THE GESTURAL AND TEMPORAL ORGANISATION OF ASSIMILATION

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ABSTRACT

An X-ray motion film study of the palatalisation of Bulgarian apico-alveolar stops and Swedish dorsovelar stops is presented. The gestures involved in an assimilation are initiated earlier, or are held longer, than in nonassimilated situations. This revision of gesture timing in relation to adjacent activity indicates that assimilation is preplanned and does not reflect coarticulation or vocal tract biodynamics. Gestural coordination for these examples is best described as coproduction than feature spreading.

INTRODUCTION

Ever since the 1960s it has been customary to distinguish between universal articulatory constraints and arbitrary language-specific speech habits [1]. The former were said to be intrinsic to the "speech mechanism" (i.e. the regular consequence of the speech motor system and the biodynamics of the vocal tract), the latter were said to be extrinsic (i.e. controlled from the brain). For many phoneticians, assimilation has come to be seen as an intrinsic process, often explained in terms of Öhman's model of coarticulation [2], where it is proposed that alveolars are palatalised and dorsovelars fronted by being superimposed on and summed with the underlying tongue body activity for a front vowel. This contrasts with the view of classical phoneticians like Sweet and Jespersen who saw assimilation as the result of preplanned reorganisation of articulation changing phoneme targets [3,4].

Two rival processes have been proposed for assimilation, feature spreading and coproduction [5]. With the feature-spreading approach, inherited from classical phonetics, the articulatory target of the assimilated phoneme is said to be changed by having the assimilating articulation incorporated into its own plan. With coproduction, the assimilating articulation is never actually copied to the assimilated phoneme but remains the exclusive property of the assimilating phoneme and is produced simultaneously with the assimilated phoneme.

These two issues, extrinsic vs intrinsic production of assimilation, and feature spreading vs coproduction, are investigated here.

This study is part of an investigation of the temporal organisation of coarticulation and assimilation [6,7,8,9]. Articulators were moved into position, their postures were retained for a while, and then they were withdrawn (these three phases of an articulator gesture are referred to here as the onset, the hold and the withdrawal, respectively). While different gestures were allocated simultaneously to different phonemes, any one articulator gesture was invoked for just one phoneme at a time. Whenever mutually antagonistic articulator gestures were required for successive phonemes, they were implemented sequentially, as expected by [10], rather than blended simultaneously as expected by [2].

PROCEDURES

The data has been obtained from X-ray films by procedures described in [6,8]. The films were made at 75 frames/sec (13.3 msecs per frame), with a 3 msec exposure during each frame. Background information on Bulgarian vowels is given in [11,12].

The Bulgarian utterance, spoken by an adult male from Sofia, was *Deteto xodi po pătishtata*, /de'teto 'xodi 'po 'pătiʃtata/, [dɪ'teto 'xɔdi 'po 'pɐtiʃtətə], the child was walking along the path.

The Swedish utterance, spoken by an adult male from Helsingborg in South Sweden, was a nonsense word *kackikakor*, /'kaki,ka:kur/, ['kaki,kɑ:kuʁ].

Articulator movement was detected and recorded by comparing midsagittal profile tracings from one film frame to the next. The articulator gestures that are relevant for the assimilations reported here are four tongue body gestures relative to the mandible (palatal, velar, uvular and pharyngeal) as described in [13], and coronal elevation relative to the tongue

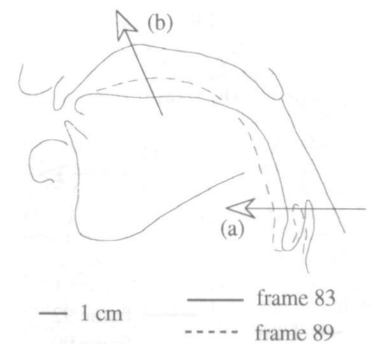

Figure 1. Two profiles from /t/ in /ăti/ (pătishtata), comparing the nonpalatalised implosion (film frame 83, final frame in /ă/ vocoid before /t/ occlusion) with the palatalised release (film frame 89, first frame of /i/ vocoid following /t/ occlusion). Note the more gradual tapering of the vocal tract posteriorly to the apico-alveolar constriction in the palatalised case. The tongue body gestures (a,b) are explained in the text.

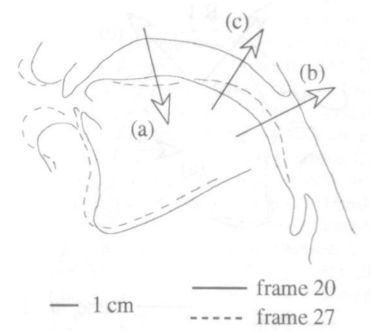

Figure 2. Two profiles from /t/ in /eto/ (deteto xodi), comparing the palatalised implosion (film frame 20, final frame of /e/ vocoid before /t/ occlusion) with the non-palatalised release (film frame 27, first frame of the /o/ vocoid following /t/ occlusion). Note the more gradual tapering of the vocal tract posteriorly to the apico-alveolar constriction in the palatalised case. The tongue body gestures (a,b,c) are explained in the text.

body [6,8]. This set of tongue gestures is available to both vowels and consonants, contrary to the view put forward by Öhman [2] and argued for by Fowler [14] that vowels and consonants are produced by independent systems. The palatal gesture is needed for front vowels and palatal consonants, the velar gesture is needed for high back vowels and dorsovelar consonants, the uvular gesture is needed for mid back vowels and uvular consonants, the pharyngeal tongue body gesture is needed for low vowels and low back consonants. The coronal gesture helps control vocal tract resonance conditions during rounded vowels [12,15].

RESULTS

Bulgarian apicoalveolar stops

The alveolar stops were palatalised on the flank that was adjacent to a front vowel. Figure 1 shows an example of a palatalised release (/t/ in /ăti/ in *pătishtata*), comparing the implosion and the release. The profiles selected are the final film frame of the vocoid segment of /ă/ and the first film frame of the vocoid segment of /i/, as these are the audible parts of the signal nearest to the silent occlusion. Figure 2 shows an example of a palatalised implosion (/t/ in /eto/ in *deteto xodi*), again comparing the implosion and the release. What is interesting here is the different timing of the articular gestures for these two contextual situations.

Gesture timing is not illustrated. For the palatalised release in Fig. 1, the pharyngeal tongue body withdrawal from /ă/ (a) and the palatal tongue body onset for /i/ (a,b) commenced already during the pre-stop vocoid segment of /ă/. They continued during the /t/ occlusion, and had progressed sufficiently by the /t/ release to palatalise it. The palatal tongue body gesture was phased relative to the coronal gesture and alveolar occlusion in such a way that the release was palatalised but not the implosion. This phasing of articulator gestures is typical of coproduction (with the palatal tongue body gesture of the post-stop vowel implemented simultaneously with the alveolar occlusion and timed to arrive at the release), rather than anticipatory feature spreading from the vowel to the alveolar stop (where the stop would get its own palatal articulator gesture copied from the vowel).

For the palatalised implosion in Fig. 2 the palatal tongue body gesture of /e/ was held until the end of its pre-stop vocoid

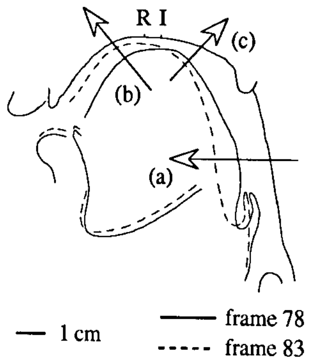

Figure 3. Two profiles from /k/ in /aki (kackikakor), comparing the nonpalatalised implosion (film frame 78, final frame in /a/ vocoid before /k/ occlusion) with the palatalised release (film frame 83, first frame of /i/ vocoid after the /k/ occlusion). The centre of the linguo-palatal contact shifted anteriorly from (I) to (R). The tongue body gestures (a,b,c) are explained in the text.

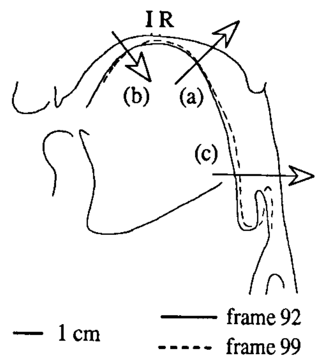

Figure 4. Two profiles from /k/ in /ika:/ (kakikakor), compariing the palatalised implosion (film frame 92, final frame in /i/ vocoid before /k/ occlusion) with the nonpalatalised release (film frame 99, first frame of /a:/ vocoid after the /k/ occlusion). The centre of the linguo-palatal contact shifted posteriorly from (I) to (R). The tongue body gestures (a,b,c) are explained in the text.

segment. The uvular tongue body onset for /o/ (a) and the palatal tongue body withdrawal from /e/ (a,b) did not commence until after the /t/ implosion. In this particular instance there is also a velar tongue body onset for the dorsovelar fricative /x/ of *xodi* (c) that commenced together with the palatal withdrawal and velar onset during the /t/ occlusion.

The palatal tongue body gesture of a front vowel in Bulgarian is thus phased in two different ways relative to the occlusion of an adjacent alveolar stop. To palatalise the implosive flank the palatal posture of the assimilating vowel is held until the end of the pre-stop vocoid segment before being withdrawn. To palatalise the release flank, the palatal onset of the post-stop vowel is activated already during the pre-stop vocoid segment and continues during the alveolar occlusion in order to be in place at the release. The palatal gesture of the vowel is not only locked to its own vocoid segment, it is also locked to the respective flank of an adjacent alveolar stop. The two different phasings point to preplanning of this assimilation.

Fant reports X-ray and acoustic data on palatalisation in Russian [16]. The vocal tract posteriorly to palatalised alveolar occlusion is more narrowly tapered, with consequently greater coupling of the turbulence source to high frequency back cavity resonances, producing a burst spectrum with more energy in the 8-9000 Hz region. The F2 locus is about 200 Hz higher. The narrower tapering can be seen in Figs. 3 and 4.

Swedish dorsovelar stops

Figure 3 shows an example of a palatalised release (/k/ in /aki/ in *kackikakor*), comparing the implosion and the release. The profiles are selected as before. Figure 4 shows an example of a palatalised implosion (/k/ in /ika:/). Here again, the gestures were timed differently for each situation.

For the palatalised release in Fig. 3, the pharyngeal tongue body withdrawal from /a/ (a), the palatal tongue body onset for /i/ (a,b) and the velar tongue body onset for /k/ (c) all commenced during the pre-stop vocoid segment of /a/, continuing during the occlusion (shifting its centre about 5 mm from I to R).

For the palatalised implosion in Fig. 4, the palatal tongue body gesture of /i/ was held almost until the end of its pre-stop vocoid segment. The the velar tongue body onset for /k/ (a) and the palatal tongue body withdrawal from /i/ (b,c) commenced simultaneously just before /k/ occlusion. The retraction from I to R during the occlusion was so slight that the release was almost as palatalised as the onset, which is surprising considering that the post-stop vowel is a dark [ɑ]-like allophone of /a/ (compare this release with the more retracted implosion after /a/ in Fig. 3). The pharyngeal tongue body onset for pre-stop /a:/ (c) did not commence until after the /k/ release, which is later than the activity in Fig. 4, and did not have any effect on the vocal tract configuration for the /k/ occlusion.

CONCLUSIONS

The timing of articulator gestures for palatalisation is best described as coproduction rather than feature-spreading.

The different phasing patterns of the palatal tongue body gesture for palatalisation of implosions and releases, for alveolar stops in Bulgarian and for dorsovelar stops in Swedish point to specific gestural reorganisation for this assimilation that is different from the regular interweaving of gestures for coarticulation. They are an example of how assimilation is a preplanned process that applies to specific phonemes in defined situations distinct from the coarticulatory adjustments of all phonemes to their neighbours.

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