Contribution to the study and modelling of coarticulation in Vowel-Consonant-Vowel sequences in French

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During the production of speech, the articulatory characteristics of each segment, can show substantial variations under the influence of the surrounding segments. This phenomenon, referred to as coarticulation, is traditionally regarded as reflecting both biomechanical characteristics of the vocal tract and the strategies governing articulatory gestures in speech.

This study focuses on the potential influence that the biomechanical characteristics of the articulators may have on coarticulatory patterns. Specifically, our goal is to evaluate two models of motor control in the generation of speech sequences. The first model is purely "sequential". That is, consonants and vowels are dealt with in a uniform manner in the planning and execution of articulatory movements. Model 2 is based on Öhman's (1967) theory that confers to transitions between vowels a specific status. In this theory, a V1-C-V2 sequence is viewed as the combination of a basic V1-to-V2 gesture with a local perturbation associated with the intervocalic consonant. The evaluation of these models will be made by comparison with articulatory and acoustic data.

The articulatory data used in this study were collected using the electromagnetic midsagittal articulographic (EMMA) system at Grenoble. The material was made up of 180 French sentences, read by three subjects at a normal speech rate. The acoustic and articulatory data were recorded simultaneously. In a first phase, a labelling of the data was carried out in order to locate specific acoustic and articulatory events, such as phoneme boundaries and kinematic landmarks. Patterns of anticipatory coarticulation in VCV sequences were analyzed for one speaker (AV).Preliminary results reveal that V2 had a statistically significant influence extending over the two preceding phonemes, up to the first vowel, in this speaker.

Beyond these phenomenological observations, it is interesting to identify the motor control strategies at the origin of this phenomenon. To assess the two models of motor control through a comparison with our empirical data, sequences of articulatory movements were generated using both models. For that purpose, we employed a two-dimensional biomechanical model of the tongue (Payan & Perrier,1997). This model allows the dynamic and biomechanical properties of the tongue to be accurately characterized. To implement and test the models of control of this artificial language, we developed a static model based on the simulations of the biomechanical model. This static model gives the relations between the motor controls commands and the spectral characteristics of the speech signal. It will be then exploited, in a second phase, in order to exploit muscular synergism and antagonism during the gesture of planning of a sequence. The planning of the sequence consists with reverse the motor controls command associated with the spectral characteristics target expected for the speech signal. Once passed the phase of planning, the movement implies to make assumptions on the variables of control and on their temporal evolution. The models of control tested are based on the assumption of a control of the movement by displacement of the targets. In our study, the model of Öhman shows the large more effects of anticipation of the vowel V2 if we compare with the sequential model. The position of V1 is affected by the vowel V2 and the speed of movement is also affected even at the beginning of the vowel V1.

Our results show that Speaker AV's data are more consistent with Öhman's model than with the sequential model. This suggests that a specific status may be attributed to the vowel-to-vowel basic gesture in Speaker AV's anticipatory strategies. These preliminary conclusions should being deepened by taking into account a larger variety of consonants, and a greater combination of vowels and consonants.