

# [ATR] in Polish<sup>1</sup>

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*Abstract. The feature [ATR] is usually used exclusively for the description of vowels. In this article, it is argued that phonotactic constraints in Polish indicate that [ATR] may be a useful dimension in the description of consonants. Under this assumption we are able to offer a straightforward and phonetically motivated account of the discussed phonotactic constraints and relate them to palatalization processes in Polish. The consequence of the assumption that [ATR] is a consonantal dimension is a reanalysis of some palatalization processes in terms of [ATR] and the need for a new typology of palatalization processes.*

## 1. Introduction.

The feature [ATR] is usually used with reference to vowels in languages where pairs of vowels differ exclusively in the position of the tongue root. In this article, we will look at phonotactic constraints in Polish regarding sequences of posterior consonants followed by unrounded vowels. I will argue that the emerging pattern can be best accounted for if we assume that consonants are specified for the tongue root position and that the discussed sequences must agree in the tongue root position. The article is organized as follows. In section 2, I will address the definition of [ATR] and remark on the feature [tense]. Section 3 presents the phonotactic constraints involving sequences of posterior consonants and unrounded vowels in Polish. In section 4 I offer a novel account of the constraints discussed in the previous section. Section 5 demonstrates the phonetic evidence supporting my account, and in section 6 I introduce more phonological evidence from Polish supporting the claim that [ATR] refers also to consonants. Some phonological processes in other languages supporting the claim that [ATR] can be used with reference to consonants will be discussed in section 7. Section 8 raises additional questions relative to this account and section 9 summarizes the discussion.

## 2. What is [ATR]?

[ATR] is a phonological feature whose phonetic correlate is the advancement of the tongue root. One consequence of the advancement of the tongue root is an enlargement of

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the pharyngeal cavity. Another articulatory correlate involved might be the lowering of the larynx, and so, in order to encompass all the phonetic effects, Lindau (1975) proposed feature [Expanded] instead of [ATR].

[ATR] was used for the first time by Stewart (1967) to account for cross-height harmony systems in languages of West Africa, where high, mid and low vowels may be either [+ATR] or [−ATR], and the vowels within one word have to agree in the position of the tongue root (but not in the height). Since then, [ATR] has been used to differentiate between more than three levels of vowel height in, for example, Bantu, Germanic and Romance languages. For example, in French and Italian the distinction between [e/ɛ] and [o/ɔ] can be expressed as the difference in [ATR] (cf. Calabrese, 1988; Kenstowicz, 1994).

There has been some discussion on the use of feature [ATR] and its relation to the feature [tense/lax] and [high] since they might be argued to describe the same phonetic effects. In the following paragraphs, the choice of the feature [ATR] for the argument in the remainder of the article will be motivated.

## 2.1. [ATR] versus [tense/lax]

As for the issue of [ATR] versus [tense/lax], Ladefoged and Maddieson (1996:304) note:

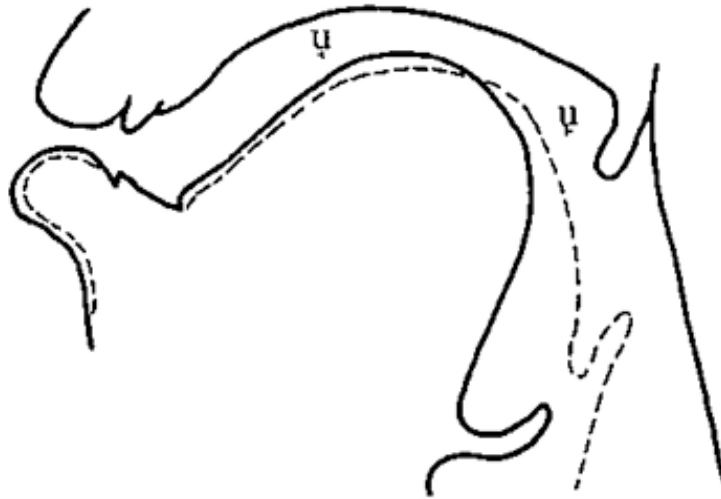
“Among front vowels, there is this parallel between [+ATR] and [−ATR] tongue root vowels on the one hand, and Tense and Lax vowels on the other, but among back vowel pairs there is no such parallel. The high back retracted tongue root vowel is always further back than its counterpart, rather than further forward, as in the case for the traditional lax back vowels. Lax vowels of all kinds are normally taken to be more centralized. Retracted tongue root vowels do not always have this characteristic.”

Ladefoged and Maddieson (1996) propose that [ATR] should be reserved for the cases wherein tongue root position alone is distinctive. They assume that the distinction in Romance and other languages traditionally referred to in terms of [tense/lax] should not be expressed in terms of [ATR] because the tongue root gesture is not separable from the raising of the tongue body.

There are several reasons why I do not follow this suggestion. First, [tense] and [ATR] do not seem to contrast in any single language (Halle & Clements, 1983). This leads one to assume that [ATR] and [tense] might be different names for a single dimension of contrast. Second, the feature [tense] has been criticized for being insufficiently defined and having weak experimental evidence (Trask, 1996). The definition of tenseness refers to overall muscular effort used in producing a sound (Crystal, 1991; 349) with a greater displacement of the active articulator from the neutral

position and a relatively strong spread of acoustic energy (Crystal, 1991:349), as well as longer duration and greater subglottal air pressure (Trask, 1996:352). For obvious reasons, it is easier to verify the position of the tongue root on X-ray tracings than the muscular effort involved. Third, Lindau (1975) demonstrated that the movement of the tongue root is not independent of the movements of the rest of the tongue, especially of the tongue body. Thus, the advancement of the tongue root will under normal circumstances cause the rest of the tongue to raise and front, and the retraction of the tongue body will result in the relative lowering and retraction of the tongue body. This raising and fronting of the tongue body will be more or less apparent in different languages, and even in languages where the [ATR] distinction is acknowledged, there are some minimal differences of the tongue body position as well, as can be seen in (1).

- (1) The [ATR] dimension in Igbo: X-ray tracings of vowels in the words obu ‘it is’ (RTR), and ‘ib’u ‘weight’ (ATR) from Ladefoged and Maddieson (1996).



Finally, the [tense/lax] distinction has been used to describe fortis/lenis or voice/voiceless distinctions in consonants, for instance in German (Jessen, 1996). Yet, there seems to be no relationship between the effects in Polish that will be discussed in this article and any dimension of voice distinction. In the following, the feature [ATR] is used but no assumption is made that [ATR] should be used only in cases where the tongue root moves alone without substantial modifications of the position of the remainder of the tongue.

## 2.2. [ATR] versus [RTR]

Yet another issue is the use of [ATR] and [RTR] (Retracted Tongue Root). The IPA has two diacritics, one for the advanced tongue root articulation and one for retracted tongue root articulation. It seems, however, that [+ATR] is often used interchangeably with [-RTR], and on the other hand, [-ATR] is really [+RTR].

In conclusion, in the remainder of the article, I will refer to the feature [ATR].

### 3. Phonotactic constraints in Polish.

In the following sections, I will argue that for Polish it is necessary to assume that both vowels and consonants are specified for [ATR]. Section 3.1. recapitulates the assumptions about the phonetic quality of Polish sounds, whereas section 3.2. demonstrates some phonotactic constraints from Polish which are problematic for accounts making no reference to [ATR].

#### 3.1. The inventory of sounds in Polish.

We will start by laying out the sound inventory in Polish. In (2) below the surface inventory of consonants is listed (cf. Rubach, 1984).

##### (2) Surface consonants in Polish

|                              | Labial | Labial<br>palatal. | Dental | Alveolar | Post-<br>alveolar<br>(retroflex) | Pre-<br>palatal | Palatal | Velar |
|------------------------------|--------|--------------------|--------|----------|----------------------------------|-----------------|---------|-------|
| Stops/<br>affricates         | p, b   | pʲ, bʲ             | t, d   | ts, dz   | tɕ, dʑ                           | tɕ, dʑ          |         | k, g  |
| Nasal<br>stops               | m      | mʲ                 | n      |          |                                  | ɲ               |         |       |
| Fricatives                   | f, v   | fʲ, vʲ             | s, z   |          | ʂ, ʐ                             | ɕ, ʑ            |         | x     |
| Liquid/<br>rhotic/<br>glides | w      |                    |        | l, r     |                                  |                 | j       |       |

Apart from the sounds listed in the table, all obstruents as well as liquids [l, r] have secondarily palatalized allophones, which occur before [i, j]<sup>2</sup>.

Post-alveolar sounds of Polish have received much attention in the literature. Ladefoged and Maddieson (1996:155) describe them as similar to the Standard Chinese laminal post-alveolar (retroflex) sounds and transcribe them with a dot underneath. The two differ in that the Polish sounds have a smaller sublingual cavity but compensate for that with the rounding of the lips, which has very similar auditory effects. In Hamann (2003) it is argued that, though not passing all the criteria, Polish post-alveolars should be regarded as retroflexes, and I adopt this transcription convention here.

The inventory of surface vowels is given in (3). Allophones other than those relevant for the further discussion are not included.

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<sup>2</sup> This process of phonetic palatalization of consonants in the context of [i, j] is often referred to as Surface Palatalization, cf. Rubach (1984).

(3) Surface vowels in Polish (nasal vowels not included)

|      | Front  | Central | Back |
|------|--------|---------|------|
| High | i      | ɨ       | u    |
| Mid  | e/ɛ    |         | o    |
| Low  | (a̯)/a |         |      |

[e] and a fronted allophone of the low vowel, i.e. [a̯], appear only in the environment of phonetically palatalized consonants.

A comment is due as to the status of [ɨ]. Phonologists usually assume that [ɨ] is a phonetically central vowel, thus, phonologically it is back (e.g. Rubach, 1984, Szpyra, 1995, Gussmann, 1992). However, framework-neutral phonetic descriptions place [ɨ] among sounds articulated with the tongue body in the front position (Wierchowska, 1967; cf. also a phonological account by Nowak, 2000). I will elaborate on this in section 5.

3.2. Constraints.

In Polish one can observe certain phonotactic constraints regarding the sequences of non-anterior coronal consonants followed by two phonemically distinct high vowels. The constraints involving high unrounded vowels are listed in (4):

(4) Phonotactic constraints involving high vowels

✓çɨ, ✓ʂɨ  
\*çɨ, \*ʂɨ

Prepalatals may be followed by a palatalizing vowel [ɨ] but not by a non-palatalizing vowel [i]. Post-alveolars may not be followed by [i] but they can be followed by [ɨ]. These constraints might be seen as a requirement for an agreement in terms of a palatalization feature: the distinction between [i] and [ɨ] has been seen usually as the frontness distinction (in terms of [+/-back] or Coronal/Dorsal). Thus, for example, Rubach (1984) proposed a retraction rule taking underlying /i/ to surface [ɨ] when in the context of post-alveolars [ʂ, ʐ, tʂ, dz]

It might be intriguing that fully parallel phonotactic constraints can be found for two allophones of the front mid vowel (Polish has one front vowel phoneme), as listed in (5).

(5) Phonotactic constraints involving mid vowels

✓çe, ✓ʂe  
\*çɛ, \*ʂɛ

The account of the data in (5) cannot refer to the feature describing the front-back dimension because both allophones of the vowel are unarguably front. Rubach (1984) mentions this allophonic effect and suggests an account in terms of tenseness, i.e. a rule changing a mid front vowel to [+tense] in the context of a high [-back] consonant (prepalatals), though without assuming that the triggering consonants should be [+tense]. Such an account of the data in (5) makes the two sets of data entirely independent.

A similar effect may be observed for the low vowel [a], that is, a more front allophone is produced in the context of prepalatals, and a more back allophone occurs in the context of post-alveolars. The two allophones differ very clearly with respect to the overall position on the front-back dimension, as well as with respect to roundness<sup>3</sup>.

The constraints involving high and mid vowels respectively are parallel from a phonetic perspective, yet as has been demonstrated, the assumption that [i]-[ɪ] distinction is to be expressed by the feature [back] makes it impossible to reflect the systematic connection between the two sets of data.

#### 4. Proposal.

Whereas earlier approaches could only offer separate accounts for the sequences with high vowels, and for the sequences with mid vowels, I would like to propose that the phonotactic constraints in (4) and (5) can be accounted for in terms of [ATR] agreement. I assume that [i] and [e] are [+ATR], like prepalatals, and on the other hand, [ɪ] and [ɛ] are [-ATR], similar to post-alveolars.

- (6) Specification of vowels and consonants in terms of [ATR]
- |                 |        |
|-----------------|--------|
| i, e, ə         | [+ATR] |
| ɕ, ʐ, tɕ, dʒ, ɲ | [+ATR] |
| ɪ, ɛ, ʌ         | [-ATR] |
| ʂ, ʐ, tʂ, dʐ    | [-ATR] |

Further, I propose a constraint to account for the observations in (4)-(5). Sequences of consonant + vowel agree in terms of the tongue root position:

- (7) Agr(CV, ATR): For CV sequences, an agreement in terms of [ATR] value holds.

In the following sections, the proposal is motivated by phonetic evidence (section 5) and more data from Polish (section 6), and further supported by analogous data from other languages (section 7).

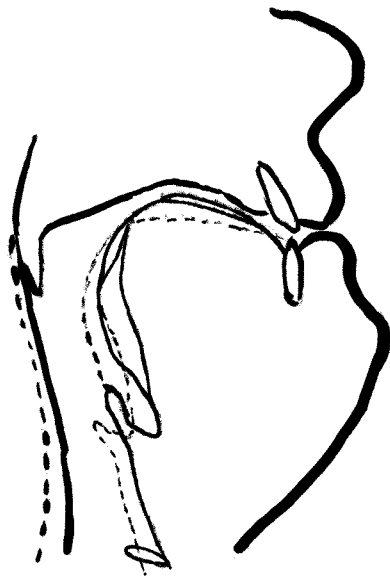
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<sup>3</sup> Roundness of the more retracted allophone of [a] in the context of a post-alveolar might be due to coarticulation with the post-alveolar.

5. Phonetic evidence.

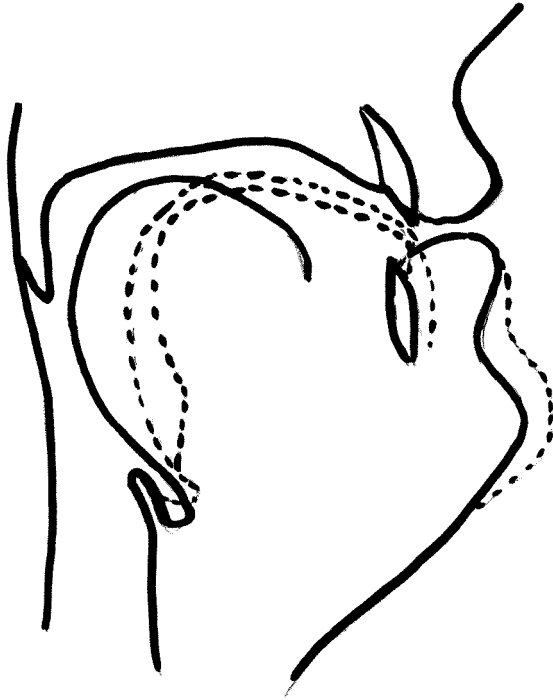
The proposal seems to be well-motivated phonetically. Thus, the high vowel transcribed usually as [ɨ] is compared in (8) with the high front [i]. The position of the tongue for [i] is represented with a solid line, the tongue position for [ɨ] – with a dotted line. We see that there is little difference as far as the position on the front-back axis is concerned. [ɨ] is articulated with the tongue body minimally retracted and lower in comparison to [i]. Critically, the tongue root differs in that for [i] the tongue root is crucially advanced and the pharyngeal cavity substantially expanded.

- (8) [i] (solid line) versus [ɨ] (dotted line) in Polish  
(adopted from Koneczna et al., 1951)



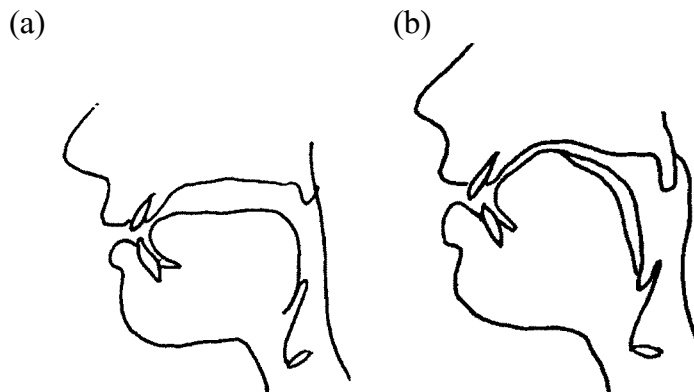
For comparison, a true back vowel is shown in (9). One can observe that the overall tongue body position for the back vowel [u] and for [ɨ] differ dramatically.

- (9) A true back vowel [u] in Polish (solid line) compared with [i] (dotted line)  
(adopted from Koneczna et al., 1951)



The consonants display a tongue root position similar to that of the vowels. A retroflex consonant, when compared with a prepalatal, is articulated with a clearly more retracted tongue root, as shown in (10).

- (10) Post-alveolar [ʂ] (a) versus prepalatal [ɕ] (b) (after Wierzchowska, 1980).



It is not claimed here that prepalatals are not [-back] and [+high]. On the contrary, the relative higher and more advanced position of the tongue body is a logical consequence of the anatomic relationship between the tongue root and tongue body as represented in (11).

- (11) Mechanics of the tongue root movements (Lindau, 1975; reproduced from Vaux 1996: 396)



## 6. More constraints.

ATR Agreement is not limited to the sequences with prepalatals and post-alveolars. Apparently all possible consonant + vowel sequences in Polish must obey ATR Agreement. As mentioned in section 2, Polish has palatalized allophones of virtually all consonants, which are realized in the context of [i] and [j]. Thus, a consonant followed by [+ATR] [i] must also be articulated with an advanced tongue root, and this is implemented with the fronting and raising of the whole tongue, resulting in secondary palatalization of the consonant. On the other hand, the sequences with no coherent [ATR] value are prohibited, see (12).

- (12)
- |       |      |     |      |
|-------|------|-----|------|
| ✓ tʲi | *tʲi | *ti | ✓ ti |
| ✓ pʲi | *pʲi | *pi | ✓ pi |
| ✓ ɕʲi | *ɕʲi | *ɕi | ✓ ɕi |

The sequences in the first column can be found in the data often cited in reference to so-called Surface Palatalization (cf. Rubach, 1984). Surface Palatalization is usually regarded as a phonetic effect.

For velars, the constraints are even more restrictive, compare (13):

- (13)
- |       |      |     |     |
|-------|------|-----|-----|
| ✓ kʲi | *kʲi | *ki | *kɨ |
|-------|------|-----|-----|

Whereas the non-occurrence of \*kɨ should probably be accounted for by an additional requirement on place agreement (assuming that [k] is dorsal, i/ɨ are both Coronal, and palatalized [kʲ] is Dorsal and Coronal, cf. Cavar, 2004), the remaining

restrictions may all be easily ascribed to the requirement on the tongue root position. Below, the interaction of Place Agreement and ATR Agreement is summarized.

(14) Velar stop + front high vowel sequences

|                                               | Place Agreement | ATR Agreement |
|-----------------------------------------------|-----------------|---------------|
| a) ki Vel. Cor.<br>-ATR +ATR                  | *               | *             |
| b) k <sup>i</sup> Vel./Cor. Cor.<br>+ATR +ATR |                 |               |
| c) ki Vel. Cor.<br>-ATR +ATR                  | *               |               |
| d) k <sup>i</sup> Vel./Cor. Cor.<br>+ATR -ATR |                 | *             |

For the whole analysis of the sequences with velar fricatives, see Cavar (2004).

The lack of sequences such as those in (14c) was analyzed in derivational approaches in terms of a separate rule fronting the underlying /i/ to surface [i] in the context of velar stops (Velar Fronting, e.g. Rubach, 1984). Velar Fronting was a mysterious rule, fronting a back vowel in the context of a back consonant. However, if [i] is taken to be a front vowel, the generalization suddenly makes more sense, and we see it is a simple place assimilation.

ATR Agreement is also surface true without exceptions for the sequences with mid front vowels, as in (15):

- (15)
- |                     |                    |
|---------------------|--------------------|
| ✓ pε                | *pe                |
| ✓ tε                | *te                |
| ✓ p <sup>j</sup> je | *p <sup>j</sup> jε |
| ✓ kε                | *ke                |
| ✓ k <sup>j</sup> e  | *k <sup>j</sup> ε  |

Whereas I do not list all impossible sequences (some might be attributed to effects other than ATR Agreement), from the overview here it is clear that no allowed sequence violates ATR Agreement. In the native vocabulary, [+ATR] vowels are preceded by palatalized consonants (dentals palatalize to prepalatals) or the vowel is accommodated to fit the pattern (velars palatalize to non-ATR retroflexes with the change of the vowel /i/ to [i], and of the vowel /e/ to [ε]). In recent borrowings, since deep palatalization processes do not operate morpheme-internally, the problem gets resolved in one of two ways: either the consonant becomes secondarily non-phonemically palatalized, or the vowel is altered. The former method is preferred now for sequences with high front vowels, whereas the latter was typical of 19th

century and earlier borrowings. This is probably due to the fact that the [i-i] distinction became phonemic, whereas this is not the case for mid front vowels.

(16) Examples

- |    |            |                   |
|----|------------|-------------------|
| a. | [sʲi]nus   | ‘sinus’           |
|    | [tʲi]k     | ‘nervous tick’    |
|    | [dʲi]nar   | ‘dinar, currency’ |
|    | [ʂʲi]raque | Chiraque          |
|    | [dzʲi]p    | ‘jeep’            |
| b. | [si]naj    | Sinai             |
|    | [di]nary   | Dinar mountains   |
|    | [ʂi]ny     | ‘rail tracks’     |

To sum up, ATR Agreement proposed to account for the phonotactic constraints regarding sequences involving prepalatal and post-alveolar consonants holds generally for all consonant + vowel sequences in Polish.

## 7. Cross-linguistic perspective.

We have observed that in Polish there is a clear correlation between [ATR] value of the vowel and the palatalization of consonants. Thus, just as Surface Palatalization of consonants in Polish might be ascribed to ATR Agreement, it might be also the case that some other palatalization processes cross-linguistically have been misinterpreted by ignoring the role of the tongue root position.

Palatalization has been usually described in terms of features referring to the tongue body and the tongue front. Such accounts have been applied to very different sets of data, including the processes which produced secondary palatalization, or changed the major place of articulation of the consonant to non-anterior coronal, did or did not involve concomitant affrication (Lahiri and Evers, 1991, Hume, 1992, Sagey, 19986, Halle, 1995). Whereas it is not excluded that many palatalization processes should be explained by reference to the tongue body position, it is possible that some cannot or should not, given the correlation between the ATR quality of vowels and the palatal quality of the matching consonants in Polish.

### 7.1. Orok and Even

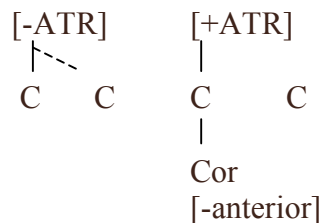
Stadnik (2000) provides an example of palatalization triggered by [+ATR] vowels from Orok. In Orok, there is a secondary palatalization of [s] in the context of [i, u], and thus, the context for palatalization is not [-back] vowels. Stadnik observes, however, that both triggering vowels share another feature, namely, [+ATR]. This analysis may be supported by another observation about the importance of [ATR] in a related language, Even (Stadnik 2000). Even is another Manchu-Tungusic language, closely related to Orok. In Even the tongue root position of vowels is also important, in particular, it governs the

distribution of adjacent velar and uvular consonants. Velar and uvular consonants appear in a complementary distribution: velar allophones appear in the context of [+ATR] vowels and uvular allophones - in the context of [-ATR] vowels.

## 7.2. Palestinian Arabic

Another example of the interaction of palatalization and tongue root features comes from Palestinian Arabic. In Palestinian Arabic (Czaykowska-Higgins, 1987) the spreading of pharyngealization is reported to be blocked by palatal sounds. Pharyngealization on consonants is described as [-ATR]. Whereas [ATR] is probably not distinctive for palatal consonants, we have no account for the blocking unless we assume that palatals are prespecified as [+ATR], as shown in (17).

### (17) Spreading of emphasis in Palestinian Arabic.



## 7.3. Palatalization and retroflexion

The retracted tongue root position, on the other hand, is often connected with the retroflexion of consonants. So, for instance, Whitney (1889:61f) proposed that retroflexion in Sanskrit (well-known Ruki rule) is triggered by environments which all are articulated with the retracted tongue position. Prescott (2004, p.c) argues that this can be formally referred to in terms of feature [RTR]<sup>4</sup>, which in our terms can be translated into [-ATR].

Retroflexion and phonetic palatalization seem to be mutually exclusive. Palatalization is connected with front vowel context and retroflexion with a back vowel context. However, this does not always need to be the case. I have discussed an example where a back [ATR] vowel triggers palatalization (Orok). As to retroflexion, there is a documented case where not all back vowels trigger retroflexion. The back vowel which does not condition retroflexion is [u]. In Sri Lankan Portuguese Creole, the dental alveolar nasal and lateral have retroflex allophones after non-high back vowels [o, ə, a], for instance [aŋima] ‘animal’ (Hume and Tserdanelis, 2002; quoted after Hamann, 2003). One could stipulate that [u] in Sri Lankan creole is [+ATR], and that the retroflexion feature is in fact [-ATR].

<sup>4</sup> For the summary of other accounts see, for example, Hamann (2003).

One of the strategies to resolve the front vowel-retroflex incompatibility is lowering of the vowel (Hamann, 2003: 99ff). In the Southern Swedish dialect front vowels and a back tense [o] are lowered before retroflexes (Svantesson, 2001, Hamann 2003). Whereas it is clear why we need lowering of front vowels before retroflexes, the reason for lowering of the back vowel is unclear, unless we assume that retroflexes and the following vowels need to agree in the tongue root position and that [o] is also [+ATR]. If vowels are lowered, it is possible that the tongue root is also retracted.

Yet another strategy to break retroflex-front vowel incompatibility is diphthongization. Hamann shows that certain diphthongization applies not only to front vowels (as expected) but also to some back vowels. These back vowels happen to be tense [u, o].

Hamann (2003:92) argues that “[s]ince the vowel [o] is articulated with a slightly less raised tongue back and with more retraction [...], it seems as if the back mid vowel is articulatorily closer to the retroflex than [u].” The figure reproduced in (18) illustrates this claim. The figure shows also that [u] has a more advanced tongue root in comparison to [o] so instead of employing a gradual feature [back], one could resort to a feature referring to the tongue root position.

- (18) Comparison of the tongue back positions for vowels [o] and [u] with the position of the tongue in retroflex stops (Hamann, 2003:93)
- |                                                                                                |                                                                                         |
|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| (a) [o] and [u] based on x-ray tracings of the cardinal vowels by Catford (1988:128 ) tracings | (b) retroflex stop (based on x-ray of a Tamil stop by Ladefoged and Maddieson (1996:27) |
|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|



There would be a reasonable formal explanation of this generalization if we assumed that palatalization involves [ATR] (or [+ATR]) specification whereas retroflexed consonants are phonetically [RTR] (or -ATR).

## 8. Consequences and Questions.

In the following sections the consequences of the ATR Agreement analysis for the general analysis of deep palatalization in Polish are discussed.

### 8.1. Analysis of velar and coronal palatalization in Polish

The fact that [i] is actually a front vowel poses a problem for the traditional analysis of the core process in Polish phonology, i.e. palatalization. If [i] is a front vowel and does not trigger palatalization, the surface palatalization feature cannot be the articulatorily defined feature [-back] (as proposed in Sagey, 1986; Halle, 1995) or the Coronal node (cf. Hume, 1992). This problem can be resolved by postulating an abstract palatalization feature (Rochoń, 2000), a floating [+high] as the palatalization feature (Nowak, 2000), or an auditory oriented palatalization feature referring to the relative height of the second formant and noise frequency<sup>5</sup>. The latter solution is adopted here following Cavar (2004). For the purposes of the current analysis we assume the following simplified definition.

- (19) [Pal] – presence of one or more of auditory subfeatures such as [HighF2] (relative high F2) and [Friction] (friction on consonants).

I assume that /i, e/ as well as Polish post-alveolars, dental affricates, prepalatals, and palatalized labials are [Pal].

In the previous section I argued that ATR agreement might account for a number of processes in Polish which so far have escaped a holistic treatment and have been regarded as unrelated. Surface Palatalization, Surface Velar Palatalization, and Velar Fronting (cf. Rubach, 1984) all derive their surface effects from ATR Agreement proposed in section 3. We discussed the data invoked in reference to Surface Palatalization, Surface Velar Palatalization and Velar Fronting in section 6. Below, another interesting consequence of ATR Agreement is discussed, i.e. i-retraction in the context of retroflexes/post-alveolars.

### 8.2. The interaction of Velar Palatalization and i-retraction

The surface observation is that the palatalizing high front vowel will always surface as [i] after the retroflex.

- |      |              |             |  |             |            |
|------|--------------|-------------|--|-------------|------------|
| (20) | i-retraction |             |  |             |            |
|      | krok         | ‘step’      |  | kro[t̪ɕi]ć  | ‘to step’  |
|      | compare      |             |  |             |            |
|      | zgod+a       | ‘agreement’ |  | zgo[d̪z̪i]ć | ‘to agree’ |

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<sup>5</sup> Noise frequency, that is the frequency where energy is concentrated in the spectrum of noise component, has been identified as an important cue in the perception of fricatives and affricates (cf. e.g. Pickett, 1999). Flemming (1995) postulates an auditory feature [Noise Frequency].

Traditionally, in the framework of lexical/cyclic phonology, an underlying front vowel [-back] triggers palatalization of the velar consonant, which later undergoes hardening (becomes [+back]) and surfaces as a post-alveolar (retroflex). The retroflex itself in the next derivational step causes the original front vowel to retract, i.e. to become [+back] and, consequently, the result of palatalization process in Polish is a [+back] consonant followed by a [+back] vowel. The derivational approach is illustrated in (21).

- (21) Derivation of krok+i+ć
- |                     |           |
|---------------------|-----------|
| UR                  | krok+i+ć  |
| Vel. Palatalization | krotʃ+i+ć |
| Hardening           | krotʂ+i+ć |
| Retraction          | krotʂ+i+ć |

This seeming paradox might be one of the reasons to evoke serial evaluation in OT (cf. Rubach 2003). However, one does not need to resort to serial derivation as soon as it can be acknowledged that palatalization and retraction are due to two independent mechanisms. Whereas apparent retraction is a result of the requirement for the ATR agreement, the actual palatalization may be attributed to the spreading of a perceptually defined feature [Pal]. This is illustrated in (23).

In (23), one of the constraints is Preserve Contrast. The constraint was motivated in Cavar (2004) and defined as in (22):

- (22) Preserve Contrast(Cor-Vel): The underlying distinction between coronal and velar segments is marked in the surface representation by at least 1 cue. (cf. Cavar 2004: 68)

A similar constraint (Minimal Distance) was postulated by Flemming (1995).

- (23) Non-derivational approach to Velar Palatalization-retraction paradox.

| krok+i+ć | Palatalization | ATR Agr | Preserve Contrast |
|----------|----------------|---------|-------------------|
| (a) ki   | *!             | *       |                   |
| (b) tʂi  |                | *!      |                   |
| ☞(c) tʂi |                |         |                   |
| (d) tɕi  |                |         | *!                |
| (e) tɕi  |                | *!      | *                 |

Candidate (a) violates palatalization constraint. Candidates (d) and (e) render the underlying /k/ the same way the underlying /t/ would be rendered (the surface effect of the palatalization of dentals is a prepalatal sound), and thus, they violate Preserve Contrast constraint (cf. Cavar, 2004). Expected candidate (b) is ruled out by the ATR Agreement. The winner is candidate (c) which does not violate any constraints. Under this approach we do not need to postulate serial evaluation.

In conclusion, the assumptions that [i] is a [-ATR, -back] vowel and that ATR Agreement holds in Polish do not contradict the Velar Palatalization data but, on the contrary, suggest a simple non-derivational account.

## 9. Conclusions.

This paper discusses a set of data from Polish and proposes a straightforward analysis based on the assumption that a sequence consonant + vowel in Polish must agree in the position of the tongue root. This analysis is not only simple and phonetically motivated, it also accounts in a unified way for a number of phenomena so-far regarded as unrelated. It sheds light on another possible analysis of palatalization effects, and suggests a need for a new typology of palatalization effects. It also gives us the tools to demystify a well-known duke-of-York type of effect in Polish, involving the palatalization of underlying velars in the context of surface retracted vowels, and offers instead a straightforward surface-oriented analysis without reference to the notion of derivation.

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