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Stem-final consonant mutations in modern Russian*

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1 Introduction

Russian stem-final consonant mutations are a change of a non-palatal stem-final segment to a corresponding palatal one when certain affixes are attached. For example, /*k*/ in *luk 'onion'* becomes /*t͡ɕ*/ in *lu͡ɕok* before the diminutive suffix *-ok-*. [1] These mutations originate in Slavic palatalizations and in particular in iotation, when every non-palatal consonant was turned into a palatal one before a front vowel or /*j*/. In modern Russian, this kind of palatalization is not language-wide anymore, it only applies to certain groups of words under certain inflectional or derivational changes:

- inflective forms of verbs in certain classes;
- comparatives formed from adjectives with stem-final velars and from certain adjectives with stem-final dental plosives;
- nouns derived with certain suffixes (in particular, diminutives).

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[1] Since the paper discusses morphophonological problems, we use IPA transcription rather than transliteration.

However, in non-standard Russian even these forms often feature mutations not attested in standard Russian or very often lack them altogether. In our earlier work (Magomedova & Slioussar, to appear; Slioussar & Kholodilova 2013), we analyzed this phenomenon in verb forms and in comparatives, collecting data on the Internet. In this paper, we present new data (an experimental study of comparatives and Internet and experimental data on nouns with diminutive suffixes) and offer a new account of the phenomenon in the Optimality Theory framework.

Mutations only occur before certain affixes, and, as we will show below, novel and nonce words do not exhibit the same pattern as other words. To account for this, we adopt the sublexical grammar approach (Becker & Gouskova 2012; Allen & Becker 2014) assuming that speakers may have specific grammars for subgroups of words that have a common property. The phonological analysis of consonant mutations is adopted from Wolf (2007). Wolf argues for an autosegmental theory of mutation and proposes that certain affixes have floating features that dock onto the stem border segment, which results in border segment mutation. The model relies on two constraints: MAXFLT[2], which protects a floating feature from deletion, and *FLOAT, which does not allow floating features in the output.

Following Wolf, we assume that Russian affixes triggering mutations have a palatal floating feature on their left edge, which docks onto stem-final segment, if it is possible, and, if not, may be realized as a separate full palatal segment. We denote this feature as *J*. A phenomenon of this kind in Yowlumne (Yawelmani) was analyzed by Zoll (1996) with a similar constraint MAX SUBSEGMENT. She argues that a glottal stop in the /-ʾ*aa*/ suffix is a floating feature rather than an underlying segment.

Consonant mutations in novel Russian words have been previously analyzed by Kapatsinski (2010) who studied verb and diminutive formation. In case of verbs, we look at inflection, rather than at derivation, so the comparison of the data and the proposed accounts is given in the fourth section where diminutives are discussed.

[2] Trommer (2008) argues that MAXFLT is unnecessarily powerful and cases described by Wolf as mutations triggered by floating features can be reanalyzed using REALIZEMORPHEME constraint introduced by van Oostendorp (2005). This discussion goes beyond the scope of our paper.

2 Proposed account exemplified on verb data

2.1 Standard forms

Several verb classes in modern Russian have consonant mutations. Their detailed description can be found in (Slioussar & Kholodilova 2013). Here we will focus on the only productive one, the I class.[3] In standard Russian, I class verbs with certain stem-final consonants have mutations in the 1SG present/future tense form and in the passive past participle: e.g. *brosʲitʲ* 'to throw' — *broʂu* — *broʂenɨj*.

We assume that the 1SG form, which originally had the *-ju* affix, has *-Ju* in modern Russian, and that the past participle affix is *-Jen-*. For reasons of space, we will discuss only 1SG forms in this paper.[4] Table 1 provides examples of 1SG forms from verbs with different stem-final consonants. It shows that the palatal segment of the suffix may appear on its own (*lʲubʲitʲ* 'to love' → *lʲublʲu*) or in coalescence with the stem-final segment (*garadʲitʲ* 'to enclose' → *garaʐu*).

Mutation	Example
d / *t* + *j* → *ʐ* / *t͡ɕ* (*ʐd* / *ʂt* in OCS, *ʂt* > *ʂt͡ɕ*)	*garadʲitʲ* 'to enclose' → *garaʐu*
z / *s* + *j* → *ʐ* / *ʂ*	*krasʲitʲ* 'to paint' → *kraʂu*
b / *p* / *v* / *m* + *j* → *bl* / *pl* / *vl* / *ml*	*lʲubʲitʲ* 'to love' → *lʲublʲu*
l / *r* / *n* + *j* → *lʲ* / *rʲ* / *nʲ*	*ranʲitʲ* 'to wound' → *ranʲu*
st / *sk* / *kt* / *gt* + *j* → *t͡ɕ* (*ʂʂʲ* in OCS), *zg* + *j* = *ʐd*	*pustʲitʲ* 'to let in' → *puʃʃʲu*

Table 1. Consonant mutations and epenthesis in I class verbs, 1SG present/future tense forms

Our proposal relies on the following constraints:

- MAXFLT: All autosegments that are floating in the input have output correspondents (Wolf 2007). Segments that have palatalization as their second articulation violate MAXFLT.
- *FLOAT: assign one violation mark to each output floating segment.

[3] We rely on the classification developed by Roman Jakobson and his followers (e.g. Davidson et al. 1996; Jakobson 1948; Townsend 1975).

[4] The situation with past participles is very similar (Slioussar & Kholodilova 2013).

- IDENT(place): assign one violation mark to each output segment that has a place feature which is different from the corresponding input segment. Segments that have palatalization as their second articulation do not violate IDENT(place).
- DEP: assign one violation mark to each output segment that does not appear in the input (this constraint blocks epenthesis).

Tableau 1 shows the ranking of these constraints for 1SG forms of I class verbs that have consonant mutations.

/*garad*/ + /*Ju*/	MAXFLT	DEP	IDENT(place)
☞*garaʐu*			*
garadʲu	*!		
garadlʲu		*!	
garadʐu		*!	

Tableau 1. Constraints for the 1SG form of *garadʲitʲ* 'to enclose'.

Labial consonants, being too far from palatal by their place, do not mutate into palatal. This would be an instance of saltation, which is known to be very rare, and we rely on the MAP(x,y) constraint (Zuraw 2007; Hayes & White 2013) to forbid it. An epenthetic palatal segment /lʲ/ violating the DEP is used instead to satisfy the MAXFLT constraint. An example is given in Tableau 2.

/*lʲub*/ + /*Ju*/	MAXFLT	*MAP(lab,pal)	DEP	IDENT(place).
lʲubʲu	*!			
☞*lʲublʲu*			*	
lʲuʐu		*!		*
lʲubʐu		*!	*	

Tableau 2. Constraints for the 1SG form of *lubʲitʲ* 'to love'

2.2 Non-standard forms

Now let us look at non-standard forms. Many novel verbs like *zafrɛndʲitʲ* 'to add to one's friend list' or *spamit'* 'to spam' were added to the I class in the last decades. In a previous study (Slioussar & Kholodilova 2013), we searched for 82 such verbs on the Internet and calculated relative frequencies of different forms. We demonstrated that forms without mutations are quite frequent and that various forms with mutations

unattested in standard Russian can be found. For example, *zafrɛndʲitʲ* can have the following 1SG forms: *zafrɛnʐu*, *zafrɛndʲu* without mutations, *zafrɛndlʲu* and *zafrɛndʐu* with two different types of palatal segment epenthesis unattested in standard Russian, as well as some other less frequent variants (for example, *zafrɛn͡tɕu*, *zafrɛnd͡tɕu*). Their relative frequencies are shown in Tableau 3 (forms from other novel verbs show a similar distribution).

/*zafrɛnd*/ + /*Ju*/	Probability[5]	DEP	MAXFLT	IDENT(place).
zafrɛnʐu	0.66			*
zafrɛndʲu	0.28		*	
zafrɛndlʲu	<0.01	*		
zafrɛndʐu	0.06	*		

Tableau 3. Constraints for the 1SG form of *zafrɛndʲitʲ* 'to add to one's friend list'

To give rise to such variation, the IDENT(place) constraint must be promoted. I.e. in a harmonic grammar, its weight should become closer to the weights of MAXFLT and DEP, while for non-novel verbs, where virtually no variation is possible, the weight of IDENT(place) is much less than the one of MAXFLT. So far, we developed a MaxEnt model specifying constraint weights only for diminutives (see section 4.4).

The form *zafrɛndʐu* with an epenthetic palatal segment is of a particular interest: we can see both the stem-final consonant and its mutation product. We cannot give a full phonological analysis of this epenthesis for now. But we suppose that, as the /d/→/ʐ/ is a frequent mutation pattern in Russian, the appearance of /ʐ/ as a surface form of the palatal floating feature *J* is a result of some kind of assimilation. We assume that this new form appeared to satisfy both the promoted IDENT(place) and the MAXFLT constraints.

Verbs with stem-final dental fricatives develop forms with an extra palatal segment slower than other verbs. We could find such forms only for one novel verb *rɛizitʲ* 'to raise'. The relative frequency of different forms in this verb is the same as in other novel verbs. We suppose that

[5] Here and below the numbers are approximate, but can be used to estimate relative frequencies.

this is due to the fact that forms with and without mutation product epenthesis (*rɛizʯu* and *rɛizʒʯu*) are phonetically almost indistinguishable.

/*rɛiz*/ + /*Ju*/	Probability	DEP	MAXFLT	IDENT(place)
rɛizʯu	0.73			*
rɛiz^{j}u	0.24		*	
rɛizl^{j}u	not attested	*		
rɛizʒʯu	0.03	*		

Tableau 4. Constraints for the 1SG form of *rɛiz^{j}it^{j}* 'to raise'

3 Comparatives

3.1 Overview and previous findings

The comparative group that has stem-final consonant mutations is not productive anymore. There are three comparative suffixes in modern Russian:

- the oldest non-productive *-Je*, which causes mutations (*daragoj* 'expensive' → *darozʯe*);
- the most frequent productive *-ee*/*ej*, which does not cause mutations in standard Russian, but sometimes causes stress shift (*ˈkrasnɨj* 'red' → *krasnjˈee*);
- a very infrequent *-ʂe*, which does not cause mutations, but sometimes causes palatalization of the stem-final segment as its second articulation (*tonk^{j}ij* 'thin' → *ton^{j}ʂe*, the *-k-* suffix is dropped).

As Table 2 shows, three groups of stem-final consonants mutate when the suffix *-Je* is attached: velars, dental plosives and dental fricatives.[6] In standard Russian, all adjectives with stem-final velars either have comparatives with the suffix *-Je* or no synthetic comparatives at all. Ten adjectives with stem-final dental plosives have forms with the suffix *-Je*,[7] while other adjectives from this group have no comparatives due to semantic restrictions or attach the suffix *-ee*/*ej* without mutations (e.g. *ʒoltɨj* 'yellow' → *ʒəlt^{j}ee*). Stem-final dental fricatives mutate in very few cases and only with *-(o)k-* suffix drop.

[6] There is also one word with a stem-final labial: *d^{j}eʂevɨj* 'cheap' → *d^{j}eʂevl^{j}e*.

[7] There is also *gatk^{j}ij* 'nasty' with an underlying /*d*/ that forms *gaʒe* with a suffix drop.

Mutation	Example
g → *ʐ*	*daragoj* ‘expensive’ → *daroʐe*
k → *t͡ɕ*	*jomkʲij* ‘capacious’ → *jomt͡ɕe*
x → *ʂ*	*suxoj* ‘dry’ → *suʂe*
d → *ʐ*	*maladoj* ‘young’ → *maloʐe*
t → *t͡ɕ*	*krutoj* ‘steep, cool’ → *krut͡ɕe*
z → *ʐ*	*nʲiskʲij* ‘low, short’ with an underlying /z/ → *nʲiʐe*
s → *ʂ*	*vɨsokʲij* ‘tall’ → *vɨʂe*

Table 2. Consonant mutations in comparatives

However, as in the case of verbs, the picture is different in various nonstandard forms. Firstly, Russian speakers occasionally form non-standard comparatives from many adjectives that have a standard form with mutations (e.g. *maladoj* ‘young’ → *maladʲee* with *-ee* instead of *maloʐe*). Secondly, non-standard comparatives are formed from adjectives that do not have a synthetic comparative in standard Russian (e.g. *dlʲinanogʲij* ‘leggy’ → *dlʲinanogʲee*).

In an earlier study (Magomedova & Slioussar to appear), we searched for nine adjectives with stem-final dental plosives and 53 adjectives with stem-final velars (39 with a standard synthetic comparative and 14 without it) on the Internet to establish the relative frequency of different forms. If an adjective had a standard comparative, 4.9% forms on average lacked mutations (up to 32.7% for certain adjectives). If there was no standard comparative, 57.9% forms on average lacked mutations (up to 100% for certain adjectives). More details can be found in (Magomedova & Slioussar to appear), while in this paper we present an experimental study that confirmed the crucial results of the Internet study and yielded some new findings.

3.2 Experiment

3.2.1 Method. 27 native speakers of Russian participated in the experiment (10 male, 17 female). Ages ranged from 18 to 56.[8] Experimental stimuli included the following adjectives:

[8] Thanks to Tatiana Matyushkina and Ekaterina Tskhoverbieva we did a separate study investigating the influence of participants’ age on the mutation rate. There were nine

- simple adjectives having standard comparatives with mutations (with velar and dental plosive stem-final consonants, with *-(o)k-* suffix that drops or does not drop and without it, as in the examples in Table 2);
- compound adjectives, group 1 (the second part is a separate adjective having a standard comparative with mutation: e.g. *trudajomkʲij* 'laborous' — *jomkʲij* 'capacious' — *jomt͡ɕe*);
- compound adjectives, group 2 (the second part is not a separate adjective, but has highly frequent cognate words with mutations: e.g. *dlʲinanogʲij* 'leggy' — **nogʲij* — *nozʹka* 'little leg, furniture leg');
- relative adjectives with the *-sk-* suffix that have no standard synthetic comparatives (e.g. *ruskʲij* 'Russian');
- several adjectives with stem-final dental fricatives that have no standard synthetic comparatives (e.g. *galubaglazʲij* 'blue-eyed');
- nonce adjectives resembling different types of real adjectives listed above.

In addition to that, we had various real and nonce filler adjectives with stem-final consonants that never mutate. The procedure involved small dialogues prompting the participant to produce comparatives. For example, the experimenter said: "This cat is fat, but my granny's cat is …". The participant was supposed to say "fatter". We had two experimental lists with 37 target adjectives and 29 fillers in every list. Dialogues with real adjectives were presented before dialogues with nonce adjectives. During the second part, we provided our participants with a printed list of nonce adjectives to avoid unnecessary confusion. There was a training session before both parts of the experiment.

3.2.2 Results. Participants' responses were recorded and then transcribed. The distribution of different forms is shown in Appendix. In the Internet study, we looked only at synthetic forms, while in the experiment, we did not put any restrictions on using analytic comparatives (the percentage of analytic forms indicates how difficult it is to form a synthetic form).

We modeled the experimental data with a mixed-effects logistic regression in the *R* software (www.r-project.org) using the *glmer* function from the *lme4* package (Bates et al. 2015). Logistic regressions

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participants aged 55 or older and nine participants aged 15 or younger. No differences between the two groups were found.

evaluated the likelihood of the occurrence of a certain form (analytic, with mutations, with a suffix drop, etc.) vs. other forms. The relevant characteristics of the adjective (real vs. nonce, group 1 vs. group 2 compound, etc.) were treated as fixed effects. All predictors were binary and centered, coded as 0.5 and –0.5. Random intercepts by participant and by item were also included in the models. For all differences reported as significant below, $p < 0.05$.

Firstly, we found that participants produced significantly fewer analytic comparatives than synthetic comparatives in general. However, they used analytic forms significantly more often with adjectives that do not have an established synthetic comparative form. This is an expected result. Secondly, less frequent adjectives have significantly more analytic forms and significantly fewer synthetic forms with mutations (we used Pearson's correlation coefficient, $p < 0.01$ for both factors, frequency information was taken from (Lyashevskaya & Sharov 2009)). Interestingly, this factor did not reach significance in the Internet study.

Thirdly, the first group of compounds (the second part is a separate adjective) had significantly more comparatives with mutations than the second one (the second part is not a separate adjective). This may be surprising because the relevant stems from the second group can be found in many highly frequent words with consonant mutations (e.g. for an adjective *dalgaruk^{j}ij* the relevant word would be *ručka* 'small hand, handle, pen', for an adjective *lapaux^{j}ij* it will be *uško* 'small ear, eyelet' etc.). Thus, it seems to be crucial whether a particular form is established, not whether the model is available. This is similar to our results with verbs: in the I class, the model is productive, but the most important factor is whether a particular form with mutations is established in standard Russian.

Now let us look at adjectives with different stem-final consonants. In the group with stem-final velars, participants formed significantly more synthetic comparatives without mutations from real adjectives that do not have an established synthetic comparative form [9] and from nonce adjectives[10], as expected. Importantly, despite different mutation ratios, there was considerable variation in every part of this group. As far as we

[9] Real adjectives that have an established comparative were coded as 0.5, real adjectives that do not were coded as –0.5, the intercept was also significant showing that participants generally use less synthetic forms without mutations than other forms.
[10] Real adjectives were coded as 1, nonce adjectives were coded as 0.

can see, apart from the factors noted above, this variation depends on the properties of particular lexical items. For example, *ubog*^{j}*ij* 'poky' is widely used in non-standard Russian, and as a result a third of its forms found on the Internet and many experimental responses lack alternations.

In the group with stem-final dental plosives, real adjectives showed no variation: all responses were synthetic comparatives with mutations. But nonce adjectives had only 19.4% forms with mutations, compared to 38.4% in the velar group. We can see that comparatives with mutations from the nine real dental plosive adjectives are stored in the lexicon and easily accessed because these adjectives are highly frequent, but the model is not productive and does not generalize to nonce words. The situation when mutations are applied to real words, but not to nonce words is unusual and has been previously documented by Zuraw (2000) for nasal coalescence in Tagalog and by Kapatsinski (2010) for velar palatalization in verb and diminutive formation in Russian.

An anonymous reviewer suggested splitting the data by consonant voicing because in diminutives, stems with the final /*g*/ lack mutations more often than with /*k*/ and /*x*/ (see Kapatsinski 2010 and section 4.2). Unfortunately, we do not have enough items to make definitive claims about every consonant. However, the overall picture seems to be different. For example, in the nonce velar group, adjectives with the stem-final /*g*/, /*k*/ and /*x*/ had 32.5%, 29.6% and 25.0% forms with alternations respectively. In the real compound 2 group, the percentages were 11.1%, 14.3% and 7.7%. Further work on comparatives is necessary to explain this difference.

We also had two types of adjectives with stem-final dental fricatives: with and without the *-(o)k-* suffix. In the suffixless group stem-final mutations occur in 10 out of 84 synthetic comparatives, one real and nine nonce (e.g. *galubaglazɨj* 'blue-eyed' → *galubaglaʐe* instead of *bol*^{j}*ee galubaglazɨj*). This is not much, but still notable because no mutations are attested in this group of adjectives in standard Russian. Thus, we can also observe overapplication of mutations, although underapplication is much more widespread. In the group with the *-(o)k-* suffix, 113 synthetic comparatives were recorded (30 real and 83 nonce) (e.g. *vɨsok*^{j}*ij* 'tall' → *vɨʂe*). The suffix is dropped and dental fricatives mutate in 31 comparatives (19 real and 12 nonce), the suffix mutates in 31 forms (9 real and 22 nonce) and is dropped with no mutation in 22 nonce forms.

Another finding is that 30 out of 968 synthetic forms from stimulus adjectives, three real and 27 nonce, had mutations with the *-ee*/*ej* suffix, while 302, 59 real and 243 nonce, attached this suffix without mutations (e.g. *marazastojkʲij* 'frost-resistant' → *marazastojčee* or *marazastojkʲee* instead of *bolʲee marazastojkʲij*). Both types of forms were attested in different stimulus groups (with stems ending in /g/, /k/ and /x/, having different suffixes etc.). Finally, in 23 forms (one real and 22 nonce), the *-şe* suffix was used.

3.3 Applying the proposed account

We will limit ourselves to adjectives with stem-final velars where all synthetic comparatives have mutations in standard Russian. We will rely on the IDENT(place) and the MAXFLT constraints introduced above (DEP [11] and *MAP are not relevant for comparatives) and on one additional constraint specifically required for stem-final velar adjectives:

- **ee*: assign one violation mark to each *-ee*/*ej* suffix.

Although *-ee*/*ej* is the most productive comparative suffix, it never attaches to stem-final velars in standard Russian. The constraint ranking is shown in Tableau 5 (we deliberately chose *ubogʲij* 'poky' that has many non-standard forms as an example to illustrate tendencies that are much less strong for most other words). We can see that, as in the case of verb forms, IDENT(place) gets promoted giving rise to comparatives without mutations and the **ee* constraint loses its importance.

/*ubog*/ + /*comp*/	Probability	MAXFLT	**ee*	IDENT(place)
ubozʲe	0.67			*
ubogʲee	0.33		*	
ubogʲe	not attested	*		
ubozʲee	<0.01		*	*

Tableau 5. Constraints for the comparative of *ubogʲij* 'poky'

Finally, let us look at the suffix *-şe*. It is by far the least frequent out of three comparative suffixes (it is present only in several standard forms), but it is productively used in non-standard Russian. For example, the

[11] Although forms like *uprugʐe* (from *uprugij* 'resilient') can be found on the Web, we cannot tell if /ʐ/ is a mutation product epenthesis or the palatal segment of the *-şe* suffix that undergoes voice assimilation.

following non-standard forms with stem-final labial fricatives and plosives can be found on the Internet, although *-ʂe* is never used with such stems in standard Russian: *krasʲivɬj* 'beautiful' → *krasʲivʂe*[12] instead of *krasʲivʲee*, *glupɬj* 'stupid' → *glupʂe* instead of *glupʲee*. We hypothesize that the reason is that *-ʂe* contains a palatal continuant segment that, as we suppose, is also underlyingly present in *-Je* as a floating feature, but allows for a complete faithfulness to the stem.

4 Diminutive nouns

4.1 Overview

A variety of derivational suffixes can trigger stem-final consonant mutations in nouns. In this paper, we focus on a group of diminutive suffixes: *-ok-*, *-ek-*, *-ik-* and *-t͡ɕik-*. We list them without any floating features at first because the picture is complicated. We will first discuss standard Russian and then turn to non-standard forms.

Historically, stems ending in velars were used with *-ek-*, which triggered mutations, while *-ok-* was attached to other stems ending in hard consonants (Kuznetsov 1953). Both suffixes triggered stress shift (with certain exceptions: for example, many Russian words have two diminutive suffixes, and, obviously, only one of them can be stressed). Then /*e*/ mutated to /*o*/ in the majority of cases. As a result, in modern Russian *-ok-* triggers mutations when it is attached to velars (see Table 3) and does not trigger them otherwise (e.g. *grʲib* 'mushroom' → *grʲibok*). *-ek-* attaches only to velars, as before. It can be seen in sequences of two diminutive suffixes (e.g. *krug* 'circle' – *kruʐok* – *kruʐót͡ɕek*) and otherwise is infrequent (e.g. *garoʂek* 'pea, polka dot'). It triggers mutations and never carries the stress in modern Russian.

Mutation	Example
g → *ʐ*	*luk* 'meadow' with an underlying /*g*/ → *luʐok*
k → *t͡ɕ*	*luk* 'onion' → *lut͡ɕok*
x → *ʂ*	*stʲix* 'poem' → *stʲiʂok*

Table 3. Consonant mutations in diminutive nouns

[12] This form is well established and widely used in non-standard Russian.

The *-ik-* suffix is used with non-velar stems and does not cause mutations in standard Russian. It also does not trigger stress shift. *-ok-* and *-ek-* lose their vowel in all forms except for nominative singular (and accusative singular in inanimate nouns), *-ik-* does not (e.g. *lʊ́t͡ɕok* 'little onion' — *lʊ́t͡ɕka,* but *nosʲik* 'little nose' — *nosʲika*). Finally, there is a more recent suffix *-t͡ɕik-* that does not cause any stem changes. *-ek-* is analyzed as a variant of *-ok-* in (Polivanova 1967) and as an allomorph of *-ik-* in (Kapatsinski 2010; Gouskova et al. 2015).[13] Sometimes all four suffixes are treated as allomorphs because in standard Russian, they are usually in complementary distribution (*zubok* and *zubʲik* from *zub* 'tooth' can exemplify an exception).

We will analyze all these suffixes separately, because, as we will show below, in non-standard Russian many nouns can be used with all of them. We searched for such forms on the Internet and conducted a pilot experiment. We are going to address the complicated relations between these suffixes in a separate study because this problem goes beyond the scope of the present paper. Here, let us focus on the questions that cannot be avoided in the discussion of consonant mutations.

First of all, we have to explain why in modern Russian *-ok-* triggers mutations when it is attached to velars, but does not trigger them otherwise (e.g. *luk* 'onion' → *lʊ́t͡ɕok,* but *lʲes* 'forest'→ *lʲesok*).[14] All previous studies of diminutive suffixes either simply describe the fact (Polivanova 1967), or do not address it (Kapatsinski 2010). We will argue that stems with different stem-final consonants attach different diminutive suffixes. Historically, velar stems used *-ek-*, and other stems used *-ok-* and *-ik-*; now velar stems attach *-Jok-* and *-Jek-*, while other stems attach *-ok-* and *-ik-*.

When velar stems attach other diminutive suffixes from this group in non-standard Russian, they also have the palatal segment requirement. Data presented in the following sections show that *-ik-* triggers consonant mutations in the majority of cases, although it does not trigger them otherwise, i.e. it should be *-Jik-*. Notably, modern Russian has other examples when velar stems attach suffixes with an underlying palatal

[13] Gouskova et al. (2015) study the distribution of diminutive suffixes without mutations.
[14] Kapatsinski (2010) claims that *-ok-* is "heavily favored by velar-final nouns". We disagree. For example, we checked that in Zaliznyak's (1987) dictionary there are about 300 *-ok-* diminutives, and they are equally distributed between velar and other stems.

segment, while other stems attach variants without it: e.g. *volk* 'wolf' → *valt͡ɕiʂka*, but *trus* 'coward' → *trusʲiʂka*, and not *truʂiʂka* with the *-(J)iʂk-* diminutive suffix). Another argument for the existence of *-Jok-* comes from forms like *lʲemʲinkt͡ɕok* (from *lʲemʲink* 'lemming') elicited by Gouskova et al. (2015). Such forms were derived only from velar stems. Similar cases of epenthesis of the mutation product, which we consider to be a surface realization of the floating feature, were also discussed in the previous sections.

4.2 Internet study

We selected 24 words with stem-final velars: 14 novel loanwords and 10 words that are rarely used in the diminutive form. For each word we searched for six nominative singular forms with *-Jok-*, *-Jek-* and *-Jik-* suffixes, with and without mutations (e.g. *blozʲik, blazok, blozek, blogʲik, blagok, blogʲek* from *blog* 'blog')[15]. The *-t͡ɕik-* suffix was not included in this study because it does not cause mutations.

The results are presented in Tables 4 and 5. The distribution of forms turned out to be different in the cases when diminutives are very infrequent and when they are relatively more frequent. *-Jik-* and *-Jek-* are unstressed, so they are difficult to distinguish aurally, and Internet data contain a lot of orthographic errors in such cases. A question may arise whether this could make a major contribution to the proliferation of forms ending in *-ik-*. Fortunately, *-Jek-* loses its vowel in most case forms, while *-Jik-* does not, e.g. *blozʲik – blozʲika, blozek – blozka.* Therefore we performed an additional search looking for various inflected forms and found numerous examples like *blozʲika, blozʲike* etc.[16] It should also be noted that almost all diminutives lacking mutations were derived from the stems with the final /*g*/. A similar tendency was observed by Kapatsinki (2010) who explains it by /*k*/ mutation being phonetically a smaller change than /*g*/ mutation (a detailed discussion can be found on page 375 of the paper).

[15] In our earlier work (Slioussar & Kholodilova 2013; Magomedova & Slioussar, to appear), we developed a method and certain tools to estimate relative frequencies of forms on the Web because the counts provided by Internet search engines are unreliable.

[16] *-Jik-* and *-Jek-* can be distinguished in such cases, but it becomes difficult to tell *-Jok-* and *-Jek-* apart. *-Jok-* also exhibits vowel drop, e.g. *blazok — blazka.* Words with *-Jok-* and *-Jek-* have different stress, but it does not help in the written form.

Mutations	Frequent (>50 diminutives found)			Infrequent (<50 diminutives found)		
	-Jik-	*-Jok-*	*-Jek-*	*-Jik-*	*-Jok-*	*-Jek-*
yes	887 36%	748 31%	743 31%	67 50%	37 27%	5 4%
no	40 2%	3 <1%	5 <1%	24 18%	0	1 1%

Table 4. Diminutives from novel loanwords

Mutations	Frequent (>50 diminutives found)			Infrequent (<50 diminutives found)		
	-Jik-	*-Jok-*	*-Jek-*	*-Jik-*	*-Jok-*	*-Jek-*
yes	90 8%	615 52%	313 26%	6 19%	15 49%	6 19%
no	145 12%	3 <1%	28 2%	3 10%	0	1 3%

Table 5. Diminutives from native words and old loanwords

4.3 Pilot experimental study

4.3.1 Method. To compare Internet and experimental data and to address several additional questions (in particular, to estimate the frequency of *-t͡ɕik-*) we conducted a small online experiment, which can be regarded as a pilot study. 59 participants took part in it (we cannot provide age and gender information because some participants did not indicate them).

The experiment consisted of two parts. In the first part we included five loanwords and five corresponding nonce nouns. All nouns were multisyllabic with the stress on the first syllable. Two real nouns and two nonce nouns had stem-final velars. The stimuli in the second part had the same characteristics, only the stress was on the last syllable.[17]

The experiment was conducted on the *Survey Monkey* website (www.surveymonkey.com) and involved the following procedure. The participants were presented with pairs like "big blog — little …" and a choice of several diminutive forms that could be used to complete them. To keep the task relatively simple, we chose three forms: with *-Jok-*, *-Jik-* (both with consonant mutations) and *-t͡ɕik-*.

[17] The first group should be more likely to take *-Jok-* (Gouskova et al. 2015).

4.3.2 Results. The distribution of participants' responses for real and nonce nouns with stem-finals velars is given in Table 6.

Condition	Example	*-Jik-*	*-Jok-*	*-t͡ɕik-*	skipped
real initial stress	*xoldʲink* 'holding'	10 17%	12 20%	37 63%	0
nonce initial stress	*martʲink*	15 25%	21 36%	23 39%	0
real final stress	*fɛjsbuk* 'facebook'	36 61%	2 3%	20 34%	1 2%
nonce final stress	*babrajk*	53 90%	3 5%	3 5%	0

Table 6. The distribution of diminutive forms in the experimental study

Since this was a pilot experiment with very few items, we cannot use statistical tests to estimate the differences between conditions. However, some tendencies are clear. Although nouns with stem-final velars are supposed to select *-Jok-*, this suffix never appears in the majority of cases. Stress-final nouns prefer *-Jik-* and then *-t͡ɕik-*, stress-initial nouns prefer *-t͡ɕik-*. Let us also add an informal observation that multisyllabic loanwords select *-Jok-* less often than monosyllabic ones (we are going to test it in subsequent studies).

4.4 Applying the proposed account

As only velars mutate, we will formulate constraints only for nouns with stem-final velars. [18] We will rely on MAXFLT and IDENT(place) introduced in section 2.1 and on the following other constraints:

- **Jik*: assign one violation mark to each *-Jik-* suffix.
- **t͡ɕik*: assign one violation mark to each *-t͡ɕik-* suffix.
- IDENT(stress): assign one violation mark for each pair of segments that changed their stress.

In case of diminutives, we can present not only constraint ranking, but also their weights obtained from a MaxEnt model of our Internet and experimental data. Tableau 6 shows constraint weights for standard diminutives.

[18] Here and below, we do not consider *-Jok-* and *-Jek-* separately.

/*luk*/ + /*dim*/	MAXFLT w=17	**t͡ɕik* w=17	**Jik* w=17	IDENT(place) w=0	IDENT(stress) w=0
☞*lúk͡ɕok*				*	*
lúk͡ɕik			*!	*	
luk^{j}ok	*!				*
luk^{j}ik	*!		*!		
luk͡ɕik		*!			

Tableau 6. Constraints for the diminutive forms of *luk* 'onion'

Tableau 7 shows the constraint weights for one of the novel loanwords, *lajk* 'like'. Unlike with novel verb forms discussed in section 2.2, where we could outline the common pattern, the model in Tableau 7 definitely cannot be extended to all novel words with stem-final velars. As we noted above, the distribution of suffixes depends on the stress pattern, length and frequency, as well as on some other factors (discussing them would lead us beyond the scope of this paper). So Tableau 7 can only be used to illustrate certain tendencies.

/*lajk*/ + /*dim*/	Probability	MAXFLT w=3.2	**t͡ɕik* w=4.4	IDENT (stress) w=1.5	IDENT (place) w=2.6	**Jik* w=1.9
laj͡ɕok	0.11			*	*	
laj͡ɕik	0.48				*	*
lajk^{j}ok	not attested	*		*		
lajk^{j}ik	0.06	*				*
lajk͡ɕik	0.34		*			

Tableau 7. Constraints for the diminutive forms of *lajk* 'like'.

As with verbs and adjectives, we can see that IDENT(place) gets promoted, giving rise to forms without mutations. IDENT(stress) also becomes more important (especially for multisyllabic loanwords, especially for those with the stress on the first syllable). At the same time, constraints against using *-Jik-* and *-t͡ɕik-* with velars are downgraded, so we observe a proliferation of forms unattested in standard Russian. In particular, let us note that the *-t͡ɕik-* suffix, like the comparative *-ʂe*, allows satisfying the MAXFLT and IDENT constraints at

the same time. Although this suffix is very infrequent in standard Russian, it became productive in non-standard forms.

An anonymous reviewer suggested that, instead of introducing a palatal segment, a constraint like *[+back][–back] can be used to forbid a velar before a front vowel. As it seems to us, this approach has the following drawbacks. Firstly, velars mutate not only before front vowels (cf. diminutives), and not only velars mutate (cf. verb and adjective forms). Our approach offers a unified treatment for all mutation cases. Secondly, we will have to specify that this constraint applies only on the border between the stem and the suffix (otherwise nouns like *kʲivok* 'nod' would not be able to form diminutives like *kʲivo͡ʧek*), and is relevant only for certain affixes. For example, the comparative *-e* triggers mutations, while *-e* used in locative singular case forms does not: e.g. *blog* 'blog' — *v bloge* 'in (a/the) blog'.

Diminutive forms from nouns with stem-final /*g*/ and /*k*/ were also analyzed by Kapatsinski (2010). In some respects, the data are similar: in both studies, the mutation rate is higher with *-ok-* and *-ek-* than with *-ik-* and stems ending in /*g*/ lack mutations more often than other stems. However, in Kapatsinski's study, *-ik-* forms lack mutations in 40% cases, while *-ok-* and *-ek-* forms *never* lack them. The picture that emerges from our Internet study is much less dramatic: we did find some *-ok-* and *-ek-* diminutives that lack mutations and observed that *-ik-* triggers mutations in the majority of cases (see Tables 4 and 5). We also noted that the mutation rate depends on frequency and are exploring other factors in our subsequent work (e.g. number of syllables).

Kapatsinski's model relies on the Minimal Generalization Learner to predict the distribution of mutations in novel loanwords. However, it does not address such questions as why the comparative and 1SG affixes trigger mutations in many consonants, while diminutive affixes do so only in velars; why *-ok-* triggers mutations in velars if it does not do so in other stems and has no front vowel, etc. These are the questions we tried to address in this paper (although, obviously, our approach lacks the valuable insights a learning model can offer).

5 Conclusions

In this paper, we studied the pattern of consonant mutations in modern Russian, looking at the distribution of various verb, noun and adjective

forms on the Internet and at experimental results. We reanalyzed materials presented in our previous papers, collected new data and suggested an explanation in terms of the Optimality Theory framework. We claimed that certain affixes that used to trigger consonant mutations because of their left-edge front vowel or /j/ in old Russian now have an underlying palatal segment (floating feature) that needs to be realized. We also argued that in non-standard Russian, the IDENT constraints that require faithfulness to the stem get promoted. This leads the speakers to avoid consonant mutations and to use suffixes like *-t͡ɕik-* and (to a lesser extent) *-ʂe* that already have a palatal segment at their left edge and at the same time allow for complete faithfulness to the stem.

References

Allen, Blake, and Michael Becker. 2014. *Learning alternations from surface forms with sublexical phonology.* Talk given at the *Phonology* conference, September 19–21, 2014.

Bates, Douglas, Martin Maechler, Ben Bolker and Steven Walker. 2015. *lme4: Linear mixed-effects models using Eigen and S4*. R package version 1.1-8.

Becker, Michael, and Maria Gouskova. 2012. *Source-oriented generalizations as grammar inference in Russian vowel deletion*. Ms. Indiana University and NYU. Available on LingBuzz at http://ling.auf.net/lingbuzz/001622.

Davidson, Dan E., Kira Gor and Maria D. Lekic. 1996. *Russian: Stage One: Live from Moscow!* Dubuque, IO: Kendall Hunt Publishing Company.

Gouskova, Maria, Luiza Newlin-Łukowicz, and Sofya Kasyanenko. Selectional restrictions as phonotactics over sublexicons. *Lingua* 167: 41–81.

Hayes, Bruce, and James White. 2013. Phonological naturalness and phonotactic learning. *Linguistic Inquiry* 44: 45–75.

Jakobson, Roman. 1948. Russian conjugation. *Word* 4: 155–167.

Kapatsinski, Vsevolod. 2010. Velar palatalization in Russian and artificial grammar: Constraints on models of morphophonology. *Journal of Laboratory Phonology* 1: 361–393.

Kuznetsov, Pyotr S. 1953. *Istoričeskaja grammatika russkogo jazyka* [Historical grammar of the Russian language]. Moscow: MGU.

Lyashevskaya, Olga, and Sergey Sharov. 2009. *Častotnyj slovar' sovremennogo russkogo jazyka* [The frequency dictionary of modern Russian language]. Moscow: Azbukovnik.

Magomedova, Varvara, and Natalia Slioussar. 2015. Paradigm leveling: the decay of consonant alternations in Russian. To appear in: *Proceedings of the 15th International Morphology Meeting.*

Polivanova, Anna K. 1967/2008. Obrazovanie umen'šitel'nyx suščestvitel'nyx mužskogo roda [Derivation of masculine diminutive nouns]. In: *Obščee russkoe jazykoznanie: izbrannye raboty [General Russian linguistics: selected papers], volume 4*, 8–22. Moscow: RGGU.

Slioussar, Natalia, and Maria Kholodilova. 2013. Paradigm leveling in non-standard Russian. In: *Formal Approaches to Slavic Linguistics: The Second MIT Meeting 2011*, ed. Alexander Podobryaev, 243–258. Ann Arbor, MI: Michigan Slavic Publications.

Townsend, Charles. 1975. *Russian word formation*. Cambridge, MA: Slavica.

Trommer, Jochen. 2008. Multiple-feature mutation and Realize Morpheme. *Linguistische Arbeitsberichte* 87: 163–182.

van Oostendorp, Marc. 2005. Expressing inflection tonally. *Catalan Journal of Linguistics* 4: 107–127.

Wolf, Matthew. 2007. For an autosegmental theory of mutation. In: *University of Massachusetts Occasional Papers in Linguistics 32: Papers in Optimality Theory III*, ed Leah Bateman, Michael O'Keefe, Ehren Reilly and Adam Werle, 315–404. Amherst: GLSA.

Zaliznyak, Andrey. 1987. *Grammatičeskij Slovar' Russkogo Jazyka. Slovoizmenenie [The Grammatical Dictionary of the Russian Language. Inflection]*. 2nd ed. Moscow: Russkij Jazyk.

Zuraw, Kie. 2000. *Patterned exceptions in phonology*. Doctoral dissertation, UCLA.

Zuraw, Kie. 2007. The role of phonetic knowledge in phonological patterning: Corpus and survey evidence from Tagalog. *Language* 83: 277–316.

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Appendix. Different types of comparatives in Experiment 1

Columns 1–5 contain numbers and percentages of different synthetic forms. All synthetic forms are considered here as 100%. Column 6 shows numbers and percentages of forms with a suffix drop (since *-(o)k-* and *-sk-* suffixes may be dropped with or without root-final consonant mutation, these numbers and percentages are counted separately from columns 1–5). Columns 7–8 contain numbers and percentages of all synthetic and analytic forms. All forms are considered here as 100%.

synthetic						**total syn-thetic**	**ana-lytic**
mutation			**no mutation**	**other**	**suffix drop**		
-Je	***-ee/ej***	***-ṣe***	***-ee/ej***				
Simple adjectives having normative synthetic comparatives with mutations (stem-final consonant: *g, k, x*).							
77 95%	0 0%	0 0%	4 5%	0 0%	0 0%	81 76%	26 24%
Compound adjectives, group 1: the second part is a separate adjective having a normative synthetic comparative with mutations (stem-final consonant: *g, k, x*).							
8 44%	1 6%	1 6%	5 28%	3 17%	0 0%	18 33%	36 67%
Compound adjectives, group 2: the second part is not a separate adjective having a synthetic comparative, but has highly frequent cognate words with mutations (stem-final consonant: *g, k, x*).							
6 29%	0 0%	0 0%	15 71%	0 0%	0 0%	21 39%	33 61%
Adjectives with an *-(o)k-* suffix (with *-z-*, *-s-* before the suffix, having normative synthetic comparatives with mutations).							
28 93%	0 0%	0 0%	2 7%	0 0%	19 63%	30 56%	24 44%
Adjectives with an *-(o)k-* suffix (with other consonants before the suffix, having normative synthetic comparatives with mutations).							
28 90%	2 6%	0 0%	1 3%	0 0%	4 13%	31 56%	24 44%

synthetic						total syn-thetic	ana-lytic
mutation			no mutation	other	suffix drop		
-Je	*-ee/ej*	*-şe*	*-ee/ej*				
Relative adjectives with a *-sk-* suffix (not having normative synthetic comparatives).							
1 20%	0 0%	0 0%	1 20%	3 60%	1 20%	5 19%	22 81%
Nonce adjectives resembling simple adjectives ending in *-g, -k, -x*.							
25 29%	6 7%	2 2%	48 56%	5 6%	0 0%	86 75%	29 25%
Nonce adjectives resembling compound adjectives, group 1.							
18 46%	3 8%	4 10%	14 36%	0 0%	0 0%	39 72%	15 28%
Nonce adjectives resembling compound adjectives, group 2.							
18 26%	3 4%	0 0%	44 65%	3 4%	0 0%	68 72%	27 28%
Nonce adjectives resembling adjectives with an *-(o)k-* suffix (with *-z-*, *-s-* before the suffix).							
34 41%	5 6%	1 1%	41 49%	2 2%	34 41%	83 77%	25 23%
Nonce adjectives resembling adjectives with an *-(o)k-* suffix (with other consonants before the suffix).							
16 34%	6 13%	8 17%	15 32%	2 4%	3 6%	47 69%	21 31%
Nonce adjectives resembling adjectives with an *-sk-* suffix.							
4 29%	3 21%	1 7%	4 29%	2 14%	3 21%	14 52%	13 48%
Adjectives having normative synthetic comparatives with mutations (stem-final consonant: *-d, -t*).							
108 100%	0 0%	0 0%	0 0%	0 0%	0 0%	108 100%	0 0%
Nonce adjectives resembling adjectives ending in *-d, -t*.							
10 16%	1 2%	1 2%	43 69%	7 11%	0 0%	62 77%	19 23%

synthetic						**total syn-thetic**	**ana-lytic**
mutation			**no mutation**	**other**	**suffix drop**		
-Je	***-ee/ej***	***-ṣe***	***-ee/ej***				
Adjectives without normative synthetic comparatives (stem-final consonant: *-z*, *-s*).							
1 3%	0 0%	0 0%	31 94%	1 3%	0 0%	33 61%	21 39%
Nonce adjectives resembling adjectives ending in *-z*, *-s*.							
9 18%	0 0%	0 0%	34 67%	8 16%	0 0%	51 75%	17 25%
Fillers (real).							
0 0%	0 0%	0 0%	211 97%	6 3%	0 0%	217 73%	79 27%
Fillers (nonce).							
0 0%	0 0%	5 2%	255 91%	21 7%	0 0%	281 82%	62 18%