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Palatalization in Russian Loanword Phonology

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The main concern of the current study is to determine what drives palatalization before [e] in the loanword phonology of Russian. What is the mechanism of learning new loanwords with respect to palatalizing (softening) a consonant before [e]? I address this question by investigating how Russian speakers produce non-native unfamiliar inputs with velar and dental consonants followed by one of the following English front vowels: /æ/, /ɛ/, and /eɪ/. The results of the study suggest that in loanwords, palatalization before [e] is driven by both, cross-linguistic typologies and the rules of the native phonology.

K e y w o r d s : consonant; vowel; sound; palatalization; loan word.

5.9.5 – Russian language. Languages of the peoples of Russia.

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1. Background: palatalization and vowel reduction

1.1. Palatalization in Russian

In Russian, palatalized and non-palatalized consonants are contrastive, as shown in (1), although, not all consonants have palatalized - non-palatalized pairs (Padgett 2001:2, Timberlake 2004:53). Consonants that are not paired are highlighted. Unpaired /ʃʲ:/, /ʧʲ/, and /j/ are always palatalized; unpaired /ʃ/, /ʒ/, /ts/ are not palatalized. The distribution of palatalized velars is very restricted in that they appear only before front vowels (Padgett 2001:2, Timberlake 2004:57).

Inventory of Russian consonants (Padgett 2001: 2)

	labial	dental	post-alveolar	palatal	velar
stop	p pʲ b bʲ	t tʲ d dʲ			k kʲ g gʲ
fricative	f fʲ v vʲ	s sʲ z zʲ	ʃ ʃʲ: ʒ		x xʲ
affricate		ts	ʧʲ		
nazal	m mʲ	n nʲ			
lateral		l lʲ			
trill		r rʲ			
glide				j	

In Russian, Cʲ and C contrast in various environments: before another consonant, word-finally, before back and front vowels, and word-finally. Palatalization is phonemic in dentals and labials (e.g., [**m**at] ‘check mate’ vs. [**m**ʲat] ‘shrunk’), but it is allophonic in velars. The non-palatalized variant occurs elsewhere (Padgett 2001:2, Timberlake 2004: 53-59).

The distribution of palatalized/non-palatalized consonants is different before the front vowels [i] and [e]. Palatalization is phonemic before high front [i] (Cʲi vs. Ci), as in [**v**itʲ] ‘twist’ vs. [**v**ʲitʲ] ‘howl’. In velars, however, only the palatalized consonants before [i] (Cʲi) are possible.

But before [e], consonants are always palatalized, regardless of their place of

articulation (e.g., ‘**b**ʲelkə ‘squirrel’, ‘**k**ʲeglʲi ‘bowling’ (Timberlake 2004).

In sum, palatalization is phonemic for dentals and labials. Palatalization is allophonic for velars, where Cʲ occurs before [e] and [i] and C is found elsewhere. Regardless of their place of articulation, consonants always palatalize before [e].

1.2. Vowel reduction in Russian

Russian has the following vowels: /i/, /e/, /a/, /o/, /u/. Stress in Russian plays a crucial role in the vowel quality. Stress is lexical and contrastive in Russian (e.g., [mu’ka] ‘flour’ vs. [‘muka] ‘torture’). Moreover, stress can fall on different syllables within a given inflectional paradigm (e.g., [ru’ka] ‘hand’ vs. [‘ruki] ‘hands’) (Timberlake 2004:29).

Unstressed vowels have shorter duration than stressed vowels. Acoustically, they are more centralized, meaning that the vowel space is more reduced than in stressed vowels.

In Contemporary Standard Russian (CSR), there are two degrees of reduction of unstressed vowels. The first-degree (moderate) reduction occurs in the first pretonic syllable. The second-degree (extreme) reduction applies to other unstressed syllables (Crosswhite 2000:109, Timberlake 2004:43-44).

In [+high] vowels, /i/ and /u/, vowel reduction has little effect. The unstressed [i] and [u] are pronounced with some laxing, but basically, vowel quality remains the same. But in non-high vowels, vowel reduction has a significant effect on vowel quality. After non-palatalized consonants in the first pretonic syllable, /a/ and /o/ merge to [ʌ] (first-degree reduction). In other unstressed syllables, /a/ and /o/ become a schwa (second-degree reduction) (see Timberlake 2004 for details).

Overall, in the native phonology, unstressed vowels reduce and become more centralized in both palatalized and non-palatalized contexts. Reduction of unstressed vowels changes both F1 and F2 formants (Bondarko *et al.* 1966:61). Unstressed non-high vowels often raise, showing lower F1 values than their stressed counterparts (Padgett 2005: 15-18).

1.3. Palatalization is loanwords

In Russian loanwords, the distribution of palatalized and non-palatalized consonants differs from the distribution in the native phonology. Consonants are always palatalized before the high front vowel [i] (e.g., [ˈlʲidʲər] ‘leader’, [ˈpatʲi] ‘party’) (Dyakonov 2014-2015).

Consonants before the mid front [e] show variation in terms of whether they are palatalized or not. Regardless of the place of articulation (labials, dentals, velars), they may appear either as palatalized (Cʲ) (e.g., [**g**ʲejt] ‘gate’) or non-palatalized (C) (e.g., [**g**ep] ‘Gap’). Cases of free variation are also possible (e.g., [**d**eˈfolt] / [**d**ʲeˈfolt] ‘default’).

In Russian loanwords, stressed syllables allow non-palatalized consonants more often than unstressed syllables (Holden 1976, Timberlake 2004: 60). Overall, palatalized dentals occur less frequently than palatalized labials and velars. Velars are the most frequent targets for palatalization (Timberlake 2004: 60).

2. Research questions and the experiment

2.1. Cross-linguistic typology on palatalization

We saw that behavior of palatalization in loanwords is not the same as in Contemporary Standard Russian (CSR). The main question of this research is to determine what drives palatalization before [e] in the loanword phonology of Russian. Why does the palatalization pattern before [e] in loanwords differ from the pattern in CSR?

Typological studies of palatalization (Bateman 2007, Chen 1973) show that there are both, a hierarchy of what types of consonants palatalize and a hierarchy of what types of vowels trigger palatalization. Based on the cross-linguistic study of 58 languages, Bateman (2007) establishes the implicational universal for palatalization targets**: labials > dentals and/or velars.** Typological surveys (Bateman 2007, Chen 1973) also establish the implicational hierarchies for palatalization triggers**: i > e > ɛ > a.** Palatalization before lower front vowels always co-occurs with palatalization before high front vowels (implicational universal). The high front [i] is the most unmarked trigger for palatalization of a preceding consonant. In sum, both vowel height and the place of articulation of a target consonant (PoA) are universal parameters for palatalization.

If Russian speakers do not always extend their native language phonology to loanwords, I propose that they are biased toward cross-linguistic phonetic naturalness (or Universal Typologies), at least to some extent (Wilson 2006). The main goal of the current experiment is to test whether universal hierarchies for vowel height and PoA drive the process of palatalization before [e] in the loanword phonology of Russian. My hypotheses are as follows:

Hypothesis 1: the place of articulation

In Russian loanwords, dentals have the strongest C/Cʲ contrast. Labials palatalize more often than dentals and velars are the least marked targets for palatalization: **velars > labials > dentals.** Universal typologies show a different hierarchy for palatalization targets. In the implicational universal, dentals and velars

are not in a hierarchical relation with respect to each other: **labials > dentals and/or velars.** Thus, we can suggest that if the mechanism of loanword adaptation relies on universal typologies and if the place of articulation (PoA) of a target consonant is dental or velar, then the place of articulation (PoA) will have no significant effect on palatalization.

This hypothesis predicts that both dentals and velars will be equal targets for palatalization. PoA will have the same effect on palatalization of dentals and velars.

Hypothesis 2: the vowel height

Universal typologies imply a correlation between vowel height and palatalization. Palatalized consonants are more likely to appear before high front vowels than before non-high vowels (Bateman 2007, Chen 1973). Russian loanwords have the same pattern: a) only C^j occurs before [i]; b) both C and C^j may appear before /e/. Such parallel suggests that if the mechanism of loanword adaptation indeed relies on universal typologies, there will be a correlation between palatalization and vowel height. The hypothesis predicts regardless of a consonant type, palatalized consonants will be more frequent before higher front vowel variants than before lower front variants. As for the vowel space, higher front vowel variants are expected to have lower F1 and higher F2 values than lower front vowel variants.

Hypothesis 3: the position of stress

In loanwords, a contrast in palatalization may also depend on a context. As Timberlake (2004:6) points out, in loanwords, consonants before [e] are more resistant to palatalization in stressed syllables than in unstressed ones. In CSR, non-high front vowels reduce in unstressed positions and vowel reduction is associated with vowel raising (Bondarko *et al.* 1966:60). I suggest that in loanwords, vowel reduction interacts with palatalization. If there is indeed a correlation between the vowel height and palatalization, I predict that stress will have a significant effect on vowel reduction. If vowel reduction involves vowel raising (centralization), target vowels will have significantly lower F1 and lower F2 values in unstressed syllables than in stressed syllables. Palatalized consonants should be more frequent before unstressed (raised) vowels than before stressed ones.

2.2 Experiment: palatalization triggers and targets

An acoustic production task was designed to test whether there is a correlation between palatalization and: a) PoA of a target C, b) vowel height, and c) position of a target C with respect to stress. Participants (*N=6*), two males and four females were recruited using recruitment posters across Stony Brook University. Based on the geographic survey, five participants reported their place of origin was Moscow and one was from St. Petersburg. Speakers were between 30 and 48 years old and had spent between 1 and 23 years in the US. All participants indicated some knowledge of English. However, all of them reported daily exposure to Russian.

Materials:

Stimuli consisted of $C_1V_1C_2V_2$'$C_3V_3C_4$ nonce words (72 target items). Each item had a dental stop (one of /t, d/) or a velar stop (one of /k, g/) followed by one of the vowels /æ/, /ɛ/, or /eɪ/ (e.g., dælə'mik, geɪʃə'mop). The English front non-high vowels /æ/, /ɛ/, and /eɪ/ were chosen in order to test whether vowel height accounts for the C/C^j variation. Dental vs. velar stops were chosen in order to test whether PoA had any significant effect on palatalization. While there was a possibility that the [+voice]/[-voice] contrast of a target C could also influence the speaker's choice for palatalization, *voice* was not expected to be a significant factor.

All the words were trisyllabic with the main stress on the final syllable. In order to test a correlation between palatalization and position of a target C with respect to stress, half of the items were created with target sounds in the initial unstressed syllable (e.g., teɪmə'rɛs (C_1V_1)) and the other stimuli targeted sounds in the stressed syllable (milə'tæs (C_3V_3)). The middle vowel (V_2) was always a schwa ([ə], as in *sofa*). There were also 18 fillers consisting of a consonant other than a dental or velar and a vowel /o/ (e.g., lomə'hɛn, ropə'sis). The items were presented three times in random order to a phonetically trained male American English speaker, who was recorded in a sound-attenuated room.

Procedure

Each participant was placed in a sound-attenuated room with the computer running Experigen - an online experiment platform (Becker and Levine 2013).

Participants were instructed to listen to a nonce English word and repeat it. In order to create the 'native-like' environment for test items, each item had to be produced by participants in a nominative and an inflected genitive or accusative form (marked by the suffix *-a*) in an appropriate context sentence. Each participant received 24 randomized test items, eight fillers, and one practice item. The total number of recorded forms including fillers and the practice item was 402, of which 288 were target item (288 = 6 participants * 24 target items * 2 morphological categories).

Results: dependent variable F1/F2

F1 and F2 values of input and output vowels were measured in order to test: a) whether speakers map nonnative vowels to the closest output available in the native phonology or they prefer to be faithful to the input; b) whether the input vowel, PoA, and stress have significant effects on F1 and F2 values. The input English vowels of the stimuli and the Russian output vowels of the participants' productions were measured, and F1 and F2 values of each target vowel, /æ/, /ɛ/, and /eɪ/, were measured using Praat (Boersma & Weenink 2015). Figure (1) gives average F1 and F2 values for the English input vowels at 50% of the vowel duration in both stressed and unstressed contexts.

Fig 1. Average of F1 and F2 values for English input vowels

a. *stressed*

target	F1(Hz)	F2(Hz)
eɪ	520	2003
ɛ	683	1796
æ	749	1762

b. *unstressed*

target	F1(Hz)	F2(Hz)
eɪ	494	2053
ɛ	630	1780
æ	663	1716

As for the output vowels, as predicted, English front vowels /æ/, /ɛ/, or /eɪ/ map to Russian [e]. Timberlake (2004:31) points out that in stressed positions, F1 of Russian [e] is around 506-702 Hz and F2 is around 1800-2400 Hz. According to Jones' study (1959: 178-182), in unstressed positions, Russian /e/ is pronounced higher and further back. It reduces to lax [ɪ] with lower F1 (250- 500 Hz) and lower F2 values (1000-2500 Hz).

Overall, Russian speakers show higher realization of the given English [-high] front vowels and produce them as variants of Russian [e]. Also, as expected, comparing stressed and unstressed positions, target vowels are pronounced as higher and more back with lower F1 and F2 values; the unstressed input /eɪ/ is closer to [ɪ] (Fig 2).

Fig 2. Average of F1 and F2 values for Russian productions

a. *stressed*

target	F1(Hz)	F2(Hz)
eɪ	443	2115
ɛ	523	1852
æ	596	1686

b. *unstressed*

target	F1(Hz)	F2(Hz)
eɪ	398	1884
ɛ	449	1645
æ	459	1559

Hierarchical linear regression models were used to assess whether the input vowel, stress, PoV, and voice were significant factors for vowel height (F1) and vowel backness (F2). The statistical analysis was done using *lme4* package (Bates, Maechler & Bolker 2013) in R (R Core Team 2014). The three-level factor *target* distinguished /æ/, /ɛ/, or /eɪ/. Using Helmert coding, the three levels were reordered into a two two-way contrasts: (eɪ vs. æ/ɛ) and (ɛ *vs. æ).* The fixed factor *stress* was also coded: *stressTRUE. vs.FALSE.* (stressed vs. unstressed). A binary predictor that contrasted the place of articulation dental vs. velar was Helmert coded into a one-way contrast: *place.vel.vs.den.*

The regression model for F1 values showed that all three target vowels /æ/, /ɛ/, and /eɪ/ had significant effect on vowel height, which confirms the correlation between the input vowel and F1 of the output. As for the effect of *stress,* we saw significantly lower F1 in unstressed syllables, suggesting that vowel raising does occur in unstressed positions. *PoV* and *voice* did not show any significant effect on vowel height.

The regression model results for F2 values confirmed the correlation between the input vowel and F2 value of the output. The effect of *PoV* was also significant, suggesting that F2 value depends on the place of articulation of the preceding consonant. As for the effect of *stress*, we saw that F2 is significantly lower in unstressed syllables than in stressed syllables, suggesting that unstressed vowels are produced as more back than the stressed counterparts.

Results: palatalization

Palatalization was recorded impressionistically by the experimenter. The effects were tested in a mixed-effects logistic regression model using R (R Core Team 2014) and lme4 package (Bates, Maechler & Bolker 2013). The effects of target vowel and place were significant. Overall, 44% of target consonants were palatalized across the subjects.

As expected, participants showed the greatest preference for Cʲ before /eɪ/, 67%, than before /ɛ/, 44%, and /æ/, 23%. Palatalization before /æ/ is the least preferred environment (figure 3).

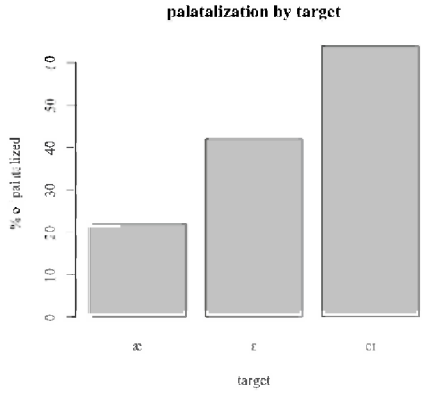

Fig 3. *Palatalization of dentals and velars before /æ/, /ɛ/, and /eɪ/.*

The results for palatalization with respect to stress are not consistent with the prediction that reduced vowels in unstressed syllables drive the process of palatalization. The overall effect of stress was not significant, but it was not consistent across the three input vowels: stress was conducive to more palatalization on /æ,ɛ/ and less palatalization on /eɪ/ (figure 4).

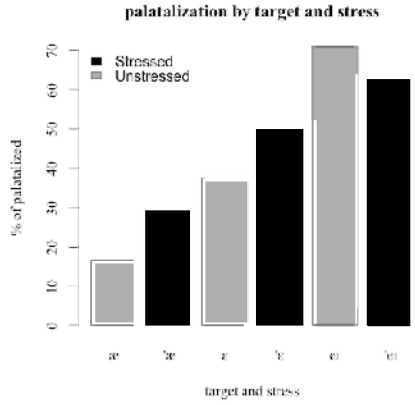

Fig 4. *Palatalization of dentals and velars before stressed and unstressed target vowels /æ/, /ɛ/, and /eɪ/.*

For the place of articulation of the target consonant, results are inconsistent with the prediction. Universal typologies predict that both places of articulation (velars and dentals) would be equal targets for palatalization. However, the results show that palatalized velars occur more frequently than palatalized dentals, 71% vs. 18% respectively (figure 5).

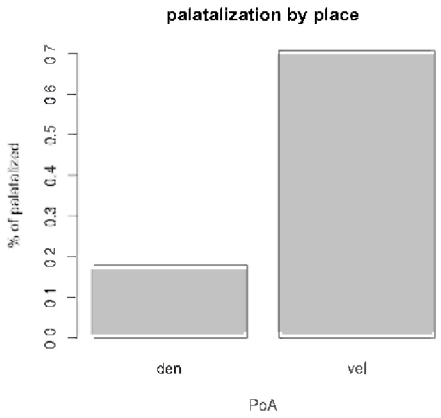

Fig 5. *Palatalization of dentals and velars in all environments*

The regression model showed that all target vowels, coded as *target (eɪ vs. æ/ɛ)* and *target (ɛ vs. æ)* have a significant effect on palatalization. The results confirm the correlation between palatalization and vowel height. Contrary to universal typology, the place of articulation is also a significant factor for palatalization. The velar place of articulation cause significant increase of palatalization, suggesting that in Russian loanword phonology, velars and dentals are in hierarchical relationship with respect to each other. The fixed effect *stress* was not significant, suggesting that position of a target consonant with respect to stress does not have any predictive power on palatalization. As expected, the additional *voice* factor did show any significant effect on palatalization.

3. Conclusion

The main question addressed in this study is what drives palatalization before [e] in the loanword phonology of Russian. The study of nonce loanwords shows that the mechanism of loanword adaptation is driven by universal typologies as well as by the native phonology.

Evidence that the mechanism of loanword adaptation relies on the native phonology comes from differences in frequency of palatalized velars vs. palatalized dentals. Following the rules of the native phonology, in loanwords, dentals show more resistance to palatalization than velars.

Evidence that the mechanism of loanword adaptation relies on universal typology comes from strong correlation of palatalization and vowel height.

The strong correlation between *stress* and F1/F2 values indicate that Russian speakers rely on the native phonological rules for vowel reduction. Similar to Russian, in loanwords, vowels reduce in unstressed positions.

Vowel reduction, however, did not show any correlation with palatalization: reduced vowels did not trigger any significant increase in palatalization. However, it is possible that high frequency existing loanwords are assimilated to the native phonology, showing native-like vowel reduction. If this is the case, vowel reduction is expected to be significant enough to trigger palatalization.

In sum, understanding an interaction of universal typology with the native phonology can shed light on the issue of how Russian speakers perceive and produce existing words borrowed from a foreign language.

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