ACOUSTIC VARIATION AND TYPES OF PALATALIZATION

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ABSTRACT

Dialectal variation in Estonian consonant palatalization (as a secondary articulation) can be accounted for in terms of location of the maximum effect of palatalization in the time dimension ("prepalatalized" vs "postpalatalized"). The same acoustic property can be used to describe cross-linguistic variation in palatalization. The effect of palatalization is manifested mainly in rise of the frequency of the second formant.

1. Specification of the Feature "Palatalized"

Palatalization in the sense of a secondary articulation (International Phonetic Alphabet (IPA): s̡ t̡ n̡ l̡ and other consonants /1: 13/) is approached in this paper.

Palatalization has been treated as a single feature both in the IPA transcription system and in the distinctive feature system of Jakobson, Fant, and Halle (the feature Sharp) /2: 31/. In later distinctive feature systems palatalization has been defined as a particular feature combination: [+high, -back] in Chomsky and Halle /3: 306/ or High, Front in Ladefoged /4: 80/.

Jakobson, Fant, and Halle propose acoustic correlates to their distinctive features. The feature Sharp, by contrast with the feature Plain, "manifests itself in a slight rise of the second formant and, to some degree, also of the higher formants" /2: 31/. Hence, the two features are relational, based on comparison of the palatalized (or sharp) consonants with the nonpalatalized (or plain) consonants, everything else (context, speaker) being equal. The feature Sharp is defined as inherent (vs prosodic), without any reference to sequence. "No comparison of two points in a time series is involved" /2: 13/.

Fall of the frequency of F1 (formant one) can compensate for F2 rise in perception /5: 6/. Ladefoged /4: 75/ also uses frequency of F1 to specify his acoustic features Height and Backness which together define palatalization in his distinctive feature system. See also /6/ and /7/ where concrete lists of simple physical parameters and their usual lack of one-to-one relation with linguistic categories (features) have been presented. Measurements /8: 220/ /9: 150/ /10: 61/ /11: 3/ /5: 3/ /12: 10/ have shown that the frequency of F2 is indeed the main (the sufficient) acoustic parameter, whose values differentiate palatalized consonants from nonpalatalized ones. However, contextual and inter-speaker variation has not been satisfactorily accounted for yet.

Contextual variation has been considered neglectable. In comparison with values for nonpalatalized consonants, F2 frequency values for palatalized consonants, measured at the terminal point (beginning or end) of a vowel formant transition, are less variable over
(1) different vowel environments
(2) different consonants of the same "point of articulation"
(3) consonants of different "point of articulation" series (labials, dentals, velars) /8: 223/.

Inter-speaker variation. Two separate threshold values have been proposed for male vs female speakers. In Russian, the crossover points of F2 distributions for palatalized and nonpalatalized consonants occurred at 1700 Hz for males, and at 1900-2000 Hz for females. (Measurements were taken within the consonant or at the beginning of a transition from the consonant to the vowel.) /11: 4/.

Relational values differ less than absolute values for high and low voices. E.g. the percentage by which F2 frequency of palatalized consonants exceeds that of nonpalatalized consonants of the same speaker was found to be approximately 30% in Estonian /9: 146/. Although such values (involving comparison with nonpalatalized consonants) show less inter-speaker variation, they are more context variable than the absolute values (because of the contextual variation of nonpalatalized consonants). Normalization for F3 frequencies has been attempted in some cases /11: 4/.

Palatalized and palatal. It is not clear whether the acoustic difference between palatalized and palatal consonants (IPA: c ɲ ɲ̟ ç j) is that of degree or whether any new acoustic parameter is involved. The two sets of consonants rarely contrast within one language. University of California, Los Angeles, Phonological Segment Inventory Database shows palalized dental/alveolars and palatals of the same manner class contrasting in Irish: n̡ and n̠ /13/. It has been proposed to distinguish in IPA three degrees of palatalization /14/, e.g. n̠ n̡ and (Estonian) ń.

2. Accounting for Dialectal and Cross-Linguistic Variation

Dialectal (or cross-language) comparison may complicate acoustic descriptions by showing consistent differences, not accountable for in terms of acoustic properties (parameters) used to specify established linguistic features (distinctions). This may point to the lack of cross-linguistic acoustic invariance of the distinctive features (categories) (see discussion of "alveolar" in /15/ /16/). Or it may indicate that distinctive features (categories) cannot account for all audible (noncontrastive) differences /7: 500/.

2.1. Estonian dialects. Both in terms of linguistic distribution of palatalized consonants /17/ and acoustically, Estonian exhibits a variety of palatalization types. Preliminary analysis of spectral characteristics of palatalization in VCV (vowel consonant (vowel)) sequences (frequencies of formants were calculated using linear prediction analysis /18/), reveals that palatalization in Estonian dialects varies with respect to the following (acoustic) features:
(1) Location of the maximum effect ("focus") of palatalization in the time dimension.
(2) Characteristics of coarticulation in the sequence VCV in different vowel combinations.

The "focus" is defined either (1) as the point (interval) in which the frequency of F2 of palatalized consonants maximally exceeds that of nonpalatalized consonants (in phonologically (near-)minimal pairs) or (2) as the point of maximum F2 in symmetrical vowel environments. Location of the "focus" on the time axis can be measured towards the left or right of the V-C boundary. An earlier "focus" on the time axis is accompanied by shorter transition to the following vowel. See Fig. 1 for two (extreme) types of palatalization, contrasting in the location of the maximum effect (A) at the transition from the consonant to the following vowel ("postpalatalized") (B) at the transition from the preceding vowel to the consonant ("prepalatalized").

2.2. Russian vs Estonian. In both languages palatalization can distinguish word meaning. Russian ves "weight" vs ves "entire". Estonian palk vs palk "beam". Russian has been the model language for the acoustic study of palatalization. Dentals, labials, labiodentals, and in more restricted environments (not word-finally) also velars palatalize in standard Russian. In standard Estonian, palatalization is limited to the position immediately after the vowel of the primary-stressed syllable, and only alveodentals t s n l can be palatalized. F2 frequency values corresponding to palatalization, assuming a single value per (phonemic) segment, overlap in the two languages /19/. Time location of maximal F2 frequency change is a more stable characteristic of the difference in palatalization between Russian and standard Estonian. The difference can be expressed in terms of the percentage by which the frequency of F2 of palatalized consonants exceeds that of nonpalatalized consonants (a) at the beginning and (b) at the end of the consonants:

	Russian s̡	Estonian alveodentals
(a)	12	24
(b)	42	3

(based on data from /5/ and /9/)

In Russian palatalization is manifested most prominently at the release of the consonant and at the transition to the following vowel, if any vowel follows (although F2 frequency in the preceding V and within C are influenced to a lesser extent). In standard Estonian, the maximum effect appears at the transition from the preceding vowel to the consonant (presence of the preceding V is obligatory, word-initial C does not palatalize). The difference in palatalization between Estonian dialects as well as between standard Estonian and Russian is similar to that, expressed with special features in /13/, nasalized : nasal release (postnasalized); aspirated : preaspirated. A general need for acoustic specifications to be time-varying /7/ /20/ and context-sensitive /21/ or in terms of longer units /22/ has been admitted.

2.3. In summary, one and the same acoustic parameter, the frequency of F2, distinguishes palatalized consonants from nonpalatalized consonants in all known cases (although contextual effects and normalization for high and low voices have not been sufficiently elaborated).

†"wages"

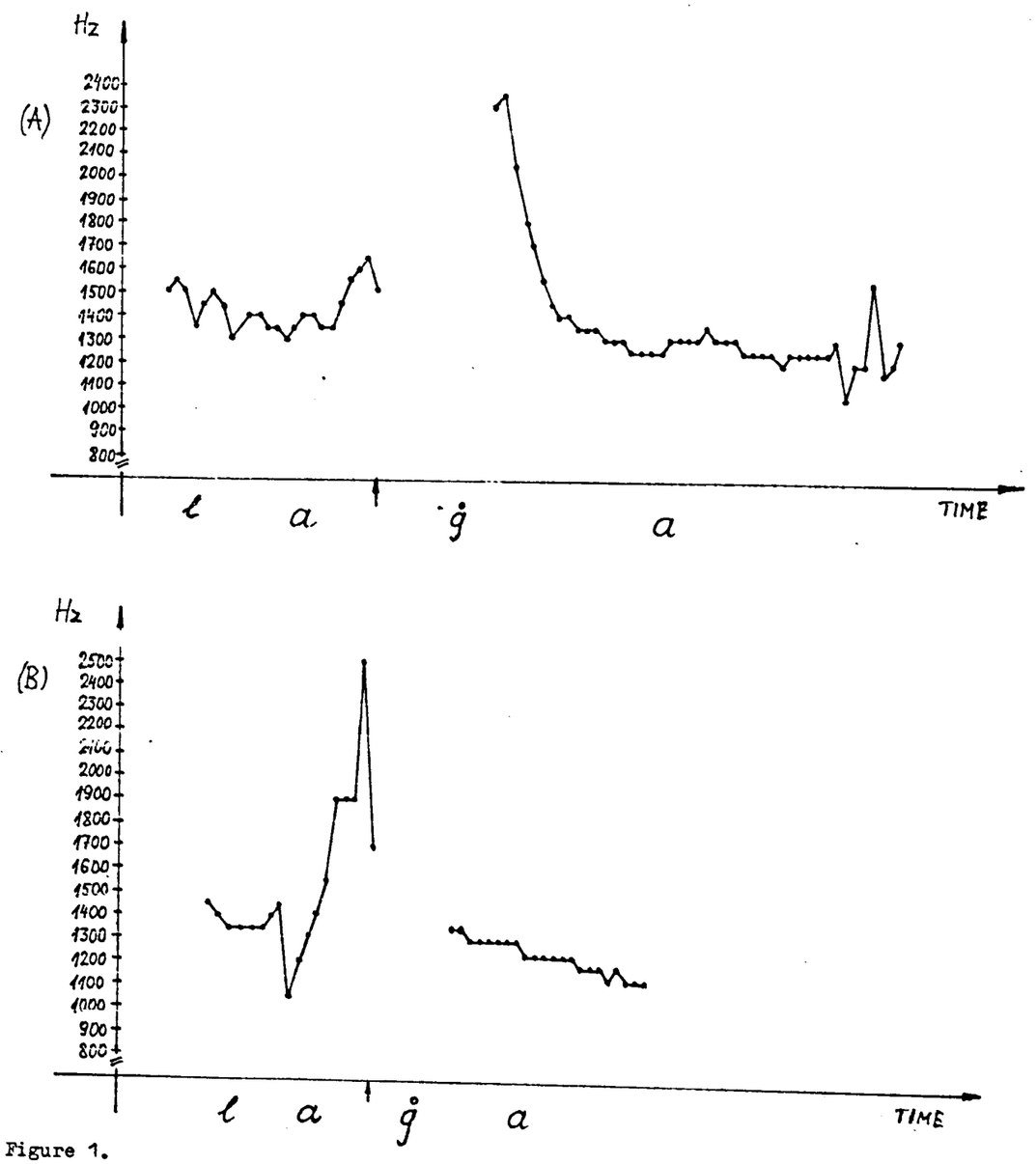

Figure 1.

F2 trajectories of the word laga "broad" in Estonian dialects. Words pronounced in isolation, slow tempo, female speaker in both cases. ↑ points to V-C boundary (the last frame where F0 appeared before voiceless consonant).
after ten milliseconds.

(A) "postpalatalized" lag̊a (Võru dialect)
(B) "prepalatalized" lag̊a (Tartu dialect)

To account for dialectal and cross-linguistic (non-contrastive) differences, time-varying values of the same parameter must be considered.

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