Russian voicing assimilation, final devoicing, and the problem of [v] (*or*, The mouse that squeaked)*

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"...the Standard Russian V...occupies an obviously intermediate position between the obstruents and the sonorants."
Jakobson (1978)

1. Introduction

Like the mouse that roared, the Russian consonant [v] has a status in phonology out of proportion to its size. Besides leaving a trail of special descriptive comments, this segment has played a key role in discussions about abstractness in phonology, about the manner in which long-distance spreading occurs, and about the the larger organization of phonology. This is largely because of the odd behavior of [v] with respect to final devoicing and voicing assimilation in Russian. Russian obstruents devoice word-finally, as in *kniga* 'book (nom. sg.) vs. *knik* (gen. pl.), and assimilate to the voicing of a following obstruent, *gorodok* 'town (nom. sg.)' vs. *gorotka* (gen. sg.). The role of [v] in this scenario is puzzling: like an obstruent, it devoices word-finally, *krovi* 'blood (gen. sg.)' vs. *krof*^{j} (nom. sg.), and undergoes voicing assimilation, *lavok* 'bench (gen. pl.)' vs. *lafka* (nom. sg.). But like a sonorant, it does not trigger voicing assimilation: compare *dver*^{j} 'door' and *tver*^{j} 'Tver' (a town). As we will see, [v] behaves unusually in other ways as well.

Why is Russian [v] special in this way? The best-known answer to this question posits that [v] is underlyingly /w/ and therefore behaves as a sonorant with respect to voicing assimilation (Lightner 1965, Daniels 1972, Coats and Harshenin 1971, Hayes 1984, Kiparsky 1985). Crucial to this account is the claim that all sonorants in fact undergo assimilation and final devoicing. A relatively late rule obstruentizes [w], accounting for its surface obstruency. This is a classic example of derivational opacity, and one that has not been adequately addressed in the framework of Optimality Theory. In spite of the great elegance of the derivational account, I will argue for a different view: Russian [v] is in fact more sonorous at the surface than any other Russian obstruent—though it is not a glide—and all of its unusual properties can be plausibly explained by considering in greater detail the phonetic properties of such a sound. Independent evidence for these claims comes from phonetic studies of [v], and from typological considerations. It follows that no serial ordering of rules or processes is required in order to explain the behavior of this sound; there is no need to call on any intermediate representation at which [v] is [w] or anything else. The account therefore bears on the general question of whether this sort of derivationality and abstractness are necessary to phonology.

The second implication of this paper concerns the theory of contrastiveness in phonology: the account here rests on an assumption that phonology can call on featural distinctions that are rarely or never contrastive, and in doing this follows a growing body of work, including Browman and Goldstein (1986) et seq., Steriade (1994), Steriade (2000), Kirchner (1997), Kirchner (2001), Flemming (1995b), Flemming (2001), Boersma (1997), Zhang (2000), and Ní Chiosáin and Padgett (2001), and references therein. An important implication of these works is that potential contrasts must be determined not by the inventory of phonological features, but by output constraints.

This article is also of interest for its account of voicing assimilation and final devoicing. First, I attempt to clarify the relevant facts, which have not been consistently reported. I then offer an account calling on positional faithfulness Selkirk (1994), Beckman (1997), Beckman (1998), but in which the privileged positions are cue-based, following especially Steriade (1997). It turns out that the cue-based approach is crucial to understanding the special behavior of [v].

2. The facts

2.1 Basics

The basic facts of Russian voicing assimilation have been well described (Avanesov 1956, Jakobson 1956, Halle 1959, among many others). The best known treatments of them in the recent generative tradition are Hayes (1984) and Kiparsky (1985). Obstruents devoice word-finally, as shown below.[1]

(1)	sled-a	slet	'track (gen./nom.sg.)'	knig-a	knik	'book (nom.sg./gen.pl.)'
	raz-a	ras	'occasion (gen./nom.sg.)'	gub-a	gup	'lip (nom.sg./gen.pl.)'
	pʲaʒ-a	pʲaʃ	'beach (gen./nom.sg.)"			

In addition, obstruent clusters within a word invariably agree in voicing, with the rightmost obstruent determining the voicing status of the cluster, as shown in (2). The examples in (2)a-c show prefixes ending in underlyingly voiceless obstruents, while (2)d-f show prefixes with underlyingly voiced consonants. The underlying status of the consonants is clear from their behavior before sonorants ((2)a and d).

(2)	a.	ot-jexatʲ	'to ride off'	s-jexatʲ	'to ride down'
	b.	ot-stupitʲ	'to step back'	s-prositʲ	'to ask'
	c.	od-brositʲ	'to throw aside'	z-delatʲ	'to do'
	d.	pod-nesti	'to bring (to)'	iz-lagatʲ	'to state; set forth'
	e.	pot-pisatʲ	'to sign'	is-kʲutʃatʲ	'to exclude; dismiss'
	f.	pod-ʒetʃ	'to set fire to'	iz-gnatʲ	'to drive out'

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

(3)	pojezd-a	pojest	'train (gen./nom.sg.)'
	vizg-a	visk	'squeal (gen./nom.sg.)'
	izb-a	isp	'hut (nom.sg./gen.pl.)'

In the next two sections I establish more precisely the conditions under which voicing assimilation and final devoicing apply. 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 one can rather clearly

distinguish facts that are both obligatory and categorical from others that are optional and gradient. My goal will be to account for only the former, since the latter are better handled by models of phonetic implementation. (In taking this position on gradient effects I follow Liberman and Pierrehumbert 1984, Keating 1988, Cohn 1990, Zsiga 1993, and many others.) Some of these conclusions will turn out to affect significantly our approach to [v].[2]

2.2 The prosodic domain of voicing effects

Final devoicing occurs at the end of a phonological word (Pwd). Following Gvozdev (1949), Jakobson (1956), Halle (1959), Vinogradov (1960), and many others, I assume that one or more prepositions plus the following major category item constitutes a phonological word.[3] These (uncontroversial) assumptions account for the lack of final devoicing in prepositions. Compare (4)a and (4)b: word-final voiced obstruents devoice before a following sonorant, unless the word is a preposition. Bracketing indicates Pwd boundaries.

(4)	a.	/otkaz lenʲ/	[otkas] [lenʲ]	'Lena's refusal'
		/sad mixaila/	[sat] [mixaila]	'Mikhail's garden'
		/grob rozʲ/	[grop] [rozʲ]	'Rosa's grave'
	b.	/iz leningrada/	[iz leningrada]	'from Leningrad'
		/pod moskvoj/	[pod moskvoj]	'near Moscow'
		/nad rozoj/	[nad rozoj]	'above the rosebush'

Voicing assimilation occurs within the Pwd, as shown below. The forms in (5)a and (5)e show the preposition-final consonant before sonorants, making clear its underlying voicing.

(5)	a.	[ot mamʲ]	'from mama'	[s mamoj]	'with mama'
	b.	[ot papʲ]	'from papa'	[s papoj]	'with papa'
	c.	[od babuʃki]	'from grandma'	[z babuʃkoj]	'with grandma'
	e.	[pod mamoj]	'under mama'	[iz mamʲ]	'out of mama'
	f.	[pot papoj]	'under papa'	[is papʲ]	'out of papa'
	g.	[pod babuʃkoj]	'under grandma'	[iz babuʃki]	'out of grandma'

In (6), the relevant clitics follow the morphological word instead. Notice, first, that final devoicing applies before these enclitics: /sad/ in (6)a surfaces as [sat] before the interrogative particle [li]. This shows that enclitics are not incorporated into the Pwd (Halle 1959). On the other hand, voicing assimilation applies across enclitic boundaries, as shown in (6)b-c.

(6)		/sok/		/sad/	
	a.	[sok] [li]	'juice (interr.)'	[sat] [li]	'garden (interr.)'
	b.	[sog] [ʒe]	'juice (emph.)'	[sad] [ʒe]	'garden (emph.)'
	c.	[sok] [to]	'juice (topic.)'	[sat] [to]	'garden (topic.)'
cf.		[sok-a]	'juice (gen. sg.)'	[sad-a]	'garden (gen. sg.)'

All sources agree on the final devoicing facts described, and on the existence of voicing assimilation within the Pwd (that is, involving prepositions). A recent phonetic study by Burton and Robblee (1997) confirms the latter. Nearly all sources describe voicing assimilation across the enclitic boundary as well, as shown in (6)b-c.[4] Things are less clear regarding voicing assimilation across major category words.[5] 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).[6] Avanesov (1972), a work notable for its degree of phonetic detail, does not mention assimilation across major category word boundaries at all. In text he transcribes, assimilation is never indicated in this context, e.g., [stekaet] [doʃʲ:] 'rain flows down', [pesok] [gorʲutʃij] 'inflammable sand', while assimilation is always transcribed within a Pwd, e.g., [od znoju] 'from (the) intense heat', from /ot znoju/, [pot svodom] '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 to posit as the domain of phonological voicing assimilation a prosodic unit that includes enclitics but is smaller than the phonological phrase. This domain, which I will call a clitic group (CG), encompasses a Pwd and additional enclitics, e.g., $\{[\text{sat}]_{\text{Pwd}}[\text{li}]_{\text{Pwd}}\}_{\text{CG}}$ 'garden (interr.)', from /sad li/, $\{[\text{is kard}]_{\text{Pwd}}\ [\text{ʒe}]_{\text{Pwd}}\}_{\text{CG}}$ 'from the maps (emph.)', from /iz kart ʒe/. (See Hayes 1989 and Nespor and Vogel 1986 on a distinction between Pwd and CG.) Independent evidence for the distinction between Pwd and CG in Russian comes from at least two directions. First, assimilation of secondary palatalization occurs within a Pwd but not between a Pwd and an enclitic (Gvozdev 1949). Second, prepositions form part of the word stress domain, sometimes receiving the stress themselves (Gvozdev 1949, Jakobson 1956), e.g., ['pod ruku] 'by the arm' (compare [pod ru'koj] 'at hand'). Enclitics are never stressed, and have no effect on stress.[7]

To conclude, the domains of final devoicing and voicing assimilation are the Pwd and the CG respectively. Voicing assimilation between CGs does occur, but with less regularity. I assume it should be accounted for by the phonetic component of Russian, separately from the facts within CGs. Here I focus on the latter facts.

2.3 Sonorants

Sonorants in Russian do not participate in the truly phonological voicing processes at all. First, they never trigger voicing assimilation. The examples below show this word-initially, word-medially, and word-finally ((7)a-c respectively).

(7)	a.	kn^{j}az^{j}	'prince'	vs.		gnut^{j}	'to bend'
		tratit^{j}	'to spend'			drat^{j}s^{j}a	'to fight'
	b.	pis^{j}ma	'letters'			bol^{j}ʃevizma	'bolshevism (gen.)'
	c.	teatr	'theater'			kadr	'film sequence'

Nor do sonorants devoice. Word-final sonorants as in (8)a are phonologically voiced. This is true even of sonorants preceded by a voiced ((8)b) or voiceless ((8)c) obstruent.

(8)	a.	mil	'dear'	b.	ʒizn^{j}	'life'	c.	litr	'liter'
		von^{j}	'stench'		bobr	'beaver'		vopl^{j}	'cry'

Finally, sonorants do not assimilate voicelessness from a following obstruent, (9)a-b.

(9)	a.	bort	'side (of a boat)'	*bo̥rt
		volk	'wolf'	*vo̥lk
	b.	rta	'mouth (gen.)'	*r̥ta
		mstit^{j}	'to avenge'	*m̥stit^{j}

Final devoicing and assimilation by sonorants in examples like (8) and (9) are often described (Coats and 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.) This point will turn out to be important when we analyze Russian [v].

First, few descriptions of Russian suggest that word-final sonorants as in (8)a devoice. Those that do, such as Bondarko (1998), make clear that this is sporadic at best.[8] It is more common to suggest devoicing in words such as (8)b-c, especially for liquids, so that /bobr/ can be [bob̥r] or even [bop̥r]. Again, however, this occurs only optionally and gradiently (Isacenko 1947, Avanesov 1956, Reformatskii 1975, Baranovskaia 1968, 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 [bob̥r] 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 [teatr] 'theater' are routine. These conclusions regarding (8) are supported by the phonetic investigation of Barry (1989). Turning finally to (9), assimilation in cases such as (9)a do not occur at all, as Barkaï and Horvath (1978) point out. Devoicing in (9)b is again more likely when the following obstruent is voiceless, and is optional ((Isacenko 1947, Avanesov 1956, Baranovskaia 1968.)

Sonorants have been said famously not only to devoice, but to be transparent to voicing assimilation in constructions as in (10), giving e.g., [od mzdʲ] and [is mtsenska] instead of (10)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. Instead we expect it to occur, once again, only gradiently and optionally. This is in fact the case. A phonetic study by

Robblee and Burton (1997) examines cases involving liquids, e.g., *s lʲdinɨ* 'from (the) ice floe', and find *no* evidence of assimilation.[9,10]

(10)	a.	ot mzdɨ	'from the bribe'	b.	iz mtsenska	'from/out of Mcensk'
		ot lʲda	'from the ice'		iz rta	'out of the mouth'

It seems likely that effects involving sonorants should be handled by the phonetic component. The larger conclusion based on the last two sections is the following: voicing assimilation, as a rule of the phonology proper, affects only strings of strictly contiguous obstruents within the CG; final devoicing affects only obstruents that are final in the PWd. These conclusions essentially remove from the phonology nearly all effects treated as postlexical phonology by Kiparsky (1985).

3. Analysis of voicing assimilation

Recent work in phonology is exploring the idea that markedness constraints should be grounded in functional phonetic considerations. Phonetic grounding itself is not new, but work such as Flemming (1995a), Steriade (1997), Kirchner (2000), Ní Chiosáin and Padgett (2001), Padgett (to appear-a), among many others, extends this idea in at least two ways. First, it is argued that constraints grounded in articulatory effort, and others in perceptual distinctiveness, must both be distinguished. Second, the range of phonetic distinctions relevant to phonology is argued to be greater than previously countenanced, a point we return to below. With these assumptions in mind, I lay out here a basic approach to the analysis of final devoicing and voicing assimilation.

3.1 Perceptual distinctiveness

The approach to perceptual distinctiveness pursued here relies on the notion of positional faithfulness. Positional faithfulness explains recurrent patterns involving positions of neutralization and the directionality of assimilation (Selkirk 1994, Beckman 1997, Beckman 1998.) The idea is that faithfulness to underlying feature values is particularly favored in positions of psycholinguistic or phonetic salience. (See the references cited for extensive discussion.) One of the positions argued to be privileged in this way is the syllable onset position (Beckman 1998, 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, and account for the leftward direction of voice assimilation in, e.g., /ot brositʲ/ → [od brositʲ], 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 (11)a. When onset clusters are derived due to cliticization of monosegmental prepositions like /k/ and /v/, as in (11)b, regressive assimilation occurs. Yet according to the view that onset position licenses distinctive voicing, words like *[kde] should be fine.

(11)	a.	gde	'where'	cf.	*kde, gte	
		kto	'who'		*kdo, gto	
	b.	k ivanu	'to Ivan'	v ivane		'in Ivan'
		k tʃeloveku	'to the man'	f tʃeloveke		'in the man'
		g dime	'to Dima'	v dime		'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 morpheme-internally, this is not true across the prefix-stem boundary, which instead coincides with a syllable boundary. The forms in (12)a, involving the prefixes /pod-/ and /ot-/, are therefore syllabified at the morpheme boundary. Evidence for this comes from the failure of a robust palatalization assimilation process across the boundary, as well as native speaker judgements (Avanesov 1972, Darden 1971). Second, words having final obstruent-sonorant sequences, as in (12)b, preserve the underlying voicing of the obstruent. These words are monosyllabic in the literary language (Zalizniak 1975), and the obstruents are therefore codas.[11]

(12)	a.	pod-jexatʲ	'to approach by vehicle'	ot-jexatʲ	'to ride off'
		pod-nesti	'to bring (up to)'	ot-nesti	'to carry away'
	b.	ʒiznʲ	'life'	pesnʲ	'song'
		teatr	'theater'	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), Steriade (1994). It is motivated also, though less directly, by Lombardi (1991), Lombardi (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).

In more recent work, 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 et al. (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. Recasting Steriade's account in terms of positional faithfulness, I assume the constraint schema shown in (13), and the universal ranking in (14). ('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.[12]

(13) $\text{IDENT}_{\text{CUE}}$(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 Pwd) ≻
WF (Pwd-final) ≻
PO (pre-obstruent)

(14) IDENT_{PS}(VOICE) >> IDENT_{WF}(VOICE) >> IDENT_{PO}(VOICE)

3.2 Articulatory effort

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. The constraint *D below captures this aspect of the voicing facts.

3.3 The account

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 (15) below for the word /god/ 'year'. A comparison of (15)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 (15)b-c makes clear.

(15)

Input: /god/	Ident_{PS}	*D	Ident
a. god		**!	
b. ☞ 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. (See references cited above.) 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.[13] ('CG' means 'clitic group', recall.)

(16) AGREE(VOICE) Within a CG, 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 1985), 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 [gde] '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.

(17) i)

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

ii)

Input: /kde/	Ident_{PS}	Agree	*D	Ident
a. kde		*!	*	
b. ☞ gde			**	*
c. kte	*!			

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

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

Tableau (19) shows why devoicing of entire clusters occurs in forms like /pojezd/ 'train'.

(19)

Input: /pojezd/	$Ident_{PS}$	Agree	*D	Ident
a. pojezd			*!*	
b. ☞ pojest				**
c. pojezt		*!	*	*

The final issue in this basic account involves the prosodic domains of final devoicing and voice assimilation. AGREE(VOICE) refers only to segments within a CG. This is possibly only one of a family of universally ordered constraints referring to successively larger prosodic domains. Mohanan (1993) notes that the tendency to assimilate is greater as the target and trigger share smaller prosodic domains, implying in Optimality Theoretic terms the scale shown below (relativized to a given feature).

(20) $AGREE_{\sigma}$ >> $AGREE_{Foot}$ >> $AGREE_{Pwd}$ >> $AGREE_{CG}$ >> $AGREE_{PPhrase}$ >> ...

In other words, according to Mohanan, the 'strength' of the assimilation requirement is greater within syllables than across them, and so on. The reference to the CG domain in AGREE(VOICE) means that assimilation *between* clitic groups is not required. Assimilation will be forced between words and enclitics, as in {sog ʒe} 'juice (emph.)', from /sok ʒe/, and between prepositions and following words, but not between CGs, as in {sok}{ʒenɨ} 'Zhena's juice'. This is shown below. In the latter example, the relevant obstruents are in separate CGs, and so AGREE is vacuously satisfied. Of course, failure of assimilation here violates AGREE relativized to the Phonological Phrase; as long as this is ranked below *D, lack of assimilation will be optimal.[14]

(21) i)

Input: /sok ʒe/	$Ident_{PS}$	$Agree_{CG}$	*D	Ident
a. {sok ʒe}		*!	*	
b. {sog ʒe}			**	*

ii)

Input: /sok ʒenɨ/	$Ident_{PS}$	$Agree_{CG}$	*D	Ident
a. {sok}{ʒenɨ}			*	
b. {sog}{ʒenɨ}			**!	*

While assimilation applies within CGs, final devoicing targets the end of Pwds. It is the reference to Pwd in the faithfulness constraints that guarantees this. According to $IDENT_{PS}$, for example, the most 'privileged' obstruent is one that precedes a sonorant in the same Pwd.

Therefore, preposition-final obstruents will be protected, as in [iz leningrada] 'from Leningrad', while other word-final obstruents will not be, as in [otkas] [lenʲ] 'Lena's refusal', from /otkaz lenʲ/. This is shown below.

(22) i)

Input: /iz leningrada/	$Ident_{PS}$	$Agree_{CG}$	*D	Ident
a. ☞ [iz leningrada]			***	
b. [is leningrada]	*!		**	*

ii)

Input: /otkaz lenʲ/	$Ident_{PS}$	$Agree_{CG}$	*D	Ident
a. [otkaz][lenʲ]			*!	
b. ☞ [otkas][lenʲ]				*

4. The problem of [v]
4.1 The facts

Descriptions of Russian have long noted the 'schizophrenic' nature of [v] (to use a term of Kavitskaya 1997). [v] behaves like a sonorant in failing to trigger assimilation, as shown below. (23)a-c show (near)-minimal pairs contrasting voiced and voiceless obstruents before [v], within a morpheme, across a prefix boundary, and across a preposition-word boundary respectively.

(23)	a.	tver^{j}	'Tver'	dver^{j}	'door'
		sverx	'above'	zver^{j}	'wild animal'
	b.	ot-vesti	'to lead away'	pod-vesti	'to lead up'
	c.	ot vas	'from you (pl.)'	pod vami	'under you (pl.)'
		s vami	'with you (pl.)'	iz vami	'out of you (pl.)'

Yet [v] behaves like an obstruent in undergoing assimilation. Note the [v] ~ [f] alternation in (24)a. In (24)b, the preposition /v/ surfaces as [v] before a sonorant, but assimilates to an obstruent. The example in (24)c shows how /v/ can both fail to trigger assimilation, and undergo it, in one form.

(24)	a.	korovok	'cow (dim., gen.pl.)'	korofka	'cow (dim.)'
		lavok	'bench (gen.pl.)'	lafka	'bench'

b. v reke 'in the river'
v gorode 'in the city'
f supe 'in the soup'

c. f skvaʒine 'in the chink' (from /v skvaʒine/)

Russian [v] also devoices word-finally, as obstruents do:

(25) prava 'right (fem.)' praf (masc.)
lʲubvi 'love (gen.)' lʲubofʲ (nom.)
krovi 'blood (gen.)' krofʲ (nom.)

The initial appearance is simple: [v] is like an obstruent in undergoing these processes, but like a sonorant in failing to trigger them. This was the traditional description, but Jakobson (1956) famously observed that things are more complicated: if [v] is followed by an obstruent, then not only does it undergo, but so do any *preceding* obstruents. Examples are given below.

(26) /pod vsemi/ → potfsemi 'underneath everyone'
/ot vdovɨ/ → odvdovɨ 'from the widow'
/k vzdoxam/ → gvzdoxam 'to the sighs'

Jakobson (1956) offers a neat alternative summary of the facts: [v] behaves like a sonorant when preceding a sonorant, and like an obstruent otherwise.

These are all of the uncontroversial facts about Russian [v], the basic facts any account of this sound must capture. There is a bit more to the picture, as we will see, but after the main account has been laid out.

4.2 An abstract account

The best known approach to [v]'s special behavior posits that [v] is underlyingly /w/ in Russian (Lightner 1965, Daniels 1972, Coats and Harshenin 1971, Hayes 1984, Kiparsky 1985). The basic idea is this: as a sonorant, [w] does not trigger assimilation. But assuming *all sonorants undergo assimilation and final devoicing*, [w] will undergo. A late rule strengthens [w] to [v] (or if devoiced, to [f]). Hayes (1984) and Kiparsky (1985) achieved the most elegant versions of this account. The discussion here largely abstracts away from differences between them and from aspects of their analyses not directly relevant here.

Consider the underlying representations in (27). Final devoicing affects not only obstruents, but sonorants, according to the account. Therefore /r/ and /w/ undergo this rule. Sonorants also undergo assimilation, though they do not trigger it, as shown. It is after these rules apply that w-strengthening occurs. This rule turns all [w] and [w̥] into [v] and [f] respectively. Since sonorants do not generally surface devoiced, derived sounds like [r̥] and [m̥] must be 'revoiced', as shown. Hayes (1984) argues reasonably that this might be a phonetic effect following from the definition of [voice] and the aerodynamics of sonorants, but this need not

concern us. The rule of w-strengthening has already applied at this stage, and [v] and [f] are not affected. As can be seen, this derivation elegantly accounts for the two basic properties of [v], its failure to trigger voicing effects while undergoing them. Crucial to the account, besides positing /w/, is the assumption that *all* sonorants undergo voicing effects.

(27)	/w skwaʒine/	/twer/	/praw/	/pod wsemi/	/iz mtsenska/
Final devoicing	—	twer̥	praw̥	—	—
Voice assimilation	w̥ skwaʒine	—	—	pot w̥semi	is m̥tsen̥ska
w-strengthening	f skvaʒine	tver̥	praf	pot fsemi	—
(Sonorant revoicing)	—	tver	—	—	is mtsenska
	[f skvaʒine]	[tver]	[praf]	[pot fsemi]	[is mtsenska]
	'in the chink'	'Tver'	'right'	'underneath everyone'	'from Mcensk'

This approach to [v]—let us call it the abstract approach—is interesting in light of recent phonological theory. The need for serial derivations has been questioned within a number of frameworks, most notably Optimality Theory Prince and Smolensky (1993) and Declarative Phonology Scobbie (1991), Coleman (1996), Ogden (1999). The abstract approach to [v] is a classic case of derivational opacity, calling on a counterfeeding rule ordering: were w-strengthening to apply before voice assimilation, [v] would trigger assimilation. Further, it is *notably* abstract, since /w/ never appears on the surface in (standard) Russian. It is not the sort of opacity that can be reanalyzed in terms of output-output correspondence (Benua 1995) or paradigm uniformity (Burzio 1994, Burzio 1996, Flemming 1995a, Kenstowicz 1996, Steriade 2000, McCarthy 2001, among others). Since /w/ *never* surfaces, there is no related output form one could designate as a base for such a relation.

Some have argued, plausibly, that the restricted serialism of levels, or strata, known to Lexical Phonology, should be carried over to Optimality Theory (see most recently, and comprehensively, Kiparsky 1998). Consider, therefore, how the abstract account for [v] would be cast within such a framework. The simplest idea might be to assume the account of voicing pursued in section 3, but to assume in addition that [v] is [w] for one stratum, while w-strengthening occurs at the next stratum. Clearly [w] would fail to trigger assimilation lexically. This means that w-strengthening, final devoicing of [v], and assimilation by [v], must all occur in the second stratum. That this simplest approach will not explain the behavior of [v] can be seen below. In the form [f skvaʒine] 'in the chink' from /w skwaʒine/, [w] occurs in both trigger and target position. In tableau (28) I assume a constraint 'w → v' as a cover for whatever forces w-strengthening. (The remaining constraints and rankings are familiar.) This rules out candidate (28)a, and requires all live candidates to have obstruent [v] or [f] instead of [w]. As obstruents, [v] and [f] fall under the jurisdiction of AGREE and are valid targets of assimilation. Candidate (28)b is therefore correctly ruled out. The problem is, [v] and [f] are now valid *triggers* as well;

this means that (28)c must lose to (28)d. (The backwards-pointing hand means that the chosen form is not correct.)

(28)

Input: /w skwaʒine/		w → v	$Ident_{PS}$	Agree	*D	Ident
a.	w skwaʒine	*!*			*	
b.	v skvaʒine			*!*	***	
c.	f skvaʒine			*!	**	*
d. ☜	v zgvaʒine				*****	**

The solution is to follow more closely the abstract approach, and allow /w/, and therefore all sonorants, to *undergo* assimilation in the first stratum, while not triggering it. This would output the intermediate representation /w̥ skwaʒine/. If assimilation did *not* occur in the second stratum, then w-strengthening would give the correct output, [f skvaʒine].

But there are major arguments against this approach. First, it is unclear what the later stratum, at which assimilation does not occur, could be. As we saw in section 2.2, assimilation occurs as late as the postlexical stratum (assuming we distinguish strata at all). This is consistent with the hypothetical account only assuming two earlier levels, such that assimilation occurs (and affects obstruents) in the first, turns off in the second, and back on postlexically. Apart from the inelegance of these assumptions, they will in any case fail. The problem is that the special behavior of /v/ is also exhibited *postlexically*, as the example derived in (28) illustrates. Indeed, Kiparsky's (1985) account for [v] assumes crucially that the serialism illustrated in (27) exists *within* a level in the form of rule ordering.

Second, any version of the abstract approach relies on the assumption that all sonorants undergo voicing effects at some level. Yet the upshot of section 2.3 is that sonorants in fact do *not* undergo assimilation. Consider the derivations of [pot fsemi] 'underneath everyone' and [is mtsenska] 'from Mcensk' in (27). These derivations are entirely parallel: /w/ and /m/ both undergo [-voice] assimilation, as do the sounds preceding them. Yet the parallelism is incorrect, as we have seen. Under certain conditions sonorants can devoice, but only gradiently and optionally. Further, those conditions do not match those of the obstruent voicing effects. The devoicing of /iz/ to [is] in [is mtsenska], in particular, occurs gradiently or not at all. In contrast, the devoicing of /pod/ in [pot fsemi], and the assimilations shown in (26), are all categorical and obligatory. (No source disagrees with this observation by Jakobson 1956.) Forms such as *[pod fsemi] are ungrammatical. The evidence simply does not support extending the account of [v] to all sonorants. But without this assumption, the abstract account loses all of its appeal: we must stipulate that only the sonorant /w/ undergoes assimilation. The problem is not merely that we must somehow target /w/ specifically; *all* accounts must say something particular about Russian [v]. The problem is rather that the stipulation in this case follows from nothing independent.

Barkaï and Horvath (1978) also note the lack of parallelism between [v] and other sonorants. In addition, they raise a third important argument against the abstract account. It turns

out that Russian [v] is not unique. The sound [v] undergoes voicing assimilation, and fails to trigger it, in several languages. Data are given below from Hebrew (Barkaï and Horvath 1978), Hungarian (Barkaï and Horvath 1978), and Czech (Short 1993). (The same pattern occurs in several other Slavic languages as well.) The (a) examples show [v] undergoing assimilation, and the (b) examples show failure to trigger it.

(29)

Hebrew	a.	/ʔahavti/	ʔahafti	'I loved'	b.	hitvakeax	'he argued'
		(ʃevet)	ʃifti	'tribal'		kvutsa	'group'
Hungarian	a.	/si:vtelen/	si:ftelen	'heartless'	b.	hatvan	'sixty'
		/e:vfordulo:/	e:ffordulo:	anniversary		ve:sve	'lost'
Czech	a.	/vtip/	fcip	'joke'	b.	tvu:j	'your'
		/vsadit/	fsaɟit	'bet'		dvu:r	'courtyard'

Why does [v], as opposed to other sounds, *recurrently* pattern in this very specific way? If we must posit that [v] is /w/, and rely on counterfeeding rule orderings, in order to account for [v] in several languages, it is likely that we are missing something. According to Barkaï and Horvath (1978), morphophonemic evidence suggests that Hebrew [v] is derived from /b/ if anything, and not /w/. More interestingly, Vago (1980) and Olsson (1992) classify Hungarian /v/ as a sonorant consonant and glide respectively. If [v] in Hungarian is indeed more sonorous than obstruents, this would suggest that facts such as those above might be amenable to a surface-oriented account. Below I take up and develop this idea for Russian. I anticipate that the account offered, or some variation of it, can extend to Hebrew, Hungarian, and similar languages.

4.3 A surface-based account

There turns out to be considerable evidence that even at the surface [v] is more sonorous than any obstruent in Russian. In what follows I show that [v] patterns with sonorants as well as with obstruents, and argue that it should be analyzed as having a status intermediate between the two, a view anticipated by Andersen (1969), Shevoroshkin (1971), Barkaï and Horvath (1978), and Jakobson (1978). From here on I transcribe it as [ⱱ̟], a modified form of the IPA symbol for a labio-dental approximant. (See below.)

Consider the evidence for the sonorancy of Russian [ⱱ̟]. First, this sound has more formant structure and intensity, and less frication, than any other Russian fricative (Bondarko and Zinder 1966, Bondarko 1977, Andersen 1969, Shevoroshkin 1971, Bondarko 1998). Since sonorancy is indicated by intensity and the presence of formant structure, and obstruency by the curtailment of these and by aperiodic noise (such as frication), this means that [ⱱ̟] is more sonorous than other obstruents. Jakobson, cited by Andersen (1969), claimed that speakers of Polish mistake Russian [ⱱ̟] for [w]. Polish has both [w] and [v], and the latter is strongly fricated

and both triggers and undergoes voicing effects. Rubach (1996) claims it is obstruent /v/ underlyingly.

Second, in spontaneous speech [ʋ̯] patterns with sonorants in commonly reducing (Bondarko and Zinder 1966, Barinova 1971, Svetozarova 1988, p.28, Pugh 1993). Reduction of [ʋ̯]—to a pronunciation like [w]—is frequent in comparison to reduction of other consonants, according to Svetozarova (1988). In particular, no other obstruents 'partially or fully vocalize' (p.34) in this way. In her discussion Svetozarova groups [ʋ̯] with the liquids because these sounds also frequently vocalize. The intensity of [ʋ̯] and the liquids relative to a neighboring vowel is measured, with [ʋ̯] having the highest intensity (that is, being most vowel-like) when reduced. This reduction occurs most often inter-vocalically (Bondarko and Zinder 1966, Barinova 1971), e.g., [jewo] for /jeʋ̯o/ 'his'. Barinova (1971) notes a strong tendency for [j] also to reduce (toward zero) in this position, and discusses [j] and [ʋ̯] together.

Third, Russian listeners confuse instances of [ʋ̯] and [f] much less often than they confuse other voiced-voiceless pairs, according to Golovnia (1987) (and references therein), who suggests that this is because [ʋ̯] is more like a sonorant than other fricatives. Zinder (1979) (pp. 78-9) states that aphasics who cannot distinguish voicing in obstruents typically can distinguish [ʋ̯] from [f].

More evidence comes from the phonotactic behavior of [ʋ̯]. According to Zalizniak (1975), [ʋ̯] groups with sonorants in requiring a non-syllabic realization of a following sonorant in words like [maʋ̯r] 'Moor', compare [ʒanr] 'genre'. In contrast, after genuine fricatives, a syllabic pronunciation is possible, e.g., [tsifr] ~ [tsifr̩] 'figure (gen.pl)'.

Russian allows an unusual number of clusters, and a full discussion of these is not possible here. However, consider onset clusters having two segments. There are many of these also, but they can be sorted into several coherent classes (see for instance Pilch 1967). Two stand out as most frequently occurring: those consisting of obstruent + sonorant, and those consisting of a sibilant and a stop in either order. Discussing the former, both Pilch (1967) and Shevoroshkin (1971) include [ʋ̯] among the 'sonorants' along with [m,n,l,r,j]. Examples like [tʋ̯oj] 'your', [dʋ̯a] 'two', [sʋ̯oj] (reflexive pronoun), [zʋ̯atʲ] 'to call', are frequent; compare [tri] 'three', [drug] 'friend', [sloj] 'layer', [znatʲ] 'to know'. To check this claim, I counted occurrences of two- and three-segment word-initial clusters in a Russian dictionary (Ozhegov 1984). Of those beginning with a stop [p,t,k,b,d,g], the clusters occurring seven times or more are shown in (30). With a cut-off of three, the clusters *pn*, *pj*, *tm*, *dl*, *dj*, *dʋ̯*, *gv*, along with *ps*, *ks*, and *tʃ:* (not the affricate) would be added.[15]

(30)	pr	tr	kr	br	dr	gr
	pl		kl	bl		gl
			kn			gn
		tʋ̯	kʋ̯			

Of three-consonant clusters beginning with [s] or [z] (the second member is usually a stop), the third member was *always* [n,l,r,j] or [ʋ̯], e.g., [skʋ̯aʒina] 'chink'.

The abstract approach to [ʋ̯] posits underlying /w/. Those advocating it have also argued that [ʋ̯] patterns with sonorants, though (interestingly) not based on any of the above. In this case

the evidence involves the patterning of [ʋ̯] in morphophonological rules. For example, Jakobson (1948) defines a 'narrow closed' class of verb stems, all ending in [j,ʋ̯,n,m], which drop this consonant before a consonantal desinence. Examples are shown below.

(31)	delaj-u-t	stan-u-t	ʒiʋ̯-u-t	(3rd plural)
	dela-l-a	sta-l-a	ʒi-l-a	(Past fem.)
	'do'	'become'	'live'	

All other consonant-final verb stems end in (unambiguous) obstruents, and these never drop. Lightner (1972), Flier (1972), Flier (1974a), Flier (1974b), and Coats (1974) capitalize on the underlying status of [ʋ̯] as /w/ in order to capture its patterning with sonorants, or with glides, in several such processes. Yet if [ʋ̯] groups with sonorants at the *surface*, then no reference to /w/ is required.

Though [ʋ̯] patterns with sonorants, there is reason to suppose that it is *less* sonorous than the other sonorants of Standard Russian.[16] After all, [ʋ̯] is virtually always classified as a fricative in studies of Russian. This assignment is based on its alternation with [f] under voice assimilation and final devoicing, just the topics under discussion here, and on the fricative noise, however weak, that characterizes it. As foreshadowed, I assume [ʋ̯] occupies a position intermediate between the obstruents and the other sonorants. What precisely is it, then?

Barkaï and Horvath (1978) and Shevoroshkin (1971) account for the behavior of [ʋ̯] by locating it on a sonority scale between obstruents and sonorants. The scale proposed by Barkaï and Horvath (1978) is shown in (32)a. They then propose the rule of voice assimilation in (32)b. The effect of this rule is to cause obstruents alone to be triggers, while [ʋ̯] joins these sounds as a target.

(32) a. stops < fricatives < v < nasals < j < r < 1
1 2 3 4 5 6 7

b. [*m*sonorant] → [αvoice] / ___ [*n*sonorant, αvoice], where $m \leq 3$, and $n \leq 2$

The claim that the labio-dental has intermediate sonority in these languages is correct, I believe, and an important step toward dealing with [ʋ̯]. But the rule based on this scale does not capture the behavior of [ʋ̯] in an explanatory way, as Olsson (1992) notes. It would be easy to switch the values of *m* and *n*, for instance, making [ʋ̯] a trigger but not a target. Yet this never happens. Is there a principled reason why [ʋ̯] *undergoes* but does not *trigger* assimilation in a range of languages?

The key, I argue, involves looking more closely at the aerodynamic properties of [ʋ̯]. The class of approximants is generally defined to include liquids and glides (Catford 1977, Ladefoged 1993). (Sounds transcribed [β,ð,ɣ] are also often described as approximants rather than fricatives.) Suppose that [ʋ̯] belongs to this class. Catford (p.63-6) defines an 'approximant' in both articulatory and aerodynamic/acoustic terms. Its articulation involves a 'slightly wider' constriction degree than that of a fricative. More interesting for our purposes is the aerodynamic result: a sound that lacks frication when voiced—but often is fricated when voiceless. For

example, [l] and [j] when devoiced, can give [ɬ] and [ç] respectively. Whether they will or not, to be more precise, depends on two factors (see Johnson 1997 and references therein). Turbulent noise, that is frication, increases as the air flow volume velocity *increases*, and as the size of the constriction channel *decreases*. So, given a constant air flow, an increase in constriction degree will tend to produce frication. Given a constant *constriction degree*, likewise, an increase in *air flow* will tend to produce frication. Voiceless sounds, having an open glottis, produce more air flow than voiced sounds. Therefore a voiceless sound is more likely than a voiced one to be fricated, for a given constriction degree. This is the source of the change from approximant to fricative when sounds like [l] and [j] are devoiced, what we might call Catford's generalization.

The idea is to derive the alternation [ʟ̥] ~ [f] from Catford's generalization combined with phonological devoicing. However, given all we have seen, it will not do simply to class Russian [ʟ̥] with [l,r,j]. Russian [ʟ̥] differs from other approximants even with respect to Catford's generalization: though any approximant can be fricated if rendered with sufficient voiceless airflow, [ʟ̥] is weakly fricated when *voiced*, and *strongly* fricated when voiceless. Let us call this kind of sound a *narrow approximant*. The feature chart below is adapted from that of Clements (1990). (The feature [vocoid] is just [consonantal] with the values reversed. The point of this is to allow one to read sonority from the number of '+' values a given sound has.) Inside the boxed portion are the features relating to oral constriction degree. I have introduced a new feature [wide], which makes the necessary distinction between narrow approximants (NA) and wide ones (WA). Liquids, glides, and vowels are [+wide], while obstruents and narrow approximants are [-wide]. We will see in section 5 that sounds transcribed [ʋ] in other languages can be [+wide], patterning with liquids and/or glides. The symbol [ʟ̥] is intended to imply a greater constriction degree than this, as in Russian.

(33)	Stop b	Fric v	**NA** ʟ̥	WA ʋ/l/r	Glide w	 |	*Nasal* m
[continuant]	-	+	**+**	+	+	|	-
[approximant]	-	-	**+**	+	+	|	-
[wide]	-	-	**-**	+	+	|	-
[vocoid]	-	-	**-**	-	+	|	-
[*sonorant*]	-	-	+	+	+		+

In order to explain the patterning of [ʟ̥] with sonorants, I propose in addition that it is [+sonorant], as shown. Both the [-wide] and [+sonorant] specifications are important. The [+sonorant] value is needed in order to group this sound with *all* of the sonorants, including nasals, which are *not* approximants; they are in fact [-continuant, -approximant], *stops* from the perspective of oral stricture. This value is well motivated by the evidence seen earlier that [ʟ̥] patterns with sonorants. The [-wide] value captures the crucial generalization about the oral stricture and aerodynamics of this sound, and replaces [-sonorant] as the means of grouping [ʟ̥] with the obstruents. For convenience, I refer to the class of obstruents and narrow approximants, that is [-wide, -nasal] sounds, as *narrow* sounds. (They are *oral* narrow sounds, strictly speaking.)

Catford's generalization, applied specifically to *narrow* approximants, can be given as in (34)a. This states in featural terms that a voiceless narrow sound is a fricative. I assume this constraint to hold universally. In Optimality Theoretic terms, it is in Gen rather than in the constraint hierarchy, meaning that all candidate outputs obey it. A second important assumption is given in (34)b, where the constraint *D (*[+voice, -son]) is elaborated upon. As we have noted, voiced obstruents are disfavored for aerodynamic reasons: voicing requires significant air flow through the glottis, and this is difficult to maintain when the vocal tract is greatly constricted. At the opposite extreme is the 'spontaneous' voicing that characterizes sonorants; these sounds have little constriction. The proposed hierarchy simply extends this reasoning: the greater the constriction in the vocal tract, the more difficult it is (for non-nasal sounds) to maintain voicing. The constraints are abbreviated as shown. The bolded constraint, which rules out voiced narrow sounds, is of particular interest here. It follows from the proposed hierarchy that if [ʋ̞] must devoice, that is if *****D/ʋ̞ >> Ident, then obstruents must also; the reverse does not hold.[17]

(34) a. If [-voice, -wide, -nasal], then [-approximant, -sonorant]

b. *[+voice, -son] >> ***[+voice, -nasal, -wide]** >> *[+voice, +approx]...
*D/v ***D/ʋ̞** *D/ʋ

The constraints and rankings shown below are familiar from section 2, except that *D has been replaced by *D/ʋ̞. This first tableau shows how final devoicing of [ʋ̞] in /kroʋ̞^{j}/ 'blood' is acheived. The faithful form [kroʋ̞^{j}] is ruled out by *D/ʋ̞. Since this constraint outranks IDENT(VOICE), the voiceless counterpart of [ʋ̞] is required. Given (34)a, this must be [f]. I assume that faithfulness to manner features outranks IDENT(VOICE), so that an output like [krow^{j}] is ruled out. It should be clear that obstruents will still devoice as well, because *D >> *D/ʋ̞.

(35)

Input: /kroʋ̞^{j}/	Ident$_{PS}$	Agree	*D/ʋ̞	Ident
a. kroʋ̞^{j}			*!	
b. ☞ krof^{j}				*

The voicing of [ʋ̞], like that of obstruents, is still protected in pre-sonorant position by IDENT$_{PS}$, as shown in (36).

(36)

Input: /ʋ̞am/	Ident$_{PS}$	Agree	*D/ʋ̞	Ident
a. ☞ ʋ̞am			*	
b. fam	*!			*

Just as *D has been recalibrated to *D/ʋ̞ in order to target narrow oral sounds, so it is with AGREE(VOICE). In principle, then, [ʋ̞] is both a trigger and a target:

(37) AGREE(VOICE) Within a CG, all contiguous [-wide, -nasal] segments share any [voice] specification.

Tableaux (38)i-ii shows how [ʋ̞] undergoes voicing assimilation before both voiced and voiceless segments. Recall again that a voiceless [ʋ̞] is by definition [f].

(38) i)

Input: /laʋ̞ka/	$Ident_{PS}$	Agree	*D/ʋ̞	Ident
a. laʋ̞ka		*!	*	
b. ☞ lafka				*
c. laʋ̞ga	*!		**	*

ii)

Input: /praʋ̞da/	$Ident_{PS}$	Agree	*D/ʋ̞	Ident
a. ☞ praʋ̞da			**	
b. prafda		*!	*	*
c. prafta	*!			**

Though [ʋ̞] is a trigger in *principle*, the tableaux in (39) show why it cannot actually trigger assimilation: because it is [+sonorant], anything positioned before it must preserve its underlying [voice] value, by $IDENT_{PS}$. From this we can infer the ranking $IDENT_{PS}$ >> AGREE, which could not be determined earlier; compare the (a) and (b) candidates below. Nor can [ʋ̞] itself change to accommodate AGREE, as in the (c) candidates, since it is also in pre-sonorant position.

(39) i)

Input: /sʋ̞erx/	$Ident_{PS}$	Agree	*D/ʋ̞	Ident
a. ☞ sʋ̞erx		*	*	
b. zʋ̞erx	*!		**	*
c. sferx	*!			*

ii)

Input: /zʯer^{j}/	Ident$_{PS}$	Agree	*D/ʯ	Ident
a. ☞ zʯer^{j}			**	
b. sʯer^{j}	*!	*	*	*
c. sfer^{j}	*!			**

The next tableau shows the form /ʯ skʯaʒine/ 'in the chink', in which we see /ʯ/ both triggering and undergoing voice assimilation. The rightmost /ʯ/ is in pre-sonorant position, as is the /k/ before it, hence neither of these can be altered, as in candidates (40)c-d. The initial /ʯ/ and /s/ are not pre-sonorant, and so must conform to AGREE.

(40)

Input: /ʯ skʯaʒine/	Ident$_{PS}$	Agree	*D/ʯ	Ident
a. ʯskʯaʒine		**!	***	
b. ☞ fskʯaʒine		*	**	*
c. ʯzgʯaʒine	*!		*****	**
d. fskfaʒine	*!		*	**

To complete the initial account of [ʯ], recall that the other approximants [l,r,j] do not pattern as [ʯ] does with respect to voicing. In our terms this is because they are [+wide] approximants. Were we to assume that *all* approximants (along with obstruents) are subject to a constraint AGREE', for example, we would wrongly predict *[ʯoɬk] for [ʯolk] 'wolf', and so on, as shown in (41). We could avoid this output by assuming (plausibly) a high-ranking constraint [*ɬ]. But then we would predict *[ʯolg], since this form is also more harmonic than [ʯolk], as can be seen.

(41)

Input: /ʯolk/	Ident$_{PS}$	Agree'	*D/ʯ	Ident
a. ʯolk		*!	*	
b. ☞ ʯoɬk			*	*
c. ʯolg			**!	*

The point is that [ʯ] does not pattern precisely with either obstruents or sonorants, but rather occupies an intermediate position. Though [ʯ] is necessarily special under any account, the one pursued here does not have the drawbacks of the abstract accounts noted earlier. First, it does not

predict incorrectly that [ɻ̥] and other sonorants will pattern the same. Second, based on general phonetic considerations, and independently known facts about [ɻ̥], it explains why [ɻ̥] undergoes but fails to trigger, while the reverse never happens. In addition, the account of [ɻ̥] is supported by prima facie examples of Catford's generalization at work under voice assimilation in other languages, such as Norwegian (Ove Lorentz, p.c.). In this language liquids devoice before voiceless consonants, becoming fricatives, as shown below. This sort of alternation suggests that Norwegian [ʁ] and [ʎ] are [-wide].

(42)	Western, Southern Norwegian:	/stɔʁ:k/	→	[stɔχ:k]	'stork'
		/hɑʁ:pə/	→	[hɑχ:pə]	'harp'
	Northern Norwegian:	/sɑʎ:c/	→	[sɑɬʲc]	'salt'

Sonorant devoicing under more 'extreme' circumstances, especially when isolated between a voiceless obstruent and a word edge, is well known. It occurs in French, for example. There too, we see an alternation between a frictionless sonorant and a voiceless fricative, e.g., [pœʁ] 'fear' versus [teatχ] from /teatʁ/. As we have seen, similar effects occur optionally and gradiently in Russian. They affect [r] most notably. Next to [ɻ̥] this sound seems the sonorant most prone to devoice in Russian. Russian [r] is a trill, therefore involving brief stop intervals; given its relatively narrrow constriction degree, its tendency to devoice is not surprising. In fact, under certain conditions Slavic [r] has become a fricative in West Slavic languages, for example Sorbian (Schaarschmidt 1998).

4.4 The importance of the cue-based approach for [ɻ̥]

The cue-based approach to positional faithfulness assumed here can be contrasted with the original approach, exemplified by Beckman (1997), Beckman (1998) and others, which assumes the relevant positions to be those classically allowed in generative phonology, especially prosodic positions such as syllable onset, or stressed syllable, etc. Section 3.1 recounted strong reasons to favor the cue-based approach. This section extends the argument, showing how only appeal to phonetic detail beyond the pale of traditional generative phonology can account for the more subtle facts involving [ɻ̥].

As we saw in section 4.1, when [ɻ̥] undergoes assimilation, so do any preceding obstruents. Tableau (43) shows how the analysis handles a case of devoicing. The faithful candidate (43)a, and (43)c-d, violate AGREE. Candidate (43)c is ruled out in any case by the undominated IDENT_{PS}, because [t], which is unfaithful to its input voicing, is located before [ɻ̥], a sonorant. None of the other candidates violate this constraint. The correct form is chosen.

(43)

Input: /pod ʯsemi/	$Ident_{PS}$	Agree	*D/ʯ	Ident
a. podʯsemi		*!	**	
b. ☞ potfsemi				**
c. potʯsemi	*!	**	*	*
d. podfsemi		*!	*	*

However, the current account fails in the case of [+voice] assimilation, as shown below. Candidate (44)b, the desired winner, satisfies AGREE completely once again. However, because now the cluster is [+voice], and [ʯ] in particular remains [ʯ], the prefix-final /t/ is in a pre-sonorant position in candidates (44)a-b. The desired winner [odʯdvʲ] violates $IDENT_{PS}$, and the incorrect (44)c is chosen as optimal.

(44)

Input: /ot ʯdoʯʲ/	$Ident_{PS}$	Agree	*D/ʯ	Ident
a. otʯdoʯʲ		*	***!	
b. odʯdoʯʲ	*!		****	*
c. ☜ otfdoʯʲ		*	**	*
d. odfdoʯʲ		**!	***	**

Dealing with this case requires that we consider more closely clusters of the form obstruent-sonorant-obstruent, as in [iz mtsenska] 'from Mcensk', and [ot mzdʲ] 'from the bribe'. Obstruent-ʯ-obstruent clusters are a subclass of these, since [ʯ] is [+sonorant]. But as we have seen, assimilation does *not* occur in such clusters in Russian apart from [ʯ], or occurs only gradiently and optionally. Tableau (45) shows why this is: the [t] in a [tm] sequence is pre-sonorant, and therefore must remain faithful to its input specification.

(45)

Input: /ot mzdʲ/	$Ident_{PS}$	Agree	*D/ʯ	Ident
a. ☞ ot mzdʲ			**	
b. od mzdʲ	*!		***	*

The case of obstruent-ʯ-obstruent is clearly different. Every source I have checked agrees with the original observation of Jakobson (1956) that assimilation here is obligatory and

impressionistically obvious. Though [ʋ̥] patterns as a sonorant in failing to trigger assimilation in other environments, it patterns as though an obstruent in this particular one. What is different?

Steriade (1997) provides a comprehensive argument for a cue-based approach to laryngeal neutralization. This argument rests in part on the failure of accounts based exclusively on syllable position. Steriade argues instead that specific reference to more phonetic detail is necessary in order to capture the true patterns. She discusses the facts of Polish from this perspective. According to Rubach (1996) and others, in the obstruent-sonorant-obstruent context we are analyzing, voicing *does* assimilate in Polish, in contrast to Russian, e.g., /litr vody/ → [lidr vody] 'liter of water'. In addition, obstruents are devoiced before word-final sonorants, as in /spazm/ → [spasm]. Though obstruents lose the voicing contrast before sonorants in these cases, they retain contrasts before vowels, syllabic sonorants, and pre-vocalic sonorants. What distinguishes these two classes, according to Steriade, is the *duration* of the sonorant period following the relevant obstruent, as depicted in (46)a-b. Vowels, syllabic sonorants, and (of course) a sequence of sonorant-vowel are all generally longer than single non-syllabic sonorant consonants. Since salient cues to obstruent voicing (most notably voice onset time and burst amplitude and duration) reside in the sonorant period following obstruent release, it is reasonable to suppose that they will be endangered just where the following sonorant period is short. That is just what the Polish facts suggest. (Steriade argues that data from Klamath further support reference to duration for explaining laryngeal contrasts.) Though I have argued that Russian is different (contrary to Steriade, who relies on Russian data I have questioned), it remains true that obstruent devoicing can occur optionally and gradiently in the environments of (46)b, e.g. [bobr] ~ [bobr̥] ~ [bopr̥] 'beaver', [oktʲabrskij] ~ [oktʲabr̥skij] ~ [oktʲapr̥skij] 'october' (see section 2.3). The gradient nature of this effect, coupled with the distinction in duration between (46)a and b, explains the Russian pattern.

(46)	a.	O V	b.	O R O	c.	O ʋ̥ O
		O R̥		O R #		O ʋ̥ #
Duration of post-release sonorancy:		O R V |.....|		|...|		|..|

How does [ʋ̥] compare in duration? Russian sources sometimes suggest that the initial sonorant consonant is syllabic in words like [mzd̬], 'bribe (gen.)', [l̥ʲda] 'ice (gen.)', and [rta] 'mouth (gen.)' (Es'kova 1971, Shevoroshkin 1971, Zalizniak 1975, Jakobson 1978). There is no agreement on this point, but the question of syllabicity per se is not at issue here. As Steriade notes, the primary perceptual correlate of syllabicity is *duration*. The fact that [ʋ̥] in words like [ʋ̥doʋ̥̬] is *never* considered to be syllabic in Standard Russian, therefore, is indirect evidence that it is even shorter in duration than the other sonorants, as shown in (46)c.

Recasting Steriade's proposal in our terms, the idea is to expand the positional faithfulness constraint IDENT$_{PS}$(VOICE), which applies given a following sonorant, into a family of constraints, according to the following hierarchy, corresponding to (46)a-c. ('PLS' and 'PSS' abbreviate 'pre-long-sonorant' and 'pre-short-sonorant' respectively.)

(47) IDENT$_{PLS}$(VOICE) >> IDENT$_{PS}$(VOICE) >> IDENT$_{PSS}$(VOICE)

The important dividing line in Russian is between IDENT$_{PS}$(VOICE) and IDENT$_{PSS}$(VOICE), so IDENT$_{PLS}$ is not shown in (48). In addition, barring any evidence to distinguish IDENT$_{PSS}$(VOICE) from any of the other lower-ranking IDENT(VOICE) constraints, I continue to group all of these together under 'IDENT'. Since IDENT$_{PS}$, as now defined, no longer protects an obstruent before a ʯ-obstruent sequence, the correct form (48)b is now chosen.

(48)

Input: /ot ʯdoʯʲ/	Ident$_{PS}$	Agree	*D/ʯ	Ident
a. ot ʯdoʯʲ		*!	***	
b. ☞ od ʯdoʯʲ			****	*
c. ot fdoʯʲ		*!	**	*
d. od fdoʯʲ		*!*	***	**

Since other sonorant consonants continue to fall under IDENT$_{PS}$, forms like [ot mzdʲ] are still correctly accounted for, as shown below.

(49)

Input: /ot mzdʲ/	Ident$_{PS}$	Agree	*D/ʯ	Ident
a. ☞ ot mzdʲ			**	
b. od mzdʲ	*!		***	*

Similarly, since a sequence of [ʯ] followed by a sonorant involves long sonorant duration, obstruent voicing continues to be protected before [ʯ] in this context:

(50)

Input: /sʯerx/	Ident$_{PS}$	Agree	*D/ʯ	Ident
a. ☞ sʯerx		*	*	
b. zʯerx	*!		**	*
c. sferx	*!			*

The key to the account is the appeal to the duration of sonorant voicing following the obstruent in question. Duration may help with yet a different puzzle involving Russian [ʯ]. Reformatskii (1975) claimed that in words like /trezv/ 'sober' and /xorugv/ 'banner', with an underlyingly voiced obstruent preceding final /v/, the penultimate obstruent need not devoice. That is, both [tresf] and [trezf] are possible. This claim has been controversial (see Coats and Harshenin 1971, Jakobson 1978, Halle and Vergnaud 1981, Hayes 1984, Kiparsky 1985, Shapiro

1993, and Kavitskaya 1997 for diverging viewpoints). The phonetic study of Barry (1989) largely confirms Reformatskii's observation of variation; however, the data are somewhat difficult to interpret. Of 27 Russian speakers analyzed by Barry, about half pronounced essentially [tresf] and [xorukf] all of the time. About a quarter of them pronounced something classified as [trezf] and [xorugf]. The remaining speakers tended to voice the /v/ also. Barry assumes that this latter pronunciation is influenced by spelling, but this may not be the case: some individuals pronounced both [trezf] and [trezv] on different occasions, suggesting the possibility that these are phonetic variants of a single phonological output.[18]

Of [tresf] versus [trezf] ~ [trezv], the first is predicted by the current account, as shown below. Note that (46)c assumes that neither obstruents preceding [ʋ̩] + obstruent, nor those preceding word-final [ʋ̩], are under the jurisdiction of IDENT_{PS}. Therefore (51)d passes this constraint.

(51)

Input: /trezʋ̩/	Ident_{PS}	Agree	*D/ʋ̩	Ident
a. trezʋ̩			*!*	
b. trezf		*!	*	*
c. ☞ tresf				**
d. tresʋ̩		*!	*	*

Once again it is useful to compare the facts of [ʋ̩] to those involving the other sonorant consonants in the same context. Sources including Reformatskii (1971) and Es'kova (1971) state these can be syllabic, e.g., [ʒizn] ~ [ʒizn̩] 'life', [kadr] ~ [kadr̩] 'film sequence'. (Such words are sometimes treated as disyllabic in poetry, for instance.) Assuming this variation is under phonological control, how can it be derived? Forms such as [kadr] are disfavored by both sonority sequencing and coda complexity, while those like [ka.dr̩], which I assume to be syllabified as shown, are not. The latter, in turn, are marked in having syllabic consonants. In tableau (52) the top-ranked constraint penalizes syllabic sonorants, and dominates a constraint against complex codas. Given such a ranking, (52)a wins. If the opposite ranking is also possible, (52)b can also surface.

(52)

Input: /kadr/	*R̩	*CC]$_{\sigma}$
a. ☞ kadr		*
b. ka.dr̩	*!	

Since [ʋ̩] is also a sonorant, the prediction is that it should behave analogously. Consider the next tableau, in which the constraints just introduced are added into the familiar constraint hierarchy

for deriving voicing effects. The two subhierarchies are mostly independent in their effects. In this tableau, for example, (53)f will win wherever the subhierarchy *R̩ >> *CC]$_{\sigma}$ is ranked. As we just saw, the effect of this ranking is to favor forms with complex codas over those with syllabic sonorants. Applied to the case of /trezv̩/, this rules out (53)a-b. I assume that candidates such as [tre.sf̩] are prohibited by an undominated constraint against syllabic *obstruents*, *O̩. The surviving candidates are submitted to the voicing hierarchy, which of course favors [tresf].

(53)

Input: /trezv̩/	*R̩	*CC]$_{\sigma}$	Ident$_{PS}$	Agree	*D/v̩	Ident
a. tre.zv̩	*!				**	
b. tre.sv̩	*!		*!	*	*	*
c. trezv̩		*			**	
d. trezf		*		*!	*	*
e. tresv̩		*		*!	*	*
f. ☞ tresf		*				**

Things are more interesting when we consider the opposite ranking motivated above, as in the next tableau. Only candidates (54)a-b pass *CC]$_{\sigma}$. Of these, it is [tre.zv̩] that best satisfies the voicing hierarchy. This is because syllabic [v̩], unlike its non-syllabic counterpart, is under the jurisdiction of IDENT$_{PS}$(VOICE), and faithfulness therefore must override assimilation. Duration is once again crucial. (Here we can also infer that *CC]$_{\sigma}$ must outrank not only *R̩ but *D/v̩, by comparing (54)a and f. The two subhierarchies are not entirely independent.) Note that we will note incorrectly predict *[mo.zg], analogous to [tre.zv̩], because of undominated *O̩.

(54)

Input: /trezv̩/	*CC]$_{\sigma}$	*R̩	Ident$_{PS}$	Agree	*D/v̩	Ident
a. ☞ tre.zv̩		*			**	
b. tre.sv̩		*	*!	*	*	*
c. trezv̩	*!				**	
d. trezf	*!			*!	*	*
e. tresv̩	*!			*!	*	*
f. tresf	*!					**

Recall from section 2.3 that in this same environment, word-final obstruent + sonorant, we find gradient (phonetic) variation of the sort [kadr] ~ [kad̥r̩]. Assuming that output [tre.zv̩] is subject

to the same variation, we predict gradient variation between [tre.zu̯] and [tre.zf̬]. This parallels the reported facts very well, in which the alternative to [tresf] seems to be [trezf] ~ [trezu̯], as noted above. Since this variation is phonetic and not phonological, there is no issue of [tre.zf̬] violating *Ọ.

An apparent drawback of the account is the assumption that the sonorant [u̯] can be syllabic and yet (phonetically) devoice. In the case of the other sonorants, the perception of syllabicity seems to correlate inversely, at least to some extent, with devoicing (see Reformatskii 1971, for example). That is, [ʒizn̥] is more likely to be perceived as monosyllabic. However, the account of [u̯] assumed in this paper posits that this sound is not merely another sonorant, but a narrow approximant, more constricted and 'obstruent-like', than other approximants. Given the greater constriction degree of [u̯], the aerodynamic considerations discussed in section 4.3 predict that this sound, more than any other sonorant, should phonetically devoice. This is in fact just the phonetic correlate of the hierachy *D/u̯ >> *D/ʋ, which favors sonorant voicing over narrow approximant voicing (see (34)b again). Given this fact, the prediction of phonetic devoicing seems very plausible.

This concludes the account of Russian voicing and [u̯]. Phonetic detail, in the form of the appeal to a new class of narrow approximants, is crucial in accounting for the basic behavior of [u̯]: its ability to undergo but not trigger (section 4.3). An appeal to duration, in addition to that, is crucial to the account of the facts seen in this section. Some more recent accounts of [u̯] in Russian (Andersen 1969, Daniels 1972, Petrova et al. 2001) and Hungarian (Olsson 1992) attempt in a different way to capture Jakobson's insight that [u̯] behaves like a sonorant before sonorants and like an obstruent otherwise. These posit rules or constraints essentially requiring that [u̯] be [+sonorant] before sonorants, while taking it to be an obstruent otherwise.[19] However, this move does not explain why [u̯] *should* alternate in this way. The account here, in contrast, grounds the facts in independently motivated phonetic principles, and in independently motivated facts of Russian.

5. Contrast and phonological features

The primary goal of this paper has been to motivate the claim, based on the Russian case study, that phonetic detail, beyond what has been traditionally assumed, is necessary to an explanatory theory of phonology. This claim contradicts the basic assumption of generative phonology and distinctive feature theory that any feature posited for phonology must be justified by a demonstration that it can be contrastive in some language. The distinctions in constriction degree and duration appealed to here do not obviously meet this criterion. In this section I do not attempt to fully motivate a theoretical response to this worry. This is being done in other recent work, including especially Kirchner (1997), Kirchner (2001), Flemming (1995b), Flemming (2001), and Boersma (1997). But given the importance of the issue, it seems necessary at least to outline a response, and its application to the case at hand.

For the purposes of discussion consider the chart below, which repeats a portion of (33), focusing solely on a continuum from fricative to glide in the voiced labial(-dental) sounds. Only the feature [wide] is new, and it differs from the others in arguably never being distinctive.

(55)

	Fric	**NA**	WA	Glide
	v	ʋ̞	ʋ	w
[approximant]	-	+	+	+
[wide]	-	-	+	+
[vocoid]	-	-	-	+

It seems appropriate to begin by surveying some of what is known about potential contrasts among these sounds. (For the sake of simplicity I ignore the bilabial approximant or fricative [β], though it certainly belongs among these sounds in a full treatment.) Unfortunately, there are some difficulties involving interpretation of transcribed data. If it is true that a sound [ʋ̞] exists as distinct from [v] and [ʋ], then it is conceivable that any sound transcribed either 'v' or 'ʋ' might actually be [ʋ̞]. To complicate things more, the symbol 'ʋ' has a manner defined by the IPA only as 'approximant', a term that includes glides. This means that 'ʋ' might denote something [+vocoid] (a glide), or [-vocoid] (what I call a 'wide approximant' in (55)). With these warnings in mind, it is clear first of all that many languages contrast something like [v] versus [w], including English and Polish. In Polish, [v] participates entirely in voicing processes, as noted earlier, and [w] not at all, a fact supporting these transcriptions. A three-way distinction transcribed [v] - [ʋ] - [w] is reported for some languages, including Urhobo (Ladefoged and Maddieson 1996) and Isoko, both West African languages. (It is surely uncommon. [ʋ] occurs in only six out of the 317 languages documented in Maddieson 1984, about 2%.) The Isoko [v] is strongly fricated, and [ʋ] hardly at all, in the limited data I have heard, supporting these transcriptions.[20] A three-way contrast seems the maximum possible. Finally, some languages have only one of these sounds. Russian has only [ʋ̞], for example. Given the caveat already mentioned, it is impossible to say how many more languages might have this sound based on available transcriptions. But if the account of voicing here is right, it occurs in languages with a similar pattern involving 'v', including Hungarian, Hebrew, and Czech. It is interesting to note that in these languages, as in Russian, 'v' stands alone. To sum up, any theory of contrast must allow for no contrast, a two-way contrast, or a three-way contrast. It is not clear that either the contrast [v] - [ʋ̞], or [ʋ̞] - [ʋ], occurs.[21] Therefore, unlike [approximant] and [vocoid] (=[consonantal]), [wide] may never be contrastive.

At the heart of the response to this challenge is the fact that in Optimality Theory, contrastiveness, like everything else, follows not (or not only) from assumptions about the input, but rather from (input-)output constraints. Thus Kirchner (1997), Kirchner (2001), and Boersma (1997) capitalize on the fact that whether a feature is contrastive or not depends on the relative ranking of markedness and faithfulness constraints referring to that feature. As is well known, the ranking Faithfulness >> Markedness entails contrast, while the reverse entails its absence (Prince and Smolensky 1993). (More fine-grained distinctions among markedness constraints, and rankings, derive patterns of allophonic distribution, partial neutralization, and so on.) Kirchner and Boersma go farther in pointing out that even features that are *never* contrastive can be harmlessly referenced by phonology, assuming that there is *no* faithfulness constraint referring to that feature.

Consider how this works for the case of the narrow-wide approximant distinction posited here. Adapting Kirchner's argument, if there is no constraint like IDENT(WIDE), then we will not incorrectly predict contrasts involving this feature. But [wide] can still be important to phonology because of its relevance to the statement of *markedness* constraints. That was just the point argued in section 4, where constraints such as AGREE(VOICE) and *D/ʯ made crucial reference to [wide]. Consider now the more basic question of how the Russian grammar outputs the sound [ʯ] rather than [w], [ʊ], [v], or something else.

Given richness of the base, any of these sounds might be posited as input. Suppose that they all map to [ʯ]. This must be due to markedness constraints. Tableau (56) makes the simplest assumption, that markedness constraints directly disfavoring these segment types are ranked so as to favor [ʯ]. For the sake of discussion, assume an input /v/ in the word /voda/ 'water'. Given this ranking of markedness constraints, this will map to [ʯ]. The mapping /v/ → [ʯ] involves a change in [approximant]. Unlike [wide], this is a distinctive feature (though not for Russian labial consonants), and it is therefore governed by an existing IDENT constraint. This constraint must of course be dominated by *v, as shown. Similar reasoning holds for input /w/ and IDENT(VOCALIC).

(56)

Input: /voda/	*v	*w	*ʊ	*ʯ	Ident(voc)	Ident(approx)
a. ☞ ʯoda				*		*
b. voda	*!					
c. woda		*!			*	*
d. ʊoda			*!			*

Given familiar reasoning, if IDENT(APPROXIMANT) instead dominated these markedness constraints, segments differing in [approximant] would surface as distinct. But because there is no IDENT(WIDE), the fate of segments differing in [wide] must come down solely to markedness. In the case of [ʊ] and [ʯ], this means the relative ranking of *ʊ and *ʯ. Since the ranking of constraints is total (ignoring treatments of variation), one of these sounds must prevail over the other. This is illustrated in the minimal tableau below.

(57)

Input: /ʊoda/	*ʊ	*ʯ
a. ☞ ʯoda		*
b. ʊoda	*!	

A different theoretical response to the issue of contrastiveness shares the assumption that contrast is regulated by constraints. Dispersion Theory (Flemming 1995a, Flemming to appear, see also Ní Chiosáin and Padgett 2001, Padgett to appear-a,b, Sanders in progress, Sanders to

appear) differs from other theories, however, in assuming that constraints regulate the perceptual distinctiveness of contrasts directly, by comparing sets of contrasting forms in the output. This idea is rooted especially in the work of Lindblom (see for example Lindblom 1986, Lindblom 1990), who has had the most success with accounts of vowel contrasts. Consonants are more difficult, because they typically differ along several auditory dimensions. The remarks here will therefore be preliminary, but to see how Dispersion Theory might apply to the case of [ⱱ̟], consider again the continuum of sounds shown in (55). There are at least three salient phonetic correlates of these contrasts. First is the presence or absence of frication; such noise declines from [v] to [w] in the order shown in the diagram, precisely because constriction degree declines. Second is the presence or absence of formant structure and periodic energy over a large range of frequencies, a rough measure of sonorancy. The sound [v] has the least of this, and [w] the most, again due to constriction degree differences. Finally, the more glide-like articulations are known to have slower formant frequency transitions compared to more constricted articulations. Once again this criterion plausibly orders the sounds as shown in (55). Though the phonetic correlates are complex, it therefore seems reasonable to take (55) to indicate roughly a perceptual scale that orders the sounds as shown. Let us call this a scale of 'constriction degree'.

This scale is repeated in (58)a. Given the discussion of existing contrasts earlier, I conjecture that the sounds [v], [ⱱ̟], and [ʋ] are perceptually crowded, while [v], [ʋ], and [w] are roughly equidistant, as schematically indicated here. Dispersion Theory posits a family of constraints regulating perceptual distance of contrast along scales such as this. An example SPACE constraint schema, relativized to this scale, is shown in (58)b. SPACE constraints for a particular scale are intrinsically ranked, with constraints disfavoring closer spacings ranked higher. In the absence of knowledge about the true perceptual distances among these sounds, suppose we label constraints according the the segments separated. Thus SPACE/V-W in (58)c requires that segments contrasting on this scale differ at least as much as [v] differs from [w], and so on.

(58)

a. Constriction degree scale: |...v...ⱱ̟...ʋ.....w...|

b. SPACE: Potential minimal pairs differing in *constriction degree* differ by at least *X* on the *constriction degree* scale

c. SPACE/V-ʋ-W >> SPACE/V-W

As this discussion suggests, a plausible hypothesis is that [ⱱ̟] never contrasts with [v] or [ʋ] because neither contrast is sufficiently distinct on this scale. In Optimality Theory this entails that SPACE/V-ʋ-W is in Gen, meaning that no candidates will be considered that violate this constraint. However, in order to see how the idea works, let us view it in the hierarchy, as in the following tableau. As already noted, Dispersion Theory works by directly comparing sets of forms for perceptual distinctiveness. Therefore inputs, and candidate outputs, are sets of forms, and not forms in isolation as is usual. (See the references cited on how this is made more precise.) Given richness of the base, both /ʋoda/ and /ⱱ̟oda/ are potential inputs, as always. The subscripts in the tableau tag these entire words in order to make clear the nature of the candidate outputs.

Candidate (59)a represents a language in which both forms survive to the output. But given SPACE/V-ʋ-W, such a language cannot win. Candidate (59)b has only [ʋoda] as the output correspondent of both input forms. In other words, this 'language' has neutralized the distinction between /ʋ/ and /ʋ̟/ in favor of the latter. Candidate (59)c has neutralized in the other direction. Which candidate wins depends on the rest of the constraint hierarchy, as shown. If SPACE/V-ʋ-W is actually in Gen, as suggested above, then candidate (59)a could in fact never win. Note that this is true whether there is a constraint IDENT(WIDE) in the hierarchy or not.

(59)

Input: /ʋoda$_1$ ʋ̟oda$_2$/	Space/v-ʋ-w	*ʋ	*ʋ̟
a. ʋoda$_1$ ʋ̟oda$_2$	*!	*	*
b. ʋoda$_{1,2}$		*!	
c. ☞ ʋ̟oda$_{1,2}$			*

What is critical here is the point that *no* language can have [ʋ̟] with either [v] or [ʋ], because SPACE/V-ʋ-W is in Gen. This is true even though markedness constraints might refer to [wide], as argued for in this paper.

Of the two approaches to the issue of contrast, I favor Dispersion Theory, because of the considerable evidence for the need to regulate contrast in this very direct way. (See the references cited.) Dispersion Theory predicts that how 'marked' a sound is depends in part on the contrasts it enters into within a given language. A general expectation is that more extreme articulations must be forced by the need to keep contrasts perceptually distinct. For example, assuming that [v] is more difficult than [ʋ̟] articulatorily (because obstruent voicing is disfavored over sonorant voicing, and perhaps because of the more narrow constriction implied), we expect, all things equal, that [v] would occur in languages having another voiced labial or labio-dental continuant, and that [ʋ̟] or one of the other continuants would be preferred otherwise. The facts surveyed here seem at least consistent with this prediction. As noted earlier, Polish contrasts [v] and [w], and the former participates fully in voicing processes. The languages surveyed here having [ʋ̟], as judged by the behavior of 'v' in voicing assimilation, have no other voiced labial continuants. It is an interesting topic for further research whether such a correlation indeed exists.[22]

6. Conclusion

Distinctive feature theory posits that phonology can access only features that are known to be contrastive in some language. This case study adds to a growing body of work which argues that phonology has access to more phonetic distinctions than that. The appeal to a narrow-wide approximant distinction explains aspects of Russian [ʋ̟] that other accounts have not. First, it correctly captures a genuine distinction between not only [ʋ̟] and the obstruents, but between [ʋ̟] and other *sonorants*. In spite of the great appeal of abstract approaches to [ʋ̟], the fact is that [ʋ̟] and other sonorants do not behave in a parallel manner. Second, it explains why [ʋ̟] undergoes assimilation but fails to trigger it, and why the reverse scenario is impossible. The fact that

essentially the same facts hold in a number of languages suggests that this is no coincidence. The explanation is rooted in well-understood phonetic principles, and is supported by the details of Russian phonetics and phonology. Finally, the use of more phonetic detail to capture generalizations does not imply the prediction of non-occurring contrasts, once we recognize that contrast is regulated by constraints.

The account here is entirely surface-oriented, unlike many previous accounts of [ʊ̟]. Russian [ʊ̟] is an interesting case study for those interested in the problem of derivational opacity. It cannot be explained by appeal to morphologically related words and so represents one of the more difficult and telling problems. Of course, a demonstration that one case does not actually involve derivational opacity hardly entails that derivational opacity is unnecessary. But it bears significantly on the debate.

Notes

*<Acknowledgements>

1. Predictable palatalization, vowel reduction, and other irrelevant surface variation are suppressed throughout the paper.

2. Kirchner (1997, 2001) argues that once phonology countenances reference to non-contrastive features, as argued for here, there is no need to handle categorical and gradient effects differently. If this turns out to be right, it should not effect the main points of this paper. An important argument later will depend on the fact that Russian [v] patterns with obstruents, categorically, in voicing effects, rather than with sonorants. This remains true however we decide to handle these two classes of phenomena.

3. Certain prepositions count as Pwds themselves, e.g., *skvoz*^{j} '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. This cannot be correct, however, 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 otʃen*^{j}*]*$_{Pwd}$ *bol*^{j}*ʃovo slona* '[from (the) very] large elephant', where the word 'very' hosts the preposition. Hence the need for the Pwd. A similar conclusion seems likely in the case of at least some enclitics, which Kiparsky also generates within the lexical phonology.

4. 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., /o'tets bʲ/ 'father (subjunctive)' (assimilation most likely), /'bratets bʲ/, 'brother (dim.) (subj.)', and /'leninets bʲ/ 'Leninist (subj.)' (assimilation least likely). She also states that longer clusters, as in /tekst ʒe/, do not assimilate fully.

5. It should be borne in mind that, given final devoicing, examples involving voiceless consonants before voiceless are not evidence for assimilation across Pwd boundaries. Final devoicing would predict, for example, [gorot] [takoj] 'such a town', from /gorod takoj/, whether assimilation

occurs or not. This point is sometimes overlooked.

6. 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 [medvetʲ] [goloden] '(the) bear (is) hungry'.

7. 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. {[buded]} {[doktorom]} 'will be (a) doctor', from /budet/ 'will be', contrast {[prevraʃʲ:aet]} {[doktor]} '(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]} {[boris]} 'Prince Boris', where assimilation is more likely, Halle (1959). These observations might be interpreted to mean that such phrases in fact have the status of clitic groups, i.e., {[buded] [dokotrom]}, {[knʲazʲ] [boris]}.

8. Such devoicing is suggested for [r] most often (Isacenko 1947, Boyanus 1955). As a trill, Russian [r] has a greater oral constriction than [l] or glides, and likely greater overall vocal tract constriction than nasals (which have the unobstructed nasal passage). It is therefore predicted to devoice more often, given the assumptions laid out in section 4. Devoicing of [r] is still by no means necessary.

9. 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 mzdɨ], nor does Reformatskii even mention such phrases. There seems to be no clear evidence, therefore, that sonorant syllabicity, even if it occurs, is an important factor here. It is worth mentioning that Robblee (1997) threw out data in which the sonorant seemed to be syllabic (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.

10. If there is no phonological voicing assimilation in [ot mzdɨ] 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 (1997) speculate that perhaps listeners perceive assimilation for other reasons: they found that the voice contrast for initial stops (but not fricatives) in such clusters was partially neutralized. Specifically, though voicing does not assimilate, the difference in stop duration due to underlying voicing is lost. Perhaps listeners perceive partially neutralized stops as somehow lacking in their own voicing and so 'assimilated'.

11. Pilch (1967) assumes that word-medial obstruent-sonorant clusters are heterosyllabic even when no prefix-stem boundary is involved, e.g., [skorb.nij] 'sorrowful', [od.no] '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., [skor.bnij], [o.dno]. (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.

12. The phrase 'or higher' and reference to 'cue strength' are intended to make the hierarchy in (14) 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.

13. It is simpler to evaluate violations of AGREE than of SPREAD, and they seem to have equivalent effects.

14. It would be easy enough to rank AGREEPPHRASE high, should we decide to attribute between-CG assimilation to the phonology.

15. Words obviously morphologically related were counted only once. Homonyms were treated as independent, each counted. Foreign words were counted also. Given the difficulty of making some of these judgements, the count should be considered very rough. The sequence [dʒ] occurred more than seven times also, though only in borrowings, e.g., *jazz*.

16. Barkaï (1978) argue the same for Hebrew [v], noting that a sonority-sensitive epenthesis rule treats [v] differently from [+son] segments.

17. I assume that this is an 'inclusion hierarchy'. That is, *D/ʊ means 'no voiced sounds of approximant constriction degree *or greater*', and so on. So [d] violates all three constraints shown.

18. There are only five words like /trezʊ̯/ in Russian, having a word-final sequence of voiced obstruent + /ʊ̯/, in Ozhegov's dictionary. It seems worth noting that all of these, except for /xorugvʲ/, are generative plural forms or 'short form' adjectives. In all of their other inflected forms the sequence is not word-final, but followed by a vowel, e.g., /trezvɨj/ 'sober' (long form). One wonders whether paradigm uniformity could be an influence here.

19. These accounts therefore predict that [ʊ̯] obstruentizes even before voiced obstruents. The proposal here predicts obstruentization only given devoicing, as seen earlier, as in [praʊ̯da] 'truth', not [pravda]. But the claim that [ʊ̯] is more of an obstruent before obstruents seems made precisely in order to explain [ʊ̯]'s behavior with respect to voicing effects; no independent reason seems to exist for it. In fact, one can find assertions tending to the opposite outside of discussions of voice assimilation. For example, Boyanus (1955) describes [ʊ̯] as a 'slight voiced glide' before obstruents. Pugh (1993) suggests that [ʊ̯] can be pronounced as something like [w] before consonants in general in standard Russian, including obstruents, e.g., [awgusta] 'august',

[aktiwnogo] 'active (gen.)'. Furthermore, there is little typological support for a claim that [ʋ̩] becomes a sonorant before sonorants. The feature [sonorant] is generally thought to never assimilate. McCarthy (1988) located it in the Root of his feature geometry representation for this reason, and many have followed him in this.

20. My source for Isoko is Peter Ladefoged's on-line version of *Vowels and Consonants*, at http://hctv.humnet.ucla.edu/departments/linguistics/VowelsandConsonants/. This is a helpful resource, since one can hear example words containing these sounds.

21. Dutch has two labiodentals, but these seem best interpreted as [v] - [ʋ]. Once again [v] patterns with the obstruents in voicing effects, while [ʋ] is neutral (Booij 1995).

22. SPACE constraints might plausibly take over all of the work done by positional faithfulness, it might be added. 'Salient' positions are not merely those in which cues are salient; they are those where perceptual distinctiveness is greatest (as Steriade 1997 notes). It would be very interesting to recast this paper's account of voicing within Dispersion Theory.

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