

ON THE RELATIONSHIP BETWEEN COARTICULATORY
EFFECT OF LIP ROUNDING AND SYLLABIC BOUNDARY
IN FRENCH

ANTONELLA GIANNINI

Ist. Universitario Orientale
Fonetica Sperimentale
Napoli, Italy

ABSTRACT

This study investigates the relationship between the extension of the coarticulatory effect of lip rounding and the syllabic boundary. The choice of lip rounding is due to the fact that it is particularly evident on the spectrogram, the formants of a labialized articulation being noticeably lower than those of its non-labialized counterpart. We have chosen French because it is a language having a vocalic system strongly affected by lip protrusion. The aim of this research is, on one hand, to verify whether among the rounded vowels different levels of labialization and, consequently, different extensions of coarticulation exist; on the other hand, to propose a model of syllabic organization for French and to compare it with those already obtained for English and Italian following the same method of analysis.

INTRODUCTION

Traditionally the term "coarticulation" has been used to indicate the phenomenon by which a speech sound is modified from its basic form because of the influence of a neighbouring sound.

The need to study this phenomenon ensued from the observation that all the speech elements always showed different characteristics according to the context. However such a way of facing the problem didn't give later on satisfactory results because to consider speech as a chain of discrete units that only marginally could be modified by the context was inadequate to the dynamic reality of speech. The point is that these supposed "discrete units", even if had gained an apparent objectiveness thanks to the larger and larger number of firstly physiological and then acoustical studies, did nothing but to propose in a new dress the classical distinction between vowels and consonants.

In the 60' a new way of dealing with the problem was suggested, leading consequently to a redefinition of the coarticulation.

In fact coarticulation, once seen as the

effect of the mechano-inertial constraints of the speech apparatus, is now considered as a reflex of the speech organization in programming units. The starting point is given now by the "articulatory syllable" that is considered as a string of elements coproduced at the level of motor command. At the beginning of each programming unit the articulators receive all the information necessary to realize the whole articulatory syllable. In the light of these considerations, as both coarticulation and syllable are the result of a single motor command, the limits of extent of the former should not go beyond the limits of extent of the latter.

The problem, this time, is to specify the limits of extension of these units and in order to do this many researches have been carried out using different analysis techniques, that is electropalatography /1/, cinefluorography /2/ and electromyography /3/ /4/.

Once more the results are not univocal and different models have been proposed that individualize the articulatory syllable now in CV now in CVC now in VC..CnV. The disagreement persists also among studies employing the same technique. In the case of the electromyography, for instance, the different results can be due to the fact that there isn't a close relationship between muscular intensity and the position assumed by the articulators. This has been clearly pointed out by Lubker and Gay /5/ who, as regards lip rounding, say that the same muscular contraction can give rise to different labial movements.

In order to overcome this impasse, in this research we'll examine the coarticulatory phenomenon from an acoustic point of view. This kind of approach is justified by the fact that each articulatory mechanism must correspond to a different acoustic signal. The risk of this kind of approach is to ascribe erroneously a given acoustic feature to an articulatory parameter. So it's necessary in this method of analysis, to choose an acoustic feature that can be ascribed without any doubt to a specific

articulatory act. For our purposes, we have chosen the coarticulatory effect of lip rounding, because, if we consider the different occurrences of nodes and antinodes of velocity of the resonances along the vocal tract, lip rounding is the only articulatory feature to cause the simultaneous drop in all formants.

The studies concerned with the extension of the lip rounding, based on electromyographic analyses, have proposed two different hypotheses: on one hand; Lubker /6/ says that the anticipation of lip rounding can start at a maximum time of about 600 ms before the rounded vowel according to the length of the consonantal string; on the other hand Bell-Berti and Harris /4/ and Gay /7/ say that the anticipation of lip rounding is of about 250 ms independently from the number of consonants preceding the rounded vowel.

Following a different kind of approach based on the analysis of the acoustic signal, Pettorino and Giannini /8/ /9/ have studied the phenomenon of the lip rounding in Italian and Pettorino /10/ in English. They point out that the time of anticipation of lip rounding is not fixed and that there is a relationship between the extension of the anticipation of the lip rounding and the system of language. In fact in Italian the anticipation is related to the position of the stop inside the consonantal string and to the number of consonants: it is of about 150 ms when only one consonant is labialized whereas it is of about 190 ms when two consonants are labialized. In English these values are longer, being of about 190 ms and 220 ms respectively, regardless of the position of the stop consonant.

In this research we have chosen French because it is a language with a vocalic

system strongly affected by lip protrusion, with six oral and two nasal rounded vowels. The aim of this experimental research is, on one hand, to verify whether among the rounded vowels different levels of labialization and consequently different extensions of coarticulation exist; on the other hand, to propose a model of syllabic organization for French and to compare it with those already obtained for English and Italian following the same method of analysis.

PROCEDURE

For the purposes of this experimental study we have prepared a list of about 200 French meaningful words containing the sequences VCV and VC..CnV. In these sequences V1 is /a/ /e/ or /i/ and V2 is /a/ /e/ /ɛ/ /i/ /u/ /o/ /ɔ/ /y/ /ø/ or /œ/. Our analysis has been limited to the oral vowels in order to avoid any possible interference caused by the added nasal cavities.

As regards VCV sequences the consonant is either a velar stop or a dental fricative. The choice of the velar stop was determined by the fact that, on the basis of the locus theory formulated by Delattre /11/, velar articulations have an F2 locus at about 3000 Hz when they are followed by an unrounded vowel, and at a lower value when they are followed by a rounded vowel. This allows us to verify spectrographically whether the velar stop is labialized or not. The choice of the fricative was determined by the fact that it shows a different distribution of the signal along the frequency scale according to whether it is labialized or not. In VCCV sequences one of the consonants is always /k/ or /g/ and the other one is selected among /s/ /l/

and /r/.

The randomized list of words has been read by two French male native speakers in an anechoic room and then recorded and analyzed using a Series 700 Sound Spectrograph by Voice Identification Inc. For each word a broad band spectrogram was obtained. Fo and intensity were measured using an FFM 650 and an IM 360 by F-J Electronics ApS.

We have compared the formant pattern of V1 in unrounded context with that of the same V1 in rounded context. As during their steady state the formant patterns don't show any noticeable difference, we have considered as onset of the lip rounding the point in which the two formant patterns diverge.

RESULTS

Figure 1 shows the average values of F1 and F2 of all vowels. We have to notice that F1 of the front rounded vowels is slightly higher than F1 of the corresponding front unrounded vowels. From an articulatory point of view this means that the difference between the two series is not only due to the presence or absence of lip rounding but also to a different opening degree and place of articulation.

Table I shows the average durations of vowels and consonants in the different sequences.

As regards VssV sequence we have to notice that, even if the traditional grammars say that in French there isn't the functional opposition between short and long /s/ (see for instance Fouché /12/), our data show that when /s/ is graphically represented by double symbol, its average duration is of about 160 ms, that is twice as long as the dental fricative graphically represented by only one symbol. In the light of this, the sequence VssV, that from a phonological point of view is con-

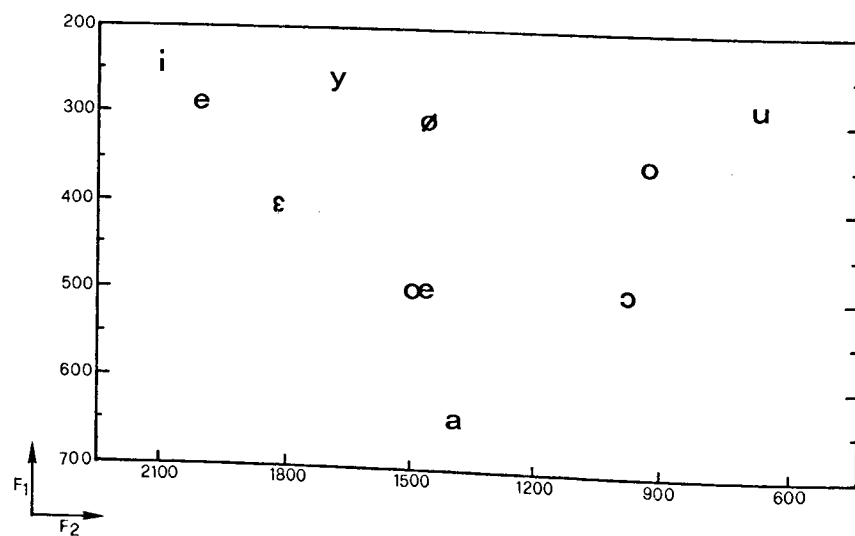


FIG. 1. Average values of F1 and F2 of French vowels.

Se 32.4.2

sidered as VCV, is here considered as VCCV. Spectrograms show that in VCV sequences, where V2 is always /u/ /o/ or /ɔ/ the consonant is always labialized and the lip rounding begins inside V1 at about 30 ms before the onset of the consonant.

When V2 is /y/ /ø/ or /œ/, no anticipatory effect of lip rounding is noticed.

As regards VCCV sequence the onset of lip rounding occurs inside the offset of C1 except when it is a stop. In this case the anticipation of lip rounding starts from the offset of V1. So in VCCV sequence we have two possible kinds of syllabic organization that is VC-CV and V-CCV.

Table II shows the anticipation of the lip rounding in the different sequences.

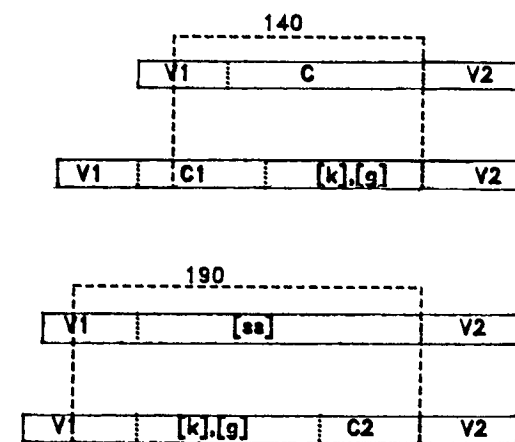


TABLE II. Anticipatory coarticulation of lip rounding in ms.

CONCLUSIONS

The data gathered in this experimental research show that the time of anticipation of the lip rounding is not fixed but it varies according to the number of consonants preceding the rounded vowel.

The times of anticipation for French are of about 140 ms when only one consonant is labialized and of about 190 ms when two consonants are labialized.

These values correspond to those found for Italian by Pettorino and Giannini /8/ /9/ but are considerably shorter than those found for English by Pettorino /10/. As we have said above, the limits of extension of the coarticulatory effect must coincide with those of the articulatory syllable. So, on the basis of our data, two different models of syllabic organization, one for Italian and French and one for English can be proposed. In addition to the difference in time of lip rounding anticipation, the two models differ also by the fact that in English in VCCV sequences the syllabic boundary always occurs inside V1

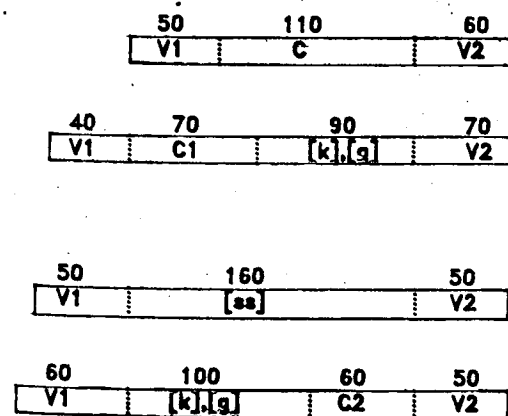


TABLE I. Average durations of vowels and consonants in ms.

whereas in French and Italian it varies according to the position of the stop inside the consonantal string. It occurs inside V1 when C1 is a stop, inside C1 when C2 is a stop.

In order to clarify whether coarticulation has to be considered independent from the language system being "supplied by universal rules" /13/ or, on the contrary, "language specific" /14/, we must say that our data don't contribute to solve the problem. In fact on one hand it seems that a relationship exists between a specific language system and its syllabic organization, English being different from Italian and French; on the other hand, as regards the anticipation of lip rounding, there isn't any difference between French and Italian even though in these languages this articulatory feature plays a different role from a phonological point of view. In fact if in Italian lip rounding can be considered redundant, in that it is always co-occurrent with backness, in French it plays a distinctive role in that it occurs independently from the place of articulation.

In order to clarify whether a relationship exists between a specific language system and its syllabic organization it would be useful, using the same experimental method, to examine other Romance and Germanic languages.

As regards the vowels /y/ /ø/ /œ/, our data show that in no sequence examined there is anticipation of lip rounding. If we consider that /y/ /ø/ and /œ/ are front rounded vowels and /u/ /o/ and /ɔ/ are back rounded vowels, there must be a relationship between place of articulation and coarticulatory effect.

In order to verify this hypothesis it would be useful to examine systems of language with a large variety of front rounded and back unrounded vowels.

REFERENCES

- /1/ V.A. Kozhevnikov, L.A. Chistovich, "Speech: Articulation and Perception" (translated from Russian), Joint Publications Research Service, Rep. 30, 543, Washington D.C., 1965.
- /2/ R.G. Daniloff, K.L. Moll, "Coarticulation of Lip Rounding", J. Speech Hear. Res. 11, 707-721, 1968.
- /3/ P.F. MacNeilage, J.L. DeClerck, "On the Motor Control of Coarticulation in CVC Monosyllables", J. Acoust. Soc. Amer. 65, 1268-1270, 1979.
- /4/ F. Bell-Berti, K.S. Harris, "Anticipatory Coarticulation: Some Implications from a Study of Lip Rounding", J. Acoust. Soc. Am. 65, 1268-1270, 1979.
- /5/ J. Lubker, T. Gay, "Anticipatory Labial Coarticulation: Experimental, Biological and Linguistic Variables", J. Acoust. Soc. Amer. 71, 437-448, 1982.
- /6/ J.F. Lubker, "Temporal Aspects of Speech Production: Anticipatory Labial Coarticulation", *Phonetica* 38, 51-65, 1981.
- /7/ T. Gay, "Coarticulation in some Consonant-Vowel and Consonant Cluster-Vowel Syllables", *Frontiers of Speech Communication Research* Ed. by B. Lindblom and S. Ohman, 1979.
- /8/ M. Pettorino, A. Giannini, "Some Aspects of Coarticulation in Italian: a Spectrographic Analysis of VV, VCV and VCCV Utterances", *Wiener Linguistische Gazette*, Suppl. 3, Wien, 1984.
- /9/ M. Pettorino, A. Giannini, "Le rapport entre syllabe et coarticulation en italien", *GALF*, Paris, 1985.
- /10/ M. Pettorino, "A Model of Syllabic Organization: a Spectrographic Study of Coarticulation in English", *IEE*, London, 1986.
- /11/ P. Delattre, "Coarticulation and Locus Theory", *Studia Linguistica* XXIII, 1-26, 1969.
- /12/ P. Fouché, "Traité de prononciation française", Paris, 1959.
- /13/ N. Chomsky, M. Halle, "The Sound Pattern of English", New York, 1968.
- /14/ R. Hammamberg, "The Metaphysics of Coarticulation", *Journal of Phonetics*, 4, 353-363, 1976.

Grateful acknowledgement is made to Umberto Cinque for his precious technical collaboration.