SOME CROSS LANGUAGE ASPECTS OF CO-ARTICULATION

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ABSTRACT

The work reported in this paper concerns som temporal aspects of vowel dynamics in English, French and Swedish. The language specific auditory effects of dynamic complexity and direction of tongue movement are starting points for a study of VCV sequences in these three languages using dynamic electropalatography. Tongue movement is compared between the three languages. Results support the assumtion that differences in auditory impressions of vowels in Swedish and English are dependent on differences in the timing of similar articulatory events whereas French seems to employ quite different articulatory strategies.

1. Introduction

This paper is a brief progress report on research activities in connection with the ACCOR project (Articulatory-Acoustic Correlations in Coarticulatory Processes: A Cross-Language Investigation) which is part of ESPRIT's Basic Research Action program. The work being reported on here is focused on articulatory dynamics in VCV utterances and, in particular, vowel dynamics in these sequences. In many dialects of English, high vowels such as /i/ and /u/ are heard to glide from a somewhat centralized towards a more cardinal vowel quality. The corresponding Central Swedish vowels tend to display a more complex dynamic behavior with a final offglide from cardinal to centralized. In French, on the other hand, these vowel colors sound essentially constant. These language specific, auditory effects are quite characteristic. From a cross-linguistic point of view, these dynamic patterns tend to typify a phonetic typology based on two continuous dimensions: 1) dynamic complexity (monophthongal, diphthongal, triphtongal, ...), and 2) direction of movement (offgliding, ongliding). Among the languages mentioned above, French would approximate the dynamically less complex type, whereas English and Swedish would approximate the dynamically more complex type; and English would approximate the ongliding type, whereas Swedish would approximate the offgliding type.

From a motor control point of view, it is of some interest to explore the articulatory means employed to bring about these effects. It might be assumed, in particular, that differences in perceived vowel dynamics between some languages (perhaps English and Swedish) are brought about essentially by means of different relative timing of onsets and offsets of parallel activity in the articulatory and phonatory subsystems, whereas the activity pattern in each particular subsystem varies less between the languages; other languages (perhaps French) might employ a different articu-

latory scheme altogether. In this paper, we present some preliminary electropalatographic (EPG) data relevant to this question.

2. METHODS

We used the EPG system available at Reading to record a set of vowel-consonant-vowel (VCV) utterances, forming all possible combinations of V=/i,a/ and C=/p,b/, spoken by an Australian English, a French, and a Swedish speaker. The English and Swedish vowels belonged to the set of tense vowels; the French vowel inventory has no tense vs. lax distinction. Randomly ordered lists of these combinations were read several times by each speaker.

3. RESULTS

We will limit this report to some results on the sequence /ipi/ as produced by the three speakers. Figure 1 shows number of activated electrodes (out of a total of 62) at various points in time for English and Swedish; from left to right: a) acoustic onset of V1, b) maximum number of activated electrodes during V1, c) acoustic offset of V1, d) minimum number of activated electrodes (for English = acoustic /p/ release, e) (only Swedish) acoustic /p/ release, f) maximum number of activated electrodes during V2, g) acoustic offset of V2. For French, where no clear maxima or minima could be discerned, the triangles correspond to a) acoustic onset of V1, b) acoustic offset of V1, c) acoustic /p/ release, d) acoustic offset of V2. Acoustic segments corresponding to /i/1, /p/ and /i/2 are indicated at the bottom of the figure for each subject. The data represent averages of 5 repetitions of the test utterance. The Swedish data are shown by filled squares, the English data by filled circles, and the French data by triangles. These symbols are connected by straight lines. The data are aligned to the point in time where there is a minimum number of active electrodes for all three subjects. This point also corresponds to the /p/ release for the Australian English and the French subject. When the data are synchronized in this way, the similarity be-

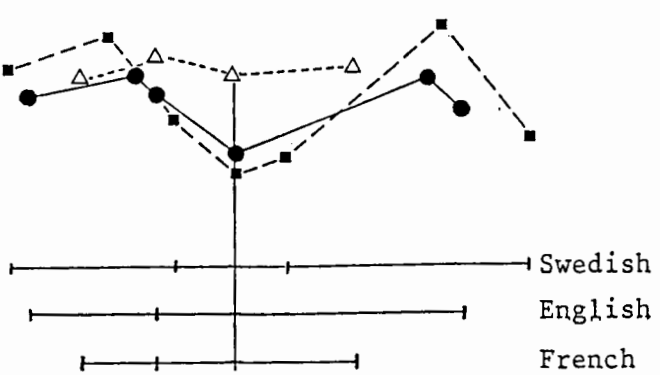

Figure 1. Number of activated EPG electrodes at different points in time during the production of the utterence /ipi/ by an Australian English (circles), a Swedish (squares) and a French speaker (triangles). Below: segment boundaries between the vocalic portion of /i/1, and /i/2.

tween the overall English and Swedish contours, and the difference between these and the French contour, are evident. In particular, the English and Swedish data both display a deep "trough" in the electrode activation pattern, corresponding to a relaxation of the tongue position roughly coinciding with the consonant; the tendency to such a trough in the French pattern is to weak to be statistically significant.

There is, however, a clear difference between the English and the Swedish contours. In the Swedish contour, most of the vowel offglides fall within the vocalic segments, whereas they mostly fall outside the vocalic segments in the English contour. In other words, the troughs in the respective EPG pattern are differently timed relative to the acoustic segment boundaries; the minimum number of activated electrodes occurs at the middle of the consonant segment in the Swedish subject, and at the C/V2 boundary in the Australian-English subject. These differences are thus due to a different relative timing between the tongue articulation underlying the EPG activation patterns and the parallel labial and glottal activities.

4. DISCUSSION

In summary, this limited data set supports the assumption that the difference in perceived vowel dynamics between English and Swedish can be primarily brought about by means of different relative timing of onsets and offsets of activity in the articulatory and phonatory subsystems, whereas French seems to employ a quite different articulatory scheme. In French, the auditory impression of a constant, non-dynamic vowel quality seems to correspond to a constant articulatory position throughout the /ipi/ sequence. This also shows that the presence of a trough in a VCV sequence is language specific rather than universal [4], and that its timing relative to acoustic boundaries is related to characteristic dynamic properties of vowels in the respective languages. A further factor possibly contributing to the presence of troughs in vowel-symmetrical utterances in English and Swedish is related to conditions on aspiration as discussed in [3] and [1] [2]. In particular, the aerodynamic requirements on the production of the stressed, aspirated /p/ release would include a relatively wide vocal tract (cf. [5]), a condition met when the high vowel position is temporarily relaxed. In French, where voiceless stops are not aspirated, or considerably less aspirated, this adjustment would not be necessary.

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