

FERNÁNDEZ, H.- GARRIDO, J. M.- de la MOTA, C. (1989)
"Modelling coarticulation in synthesized Spanish lateral
consonant [l]", in SZENDE, T. (Ed.) *Proceedings of the Speech
Research '89. International Conference. Magyar Fonetikai
Füzetek / Hungarian Papers in Phonetics* 21. Budapest,
Hungria, 1-3 de junio de 1989. Budapest: Linguistics Institute
of the Hungarian Academy of Sciences. pp. 210-213. ISSN:
0134-1545.

[http://liceu.uab.es/publicacions/Fernandez
_Garrido_Mota_89_Coarticulation_Synthesize
d_Lateral.pdf](http://liceu.uab.es/publicacions/Fernandez_Garrido_Mota_89_Coarticulation_Synthesize_d_Lateral.pdf)

MODELLING COARTICULATION IN SYNTHESIZED SPANISH LATERAL CONSONANT [l]

M^a Helena FERNANDEZ¹, Juan M. GARRIDO² and Carme DE LA MOTA²

(1) Universidad de Alicante (Spain)

(2) Universitat Autònoma de Barcelona (Spain).

0. INTRODUCTION

Several works on acoustic analysis of lateral [l] (*e. g.* CHAFCOULOFF [2]) have pointed out that this consonant does not show a high degree of coarticulatory resistance. The most important variations due to coarticulation have been found in F2 frequency, but little is known about its role in the perception of this consonant. The importance of the transitions in perception of [l] has been also investigated in some synthesis experiments. O'CONNOR *et al.* [5] and LISKER [4] studied transitions duration and slope as perceptual cues for [l]; AINSWORTH [1] revealed that short duration of F1 transitions is also relevant. However, it has not been paid attention enough to F2 transitions.

The aim of this paper is to study the role of coarticulatory phenomena in lateral + vowel combinations. The intelligibility and naturalness of the synthesized laterals have been assessed using a battery of perceptual tests.

1. EXPERIMENTAL ANALYSIS

1.1 Stimuli production

Several vowel + lateral + vowel combinations have been synthesized and used as stimuli in a perceptual test. The generation of these sequences has been carried out in the following way:

- a) Steady-state of [l]: formants at 475, 1455, 2575 and 3700 Hz; spectral zero at 2100 Hz.
- b) [l] - vowel transitions: F2-F4 starting points placed at [l] F2-F4 frequencies. F1 placed at the same frequency than the vowel.

- c) Vowel steady-state: formants at standard frequency values for the five Spanish vowels.

The values for duration have been fixed at 100 ms. for vowels, 60 ms. for the lateral consonant and 5 ms. for each of the four transition steps. [l] has been synthesized with a constant overall intensity level, while the intensity level in vowels is variable. We assume, as it has been previously stated (CHAFCOULOFF [3]), that the relationship between the intensity of the three first spectral peaks in [l] clearly determines the quality of the lateral consonant.

1.2 Elaboration and realization of perceptual tests

Three different tests have been designed in order to discuss the effect of coarticulation in the steady-state of [l], in transitions and in both elements.

Test 1: F2 frequencies in [l] are fixed, but there are three different possible levels for F2 frequencies in transitions.

Test 2: Only the steady-state consonant is manipulated. There are three different sequences, depending on the coarticulation degree between F2 frequency in the lateral consonant and in the following vowel.

Test 3: Both F2 frequencies in the steady-state of [l] and in transitions are manipulated in three different sequences.

Fifteen items were generated to study the three possible sequences obtained for [l] closed to the five Spanish vowels. These recorded stimuli were grouped in thirty pairs in random order. The same method was applied in the three tests. A panel of 40 listeners (native Spanish speakers, about 20 years old, students at the Alicante University) were asked to choose the best item in each pair. The whole serie had 90 pairs. They could listen to each one twice.

3.RESULTS

The results of the perceptual tests are shown in Figure 1 below:

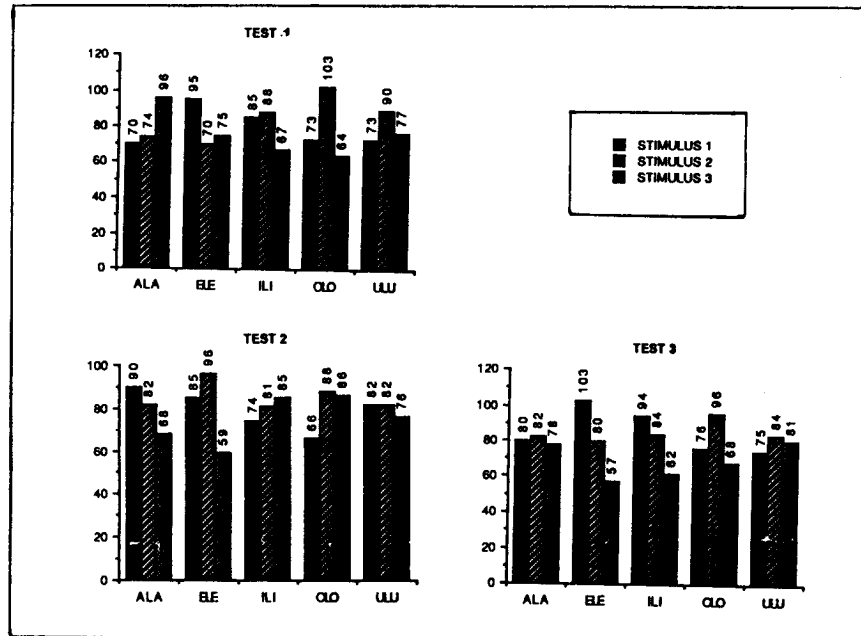


Figure 1.

Some remarks can be made about this data:

a) Stimulus 2 is generally the preferred one in the three tests. In test 1 stimulus 2 was considered the best one in [ili], [olo], [ulu]; stimulus 3 was the most preferred in [ala], and stimulus 1 in [ele]. In test 2 stimulus 2 was also the best one in three cases ([ele], [olo], [ulu]); stimulus 3 was the best one in one case [ili], and stimulus 1 in [ala]. Finally, in test 3, stimulus 2 was the best in [ala], [olo], [ulu], and stimulus 1 in the other cases ([ele], [ili]).

b) Further, we can see that stimulus 2 is also the best one both in the first and the second test, if we consider the results for five vowels together (425 and 429 answers, respectively); in test 3, however, stimuli 1 and 2 were more or less at the same level (428 answers for stimulus 1 and 426 for stimulus 2).

c) The preference for stimulus 2 is clear in any of the three tests whereas the vowel after [l] is back ([o],[u]). When the vowel is [i] or [e] the number of choices for stimulus 1 is greater than in back vowels (stimuli with [e] are the preferred ones). When the vowel is [a], however, there is no preference for any stimulus.

d) The differences between stimuli are clearer in test 1. These differences are the same in test 3. This seems to indicate the importance of transitions as coarticulatory perceptual cues.

4. CONCLUSION

The results of these tests suggest that there is a tendency to prefer items in which there is a certain degree of coarticulation generated with intermediate values between [l] and the vowel. This is specially the case in [o] and [u]. Nevertheless, for [i] and [e] the degree of coarticulation seem to be less important. An excessive coarticulation is related to a low identification score. It also seems that changes in F2 transitions are more important for the perception of lateral consonants than changes of the second formant in the steady-state of the consonant.

As we were working on the role of coarticulatory phenomena in [l] perception, the tendencies observed in our results also suggest that variations in the degree of coarticulation do not seem to be a primary factor in the correct identification of the consonant. However, this element is important from the point of view of naturalness.

REFERENCES

- [1] AINSWORTH, W.A. (1968) "First formant transitions and the perception of synthetic semi-vowels" *JASA*, 44, 3, pp. 689-694.
- [2] CHAFCOULOFF, M. (1980) "Les caractéristiques acoustiques de [j, y, w, l, r] en français" *Travaux de l'Institut de Phonétique d'Aix*, Vol. 7, 1-52.
- [3] CHAFCOULOFF, M. (1983) "A propos des indices de distinction [l-r] en français" *Speech Communication*, 2, pp. 137-139.
- [4] LISKER, L. (1957) "Minimal cues for separating [w, r, l, j] in intervocalic position" *Word*, 13, 2, pp. 257-267.
- [5] O'CONNOR *et al.* (1957) "Acoustic cues for the perception of initial [w, j, r, l]" *Word*, 13, pp. 24-43.