

# Incomplete Neutralization in Eastern Andalusian Spanish: Perceptual Consequences of Durational Differences Involved in S- Aspiration

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## ABSTRACT

The present paper describes an experiment designed to assess the perceptual consequences of two attested phonetic differences, both durational in nature, said to represent incomplete neutralization in Eastern Andalusian Spanish s-aspiration. For word-medial cases of s-aspiration, it is found that the length of a stop consonant following aspiration, but not the length of aspiration itself, can serve as a strong, disambiguating cue to listeners in making phonemic decisions as to an underlying coda. These results compliment evidence from production suggesting that coda contrasts are incompletely neutralized in this variety of Spanish and, further, that incomplete neutralization is a phenomenon which can and should be studied beyond the cases of final devoicing to which most previous investigation has been limited.

## 1. INTRODUCTION

S-aspiration is the term commonly used to refer to the realization of syllable final /s/ as aspiration/breathy voicing in a number of varieties of Spanish in Spain as well as the Americas ([1], [6], [8]). This process gives rise to forms like those in (1):

(1)	/mas/	[ma <sup>h</sup> ]	“more”
	/kasas/	[kasa <sup>h</sup> ]	“houses”
	/komes/	[kome <sup>h</sup> ]	“you eat”

The Eastern Andalusian variety of Spanish (EAS), however, is unique in that any coda obstruent is neutralized in the same manner, not merely /s/ [3], [4] and [5]. Furthermore, s-aspiration occurring word-medially is accompanied by the gemination of a following consonant, as shown in (2):

(2)	/asta/	[a <sup>h</sup> t:a]	“until”
	/apta/	[a <sup>h</sup> t:a]	“apt”
	/akta/	[a <sup>h</sup> t:a]	“certificate”

Although the examples in (2) illustrate what are usually regarded as homophones in EAS, [4] report on a production study examining similar forms, and suggest that subtle durational differences in aspiration and stop gemination persist in maintaining the underlying contrast. In particular, although all medial codas surface as both aspiration and gemination in EAS, the aspiration replacing underlying /s/ was found to be significantly longer than that found in place of underlying /p/ or /k/; underlying coda /p/ and /k/, in turn, were found to surface with shorter aspiration but a geminate defined by a longer period of closure. Given these findings, the authors in [4] conclude that neutralization of coda contrasts in EAS is phonetically incomplete.

### 1.1. Incomplete Neutralization

Phonological neutralization refers to the loss of a phonemic contrast in a particular environment. The matter, however, may not always be this simple and categorical, as a number of studies have shown that phonetic traces of an underlying segment may sometimes persist in productions, even in the neutralizing context. The most frequently cited examples of this “incomplete” neutralization come from phonetic studies of final devoicing, the cross-linguistically quite common phonological process whereby voicing contrasts are lost syllable-finally. In such studies, acoustic correlates of phonological voicing, such as preceding vowel length and (in the case of stops) the duration of closure and voicing into closure, are said to differ –and to do so in the direction expected were the underlying segment permitted to surface. Although such incomplete neutralization is typically characterized by durational differences less than 15 or 20 milliseconds – far smaller than anything assumed to represent linguistic contrast in the typical sense – the compelling fact is that these differences are consistently in the direction of the underlying contrast. Moreover, it has been reported for German and Dutch cases of final devoicing that such durational differences can be useful to listeners in recovering the neutralized segment (for a review see [7], and [9]).

While the results of such studies are intriguing and have stimulated interesting work in both phonetics and phonology, virtually *all* studies concerning incomplete neutralization have investigated final devoicing, a strikingly small survey of the neutralizing phenomena observed in the world's languages. Given comparably little evidence for incomplete neutralization in cases other than final devoicing, it is unclear that the results of such studies are correctly generalized to phonological neutralization as a whole. Furthermore, it is production which has typically been the focus of this line of research. As there lacks a perceptual study testing durational differences reported in [4] and [5], and because it affords an opportunity to extend the investigation to a very different variety of neutralization, s-aspiration in EAS is of special interest.

## 1.2. Durational Cues in EAS S-Aspiration: Aspiration and Stop Closure

If the phonetic length of aspiration following the first vowel, or that of the geminated stop following the aspiration serve as disambiguating cues to an underlying coda consonant in minimal sets like (2), then phonemic decisions by listeners should vary, above chance level, along with changes in these durations in a perception experiment. The null hypothesis, however, suggests that no significant change in /asta/, /apta/, or /akta/ responses should occur in response to the manipulation of either of durational variables. The aim of the present study is to ascertain the neutralizing status of EAS s-aspiration by examining the effects of aspiration and stop closure duration on judgments of tokens varying in these two phonetic parameters.

## 2. METHOD

### 2.1. Materials

A native speaker of EAS from Jaén was digitally recorded (22050 Hz) in a sound attenuated room at the Universitätsklinikum in Leipzig, Germany using a Samson C01U USB condenser microphone and saved as sound files on a Gateway MX 6214 computer. All analysis and editing was done using the speech analysis software Praat [2]. The speaker read the carrier sentence *oye, dime \_\_\_\_\_, tío* ("hey, say \_\_\_\_\_, dude"). This sentence was used to encourage informal, colloquial pronunciations.\* Embedded in the carrier sentence were words with medial codas, including the word *hasta*. An aspirated pronunciation of this word was needed for editing and was obtained in the third repetition of the list read by the speaker.

In this case, no evidence of the high-frequency noise characteristic of /s/ was apparent in the waveform or spectrogram. Rather, aspiration followed the end of the first vowel, marked by a clear drop in amplitude before the period of silence indicative of stop closure. In order to test the relevance of aspiration and closure duration to perception, this token, [a<sup>h</sup>t:a], was edited to manipulate these aspects of the signal. Two sets of durational continua were created in the manner described below.

#### 2.1.1. Aspiration Continuum

Experimental tokens intended to test the effect of aspiration duration on listener judgments as to the underlying form of [a<sup>h</sup>t:a] were created by either removing a 25 ms period of aspiration from the signal, or by copying 25 ms of aspiration and splicing it into the existing period of aspiration. This resulted in three versions of the original [a<sup>h</sup>t:a] token, each with a progressively longer period of aspiration following the first vowel. The range, 30 ms to 80 ms was chosen because it roughly represents the range which has been observed for s-aspiration produced by actual speakers of EAS (see [4]).

#### 2.1.2. Closure Continuum

Tokens varying in stop gemination duration were created in the same manner as was done for aspiration duration. In this case, a 50 ms period of the signal was either removed from the closure interval or copied and spliced into the existing period of closure. The result was a four-step continuum which varied in closure duration from 60 ms to 210 ms. As for the aspiration continuum, this range was chosen because it represents, approximately, that which is found in actual speech in EAS.

### 2.2. Participants

Participants were 23 students at the University of Granada, ages 17 to 26; 12 were male and 11 were female. All were native to Eastern Andalusia: 20 were from Granada and 3 from Jaén. None reported any history of hearing problems and all were paid for their participation.

### 2.3. Procedure

All instructions and explanations were given to participants in Spanish and only Spanish was used while the experiment was carried out. Participants were asked to listen to recordings of the carrier sentence *Oye, dime \_\_\_\_\_, tío* and to select on an answer sheet the word which was heard embedded in the sentence. The words appeared as multiple choice options in Spanish orthography (*hasta, apta, acta*). It

was explained to participants that in many cases they would be asked to make fine distinctions, and thus the task would often be difficult. They were further told that there were no “right” or “wrong” answers, that the study was interested only in their personal impressions of the recordings, and that they should immediately mark the answer they thought best represented what they had heard. Before beginning the actual experiment, a short practice trial of five items was carried out in order to familiarize the participants with the recordings and with the task.

Each token was presented twelve times. Thus, 828 tokens with varying aspiration durations were presented (3 aspiration duration conditions x 12 randomized repetitions x 23 participants = 828), as were 1,104 tokens intended to test closure duration (4 closure duration conditions x 12 randomized repetitions x 23 participants = 1,104), for a total of 1,932 presentations of the experimental [a<sup>h</sup>t:a] tokens. Each test item was separated by a non-experimental “filler” item during presentation. All items were presented binaurally over Sony MDR-V500 closed, dynamic headphones at a comfortable listening volume in a quiet room at the University of Granada.

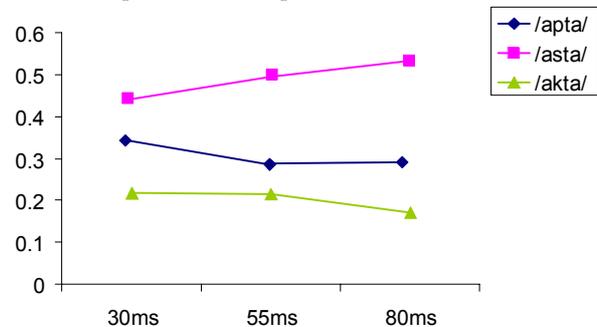
### 3. RESULTS

It should be emphasized that there was no “accuracy” to be reported for this forced-choice experiment. That is, all experimental tokens were actually manipulated versions of [a<sup>h</sup>t:a], varying in either stop closure or aspiration duration, and so there were no “correct” or “incorrect” responses. Rather, the experiment was intended to test the effect of durational differences on the perception of the experimental tokens and of primary interest were any changes in /asta/, /apta/ and /akta/ responses in reaction to the durational conditions. The proportions of each response for individual listeners were therefore calculated for each durational condition, for each of the two continua and analyzed using repeated measures ANOVA. Where applicable, a post-test was also performed to determine if the relationship between duration and the proportion of a given response was linear.

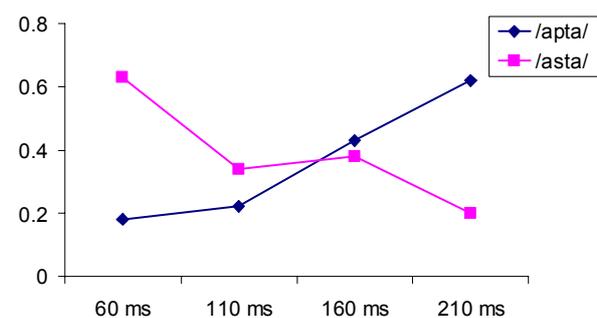
Although differing numerically, the proportion of responses across aspiration conditions for /asta/ ( $F(2,22) = 2.49$ ,  $P = 0.0944$ ), /apta/ ( $F(2,22) = 1.90$ ,  $P > .1$ ), and /akta/ ( $F(2,22) = 1.079$ ,  $P > .1$ ) were all found to be insignificant. Because varying the duration of aspiration on the first vowel of the experimental token did not result in a significant change in the proportion of responses, no test for a linear trend was performed. Group means across conditions for all three responses are shown in figure 1.

The effect for length of closure duration, however, was significant for /asta/ responses ( $F(3,22) = 26.40$ ,  $P < 0.0001$ ), as was a linear trend for /asta/ responses ( $F(1,22) = 93.22$ ,  $P < 0.0001$ ); the effect was also significant for /apta/ responses ( $F(3,22) =$

**Figure 1.** Proportions of /apta/, /asta/ and /akta/ responses across aspiration duration conditions.



**Figure 2.** Proportions of /apta/ and /asta/ responses across closure duration conditions.



39.47,  $P < 0.0001$ ); a linear trend was significant as well ( $F(1,22) = 150.34$ ,  $P < 0.0001$ ). Responses for /akta/ did not vary significantly across closure duration conditions ( $F(3,22) = 2.20$ ,  $P = .076$ ), and therefore no post-test for a linear trend was performed. Group means across conditions for the two significantly affected responses, /asta/ and /apta/, are shown in figure 2.

### 4. DISCUSSION

Previous work examining s-aspiration in EAS suggests that small durational differences represent a case incomplete neutralization ([4] and [5]), yet no study has, until now, investigated the perceptual consequences of such durational differences. The results of the experiment described above strongly suggest that closure duration can serve as a cue to a particular underlying coda, namely coda /p/, indicated by a sharp increase in the proportion of /apta/

responses as closure duration increased. This is the pattern to be expected if listeners are sensitive to the differences in production reported in [4] and [5]. However, not all the phonetic differences involved in EAS s-aspiration were utilized by listeners, as varying the length of aspiration did not evoke any kind of contrast in listeners' judgments.

The neutralizing status of s-aspiration in EAS therefore appears similar to the incomplete neutralization reported in studies of Dutch and German, in that very small durational differences attested in "neutralized" productions were useful to listeners. Yet, as intriguing as they may be, previous studies have been quite restricted in scope, limited to the neutralization of syllable-final voicing contrasts. Consequently, generalizing their results to phonological neutralization as a whole has remained precarious. One purpose of the present study was to extend the discussion to another, very different case of neutralization. That the results discussed here for s-aspiration resemble those found in perceptual studies of incomplete devoicing supports the notion of incomplete neutralization as an aspect of phonological neutralization more generally. There remains, however, a rich array of neutralizing phenomena to be studied in the phonologies of the world's languages, and it is clear that more diverse investigations will greatly benefit the line of research concerning the phonetics of phonological neutralization.

## 5. CONCLUSION

This study investigated the effects of two potential phonetic cues on the perception of medial codas in Eastern Andalusian Spanish. Although in EAS the phenomenon of s-aspiration is said to neutralize obstruent coda contrasts, previous production studies have reported small but consistent durational differences in aspiration and closure duration which distinguish underlying coda /s/ from underlying coda /p/ and /k/. In the case of closure, it was found that listeners were sensitive to durational manipulation, using differences to make phonemic decisions well above chance level in a forced-choice perception experiment, although an effect of this sort was not found for aspiration duration. It is further highlighted that, given the almost exclusive focus on final devoicing in the literature, the discussion concerning incomplete neutralization will benefit from studies examining various other examples of the phenomenon.

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\*The word *tío* in Spanish literally means "uncle", but is often used colloquially in Andalusia, and in Peninsular varieties generally, to mean "dude", "pal" or "man" (cf. [4]). Colloquial pronunciations were desirable, as s-aspiration is said to be typical of this register of speech.