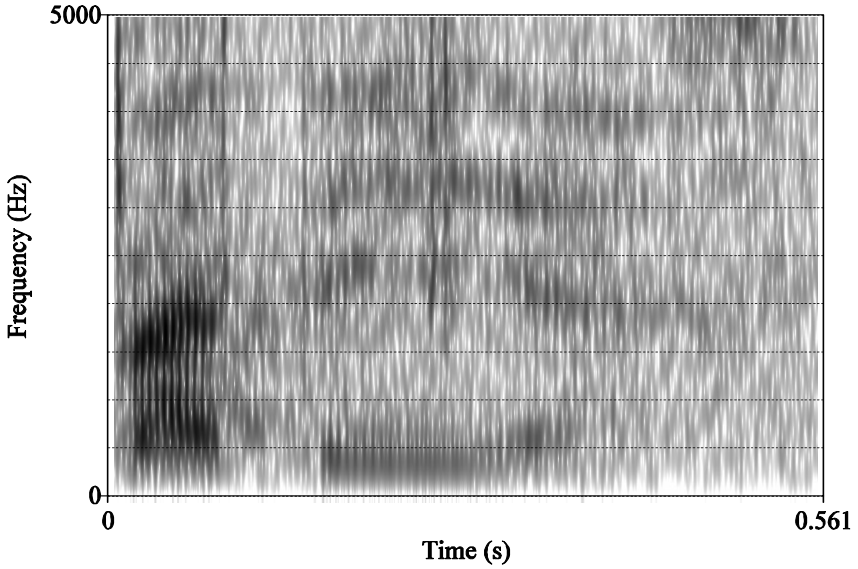

Figure 3. Spectrogram of *patillas* [pa.ˈt̪i.ʝas] 'sideburns'

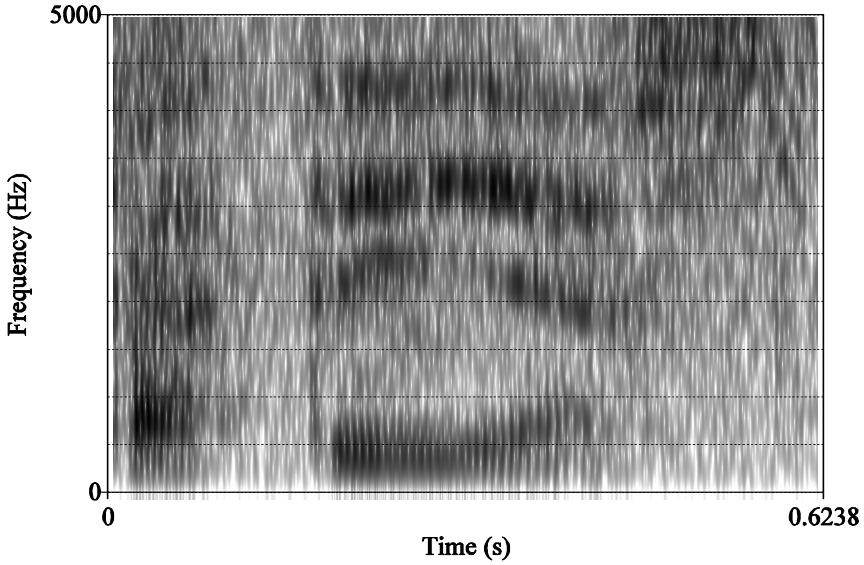

Figure 4. Spectrogram of *pastillas* [paø.ˈt̪i.ʝas] 'pills'

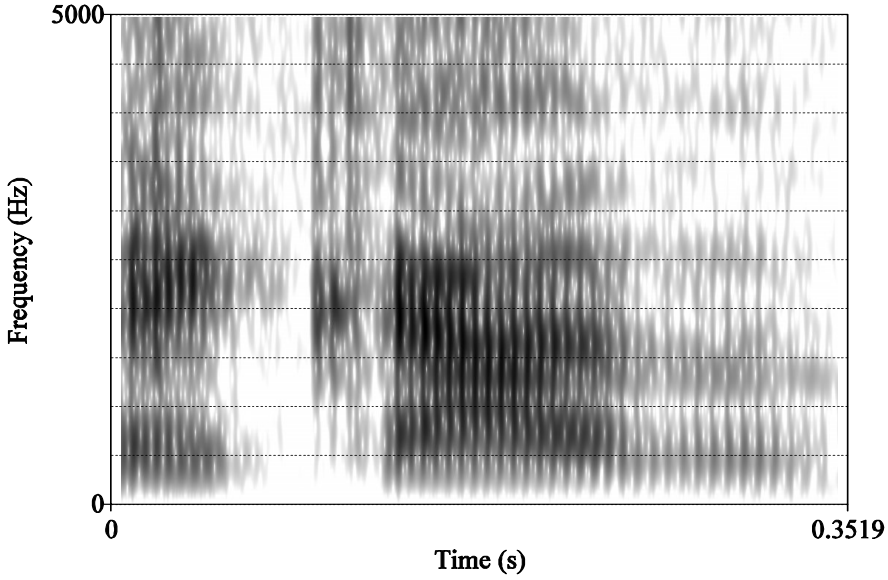

Figure 5. Spectrogram of *pecado* [pe.ˈka.ð̞o] 'sin' (n.)

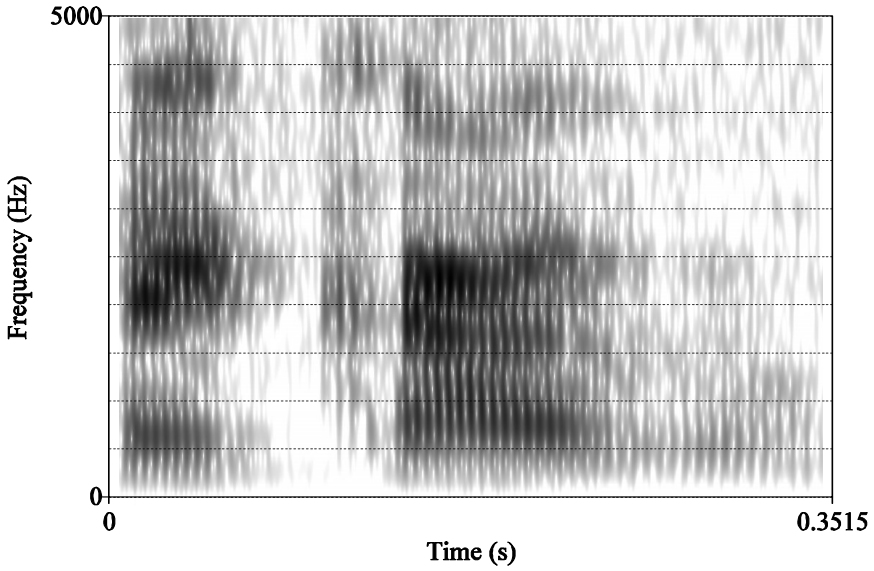

Figure 6. Spectrogram of *pescado* [peø.ˈka.ð̞o] 'fish' (n.)

The spectrographic data also reveal that there were no consistent, systematic differences in the length of the vowel + /s/ → [ø] compared to the length of the vowel alone in word- and utterance-final positions for the twenty-two word pairs analyzed in Parts I, III, and IV. In fifteen of the pairs, the vowel followed by the [ø] allophone of /s/ was from 1.0% - 42.7 % longer while in seven of the pairs, the vowel followed by the same variant was from 1.3% - 59.5% shorter. Overall, the length of the vowel preceding the [ø] allophone of /s/ was slightly longer than the syllable with just the vowel alone in

68.2% of these twenty-two contrastive tokens. Nevertheless, not only did word-final length distinctions fail to ensure a correct response by the listener (as suggested by their low response rates on these three portions of the perception test), but also there is no evidence in favor of a positive correlation between any specific word and word length. For example, one finds the same word from Part I, *buscas* [ˈβus.kaø] 'look for' (2SG.PRES.IND), with both an increase and a decrease in total length, respectively 8.9% and 51.2%. In addition, despite the fact that the word *casas* [ˈka.saø] 'houses' from Part III shows a 42.7% increase in length, only two participants were successfully able to identify it. Furthermore, the word *comprendes* [kom.ˈpɾen̪.d̪eø] 'comprehend' (2SG.PRES.IND) from Part I shows a slight decrease in word length by 12.7% yet was identified correctly in one of its instances in the perception test by fourteen of the twenty-five participants.

Vowel quality was also examined in order to determine if an allophonic alternation of vowels was another possible factor that might have helped the participants successfully discriminate between tokens with a vowel alone or a vowel + [ø] in Part II of the perception test. Resonant frequencies for the vowels under investigation were collected and evaluated since these unequivocally identify each vowel as unique from all others. Formant values vary with each production of a specific speech sound and, as a result, one must look for steady trends in their movement in order to categorize, with some degree of certainty, a vowel as more open or closed with respect to another. More specifically, a lower F1 value indicates a higher articulatory positioning of the tongue and a higher F2 value implies a more front articulatory positioning of the tongue in the buccal cavity. For example, a consistent increase in F1 and decrease in F2 values determine whether /i/ and /e/ have laxed to /ɪ/ or /ɛ/, a consistent increase in both F1 and F2 values indicates whether /u/ and /o/ have laxed to /ʊ/ and /ɔ/, and, finally, a consistent decrease in both formant values suggests that /a/ has laxed to /ɑ/.

In comparing the formant frequencies for each of the three minimal pairs tested in Part II, one finds no regular differences in the structure of the formants between the vowels alone and when followed by deleted post-nuclear /s/. Even though the vowel preceding /s/-deletion in the lexeme *busque* [ˈβuø.ke] 'look for' (3SG.PRES.SUBJ) did exhibit a slight increase in the values of F1 and F2 suggesting a slight opening or laxing of that vowel, considering that none of the other word pairs demonstrated a similar allophonic alternation, one can feel confident that the differences observed were not deliberate. Therefore, the participants must have relied solely on a contrast in vowel duration to correctly identify the test words in this section of the perception test.

The formant structure of the vowels under investigation in Parts I, III, and IV do not provide patterned evidence either of an alternation in vowel quality, neither for all instances of the same vowel nor for all the vowels analyzed together. A study of the first

formant frequencies, F1, for the vowels within each of the twenty-two minimal pairs showed that, in eight of the pairs, the F1 frequencies were from 9 Hz. to 231 Hz. higher for the vowel not followed by /-s/ → [ø] and in the remaining fourteen pairs, the F1 frequencies were from 2 Hz. to 239 Hz. lower for the vowel not followed by the [ø] variant of /-s/. An examination of the second formant frequencies, F2, for the vowels under study revealed that, in ten of the pairs, the F2 frequencies were from 9 Hz. to 267 Hz. higher for the vowel not followed by post-nuclear /s/-deletion and in the remaining twelve pairs, F2 frequencies were from 4 Hz. to 329 Hz. lower. Finally, a comparison of the third formant frequencies, F3, for these same vowels showed that in exactly half of the pairs, the F3 frequencies were from 9 Hz. to 287 Hz. higher for the vowel not followed by a deleted post-nuclear /s/ and in the remaining eleven pairs, F3 frequencies were from 5 Hz. to 374 Hz. lower for vowels not followed by the [ø] allophone of /s/. In 27.3% of the twenty-two minimal pairs, lower second and third formant frequencies for vowels followed by /s/ → [ø] seem to indicate that these vowels could be characterized as more open or less tense. However, as the relatively low occurrence rate indicates, no consistent qualitative vowel alternation compensates for post-nuclear /s/-deletion in word-final position for these particular speakers of Andalusian Spanish.

Table 3 compares the formant structures of seven sets of words spoken by three of the test-subjects, S1, S2, and S4, since they produced more examples of the sibilant [s] in their original recordings. This table presents a three-way comparison of tokens which exhibit the vowel alone, the vowel followed by the [s] allophone of /s/, and the vowel followed by the [ø] allophone of /s/. Corresponding spectrograms for four of these word pairs exhibiting the vowel alone and the vowel followed by /-s/ → [ø] are provided as well. Two words from each set were taken directly from the perception test-tape; e.g. *prima* ['pɾi.ma] 'cousin' (f.) versus *primas* ['pɾi.maø] 'cousins' (f.). The remaining word exhibiting /-s/ → [s], e.g. *primas* ['pɾi.mas], was taken from the original recordings of test-sentences A or B. The data provide no evidence of any unvarying decrease in the formant structures for the syllable followed by [ø]. All analyzed vowel formants for each set of three words show both an increase and decrease in F1, F2, and F3 frequencies. In light of the evident dearth of any noteworthy qualitative alternation in the vowels examined in Parts I-IV of the perception test, phonemic status cannot be afforded to open vowels in this particular dialect of Spanish.

Table 3. Comparison of formant structures of seven sets of words from subjects S1, S2, and S4: vowel, vowel + /s/ → [s], and vowel + /s/ → [ø]

Word		Subject	First Formant	Second Formant	Third Formant
prima	[ˈpɾi.ma]	S2	730	1552	2297
primas	[ˈpɾi.mas]	S2	576	1706	2050
primaø	[ˈpɾi.maø]	S2	499	1654	2311
busca	[ˈβus.ka]	S2	777	1480	2167
buscas	[ˈβus.kas]	S2	798	1634	2786
buscaø	[ˈβus.kaø]	S2	791	1639	2158
ve	[ˈβe]	S4	831	1986	3029
ves	[ˈβes]	S4	689	1994	2896
veø	[ˈβeø]	S4	794	1870	2856
salga	[ˈsal.ɣa]	S4	788	1584	2565
salgas	[ˈsal.ɣas]	S4	702	1646	2729
salgaø	[ˈsal.ɣaø]	S4	739	1614	2635
pecado	[peˈka.d̪o]	S2	613	2052	2473
pescado	[pesˈka.d̪o]	S2	662	2017	2984
peøcado	[peøˈka.d̪o]	S2	611	2118	2473
taxi	[ˈt̪ak.si]	S1	467	2278	3007
taxis	[ˈt̪ak.sis]	S1	491	2124	2780
taxiø	[ˈt̪ak.siø]	S1	519	2348	2829
foto	[ˈfo.t̪o]	S1	737	1461	2719
fotos	[ˈfo.t̪os]	S1	749	1442	2631
fotoø	[ˈfo.t̪oø]	S1	756	1452	2592

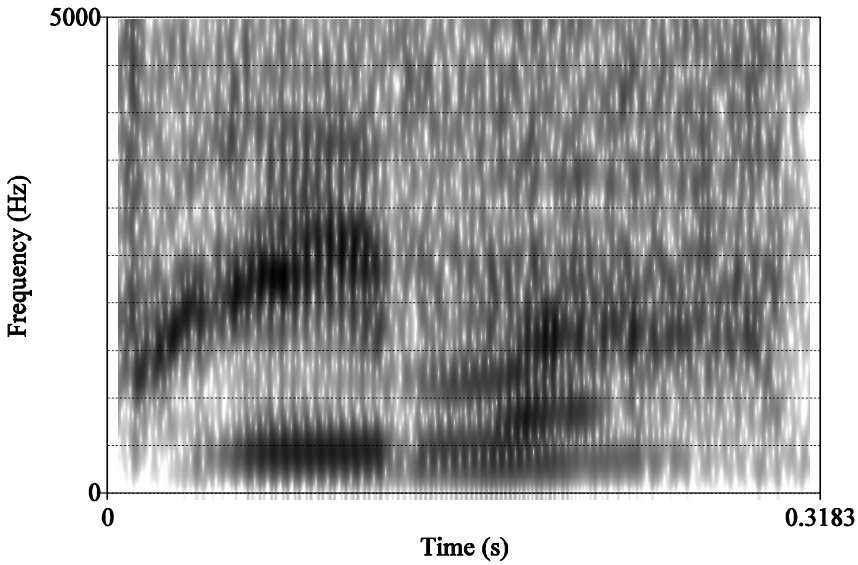

Figure 7. Spectrogram of *prima* [ˈpɾi.ma] 'cousin' (f.)

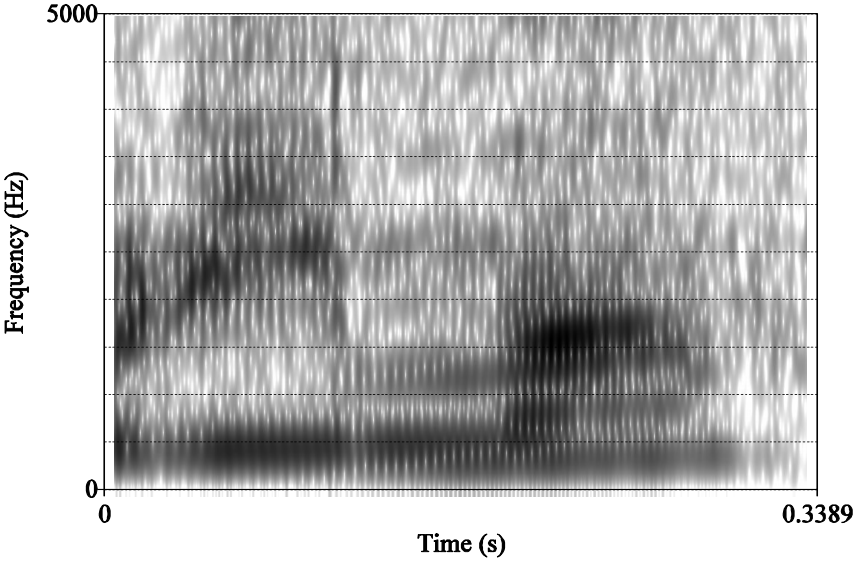

Figure 8. Spectrogram of *primas* [ˈpɾi.maɣ] 'cousins' (f.)

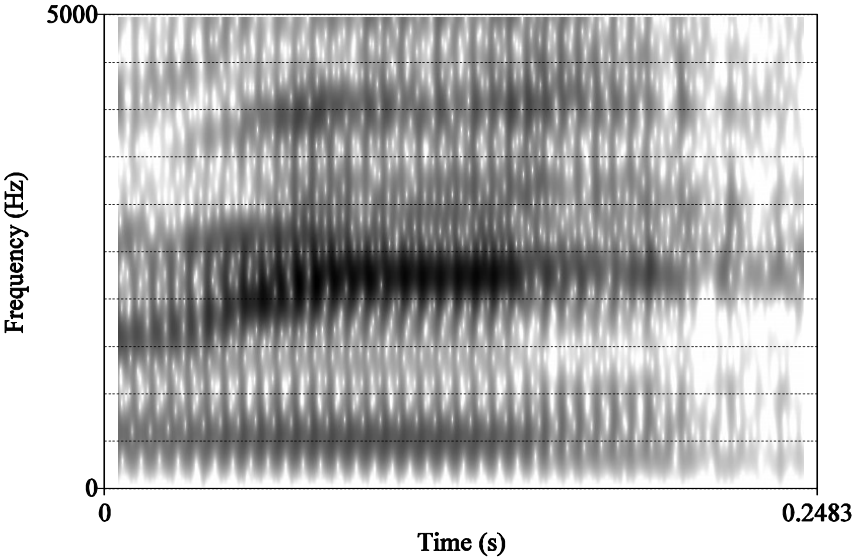

Figure 9. Spectrogram of *ve* [ˈβe] 'sees' (3SG.PRES.IND)

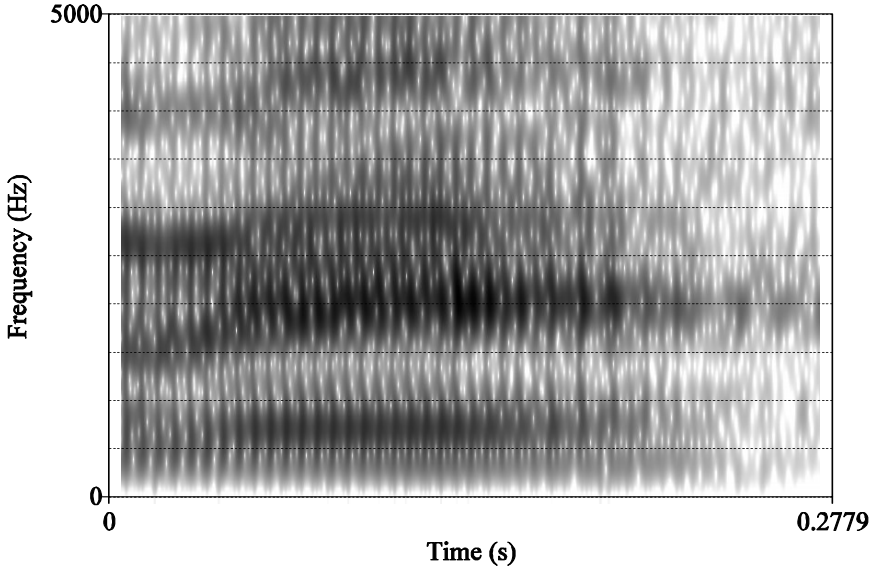

Figure 10. Spectrogram of *ves* [ˈβeø] 'see' (2SG.PRES.IND)

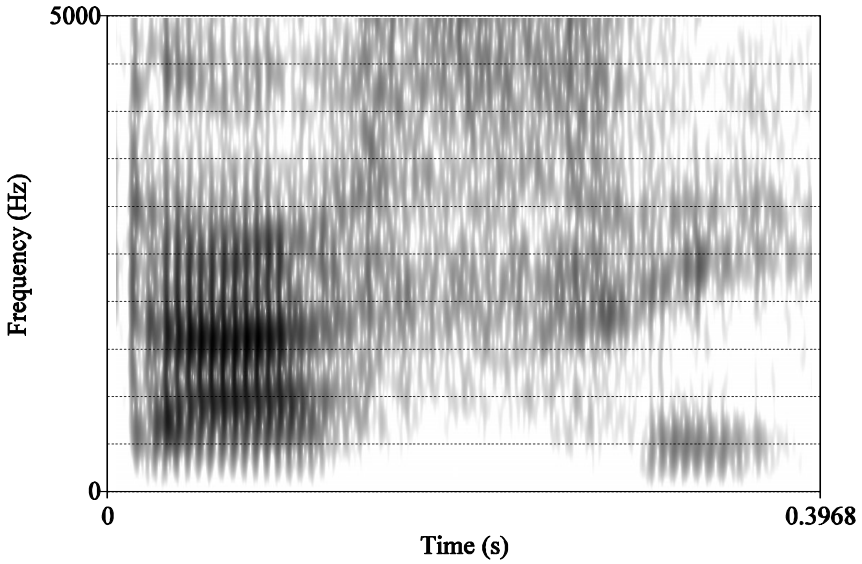

Figure 11. Spectrogram of *taxi* [ˈt̪ak.si] 'taxi' (n.)

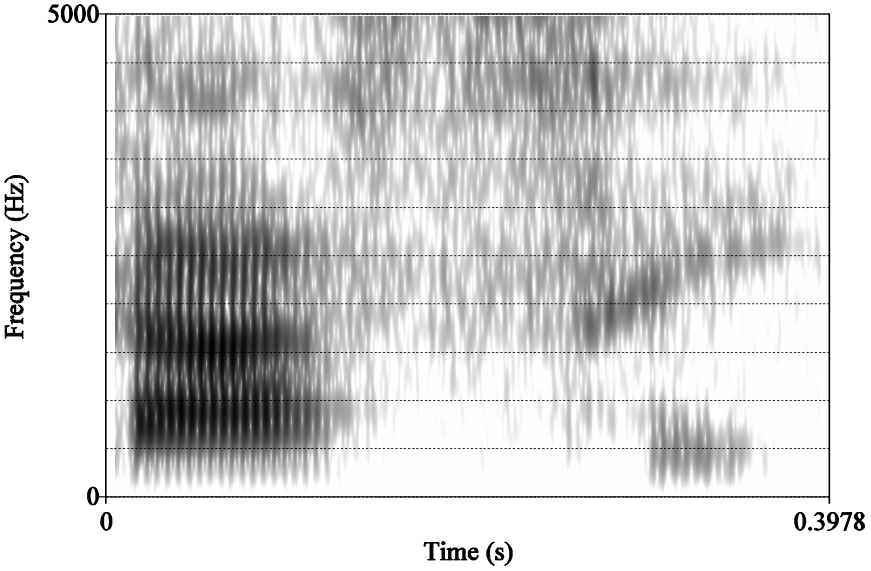

Figure 12. Spectrogram of *taxis* [ˈt̪ak.siø] 'taxis' (n.)

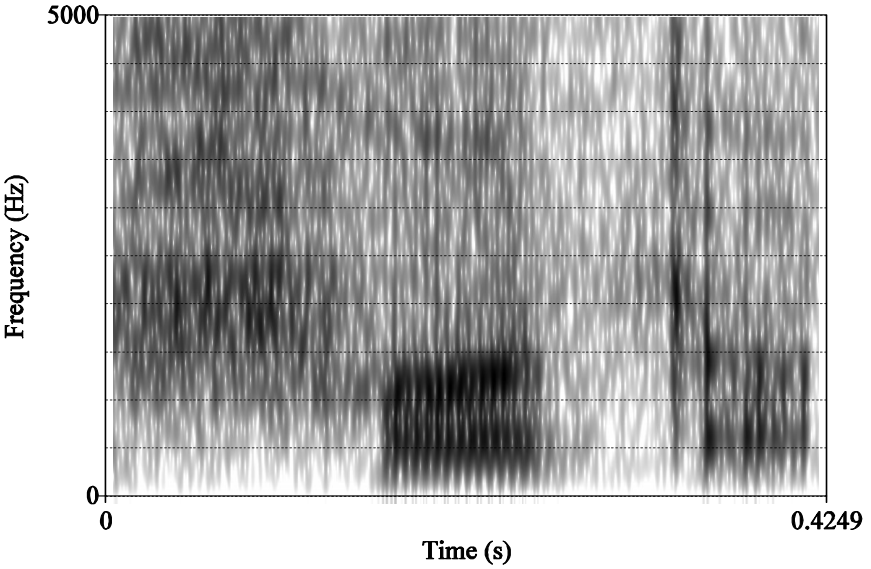

Figure 13. Spectrogram of *foto* [ˈfo.t̪o] 'photograph' (n.)

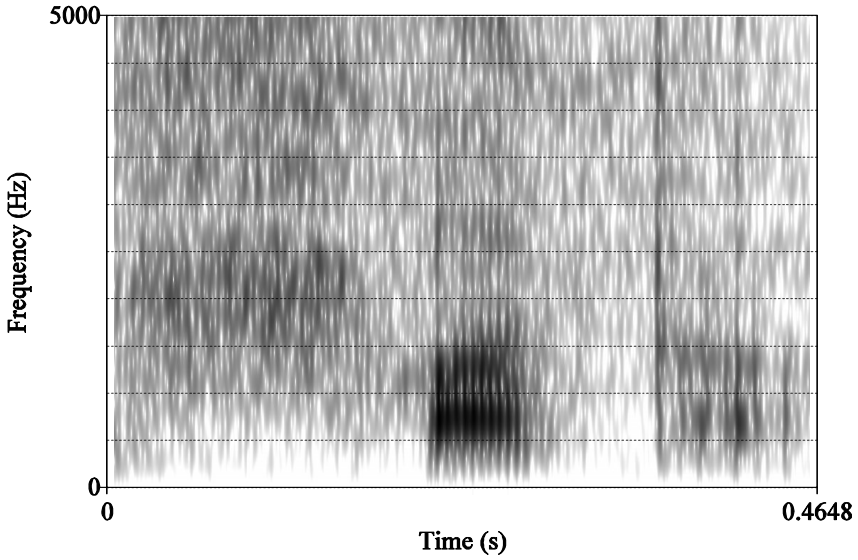

Figure 14. Spectrogram of *fotos* ['fo.t̪oø] 'photographs' (n.)

The results of this study with regard to the percentage of correct response rates on the perception test reinforce the findings of both Hammond (1978) and Figueroa (2000) who both reported comparably high positive response rates for Part II (91.6% and 93.8% respectively), and relatively low correct response rates for Parts I (60.5% and 52.3%), III (51.5% and 52.3%), IV (56.0% and 62.3%), and overall (59.5% and 58.6%). It is interesting to note that the item(s) in Part II that caused the greatest number of difficulties in all three of our studies were the tokens with the smallest increase in syllable length over the syllable with just the vowel alone. However, while these specific test-words demonstrated a 35.6% (Hammond 1978) and 38.0% (Figueroa 2000) increase and were correctly identified at rates of 55.0% and 65.0% respectively, the item most frequently missed from this study at a rate of 100% showed a very minimal increase in length (7.0%) indicating that at no point did the compensatory process of vowel lengthening in this test-word provide adequate acoustic indications for correct discrimination. The present findings are in marked contrast to those of Alemán (1977) as she did not report any compensatory lengthening in the vowels preceding /s/ → [ø] in syllable-final position within the word.

Similar to Figueroa (2000), yet in contrast to Hammond (1978), in the comparative measurements of segment length of the word pairs from Parts I, III, and IV of the perception test, lengthening occurred in 68.2% of the tokens exhibiting a vowel followed by the [ø] variant of /s/ in word-final position. These findings contrast with those of Hammond (1978) as he did not find any significant instances of increased syllable length for vowels followed by /s/ → [ø] in the same environment.

The analysis of the formant frequency data in all three studies showed quite similar tendencies. A lack of consistency in F2 and F3 values for the majority of the tokens studied led us to conclude that no systematic, qualitative alternation exists between vowels in syllables closed by a deleted /s/ and vowels in open syllables. Overall, barring a few minor exceptions, the format frequency values for this study were within the ranges reported in the two previous studies. As such, the results of this study confirm the findings of both Hammond (1978) and Figueroa (2000) for another coastal variety of Spanish.

4. Conclusions

The main objective of this study was to examine one of the most frequently discussed phonological processes in Spanish, that of syllable-final /s/-deletion, in an attempt to identify the possible existence of any systematized compensatory phonetic and/or phonemic mechanisms employed by native speakers of Andalusian Spanish to resolve the ambiguity left in the wake of final /s/-deletion. Many previous descriptive studies have impressionistically claimed, in those dialects that exhibit final consonant deletion, an expanded vocalic inventory directly resulting from post-nuclear /s/-deletion; that is a phonemic restructuring sans empirical corroboration.

The experimental data from this study not only refute those hypotheses favoring *desdoblamiento fonológico* in Andalusian Spanish but also demonstrate that, in word- and utterance-final positions, no compensatory mechanism (neither vowel lengthening nor an open ~ closed vowel alternation) serves to disambiguate word pairs rendered homophonous by the deletion of post-nuclear /s/. The participants' low correct response rates for Parts I (54.1%), III (56.7%), and IV (55.0%) of the perception test coupled with the data from the spectrographic analysis, which reveal a lack of any regular increase in vowel length or decrease in the second and third formant frequencies, not only undermine Kiparsky's Distinctiveness Conditions (1982) but also do not provide evidence in favor of phoneme identification.

On the other hand, a phonological compensatory process of vowel lengthening does occur in Andalusian Spanish in order to distinguish word-medial contrasts with respect to the presence or absence of deleted post-nuclear /s/. The length of the preceding vowel + [ø] increased an overall average of 24.4% over the length of the vowel alone, thereby providing the participants with acceptable acoustic cues to correctly distinguish these same pairs at a considerable rate of 79.0% on Part II of the perception test.

In light of these findings, an expanded set of phonemes above the traditional five-vowel system for Spanish cannot be proposed for this dialect as there appears to

be no consistent phonemic or phonetic contrast between open and closed vowels preceding /s/ → [ø], /s/ → [s], and [ø] in syllable-final position both word-internally and word-finally in Andalusian Spanish.

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School of Languages and Cultures, Department of Spanish and Portuguese
Purdue University
Indiana, USA
carlsokm@purdue.edu

Appendix[8]

Test sentences- Form A

*1. Me lo dijo ayer.
*2. El tren sale a las ocho.
3. ¿No te gusta jugar al tenis?
4. Ayer pintaron la casa.
5. Es cierto que lo busca.
*6. Juan trabaja mucho en la universidad.
7. Roberto es el hombre con barba y patillas.
8. No creo que salga.
9. Pablo mira tus fotos.
10. Estaba muy contento.
11. Es posible que lo haga.
12. No conozco esa metrópoli.
*13. El ideal de esta gente no consiste en gobernar, sino en ser gobernados.
14. Puedes escribir con bolígrafo o con lápiz.
*15. Tengo que estudiar ahora.
16. No he pasado nunca por esas calles.
17. Esta es la lección que no entiende.
18. Tengo el libro que buscas.
*19. Aunque me gusta cantar, prefiero bailar.
20. En este barrio buscábamos las casas.
21. ¿A qué hora llega el buque?
22. Es importante que salgas.
*23. Fuiste a la fiesta, ¿verdad?
24. ¿Dónde están esos pueblos?
*25. No dejes de escribirme.
26. Una es para mi tía y la otra es para mis padres.
*27. Cuando vaya a mi pueblo no deje de avisarme.
28. No me gusta comer el arroz.
29. Las cosas pequeñas las meteré en la maleta.
*30. Voy a la escuela mañana.
31. Obtuve el pasaporte y nos fuimos para París.
*32. No has terminado el trabajo todavía.
33. Juan es muy alto.
34. Alicia sabe más que sus padres.

[8] Starred items are control sentences.

35. El matar es un gran pecado.
36. Dudo que lo hagas.
37. Esos hombres se fueron en taxis.
38. Los camiones no pasan por esa calle.
39. ¿Quieres acompañarme a hablar con mi sastre?
40. Favor de prestarme tu libro.
*41. Las niñas del colegio se pusieron a cantar.
42. Sus padres se fueron para ese pueblo.
43. Los señores viven en estas casas bonitas.
44. Hay varios problemas que no comprendes.
45. ¿Dónde está la casa de su prima?
46. Favor de repetirme la frase otra vez.
47. Creo que la ve.
48. Creo que la ves.

Test Sentences- Form B

*1. Tengo que estudiar ahora.
*2. Voy a la escuela mañana.
3. ¿No te gusta jugar al tenis?
4. Ayer pintaron las casas.
5. Es cierto que lo buscas.
*6. El tren sale a las nueve.
7. Tengo que tomar estas pastillas.
8. No creo que salgas.
9. Pablo mira tu foto.
10. Estaban muy contentos.
11. Es posible que lo hagas.
12. No conozco esas metrópolis.
*13. Las niñas del colegio se pusieron a cantar.
14. Favor de repetirme las frases otra vez.
*15. No has terminado el trabajo todavía.
16. No he pasado nunca por esa calle.
17. Esta es la lección que no entiendes.
18. Tengo el libro que busca.
*19. Cuando vaya a mi pueblo no deje de avisarme.
20. En este barrio buscábamos la casa.
21. Es importante que lo busque.
22. Es importante que salga.
*23. El ideal de esta gente no consiste en gobernar, sino en ser gobernados.

24. ¿Dónde está ese pueblo?
*25. Aunque me gusta cantar, prefiero bailar.
26. Una es para mi tía y la otra es para mi padre.
*27. Fuiste a la fiesta, ¿verdad?
28. La capital de Bolivia es La Paz.
29. Las cosas pequeñas las meteré en las maletas.
*30. Juan trabaja mucho en la universidad.
31. Obtuve los pasaportes y nos fuimos para París.
*32. No dejes de escribirme.
33. Juan y José son altos.
34. Alicia sabe más que su padre.
35. No me gusta comer el pescado.
36. Dudo que lo haga.
37. Esos hombres se fueron en taxi.
38. Los camiones no pasan por esas calles.
39. ¿Quieres acompañarme a hablar con mis sastres?
40. Favor de prestarme tus libros.
*41. Me lo dijo ayer.
42. Sus padres se fueron para esos pueblos.
43. Los señores viven en esta casa bonita.
44. Hay varios problemas que no comprende.
45. ¿Dónde está la casa de sus primas?
46. Hoy día hace calor otra vez.
47. Piensa que la ve.
48. Piensa que la ves.

西語安大路西亞方言中音節尾/s/消失之母音代償程序的聲學與辨別分析

克莉斯汀・卡森
普渡大學

根據 Kiparsky (1982) 所提的「表意明確論」，凡和字義有關的訊息會在該字的表面結構存留下來。因此對於某些西班牙文方言中，字尾/s/消失的情況應該不會發生。即使發生了，也應該有某種替代的結構來取代這消失的/s/。本文延用 Hammond (1978)和 Figueroa (2000)的研究方法，研究目的乃使用實驗的方式，來探究西班牙安大路西亞（Andalusia）方言中是否存在某種替代結構，像是把母音延長或是改變母音來取代消失的/s/字尾。六位安大路西亞方言母語人士參與此項研究，並以他們的語言樣本制作了一份包含四大類組的語言辨別測驗。之後，再請二十五位也是安大路西亞的母語人士完成該測驗看他們是否能分辨因/s/消失而形成的同音異義字。最後再將這些字用光譜儀分析。研究結果發現安大路西亞方言並無任何替代結構來取代消失的/s/字尾，但確有足夠的證明顯示，音節中若有/s/消失了，則該音節的母音發音長度較原字平均長約 24.4%，例如，79%的參與者能夠成功地辨識 buque ['βu.ke] ‘船’vs. busque ['βuø.ke] ‘尋找’。這份研究結果與 Hammond (1978)對邁阿密古巴人的西語方言研究和 Figueroa (2000)對波多黎各的方言研究一致。

關鍵詞：安大路西亞方言、/s/消失、功能假說、代償性延長