CROSS-LINGUISTIC ASPECTS OF COARTICULATION: AN ACOUSTIC AND ELECTROPALATOGRAPHIC STUDY OF DENTAL AND RETROFLEX CONSONANTS

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ABSTRACT

In Hindi, Swedish and Tamil retroflexes show a more posterior articulation at the beginning of the closure than at the release. Also their exact place of closure is vowel-dependent, whereas that of dentals is constant. Locus equation parameters provide a clear basis for separating dentals from retroflexes at closure onset, but fail to support the idea that *degree of vowel-consonant coarticulation* varies with place, and/or is language-dependent.

MEASUREMENTS

The present data come from two speakers of Hindi, two speakers of Swedish and two speakers of Tamil. Electropalatographic and acoustic records were obtained from all of them. The Hindi and Tamil speakers were asked to produce isolated words of either [a'CV] or ['VCa] structure with V = /i/, /e/, /a/, /o/ or /u/. The Swedish utterances, prosodically similar to *gul hatt*, had symmetrical ['V:'CV:] structure. The present findings are based on measurements for V = /i/, /e/, /ɛ/, /a/, /o/ or /u/. The test words were read five to six times. Formant estimates were made from spectrograms and short-term spectra using the MIX software of R Carlson (KTH). For all samples, formant frequencies were measured in the first vowel 80 ms before the VC boundary; at the last glottal pulse of first vowel before closure (=VC boundary); at the burst; at the first glottal pulse of second vowel (=CV boundary); and in the second vowel 80 ms after the CV boundary. The EPG data were collected using the Reading system [1].

RESULTS

Figure 1 compares several aspects of the data. Average values are shown from a Swedish speaker (OE, left two columns) and for a Hindi speaker (RM, right two columns). For dentals the place of articulation is at the first row of EPG electrodes. There is no variation with vowel context. Nor is there a change from the VC to the CV condition. However, the retroflex data differs in that the exact place does indeed depend on the vowel front vowels having more anterior variants of retroflection. Also there are marked differences between the VC and the CV samples: During the closure the place of contact slides forward so that the contrast between dental and retroflex is larger at the VC than at the CV boundary. The retroflex data for the other speakers exhibit similar patterns of vowel dependence and closure displacement. These findings confirm previous findings on Hindi [2]. The formant measurements are in the form of "locus" plots with the F2 and F3 onsets-offsets plotted against the F2 in the adjacent vowel (first vowel for VC, second for the CV). There is a marked difference between the lines fitted to the F3 data. For dentals, horizontal patterns prevail. For retroflexes, lines are steeper roughly parallel to those of F2.

A comparison of slopes and intercepts for locus equations fitted to the F2 data for each speaker individually reveals no

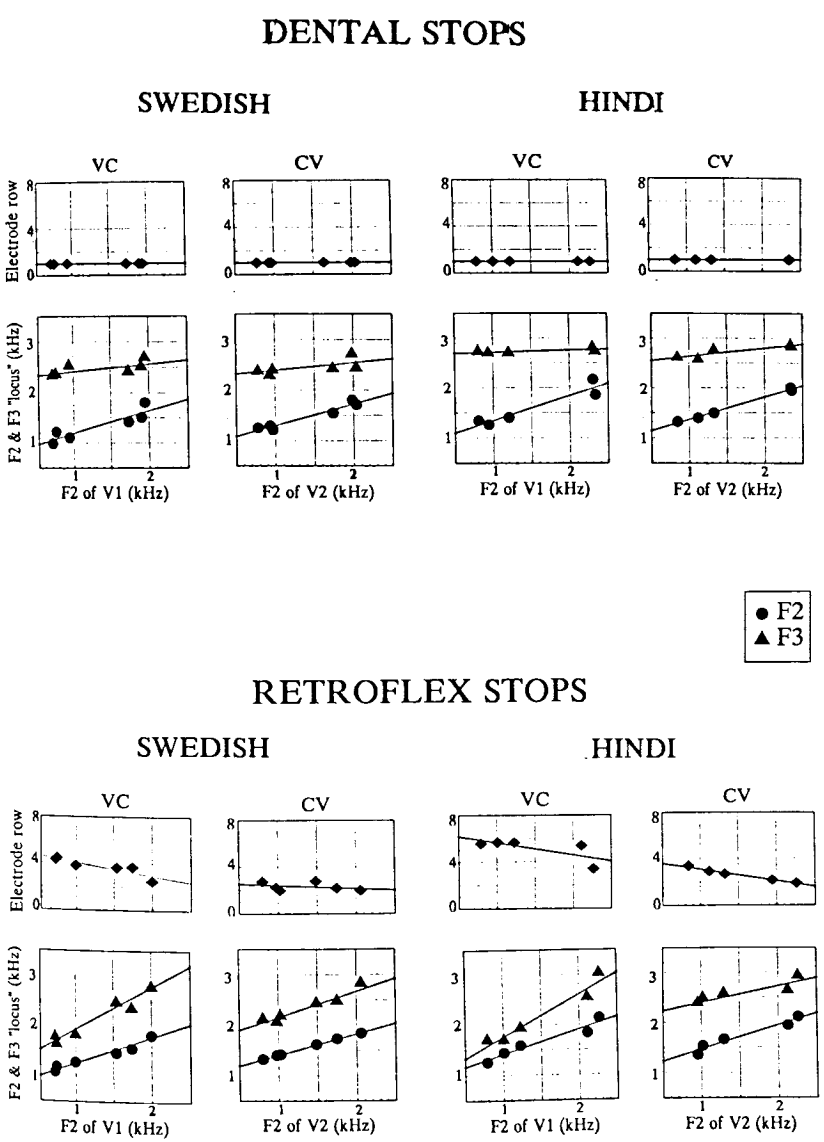

Figure 1. The top half of the figure pertains to dental, the lower half to retroflex observations. The column to the left shows measurements made at the VC boundary, to the right CV observations. The smaller panels (EPG) indicate place of stop closure (specified by electrode number) and are paired with a plot of F2 and F3 onset (VC or CV) versus F2 in vowel (first or second). The calibration of the x-axis is F2 of first or second vowel.

major differences between dentals and retroflexes. This is in agreement with the results reported by Sussman et al [3]. Since, theoretically, F2 ought to be associated mainly with the cavity behind the closure, this finding implies that dentals and retroflexes invoke similar coarticulation patterns with respect to underlying tongue body configurations. Consequently, a more posterior retroflection does not necessarily presuppose a tongue body which is also more posterior. Sublaminal articulations are allegedly typical of Tamil retroflexes [4]. They involve the tongue underside and might therefore be assumed to constrain the mobility of the tongue body even more severely than laminal retroflexes and dentals. Krull [5] has suggested that, for a given place of articulation, variations in the slope andintercept of locus equations could be seen as variations in *degree of coarticulation.*

However the present investigation provides no basis for identifying significant differences in slopes and intercept values in the F2 of Swedish and Hindi laminal retroflexes and Tamil sublaminal retroflexes.

A partial summary of the locus equation results is presented in Figure 2: The diagrams pertain to F3 at the VC and at the CV boundary.

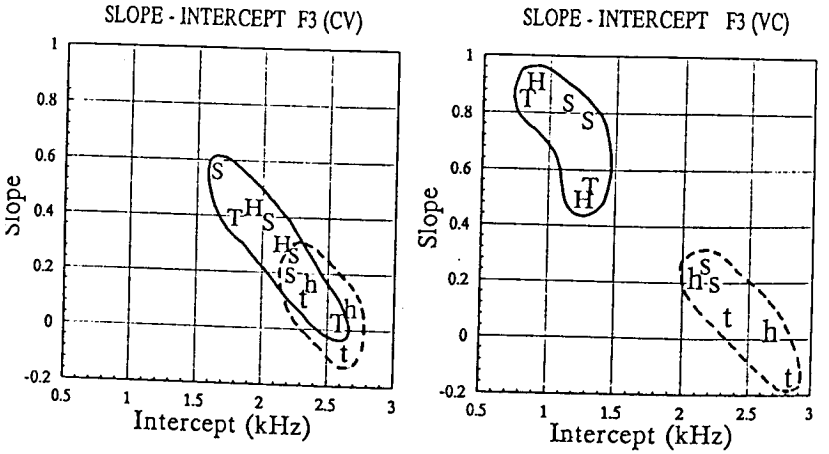

Figure 2. Locus equation slopes and intercepts for F3 at the VC boundary (right) and CV boundary (left). Data for all speakers indicated by language name initial. Uppercase stands for retroflexes, lowercase for dental articulations.

Here slopes are plotted against intercepts for all speakers. Dentals and retroflexes form clearly separated clusters in the case of VC, but they are less distinct for CV. There is no clear-cut or systematic grouping of the speaker pairs which leads us to conclude that coarticulation patterns are similar in the six speakers investigated.

CONCLUSIONS

1. With respect to the time course of retroflex production, it was found that, in all three languages, retroflexes showed a more posterior articulation at the beginning of the closure than at the release. Also their exact place of closure is vowel-dependent, whereas that of dentals is constant (Figure 1).

2. Do locus equation parameters provide invariant place correlates separating dentals and retroflexes in a vowel-independent manner [6]? The answer based on the present data is no with respect to F2, but yes in terms of F3 (Figures 1 and 2).

3. Is there evidence of a more restricted tongue body variation (less coarticulation) in retroflexes than in dentals? On the basis of considerations of articulatory synergy [7], it might be assumed that a more posterior retroflection would create a preference for a tongue body which is also more posterior. Applying the reasoning of Krull [5], we conclude that, for the present analyses, *degree of coarticulation* does not seem to be less in retroflexes. This conclusion is based on the fact that the slopes and intercepts of F2 locus equations were found to be remarkably similar in comparisons of each speaker's dentals and retroflexes.

4. We were unable to identify reliable articulatory or acoustic evidence for the laminal variant of retroflection supposedly characteristic of Hindi and Swedish as opposed to the sublaminal articulation of Tamil [4]. That may be due to the need for more fine-grained analyses than the ones undertaken so far.

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