THE ROLE OF DURATION IN STOP LENITION IN SPANISH

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ABSTRACT

The present study investigates the role of duration in the phenomenon of spirantization in Spanish. Spirantization in Spanish is a phonological/phonetic weakening phenomenon by which voiced stops alternate with voiced continuants as a function of context. Recent studies have revealed that some factors other than context may play a role in the phenomenon, such as speaking rate. Our hypothesis states that the constriction degree of the actual realization of the spirantized segment also depends on the speaking rate. To test our hypothesis, an experiment was designed in which the duration variable was controlled for (two rates were used). Acoustic measurements were taken of the target segments, which showed that at the slow rate, speakers tended to produce closer, longer segments than at the fast rate. This supports our hypothesis that a clear correlation exists between magnitude and duration of the constriction.

1. INTRODUCTION

The aim of the present study is to investigate the role of duration in the phenomenon of spirantization in Spanish. Spirantization in Spanish has revealed as a lenition process in which the voiced stops [b], [d], [g] alternate with the voiced continuants [β], [θ], [ɣ] (also called approximants) in some contexts. Recent studies—Martínez Celdrán [6]; Romero [8]—have shown that the traditional view of spirantization as a stop/fricative alternation is a rather simplistic view of the phenomenon. Instead, the focus has shifted towards regarding spirantization as a process of reduction or weakening, whereby the continuant allophones result from the relaxation of the constriction necessary for the formation of a stop.

Following up on this approach to the process as a weakening phenomenon, recent studies (Romero [7]) have also shown that spirantization is not a categorical process, that is, the actual realization of the continuants will depend on the context, more specifically, on the constriction degree of the adjacent segments. Furthermore, other factors have been posited to play a role in the actual outcome of the spirantization process, such as speaking rate or speaking style. Martínez Celdrán [5] showed that a range of different realizations could be possible even in cases where the approximant should be expected, which suggests that, although the context has a determinant role, the possible results of this reduction process will be affected by some other factors.

From this less categorical point of view, this study investigates the possible role of duration in the phonetic realization of the spirantized segments. It has been observed that there is a correlation between degree of spirantization (reduction) and duration, in the sense that the more reduced—less stop-like—the segments are, the shorter their duration is. Indeed, there seems to be a general relationship in lenition processes between magnitude and duration of the constriction. So our hypothesis states that magnitude and duration go along in the process of spirantization in Spanish. If, as Romero [9] claims, spirantization is “a process of reduction of a voiced stop which affects not only the duration but also the magnitude of the closure”, we hypothesize that this magnitude—or constriction degree—is conditioned by the duration of the segment. Thus, if the speaker devotes more time to the production of the spirantized segment, the organs will tend to make a more complete closure.

In order to test our hypothesis, an experiment was designed in which the duration variable was controlled for. Four native speakers of Spanish were asked to read a series of sentences that contained spirantized segments at two different rates. The design included all the possible contexts where spirantization occurs. It was expected that by slowing down the speaking rate, speakers would be more likely to produce closer, longer segments than at the fast rate. The present data belongs to a pilot study with the characteristics described below, and its purpose is to confirm a general tendency of the results towards the assumptions implied in our hypothesis.

2. EXPERIMENTAL DESIGN

2.1. Experimental material and independent variables included in the design

The experimental material included in the design takes into account the following independent variables: speaking rate, place of articulation, context and word type. The speaking rate was controlled for to obtain two different rates; one of them corresponds to Harris's “alegreto” [2], that is, a moderately fast, colloquial way of speaking, while the other rate is very slow and extremely precise. The place of articulation comprises labial, dental and velar, and the context includes all the cases in which the usual result is an approximant; after vowel, after fricative, after rhotic and after lateral, but we also consider the context NASAL+STOP as control group, in order to characterize all the possible outcomes.

The above mentioned variables are embedded in a target word that appears in the carrier sentence “Diga ______ cada vez” (“Say ______ each time”). This word displays the following characteristics: (i) it has two syllables, (ii) stress falls on the first syllable, (iii) the segment under study appears in the unstressed syllable, (iv) the word contains the vowel [a] (except for two contexts in which examples have not been found). Two word inventories make up the experimental material: one with real words and another with non-words, which constitute the word-type variable.
2.2. Experimental procedure and dependent variables included in the design

Four male adult native speakers took part in the experiment. Three of them were from Barcelona (Spain) and one from Madrid (Spain). Data from all four were collected in various recording sessions, in which a digital tape recorder was used. The words the subjects were to read were presented randomly in the carrier sentence and in two different lists: one for the real words, and another for the non-words. The lists had to be read five times by each subject and for each speaking rate (fast, slow). Speaking rate had to be controlled by the researcher so as to get the same rates from each subject in his own productions.

Only the recorded material from two subjects was analyzed for this pilot study (RM and RO). This material was digitized at 10,000 Hz to a CSL (Computerized Speech Lab) System belonging to the Laboratorio de Fonética de la Universidad de Barcelona. This system has also been used to perform the acoustic analysis of the data. This analysis consisted in measuring segmental duration, on the one hand, and RMS amplitude, on the other hand, as an acoustic correlate of constriction degree. For close sounds, measurements of segmental duration were obtained by using the adjacent segment formants or transitions as reference points as well as the stop burst and the subsequent lag in the onset of voicing, together with the onset of intensity for the burst. For those segments with few formants and no clear closure, the reference was the adjacent segment periodicity (or noise). RMS amplitude was measured relative to that of the adjacent vowel; the amplitude of the consonant was subtracted from that of the vowel (C-V ratio) in order to compensate for differences in absolute intensity in the recording process.

Since a vowel is more intense than a consonant, and considering that the voiced continuants—or approximants—resulting from spirantization are more vowel-like in their constriction degree than stops, it was expected that the C-V ratio would increase as duration increased (according to the speaking rates). Table 1 below summarizes the variables under analysis in the present study and shows the actual words presented for each context.

<table>
<thead>
<tr>
<th>LABIAL / REAL WORD</th>
<th>FAST RATE</th>
<th>SLOW RATE</th>
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<tbody>
<tr>
<td>DURATION</td>
<td></td>
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<tr>
<td>VCV (lava)</td>
<td>VCV</td>
<td></td>
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<td>VSCV (isba)</td>
<td>VSCV</td>
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<tr>
<td>VMCV (bamba)</td>
<td>VMCV</td>
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<tr>
<td>VRCV (larva)</td>
<td>VRCV</td>
<td></td>
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<tr>
<td>VLCV (alba)</td>
<td>VLCV</td>
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<td>C-V RATIO</td>
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<tr>
<td>VCV</td>
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<td>VSCV</td>
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<td>VRCV</td>
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<td>VLCV</td>
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Table 1. Variables included in the pilot study.

3. RESULTS

In our study, 4-5 productions were analyzed for each item (real word, labial). For each of the dependent variables (duration and C-V ratio), an average of the productions was calculated and an analysis of variance was applied to the results. This analysis considered the two independent variables (speaking rate and context) and was performed with the StatView statistics package for the Macintosh computer.

The global results for duration showed a main significant effect for the independent variable ‘speaking rate’ in both subjects: F(1,36)=51.751, p< .01 (RO) and F(1,48)=52.072, p< .01 (RM). Post-hoc tests (Fisher) were applied for comparisons between individual treatments. These showed that the effect for ‘speaking rate’ is always significant so that the resulting segment in the slow rate is always the longest in both subjects. The main effect ‘context’ does not seem to be significant in RO. F(3,34)=1.950, p> .01, while in RM it is significant only for some comparisons: F(4,48)=5.197, p=.0016. When context and speaking rate are combined, there is also some significant interaction between both variables for RM.

The results for C-V ratio (RMS amplitudes) showed similar patterns. On the one hand, the main effect for ‘speaking rate’ is highly significant in both subjects: F(1,36)=26.487, p< .01 (RO), and F(1,48)=30.111, p< .01 (RM), so closer segments were always produced at the slow rate. On the other hand, the effect ‘context’ is mainly non-significant for both subjects, although some significance is shown for some individual comparisons in RO: F(3,34)=3.928, p= .0165; in the combination of both independent variables, comparisons between extreme points appear as significant for the effect ‘context’ (VCV vs VMCV and VCV vs VSCV, respectively): F(4,40)=7.121, p=.0002 (RM), F(3,30)=7.861, p=.0005 (RO). In RM there is also a significant interaction between both variables.

4. DISCUSSION

The results of the statistical analysis in our study show a clear tendency as to the effect ‘speaking rate’ on the duration (or length) of the segment and C-V ratio. The means for duration are always higher at the slow rate. Although they are higher for RM, they are significant for both subjects (see figure 1), so the duration of the constriction becomes longer in the slow rate.
Figure 1. Mean duration values (ms) for the slow and fast speaking rates.

The mean values for the C-V ratio are shown in Figure 2. The differences between the RMS amplitude of the adjacent vowel and the consonant are significantly larger for the slow rate. This supports the hypothesis that the longer realizations in the slow rate are also closer in their constriction degree.

Figure 2. Mean C-V ratio values (db) for the slow and fast speaking rates.

The results for the main effect 'context' are not as significant as for the effect 'speaking rate', although it becomes significant for some individual comparisons. The C-V ratio results for the independent variable 'context' appear as significant across 'speaking rate' for RM in some individual comparisons between VMCV and the rest of contexts. In Figure 4, an important difference is observed between the value for this context and the rest in the fast rate, while this difference is not observable in the slow rate. This supports our assumption that at the slow rate the realizations are closer, so a smaller or no difference can be expected with respect to the stop in the control group.

Figure 3. Mean duration values (ms) for effect 'context' across 'speaking rate' (RM).

Figure 4. Mean C-V ratio values (db) for effect 'context' across 'speaking rate' (RM).
Finally, in Figure 5, a spectrographic image is shown for the two rates. As it can be seen, at the slow rate the realization shows a clear closure and no formant structure.

![Spectrographic image](image1)

![Spectrographic image](image2)

Figure 5. Spectrographic images for VCV ([laβa]) at the fast rate (above) and at the slow rate (below) (RM).

5. CONCLUSIONS

The data presented in this study have provided experimental evidence that duration plays a role in the phenomenon of spirantization in Spanish. Speaking rate has a clear effect on the length and the constriction degree of the segment. Thus, the resulting realization is longer and closer, with a spectrographic image showing a closure and no formant structure.

The effect of speaking rate across contexts also seems to give some support to our hypothesis since at the slow rate the effect is maintained for all contexts. However, the significance shown for the differences between individual comparisons is not the same for both subjects. Although this significance (whether for duration or C-V ratio) is mainly associated with comparisons between extreme points (e.g., VCV vs VMCV), some more data are necessary to observe a clear tendency for this effect.

On the whole, the results obtained support our hypothesis that duration and magnitude of the constriction are highly correlated, and give further evidence of the non-categorical nature of spirantization in Spanish.

REFERENCES