

Obstruent Voicing Assimilation in Russian

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1 Introduction

Russian is known for having a fascinating phonology because of how it deals with voiced and voiceless obstruents at different positions in a word. This short paper will look at how Russian deals with voiced-voiceless obstruent clusters that appear across word boundaries. To do so, we will look at the phonological variation of three different prepositions when they precede obstruents in a subsequent word. This variation and transformation will then be formalized using formal FO and MSO logic.¹

2 General Description on the Data

In this analysis, we will look at only three Russian prepositions and see how these prepositions vary in their SRs. Our sample consists of prepositional phrases consisting of each of these prepositions followed by a single word as their object (data from (Halle and Clements 1983:p.109)).

‘from’	‘without’	‘next to’	Gloss
at rózi	bʲiz rózi	u rózi	‘rose’
at áli	bʲiz áli	u áli	‘Ala’ (name)
at karóvi	bʲis karóvi	u karóvi	‘cow’
ad baradí	bʲiz baradí	u baradí	‘beard’
at sʲistrí	bʲis sʲistrí	u sʲistrí	‘sister’
at iri	bʲiz iri	u iri	‘Ira’ (name)
ad galavi	bʲiz galavi	u galavi	‘head’
ad valni	bʲiz valni	u valni	‘wave’
at luni	bʲiz luni	u luni	‘moon’
at pʲiti	bʲis pʲiti	u pʲiti	‘heel’
at mʲɛni	bʲiz mʲɛni	u mʲɛni	‘change’

¹This was made in 2016 during my first year; I have made some minor formatting changes since. I apologize if my first-year writing is horrid.

Any variation we find in their SRs should depend on their phonological contexts. The prepositions, their SRs, and their phonological contexts are the following:

The following generalizations can be made for each allomorph:

(1) *Generalizations on Russian*

- a. ‘from’ surfaces as [at] before voiceless stops, voiceless fricatives, nasals, liquids, and vowels
- b. ‘from’ surfaces as [ad] before voiced stops and voiced fricatives
- c. ‘without’ surfaces as [bʲis] before voiced stops and voiced fricatives
- d. ‘without’ surfaces as [bʲiz] before voiceless stops, voiceless fricatives, nasals, liquids, and vowels
- e. ‘next to’ surfaces as [u] before all sounds

The morpheme ‘next to’ has only one SR [u]. Without any alternations, it is simple to argue that its underlying form is /u/. The other two morphemes ‘from’ and ‘without’ each have two allomorphs that differ in the voicing of the final consonant, i.e. [at] vs. [ad] and [bʲis] vs [bʲiz]. The alternation between the two allomorphs for each preposition is predictable when preceding an obstruent (stops and fricatives). For all four allomorphs, the voicing of the preposition’s final consonant agrees with the voicing of the subsequent word’s initial obstruent. That is, if the word after the prepositions starts with a voiceless obstruent, then the preposition has to end with a voiceless obstruent. But, if the word starts with a voiced obstruent, then the preposition has to end with a voiced obstruent, e.g. [at karovi] ‘from cow’ vs. [ad baradi] ‘from beard’. However when the preposition is followed by a voiced sonorant (nasals, liquids, and vowels), the voicing of the preposition’s final consonant is not predictable. Specifically ‘from’ surfaces as its [at] allomorph and ‘without’ surfaces as its [bʲiz] allomorph, e.g. [at luni] ‘from moon’ and [bʲiz luni] ‘without moon’.

To encode the unpredictability of the preposition before voiced sonorants, the underlying form for ‘from’ must be /at/ and the underlying form of ‘next to’ must be /bʲiz/. As for the voicing alternation before obstruents, the underlying forms are subject to phonological process of voicing assimilation whereby an obstruent assimilates in voicing to subsequent obstruent. We do not have enough evidence to show if this process is restricted to obstruent clusters across word boundaries or if it can also apply within a word. If it were to apply to within a word or morpheme, we would predict that we could not find any voiced-voiceless obstruent clusters in the same word. Although we have a small sample of words, the only instance of an obstruent cluster we find is for ‘sister’: [sjistri]. The lack of a voicing conflict in ‘sister’ suggests that Russian phonology does not allow voiced-voiceless obstruent clusters.

3 Formalizing the Variation

The voicing variation can be described as follows:

Obstruent Voicing Assimilation

An obstruent becomes voiceless before a voiceless obstruent, and voiced before a voiced obstruent.

Before we begin to capture the formal logic behind the above simple rule, we should first note that the data doesn't show how Russian would treat a cluster of more than two obstruents, e.g. /atbta/. For simplicity, our transformation will target only two-obstruent clusters.

Furthermore, the transformation only affects voicing. It can cause the surface specification for voicing to differ from its underlying specification. The change is based on the successor relations among obstruents. Thus, our word models for both underlying and surface words should include the binary successor relation (\triangleleft) a set of unary features \mathcal{F} . In \mathcal{F} , two important features `sonorant` and `voiced`. The other features play no role in voicing assimilation. They are provided for the sake of completing the feature inventory of Russian which includes labials, dorsals, fricatives, etc. and no other feature. Provided below are the word models.

Underlying and surface word model

$$\langle D, \triangleleft, \forall \text{feature} \in F \rangle$$

Figure 1: Models for underlying and surface forms.

As for specifying the transformation, we need a copy set C of cardinality $k = 1$ or $C=1$. The copy corresponds to our SR after assimilation has occurred on our UR. Thus, $\varphi_{\text{sonorant}}(x)$ and all other features except for voicing can be assigned as follows: $\forall f \in \mathcal{F} - \{\text{voiced}\} \stackrel{\text{def}}{=} f(x)$. Thus we have

- (2) $\varphi_{\text{sonorant}}(x) \stackrel{\text{def}}{=} \text{sonorant}(x)$
- (3) $\varphi_{\text{coronal}}(x) \stackrel{\text{def}}{=} \text{coronal}(x)$
- (4) ...

However, voicing is more complicated because a sound x may or not be voiced depending on its manner of articulation and phonological context. Because the predicate $\varphi_{\text{voiced}}(x)$ is evaluated to True to mean that x is voiced, it would simpler to think of the transformation in terms of the phonological contexts that would cause x to surface as voiced. The conditions for voicing depending on x 's manner of articulation, its position in an obstruent cluster, and its underlying voice specification:

- (5) *'Algorithm' for Russian generalizations*
 - a. If x is a sonorant, x will surface as voiced if it is underlyingly voiced.
 - b. If x is an obstruent, and if x is not in a cluster, x will surface as voiced if it is underlyingly voiced.
 - c. But if x is an obstruent, and if x is in a cluster,
 - i. and if x is the first obstruent, x will surface as voiced if the second obstruent is voiced.
 - ii. and if x is the second obstruent, x will surface as voiced if it is underlyingly voiced.

The above contexts and their subparts can be easily translated into logical predicates:

- (6) *Predicates for Russian generalizations*

- (7) D1: $\text{VoicedSonorant}(x) \stackrel{\text{def}}{=} \text{sonorant}(x) \wedge \text{voiced}(x)$
- (8) D2: $\text{SingletonVoicedObstruent}(x) \stackrel{\text{def}}{=} \neg \text{sonorant}(x) \wedge \text{voiced}(x) \wedge \neg \exists(y)[\neg \text{sonorant}(y) \wedge (x \triangleleft y \vee y \triangleleft x)]$
- (9) D3: $\text{FirstObstruentBeforeVoiced}(x) \stackrel{\text{def}}{=} \neg \text{sonorant}(x) \wedge \exists(y)[x \triangleleft y \wedge \neg \text{sonorant}(y) \wedge \text{sonorant}(y)]$
- (10) D4: $\text{SecondVoicedObstruent}(x) \stackrel{\text{def}}{=} \neg \text{sonorant}(x) \wedge \text{voiced}(x) \wedge \exists(w)[w \triangleleft x \wedge \neg \text{sonorant}(w)]$
- Then the positions that are voiced in the output form in Russian can be expressed as follows.

$$\varphi_{\text{voiced}}(x) \stackrel{\text{def}}{=} \text{VoicedSonorant}(x) \wedge \text{SingletonVoicedObstruent}(x) \wedge \text{FirstObstruentBeforeVoiced}(x) \wedge \text{SecondVoicedObstruent}(x) \quad (1)$$

$$\quad \quad \quad \text{FirstObstruentBeforeVoiced}(x) \wedge \text{SecondVoicedObstruent}(x) \quad (2)$$

A segment will be voiced if it satisfies $\varphi_{\text{voiced}}(x)$ which is a disjunction of the first four predicates D1-D4. A segment x has to satisfy one of these disjoined predicates to be voiced. Because of the way the predicates are formulated, a segment can satisfy at most one predicate. The predicates match the contexts for voicing in (5). Specifically D1(x) matches (5a), D2(x) matches (5b), D3(x) matches (5c-i), and D4(x) matches (5c-ii). The first predicate $\text{VoicedSonorant}(x)$ or D1(x) is evaluated to true when x is a voiced sonorant. The second D2(x) or $\text{SingletonVoicedObstruent}(x)$ is evaluated to true when x is a voiced obstruent that is outside of an obstruent cluster, i.e. it neither comes before or after another obstruent. The third D3(x) or $\text{FirstObstruentBeforeVoiced}(x)$ is evaluated to True when x is an obstruent that is succeeded by voiced obstruent y in a cluster. It is the first obstruent in an obstruent cluster and it assimilates to the voicing of y . Finally, the fourth D4(x) or $\text{SecondVoicedObstruent}(x)$ is evaluated to True when x is a voiced obstruent that succeeds an obstruent. It is the second obstruent in the cluster and its underlying voicing feature will spread regressively in the cluster. If x does not satisfy any of the disjoined predicates, then it will surface as voiceless.

To illustrate, the following table 1 shows the underlying forms of all logically possible different combinations of segments, contexts, and their evaluation of the predicates in $\varphi_{\text{voiced}}(x)$. For obstruents, we focus on the underlying coronals and liquids: /r/, /l/, /d/. For brevity, the table refers to the four disjoined predicates in $\varphi_{\text{voiced}}(x)$ as D1(x), D2(x), D3(x), and D4(x). If a segment x satisfies one of these disjuncts, it would satisfy $\varphi_{\text{voiced}}(x)$ and surface as voiced.

Table 1: Different contexts for voicing of /r/, /t/, and /d/

Line	Manner	Cluster	Voicing	UR	D1(x)	D2(x)	D3(x)	D4(x)	Voiced(x)	SR
1	Son.	N/A	Voiced	/ara/	T	F	F	F	T	[ara]
2		N/A	Voiceless	/ar.a/	F	F	F	F	F	[a ^h ra]
3	Obst.	Singleton	Voiceless	/ata/	F	F	F	F	F	[ar.a]
4			Voiced	/ada/	F	T	F	F	T	[ada]
5	Obst.	O1 in Cluster	Voiceless	/atpa/	F	F	F	F	F	[atpa]
6			Voiced	/atba/	F	F	T	F	T	[adba]
7			Voiceless	/adpa/	F	F	F	F	F	[atpa]
8			Voiced	/adba/	F	F	T	F	T	[adba]
9	Obst.	O2 in Cluster	Voiceless	/apta/	F	F	F	F	F	[apta]
10			Voiced	/abta/	F	F	F	F	F	[apta]
11			Voiceless	/apda/	F	F	F	T	F	[abda]
12			Voiced	/abda/	F	F	F	T	F	[abda]

For sonorants (lines 1-2) and singleton obstruents (3-4), they surface as voiced when they are underlyingly voiced. For the voiced sonorants, D1(x) would be True; and for voiced sonorants D2(x) would be True. For obstruents in a cluster, it depends on whether they are the first or second obstruent in the cluster. If it is the first obstruent O1 (5-8), it will surface as voiced only if the second obstruent is voiced. It would satisfy D3(x). If the obstruent in the cluster is the second obstruent O2 (9-12), it will surface as voiced if it is underlyingly voiced. It will satisfy D4(x).

To graphically illustrate, take the case of /adpa/→[atpa]:

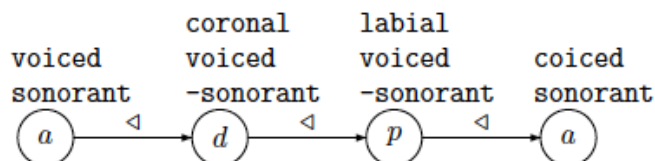


Figure 2: A graph representing the word model of the UR for hypothetical word /adpa/ which has an underlying obstruent cluster.

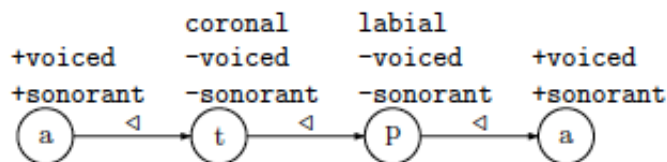


Figure 3: A graph representing the word model of the SR for hypothetical word [atpa] after the underlying /d/ devoiced because of /p/.

4 Conclusion

As this paper has shown, there is a clear phonological variation present in obstruent clusters in Russian. Our analysis of such with prepositions and their objects shows that within an obstruent cluster, an obstruent assimilates the voicing feature of its following obstruent. This case of assimilation can be described in various logical forms.

References

Halle, M. and G. N. Clements (1983). *Problem book in phonology: a workbook for introductory courses in linguistics and in modern phonology*. MIT Press.