THE ARTICULATION OF SECONDARILY PALATALIZED CORONALS IN POLISH

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ABSTRACT

The articulation of secondarily palatalized vs plain coronals in Polish is studied in a parallel electropalatographical (EPG) and electromagnetic-articulographical (EMA) experiment. The EPG data of four Polish subjects are analyzed with respect to the tongue contact area at the beginning, center and end of the consonantal articulation. The movements of three fleshpoints of the tongue (.5 and 2.5 cm behind the tongue tip and also at .5 cm sublaminally) were recorded by EMA. Their position was measured at velocity minima of the tongue blade corresponding to the consonantal target and to the initial phase of the vocalic portion, respectively. The results show that secondary palatalization in general is realized by raising the predorsum. This holds true for the laminally produced stop [t] as well as for the retroflex fricatives [ʂ] and [ʐ] ([r], which is most often realized as a flap [ɾ] behaves in a similar fashion as the fricatives).

1. INTRODUCTION

In Polish coronals have been argued to undergo various kinds of palatalization rules, e.g. Coronal Palatalization and J-Palatalization [1, 3]. While Coronal Palatalization is triggered by palatalizing suffixes, J-Palatalization occurs in well-defined grammatical contexts. Both palatalization types change the place and/or manner of articulation of coronals. For example, Coronal Palatalization changes the dental plosive [t] to the alveolo-palatal affricate [t͡ɕ], the alveolar trill [r] to the 'flat postalveolar (retroflex)' fricative [ʐ] (cf. [2]) and the alveolar fricative [s] to the alveolo-palatal fricative [ɕ]. On the other hand, J-Palatalization changes [t] to the alveolar affricate [t͡s] or the postalveolar (retroflex) affricate [t͡ʂ] and [s] to the postalveolar (retroflex) fricative [ʂ].

The outputs of these palatalization rules affecting coronals are in contrast to palatalization found in foreign, mostly assimilated, words. Interestingly, only this kind of palatalization manifests itself with a secondary articulation. For example, *optimum* is realized as [ɔptʲimʊm]. In native vocabulary the secondarily palatalized coronals are systematically avoided by replacing [i] with the high central unrounded vowel [ɨ]. This change is assumed to require a phonological rule called Retraction [1], according to which [i] is turned into [ɨ] after hard dental/alveolar and retroflex consonants.[1]

Taking into consideration both the avoidance of the secondary palatalization of coronals by Polish speakers on the one hand, and its presence in a limited number of words on the other hand, we pose the question of whether or not there exists articulatory motivation for the existing asymmetry. Why do speakers change the vowel [i] into [ɨ] while other vowels remain unchanged? Another question we pose concerns the involvement of the predorsum in palatalization. Do plain and palatalized [t] differ with respect to apicality/laminality? Finally, we want to examine how the palatalization is realized in the case of [ʂ], [ʐ] and [r].

2. ARTICULATORY MEASUREMENTS

In order to answer these and related questions we conducted a parallel electropalatographical (EPG) and electromagnetic-articulographical (EMA) experiment.

2.1. Subjects and Material

Four native speakers of Standard Polish (2 female (JOA, MAR), 2 male (KAP, LAB), mean age of 30 years) served as subjects. They read the test words embedded in the carrier frame *powiedziałem ... bez pośpiechu* ('I said ... without hurry') ten times (JOA only five times) in randomized order as prompted by the screen for stimulus presentation (cf. fig. 1). The test words displayed the initial coronal consonants [t, r, s, ʂ, ʐ] in a plain and a palatalized version (e.g. *tyki* [tɨki] 'poles' vs *tiki* [tʲiki] 'ticks', *ryki* [rɨki] 'roars' vs *riksza* [rʲikʂa] 'ricksha(w)', *zywego* [ʐɨvɛgɔ] 'alive' (gen.sg.) vs *Ziwago* [ʐʲivagɔ] 'proper name', *Chicago* [ʂʲikagɔ] vs *szykana* [ʂɨkana] 'vexations', *sera* [sɛra] 'cheese' (gen.sg.) vs *Sierra* [sʲɛra] 'Sierra'.

2.2. Method

The consonantal articulation was recorded by midsagittal electromagnetic articulography (EMA, Carstens AG 100, 5 channels) and by electropalatography (EPG, Reading system 3.0 with 62 electrodes in 8 rows; cf. fig. 1) in parallel.

The palatographic data were analyzed at three different points in time, i.e. at the beginning of consonantal articulation, at the point of maximal constriction, and at the beginning of the CV transition. The parameters extracted were the center of gravity of the contact area expressed by its row position (henceforth gravity) and the number of electrodes contacted (henceforth weight).

The EMA receiver coils were mounted at the tongue blade ca .5 cm behind the tongue tip laminally and 2 cm farther back predorsally. The third coil was mounted sublaminally, again ca. .5 cm. behind the tongue tip (cf. fig. 1). Their position was analyzed at the time points of minimal tangential velocity of the laminal coil corresponding most closely to the consonantal target and to the initial phase of the following vocalic portion, respectively.

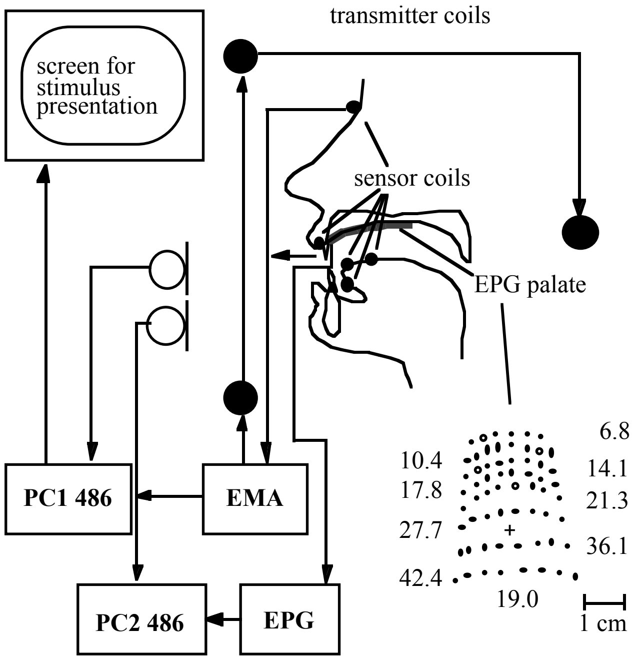

Figure 1. Scheme of the experimental setup and of the electrode placement on a sample EPG palate (male; the numbers besides the palate give the mean distance of the electrode rows from the inner edge of the upper incisors (in mm); the cross marks the highest point of the palate with its distance from the bite plane given below).

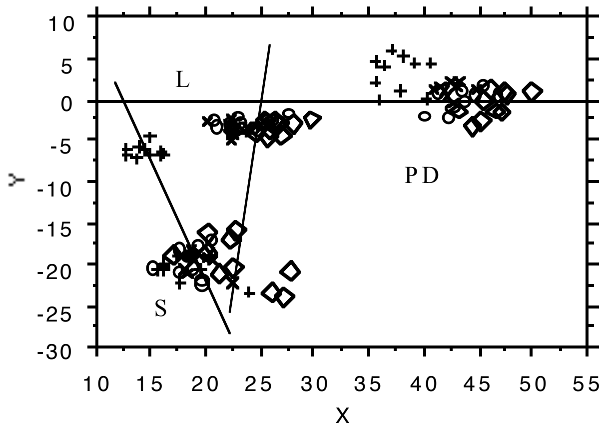

Figure 2. Scatter plot of the coil positions for the palatalized consonantal target in [i] context with superimposed lines of tongue tip orientation for [t] and the other consonants (subject KAP; L laminal coil, S sublaminal coil, PD predorsal coil; + [t], ◊ [r][3], x [ṣ], ¤ [ẓ]).

2.3. Results

Different analyses of variance were run for each subject separately for testing both the effects of consonantal category [t, r, ṣ, ẓ] and palatalization as independent variables in the context of the vowel [i] (also including [s] in the context of [ɛ]). In addition, the influence of the different vowel contexts ([i, u, a]) and palatalization was tested for [t] and [r].

2.3.1. EMA Measurements. Analyses of variance of the EMA data showed consistent effects of palatalization mainly in the higher position of the predorsal coil. All subjects showed this effect ($p < .001$), sometimes accompanied by a consonantal effect. The mean vertical difference between palatalized and plain articulations in [i] context is given in table 1.

subject	JOA	MAR	KAP	LAB
consonant	.9	3.1	2.4	2.3
transition	2.2	3.0	3.2	4.1

Table 1. Mean elevation of the predorsum with palatalization at both measuring points (in mm).

A stable consonantal effect was observed with respect to the angle given by the connecting line between the laminal and the sublaminal coil and the vertical axis of the measurement coordinates. A clockwise rotation of this connecting line can be interpreted as a curling back of the tongue tip (retroflexation). All subjects showed a significant difference ($p < .001$, JOA $p < .05$) between [t] and the other consonants as shown in table 2 (cf. also fig. 2).[2]

subject	JOA	MAR	KAP	LAB
[ẓ]	43.2	14.3	25.0	22.0
[ṣ]	40.9	12.3	23.5	15.9
[r]	37.4	10.9	24.8	15.4

Table 2. Back rotation of the tongue tip relative to its position for [t] (in degrees).

2.3.2. EPG Measurements. The gravity parameter distinguishes between the consonantal categories as to be expected: [t] is articulated more anterior than both [ṣ] and [ẓ]. For [r] this parameter is not very reliable since only in very rare cases (mainly for subject KAP) there are clear contacts visible in the EPG pattern. Only KAP produced a clear alveolar trill whereas the other subjects showed flapped productions with minimal contacts visible in the EPG recording (also resulting in extremely minimal values for the weight parameter). The effect of palatalization on the other hand is consistently observable in the weight parameter, especially for the measurement at the beginning of the CV transition (cf. table 3).

subject	JOA	MAR	KAP	LAB
begin cons.	.312 n.s.	.285 *	.316 *	.199 n.s.
max. const.	.568 ***	.498 ***	.409 **	.434 ***
transition	1.056 ***	1.169 ***	.880 ***	.854 ***

Table 3. Mean difference in weight between palatalized and plain articulations at the three measurement points ([i] context; * $p < .05$, ** $p < .01$, *** $p < .001$).

Figure 3 illustrates this effect that is due to a larger contact area of the lateral tongue border in palatalized articulations. As can be seen, this does not result in a shifting of the place of maximal constriction and therefore does not result in a significant effect of palatalization on the dependent variable gravity.

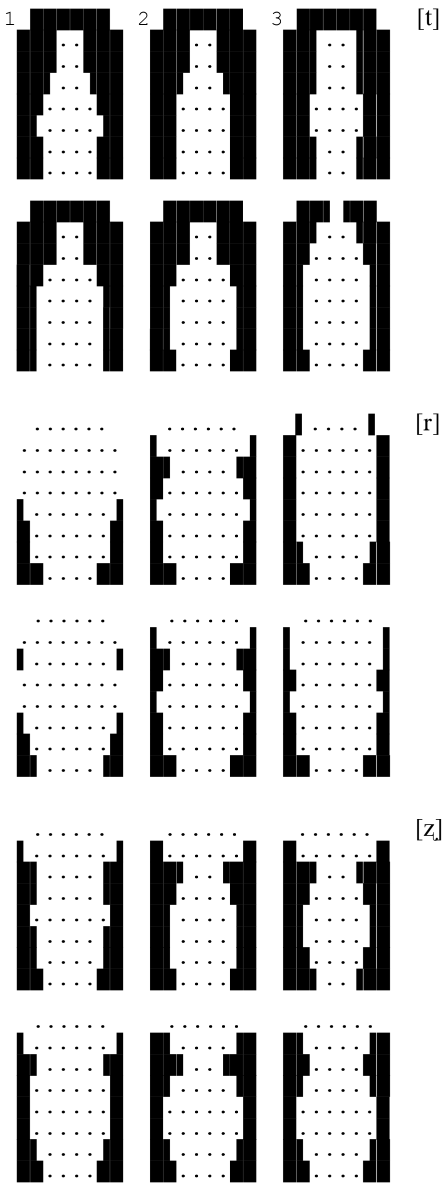

Figure 3. Scheme of mean contacts at the three measurement points (columns 1-3) for palatalized and plain [t, r, ʐ] in [i] context (subject KAP).

That this effect is not due to the vowel alternation between [i] and [ɨ] (cf. the introduction above) can be gleaned from the analysis of the articulation of [t] in different vowel contexts (cf. table 4).

subject	JOA	MAR	KAP	LAB
a	1.135 ***	1.269 ***	.605 n.s.	.715 ***
i	.532 **	.810 ***	.894 ***	.746 ***
u	1.033 ***	.710 ***	.209 n.s.	.189 n.s.

Table 4. Mean difference in weight between palatalized and plain [t] measured at the CV transition in the different vowel contexts.

Note that although for this parameter subject KAP shows no effect of palatalization for [a] and [u], the analysis of the position of the predorsal coil as measured by EMA again reveals a vowel independent elevation of the predorsum in palatalized [t].

3. DISCUSSION

The results of the analyses of our articulatory data clearly demonstrate that the secondary palatalization of coronals in Polish manifests itself phonetically in a purely secondary articulation, i.e. an elevation of the predorsum. In contrast to the phonologically productive palatalization processes of Polish it does not result in a change of place (or manner) of articulation. This holds true for the laminally produced consonants [t] and [s] as well as for the retroflex fricatives [ʂ] and [ʐ].

The plain and the palatalized alveolar plosive normally is produced with the tongue blade. This was visible in EPG contacts affecting more than one or two rows of electrodes. Only subject KAP's data sometimes (but not exclusively for plain stops) displayed apical production, too. This observation is in contrast to the description in [4] that regards plain stops as apical and their palatalized counterparts as produced with an additionally raised predorsum. It is also contrary to the hypothesis that plain and palatalized alveolar stops may be distinguished by apicality vs laminality.

The fricatives [ʂ] (in Polish orthography <sz>) and [ʐ] (in Polish orthography <rz> or <ż>) as well as [r] are produced with a tongue tip that is bent backwards in relation to its position for [t] and [s]. These fricatives [ʂ] and [ʐ] are traditionally referred to as 'postalveolar' among Slavists (cf. [3]) and usually transcribed as [š] and [ž]. With respect to our data and following [2] they are to be described as retroflex. With regard to the tongue tip orientation of [r] that usually is regarded as an alveolar trill a slightly retroflexed position is to be expected. This is indeed visible in our data. Furthermore, the most common articulation (with the exception of subject KAP's productions) in our experiment is a flapped (seemingly retroflex) articulation, not only for the palatalized variant (as according to [4]).

The common articulatory pattern of secondary palatalization, i.e. the raised predorsum, in our data is independent of the vowel context. Only some slight timing differences between primary and secondary articulation depending on vowel category (especially in case of [u]) are visible.

Returning to the question posed in the introduction as to why Polish speakers systematically avoid secondary palatalization of coronals we suggest that it is the secondary raising of the predorsum as an accompaniment of the vowel [i] triggering this phonetic palatalization that causes articulatory difficulties. In native Polish vocabulary this 'costly' gesture is avoided by Retraction. This is normally not possible for foreign words with another vowel following the [i], where this [i] has to be realized as secondary articulation of the preceding consonant. Interestingly, one of the subjects of our experiment (LAB) made use of Retraction by applying it to foreign words such as *riksza* and *Ziwago* which independetly confirms the reluctancy of Polish native speakers to the raised predorsum of secondarily palatalized coronals. (cf. also note 1).

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NOTES

1. Retraction is sometimes found even in foreign vocabulary, e.g. *meeting* is realized either as [mitʲiŋ] or [mitɨŋ].
2. [s] in the context of [ɛ] patterns with [t].
3. Due to conversion errors by importing the figure into MS Word these are only 'raw diamonds'.

REFERENCES

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