

AUDITORY FACTORS IN THE EMERGENCE OF PREPALATAL AFFRICATES IN POLISH

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Abstract. The idea that auditory factors play a role in phonology besides articulation has gained more and more attention in recent years (cf. Steriade, e.g. 1997, 2001; Flemming, 1995/2002; Boersma, 1998; Padgett, 2001a, 2001b; Hume and Johnson, 2001, and references therein; NiChiosain and Padgett, 2001, Cavar, 2003, and many others). The standard assumption for Polish so far has been that the emergence of prepalatal affricates is of articulatory nature and accounts have been offered in terms of articulatory features (e.g. Rubach, 19984; Szpyra, 1995; Cavar, 1997). I will argue that, though articulatory factors may play here some role, the driving force is of auditory background. Two parameters will be investigated separately, namely, place of articulation, and stridency. Arguments from the typology of consonantal inventories, and from the phonology of standard Polish and Polish dialects will be presented to support this view.

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Transcription key

Instead of the IPA transcription the following symbols have been used:

ś, ź, tś, dź, n̊ – prepalatal sounds

š, ž, tš, dž – post-alveolar sounds as in Polish; palatoalveolar sounds as in English¹

¹ Post-alveolar sounds in Polish and palatoalveolars (e.g. in English) differ substantially with respect to articulation. The same symbol is used in this paper because they do not contrast in the discussed

s, z, ts, dz, r – retroflexes

šx – simultaneous palatoalveolar and velar fricative as in Swedish

' - secondary palatalization

superscript ſ, ž, ç, j – secondary articulation with friction in the prepalatal and palatal areas respectively; in particular, superscript j is used to transcribe a secondary articulation in a palatal area with friction and voicing

y – high central non-round vowel, e.g. as in Polish

1. Introduction

A claim may be safely made that prepalatals are relatively rare sounds cross-linguistically. In the survey by Ladefoged and Maddieson (1996) two languages are mentioned with phonemic prepalatals, namely, Polish and Mandarin Chinese. Additionally, Serbian/Croatian has phonemic prepalatal affricates (but no fricatives), Swedish – a prepalatal voiceless fricative, Irish and Twi – allophonic prepalatals. If prepalatals are less frequent cross-linguistically than sounds produced at other places of articulation, the question arises as to why languages have prepalatals altogether. The answer so far has been given in terms of articulatory assimilation (e.g. for Polish: Rubach, 1980, 1984; Szpyra, 1995; Cavar, 1997). I would like to propose that articulatory accounts may only be a part of the explanation, and also perceptual (auditory) factors have to be involved in the phonological analysis of prepalatals. This article is organized as follows. First, I will give an introduction on prepalatals in Polish and show some previous articulatory accounts. Two questions will be posed as to why prepalatals emerge, and why prepalatals become affricates. To answer the first question, I will draw on facts from other languages than Polish. To answer the latter question, I will proceed and present three arguments from Polish. Further, I will present some diachronic perspective to the problem of contrast in Polish. Finally, I will summarize the discussion.

2. Polish prepalatals: earlier analyzes

Polish inventory of consonants in presented in (1):

- (1) Consonant inventory in Polish

inventories.

<i>Place</i>	<i>Labial</i>	<i>Pal. Labials</i>	<i>Dental/ alveolar</i>	<i>Post- alveolar</i>	<i>Prepalatal</i>	<i>Palatal</i>	<i>Velar</i>
Plosive	p, b	p', b'	t, d				k, g
Affricat e	f, v	f', v'	ts, dz	tš, dž	tš, dž		
Fricativ e	m	m'	s, z	š, ž	ś, ž		
Nasal			n			ń	
Lateral			l				
Rhotic	w		r			j	
Glides							

Polish has a fully fledged set of prepalalats involving voiced and voiceless fricatives and affricates, as well as a prepalatal nasal. Here, we will only concentrate on prepalatal affricates. In the coronal area, there are three places of articulation, i.e. anterior (dental), post-alveolar, and prepalatal. Polish has phonemic palatalized labials but no phonemic palatalized velars.

Polish prepalalats may be both underlying and derived in phonological processes (with surface alternations). An example of such a process is Coronal Palatalization (c.f. Rubach, 1984):

(2) Coronal Palatalization

ra[t]+a 'rate'	ra[tš]+e 'Dat./Loc.Sing.'
mo[d]+a 'fashion'	mo[dž]+e 'Dat./Loc. Sing.'
ra[s]+a 'rase'	ra[ś]+e 'Dat./Loc.Sing.'
zara[z]+a 'plague'	zara[ż]+e 'Dat./Loc.Sing.'

A parallel alternation can be observed for an alveolar nasal stop, and interestingly, for the labial glide, however, these alternations will not be discussed in this paper. Coronal Palatalization has been accounted for in the framework of Lexical Phonology in Rubach (1984).

(3) Coronal Palatalization: Rubach (1984)

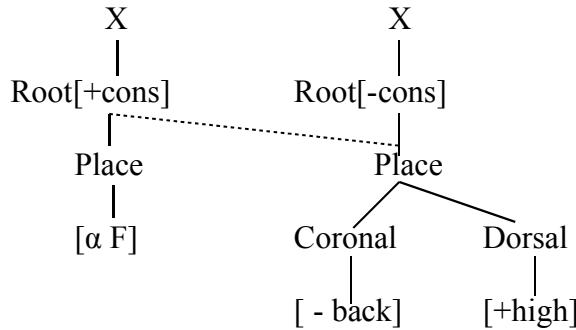
[+anterior, + coronal, -delayed release, α obstruent] →
[-back, + distr, +high, -anter, α strident] /
_____-[-cons, -back]

In the notation as in (3) above, Coronal Palatalization is viewed as an articulatory assimilation in terms of feature [-back]. However, the change to [-back] results for consonants in secondary palatalization. Yet, in Polish Coronal Palatalization two other qualities are changed in the output (when compared to the input): all sounds undergoing Coronal Palatalization become [-anterior] and obstruents become [+strident]. Given the

notation, the insertion of features [-anterior] and [strident] is arbitrary.

In the framework of Feature Geometry, Coronal Palatalization was dealt with in Szpyra (1995, 2001). Szpyra (1995, 2001) assumes that Polish has a general rule of palatalization as in (4), where the place features of a front vowel spread onto a preceding consonant, and subsequent Spell-out (5) takes care of the surface result of the palatalization of coronals.

(4) Palatalization: Szpyra (1995, 2001)



(5) Coronal Spell-out: Szpyra (1995)

t', d', s', z', n', l', r' → tś, dź, ś, ž,ń, l, ž

We see that Feature Geometric solution has to deal with the same problem as Lexical Phonology account proposed by Rubach (1984), that is, it generates the secondary palatalization of the consonants, which can only be seen as an abstract intermediary stage, but it does not explain the surface form, that is, the exact place of articulation changed to prepalatal (*[-anterior]*) area, and the stridency of resulting obstruent prepalatals.

We have to admit that the change to prepalatal area of articulation is not a banal issue. On the one hand, as we observed, prepalatals are not that common cross-linguistically, and, on the other hand, palatalization usually results in either secondary palatalized segments (e.g. secondary palatalized coronals), as, for instance, in Russian (6), or in palatoalveolars, as in Korean (Kim, 2001), Quebec French (Hume, 1992), dialects of Italian (Calabrese, 1993), Kinyarwanda (Ladefoged and Maddieson, 1996), dialects of German, and English, compare (7).

(6) Results of palatalization in Russian

mod+a 'fashion, Nom.Sing.'	mod'+e 'fashion, Loc./Dat. Sing.'
flot 'fleet, Nom.Sing.'	flot'+e 'fleet, Loc./Dat.'

(7) Results of palatalization in English

reques[t] 'request'	ques[tś]ion 'question' UR: /...t+jVn/
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colli[d] 'collide'
obse[s] 'obsess'
confu[z] 'confuse'

colli[ž]ion 'collision' UR: /...d+jVn/
obse[š]ion 'obsession' UR: /...s+jVn/
confu[ž]ion 'confusion' UR: /...z+jVn/

Thus, two questions remain: why do we get prepalatals in Polish instead of palatalized dentals or unmarked palatoalveolars? And why prepalatals have to be strident? The questions will be dealt with in the following sections.

3. Change to the prepalatal area of articulation

The observation is that prepalatals appear in languages only if the inventory of consonants is “crowdy” within a particular dimension (Flemming, 1995 about vowel inventories; Padgett 2001a, 2001b about consonantal inventories involving segments with secondary articulations). If we have many contrasts to be expressed in a given language, we will choose sounds which are more extreme articulatory and thus produce more extreme and salient acoustic patterns. Thus, prepalatals will be preferred over palatoalveolars because they have higher formant transitions than the latter, and which differ to more extent from other coronals (dentals). Prepalatals require more extreme position of articulators than e.g. palatoalveolars, they cost more energy, consequently, they should be disfavored for the articulatory sake. The claim is that the necessary condition for the emergence of prepalatals is the existence of a more complex system of contrasts the language needs to express. This claim seems to be borne out.

For example, Swedish has a very rich inventory of voiceless fricatives, containing [f, s, ʂ, ſx²](cf. Lindblad, 1980). Thus, it has three coronal places of articulation, as opposed to most common systems with two coronal places of articulation. Interestingly, Swedish does not have cross-linguistically more common sounds such as palatoalveolar and velar fricatives, but instead – a prepalatal and a palato-velar labialized fricative.

Another example comes from Mandarin Chinese. Here again, a three-way contrast in the coronal area exists, contrasting dental, retroflex, and prepalatal voiceless fricatives (Li, 1999: 200). Additionally, apart from the series of voiceless fricatives, there are also parallel series of voiceless unaspirated stops/affricates, and a series of voiceless aspirated stops/affricates, resulting in a fairly complex system of contrasts in the coronal place of articulation.

²[ſx] is here the palato-velar labialized voiceless fricative, and not a sequence of a palatal and velar fricatives.

(8) Mandarin Chinese: inventory of coronal obstruents

	dental	dental fricative/affricate	retroflex	prepalatal
non-cont. unaspirated	t	ts	<u>ts</u>	tś
non-cont. aspirated	t ^h	ts ^h	<u>ts^h</u>	tś ^h
fricatives		s	<u>s</u>	ś

Polish fits the described pattern in that it also has a three-way contrast in the coronal area of articulation, as well as a regular two-way voice distinction, that is, it has more “crowdy” perceptual space than languages on average. Thus, the emergence of prepalatals in Polish (instead of secondary palatalized dentals or palatoalveolars) may be perceptually conditioned; prepalatals appear to provide the listener more salient contrasts.

4. The role of perceptual factors in the emergence of strident prepalatals

It has been often assumed that strident articulation in the post-alveolar area is the unmarked one. For example, in Lahiri and Evers (1991) it is assumed that:

“Stridency emerges because of the change to the palatoalveolar region, where the unmarked articulation of all obstruents is with stridency.”

Whereas articulatory factors may play a role here, resulting in markedness effects for post-alveolar area, I will discuss in the following sections arguments for the auditory genesis of affrication in Polish; to exclude possible articulatory factors from the discussion, I will concentrate on the phenomena in the labial and velar places of articulation, and show that auditory accounts are clearly to be favored over pure articulatory accounts. The assumption is that if articulatory factors cannot explain the labial and velar data, and the explanation is auditory, then auditory considerations may not be completely excluded from the analysis of prepalatals.

4.1. Frication of palatalized labial stops

In the dialects of northern and north-eastern Poland (Masovia, Kurpie) as well as in Kashubian, a palatalized labial stop will be realized with a secondary articulation: the secondary stricture is made in the prepalatal to prevelar region, however, unlike for the regular secondary palatalization, the stricture is more radical and a clear friction is produced (cf. Friedrich, 1955; Zduńska, 1965; Lorentz, 1958). Sometimes, the two gestures do not overlap in time anymore with a fricative clearly following a (depalatalized then) labial stop, which in the examples below is transcribed then as e.g. [Cś].

(9)	Kurpie dialect (from Friedrich, 1955: 81ff)	
	drop'	'local bird species'
	nop ^c erf	'firstly'
	p ^s eńtšu	'five'
	dropś	'local bird species'
	gołompś	'pidgeon'
	zb'era	's/he collects'
	še rob ^j u	'they do themselves'
	sob ^z e	'myself, dat.'
	lub ^z uo	's/he liked'
	sobže	'myself, dat.'

As one can see, the realization may vary even for one word ([drop'], [dropś]), however, with majority of realizations with more or less independent friction element. For example, the ratio between realizations of voiceless stops p' - p^c - p^s - pś in village Łączki (northern east of Kurpie area) equals 1 : 3 : 25 : 8, that is, with the overwhelming majority of secondary friction in the prepalatal area. Similarly, the ratio for voiced stops b' - b^c - bż - bź equals 2 : 1 : 18 : 8 with the majority of realizations with a prepalatal friction³ (Friedrich, 1955).

One can observe that the realization does not depend directly on the position of the palatalized segment within the word or syllable, and it may occur before both front and back vowels. The exception is that if friction is produced word-finally, then it is more independent from the labial articulation, with a fricative segment following the labial rather than with a fricative secondary articulation in the second part of the labial articulation. Also, the discussed realization of palatalized labial stops is independent of morpheme boundary, that is, the effects are the same whether for underlying palatalized labials or for labials palatalized in the context of morphemes with an initial front vowel:

- (10) zro[bži] 'will do' (UR: /zrob+i/) [bži]dna 'poor' (UR: /b'id+n+a/)

One has to note that the described effects cannot be regarded as an articulatory simplification. Secondary palatalization of labials is already a relatively complex sound, as it requires a coordination of two gestures: a labial occlusion and the raising of the tongue towards the hard palate. The pronunciation with a friction is additionally difficult because it requires high level of control over the grade of stricture. If we adopt an auditory perspective, however, the analysis is more explanatory. First, we notice that the cues for the secondary palatalization is in Polish dialects high F2/F3 transition into the following vowel, and this cue alone is not very salient. On the other hand, listeners tend to analyze high F2/F3 transition before a vowel as a cue for the height and frontness of the following vowel (Bladon, 1986; Ohala, 1992), thus the consonant might be easily

³ In this study I focus on the effects for stops. For palatalized labial fricatives the general picture is even more complex involving often a complete deletion of the labial gesture. This is not going to be discussed in this paper. Also, in the southern-western part of Kurpie, the dominant type is with a palatal friction ad with a higher percent of realizations without any friction (Friedrich, 1955:81)

misinterpreted as non-palatalized even if acoustically the cue is present. This kind of misinterpretation cannot happen if formant transition is enhanced additionally with friction. Friction cannot be misinterpreted as a cue for the vowel, and additionally it is a very salient cue, which successfully marks the contrast between the palatalized versus non-palatalized segments.

4.2. j-insertion after palatalized labials in standard Polish⁴

In the standard Polish both underlying palatalized labials and labials palatalized in palatalization processes will be realized as a [pj], where [p] is any labial consonant, and [j] a palatal glide. The consonant is secondarily palatalized towards the end of its articulation (not in the first part). Consider the examples:

- (11) j-insertion after palatalized labials

[p'jes]	'dog'	[b'jes]	'devil'
[p'jawy]	'they were crying'	[b'jawy]	'white'
[p'ore]	'I wash'	[b'ore]	'I take'

As shown by the examples in (11), the insertion of [j] after a palatalized labial will occur both before front and back vowels. j-insertion will occur also for palatalized segments derived in a synchronic palatalization, e.g. in (12):

- (12) j-insertion in a synchronic palatalization process

gru[p+a]	'group, Nom.Sing.'	gru[p'j+e]	'group, Dat./Loc. Sing.'
gru[b+a]	'thick, fem.'	gru[b'j+e]+ć	'to become thick'

This data might probably be seen as a kind of anticipatory assimilatory overshoot, if it were not for the behavior of palatalized labials before a high front vowel, as in (13). There is no j-insertion before [i] morpheme internally (13a), as well as before palatalizing suffixes, as illustrated in (13b)

- (13) No j-insertion before [i]

(a)	[p'i]sk	'squick'
	[b'i]ć	'to beat'
(b)	chło[p'+i]	'peasants'
	gru[b'+i]	'thick, Nom. Pl. virile'

An analysis of the palatalization of labials has been offered in Rubach (1984).

- (14) j-insertion (Rubach, 1984)

$$\emptyset \rightarrow j / [lab] __ [+syll, -high, -back]$$

⁴ I analyze the data from WPK (Warszawska Polszczyzna Kulturalna: Warsaw educated dialect).

If j-insertion were articulatory driven, we would expect that if it occurs in the context of a mid front vowel [e], it should also occur in the context of a high front vowel [i] too. [i] is articulated with a more extreme deviation from the neutral tongue position than [e], thus, if we expect some kind of articulatory anticipatory effects, we would predict that the effects should be stronger in the context of [i] than in the context of [e]. This prediction is not borne out, and the lack of [j] insertion before [i] remains arbitrary in a purely articulatory framework.

In contrast, an auditory perspective is able to provide an explanation of the data. First, we have to observe that j-insertion provides an extra cue for palatalized labials. For secondary palatalization, the formant transitions are extremely short, but the inserted [j] gives the listener lots of extra time to perceive high F2/F3 values. Thus, j-insertion might be a strategy to enhance the acoustic cues of palatalized labials. Second, [j] and [i] are very similar acoustically and perceptually, so the distinction between the two may be not obvious. In fact, many languages forbid sequences of [ji] in general (Ohala, 1992)⁵. Consequently, if we adopt the assumption that [j] is inserted to provide an additional perceptual cue, the lack of [j] insertion before a vowel is to be expected because [j] before [i] does not facilitate perception. In other words, [j] insertion before [i] could not provide an extra cue for the perception of the palatalized consonant, and it does not occur.

Notice, that in frication dialects discussed in the previous section there is no ban on frication before [i], e.g.

- (15) No ban on frication before [i] (from Friedrich, 1955: 82ff)

kobźiti	'women'
b'ijok	'a tool for whipping e.g. butter'
p'irsi	'first'

This observation supports the auditory genesis of the effects. Frication remains salient before [i], thus, there is no difference in the behavior of palatalized labials before front and mid vowels.

4.3. Lack of j-insertion after palatalized velars

Should j-insertion in standard Polish be articulatory driven, we would expect that [j] should be also inserted after palatalized velars. The back part of the tongue is a much less flexible articulator than lips, thus we would expect in general more and stronger assimilatory effects involving velars than labials. This kind of argumentation is present in Flemming (1995) who claims that palatalization processes are cross-linguistically more likely to involve velars than labials, and that there is a relationship such that if in a given language labials undergo palatalization, velars must palatalize too, but not the other way round. Thus, the prediction for Polish would be that since we have j-insertion after labials, we should have j-insertion after velars. This is not the case. Velar stops regularly

⁵ This seems to be the case in Polish. Polish has two words with [ji] sequence, which are [ji]ng 'ying', and [ji]dysz 'Yiddish', where neither of them is native Polish, and both of them belong to rather marked scientific style. For Polish native vocabulary, we observe often a deletion of [j] before [i], e.g. [muj] versus [moix], UR /moj+ix/, where the result contains a highly marked hiatus.

palatalize to prevelars before any surface front vowel, however, [j] is never inserted:

- (16) No j-insertion after velars
- | | | |
|---------------|------------|---------------------|
| kro[k] 'step' | kro[k'+em] | 'step, Inst. Sing.' |
| ró[g] 'horn' | ro[g'+em] | 'horn, Instr.Sing.' |

Notice that in these cases there is also no frication.⁶ Why do we have j-insertion after palatalized labials but no such effect after palatalized velars? The answer I would like to offer is by reference to the presence versus absence of a phonemic contrast. I repeat the phonemic chart for Polish:

- (17) Consonant inventory in Polish, repeated

<i>Place</i>	<i>Labial</i>	<i>Pal. Labials</i>	<i>Dental/ alveolar</i>	<i>Post- alveolar</i>	<i>Prepalat- al</i>	<i>Palatal</i>	<i>Velar</i>
Plosive	p, b	p', b'	t, d				k, g
Affricate	f, v	f, v'	ts, dz	tš, dž	tś, dź		
Fricative	m	m'	s, z	š, ž	ś, ž	ń	
Nasal			n				
Lateral			l				
Rhotic	w		r			j	
Glides							

We have seen that Polish has a phonemic distinction between palatalized and non-palatalized labials. It makes sense to enhance the contrast by additional acoustic cues, and this is what happens both in the dialects and in standard Polish. On the other hand, there is no phonemic contrast between palatalized and non-palatalized velars, thus, there is no reason to add an extra cue if there is no contrast to enhance. Thus, it seems reasonable to claim that secondary palatalized sounds tend to be enhanced auditorily – by means of additional frication, or glide insertion – to mark phonemic contrasts in a more optimal way.

5. Diachronic excursion

⁶ The process discussed in this article is often referred to as Surface Velar Palatalization. Here, the vowel triggering the palatalization of the velar consonant is often analyzed in the literature as an underlying back vowel, because it does not trigger any palatalization of consonants in the other places of articulation, compare also examples in (20). There are other palatalization processes in Polish that involve velar consonants, e.g. 1st and 2nd Velar Palatalization (c.f. Rubach, 1984). However, the output of the latter processes is not phonetically secondarily palatalized, so it makes no sense to expect j-insertion there, assuming articulatory hypothesis.

Perhaps it might be interesting to provide a diachronic perspective to the Polish data discussed in sections 4.2. and 4.3. Historically, Polish had regular distinction between (secondarily) palatalized and plain consonants⁷ in all three major places of articulation, with a phonemic system for obstruents as represented in (18) below:

- (18) Historical system of phonemic contrasts
- | | | |
|---------------------|---------------------|--------------------|
| plain labials | plain dentals | plain velars |
| palatalized labials | palatalized dentals | palatalized velars |

The system represented in (18) evolved to modern Polish system illustrated in (19), where with the substantial changes in the phonetic realization of sounds, the historical system of contrasts has been fully preserved:

- (19) Modern Polish system of contrasts
- | | | |
|---------------------|---------------|----------------|
| plain labials | plain dentals | plain velars |
| palatalized labials | prepalatals | post-alveolars |

In the system in (19) there is no space for phonetically palatalized velars that have been discussed in section 4.3. In fact, the palatalized velars appear only in the context of morphemes (beginning with a front vowel) which normally do not trigger palatalization of consonants produced in other places of articulation. Thus, we can compare the behavior of consonants in the context of a “normally non-palatalizing” suffix -em (Instr. Sing. of masc. Nouns):

- (20) (Lack of) palatalization in the context of -em
- | | | |
|-----------------------|----------------------|-------------------|
| grzy[b]+em 'mushroom' | chło[p]+em 'peasant' | lu[d]+em 'people' |
| bra[t]+em 'brother' | wro[g']+em 'enemy' | bra[k']+em 'lack' |

In contrast, regularly palatalizing morphemes (i.e. Those that trigger palatalization of labials and dentals) produce post-alveolar affricates as surface realization of underlying velars, where – again affrication may be seen as a means to enhance the contrast between the three series of coronal sounds: dentals, prepalatals and post-alveolars. Thus, one could claim that non-phonemically palatalized velars actually cannot be affricated for the very reason of preserving the contrast between the palatalizing and non-palatalizing front vowel.

6. Summary and conclusions

In this article it has been argued that auditory factors play a vital role in the emergence of prepalatals. Two aspects have been investigated, namely, the prepalatal place of

⁷ It is plausible that the “plain” series was in fact phonetically velarized, as this is the case in modern Russian or in Irish (c.f. Padgett, 2001a, b)

articulation, and the stridency of prepalatal obstruents.

First, I have shown that the prepalatal place is relatively rare across languages of the world but in the cases when a given language contains a prepalatal in its inventory, there is a more complex network of contrasts. The conclusion is that an abundance of contrasts in a language is a prerequisite for the emergence of a prepalatal place of articulation in that given language.

Second, I looked at the emergence of stridency in prepalatals. All prepalatals are strident, and IPA has no symbol for a prepalatal stop. When alternating with stops in other places of articulation, the prepalatal output is an affricate. Since in the case of the prepalatal place it is very difficult to eliminate articulatory factors, I examined the data from Polish involving consonants produced in other places of articulation, in a dialect and in the standard Polish. I concluded that the dialectal secondary frication of palatalized labials as well as standard Polish j-insertion after palatalized labials cannot be explained in terms of articulation, however, an analysis in terms of auditory enhancement offers itself. I argue that secondary palatalization needs to be enhanced auditorily by extra phonetic cues. On the other hand, assuming articulatory genesis of the effects on palatalized labials, we should expect similar processes operating on palatalized velars, which is not the case. I account for the lack of frication or j-insertion in velars by pointing to the fact that the palatalization in labials - but not in velars - is phonemic. Thus, the hypothesis of auditory enhancement gains additional support from the lack of articulatory effects where they are expected.

Finally, I argue that if auditory factors are powerful enough to produce effects in labials and velars, there is also no reason to exclude them from the analysis of coronal sounds. Thus, I conclude that the stridency in prepalatal affricates is not only for the articulatory reasons, but it serves to enhance the auditory cues which help to differentiate between plain coronals and palatalized prepalatals.

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