

The Role of Prosody in Russian Voicing¹

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1. Introduction

Though Russian voicing assimilation and final devoicing have received a great deal of attention in the literature on generative phonology, there are still basic aspects of the data that are not widely understood or agreed upon. They can be unified under the question, What role does prosody play in the Russian voicing facts? The answer given here will in some ways affirm the role of prosody in the Russian facts and in others exclude it. On the affirmative side, Russian voicing assimilation cannot be understood without reference to higher prosodic units such as the prosodic word. I will present an analysis of the word-level prosody of Russian inspired by Ito and Mester (2007; 2009; see also this volume) (an approach also pursued by Selkirk to appear), one which eschews the ‘Clitic Group’ and other categories apart from the Phonological Word and the Phonological Phrase. On the negative side, I argue that characterizing the triggers and targets of the voicing processes by means of syllable position cannot work for Russian; the account instead requires a cue-based approach, of the sort advocated by Steriade (1997).

This paper provides an analysis of Russian voicing assimilation and final devoicing couched within Optimality Theory (Prince & Smolensky, 1993 [2004]), one that is cue-based but sensitive to questions of higher prosodic structure. An important goal will be to elucidate areas where the facts have been unclear in the past. Apart from prosody-related matters, this includes for example the controversial status of sonorants in the voicing processes. As we will see, there is an important distinction to be made between processes that apply exceptionlessly and categorically and those that do not.²

2. Basics facts

The basic facts of Russian voicing assimilation have been well described (Avanesov, 1956; Jakobson, 1956; Halle, 1959; Hayes, 1984; Kiparsky, 1985, among many others). Obstruents devoice word-finally; compare the (a) and (b) forms below.³

(1)

a. /slʲed-a/	slʲi'd-a	'track (gen.sg.)'	b. slʲet	(nom.sg.)
/raz-a/	'raz-ə	'occasion (gen.sg.)'	ras	(nom.sg.)
/plʲaz-a/	'plʲaz-ə	'beach (gen.sg.)'	plʲaʂ	(nom.sg.)
/knʲig-a/	'knʲig-ə	'book (nom.sg.)'	knʲik	(gen.pl.)
/gu'b-a/	gu'b-a	'lip (nom.sg.)'	gup	(gen.pl.)

In addition, obstruent clusters within a word invariably agree in voicing; the cluster's voicing is predictable from the cluster-final consonant's voicing, as shown in (2). The examples in (2)a-b show prefixes ending in underlyingly voiceless obstruents, while (2)c-d show prefixes with underlyingly voiced obstruents. The underlying status of the consonants is clear from their behavior before sonorants (the (i) examples).

(2)

- a. i. /ot-'jexatʲ/ ət-'jexətʲ 'to ride off'
ii. /ot-stu'pʲitʲ/ ət-stu'pʲitʲ 'to step back'
iii. /ot-'brosʲitʲ/ əd-'brosʲitʲ 'to throw aside'
- b. i. /s-'jexatʲ/ 's-jexətʲ 'to ride down'
ii. /s-pro'sʲitʲ/ s-prə'sʲitʲ 'to ask'
iii. /s-dʲelatʲ/ 'z-dʲelətʲ 'to do'
- c. i. /pod-nʲe'stʲi/ pəd-nʲi'stʲi 'to bring (to)'
ii. /pod-pʲi'satʲ/ pət-pʲi'satʲ 'to sign'
iii. /pod-'zɛtʲʲ/ pəd-'zɛtʲʲ 'to burn'
- d. i. /iz-la'gatʲ/ iz-lə'gatʲ 'to state; set forth'
ii. /iz-klʲu'tʲʲatʲ/ is-klʲu'tʲʲatʲ 'to exclude; dismiss'
iii. /iz-'gnatʲ/ iz-'gnatʲ 'to drive out'

Final-devoicing 'feeds' voicing assimilation; that is, all of the obstruents of a word-final cluster are devoiced:

(3)

- a. /'pojezd-a/ 'pojizd-ə 'train (gen.sg.)' b. 'pojist (nom.sg.)
/'vʲizg-a/ 'vʲizg-ə 'squeal (gen.sg.)' vʲisk (nom.sg.)
/i'zb-a/ i'zb-a 'hut (nom.sg.)' isp (gen.pl.)

Apart from these basic facts, accounts of Russian voicing differ significantly. The areas of disagreement or unclarity fall mostly into two categories: the behavior of voicing assimilation across word boundaries, and the behavior of sonorants. It turns out that one can plausibly distinguish facts that are categorical and obligatory from others that are gradient and therefore optional.⁴ My goal will be to elucidate these distinct sets of facts and provide a formal account for only the former set, since the latter are better handled by models of phonetic implementation. In taking this position on gradient effects I follow Keating (1988), Liberman and Pierrehumbert (1984), Zsiga (1993), and many others.

3. Sonorants

Sonorants in Russian do not participate in the truly categorical voicing processes at all. First, they never trigger voicing assimilation. The examples below show this word-initially, word-medially, and word-finally, (4)a-c respectively.

- | | | | | | | |
|-----|----|-----------|------------|-----|---------------|---------------------|
| (4) | a. | knʲasʲ | 'prince' | vs. | gnutʲ | 'to bend' |
| | | ʼtratʲitʲ | 'to spend' | | ʼdrat:sə | 'to fight' |
| | b. | ʲpʲisʲmə | 'letters' | | bəlʲʂivʲiʲzmə | 'bolshevism (gen.)' |
| | c. | tʲiʲatr | 'theater' | | kadr | 'film sequence' |

Nor do sonorants devoice, except for low-level gradient effects. Word-final sonorants as in (5)a are pronounced as voiced in careful speech. This is true even of sonorants preceded by a voiced ((5)b) or voiceless ((5)c) obstruent.

- | | | | | | | | | | |
|-----|----|------|----------|----|--------|----------|----|-------|---------|
| (5) | a. | mil | 'dear' | b. | zʲɪznʲ | 'life' | c. | ʲlitr | 'liter' |
| | | vonʲ | 'stench' | | bobr | 'beaver' | | voplʲ | 'cry' |

Finally, sonorants do not acquire voicelessness from a following obstruent, (6)a-b.

- | | | | | |
|-----|----|---------|--------------------|----------|
| (6) | a. | bort | 'side (of a boat)' | *bort |
| | | volk | 'wolf' | *volk |
| | b. | rta | 'mouth (gen.)' | *rta |
| | | mstʲitʲ | 'to avenge' | *mstʲitʲ |

Final devoicing and assimilation by sonorants in examples like (5) and (6) are sometimes described (Coats & Harshenin, 1971; Daniels, 1972; Hayes, 1984; Kiparsky, 1985), but once again there is a distinction to be made here between obligatory, categorical rules, and optional, gradient ones. (The references cited in fact make this distinction, especially Kiparsky 1985.) Let us consider (5)-(6) in more detail.

First, few descriptions of Russian suggest that word-final sonorants as in (5)a devoice. Sources that do make clear that this is sporadic and partial (Bondarko, 1998:121; Kniazev, 2006:74; the latter explicitly classifies sonorant devoicing as phonetic, as opposed to phonological obstruent devoicing).⁵ It is more common to suggest devoicing in words such as (5)b-c, especially for liquids, such that /bobr/ can be [bobr̥] or even [bop̥r̥]. Again, however, this occurs only optionally and gradiently (Isacenko, 1947; Avanesov, 1956; Baranovskaia, 1968; Reformatskii, 1975; Bondarko, 1998), being more likely in fast or casual speech and if the preceding obstruent is voiceless. According to Reformatskii (1975) and Avanesov (1956), for example, pronunciations such as [bobr̥] are merely possible, more likely in fast speech, and any devoicing of the preceding obstruent is partial. Indeed, (near)-minimal pairs such as [kadr] 'film sequence'

and [tʲiatr] 'theater' are routine. These conclusions regarding (5) are supported by the phonetic investigation of Barry (1989). Turning finally to (6), assimilation in cases such as (6)a do not occur at all, as Barkaĭ and Horvath (1978) point out. Devoicing in (6)b is again more likely when the following obstruent is voiceless, and it is optional (Isacenko, 1947; Avanesov, 1956; Baranovskaia, 1968). Figure 1a-b show example spectrograms of /l/ in just this environment, before a voiced and voiceless obstruent (respectively); as can be seen at least for this speaker, the /l/ is far from voiceless in Figure 1b. These spectrograms are entirely representative of this speaker. (On the source of this data see below.)

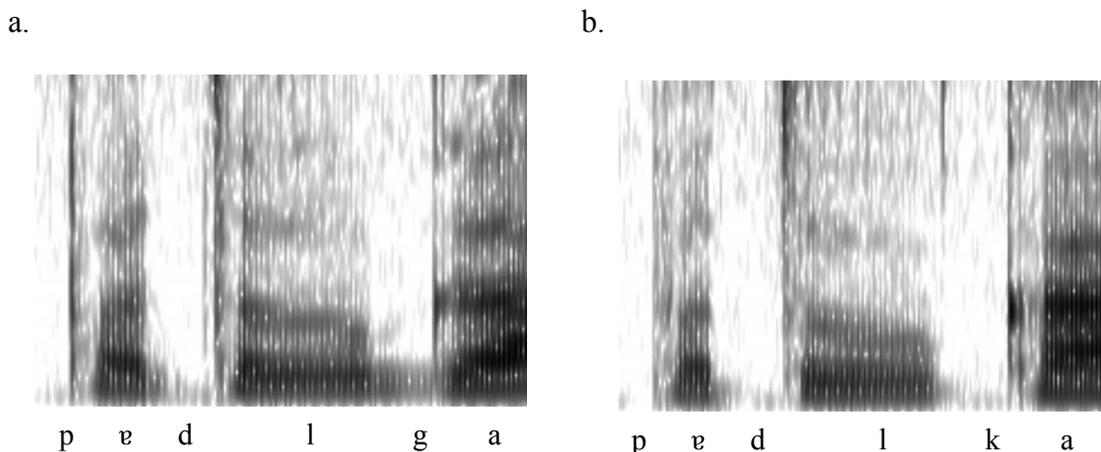


Figure 1: Spectrograms of word-initial [l] before a voiced (a) and voiceless (b) velar.

Sonorants have been said famously not only to devoice, but to be transparent to voicing assimilation in constructions as in (7), giving e.g., [ɛt mzdʲi] and [iz 'm̄tsʲenskə] instead of (7)a-b respectively (Jakobson, 1956; Hayes, 1984; Kiparsky, 1985). This has always been a controversial claim; some sources, such as Shapiro (1993), deny it altogether. Given the facts above, it would be very surprising if this were indeed a phonological rule of Russian. At best we expect it to occur, once again, only gradiently and optionally. Indeed, a phonetic study by Robblee and Burton (1997) examines cases involving liquids, e.g., *s l'dinʲi* 'from (the) ice floe', and finds no evidence of assimilation, though the authors do not rule out the possibility of gradient assimilation.⁶

(7)

- | | | | | |
|----|-----|-----------------|------------------|----------------------|
| a. | i. | /ot mzdɪ/ | [ɛt mzdʲi] | 'from the bribe' |
| | ii. | /ot l'da/ | [ɛt l'da] | 'from the ice' |
| b. | i. | /iz 'm̄tsenska/ | [iz 'm̄tsʲenskə] | 'from/out of Mcensk' |
| | ii. | /iz rta/ | [iz rta] | 'out of the mouth' |

The graph in Figure 2 shows the duration of voicing within Russian [l,r,m] in a context similar to that shown in (7). The data are from recordings of a 20-year-old female student from St. Petersburg, recorded at St. Petersburg University.⁷ The nonce words *lkara*, *rkara*, *mkara* were

recorded in the carrier phrases [on pəlu'tʃil ət __ 'dʲesʲitʲ ru'bʲej] 'He received 10 rubles from __'; and the nonce words *lkarom*, *rkarom*, *mkarom* in the carrier phrase [on nɐ'sol pɛd __ 'dʲesʲitʲ ru'bʲej] 'He found 10 rubles under __'. These carrier phrases put the nonce words in just the environment of preposition + noun seen in (7), half with a preceding [t] and half with a preceding [d]. The boxplots in Figure 8 each represent five tokens. If these data are representative, they suggest that [r] has less closure voicing duration than [l] and [m], and perhaps that there is more devoicing of [m] when [t] precedes compared to [l] and [r].⁸ (Both of these effects are significant at $p < .001$ for this speaker.) However, for our purposes what is more important is that all of these tokens have closure voicing, ranging from 13 to 143 ms. These data are consistent with gradient (phonetic) devoicing, but not categorical (phonological) devoicing.

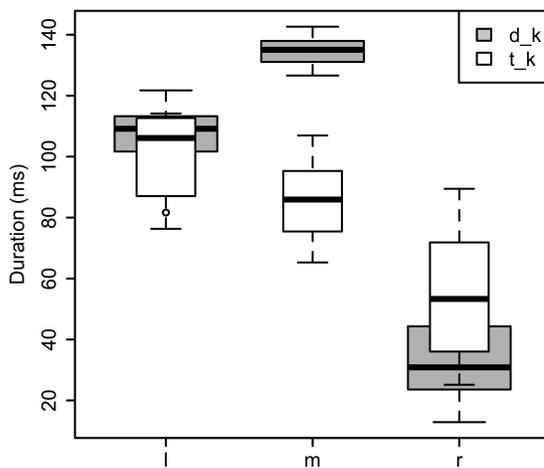


Figure 2: Duration of voicing within Russian [l,r,m] after [t] (white) or [d] (shaded) and before [k], in a context similar to that shown in (7).

If there is no phonological voicing assimilation in *ot mzdʲi* etc., then why do some sources, most notably Jakobson, claim there is? We cannot rule out different dialects or idiolects, of course, but putting this aside, the claim here still allows for optional, gradient assimilation in fast or casual speech. Further, Robblee and Burton (1997) speculate that perhaps listeners perceive assimilation for other reasons: they found that the closure duration of stops in such clusters, one cue to voicing, was neutralized (though not in the way predicted by assimilation!). Perhaps listeners perceive partially neutralized stops as somehow lacking in their own voicing and so 'assimilated'. This explanation cannot extend to fricatives.

It seems likely that voicing effects involving sonorants should be handled by the phonetic component.

4. Voicing across words

The Russian voicing effects provide evidence of significant higher prosodic structure, in particular structure around the level of the prosodic word. First, Gvozdev (1949), Jakobson

(1956), Halle (1959), Vinogradov (1960), and many others assume that one or more prepositions plus the following major category item constitutes something like a phonological word.⁹ This assumption accounts for the lack of final devoicing in prepositions. Compare (8)a and (8)b: word-final voiced obstruents devoice before a following sonorant, unless the word is a preposition. Bracketing now indicates hypothesized prosodic word boundaries.

- (8) a. /ot'kaz 'l'eni/ [ɐt'kas] ['l'enʲi] 'Lena's refusal'
 /sad m'i'xaila/ [sat] [m'i'xailə] 'Mikhail's garden'
 /grob 'rozi/ [grop] ['rozʲi] 'Rosa's grave'
- b. /iz l'en'in'grada/ [iz l'in'in'gradə] 'from Leningrad'
 /pod mo'skvoj/ [pəd məs'kvoj] 'near Moscow'
 /nad 'rozoj/ [nəd 'rozəj] 'above the rosebush'

Voicing assimilation occurs within this same domain, as shown below. The (i) forms in (9) show the preposition-final consonant before sonorants, making clear its underlying voicing.

- (9)
- a. i. /ot 'mami/ [ɐt 'mamʲi] 'from mama'
 ii. /ot 'papi/ [ɐt 'papʲi] 'from papa'
 iii. /ot 'babušk'i/ [ɐd 'babušk'i] 'from grandma'
- b. i. /s mamoj/ ['s maməj] 'with mama'
 ii. /s papoj/ ['s papəj] 'with papa'
 iii. /s babuškoj/ ['z babuškəj] 'with grandma'
- c. i. /pod 'mamoj/ [pəd 'maməj] 'under mama'
 ii. /pod 'papoj/ [pɐt 'papəj] 'under papa'
 iii. /pod 'babuškoj/ [pəd 'babuškəj] 'under grandma'
- d. i. /iz 'mami/ [iz 'mamʲi] 'out of mama'
 ii. /iz 'papi/ [is 'papʲi] 'out of papa'
 iii. /iz 'babušk'i/ [iz 'babušk'i] 'out of grandma'

Things are somewhat different when it comes to enclitics as in (10). Notice, first, that final devoicing applies before these enclitics: /sad/ in (10)a surfaces as [sat] before the interrogative particle [l'i]. As the bracketing suggests, I assume therefore that clitics are not included in the prosodic word-like domain being entertained. (See Halle, 1959 for a similar proposal in terms of boundary symbols.) On the other hand, voicing assimilation applies across enclitic boundaries, as shown in (10)b-c.

(10)	/sok/		/sad/	
a.	[sok] ʎi	'juice (interr.)'	[sat] ʎi	'garden (interr.)'
b.	[sog] zɨ	'juice (emph.)'	[sad] zɨ	'garden (emph.)'
c.	[sok] tə	'juice (topic.)'	[sat] tə	'garden (topic.)'
cf.	[sok-ə]	'juice (gen. sg.)'	[sad-ə]	'garden (gen. sg.)'

All sources agree on the final devoicing facts described above, and on the existence of voicing assimilation within the ‘prosodic word’ (that is, involving prepositions). A phonetic study by Burton and Robblee (1997) supports the latter. Nearly all sources describe voicing assimilation across the enclitic boundary as well, as shown in (10)b-c.¹⁰

Things are less clear regarding voicing assimilation across major category words.¹¹ Here many sources either explicitly deny it ever occurs (Isacenko, 1947), though this is incorrect, or state that it occurs optionally and/or gradiently (Isacenko, 1955; Halle, 1959; Baranovskaia, 1968; Shapiro, 1993).¹² Avanesov (1972), a work notable for its degree of phonetic detail (though also for its normative intentions), does not mention assimilation across major category word boundaries at all. In text he transcribes, assimilation is never indicated in this context, e.g. [stʃi'kajit] [doʃʃi:] 'rain flows down', [pʲi'sok] [gɐ'rʲutʃʲij] 'inflammable sand', while assimilation is always transcribed within a prosodic word, e.g., [ɐd 'znoju] 'from (the) intense heat', from /ot 'znoju/, [pɐt 'svodəm] 'under (the) arch', from /pod svodom/. (All examples p.363.) On the other hand, phonetic studies by Paufoshima and Agaronov (1971) and Wells (1987) find assimilation across such boundaries in most instances. Even here, though, the results are not uniform, with failure to assimilate, and partial assimilation, occasionally occurring.

A conservative position, therefore, would be *phonological* voicing assimilation applies within prosodic words but not across them. Though further phonetic study is warranted, the evidence suggests that when assimilation happens across words, it happens gradiently.

This section and the last have argued that Russian voicing effects that occur across major category word boundaries, and those involving sonorants, should not be handled by the phonology, because they do not apply categorically. A shadow may be cast over this attempt to distinguish the categorical vs. the gradient by the observation that Russian final obstruent devoicing – treated as categorical here – is phonetically incomplete (Dmitrieva, 2005). Dmitrieva’s careful phonetic study finds that underlyingly voiced obstruents in (largely) monosyllables like /zub/ 'tooth' show vestiges of their voicing in their surface pronunciations. This finding mirrors results for other languages having final obstruent devoicing, including Polish, German, and Catalan. (See Dmitrieva for an overview of the literature.) Given this fact, can even final obstruent devoicing be called categorical?

In fact, the gradient effects discussed above and incomplete obstruent devoicing are fundamentally different. Sonorant devoicing, for example, ranges from full to nonexistent, depending on rate/style of speech, phonetic context, etc. Crucially, it can fail to occur at all. On

the other hand, obstruent devoicing cannot fail (putting aside deliberate spelling pronunciations). In fact, incomplete obstruent devoicing is subtle enough that it has become widely acknowledged over the last decades only due to instrumental phonetic techniques. For her Russian subjects that had no exposure to English (an important control, since English obviously lacks final devoicing), Dmitrieva found differences between pairs like /zub/ and /sup/ based on two measurements of the final consonant: duration of the closure, and duration of the release.

As some have argued, the existence of incomplete neutralization may require an approach in which phonology is not seen as derivationally prior to phonetics, or as different from phonetics as is widely assumed (see recent discussion and references in Gafos, 2006; Yu, 2007). However, even in Gafos's (2006) dynamical systems approach to phonology, obstruent devoicing patterns as in Russian are handled by means of 'macroscopic parameters' controlling 'qualitatively distinct modes of the voicing system' (p. 58), while incomplete neutralization results from the (parallel) interaction of these stable parameters with a scalar variable denoting 'intentional strength' (representing an intention of producing the underlying voicing). At the end of the day, any approach to phonology must represent the difference between 'stable', categorical patterns and those that are more 'scalar' or gradient.

5. The prosody of Russian voicing assimilation

5.1 Higher prosodic structure

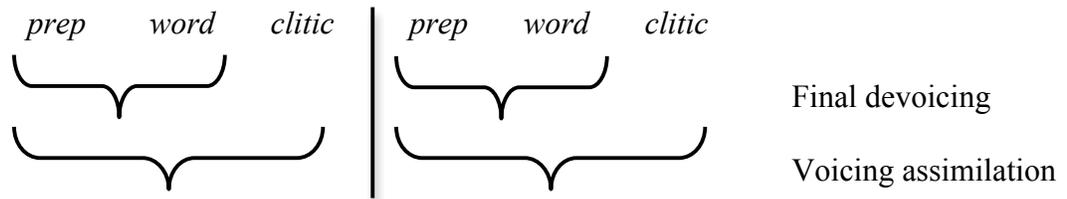
In order to capture the special behavior of enclitics, Padgett (2002) called on a clitic group domain, assuming it encompassed a prosodic word (as described above) and additional enclitics, e.g., [[sat]_{Pwd} l'i]_{CG} 'garden (interr.)', from /sad l'i/, [[is kard]_{Pwd} z'i]_{CG} 'from the maps (emph.)', from /iz kart z'e/. (See Nespor & Vogel, 1986; Hayes, 1989 on a distinction between prosodic word and clitic group.) The domain of voicing assimilation was argued to be the clitic group, while devoicing occurred at the end of a prosodic word. There is independent evidence for excluding enclitics from prosodic words in Russian: prepositions form part of the word stress domain, sometimes receiving the stress themselves (Gvozdev, 1949; Jakobson, 1956), e.g., [p'od ruku] 'by the arm' (compare [pəd ru'koj] 'at hand'). Enclitics are never stressed, and have no effect on stress.

Though the prosodic distinctions outlined above are well motivated, recent work on the prosodic hierarchy questions making a distinction between categories like prosodic word and clitic group. In a very general study of higher prosodic categories and relations, Ito and Mester (2007, 2009) argue that such distinctions are both too rich and too poor. (See also Selkirk, to appear.) They are too rich in that they imply a seemingly limitless and inconsistent inventory of prosodic categories; they are too poor in nevertheless providing too little structure to account for facts. To handle prosodic word-like facts, Ito and Mester argue for only one prosodic word-like category; following Ito and Mester I will label this category 'ω'. However, they also argue that prosodic categories like ω can form recursive structures having maximal and minimal projections, ω_{Max} and ω_{Min}. Crucially, phonological processes can make reference to ω_{Max} or ω_{Min}. They may also refer to ω, encompassing ω_{Max}, ω_{Min}, and any intermediate projections of ω. Importantly, there is

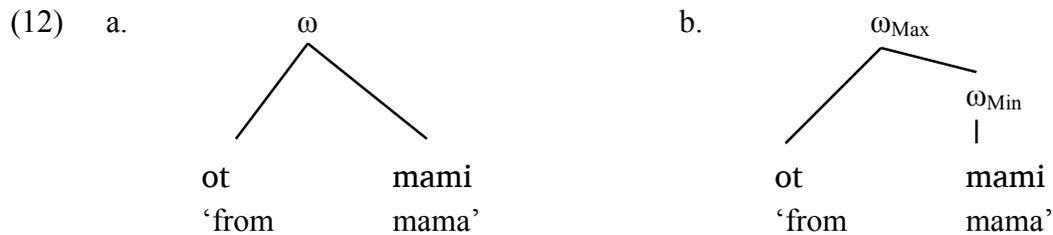
no way to refer to intermediate projections exclusively. Let us consider the Russian facts within this framework.

The diagram in (11) recapitulates the facts to be explained. Prepositions together with a following open class word form a domain of final devoicing; that is, devoicing occurs at the end of this domain. This domain and a following clitic form a larger voicing assimilation domain. Voicing assimilation (at least as a categorical rule) does not apply across the boundary of this larger domain.

(11) Prosodic domains of Russian voicing

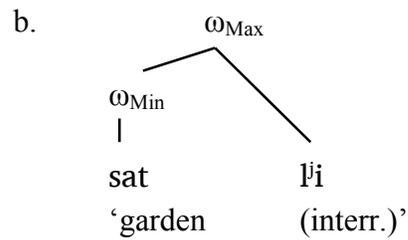
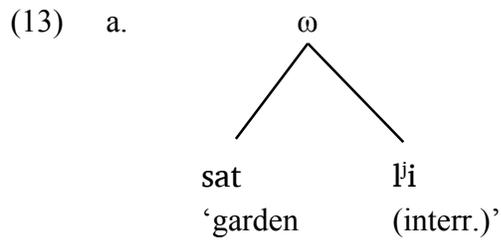


Further evidence for the smaller ω domain, as noted above, is its status as the domain of word stress. Prepositions cannot be ω themselves, because they do not bear stress independent of a following open-class item and because they do not devoice finally. However, these facts still leave the two possibilities shown in (12) for incorporating a preposition into ω : simple incorporation (as in (a)), or adjunction (as in (b)).

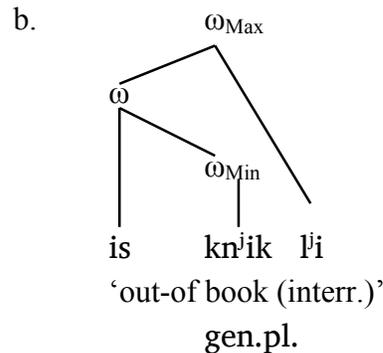
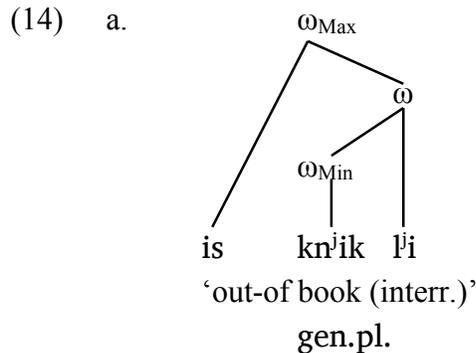


There is reason to favor (12)b for Russian. Though prepositions group with following words for the purposes of stress and voicing assimilation, they are arguably ‘aloof’ in other respects. First, some researchers claim that prepositions are separated from what follows by a syllable boundary, even when the sequence in question would form a fine onset. (This fact is relevant to the analysis of voicing assimilation in the next section.) Second, though adjacent consonants assimilate in secondary palatalization within words, they can fail to do so across the preposition-word boundary. (See Darden, 1971; Avanesov, 1972 on both points.) For just these reasons Zubritskaya (1995) treats prepositions as adjoined to the prosodic word as in (12)b. Gribanova (2010) presents further arguments for this structure for Russian prefix-verb stem complexes, which behave identically to preposition-word complexes in many respects.¹³

Turning to enclitics, the structure for *sat li* ‘garden (interrogative)’ cannot be (13)a. The reason, recall, is that final devoicing applies to *sat* (underlying /sad/) in such cases. For this to happen the /d/ must be ω -final. A structure such as (13)b would capture this difference in a way parallel to the clitic group idea.



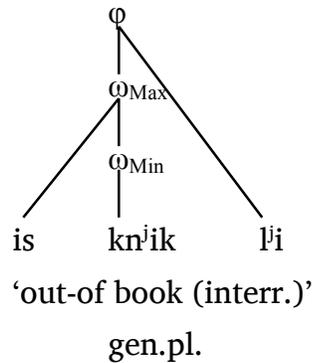
There is a problem with (13)b as well, however. Consider sequences containing both a preposition and an enclitic particle, assuming the enclitics are indeed part of ω as in (13)b. Since both kinds of clitic must adjoin, we might entertain either of (14)a-b for a phrase like /iz knʲik li/ ‘out of the books (interr.)’. We can immediately rule out (14)a: it does not capture the prosodic unity of the preposition-plus-following-word, e.g., the fact that this grouping constitutes the domain of stress.



The problem is that (14)b also fails to capture this grouping adequately. Though [is knʲik] ω is indeed a prosodic word in (14)b, there is no way within Ito and Mester’s theory to single out this intermediate ω domain *uniquely*. If ω is a stress domain, then ω_{Max} must be a stress domain; but this is not the desired prediction.

I therefore follow Gouskova (2009), who argues that enclitics are incorporated directly into the phonological *phrase* (notated as ‘ φ ’):

(15)



We can now generate the Russian voicing facts by assuming that devoicing is final in the prosodic word, and, following Gouskova, that voicing assimilation is blocked only by the *left* edge of a prosodic word ω . In our terms here it is specifically the onset of the *maximal* prosodic word ω_{Max} that blocks assimilation. (Compare Ito and Mester’s to-appear-a appeal to the onset of ω_{Max} to explain the intricate facts of *r*-sandhi in English dialects.)

The larger conclusion, following up on sections 3 and 4, is the following: voicing assimilation, as a rule of the phonology proper, affects only strings of strictly contiguous obstruents, so long as they are not separated by the left edge of ω_{Max} ; devoicing affects only obstruents that are final in the prosodic word.¹⁴

5.2 Lower prosodic structure

As foreshadowed in the introduction, an important theme in the analysis of Russian voicing below has to do with the importance, on the one hand, and the limitations, on the other, of prosody in understanding the facts. Higher-level prosody matters for reasons discussed in the previous section. However, the role of lower-level prosody – namely, the syllable – is called into question. In particular, an analysis of the triggers and targets of Russian voicing processes can only be understood within a cue-based approach of the sort argued for by Steriade (1997). The account below will call on constraints that are grounded in both perception and articulation, but it is the role of perception that will be of greater interest.

The approach to perceptual distinctiveness pursued here relies on the notion of positional faithfulness (Selkirk, 1994; Beckman, 1997, 1998). According to positional faithfulness theory, one of the positions that is privileged for the purposes of faithfulness is the syllable onset position (and see related earlier work on onset versus coda licensing, especially Itô, 1989; Goldsmith, 1990). We might therefore distinguish between a plain IDENT(VOICE) constraint and a higher-ranking one relativized to onset position (as in Lombardi, 1999), and account for the leftward direction of voice assimilation in, e.g., /ot 'brosʲitʲ/ → [ɐd 'brosʲitʲ], by this means.

There is a problem, however. As Pilch (1967) and especially Darden (1991) show, in Russian it is not onset position, but rather position before a sonorant that retains underlying voice. First, obstruent clusters must agree in voicing even when all obstruents are in the syllable onset, as shown in (16)a. When onset clusters are derived due to cliticization of monosegmental

prepositions like /k/ and /v/, as in (16)b, regressive assimilation occurs. Yet according to the view that onset position licenses distinctive voicing, words like *[kdʲe] should be fine.

- | | | | | | |
|------|----|----------------|--------------|-----------------|--------------|
| (16) | a. | gdʲe | 'where' | cf. | *kdʲe, gtʲe |
| | | kto | 'who' | | *kdo, gto |
| | b. | kʲ i'vanu | 'to Ivan' | vʲ i'vanʲi | 'in Ivan' |
| | | k tʃilʲe'vʲeku | 'to the man' | f tʃilʲe'vʲekʲi | 'in the man' |
| | | 'g dʲimʲi | 'to Dima' | 'v dʲimʲi | 'in Dima' |

Second, obstruent voicing in fact contrasts in coda position, so long as a sonorant follows. This can be seen in two ways. First, though onsets are usually argued to maximize within morphemes, this is not true across the prefix-stem boundary, which instead coincides with a syllable boundary, as we saw earlier. The forms in (17)a-b, involving the prefixes /ot-/ and /pod-/, are therefore syllabified at the morpheme boundary. Second, words having final obstruent-sonorant sequences, as in (17)c-d, preserve the underlying voicing of the obstruent. These words are monosyllabic in the literary language (Zalizniak, 1975), and the obstruents are therefore codas.¹⁵

- (17)
- | | | | | |
|----|-----|----------------|----------------|--------------------------|
| a. | i. | /pod-'jexatʲ/ | [pəd-'jexətʲ] | 'to approach by vehicle' |
| | ii. | /pod-nʲe'stʲi/ | [pəd-nʲi'stʲi] | 'to bring (up to)' |
| b. | i. | /ot-'jexatʲ/ | [ət-'jexətʲ] | 'to ride off' |
| | ii. | /ot-nʲe'stʲi/ | [ət-nʲi'stʲi] | 'to carry away' |
| c. | i. | /zʲɪznʲ/ | [zʲɪznʲ] | 'life' |
| | ii. | /pʲesnʲ/ | [pʲesnʲ] | 'song' |
| d. | i. | /te'atr/ | [tʲi'atr] | 'theater' |
| | ii. | /kadr/ | [kadr] | 'film sequence' |

Padgett (1995) argues that the feature [release], and not onset position, is the relevant notion of salience, for assimilation of place, as well as assimilation of voicing as in Russian. 'Release' is understood in that work to include both a burst, for consonants having one, and the following moments of consonantal offset which contain formant transitions, information on voice onset time, and other phonetic cues. The use of [release] in phonology is motivated by Selkirk (1982), Kingston (1990), and especially Steriade (1993, 1994). It is motivated also, though less directly, by Lombardi (1991, 1999), Cho (1990), and Rubach (1996); the latter two single out 'pre-obstruent' as a weak position for voice. Padgett (1995) assumes, first, that obstruents are universally [+release] before tautosyllabic sonorants (adapting the view of Lombardi), and second, that they are [+release] word-finally in some languages (in order to capture the common resistance to neutralization in specifically word-final codas).

Steriade (1997) reviews the evidence from Pilch (1967) and Darden (1991) on Russian, noting the problems with referring to syllable position. She further shows that syllable structure fails to predict patterns of voicing neutralization in a range of other languages. Other work, including Rubach (1996), Kenstowicz, Abu-Mansour, and Törkenczy (to appear), Petrova, Plapp, Ringen, and Szentgyörgyi (2001), and Wetzels and Mascaró (2001), extends this conclusion to still more languages. Steriade argues for a more articulated hierarchy of positions based on direct reference to the number and quality of phonetic cues to the obstruent voicing contrast. In this hierarchy, it is position before a sonorant, whether tautosyllabic or not, that is most perceptually privileged. On the other hand, neutralization is most likely before an obstruent. Word-final neutralization takes an intermediate position. Thus the three-way positional distinction suggested in Padgett (1995), minus the reference to syllable position, follows from a direct appeal to the relevant cues: burst properties and voice onset time are best perceived during the modal voicing of a following sonorant; pre-obstruent obstruents lack voice onset time cues, and are the most likely to lose burst cues as well, due to a following potentially overlapping obstruent. Steriade presents her account in terms of a hierarchy of markedness constraints penalizing voicing in the relevant contexts. I recast this idea in terms of positional faithfulness, assuming the constraint schema shown in (18), and the universal ranking in (19). ('PS' and 'PO' mean 'pre-sonorant' and 'pre-obstruent'.) In Russian it is only the distinction between $IDENT_{PS}$ and $IDENT$ in other contexts that is relevant, so I collapse $IDENT_{WF}$ and $IDENT_{PO}$ into $IDENT$ in what follows. Note the stipulation that 'pre-sonorant' must involve a sonorant in the same maximal prosodic word.¹⁶

(18) $IDENT_{CUE}(VOICE)$ An output obstruent of cue strength X or higher, and its input correspondent, have identical values for the feature [voice].

Cue strengths PS (before a sonorant in the same ω_{Max}) >
 WF (ω -final) >
 PO (pre-obstruent)

(19) $IDENT_{PS}(VOICE) \gg IDENT_{WF}(VOICE) \gg IDENT_{PO}(VOICE)$

6. The account

Our perceptually motivated constraints need to be supplemented with one rooted in articulatory difficulty. The basic facts involving articulatory difficulty and voicing are well known. Voiced obstruents are disfavored in comparison to their voiceless counterparts for aerodynamic reasons: it is difficult to maintain voicing given the build-up in supraglottal pressure that obstruents entail (Jaeger, 1978; Ohala, 1983; Westbury & Keating, 1986). The constraint *D below captures this aspect of the voicing facts.

The account then proceeds as follows. First, final devoicing results from the interaction of positional privilege and the general prohibition on voiced obstruents *D, following Steriade (1997) and Lombardi (1999). This is shown in (20) below for the word /god/ 'year'. A comparison of (20)a-b shows that *D dominates $IDENT(VOICE)$. In pre-sonorant positions, on the other hand, the voicing contrast is maintained. Hence $IDENT_{PS}(VOICE)$ must dominate *D, as the comparison between (20)b-c makes clear.

(20)

Input: /god/	Ident _{PS}	*D	Ident
a. god		**!	
b. god got		*	*
c. kot	*!		**

Voicing assimilation requires the addition of a constraint favoring assimilation. The constraint proposed below says nothing about directionality of assimilation, since this follows precisely from the positional faithfulness constraints. The formulation of the constraint follows Bakovic (2000) and references therein. Like the SPREAD constraints of Padgett (1995) and Walker (1998) (and unlike alignment constraints), it does not build in directionality of assimilation.¹⁷

(21) AGREE(VOICE) Adjacent obstruents agree in [voice] specification.

As Lombardi (1999) and Steriade (1997) do, I assume that the constraint targets obstruents in particular. It would be better to derive the difference between sonorants and obstruents from independent considerations (compare the use of underspecification in Kiparsky 1995), but this would require more discussion than is feasible here.

AGREE(VOICE) must dominate *D, because assimilation of voicing creates voiced obstruents; it must also dominate IDENT, since assimilation overrides underlying [voice] specifications. The two tableaux below derive [kto] 'who' and [gd^je] 'where'. As shown, even if we specify the initial consonant for the wrong value underlyingly (as richness of the base implies must be possible), it will surface as required. The result of undominated IDENT_{PS} and AGREE is clear: the underlying voicing specification of a pre-sonorant obstruent must be preserved, and any preceding obstruent must agree with this specification.

(22) i)

Input: /gto/	Ident _{PS}	Agree	*D	Ident
a. gto		*!	*	
b. gto kto				*
c. gdo	*!		**	*

ii)

Input: /kd ^j e/	Ident _{PS}	Agree	*D	Ident
a. kd ^j e		*!	*	
b. kd^je gd ^j e			**	*
c. kt ^j e	*!			*

Given all of the above, we have the overall ranking shown below.

(23) IDENT_{PS}, AGREE >> *D >> IDENT

Tableau (24) shows why devoicing of entire clusters occurs in forms like /'pojezd/ 'train'.

(24)

Input: /'pojezd/	Ident _{PS}	Agree	*D	Ident
a. 'pojizd			*!*	
b. 'pojist				**
c. 'pojizt		*!	*	*

The final element in the account involves the larger prosodic domains of final devoicing and voice assimilation. Tableaux (25)i-iii compare what happens to an underlying voiced obstruent when it surfaces before a sonorant within a prosodic word (i) versus across a prosodic word boundary (ii-iii). (Recall that (25)iii involves an enclitic that is outside of the prosodic word.) Because IDENT_{PS} applies only when the following sonorant is contained within the same ω_{Max} as the target obstruent, it is in force for the final [z] of the preposition [iz] (and the final [d] of [l'in'in'gradə]) in (25)i but not for the final obstruents of [et'kas] or [sat] in (25)ii-iii. Therefore final obstruents in prepositions do not devoice, while those ending major class words do, even when they precede an enclitic as in (25)iii.

(25) i)

Input: /iz l'in'in'gradə/	Ident _{PS}	Agree	*D	Ident
a. [iz l'in'in'gradə] _ω			***	
b. [is l'in'in'gradə] _ω	*!		**	*

ii)

Input: /ot'kaz l'eni/	Ident _{PS}	Agree	*D	Ident
a. [et'kaz] _ω [l'en ^ɤ i] _ω			*!	
b. [et'kas] _ω [l'en ^ɤ i] _ω				*

iii)

Input: /sad l'i/	Ident _{PS}	Agree	*D	Ident
a. [sad] _ω l'i			*!	
b. [sat] _ω l'i				*

However, more must be said in order to capture voicing assimilation to enclitics while blocking it across prosodic words. As (27)i shows, the account so far does correctly predict assimilation to enclitics. We need a means of ruling out assimilation in (27)ii. As indicated above, I follow Gouskova (2009) in assuming that assimilation is blocked specifically by the left edge of a

maximal prosodic word. (In order to allow assimilation between a word and a preposition, this must be specifically a *maximal* prosodic word.) I adapt Gouskova’s NOSTRADDLING constraint for this purpose, shown below. The constraint, which depends on an understanding of assimilation as feature linking (as opposed to copying) is given rather informally here. See Gouskova for more formal treatment.

- (26) NOSTRADDLING A [voice] specification cannot be linked to segments separated by a ω_{Max} boundary.

Crucially, NOSTRADDLING is vacuously satisfied in (27)i. This is because, recall, enclitics are argued to be incorporated directly into the phonological phrase. They are neither prosodic words themselves nor incorporated into prosodic words. On the other hand, NOSTRADDLING prevents assimilation in (27)ii.

- (27) i)

Input: /sok zɛ/	NoStraddling	Ident _{PS}	Agree	*D	Ident
a. [sok] _ω zɛ̣			*!	*	
b. ☞ [sog] _ω zɛ̣				**	*

- ii)

Input: /sok zɪnʲi/	NoStraddling	Ident _{PS}	Agree	*D	Ident
a. ☞ [sok] _ω [zɪnʲi] _ω			*	*	
b. [sog] _ω [zɪnʲi] _ω	*!			**	*

7. Conclusion

One goal of this paper has been to clarify, as much as possible, the facts of Russian voicing, especially with regard to prosodic structure and the behavior of sonorants. Attention to the difference between obligatory, categorical rules versus variable, gradient ones reveals, first, that sonorants do not participate in Russian voicing processes as obstruents do. It also reveals an important divide between assimilation between prosodic words and assimilation among more prosodically ‘close’ elements; only the latter apply regularly and categorically. I have argued, building on previous work, that lower-level prosody, in particular syllable-based prosody, cannot help us explain the conditions under which voicing assimilation and devoicing apply; rather, we must call on a cue-based analysis for this, one that is oblivious to syllabic constituency. On the other hand, the voicing facts provide strong arguments for higher-level prosodic structure. Working within Ito and Mester’s (2007, 2009) framework, I have argued that devoicing affects prosodic word-final consonants. Voicing assimilation applies within prosodic words and even across right ω boundaries (in the case of clitics). However, it is blocked by the left boundary of a maximal prosodic word. The special status of the left boundary of ω_{Max} echoes the findings of Ito and Mester for independent facts.

Notes

1 I am very grateful to Shigeto Kawahara, Rachel Walker, and an anonymous reviewer for comments that improved this paper.

2 Some of the ideas in this paper first appeared in Padgett (2002). Another goal of that paper was to analyze the controversial and interesting behavior of Russian [v] in the voicing facts. That large issue is left aside here.

3 Surface forms reflect rules of vowel reduction. Palatalization is treated as underlying in all cases, though nothing hinges on this.

4 Gradient processes by definition might apply fully, partially, or not at all, depending on matters like phonetic context and rate of speech. Such processes are 'optional' in the sense of having failure to apply as an endpoint in their gradient range of behavior. It is only in this sense that I refer to optionality in what follows.

5 Final devoicing is suggested for [r] most often (Isacenko, 1947; Boyanus, 1955), but it is still by no means necessary.

6 Hayes (1984) and Kiparsky (1985) report that whether assimilation occurs in clusters like these depends on whether the intervening sonorant is rendered syllabic. If so, then assimilation is blocked; otherwise it occurs. However, it seems the sources cited have been misunderstood on this point. Jakobson (1978) mentions a 'stylistic option' by which these sonorants can be pronounced as syllabic, but says nothing about whether assimilation then occurs. He cites Reformatskii (1971) on the existence of syllabic sonorants in Russian. Though Reformatskii argues that syllabic sonorants occur under certain conditions, the conditions stated do not include sonorants in phrases like *ot mzdʲi*, nor does Reformatskii even mention such phrases. There seems to be no clear evidence, therefore, that sonorant syllabicity is an important factor here. It is worth mentioning that Robblee and Burton threw out data in which the sonorant seemed to be syllabic (1997, footnote 7). Therefore the sonorants they analyzed were deemed to be non-syllabic, and yet these are just the sonorants that should allow assimilation to propagate through them, according to the claim entertained in this note.

7 I am very grateful to Evgenia Altukhova for carrying out the recordings for me.

8 Duration of voicing was measured, not duration relative to closure, due to the difficulty of establishing segment boundaries. Since [r] may be shorter than [l] or [m], the lower voicing values for [r] do not imply devoicing.

9 Certain prepositions count as prosodic words themselves, e.g., *skvozʲ* 'through', similar to English prepositions like 'between'. Note that Kiparsky (1985) treats prepositions as generated within the lexical phonology, since for the purposes of voicing they pattern as part of the word. As an alternative to a prosodic word-based approach, however, this cannot be correct, since they are in every way syntactic prepositions: the word to which they attach can be anything noun-phrase initial, whether a noun, adjective, adverb, or something else, e.g., [*ot otʃenʲ*]_{Pwd} *bolʲšovo slona* '[from (the) very] large elephant', where the word 'very' hosts the preposition. Hence the need for the prosodic word. A similar conclusion seems likely in the case of at least some enclitics, which Kiparsky also generates within the lexical phonology.

10 One exception is Baranovskaia (1968), who claims that whether assimilation occurs here depends on the position of stress in the major category word, with diminishing likelihood the farther it is away, e.g., /oʲtʲets bi/ 'father (subjunctive)' (assimilation most likely), /bratʲets bi/

'brother (dim.) (subj.)', and /'lʲenʲinʲɛts bi/ 'Leninist (subj.)' (assimilation least likely). She also states that longer clusters, as in /tʲɛkst zɛ/, do not assimilate fully.

¹¹ It should be borne in mind that, given final devoicing, examples involving a voiceless consonant before another voiceless one are not evidence for assimilation across prosodic word boundaries. Final devoicing would predict, for example, [ˈgɔrət] [tɐˈkoj] 'such a town', from /ˈgorod taˈkoj/, whether assimilation occurs or not. This point is sometimes overlooked.

¹² See note 15, p.64 of Halle (1959). Jakobson (1956) cites many examples exemplifying assimilation across words, but also notes (p.507) that assimilation can fail, giving the example [mʲiˈdvʲetʲ] [ˈgɔlədʲin] '(the) bear (is) hungry'.

¹³ On the other hand, Gribanova argues that prepositions (unlike prefixes) are (at least often) adjoined not to a following ω but to a following phonological phrase. This claim is based on some differences in the behavior of *jer* realization in prepositions compared to prefixes. I leave the resolution of this issue to future research.

¹⁴ There are apparent cross-word assimilation facts that appear to threaten the generalization that assimilation is delimited by the ω_{Max} boundary. For example, Wells (1987), who conducted a phonetic study of verbal collocations, suggests that assimilation is more likely as the verb becomes more semantically 'empty', e.g. [ˈbudʲid ˈdɔktərəm] 'will be (a) doctor', from /ˈbudʲet/ 'will be', contrast [prʲivʲrɐˈfʲːajit ˈdɔktər] '(the) doctor converts'. Wells and other works suggest that the likelihood of assimilation also depends on the syntactic boundary involved, and on the closeness of 'contact' between the relevant words, e.g., [knʲazʲ bɐˈrʲis] 'Prince Boris', where assimilation is more likely (Halle, 1959). However, these observations about semantic 'emptiness' and 'closeness' might be interpreted to mean that such phrases in fact have the status of single maximal prosodic words, i.e., [ˈbudʲid ˈdɔkətʲrəm] ω_{Max} , [knʲazʲ bɐˈrʲis] ω_{Max} .

¹⁵ Pilch (1967) assumes that word-medial obstruent-sonorant clusters are heterosyllabic even when no prefix-stem boundary is involved, e.g., [ˈskorb.nij] 'sorrowful', [ɐd.ˈno] 'one (neut.)'. Steriade (1997) follows him in this, citing this as further evidence against the syllabic approach to voice neutralization, since here the voicing contrast is maintained also. However, most Russian sources claim that onsets are maximized in such cases, i.e., [ˈskor.bnij], [ɐ.ˈdno]. (Bondarko, 1998 provides an overview of positions on this question.) In general there is little evidence bearing on the syllabification of stem-internal clusters in Russian.

¹⁶ The phrase 'or higher' and reference to 'cue strength' are intended to make the hierarchy in (19) an 'inclusion hierarchy'. Thus, violation of one IDENT constraint entails violation of the lower ranking ones. I assume (as Steriade 1997 does) that it is ultimately cue strength, rather than environment per se, that matters. The latter can appear formally very arbitrary.

¹⁷ It is simpler to evaluate violations of AGREE than of SPREAD: the former assesses a violation for every pair of segments that disagree in (or do not share) the relevant feature, while the autosegmentally-oriented latter assesses one for every feature(F)-segment(S) pair such that F is not linked to (S); the constraints seem to have equivalent effects for the cases discussed here.

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