

Some cross-linguistic patterns in the study of dorsal obstruent production.

Introduction

The classification of the palatal place of articulation has already been inconsistent between the classical feature systems of the “Preliminaries to speech Analysis” (Jakobson et al., 1952, PSA) and the “The Sound Pattern of English” (Chomsky & Halle, 1968, SPE). SPE replaced the PSA [grave/acute]-feature with the feature [coronal], defining coronal sounds as sounds “produced with the blade of the tongue raised from its neutral position”. But this adoption was not one-to-one in the sense that the specification was identical for labials, velars and all coronal places with the one exception of the most posterior palatal place. In the phonological literature, a revision of the feature coronal equating it with [grave/acute] indeed has been advocated by Lahiri & Blumstein (1984) and others. This issue has remained of major interest in the constituency of feature-geometric models (Clements, 1985; Clements & Hume, 1995; Lahiri & Evers, 1991), but even in more recent work, a reflex of this mismatch remains, when, like in e.g. Hall (1997), where noncontinuants and continuants - stops and fricatives - are treated differentially in their coronality specification: While palatal *fricatives* are treated as noncoronals, the existence of noncoronal palatal stops is denied altogether, they are universally coronal and their articulatory implementation is alveopalatal.

This study aims at crosslinguistic comparisons of EMA movement data with regard to A) German velar stops and fricatives and B) Hungarian velar and palatal stops. The derivation of specific hypotheses from theoretical approaches is not warranted for all phonological theories available, especially if one decides to take coarticulatory phenomena into account, and we therefore have to concentrate on selected approaches, arising from distinct traditions on how to reflect the division of labour between Phonetics and Phonology (see Beckman, 1999): a) Neo-generative approaches assume discrete phonological categories, which are interfaced with the speech production apparatus as rewrite-statements expressed in terms of derivational rules. b) alternative approaches emphasize the physical and conceptual constraints, which form the common features of phonological organization and contrast, and theories of phonological representation must be directly evaluated as models of human speech production and perception (e.g. Browman & Goldstein, 1993). As an instantiation of the first class of theories it is possible to evaluate the target-and-interpolation approach as worked out in a series of papers by Keating based on a version of underspecification theory (1988b, 1988a, 1991, 1993), the second class of theories is centered around the framework of Articulatory Phonology and Task Dynamics (Saltzman & Munhall, 1989). It has been instantiated for the concrete topic under investigation by the degree of articulatory constraint (DAC)- scale (Recasens, 2002, e.g.), which will not be discussed in depth though.

Experimental Setup

We acquired tongue, jaw and lower lip movements of four German and four Hungarian speakers by means of Electromagnetic Midsagittal Articulography (EMMA, AG100, Carstens). The material consisted of movement trajectories of anterior and posterior parts of the tongue dorsum during symmetrical /CVCa/ -sequences, where /V/ was one of the long Hungarian vowels /i, a, u/ or the tense German equivalents. C were either the palatal or velar stop consonant for Hungarian or the velar stop or fricative for German.

Results

Reasonably, three experimental contrasts can be set up for our data, a) an intra-language comparison between Hungarian palatal and velar stops, b) an intra-language comparison between German palatal fricatives (and allophones) versus velar stops and c) a comparison of velar stops across both languages. These contrasts likewise guide the presentation of our still preliminary results before turning to a more general discussion.

Intra-language, palatal versus velar stops (Hungarian): In short, Keating’s approach proposed that *palatals* are complex segments involving both coronal and tongue body articulation, i.e. the representation of the palatal has, in feature-geometric terms, specifications on the dorsal as well as on the coronal node (Keating, 1988a). Of essential interest for the *velars* is the specification for the feature [back]: She makes explicit reference to the work of Houde (1968) while stating that velars “lack inherent specification for Back (Keating, 1991, p. 17)”, and that “velar fronting is something that happens *gradually over the course of the velar*”. Keating views this as a “*transparency effect of the velar with respect to Backness*” (Keating, 1993, p. 17). Referring to Houde’s work enforces a closer look at the so-called articulatory “loops”, which have often been observed in V1-[Velar]-V2-sequences (e.g. Mooshammer et al. (1995)), and are more recently discussed in connection with motor control or tongue biomechanics (Perrier et al., 2003). The intra-language analyses for Hungarian can be summarized as follows:

- Coarticulatory resistance of the palatal stop: The palatal is not very prone to vowel-like influences: (a) the palatal exhibits a rather stable configuration in comparison to the velar. This stable configuration is similar to an /i/-like shape (b) the palatal exerts an influence on the vowel articulation inasmuch as the size of the medial vowel space is shrunk in comparison to vowel space in the context of the velar stop.
- The initial palatal in the context of the back vowel /u:/ is articulated further back than the other palatals and isolated from the relatively stable configuration we observed for the remaining palatals. Furthermore, for two out of our four speakers, the movement amplitude of the palatal in /u:/-context *during* closure is among the highest amplitudes altogether.

Intra-language, palatal fricative versus velar stops (German): It is possible to derive expectations directly from Articulatory Phonology, hypothesizing that there should be no differences in constriction place, only in constriction degree. This is at odds with more phonological views which often have argued that variation within phonemes and allophones should be distinguished from coarticulatory/assimilative variation. Further, in order to compare coarticulatory patterns of the German obstruents to the Hungarian patterns above, averaged targets were subjected to standard Principal Component Analyses.

- We compared the distances for the rearmost (tongue back) sensors (measured at the temporal midpoint of the friction interval and the time of the the release burst - for stops) between the most distant allophones/variants /i/ and /u/ of the sounds

under consideration. Results show that the distances between the most anterior and the most posterior variants/allophones are generally larger for /x/ than for /k/.

- The palatal fricative, while itself showing bigger differences between its contextual variants, influences neighbouring vowels stronger, inasmuch the surrounding vowel space is shrunk, although to a lesser degree than in the context of the Hungarian palatal.

Velar stops across languages (Blocking Hypothesis): This contrast asks for the blocking of velar transparency on the level of phonetic planning in the Keating framework, i.e. is there a phonetic implementation rule which specifies the backness of the velar in a language like Hungarian which has an additional palatal stop, or, is more contextual variation observed for German velar stop production than for the Hungarian velars. We operationalized this questions by calculating an index of contextual variability as the ellipse areas of the rear-most EMA sensor of the velar stops at burst time over all vowel contexts, separately by speaker and language. The observed patterns show no signs of a diminished contextual variability. These results are still preliminary though, as it is possible to derive other operationalizations of contextual variation from the same data which could potentially give rise to different interpretations.

Discussion

At first sight, predictions made by target-and-interpolation approaches as the one proposed by Keating fits the data presented quite well. This in particular holds for the palatal stop with its extremely strong coarticulatory impact and its stable posture, which might justify a complex specification of palatal stops as compared to velars and also of palatal stops as compared to fricatives. The empirical resolution of AP on the contrary seems to be not high enough to distinguish between the patterns of velar and palatal stops in Hungarian. This to some extent surely is due to the fact that AP was developed for AE in the first place, and there was no necessity to make more fine-grained differentiation of tongue body articulations. One further step in the analysis would be to discuss these results in the framework of the DAC-scale, as envisioned in the introduction. Still, approaches like Keating's are not without problems either: Within this framework it is not always easy to decide between phonetic implementation rules generating the articulatory program and effects of the articulatory periphery. This is evidenced by the data presented here aiming at the cross-linguistic comparison of the velar stops: Hungarian shows no signs of a diminished contextual variability in comparison to German, although the insertion of backness earlier in the derivation would make sense in terms of a better recoverability of segmental identity for this language. The problematic of determining the correct "moment" in the derivational chain for feature insertion has also been pointed out by Beckman (1999, p.215), questioning altogether whether Keating's approach "casts the burden into the right direction". She rather proposes to "look for a more complete model of coarticulation to explain the apparition of a categorical specification". Beckman proposes that this can be achieved by having a closer look on phonetic phenomena like the quantal region in the mapping from constriction place to F2 and by doing more basic speech research on aerodynamic and other causes for the forward "loop" trajectories. Anyhow, we had a closer look at distances travelled during oral closure, and the stable palatal stop exhibited such large movements patterns during closure, that this hypothesis can almost safely be ruled out as a source for contextual variation. This suggests that articulatory looping pattern should not be discussed in terms of contextual variation for velars altogether, but rather are an extralinguistic topic for speech production per se exercising the division between aerodynamic and biomechanical factors from principles of a general movement economy.

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