# Russian Palatalization in Stratal OT: morphology and [back]*

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## 1 Introduction

The complex facts of Russian palatalization have long been the focus of phonological research. Although there are several accounts of the facts cast in a derivational framework, do date there has been no unified analysis of the whole system of palatalization and its interaction with morphology within Optimality Theory. In this paper I analyze some facts of Russian palatalization and discuss their relationship with the morphology of Russian.

The central problem is the following: CV sequences which stand in violation of one or more markedness constraints relating to palatalization are repaired in a variety of ways, depending on the morphological context. Any account of the palatalization facts must necessarily deal with the morphological facts as well, and show how the two are interdependent. In addition, most of the palatalization-related processes in Russian exhibit a Derived Environment Effect. Incorporating this into the analysis will also prove essential.

## 2 The data

In underived environments, Russian has a palatalization contrast in all consonants except *ž*, *š*, and *c*, which are always plain, and *č*, *šː*,

* I would like to thank the FASL audience, the 2002 TREND audience, two anonymous reviewers, as well as Luc Baronian, Edward Flemming, Andrew Koontz-Garboden, and especially Paul Kiparsky and Ora Matushansky for criticism and suggestions. The errors are mine. This material is partly based upon work supported under a National Science Foundation Graduate Research Fellowship.

and *j*, which are always palatalized.[1] The contrast is present before all vowels except *i* and *y*. In (1) below I illustrate possible CV sequences.

(1)

| | | | | |
|---|---|---|---|---|
| C$^{j}$i | Cy | | C$^{j}$u | Cu |
| C$^{j}$e | Ce | | C$^{j}$o | Co |
| | C$^{j}$a | Ca | | |

Some of these sequences, such as plain Cs followed by *e* and palatalized velars followed by back vowels, exist only in loanwords. The item *k$^{j}$ure* 'priest' exemplifies both possibilities.[2] In what follows I will not attempt to exclude these cases by assigning them to deviant loan phonology, but will assume that they instantiate the possibilities present in the palatalization system of Russian.

In morphologically derived environments (CV sequences that span a morpheme boundary) several modifications of the underlying value of [back] are possible, driven by constraints that enforce the agreement in backness between adjacent consonants and vowels. As we will see, this agreement is achieved to various degrees across various types of boundaries, and is enforced through a variety of repair strategies.

Let us first consider non-velar consonants, also excluding the 'unpaired' *ž*, *č*, *c*, etc., which normally do not undergo any modification. When followed by *e* in a morphologically derived environment, the underlying /C/ surfaces as [C$^{j}$] within words and remains intact across word boundaries, shown in (2).[3]

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[1] I use traditional Slavist transcription for *c* = [ts], *y* = [ɯ]. I use the phonetically more accurate *šː* for the sound traditionally transcribed as *šč*, and indicate palatalization with superscript *j*. I transcribe vowels orthographically. *O* and *I* are the back and front *yers*, respectively.

[2] Four of the forms of the native verb *tkat$^{j}$* 'weave' also have palatalized velars + back vowels: *tk$^{j}$oš*, *tk$^{j}$ot*, *tk$^{j}$om*, *tk$^{j}$ot$^{j}$e*, as do forms of verbs like *peč* 'bake' in some dialects.

[3] Due to lack of space I will not deal with palatalization across prefix-word and word-word boundaries.

(2) Non-velar Cs followed by *e*

a. Palatalization: across morpheme boundaries

/stran-e/ → *stranʲe* 'country.DAT'

/zʲemlʲ-e/ → *zʲemlʲe* 'land.DAT'

b. No change: across word boundaries

/dal eto/ → *dal eto* 'gave this'

/dalʲ eta/ → *dalʲ eta* 'this distance'

In the case of non-velar consonants followed by the vowels *i* and *y*, there are three patterns of backness adjustment. In some cases, the suffix always begins with an *i*, and the consonant is always palatalized (3a). In other cases, both within words and across word boundaries, the backness of the vowel agrees with the underlying backness of the consonant (3b), resulting in a *i*/*y* alternation. Finally, in a few cases, the suffix has an invariant *y* and the backness of the consonant adjusts accordingly.[4]

(3) Non-velar Cs followed by *i* and *y*

a. Invariant *-i* + palatalization: *-išːe*, *-ist*, verbal markers

/dom-išːe/ → *domʲišːe* 'house.AUGM'

/alʲt-ist/ → *alʲtʲist* 'viola player'

/xod-it/ → *xodʲit* 'go.3SG'

[4] Ora Matushansky argues (p.c.) that depalatalization before back vowels does not exist. Indeed, with the suffix *-ynʲa* there are very few convincing examples, such as *gusynʲa* and *gosudarynʲa* (cf. *gusʲ* and *gosudarʲ*), and no good examples with *-yga* and *-yš*. There are a number of items with *-inʲa*, but all of them end in velars (*inokinʲa*, *monaxinʲa* 'nun'), where *y*-fronting is expected. While the facts of depalatalization are far from convincing, what is clearly a robust generalization is that outside of velar-final stems, there are no words with *-inʲa*, with a [–back] consonant that is underlyingly [+back]. This calls for an explanation. In what follows I will be assuming that the suffix is indeed *-ynʲa*. The paucity of examples like *gusynʲa* is then due to the fact that the suffix does not productively attach to Cʲ-final stems.

b. *i*/*y* alternation: GEN.SG *-i*/*-y*, adjective *-ij*/*-yj*
/stran-y/ → *strany* 'country.GEN'
/zemlʲ-y/ → *zemlʲi* 'land.GEN'
c. *i*/*y* alternation: across word boundaries
/dom iry/ → *dom yry* 'Ira's house'
/bolʲ iry/ → *bolʲ iry* 'Ira's pain'
d. Invariant *y* + depalatalization: *-ynʲa*
/rab-ynʲa/ → *rabynʲa* 'slave.FEM'
/gusʲ-ynʲa/ → *gusynʲa* 'goose.FEM'

Finally, the most complicated case are the velars *k*, *g*, *x*. There are three patterns here. First, the velars may undergo a process known as Velar Palatalization (VP),[5] whereby they become post-alveolar *č*, *ž*, *š* (4a). This occurs before certain suffixes. Second, before a different set of suffixes, velars become palatalized, turning into *kʲ*, *gʲ*, *xʲ* (4b).[6] Third, across word boundaries, the backness of the vowel *i* and *y* can be adjusted to the palatality of the velar (4c).

(4) Velar Cs
a. Velar Palatalization: *-išːe*, *-enʲje*, verbal markers
/drug-išːe/ → *družišːe* 'friend.AUGM'
/pʲek-enʲje/ → *pʲečenʲje* 'cookie'
/krʲik-it/ → *krʲičit* 'cry.3SG'
b. Palatalization: *-ist*, GEN.SG *-i*/*-y*, adjective *-ij*/*-yj*
/tank-ist/ → *tankʲist* 'tanker'
/ruk-y/ → *rukʲi* 'hand.GEN'
/vysok-yj/ → *vysokʲij* 'tall.MASC'

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[5] Some authors use the term Velar Mutation instead. I stick to Velar Palatalization because this term reflects the name of the sound change First Velar Palatalization (*pervaja palatalizacija zadnejazyčnyx*), which is the diachronic source of the alternation.
[6] Although not crucial for anything that follows, my assumptions about the featural content of *č*, *ž*, *š* vs. *kʲ*, *gʲ*, *xʲ* are that the former are [–ant, cor] and the latter are [–back, dors].

c. *i/y* alternation: across word boundaries
/vnuk idʲot/ → *vnuk ydʲot* 'the grandson is coming'

The following table (5) provides a summary of the facts presented in this section. On the left side are representative suffixes, and the columns illustrate the backness adjustments that take place before each suffix type.

(5)

| | non-velar C | non-velar Cʲ | velar |
|---|---|---|---|
| -itʲ, -enʲje | Cʲ | Cʲ | Čʲ |
| -ist, -izm | Cʲ | Cʲ | Kʲ |
| -i/-y | Cy | Cʲi | Kʲi |
| -e | Cʲe | Cʲe | Kʲe |
| #V | CV | CʲV | KV |
| #y | Cy | Cʲi | Ky |

Accounting for Russian palatalization largely amounts to providing a principled explanation for which repair strategy is used in which type of sequences. In the sections that follow I will attempt to give such an explanation.

## 3 Analysis in OT

In this section I show how Stratal OT can handle the data introduced in the previous section. In section 3.1 I argue for classifying all Russian suffixes into two groups, depending on the phonological processes taking place at the boundary between stems and those suffixes. In section 3.2 I apply Stratal OT to the data, showing how different constraint ranking at different strata can account for the facts at hand.

From table (5) it is clear that none of the [back]-adjusting processes can be formulated in a simple fashion. Take VP as an example (see (4a)). It applies before some suffixes beginning with [–back], such as the verbal inflectional markers or the abstract noun *-enʲje*, but it fails before other [–back] segments, such as the suffixes *-ist*, *-izm*, or the genitive suffix *i/y* in forms like *rukʲi*. Similarly, the conditions of the alternation between *i* and *y* cannot be formulated in a straightforward way, since it takes place in some suffixes but not in others.

Halle and Matushansky's (2002) attempt to deal with these phenomena, cast in a derivational framework, faces two difficulties. First, the failure of VP in cases such as the suffixes *-ist* or the dative *-e* has to be treated as an exception. As for forms like *rukʲi*, their analysis runs as follows. The underlying shape of the suffix is *-y*; the velar is palatalized before *y* by the rule shown below in (6a); the vowel is then fronted by a later rule (6b), called HI-SWITCH. The whole derivation is shown in (6c).

(6) a. *k*, *g*, *x* → [–back] / __ $V_{[+high, -round]}$
b. $V_{[+high, -round]}$ → [aback] / $C_{[^{a}back]}$ __
c. /ruk-y/ → rukʲy → *rukʲi*

The HI-SWITCH rule is non-cyclic, and ordered at the end of the set of rules which Halle and Matushansky discuss. Because of this assumption, they have to resort to the arbitrary rule (6a), palatalizing a velar in a [–round] context which, phonetically, has nothing to do with palatalization. This rule is the second difficulty faced by their analysis. There is no other way to derive forms like *rukʲi*: fronting the vowel first instead of palatalizing the velar will give incorrect **ruky* due to the HI-SWITCH rule: /ruk-y/ → [ruki] → **ruky*.

Rubach's (2000) proposal deals with a subset of data I examine here, namely surface palatalization restricted to the context of the segments *i* and *j*, within a version of Stratal OT. The main insight of his analysis is that there is a single constraint enforcing [aback] harmony in CV sequences, and the choice of repair strategy depends on the domain of application: surface palatalization within words and vowel adjustment across word boundaries. Below I build on Rubach's basic insight, by looking at data which he did not consider.

I take as a starting point the fact that VP fails to apply before a set of suffixes which synchronically cannot be defined in phonological terms. Let us call VP-conditioning suffixes Class 1 and those that do not condition VP Class 2. It turns out that some of the other properties of suffixes that we have discussed are not distributed randomly between Class 1 and Class 2 suffixes. Consider *i*/*y* alternation. There are two main types of suffixes here: those with an invariant *-i*, and those with an alternating *i*/*y* vowel. The former include verbal inflectional endings and some derivational suffixes like *-ist*, *-izm*. The latter include nominal inflectional endings such as the genitive *-i*/*-y*, and adjectival suffixes such as *-ij*/*-yj*. Table (7) shows that of the four logically possible combinations of the two properties, one is unattested: suffixes with alternating *i*/*y* which at the same time condition VP.[7]

(7)

| | Class 1<br>Cond. VP | Class 2<br>No VP |
|---|---|---|
| invariant *i* | *-it$^{j}$* | *-ist*, *-izm* |
| invariant *y* | *-yn$^{j}$a* | none |
| alternating *i*/*y* | none | *-i*/*-y* (GEN) |

[7] Note that this gap cannot be explained by the absence of underlyingly palatalized stem-final velars. Since the sequence *Ky* is prohibited across morpheme boundaries, when a suffix like the genitive *i*/*y* is attached to a velar-final stem, the result cannot be *Ky*, but is always *K*/*i*. There is no apparent reason why VP should not apply to give *Či* in these circumstances.

There are a number of suffixes in Russian that begin with a floating [–back] feature, which I symbolize with a superscript *j*. (8) below illustrates two such suffixes, the adjectival *-jsk* and the nominalizing *-jb*. The interesting generalization here, illustrated in table (9), is that every suffix that begins with a floating [–back] also conditions VP.[8]

(8) a. /general-$^{j}$sk-ij/ → *general$^{j}$skij* 'general.ADJ'
/volg-$^{j}$sk-ij/ → *volžskij* 'Volga.ADJ'
b. /pros-$^{j}$b-a/ → *pros$^{j}$ba* 'request'
/drug-$^{j}$b-a/ → *družba* 'friendship'

(9)

| | Class 1<br>Cond. VP | Class 2<br>No VP |
|---|---|---|
| [–back] vowel | *-it$^{j}$* | *-ist*, *-izm* |
| floating [–back] | *-jb*, *-jsk* | none |

Furthermore, there is another phonological process in Russian whose application is sensitive to the distinction between Class 1 and Class 2. This is Coronal Palatalization (CP), which turns coronal obstruents into postalveolars, shown informally in (10) below.

(10) a. Coronal palatalization (CP)
*s*, *z*, *t*, *d* → *š*, *ž*, *č*, *ǯ* / __ *j*

[8] A reviewer points out that the generalization only affects *l* and the velars. This is true for coronal-initial suffixes; in the case of *-jba*, the floating [–back] also affects coronals: *xod-jba* 'walking', cf. *xod*. Which consonants are affected is determined by independently needed constraints on palatality in consonant clusters, which I do not discuss here. In addition, as the same reviewer reminds me, the [–back] fails to manifest itself in some itmes, mostly foreign place names, e.g. *gaag-skij* 'from The Hague', *t$^{j}$urk-skij* 'Turkic'. Adjectives for city names ending in *-burg* exist in two variants, e.g. the prescriptive *peterburg-skij* and *orenburg-skij* in addition to *peterburž-skij* and *orenburž-skij*, frequent though frowned upon.

b. /xodi-ju/ → [xodju] → *xožu* 'walk.1SG'
/pisa-ju/ → [pisju] → *pišu* 'write.1SG'

Not every suffix beginning with *j* conditions CP, cf. forms like /sudi-j-a/ → *sud'ja* 'judge', /bez-les-je/ → *bezles'je* 'treeless place', /bez-vod-je/ → *bezvod'je* 'waterless place', /brat-ja/ → *brat'ja* 'brothers'. The generalization here is that every CP-conditioning suffix belongs to Class 1.[9]

The following table (11) summarizes the properties of the two classes of suffixes.[10]

(11)

| Class 1 | Class 2 |
|---|---|
| VP | no VP |
| CP | no CP |
| floating [–back] | no floating [–back] |
| no *i*/*y* alternation; most suffixes have *-i* | some suffixes have *i*/*y* alternation; others have *-i* |

*3.2 Stratal OT*

The theory of Stratal OT (Kiparsky 2000, to appear) assumes the architecture of phonology shown in (12) below. Each stratum is an

[9] Ora Matushansky (p.c.) cites *-iv-aj* as a potential counterexample, as in *natruž-iv-at'* 'overwork (a body part)' vs. *podtask'-iv-at'* 'haul bit by bit'. However, a closer look shows that these two words have different morphological structure. The suffix /-yv-aj/, with post-velar fronting, gives *podtask'ivat'* in the same way as we have *ruk'i*. This suffix also appears in *pod'el-yv-at'* 'do on and off', and, after a coronal obstruent without the application of CP, *zaklad-yv-at'* 'pawn', or *otp'is-yv-at'* 'write off'. Verbs like *natružívat'* are derived from 2nd conjugation verbs (*trud'it'*), where the conjugation class marker is *i*, which conditions the changes of the stem-final consonant. Informally, the derivation is as follows: /trud-i-yvat'/ → [trudjyvat'] → *tružívat'*. Similarly with *zam'ešívat'* 'mix in' (*m'es'it'*), *uxažívat'* 'care for' (*xod'it'*), *ulažívat'* 'settle' (*lad'it'*), and many others.

[10] The classes 1 and 2 have only been defined for suffixes beginning with [–back]. The assignment of the other suffixes to either of the two classes remains indeterminant.

system of ranked OT constraints, and the strata are serially related so that the output of stem-level phonology is the input to word-level phonology, and the output of word-level phonology is the input to postlexical phonology. Strata may differ in their constraint ranking. The domains of application of each stratum are determined on morphological grounds; affixes subcategorize for whether they attach to stems or words, and for whether they make stems or words.

(12) [Stem level phonology] ⇒ [Word level phonology] ⇒ [Postlexical phonology]

My proposal is that Class 1 suffixes, as defined in the previous section, are suffixes which attach to stems and make stems and therefore feed stem-level phonology, while Class 2 suffixes attach to stems or words and make words, and thus feed word-level phonology. The differences in the phonological processes that affect CV sequences in these two classes of affixes are then attributed to the different constraint rankings at the stem level and the word level.

In (13) below I introduce the markedness constraints needed to account for palatalization. These two constraints are needed both cross-linguistically, in order to capture the generalization that only languages with neutralizing palatalization before high front vowels also have neutralizing palatalization before mid front vowels, and in order to account for the Russian facts, where, in underived environments, palatalization is neutralizing before *i* but not before *e*.

(13) a. PAL-*i* 'Cs before *i* are [–back]'
b. PAL-*front* 'Cs before [–back] Vs are [–back]'

I will discuss the relevant faithfulness constraints in more detail below in Section 4.2. For now it is sufficient to introduce the three constraints in (14); the need for both MAX and DEP will be further justified when I discuss the Derived Environment Effect. The vowel faithfulness constraint (14b) can be understood as a shorthand for

both MAX and DEP ranked the same in the hierarchy; I make no theoretical claim about both MAX and IDENT constraints being present in the system.

(14) a. MAX[back]/C 'input C backness is present in output'
DEP[back]/C 'output C backness is present in input'
b. ID[back]/V 'input and output Vs have identical [back] values'

These constraints come with the assumption that consonants in both the input and the output may be specified for either value of [back], or may lack the feature altogether. This is illustrated below in (15). The importance of this assumption will once again be clear below in the discussion of the Derived Environments. I will symbolize [+back] consonants as $C^{\text{ɰ}}$ and [–back] consonants as $C^{\text{j}}$.

(15) a. $C^{\text{ɰ}}$ b. $C^{\text{j}}$ c. C
|
[+back] [–back]

For now, in order to illustrate the difference between the stem-level and word-level ranking, I will treat only morphologically derived CV sequences. Consider first Velar Palatalization. This process can be analyzed as follows. For non-velar consonants, *Ci* sequences that violate PAL-*i* can be repaired by simple palatalization, giving *C$^{\text{j}}$i*. However, due to the high-ranking constraint against palatalized velars, call it *K$^{\text{j}}$, such a solution is not an option for *Ki* strings. A more unfaithful mapping, one involving MAX[place] violation, is forced in order to satisfy PAL-*i*. Thus, the ranking of the constraints must be as shown in (16) below. Velar Palatalization applies due to the undominated markedness constraints PAL-*i* and *K$^{\text{j}}$.

(16) Stem level ranking
PAL-*i*, *K$^{j}$ >> MAX[place], MAX[back]

The ranking shown above only holds at the stem level, where VP applies. At the word level, where simple palatalization takes place instead of VP, as in *ruk$^{j}$i*, the faithfulness constraint MAX[place] must be ranked high enough to prevent the change from a velar to a post-alveolar. The word level ranking is shown in (17) below.

(17) Word level ranking
PAL-*i*, MAX[place] >> MAX[back], *K$^{j}$

Let us now consider the behavior of the suffix-initial vowels *i* and *y* at the stem and word levels. First, both PAL-*i* and PAL-*front* are undominated at both stem and word level, since derived CV sequences cannot be of the shape **Ci* and **Ce*. However, the repairs chosen at each level are in part different. Recall from table (7) that suffixes with invariant *i* exist at both levels, suffixes with alternating *i*/*y* exist only at the word level, and suffixes with invariant *y* marginally exist at the stem level. This means that at the stem level, vowel faithfulness is ranked higher than consonant faithfulness, preventing *i*/*y* alternation, while at the word level consonant faithfulness outranks vowel faithfulness. The rankings are illustrated in (18), and the tableaux in (19) and (20) illustrate the stem level and the word level mappings, respectively.[11] I omit from the tableaux the undominated PAL constraints and candidates that violate them. These tableaux serve as preliminary illustrations of the difference between stem and word level; the analysis will be augmented below.

[11] Due to lack of space I will not treat the constraints that are responsible for the inventory of CV sequences, in particular the absence of C$^{j}$y. I will simply omit candidates involving such sequences. An account along the lines of Padgett 1999, 2001, deriving the system of contrasts from the constraints on effort and distinctiveness, can be applied here as well. Informally, *t$^{j}$y* is too indistinct from both *ty* and *t$^{j}$i*, and this fact accounts for its absence in the inventory of Russian.

(18) a. Stem level ranking
PAL-*i*, PAL-*front* >> ID[back]/V >> MAX, DEP[back]
b. Word level ranking
PAL-*i*, PAL-*front* >> MAX,DEP >> ID[back]/V

(19)

| Stem level | | | ID [back]/V | MAX [back]/C | DEP [back]/C |
|---|---|---|---|---|---|
| /žen-it$^{j}$/ | ☞ | *žen$^{j}$it$^{j}$* | | | * |
| | | *žen$^{ɯ}$yt$^{j}$* | *! | | * |
| /gus$^{i}$-yn$^{j}$a/ | ☞ | *gus$^{ɯ}$yn$^{j}$a* | | * | * |
| | | *gus$^{j}$in$^{j}$a* | *! | | |

At the stem level, ID[back]/V must be ranked above both of the consonant faithfulness constraints in order to prevent any adjustment in vowel backness as a solution to PAL-violating input sequence. Note that for the *i*-initial suffixes, the candidate that adjusts vowel backness is harmonically bound. Indeed, such suffixes induce stem-final palatalization both at the stem and the word level.

(20)

| Word level | | | MAX [back]/C | DEP [back]/C | ID [back]/V |
|---|---|---|---|---|---|
| /al$^{j}$t-ist/ | ☞ | *al$^{j}$t$^{j}$ist* | | * | |
| | | *al$^{j}$t$^{ɯ}$yst* | | * | *! |
| /zeml$^{j}$-y/ | | *zeml$^{ɯ}$y* | * | * | |
| | ☞ | *zeml$^{j}$i* | | | *! |
| /stran-y/ | ☞ | *stran$^{ɯ}$y* | | * | |
| | | *stran$^{j}$i* | | * | *! |

At the word level, ranking vowel faithfulness below at least one of the consonant faithfulness constraints results in the *i*/*y* alternation seen in the genitive suffix, since high-ranking consonant faithfulness prevents depalatalization in forms like *zemʲi*. In the case of *-ist*, a suffix with an invariant *i*, the candidate *alʲtʷyst* is harmonically bound, so palatalization is the only option for such suffixes.

## 4 Derived Environment Effects

Processes which exhibit the Derived Environment Effect (DEE) apply only to strings that are derived either through an application of another phonological process (phonological DEE), or through morpheme concatenation (morphological DEE). The latter type are the focus of this study. I begin in the next section by listing the Russian facts which call for an analysis in terms of the DEE, and then present an account of the DEE in OT based on underspecification.

### *4.1 The Russian facts*

Several palatalization-related processes are subject to the morphological DEE. First, the status of VP as a process subject to the DEE has long been recognized. Velars undergo this process only if followed by [–back] segments that belong to a different morpheme, but plain palatalization applies morpheme-internally (21).

(21) a. /pʲek-enʲje/ → *pʲečenʲje* 'cookie'
/drug-ʲba/ → *družba* 'friendship'
b. /kʲistʲ/ → *kʲistʲ* 'brush'
/kʲem/ → *kʲem* 'who.INSTR'

Less often recognized in the literature is the DEE sensitivity of palatalization before *e* (though cf. Padgett 2001, and Rubach 1984

for an analogous situation in Polish). If we take the large number of loanwords with plain Cs followed by *e* to be part of the Russian phonological system, then the account for the distribution of Ce/C$^{j}$e sequences must appeal to the DEE. Plain Cs before *e* are allowed only morpheme-internally (22).

(22) a. /l$^{j}$et-e/ → *l$^{j}$et$^{j}$e* 'summer.LOC'
/jav-l-en$^{j}$je/ → *javl$^{j}$en$^{j}$je* 'appearance'
b. /sv$^{j}$iter/ → *sv$^{j}$iter* 'sweater'
/sv$^{j}$iter-e/ → *sv$^{j}$iter$^{j}$e* 'sweater.LOC'

*4.2 Underspecification as a solution to the DEE problem*

In derivational phonology, the theory of underspecification was a natural consequence of the general principle of eliminating all predictable information from underlying representations. It was assumed that unmarked feature values, such as the [+voice] feature of nasals, being predictable, need not be recorded in the lexicon and may be assigned by default rules in the course of derivation (Kiparsky 1985). Kiparsky 1993 showed that precisely this version of underspecification theory, where unmarked feature values are banned from the lexicon, may provide a general solution to the problem of DEE. He showed that as long as a rule is feature-filling and not feature-changing, underspecification theory can account for the DEE of that rule.

Such a view of underspecification is incompatible with OT, because of the principle of Richness of the Base (ROB), which forces generalizations to be derivable from constraint ranking instead of being located in the input. Since the underspecification account relies on a particular choice of input, it cannot be directly translated into OT.

However, it is also possible to take advantage of ROB, together with an independently justified theory of constraints, in order to

account for the DEE, as is shown in the work of Inkelas (1994, 2000). By ROB, any of the representations in (15) are eligible inputs: consonants fully specified for either value of a feature, or ones left without a value for that feature. If faithfulness constraints are separated into MAX and DEP versions, penalizing feature deletion and feature insertion, respectively, an OT analysis can mimic the difference between feature-changing and feature-filling rules of the derivational theory by ranking MAX and DEP differently. In particular, the ranking MAX >> *markedness* >> DEP should produce the following effect: the markedness constraint is enforced only by feature insertion, never by feature deletion, since MAX is high-ranked but DEP is low-ranked. Thus, the process driven by that markedness constraint is feature-filling, not feature-changing.

Let us take Russian *Ce*-palatalization as a concrete example. We have the constraints MAX[back] and DEP[back], and the constraint PAL-*front*, the markedness constraint driving the process. Let us examine the patterns derived by the six possible rankings of the constraints MAX[back], DEP[back], and PAL-*front*. First, if PAL-*front* outranks both faithfulness constraints, palatalization will apply to all consonants, no matter which of the representations in (15) we choose. Likewise, if both of the faithful-ness constraints outrank PAL-*front*, palatalization will never apply. This leaves us with two rankings: DEP[back] >> PAL-*front* >> MAX[back] and MAX[back] >> PAL-*front* >> DEP[back]. The first of these rankings, with the anti-insertion DEP constraint undomi-nated, will also result in palatalization never applying, since no feature values can be introduced to the output that are not present in the input.[12]

The final ranking, MAX >> *markedness* >> DEP, produces the pattern where only underspecified consonants undergo palataliza-

[12] More precisely, this ranking yields an undesirable three-way surface contrast between [+back], [–back], and underspecified consonants. Imposing a fixed MAX >> DEP ranking for each feature will rule out this possibility but is itself in need of justification. This is a significant problem which remains for future study.

tion, while fully specified consonants are mapped faithfully from input to output. This is the core of Inkelas' solution to the DEE problem: segments in derived environments are underspecified for the alternating feature.

So far, the analysis seems stipulative, since we are deriving the needed effect not only from the constraint ranking but also crucially from the properties of the input, namely by requiring that alternating segments be underspecified while non-alternating segments be fully specified. This is an ROB-related problem, which comes in two parts—for underived and for derived environments—which I will address in turn.

On the present analysis, what makes an environment derived is phonological locality, determined on independent grounds for each process. A process subject to DEE applies to any underspecified representation, but an actual alternation only occurs if that segment is phonologically local to the affix, i.e., if there is a markedness constraint whose domain of application includes both that segment and some portion of the affix. By ROB, any of the three representations in (15) are possible outside of the derived environments. Thus, the *s* of *sʲer* 'gray.MASC' is [–back], while the *s* of *sʷʲer* 'sir' is [+back], and, in addition, the underspecified representation /ser/ is also permitted in this environment. However, such a representation would simply map to one of the licit outputs of the language—the process driven by the markedness constraint would apply to this underspecified segment. Thus, /ser/ will map to *sʲer*, since markedness dominates the anti-insertion DEP[back] constraint. Since the segment is not phonologically local to any affix with respect to any palatalization process, no alternation will result.

The second half of the ROB problem has to do with derived, i.e. alternating environments. If all three representations are possible here, then we are predicting a three-way contrast. In the case of Russian *Ce*-palatalization, we expect three kinds of stems: those with invariant [–back] consonants, those with invariant [+back] con-

sonants, and alternating stems. Of these three possibilities, only two, namely [–back] and alternating, are attested. There are no stems that end in consonants failing to undergo *Ce*-palatalization, i.e. no stems like /ruk-e/ → **ruke*.[13] Inkelas provided an external explanation for the absence of a three-way contrast in the case of Finnish assibilation. In the Russian case, an external explanation is also available. Suppose a stem with a consonant specified for [+back] were to exist. The only form where this stem would be different from a stem with an underspecified consonant would be the dative-locative case in the first declension (*a*-stems) and the locative case in the second declension (*o*-stems), since these are the only suffixes that begin with *e*. There are also a handful of derivational suffixes beginning with *e*, where the effect would also be seen. Elsewhere in the paradigm, such stems would be identical to underspecified stems. Since the contrast between the two kinds of stem is not distinct enough, it is not surprising that Russian has not developed this three-way contrast.

The theory of underspecification is unable to give a general account for the absence of three-way contrasts in such cases. Other theories of the DEE, such as Comparative Markedness (McCarthy 2002) and Constraint Conjunction (Łubowicz 1998), derive only a two-way contrast. It seems, however, that this may be not a defect but a merit of underspecification theory, given the existence of cases like Turkish intervocalic voicing, discussed at length by Inkelas (1994, 2000), which exhibits precisely the type of a three-way contrast predicted by underspecification: invariant voiced and voice-less consonants, and alternating consonants. Unless some general prin-

[13] The failure of *Ce*-palatalization in nouns ending in the consonants *š*, *ž*, and *c* follows from undominated constraints prohibiting those consonants from being palatalized. A reviewer suggests that *š*-final words may be problematic, because a palatalized version does exist, namely *šʲ:*. Since *šʲ:* patterns as a consonant cluster—e.g. taking the imperative allomorph *-i* which occurs after consonant clusters—it is reasonable to treat is as an underlyingly complex segment, simplified only postlexically. This would save *š* from being palatalized to *šʲ:* at the word level.

ciple is found which would allow us to predict which type of DEE-sensitive processes should exhibit a three-way contrast and which should not, local solutions ruling out the third member of a contrast based on functional or other external explanations are not inferior to analyses that rule out three-way contrasts altogether, leaving phenomena like Turkish intervocalic voicing outside of their scope.

It remains to combine the analysis of Russian palatalization from section 3.2 with the analysis of the DEE, to derive the final version of the stem level and word level rankings. In order to derive the DEE of the *Ce*-palatalization, the markedness constraint that drives it, namely PAL-*front*, must be ranked between the MAX and DEP versions of the backness faithfulness constraints. Similarly, at the stem level, the VP constraint *K$^{j}$ must rank between the MAX and DEP constraints for place, while at the word level both faithfulness constraints are undominated. These rankings are shown in (23) below.

(23) a. Stem level ranking
PAL-*i*, ID[back]/V >> MAX[back]/C >> PAL-*front* >> DEP[back]/C
MAX[place] >> *K$^{j}$ >> DEP[place]

b. Word level ranking
PAL-*i*, MAX[back]/C >>PAL-*front* >> DEP[back]/C, ID[back]/V
MAX[place], DEP[place] >> *K$^{j}$

## 5 Conclusion

In this paper I have analyzed the facts of Russian palatalization within Stratal OT. I have argued for separating the suffixes into two classes, based on the phonology that takes place at the boundary between stems and those suffixes. A crucial argument for this analysis is the observation that different suffixes select different phonological repair strategies for CV sequences violating palatalization constraints. The repair strategy chosen is not predictable from the pho-

nological shape of the suffix itself. Separating the morphology into two strata provides a natural solution to the problem.

Furthermore, I argue that the different behavior of CV sequences in underived and derived environments calls for an analysis in terms of underspecification, which uses independently needed faithfulness constraints and general representational assumptions to account for the DEE.

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