# ARTICULATORY STRATEGIES FOR THE PRODUCTION OF /l/

*A. Marchal, M. Chafcouloff and S. Lapierre*
*CNRS URA 261 Parole et Langage*
*Université de Provence, Aix-en-Provence, France*

## ABSTRACT

The spatio-temporal organization of lingual "gestures" for the production of /l/ is investigated in nonsense words, words and sentences. Our data reveals important differences across speech items and across speakers. The phasing of the gestures indicates that our speakers adopt different production strategies in the various contexts.

## INTRODUCTION

Until recently, most of the studies on speech production have relied upon acoustic and articulatory data from nonsense words. This type of speech material allows for a fine control of linguistic and prosodic variables which interact in a speech sequence, but it is questionable whether results obtained from these carefully designed experiments bear any signifiance for the understanding of the process involved in the production of other speech items such as words, sentences... The spatio-temporal organization of lingual "gestures" for the production of /l/ is compared across speech items and across speakers.

## METHODOLOGY

Data for this study has been extracted from the multilingual EURACCOR database [1]. This database consists of simultaneous digital recordings of the acoustic soundwave, of the laryngograph signal, of oral and nasal airflow and of linguo-palatal contacts. Multisensor data has been collected for the production of VCV nonsense words, isolated words matching phonetically the nonsense words, and the same words embedded in sentences. The speech items have been repeated 10 times at a normal rate. We have analysed here the production by two French female speakers ("ad", "gc"; 20 ~ 25 years old; no sociogeographic marks of pronunciation or speech defect) of the sequence /ulu/ in the nonsense word " oulou " and in " Toulouse ", the french town, as isolated word and " Toulouse " embedded in the sentence: " La cousine de Vichy épousa un hippie à Toulouse ".

The various acoustic, aerodynamic and articulatory signals available in the ACCOR database are annotated independently [2]. The present study relies on EPG data only. The following landmarks have been identified: the onset of the forward movement of the tongue, the lateral closure, the maximum constriction and the lateral release. They are annotated respectively as ACE, LCE, MCE and LRE. In addition, the beginning and the end of lingual activity is labelled GOE and GEE. The data from these annotation points is used as the basis for the subsequent spatial and temporal analyses. EPG patterns at ACE, LCE, MCE and LRE have been analysed as an indication of the amplitude of the tongue tip gesture. The temporal organization of the gestures is given by the durations between these marks. They correspond to the following phases: approach (ACE-LCE); closure (LCE-MCE) and release (MCE-LRE). EPG data has been statistically analyzed using the paired t-test and the ANOVA linear regression method.

## RESULTS

### Spatial Organization

On a hyper- to hypo-continuum and in the framework of the H & H theory [3], the following prediction can be made: the amplitude of the lingual gesture is expected to be larger for the nonsense words than for real words, and it should be the smallest for the sentence context



[4]. The amplitude of the tongue gesture can be estimated from the number of activated electrodes. Measurements were made at the point of maximum contact MCE and at ACE and LCE for the three speech types: Total number of linguo-palatal contacts, number of contacts by rows and by palatal areas (A=alveolar; B=prepalatal; C=palatal; prevelar, as shown in Fig. 1):

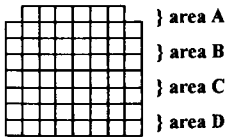


*Figure 1. Area delimitations of the EPG frame*

As far as the general spatial organization is concerned, two remarks can be made: 1) There is no significant difference between the number of linguo-palatal contacts between nonsense words, words and sentences for both speakers in each context. This means that they both reach similar spatial targets in terms of general amplitude of the lingual gesture.; 2) Concerning the contexts, the difference which is observed between the mean contact number for each articulatory landmark is more important for the nonsense words than for the other speech contexts. For example, the mean difference between the number of contacts of ACE and LCE in sentences for "gc" speaker is 7.3 contacts against 11.7 in nonsense words (23.3 cts - 16 cts against 23.1 - 11.4 cts), contrary to Farnetani [5], these differences are however not significant.

When we consider the number of contacts in the various palatal areas, the same tendency can be observed for the alveolar and prepalatal regions. We note that the gesture amplitude for the nonsense word is not significantly different from the other contexts, but it is suggested that the nonsense context differs most from the sentence context and suggest the following decreasing order of gesture amplitude: nonsense word/word/sentence contexts.

### Temporal Organization

The first part of the temporal analysis consisted in comparing the total duration of /l/ as a function of the given contexts (Fig.2). The ANOVA analysis of variance indicates a significative difference between the total duration of the articulation for three contexts, F(27.2), $p$ <.001 for "ad" speaker, F(26.7), $p$ <.001 for "gc" speaker. As could have been expected, we observe the shortest duration for /l/ in the sentence, then by increasing order in the real word and in the nonsense word.

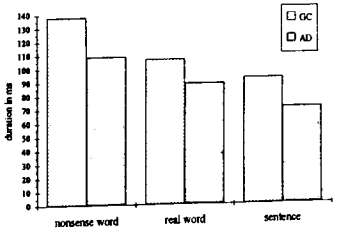


*Figure 2: Mean total duration of /l/ in French for speakers "ad" & "gc" from EPG data*

The question arises to know if the variation of the total duration which was observed as a function of context affects equally or not each phase. If the ratio duration of phases / total durations of /l/ is kept constant, this would imply that the internal organisation of the various gestures involved in the production of /l/ is not altered as a function of the context. The duration of each phase is proportionally increased or decreased from sentences to nonsense words. Since the amplitude is not affected (previous observations), this would imply that there exists a saturation effect and that the intended lingual gesture is in fact masked by competing demands on the articulator. An alternative hypothesis would explain the observed facts as an internal

reorganisation of the various phases. This is indeed what our analysis reveals for speaker "ad": The relative duration of phase 1 and phase 2 is primarily concerned. There is a clear shortening of the approach to constriction in the sentence context for speaker "ad" but not for speaker "gc".To illustrate this difference in articulatory organization, we have adopted a phase representation. This representation (Fig.2 & 3) uses phase/total duration ratio. Each angle indicates the relative timing of each phase translated into degrees. The circumference corresponds to the total duration of the consonant.

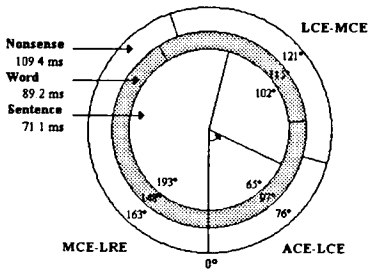


*Figure 2. Articulatory phases for /l/: speaker "ad"*

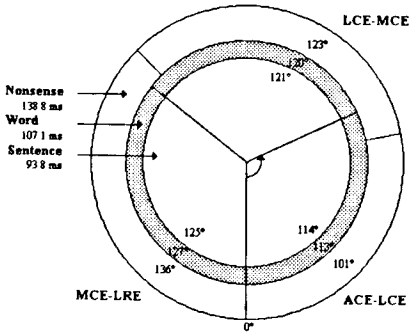


*Figure 3. Articulatory phases for /l/: speaker "gc"*



## DISCUSSION AND CONCLUSION

We have to be extremely careful with the interpretation of these results, since the data presented here is based only on the production of 2 speakers who produced the speech items 10 times. However the fact that they differ in the reorganization of the lingual gestures across speech material contexts is in itself interesting and raises the following questions which should be addressed in a broader study: Does this apparent difference of strategy in the lingual gesture reflect a real difference in the tongue kinematics or does the EPG technique which shows only the contacts biaise the data ? The production of /l/ requires not only a lateral closure, but also a specific shape of the tongue behind the contact area. The curvature of the tongue is in part responsible for the turbulent flow conditions needed for /l/. The form of the cavity behind the closure depends also on the shape of the palate. The plastercasts of our 2 speakers show large morphological differences. The palate for "gc" is more flat than the palate of "ad".

It seems very important in addition to linguo-palatal contact patterns to obtain data on the distance from the tongue to the palate. As a first attempt to answer this question, we will record simultaneously EPG and EMMA with coils on the tongue dorsum.

Concerning the use of nonsense word material for the investigation of speech production, our EPG data would suggest a positive answer for one speaker and a negative one for the other speaker. For both speakers, there is a general tendency to shorten the articulation of /l/ in sentences with respect to words and nonsense words. However, the timing of the various phases differ from one speaker to the other. The decrease is proportionnal for "gc". In that case, results from nonsense words can be extrapolated to /l/ in sentences. This is not true for speaker "ad" where a reorganization of the timing of the approach to constriction phase can be observed. Further multisensor investigation of articulatory gestures is still needed to indicate how real is lab speech.

## ACKNOWLEDGMENTS

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