

An overview of palatalization-*i**

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Rubach, Jerzy. 2002. An overview of palatalization-*i*. *Studies in Phonetics, Phonology and Morphology*. 8.2. 169-186. This article looks at the problem of palatalization before *i* from various perspectives: SPE, Lexical Phonology, Feature Geometry, and Optimality Theory. It shows how each of these theories arrives at an analysis of the data from Russian. These analyses are different in terms of how they capture phonological generalizations because the fundamental assumptions of each framework are different. It is concluded that the tenets of lexical versus postlexical derivations and feature geometry, on the one hand, and the tenet of universalism, on the other hand, are fundamental to an insightful analysis of the palatalization before *i* required by the grammar of Russian. (University of Iowa/University of Warsaw)

Key words: Palatalization, Optimality Theory, Lexical Phonology, Russian.

The goal of phonological theory is to provide a framework that must fulfill three fundamental conditions. First, it must have formal means, a vocabulary, in which to state phonological generalizations. Second, it must have an organizational frame in which to state the interaction of generalizations. Third, it must define the concept of what constitutes a legitimate phonological generalization. The development of generative phonology shows how these three fundamentals of a framework have changed over a period of years.

A formal vocabulary of *The Sound Pattern of English* (Chomsky and Halle 1968; SPE hereafter) looks unsophisticated from the perspective of later theoretical developments. Generalizations (rules) are stated in terms of distinctive features that are ordered linearly rather than hierarchically. The objective is to arrive at rules that are as general as possible in the sense that they cover the widest the data range of inputs in the widest range of environments permitted by the data. For example, Russian has a palatalization process that turns hard consonants into soft consonants¹ before *i* and *e*.² In (1) we look at //t// and //s//³ as examples of inputs, but the process is completely general and includes all consonants.

* I would like to thank the two reviewers of this journal for their helpful comments. I am also grateful to Yola Kallestinova for her help with the Russian data and to Craig Dresser for his assistance with the technical matters.

¹ The terms “hard consonant” and “soft consonant” are explained below.

² I ignore here the context of *j* that can be subsumed under the generalizations that refer to *i* (but see Rubach 2000a).

³ I enclose underlying representations in double slashes, intermediate representations in single slashes, and phonetic representations in square brackets.

- (1) *brat* [t] ‘brother’ (nom.sg.) - *brat+e* [t'+ε] (loc.sg.) - *brat+ik* [t'+i] (diminutive)
most [t] ‘bridge’ (nom.sg.) - *most+e* [t'+ε] (loc.sg.) - *most+ik* [t'+i] (diminutive)
nos [s] ‘nose’ (nom.sg.) - *nos+e* [s'+ε] (loc.sg.) - *nos+ik* [s'+i] (diminutive)
matros [s] ‘sailor’ (nom.sg.) - *matros+e* [s'+ε] (loc.sg.) - *matros+ik* [s'+i] (diminutive)

Descriptively, the palatalization in (1) seems to call for the following two rules.

- (2) a. Palatalization-*e*: [+cons] → [-back, +high] / — [+syll, -back, -high]⁴
 b. Palatalization-*i*: [+cons] → [-back, +high] / — [+syll, -back, +high]

SPE places a penalty on statements such as those in (2). The criticism is based on two types of argument. First, (2a) and (2b) are inadequate from the formal point of view because they contain much redundancy: the inputs and the outputs are exactly the same while the environments overlap in two out of three features. This redundancy offends the simplicity metric, an SPE evaluation mechanism that counts features in rules and places value on the statement of the rule that employs the smallest number of features.

The second argument is that it becomes an accident that (2a) and (2b) are ordered together in the grammar of Russian. Indeed, there is no evidence that some rule might need to apply after (2a) and before (2b). The ordering argument is strengthened by the contention that in language change rules (2a) and (2b) behave as a block. That is, while language change uses rule reordering as one possible type of grammatical change, there is no evidence that rules such as (2a) and (2b) could be reordered, *vis-a-vis* some other rules, separately from each other. In sum, according to SPE, rules (2a) and (2b) need to be collapsed into a single palatalization rule in (3).

- (3) Russian Palatalization: [+cons] → [-back, +high] / — [+syll, -back]

Ukrainian has palatalization exactly as in Russian, but the trigger of the process is limited to //i//. That is, we have palatalization before //i// but not before //ε// (Bilodid 1969). As was the case in (2), the rule is fully general. In (4) we give examples of stems ending in //t// and //s//.

- (4) *brat* [t] ‘brother’ (nom.sg.) - *brat+iv* [t'+i] (gen.pl.) - *brat+e* [t'+ε] (voc.sg.)
holos [s] ‘voice’ (nom.sg.) - *holos+iv* [s'+i] (gen.pl.) - *holos+e* [s'+ε] (voc.sg.)

The rule is stated as follows.

- (5) Ukrainian Palatalization:
 [+cons] → [-back, +high] / — [+syll, -back, +high]

⁴ Russian has no low front vowels. Consequently, specifying [-low] in the environment is not necessary to define //ε//.

Notice that the statement of Palatalization in Ukrainian (5) is identical to the partial statement of Palatalization in Russian (2b), but this is not a problem from the point of view of SPE. The reason is that rules are language-specific and Russian is a different language from Ukrainian.

Looking further at Russian phonology, we observe that *//i//* is retracted to [i] after hard consonants across word boundaries,⁵ where [i] is a high back unrounded vowel.

- (6) Irin+a [ir'ina] 'Irene' (nom.sg.)
 - brat Irin+y (gen.sg.) [brat ir'ini] 'Irene's brother'
 - nos Irin+y [nosir'ini] 'Irene's nose'

The logic of vowel retraction becomes clear when we realize that in Russian all consonants show a secondary articulation effect: they are either palatalized (soft consonants) or velarized (hard consonants). That is, there are no neutral consonants. Palatalized consonants are [+high, -back] while velarized consonants are [+high, +back]. Palatalization and velarization are either the property of underlying representations (7a) or are derived by rule (7b).

- (7) a. los' [los'] 'moose': *l* is a velarized *//l//* while *//s'//* is a palatalized dental
 b'uro [b'uro] 'office': *b* is a palatalized *//b'//* while *//t//* is a velarized *//t//*
 b. l'ub+i+t' [l'ub'+i+t'] 'to love': *//l'//* and *//t'//* are underlyingly palatalized consonants but [b'] is derived by Palatalization (compare *l'ub+ov* 'love' (N), where *b* is hard)
 žon+e [žin'+ε] 'wife' (fem. dat.sg.): [n'] is derived from *//n//* by Palatalization (compare a hard [n] in žon+a [žin+a], nom.sg.) while [ʒ] comes from *//ʒ'//* by Hardening

Hardening requires clarification. It is a context-free rule that takes soft *//ʃ' ʒ'//* (underlying or derived)⁶ to hard [ʃ ʒ]. One reason why [ʒ] has to be soft in the underlying representation of *žon+e* is that the noun shows an effect of Ikanie, a vowel reduction process of Russian that turns non-high vowels into [i] in unstressed syllables if the preceding consonant is soft. If the preceding consonant is hard, non-high vowels are reduced to [u] (or schwa), a reduction that is known as Akanie (Avanesov 1968). I illustrate this in (8). The forms on the left establish the underlying vowel because the vowel occurs under stress, which means that Ikanie and Akanie are inapplicable. The forms on the right document reduction: Ikanie after soft consonants (8a) and Akanie after hard consonants (8b).

⁵ Also in prefixes and in the context of Hardening, as I note later.

⁶ *//ʃ' ʒ'//* are derived from the velars *//x g//* by Velar Palatalization, a rule that I do not discuss here, but see Lightner (1972) and Plapp (1996).

- (8) a. Ikanie: s'ol [s'ól] (an accent marks stress), underlying //s'ol// 'village' (neuter gen.pl.) - s'ol+o [s'it+ó], underlying //s'ol+ó// (nom.sg.); note: stress on suffixes is the property of the underlying representation (see Melvold 1990)
- b. Akanie: stol [stól], underlying //stoł// 'table' (masc. nom.sg.) - stol+a [stɔł+á], underlying //stoł+á// (gen.sg.)

The underlying vowel in the root in *żon+e* 'wife' (dat.sg.) is //o// because [o] surfaces under stress in *żon* [ʒon] (gen.pl.). If the [ʒ] were hard in the underlying representation, we would expect Akanie to occur, as //o// → [ɔ] when unstressed (8b). But what we find in *żon+e* is a high vowel [ʒin'+e]. The [i] can be derived from /i/ by Retraction: *i* → *i* after hard consonants, illustrated in (6). In sum, all that we need is that the underlying //o// in *żon+e* must be preceded by a soft consonant, so that Ikanie rather than Akanie can apply. This effect is achieved if we assume that [ʒ] derives from the underlying soft //ʒ'//. Then, the underlying representation of *żon+e* is //ʒ'on+é//, where the dat.sg. morpheme is //é//. (The vowel is stressed in the underlying representation, see Melvold 1990.) The derivation is as follows.

- (9) //ʒ'on+é//
 ʒ'on'+é Palatalization (3); informally: *C* → *C'* / — [V, -back]
 ʒ'in'+é Ikanie; informally: *ε o a* → *i* / *C'* — when unstressed
 ʒin'+é Hardening; informally: *f' ʒ'* → *f ʒ* context-freely
 ʒin'+é Retraction; informally: *i* → *i* after a hard consonant

To summarize, Russian consonants are either soft (palatalized) or hard (velarized), and there are no neutral consonants, i.e. consonants that would be neither palatalized nor velarized. The softness and the hardness can come either from the underlying representation or from the application of rules (here: Palatalization and Hardening).

Given this background, Retraction exhibited in (6) is stated as a rule that assimilates the front vowel to the [+back] (velarized) consonant, a process that is just as natural as Palatalization (3), where the [+back] (velarized) consonant assimilates to the front vowel.

- (10) Retraction
 a. informally: *i* → *i* / C[+back] —
 b. formally: [+syll, +high, -back] → [+back] / [+cons, +back] —

Notice that Retraction and Palatalization (for the part stated in 2b) are incompatible operations, which is shown schematically in (11).

- (11) C[+back] V[+high, -back], that is, //Ci//:
 Ci → C'i (Palatalization)
 Ci → Ci (Retraction)

SPE provides an organizational frame for solving the incompatibility of Palatalization and Retraction: it is the concept of derivation with an associated assumption that rules may be ordered. A further SPE tenet is that rules need to be specified individually as applying either inside words or across word boundaries. In the latter case, the word boundary # can be obligatory or optional (marked by parentheses). Since the SPE statement of Palatalization in (3) does not mention # or (#), the rule can apply only inside words. The context of Retraction must be different in this regard: *i* → *i* / C [+back] (#) — because the rule applies both inside words (*žon+e* in 9) and across word boundaries (the examples in 6). Palatalization and Retraction are ordered, with the former preceding the latter. The derivation of *brat Irin+y* //brat irin+i// 'Irene's brother' is as follows.

- (12) //brat # irin+i//
 brat # ir'in+i Palatalization: /r/ → [r'] because /ri/ occurs inside the word but not */t # i/ → [t' # i] because Palatalization cannot apply across word boundaries
 brat # ir'in+i Retraction: /t # i/ → [t # i] because Retraction may apply across word boundaries

With regard to the three fundamentals of a phonological framework: (i) formal vocabulary, (ii) organizational frame, and (iii) legitimacy of generalizations, Lexical Phonology is a contribution to (ii): organizational frame (Kiparsky 1982, Mohanan 1986, Booij and Rubach 1987). A rule is assigned to one of the three components envisaged by lexical phonology (Booij and Rubach 1987): the cyclic component, the postcyclic component or the postlexical component. The first two components are lexical, which means that they are limited to the domain of the word. Given the facts in (1) and (6), Palatalization is a postcyclic lexical rule while Retraction is a postlexical rule.⁷ The ordering stipulation in the SPE derivation in (12) is not necessary any more: Palatalization must apply before Retraction because the Lexical Phonology model predicts that lexical derivation must precede postlexical derivation.

As a general observation, it should be noted that SPE makes no attempt to collapse Palatalization and Retraction into a single generalization (rule). Such an attempt cannot be undertaken because, first, the operations *Ci* →

⁷ Palatalization applies across morpheme boundaries and inside roots, as in //irin+ε// → [iri'n'+ε], *Iren+e* 'Irene' (dat.sg.). It cannot be a cyclic rule because cyclic rules cannot apply morpheme-internally. Retraction is postlexical because it applies across word boundaries. Like any postlexical rule, it may also apply inside words, as in (9). That is, postlexical rules apply 'across-the-board.'

$C'i$ and $Ci \rightarrow C\acute{i}$ are incompatible and, second, the rules are distinct formally: Palatalization applies not only before $//i//$ but also before $//\epsilon//$ while Retraction has only $//i//$ but not $//\epsilon//$ as its focus. The SPE analysis of Palatalization and Retraction as separate rules is carried over into Lexical Phonology because Lexical Phonology is not a theory of rule formalization (fundamental (i): formal vocabulary). Rather, it is a theory of rule interaction in a new organizational frame that it provides (fundamental (ii): organizational frame).

To summarize, we have looked at two fragments of Russian phonology: consonant palatalization and vowel retraction. These processes are subsumed under two rules: Palatalization (3) and Retraction (10).

The final step in broadening the range of data for our analysis is to consider the fronting of $//i//$ to $[i]$, which is the reverse of Retraction. This process is documented by the data in (13), where (13a) shows that the underlying representation of the masculine nominative plural ending is $//i//$ and (13b) suggests that $//i//$ is turned into $[i]$ after soft consonants.

- (13) a. most 'bridge' - most+y [t+i]
 nos 'nose' - nos+y [s+i]
 b. put' 'journey' - put+i [t'+i]
 los' 'moose' - los+i [s'+i]

There is little doubt that $//i//$ is the underlying vowel in (13). Had it been $//i//$, as (13b) might misleadingly suggest, we would not be able to make sense of contrasts such as those in (14).

- (14) most [t] 'bridge' - most+ik [t'+i] (diminutive): $//t// \rightarrow [t']$ by Palatalization because $//i//$ is a front vowel

versus

most [t] 'bridge' - most+y [t+i] (nom.pl.): underlying $//i//$ surfaces as $[i]$; no Palatalization because $//i//$ is a back vowel (see Plapp (1996) for further discussion)

To conclude, the data in (13b) show that $//i//$ assimilates to the palatalized consonant and becomes [-back], a very natural process that is now stated in (15).

- (15) Fronting
 a. informally: $i \rightarrow i / C'$
 b. formally: [+syll, +back, -round] \rightarrow [-back] / [+cons, +back]

Notice that Fronting looks extremely similar to Retraction. In fact, these rules express a single generalization: the consonant and the vowel agree in backness.

Rules expressing agreement in features would not pass unnoticed in the SPE format. A convention, known as ‘alpha variable’ (where alpha ranges over the values plus and minus) collapses Retraction and Fronting into a single rule that I call Vowel Assimilation.

- (16) Vowel Assimilation:
 [+syll, +high, -round] → [αback] / [+cons, αback]

Vowel Assimilation is embraced by Lexical Phonology since it fits well into its model of rule organization. Recall that Retraction is a postlexical rule because it applies in sentence phonology (the data in 6). Fronting is seen as an active process in the domain of words, as shown by (13b), but this is not a problem. As mentioned in footnote 7, postlexical rules apply ‘across-the-board’, that is, everywhere: inside roots, across affix boundaries and across word boundaries.

Now that Fronting is part of Vowel Assimilation and hence, as a postlexical rule, is free to act in sentence phonology, the question is whether it generates the correct surface facts. The answer is affirmative: the vowel is front when the consonant is palatalized, as shown in (17).

- (17) put’ Iriny [put’ ir’ini] ‘Irene’s journey’
 los’ Iriny [los’ ir’ini] ‘Irene’s moose’

In sum, SPE and Lexical Phonology posit two rules to account for the assimilatory process referring to [±back] in consonant - vowel sequences: Palatalization and Vowel Assimilation. These rules cannot be subsumed under a single generalization for the following reasons.

- (i) They are formally distinct. Palatalization includes the context of both //i// and //ε// while Vowel Assimilation refers only to high vowels. Furthermore, Palatalization affects the consonant while Vowel Assimilation affects the vowel.
- (ii) They perform incompatible operations: $Ci \rightarrow C'i$ (the portion of Palatalization that refers to the //i// context) versus $Ci \rightarrow C\acute{i}$ (the portion of Vowel Assimilation that states Retraction)
- (iii) Their formal status is different: Palatalization applies in the domain of words and is hence postcyclic whereas Vowel Assimilation applies both in the domain of words and in the domain of sentences and is hence postlexical.

Even though these arguments are convincing, the analysis does not seem to be fully satisfactory. It is difficult to resist the feeling that some generalization is being missed. After all, on a more general level than that provided by the analysis, Palatalization and Vowel Assimilation are two different tools to express what arguably is a single generalization in surface

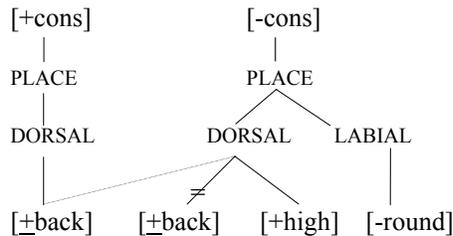
phonology: there is a perfect harmony between consonants and high unrounded vowels in the sense that either both are [-back], *C'i*, or both are [+back], *Ci*. That is, Palatalization and Vowel Assimilation share a target: consonants and vowels must agree in backness.

The similarity between Palatalization and Vowel Assimilation is made more apparent by post-SPE developments in the theory of phonological representations. Autosegmental phonology (Goldsmith 1979, Halle and Vergnaud 1980, Clements 1986, and others) enriches the grammar of representations by postulating three independent tiers that are linked by a system of associations: the melody, the skeleton and the syllable. Relevant for our purposes is the structure of the melodic tier because it is this tier that encompasses feature changing operations and these are the operations expressed by Palatalization and Vowel Assimilation.

The melodic tier is viewed as a feature tree, with nodes and features occupying independent tiers, a theory that is known as Feature Geometry (Clements 1985, Sagey 1986, McCarthy 1988, Halle 1992, and others). Assimilatory processes are analyzed as 'spreading *cum* delinking' operations.

For Vowel Assimilation, the spreading imperative is of little consequence because the alpha variable convention used in (16) conveys the same message as spreading: the consonant and the vowel share the value for [\pm back]. Technically, Vowel Assimilation is stated as in (18), where I adopt a version of the Halle-Sagey model of feature geometry (Sagey 1986, Halle 1992; see Kenstowicz 1993 for a review). Note that the secondary articulation property of a consonant (velarization or palatalization) is represented as the presence of the node DORSAL with the vocalic feature [\pm back]: [+back] for velarization and [-back] for palatalization. It is clear that these are secondary articulations because the ROOT node has the feature [+cons]. The segment on the right in (18) is a high nonround vowel, that is, //i// or //i̟//.⁸ Here the DORSAL node and the associated features refer to vowels, which is clear from the fact that the ROOT node is [-cons].

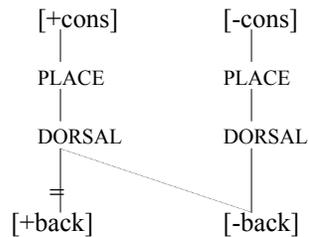
(18) Vowel Assimilation



⁸ The rounded vowel //u// does not front, for instance, *l'ubov* [l'ubof] 'love' (N).

Feature geometry is of consequence for the statement of Palatalization because the rule can no longer insert the feature [+high] onto the consonant. (Recall that palatalized consonants are not just [-back] but also [+high].) The reason is that [+high] could not be spread from //ε//, which is a mid and hence [-high] vowel.⁹ Therefore all that Palatalization does is spread [-back] from the vowel onto the consonant. This operation is displayed in (19).

(19) Palatalization



Since palatalized consonants need to be [+high] and (19) does not spread height, the output of (19) must undergo a spell-out operation that provides [+high].

(20) Height Spell-out: [+cons, -back] → [+high]

To conclude, we have arrived at two important points in our analysis. First, the grammar has spell-out rules such as (20) and these rules are universal because all palatalized consonants are always [+high]. Second, now that [+high] has been taken out from the statement of Palatalization, the Palatalization rule and the Vowel Assimilation rule have become disturbingly similar. Addressing this similarity is a starting point for a reanalysis of Palatalization and Vowel Assimilation in the framework of Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1995; OT henceforth).

In my view, the most important contribution of OT to phonological theory is the tenet that phonological generalizations, now stated as constraints rather than as rules, are universal. This is a logical extension of the system that existed prior to the advent of OT. This system had universal

⁹ Actually, this insertion is not necessary for Russian, which has velarized consonants at the input to Palatalization, and Russian velarized consonants are [+high] in addition to being [+back]. The insertion of [+high] as an operation is valid for languages that do not have velarization but have palatalization, for instance, Slovak (see Rubach 1993) or for languages that have weak velarization that is represented as [+back] without the concomitant [+high] on the consonant, for instance, Polish (Wierzchowska 1963, Rubach 1984). Let me note that all the arguments presented in this article for Russian carry over to Polish in an almost fully direct way. The difference is that Polish limits Retraction to the environment of hard coronals, which makes the rule slightly less general than it is in Russian (see Rubach 1984).

rules, such as (20), and had constraints. For instance, the Sonority Sequencing Generalization of Jespersen (1904)¹⁰ determines the well-formedness of syllable structure, where the vowel that constitutes the nucleus is the most sonorous segment and sonority decreases as we move toward the outer members of the syllable margins.¹¹ But, as a legacy of SPE, the system existing prior to OT assumed that the points of difference among languages should be ascribed, among other things, to the fact that languages have different rules. Thus, the difference between Russian that has palatalization before //i// and //ε// and Ukrainian that has palatalization only before //i// is analyzed as a difference in the rule systems: Russian has rule (3) whereas Ukrainian has rule (5). The underlying assumption here is the one made by SPE: rules are language-specific. As a consequence of this assumption, the facts of Ukrainian cannot be legitimately used to argue for the statement of Palatalization in Russian. Once the tenet that phonological rules are language-specific is abandoned, it becomes not just legitimate but simply imperative to use cross-linguistic evidence for the statement of phonological generalizations. The argument regarding Palatalization is now as follows. Precisely because Ukrainian does not have palatalization before //ε//, the statement of Palatalization cannot be the one given in (3) that includes both //i// and //ε// as triggers of the process. Rather, we have two independent palatalization constraints (Rubach 2000a).

- (21) a. PAL-*i*: A consonant and a following high vowel agree in backness
 b. PAL-*e*: A consonant and a following mid vowel agree in backness

It might be argued that by stating PAL-*i* and PAL-*e* as separate constraints we forfeit the generalization that in Russian the contexts of //i// and //ε// act together as triggers of palatalization. This objection is countered by the fact that Russian palatalization is entirely exceptionless before //i// but has exceptions before //ε//, for instance, *sintetika* [sʲintetʲika] ‘acrylic material’, where *s* and *t* are palatalized before //i// but the *t* before the *e* remains hard. Thus, it is simply not true that //i// and //ε// act in the same way toward palatalization. Exactly the same is true in Polish.¹²

The upshot of stating PAL-*i* and PAL-*e* as separate constraints is that PAL-*i* now subsumes Vowel Assimilation because all that it mandates is an agreement in backness and it is irrelevant if this agreement is achieved at the cost of palatalizing the consonant or at the cost of retracting the vowel. PAL-*i* expresses the overriding generalization missing in Palatalization and Vowel Assimilation that these processes conspire in order to force the agreement in backness between a consonant and a following high vowel.¹³

¹⁰ This constraint was introduced into generative phonology by Selkirk (1984).

¹¹ See Blevins (1995) and Rubach (1999) for a review of these issues.

¹² For instance, while //ε// in general triggers palatalization, the //ε// of the masc. instr.sg. suffix *-em* does not: *kot+em* [tʲ] ‘cat’; see Rubach (1984).

¹³ As noted in footnote 8, the disagreement in backness is found with [u] occurring after a

In a phonological system such as that of Russian that has both velarized and palatalized consonants, on the one hand, and //i// as well as //i̯//, on the other hand, PAL-*i* makes five typological predictions.

- (22) a. C([+back]) I → C([-back]) I (Palatalization)
 b. C([+back]) I → C([+back]) i̯ (Retraction)
 c. C([-back]) i̯ → C([-back]) i (Fronting)
 d. C([-back]) i̯ → C([+back]) i̯ (Depalatalization)
 e. C([+back]) i̯ and C([-back]) i̯ (the faithful candidates; agreement in backness between the input and the output; no change is predicted to occur because PAL-*i* is satisfied)

Of these five typological predictions, four are attested in Russian, as has been shown earlier. It might be added that the cases subsumed under (22e) occur in *most+y* //most+i̯// = [most+i] ‘bridges’ for the C([+back]) i̯ combination and in *los'+ik* //los'+ik// = [los'+ik] ‘moose’(diminutive) for the C([-back]) i̯ combination. (Currently, I have no evidence for Depalatalization (22d) since it does not occur in either Russian or Polish but my statement of PAL-*i* in (21a) predicts that it should exist.)

With regard to the organizational frame, in which to state the interaction of generalizations (constraints), OT departs radically from the rule framework. Most significant here are the following two tenets. First, constraint interaction is fully parallel and there is no serial derivation (strict parallelism) and, second, in stating generalizations, the structural description is divorced from the structural change. That is, OT markedness constraints prohibit or require certain structures (negative and positive constraints, respectively) but, as a matter of principle, they do not say how the prohibition or the requirement should be executed. The execution, i.e. the way in which a given language achieves the desired target, follows from the interaction of constraints because it is the interaction (expressed as constraint ranking) that is language-specific and not the constraints themselves. This being the assumption, the various ways of achieving the agreement in backness in (22) mandated by the undominated PAL-*i* are a matter of how faithfulness constraints interact with each other. Since the operations in (22) involve feature changing, they fall under the jurisdiction of the IDENT(Feature) constraints. It seems that relevant to the analysis are the following two faithfulness constraints.

soft consonant. PAL-*i* would predict that the //u// should front to [ū] in *l'ubov* ‘love’ (N). The absence of such fronting (at least in the phonological sense) is a consequence of an independent fact: Russian has no front rounded vowels, hence the segment inventory constraint against such vowels, *V([-back, +round]), is undominated.

- (23) a. IDENT-V([±back]): The input value of [±back] on a vowel must be preserved in the output correspondent of that vowel
 b. IDENT-C([±back]): The input value of [±back] on a consonant must be preserved in the output correspondent of that consonant

A permutation of the constraints in (23) yields the typology in (24). The mechanics of evaluation is illustrated by looking at an abstract input //tʰi/, where //tʰ// is a velarized consonant, as in Russian.

(24) PAL-*i* is an undominated constraint

- a. //tʰi// → [tʰi]: Palatalization (22a);
 IDENT-V([±back]) >> IDENT-C([±back])

	PAL- <i>i</i>	IDENT-V([±back])	IDENT-C([±back])
1. tʰi			*
2. ti		*!	
3. ti	*!		

- b. //tʰi// → [ti]: Depalatalization (22d); same ranking as in (a)

	PAL- <i>i</i>	IDENT-V([±back])	IDENT-C([±back])
1. tʰi		*!	
2. ti			*
3. ti	*!		

- c. //tʰi// → [tʰi]: Fronting (22c); IDENT-C([±back]) >> IDENT-V([±back])

	PAL- <i>i</i>	IDENT-C([±back])	IDENT-V([±back])
1. tʰi			*
2. ti		*!	
3. ti	*!		

- d. //tʰi// → [ti]: Retraction (22b); same ranking as in (c)

	PAL- <i>i</i>	IDENT-C([±back])	IDENT-V([±back])
1. tʰi		*!	
2. ti			*
3. ti	*!		

The problem with this analysis is the prediction that a language that has Palatalization must also have Depalatalization because (24a) and (24b) are distinguished solely by the property of the inputs rather than by constraint ranking. If the input is a [-back] vowel, then the ranking IDENT-V([±back])

>> IDENT-C([±back]) yields Palatalization (24a). If, on the other hand, the input is a [+back] vowel, then the same ranking yields Depalatalization (24b). The facts attested in Russian show that Palatalization (24a) occurs but Depalatalization (24b) does not occur. Notice that the change of ranking from IDENT-V([±back]) >> IDENT-C([±back]) to IDENT-C([±back]) >> IDENT-V([±back]) does not help. This ranking produces Fronting (24c) and Retraction (24d), both of which are attested in Russian, but does not eliminate Depalatalization (24b). Furthermore, Depalatalization preempts Fronting, which is incorrect for Russian.

The solution to this dilemma is to relativize the constraints with regard to the values plus and minus. Thus, (23) is replaced with (25).

- (25) a. IDENT-C(+back): Input [+back] on a consonant must be preserved in the output correspondent of that consonant
- b. IDENT-C(-back): Input [-back] on a consonant must be preserved in the output correspondent of that consonant
- c. IDENT-V(+back): Input [+back] on a vowel must be preserved in the output correspondent of that vowel
- d. IDENT-V(-back): Input [-back] on a consonant must be preserved in the output correspondent of that consonant

A permutation of these constraints derives each of the typological operations in (22): Palatalization, Retraction, Fronting, and Depalatalization. This is illustrated in (26), where the constraints that are mute on the input are omitted, for instance, IDENT-V(+back) is mute on the input //ti// because the input vowel is front rather than back.

(26) PAL-*i* is an undominated constraint

- a. //ti// → [tʰi]: Palatalization (22a); IDENT-V([-back]) >> IDENT-C([+back])

	PAL- <i>i</i>	IDENT-V([-back])	IDENT-C([+back])
1. tʰi			*
2. ti		*!	
3. ti	*!		

- b. //ti// → [ti]: Retraction (22b); IDENT-C([+back]) >> IDENT-V([-back])

	PAL- <i>i</i>	IDENT-C([+back])	IDENT-V([-back])
1. tʰi		*!	
2. ti			*
3. ti	*!		

- c. //tʰi// → [tʰi]: Fronting (22c); IDENT-C([-back]) >> IDENT-V([+back])

	PAL- <i>i</i>	IDENT-C([-back])	IDENT-V([+back])
1. tʰi			*

2.	t̥i		*!	
3.	ti	*!		
d. //t̥i// → [ti]: Depalatalization (22d); IDENT-V([+back]) >> IDENT-C([-back])				
		PAL- <i>i</i>	IDENT-V([+back])	IDENT-C([-back])
1.	t̥i		*!	
2.	t̥i			*
3.	ti	*!		

A further theoretical question is how PAL constraints can be made ineffective in the choice of the optimal candidate. If a language has no palatalization, the procedure is the same as in all cases in which the effect of a markedness constraint should not carry over to the optimal candidate: here the faithfulness constraints in (25) are ranked above the PAL constraints in (21). Further, the statement of palatalization in SPE rules (3) and (5) accounts for the difference between a language that has palatalization before /i ε/ and a language that has it only before /i/. An OT equivalent is a matter of how PAL-*i* and PAL-*e* are ranked *vis-a-vis* the IDENT constraints in (25). The rankings are displayed in (27).

- (27) a. PAL-*i*, PAL-*e*, IDENT-V([-back]) >> IDENT-C([+back]): palatalization before /i ε/
 b. PAL-*i*, IDENT-V([-back]) >> IDENT-C([+back]) >> PAL-*e*: palatalization before /i/ but not before /ε/¹⁴

Finally, the observation that palatalization before /ε/ implies palatalization before /i/ but not vice versa (Chen 1973) is captured by fixed ranking. The claim is that PAL-*i* is ranked universally above PAL-*e*. Given this claim, the unranked PAL-*i*, PAL-*e* in (27a) are now corrected to PAL-*i* >> PAL-*e*. While various faithfulness constraints may intervene between PAL-*i* and PAL-*e*, as in (27b), it is never the case that PAL-*e* is ranked higher than PAL-*i*.

Returning to the analysis of Russian, we note that there is no permutation of the constraints in (25) that can account for the following significant fact: the violation of PAL-*i* in the input /Ci/ can be removed by either palatalizing the consonant, *Ci* → *C'i*, or by retracting the vowel, *Ci* → *Cɨ*, and both of these strategies are attested in Russian. These operations are incom-

¹⁴ A language that has no velarization achieves the same result by replacing IDENT-C([+back]) with $0 \rightarrow 1$ IDENT-C[-back]. While IDENT-C([+back]) demands the preservation of [+back] in the output and is thus an $1 \rightarrow 0$ (input → output) constraint, $0 \rightarrow 1$ IDENT-C[-back] has the reverse effect by mandating the identity between the output and the input. It prohibits the addition of [-back] to a consonant because it demands that [-back] in the output be matched with [-back] in the input. A palatalized consonant in the output matched with a non-palatalized consonant in the input fails on this count and incurs a violation of $0 \rightarrow 1$ IDENT-C[-back]. See Pater (1999) for a discussion of the split between $1 \rightarrow 0$ and $0 \rightarrow 1$ constraints.

patible and cannot be accommodated in a single grammar because they lead to a ranking paradox, compare (26a) and (26b).

The ranking paradox is solved if we adopt the insight of Lexical Phonology that the lexical component and the postlexical component may differ with regard to the interaction of phonological generalizations. Translated into the constraint systems of OT, this insight is expressed as the reranking of constraints between the lexical level and the postlexical level (Kiparsky 1997 and 2000, Rubach 1997, 2000a and 2000b). Since palatalization occurs at the lexical level in Russian, the constraints are ranked as in (26a). At the postlexical level, IDENT-C([+back]) is reranked above IDENT-V([-back]), as in the evaluation shown in (26b). The result is that the optimal resolution of the changes mandated by PAL-*i* is vowel retraction: $Ci \rightarrow C\dot{i}$. These two scenarios are illustrated by alternations such as those in (28).¹⁵

- (28) brat [brat] ‘brother’ - brat+ik [brat’+ik] (diminutive)
 Irin+a [ir’in+a] ‘Irene’ - brat Irin+y [brat ir’in+i] ‘Irene’s brother’

It should be noted that Retraction, displayed formally in (26b), is not limited to the juncture between words. It occurs also word-internally in instances which, for independent reasons, escaped Palatalization at the lexical level. One such reason is the occurrence of a vowel between the consonant and //i// at the lexical level. For example, the prefix *ot-* derives from the underlying //otO//, where the capital //O// denotes a floating vowel called a yer.¹⁶ The //O// persists through the lexical derivation in order to account for a pattern of vowel - zero alternations in stems and prefix - stem concatenations (Pesetsky 1979, Rubach 1984 and 2000a).¹⁷ The /O/ blocks Palatalization in *ot+yyskat* ‘find out’ (compare *iskat* [iskat’] ‘search’), which comes out as /otO+iskat’/ from the the lexical level. This output is processed further at the postlexical level, where /O/ deletes, opening /i/ to Retraction: [ot+Hskat’].¹⁸

To conclude, the treatment of palatalization before *i* in Russian shows significant differences in the analysis that stem from the differences in the assumptions made by various theoretical frameworks: from SPE through Lexical Phonology to OT. The foundations of generative phonology laid

¹⁵ The absence of Depalatalization, $C'i \rightarrow C\dot{i}$, in Russian shows that IDENT-C([-back]) must be an undominated constraint.

¹⁶ See Rubach (1986) and Kenstowicz and Rubach (1987) for an analysis of such vowels in Polish and Slovak.

¹⁷ Compare:

oto+brat ‘take away’ (perfective), //otO+bIr+a+t’// \rightarrow [oto+br+a+t’] (actually, [AtAbrát’] by Akanie), where the first yer vocalizes as [o] while the second yer deletes

versus
ot+bir+a+t ‘take away’ (imperfective), //otO+bIr+aj+t’// \rightarrow [od+b’ir+a+t’], where the root yer vocalizes as [i] in derived imperfectives while the prefix yer deletes. Note: [o] is actually [Λ] by Akanie and $t \rightarrow d$ by Voice Assimilation.

¹⁸ Actually, [ut+Hskát’] due to Akanie.

out in SPE have been modified considerably in Lexical Phonology and in OT. Of these modifications, two are particularly significant: the distinction between lexical and postlexical phonology and the concept of language-specific grammars as systems of universal generalizations. The former restricts the analysis in a descriptively adequate way. The latter opens a broad perspective on what constitutes a legitimate generalization by bringing in cross-linguistic evidence. The result is that PAL-*i* as an undominated constraint enforces interaction between several disparate constraints. This interaction unveils typological differences across languages and, as documented by Russian, within the grammar of a single language at the interface between lexical phonology and postlexical phonology.

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Received: October 20, 2002

Accepted: November 30, 2002