Published in: The Canadian Linguistic Association Annual Proceedings, 1998, pp. 38-50.

LABIAL PALATALIZATION: A GESTURAL ACCOUNT OF PHONETIC IMPLEMENTATION*

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1. Introduction.

In this paper I present an analysis of surface realizations of palatalized labials in several dialects of Polish. This account has two parts: first, I will demonstrate that the attested gradiency and variability in realization of palatalized labials result from dialect-specific gestural interpretations of the same phonological representation; then, I will show that these patterns of realizations are motivated by the need to preserve and enhance a phonemic contrast.

I adopt the gestural approach to phonetic implementation (Browman & Goldstein 1989; Zsiga 1997) and an Optimality Theoretic (OT) approach to enhancement as maximizing perceptual contrastiveness (Flemming 1995, Ní Chiosáin & Padgett 1997). The analysis is based on the data from dialects spoken in four villages of northeastern Poland (Mazovia, Varmija and Mazury) documented in Basara et al. 1959 and Zduńska 1965. I also refer to general works on Polish dialects (Dejna 1993 and Stieber 1968). My assumptions about Polish phonology are based on Bethin 1992, Chen 1996, Rothstein 1993, and Rubach 1984. The phonetics of Polish consonants is drawn from Wierzchowska 1980 as well as Ladefoged & Maddieson 1996.

The paper is organized as follows. Section 2 presents the data on palatalized labials in the different dialects. Section 3 is devoted to the analysis. In 3.1 and 3.2 I outline my assumptions. Section 3.3 focuses on the articulatory representations of palatalized labials, while 3.4 addresses the perceptual aspect of the plain-palatalized contrast.

2. Data: palatalized labials.

Mazovian dialects, like Standard Polish, have palatalized labials both in derived and non-derived environments. In (1) I present alternations of plain labials with the palatalized ones attested in the dialects. As we see, plain labials are found

*I would like to express my gratitude to Keren Rice for her numerous comments and advice on this paper. Many thanks to Joseph Schallert, Hank Rogers, and the University of Toronto Phonology Group. I am also grateful to Greg Kondrak for checking the data. All errors are mine. This research was funded by SSHRC research grant number 410-96-0842.

in the environment before non-front vowels and finally (and before consonants). They are identical across the dialects. The palatalized labials are often found before front vowels. Here we find a range of realizations from a labial with a secondary palatal articulation in dialect I to a plain labial with a strident release as in dialect IV.

(1) Plain-palatalized alternations[1]:

	Plain	**Palatalized**				
Dialects[2]:	All	I	II	III	IV	Gloss
a.	*ła*[p]*a*	*ła*[pʲ]*e*	*ła*[pj]*e*	*ła*[pç]*e*	*ła*[pɕ]*e*	‘paw’ nom., loc. sg.
b.	*ro*[b]*ota*	*ro*[bʲ]*i*	*ro*[bj]*i*	*ro*[bj̨]*i*	*ro*[bʑ]*i*	‘work’, ‘make’

The occurrence of palatalized labials in non-derived environment is illustrated in (2). The range of outputs here is identical to those in derived forms. The fact that palatalized labials are found before non-front vowels allows one to consider them phonemic. A pairs contrasting plain and palatalized labials is given in (3).

(2) Palatalized labials in non-derived environments:

Dialects:	**I**	**II**	**III**	**IV**	**Gloss**
a.	[pj̇]*ivo*	[pj]*ivo*	[pç]*ivo*	[pɕ]*ivo*	‘beer’
	[pj̇]*otr*	[pj]*otr*	[pç]*otr*	[pɕ]*otr*	‘Peter’
b.	[bj̇]*ały*	[bj]*ały*	[bj̨]*ały*	[bʑ]*ały*	‘white’
	ko[bj̇]*eta*	*ko*[bj]*eta*	*ko*[bj̨]*eta*	*ko*[bʑ]*eta*	‘woman’

(3) [p]*asek* ‘belt’ [pʲ]*asek* ‘sand’

I summarize the phonetic outputs of palatalized labial stops in (4). It is important to notice that these surface variants are similar in the way that they have both labial and palatal components. While the labial component is the same for all the dialects, the palatal one may be realized in a variety of ways. It may surface as

[1] I use IPA symbols for transcription. These correspond to the traditional transcription used in Polish literature in the following way: pʲ = p', bʲ = b'; ç = χ', j̨ = ɣ', ɕ = s', ʑ = z', ɲ = ń, etc.

[2] The dialects are spoken in the following villages: Bartki (Dialect I), Kręgi Stare (Dialect II), Mrągowo (Dialect III), Jabłonka (Dialect IV).

a secondary articulation off-glide (dialect I), an independent glide[3] (dialect II), a voiced/voiceless non-strident/strident fricative (dialects III and IV). While in some dialects the glide retains its voiced, oral, non-strident quality (dialects I and II), in others it agrees with the preceding consonant in voice (dialects III and IV). Whether the second component surfaces as a fricative is also conditioned by the preceding obstruent.

(4) Summary of phonetic realizations (for labial stops):

I	[pʲ] [bʲ]	palatalized labials
II	[pj] [bj]	labials + palatal glide
III	[pç] [bʝ]	labials + non-strident palatal fricative
IV	[pɕ] [bʑ]	labial + strident prepalatal fricative

These realizations are additionally complicated by gradiency and 'free' variation effects as well as optional change of primary place of articulation to coronal in case of fricatives and nasals (see Kochetov 1998b).

It should be mentioned that while the outputs in dialects I and II present an unmarked case common cross-linguistically (as, for example, [pʲ] in Russian or Irish, and [pj] in Lithuanian), affrication and coronalization of labials are rather uncommon processes (Bhat 1978), and these cases are often obscured by further diachronic developments.

One may ask a number of questions with respect to these data. First, are the *phonological* representations of palatalized labials identical across dialects? Assuming they are the same, why does the same input produce a number of outputs? Second, what is the source of diversity: *phonology* or *phonetics*? Can one account for the variation and gradiency of palatalized labials using the traditional representations and features? And finally, what determines the choice of surface variants in each case?

In this paper I will not attempt to answer all of these questions. My focus will be on the *phonetic* realization of palatalized stops. In my analysis, however, I will make certain key assumptions about the phonological aspect of the process.

3. Analysis.

The key proposal is that the palatalized labials in the dialects in question have the *same* phonological representation, a complex segment characterized by primary place [labial] and secondary-place [coronal]. I argue that the diversity

[3] Variation between [pʲ] and [pʲj] is also found in Standard Polish (*Labiovelar Decomposition*: Bethin 1992: 90-92).

comes from the phonetic implementation of this representation. Different timing and overlap relations of *articulatory gestures* result in various phonetic outputs. Furthermore, the relations between gestures are not random. They serve to enhance the contrast in order to fulfill dialect-specific requirements, or constraints, on minimal distance.

3.1. Assumptions: Phonology.

Inventories of dialects I-IV[4] (see Kochetov 1998b) have much in common, having contrastive sets of plain and palatalized labials and velars (with the exception of dialect I, where palatalized velars are not contrastive) and some common dental, alveolar, and prepalatal segments. However, they differ in the phonetic realization of palatalized labials, some prepalatals, and palatalized velars. Some dialects have additional postalveolar and palatal sounds. A lexical constraint, or rule, General Palatalization (Bethin 1992: 107-108; cf. Chen 1996, Rothstein 1993, Rubach 1984), provides a key to the phonological interpretation of the surface inventories. All the consonants in Polish dialects belong to two major phonological classes: either plain or palatalized segments. Plain segments alternate with palatalized ones when General Palatalization applies (see Kochetov 1998a). Thus, although palatalized labials in the dialects are different phonetically, their phonological relation to the plain segments is the same for all the dialects.

If all palatalized consonants, regardless of their phonetic realization, derive from either a coronal followed by a front vowel or an underlying consonant with a secondary articulation, an abstract phonological inventory which is identical for all four dialects can be proposed (5) (cf. Chen 1996 for Standard Polish).

(5)

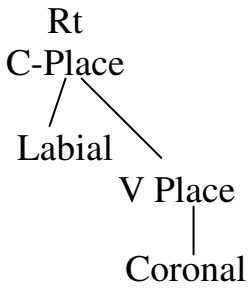
Labial		Coronal		Velar	
p	p'	t	t'	k	k'
b	b'	d	d'	g	g'
f	f'	s	s'	x	x'
v	v'	z	z'		
m	m'	n	n'		
		l	l'		
		r	r'		
			j		

[4]Unlike Standard Polish, the dialects have simplified inventories of coronal obstruents, so called *mazurzenie*.

All segments are phonologically contrastive in terms of palatalization. I represent a *phonological* palatalized consonant with an apostrophe, following the Slavic tradition.

I assume that this abstract segment has a phonological representation as in (6), which is a consonant with a primary labial and secondary coronal places of articulation (Hume 1992, Chen 1996, etc.). I will show later (section 3.3) that this representation can have a variety of phonetic manifestations.

(6)



Further arguments in support of this phonological representation and its treatment as a phonological unit come from syllabification and morpheme structure. These arguments will not be considered here (see Bethin 1992 for Standard Polish; cf. Kochetov 1998). It is important to note that this approach predicts that palatalization process as presented in (2) and affrication are separate processes, motivated by different factors. The first one, palatalization, is a phonological process that is lexical in the traditional sense and categorical in nature. It is shared by all dialects. The second one is a phonetic process, which is context-free (found both in derived and non-derived environments) and it proceeds differently in various dialects.

3.2. Assumptions: phonology-phonetics interface.

Now I turn to a gestural account of phonetic realization. The question is: given *one* phonological representation, how can we obtain *a number* of surface variants? In my analysis I follow Zsiga 1997 assuming that phonology makes use of categorical features and phonetics employs gestures that encode quantitative information, duration and gradiency. At the phonology-phonetics interface phonological features are mapped to phonetic gestures.

Below I briefly introduce some basic notions of Articulatory Phonology (Browman & Goldstein 1989) which I assume in my gestural account. The phonetic *gesture* is understood here as an articulator set of 'coordinated tasks or directed movements of articulators within the vocal tract.' It is characterized by several variables (7). *Constriction degree* is [closed] for stops, [critical] for

fricatives, and [narrow] for glides. It is also [narrow] for high vowels, [mid] for mid ones, and [wide] for low ones. *Constriction location* can be specified for [labial], [dental], [alveolar], [palatoalveolar], [palatal], [velar], etc. *Stiffness* denotes the value of tract variables, corresponding to the phonological feature [consonantal].

(7) a. Relevant articulator sets and parameters (after Browman & Goldstein 1989):

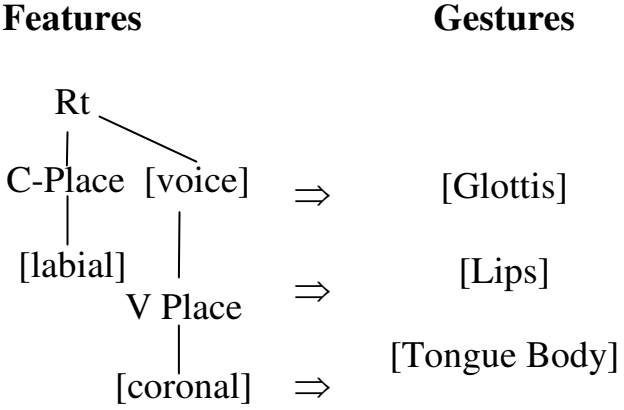
Gestures:	
Articulator Set	*Dimensions*
Lips	constriction degree, constriction location, stiffness
Tongue Body (TB)	constriction degree, constriction location, stiffness
Glottis	constriction degree, stiffness
Velum	constriction degree

b. *Constriction degree:* closed, critical, narrow, mid, and wide;
Constriction location: labial, alveolar, palatoalveolar, (pre)palatal, velar, pharyngeal, etc.;
Stiffness: value of tract variables (=[consonantal]).

Each gesture has an extent in time. It can overlap with other gestures and have different magnitude. Different relations of gestures in time result in allophonic variation and various kinds of coarticulations. Thus, a phonetic gesture encodes quantitative and gradient information.

Given the abstract phonological representation of a palatalized labial segment (6), we can map the feature C-place [labial] onto the gesture of [Lips], and the feature V-place [coronal] onto the gesture [Tongue Body] (8). The values of the feature [voiced] are presented by the gesture Glottis. Then, these gestures, or articulator sets, are additionally specified for constriction degree, constriction location, and stiffness (given in (7b).

(8) Mapping phonological features onto phonetic gestures (after Zsiga 1997; cf. Chen 1996):

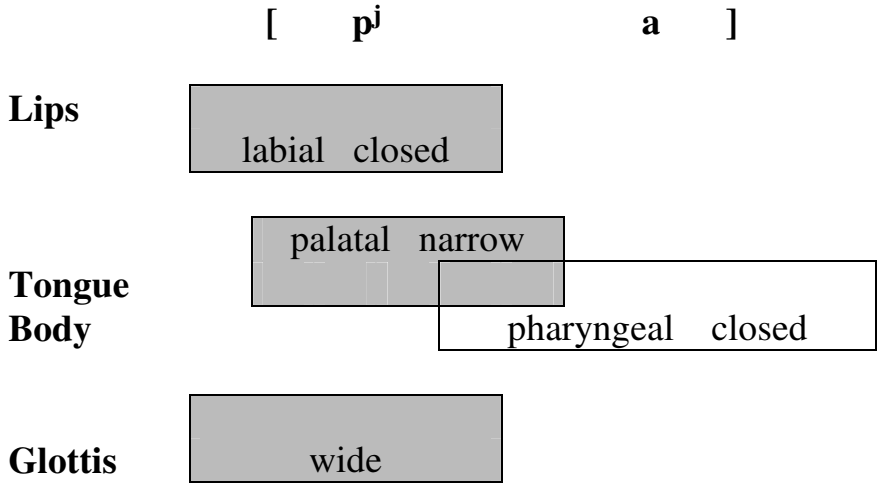


3.3. Representations of palatalized labials.

In this section I examine gestural representations of palatalized labials. I demonstrate that the range of phonetic realizations of palatalized labials can be represented as different timing relations of several articulatory gestures. To save space I limit the discussion to voiceless stops, focusing primarily on dialects I, II, and IV.

Let us consider a gestural score for the initial consonant-vowel sequence [pʲa] of the word *piasek* 'sand' (9). The gestures are represented as boxes. They are labeled for constriction location and constriction degree. The gestures involved in the articulation of a consonant are shaded. The horizontal dimension represents time. Below the score I summarize the temporal relation (alignment) of gestures and the auditory output of this alignment. Thus, the simultaneous alignment of Lips, TB-palatal, and Glottis gives a palatalized labial as an output, as in dialect 1.

(9) Gestural score for [pʲa]*sek*, dialect I:



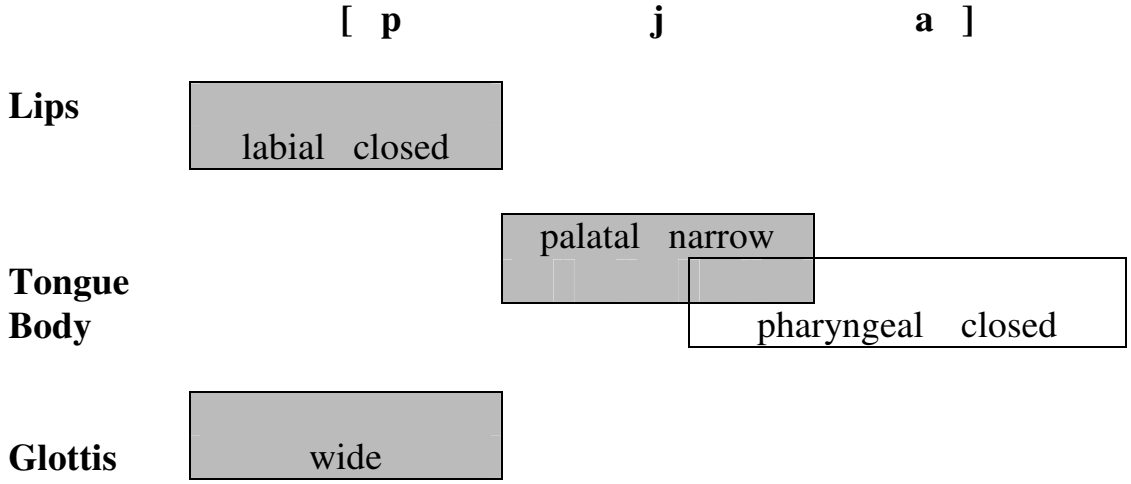
Alignment: Lips and Glottis simultaneous, no overlapping
TB is slightly delayed, slight overlapping
TB_1 and TB_2 overlapping

Output: a palatalized labial

One may observe that there could be three basic ways to align this gesture. It can precede Lips, be simultaneous with this gesture, or follow it. There is also an infinite number of intermediate combinations of these gestures from the complete simultaneity to no temporal overlap between them. What we commonly find in languages, however, is a palatal off-glide following the labial (Bhat 1978). This seems to be motivated by the fact that it is harder to perceive a palatal gesture articulated simultaneously with the stop, since the stop would block it. In contrast, a partially delayed gesture produces formant transitions on the following vowel which are crucial to the identification of a palatalized consonant (Ladefoged & Maddieson 1996:364). The following vowel is usually fronted. The representation of this gestural combination in (9) models observed articulatory movements (based on X-ray tracings and palatograms in Wierzchowska 1980:94-95) and shows that the high second formant (F2) in the C-V transitions result from an overlap of the two TB gestures.

A delay in the articulation of the palatal TB will produce a longer and more salient off-glide. Its length depends on how much this gesture is delayed or how much it expands. One of the extremes would be a complete temporal sequence of gestures, so called 'asynchronous palatalization' (Zduńska 1965) (10). This variant is common in dialect II.

(10) Gestural score for [pja]*sek*, dialect II:



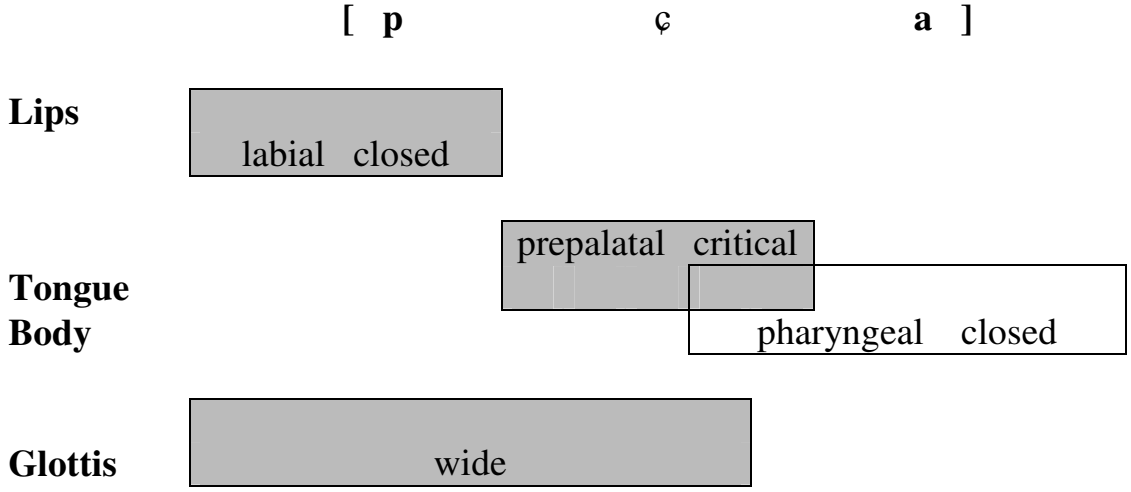
Alignment: Lips and Glottis simultaneous, no overlapping
TB follows Lips, no overlapping
TB_1 and TB_2 overlapping
Output: labial + palatal glide

The same alignment of the gestures of Lips and TB is found in dialects III and IV as well. In addition to this, however, we observe a coarticulation of the glide with the preceding stop in voice, which is modeled as an expansion of the gesture [wide glottis] in time (11).

The effect of this alignment is the sequence labial + prepalatal fricative, as in dialect IV. This variant in (11) adds an important acoustic component, or a cue, to the segment: the strident fricative release (Flemming 1995). Devoicing of the glide is accompanied by its concomitant affrication: blending of the values [closed] and [narrow] results in an intermediate value [critical], characteristic of a fricative.

As I have shown, all the attested realizations of palatalized labials in the dialects in question can be easily captured by a few basic combinations of the same gestures. It should be noted that the gestural model also allows one to capture a gradient range of intermediate realizations found in the dialects (Kochetov 1998b).

(11) Gestural score for [pɕa]*sek*, dialect IV:



Alignment: Glottis expanded, overlapping with TB
TB follows Lips, no overlapping
TB_1 and TB_2 overlapping
Output: labial + prepalatal fricative

3.4. Palatalized labials: enhancing the contrast.

As I have mentioned, phasing parameters, or timing relations, are dialect-particular. However, it is not clear what conditions the choice of a well-formed gesture combination in a particular dialect. To answer this question I turn to the perceptual aspect of the problem: in order to be perceived, a marked phonological contrast has to be maximized, or phonetically *enhanced*. Here I build on the recent works dealing with maximization of contrast within the Optimality Theory framework (Flemming 1995, Ní Chiosáin & Padgett 1997, etc.).

The comparison of basic surface realizations in (12) of palatalized labials shows that they differ in release that has a number of different perceptual cues that help a listener correctly identify the segment. I use the auditory features given in Flemming 1995. They represent different auditory dimensions and may have different degrees of perceptual salience. For our purposes these differences are not relevant and will not be discussed. An important point to note is that phonetic salience is a property of a contrast that a segment enters into rather than of a segment per se.

(12) Perceptual cues to palatalized labials (after Flemming 1995):

		p	p^j	pj	pç	pɕ
Release:	high F2	-	+	+	+	+
Duration:	long	-	-	+	+	+
Noise Intensity:	fricative	-	-	-	+	+
	strident	-	-	-	-	+

Let us look at a minimal pair in dialect I (13a). The plain and palatalized labial stops differ in one feature, [high F2] at the release. This difference is sufficient for distinguishing the contrast. We can represent it as a hypothetical minimal auditory distance 1 (13b). That is, no contrast is possible if the distance is less than this. However, for a speaker, and a listener, of dialect IV this distinction is too fine and more features are necessary to preserve the contrast. Thus, the dialect makes use of not only high F2, but also strident fricative noise and the overall duration (14).

(13) a. Dialect I: [p]*asek* • [p^j]*asek:*
‘belt’ ‘sand’

b. Minimal distance 1 p.....p^j
|_____|

(14) a. Dialect IV: [p]*asek* • [pɕ]*asek:*

b. Minimal distance 4 p.....p^j.....pj.....pç.....pɕ
|_____|

This can be formalized using Optimality Theory constraints that require a language to maintain a palatalized contrast (CONTRAST) and at the same time to preserve the input (IDENT) (15). The latter is in fact a family of constraints on *faithfulness* to the phonological input: the gestures of TB, Lips, Glottis, and their alignment.

(15) Constraints on contrasts and minimal distance (after Flemming 1995):

CONTRAST (pal): Maintain a palatalized contrast (cf. Ni Chiosan & Padgett 1997)

IDENT p^j: Preserve the palatalized labial stop
= IDENT p^j (TB), IDENT p^j (Lips), IDENT p^j (Glottis), IDENT (Align).

The minimal distance requirements can be satisfied by the constraints in (16), which are harmonically ordered together with the constraint CONTRAST. Exact numbers are not crucial to the discussion.

(16) Minimal distance constraints for palatality contrasts:
MINDIST =1: Differ in F2;
MINDIST =2: Differ in F2 and overall duration;
MINDIST =3: Differ in F2 and fricative release;
MINDIST =4: Differ in F2, fricative and strident release.

Each language, or dialect in our case, has a specific ranking of the constraints in given in (15) and (16). All the constraints are violable, or can be overridden by higher ranked constraints. Ranking of a subset of constraints for dialect I is presented in (17) together with some possible candidates, contrasting pairs. A highly ranked constraint CONTRAST (pal) rules out the candidate that neutralizes the contrast, that is (e). Faithfulness to the input is also important in the dialect, thus all the candidates that involve deviation from the input in terms of gestures and their values fail. Note that the violation of faithfulness is relative. The candidates with a more enhanced contrast (e.g. (d)) violate the constraint most. The optimal candidate is (a), although it does not satisfy the requirements of minimal distance 2 and more.

(17) Dialect I:

	CONTRAST (pal)	MINDIST =1	IDENT p^j	MINDIST =2	MINDIST =3	MINDIST =4
a. ☞ p • p^j				*	*	*
b. p • pj			*!		*	*
c. p • pç			**!			*
d. p • pɕ			***!			
e. p	*!	*	****	*	*	*

The single difference between the rankings of constraints in dialects I and IV is that in IV (18) IDENT is outranked by higher minimal distance constraints (MINDIST =2, 3, 4). Thus, the only candidate that has the maximal contrast, (e), fares well, even though it involves a considerable deviation from the input. All other candidates do not satisfy different constraints on minimal distance and, therefore, lose out.

(18) Dialect IV:

	CONTRAST (pal)	MINDIST =1	MINDIST =2	MINDIST =3	MINDIST =4	IDENT p^j
a. p • p^j			*!	*	*	
b. p • pj				*!	*	*
c. p • pç					*!	**
d.☞ p • p̧						***
e. p	*!	*	*	*	*	****

It is important that all four dialects have the same fixed hierarchy of contrast and minimal distance. They differ only with respect to ranking of the faithfulness constraint, IDENT, against this hierarchy.

4. Conclusion.

In this paper I have demonstrated that palatalized labials in the Polish dialects in question have the same abstract phonological representation. The source of output diversity and gradiency is in different overlap and timing relations of several articulatory gestures. The range of possible gestural patterns is constrained by the dialect-specific need to preserve and maximize the auditory distinctiveness of the surface contrast. The account makes certain predictions about the range of realizations of palatalized labials and consonants of other places of articulation as well as about the process of palatalization in general.

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