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Contrast is irrelevant in phonology: A simple account of Russian /v/ as /V/

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1 Introduction

The central claim of this paper is that contrast is irrelevant to the computations of I-phonologies. This was implicitly demonstrated in *The Sound Pattern of Russian* by Morris Halle (1959), but it has been widely unappreciated or ignored since. Failure to appreciate Halle's lesson has led to many convoluted attempts to deal with phonological patterns that turn out to be amenable to fairly straightforward analysis, once a few simple formal assumptions are made, and contrastiveness and the related notion of markedness are eschewed. I first explain my interpretation of Halle (1959) using toy grammars for the sake of clarity. I then turn to an analysis of the longstanding problem of Russian /v/ with respect to rules involving voicing alternations. Based on the Russian and an example from Tangale, I argue that contrast with respect to a feature F is neither a necessary nor a sufficient condition for predicting phonological behavior of segments with respect to F.

2 How Halle (1959) banned contrast

It is almost universally accepted as a truism that the notion of contrast is important in phonology: "Contrast... is one of the most central concepts in linguistics" (Dresher, 2009). I argue that this is a mistake, and that a crucial argument against the role of contrast is a trivial corollary of Halle's (1959) arguments against separating morphophonemic and phonemic rules.

Consider the hypothetical Language A in (1):

(1) Language A

N	with-N	for-N	
ma	mado	manu	*rat*
mas	mazdo	masnu	*mat*

An obvious analysis is that /s/ is voiced to [z] before /d/. Suppose there are no other sources of [z], aside from /s/ before a voiced obstruent. In other words, [z] is always derived from /s/. Keeping things simple for now, we might posit a rule like (2):

(2) 'Allophone' rule: s → z/ ___d

Now consider a language that presents the same data as Language A, but along with the additional forms in Language B in (3):

(3) Language B

N	with-N	for-N	
ma	mado	manu	*rat*
mas	mazdo	masnu	*mat*
maz	mazdo	maznu	*cat*

Once again, we can posit the rule we saw above, but now it is a neutralizing rule, because we need to posit an underlying contrast between /s/ and /z/, given the minimal pairs *mas/maz* and *masnu/maznu*.

(4) 'Neutralizing' rule: s → z/ ___d

Obviously, the rules in (2) and (4) are identical. So, what is the difference between the two languages, Language A and Language B? As far as the grammars are concerned, the languages are *computationally* identical. They contain the same rule. **The only difference between the languages is in the contents of their lexicons.** We linguists can label the rule of Language A as allophonic (or phonemic-to-phonetic), and the rule of Language B as neutralizing (morphophonemic-to-phonemic), but that difference is not part of the ontology of grammar, since Halle's (1959) discussion of Russian.

Of course, the two data sets present the linguist (and learner) with different epistemological challenges. For Language A, we need to rely on the fact that the occurrence of [s] before [n] and before a word boundary cannot be described as a natural class of environments, whereas the occurrence of [z] before just [d] (or, perhaps, before all voiced obstruents) *can* be described in natural class terms. Such considerations allow us to posit underlying /s/ for 'mat'. In Language B, if we assume that 'mat' has either /s/ or /z/, then 'cat' tells us that 'mat' can't have /z/, so it must have /s/, basically by appeal to the rule of inference *modus tollendo ponens*: If we know that (p or q) is true, and we know that q is false, then we know that p is true (see Bale and Reiss, Forthcoming, for extended discussion in the context of phonology pedagogy).

Note that there is no need to encode in Language A a morpheme structure constraint against underlying /z/—there is no underlying /z/ because a learner

confronted with data like Language A won't set up any lexical items with /z/. On the other hand, a learner faced with data like Language B will be forced to set up distinct phonological representations for 'mat' and 'cat'.

Consider another language, Language C, that combines the situations in Language A and Language B. Like Language B, Language C has a neutralizing rule of voicing assimilation, such that /s/ becomes [z] before /d/. Like Language A, it has an underlying voiceless fricative, say /x/ that voices to [ɣ] before /d/, but there is no reason to posit an underlying /ɣ/, since, we'll assume, every [ɣ] can be derived from /x/. Suppose there are no other obstruents in the language. The data for this Language C looks like what we see in (5):

(5) Language C

N	with-N	for-N	
ma	mado	manu	*rat*
mas	mazdo	masnu	*mat*
maz	mazdo	maznu	*cat*
max	maɣdo	maxnu	*hat*

At this point, we can write a single rule like the following, using features and a notation explained below:

(6) $$\left[\ -\textsc{Sonorant}\ \right] \rightarrow \{\ +\textsc{Voiced}\ \} \ /\ \underline{\quad}\left[\begin{array}{l} +\textsc{Voiced} \\ -\textsc{Sonorant} \end{array}\right]$$

Note that the voiced /n/, does not trigger voicing of preceding obstruents, because it is specified + Sonorant.

We have now constructed a toy version of important aspects of Halle's discussion of Russian. Applied to our data, Halle's argument is that it would be inelegant to posit two rules in the grammar of Language C, one that applies to /s/ but not /x/, and another that applies to /x/ but not /s/. In other words, Halle argues against the distinction between what I am calling neutralization and allophone rules.

I propose that Halle's conclusion is tantamount to the following claim:

(7) **No contrast in phonology (Ncip):** Rules are blind to the content of the lexicon. Rules are functions that map segments to segments depending on their local context (syllable structure, precedence relations, etc.) Global or systemic considerations such as the content of segment inventories are not relevant to rules.

It follows from (7) that there is no mechanism in phonology to consider the contents of the lexicon. From the phonology's point of view, there is no such thing as a neutralization rule or an allophonic rule. Those are taxonomic labels that linguists use to describe mappings between underlying forms and surface forms, but they have no status in the theory. In plain English, the phonology doesn't 'care' about contrast, because it has no mechanism by which to do so.

Despite the influence of Halle's discussion of Russian voicing assimilation and the rejection of separate levels for morphophonemic and phonemic rules, the corollary of a rejection of the relevance of contrast has not been appreciated.

3 Voicing and sonorants

Looking back at the forms of Language C, we see that the nasal /n/ does not cause voicing of /s/ to [z] or of /x/ to [ɣ]. Let's assume that all sonorants in the language behave like the nasals in this regard. There are basically two approaches to handling such a situation. The approach advocated here is that this detail of the rule in (6), the need to specify that the trigger is - SONORANT, is just like any other aspect of the rule. It is a 'local' stipulation that makes the rule what it is. Perhaps it is better to not call it a stipulation, but rather just a specification that constitutes the rule, like all its other parts. The existence of such details in a rule is just the normal use of the combinatoric feature system. Natural classes of targets, environments and triggers can be specified by various feature combinations—if we could not do so, why would we have posited such a feature system? It serves no other purpose. (See David Odden's contribution to this volume, which makes the same point, as do Odden (1988) and Reiss (2003)).

The alternative to such a local explanation is to seek a 'global' explanation. One type of global explanation involves putative markedness considerations concerning voicing in sonorants and voicing assimilation to sonorants, including the observation that it is rare to find voicing contrasts in sonorants (although, there are well-described languages with distinctive voicing in sonorants according to Gordon and Ladefoged (2001)).

So, one version of this approach is to use a rule like (8), which leaves out the superficially relevant - SONORANT specification on the trigger that we saw in (6):

(8) [−SONORANT] → { +VOICED } / ___[+VOICED]

This rule can be made to work in various ways. One way is to claim that sonorants are in fact not voiced at the stage in the derivation at which the rule applies. This is the approach of Kiparsky (1985), for example, in his discussion of Russian and other languages. In fact, Kiparsky is forced, by his attachment to contrast, to assume that sonorants are not marked for voicing in the lexicon (see below), but he has the grammar fill in on sonorants the "unmarked" value late in the derivation. This gets him into trouble in his analysis of English, where he inexplicably takes the plural suffix to be /-s/, and needs sonorants to be overtly + VOICED late in the derivation in order to form a natural class with voiced obstruents, so that he can derive, *e.g., bell*[z] and *dog*[z]. Unfortunately, since the rule is post-lexical (by his own hypothesis) he fails to account for the lack of voicing in, say, *force, false, quince*.

A second approach is to propose that voicing, that is vocal fold vibration, in sonorants, does not correspond to the same valued feature, + VOICE that vocal fold vibration corresponds to in obstruents like /d/ or /z/—this is the idea behind the SV (for Sonorant Voicing or Spontaneous Voicing) feature node of work like Rice (1993).

Both of these solutions seem to undermine the whole idea of a combinatoric feature system and reflect a confusion of levels of explanation. The point

of having a feature system is to define natural classes of segments by cross-categorization. If we treat segments as sets of valued features, then natural classes are set of sets of valued features. The natural class of voiced obstruents is the set of segments that are each a superset of the set of valued features {+ VOICE, - SONORANT}. This natural class of segments is a subset of the natural class whose members are each supersets of {+ VOICE}. As we remove specifications, the extension of the relevant class gets bigger (or stays the same). Either of these natural classes can appear in rules to define a target or environemnt of rule application.

So, why do what Kiparsky does and leave out the specification - SONORANT that gives you exactly the set of triggers you want for the rule to apply correctly? And why do what Rice proposes and introduce a new feature that describes a set of segments that is extensionally equivalent with the set whose member segments are supersets of {+ SONORANT,+ VOICE}? We have a perfectly good way to describe the segments we want to describe—why not use it?

The confusion inherent in these approaches is that they don't separate (i) the question of how to encode the special behavior (or non-behavior) of sonorants *vis-à-vis* other voiced consonants in various rules from (ii) the question of which phonetic properties of sonorants make their voicing different from that of obtruents in perception and articulation. Whatever these properties are, they influence (or rather constitute) perceptual biases during language transmission. These directional biases during acquisition help explain the ontogeny of sound changes that are the source of many common phonological rule types. I thus reject here, as elsewhere (Hale and Reiss, 2008), the practice of building such putative typological patterns into the phonological module of grammar, adopting instead the position of historical linguists like Mark Hale (2007) and phoneticians like John Ohala (1990) that phonetic diachronic explanations should not be duplicated in grammar (again, see Odden's contribution to this volume, as well as Blevins', for related discussion).

Here, I am specifically challenging the idea that the different behavior of sonorants with respect to voicing in the numerous numerous languages that act like Language C (including Russian, Hungarian, and English under standard (non-Kiparskyan) assumptions) in not having obstruents assimilate to the voicing of sonorants, should be related to the absence of a voicing contrast in sonorants in the language. I reject the idea that this lack of contrast needs to be encoded in the phonological computational system. The putative markedness of voiceless sonorants has no bearing on whether voiced sonorants have a special kind of voicing, either unspecified, or else specified as SV.

So, why do many phonologists implicitly accept that the presence or absence of a contrast in the lexicon is irrelevant to the nature of the *targets* of the voicing assimilation rule in a situation like Language C (in that allophonic and neutralizing applications are not distinguished), but they explicitly insist that the absence of a contrast in the lexicon *is* relevant to the nature of the *trigger* of such a voicing rule—the absence of voiceless sonorants is supposed to be relevant in cases like Language C? My strategy in addressing what I perceive to be an unprincipled appeal to contrastiveness is to provide a solution to the

classic problem of the voicing-related behavior surrounding /v/ in Russian. If the account, which makes no reference to contrast, is attractive, this at least suggests that a contrast-free phonology may be workable.

Before proceeding, let's be clear that contrast is obviously used as a *heuristic* by phonologists. The contrast in the minimal pair *mas/maz* in (5) tells us that it might be a good idea to posit different underlying forms for the two words. But that is a matter of epistemology, a matter of how we figure out the phonology, as discussed above. The phonological computation system does not have the notion 'minimal pair', and thus it does not need to have the notion of 'contrasting feature'. Since much discussion of contrast involves features that are or are not contrastive in a given context, like say, the non-contrastiveness of VOICE in English sonorants, we need to be clear that we are rejecting even this relativized notion from playing a part in phonological computation.

4 Appeals to contrast are opportunistic

The Chadic language Tangale has nine surface vowels. There are four ± ATR pairs /i,ɪ,e,ɛ,u,ʊ,o,ɔ/ and a single unpaired low vowel, /ɑ/, which is - ATR. In (9), a suffix with the vowel /ɑ/, /-nɑ/ can surface after both + ATR and after - ATR vowels, as in (ab), respectively.

In (cd), the suffix U (underspecifed for ATR), surfaces with the ATR value of the preceding vowel. The form in (e) suggests that the low vowel is indeed - ATR and that this value can spread to the suffix from the low vowel. In (f), we see that two suffixes in a row with the underlying /U/ vowel will both copy the ATR value from the first specified vowel to the left (see Mailhot and Reiss, 2007, for one proposal concerning how this might work without iterative application). In (g), we see that the suffix surfaces with the -ATR value of the /ɑ/, and not with the + ATR value of the /i/ in the root.

(9) Tangale ATR harmony (van der Hulst and van de Weijer, 1995)

a.	peer-nɑ	[peernɑ]	'compelled'
b.	pɛd-nɑ	[pɛdnɑ]	'untied'
c.	seb-U	[sebu]	'look' (imp.)
d.	kɛn-U	[kɛnʊ]	'enter' (imp.)
e.	ʔwɑr-U	[wɑrʊ]	'go' (imp.)
f.	ɗob-Um-gU	[ɗobumgu]	'called us'
g.	ɗîb-nɑ-m-gU	[ɗîbnɑmgʊ]	'called you (pl.)'

The Tangale pattern is only surprising if one thinks that the ATR value on /ɑ/ should not be visible, or should be phonologically inactive because there is no ATR contrast in low vowels. Without such a prejudice, Tangale is completely straightforward. Now, there *are* cases of languages with so-called transparent vowels, and it is sometimes possible to build an explanation for such behavior around the presence or absence of contrast in the segment inventory, but for our purposes, Tangale is sufficient to demonstrate that even features that do not contrast in a given environment can be phonologically active. If contrast is

invoked opportunistically in languages where it works, but ignored in cases like Tangale, it has no explanatory power. One version of the opportunistic appeal to contrast is the "parameterization" of rules in Nevins (2010, especially Chapter 3), who allows each rule to be specified as to whether or not it is sensitive to non-contrastive features. Although it is easy to state such a condition on rules, this kind of systemic sensitivity forces the rule component to have access to the segment inventory in the lexicon and to contain a separate module to determine which features are contrastive in a given context. If we can do without such complications by just using correctly specified rules, then global economy for UG should trump this mechanism, even if it sometimes simplifies the description of particular languages. To make this concrete, a rule like (6) looks less economical than a rule like (8), but the latter requires further mechanisms such as reference to the non-contrastiveness of voicing in sonorants or new features like SV. If we can do without such mechanisms in UG, then we should, by Occam's Razor.

5 Russian voicing patterns

Let's turn now to an account of voicing rules in Russian that does not appeal to contrast. Although my conclusions are diametrically opposed to many of those in Padgett (2012, 2002), it is hard to overstate my debt to those papers for their clarity and their thoughtful treatment of the complex phonetic and phonological issues involved in the Russian data, and their clear presentation of the often conflicting accounts of the language. I steer clear of the issues of syntax-phonology interface (*e.g.* word-final devoicing does not occur at the end of a preposition followed by its object, presumably because the two are in the same *phonological word*), and also of the murky domain of gradient phonetic-y phenomena (including claims that sonorants "optionally and gradiently" devoice word-finally), and I adopt wholesale Padgett's feature-level interpretation of the patterns within clitic groups and phonological words. This paper deals only with what Padgett calls "categorical and obligatory processes".

Russian has two processes that we need to consider. First, there is a rule of word final devoicing (FD) which affects all obstruents. Each voiced obstruent has a voiceless counterpart that shows up in final position, and each of those voiceless segments is found underlyingly. Sonorants are not subject to FD—I assume they are voiced underlyingly, and they remain voiced word-finally.

FD in Russian feeds a rule of Voicing assimilation (VA) that is much like what we illustrated in Language C. There are a few details of Russian to consider. First, VA applies within a cluster at the end of a word, and also across certain word boundaries, presumable when the words are within some structural unit, say, the same phonological word. We are only concerned with the cases where the rule does apply—the syntactic conditioning for this phrasal phonology is not our concern here. Second, clusters assimilate to the voicing of the rightmost member, and the rule appears to apply iteratively from right to left. Third, some applications of VA are neutralizing, for example, cases that voice /t/ to [d] or /k/ to [g] or /s/ to [z], but some applications are 'allophonic' since some

voiceless obstruents do not have voiced counterparts that appear in the lexicon. For example, there is no reason to posit lexical /ɣ/, but this segment does appear in surface forms as the result of VA applied to /x/ (see Halle, 1959, p.22). In the rest of this section, we illustrate these two rules with Russian data. We will begin with simple cases, and take the opportunity to introduce some non-standard assumptions that we adopt. The Russian data we present appears in various places in the literature. We leave the discussion of /v/ to the following section.

5.1 Russian Final Devoicing

The paradigms in (10ab) illustrate that Russian has final devoicing, and not a voicing rule.

(10) Russian final devoicing

a. porok-a	porok	'vice (gen./nom.sg.)'
b. porog-a	porok	'threshold (gen./nom.sg.)'
c. sled-a	slet	'track (gen./nom.sg.)'
d. knig-a	knik	'book (nom.sg./gen.pl.)'
e. raz-a	ras	'occasion (gen./nom.sg.)'
f. gub-a	gup	'lip (nom.sg./gen.pl.)'
g. plʲaʒ-a	plʲaʃ	'beach (gen./nom.sg.)'

The rest of the forms show further examples of FD. A first pass at a rule of final devoicing would complete the process in one step, something like (11):

(11) $\left[\ -\textsc{Sonorant}\ \right] \rightarrow \{\ -\textsc{Voiced}\ \}\ /\ \underline{\quad}\%$

In the following subsections, I explain my notation and refine this formulation.

5.2 Notation

I adopt several modifications of standard rule notation to clarify the set theoretic types relevant to phonology (see Bale et al., 2014; Bale and Reiss, Forthcoming, for details). Segments are treated as sets of ordered pairs which, in turn, are just the familiar valued features like - Voiced.[1] So, a segment like /t/ is just the set {- Voice, - Labial, - Continuant, - Sonorant, ...}. A segment must be a *consistent* set of valued features, which means that if, for a feature F, αF is a member of the segment, then $-\alpha$F is not. However, segments need not be *complete*. This means that for some features, a segment can lack ordered pairs containing those features. In other words, underspecification is allowed.

[1] I am not implying that we have anywhere close to the correct characterization of the universal feature set. In Hale et al. (2007) we argue that there are probably many more than the twenty or so assumed in much work. My acceptance of a universal innate feature set with regular phonetic correlates (subject to some important caveats) is sometimes taken to be at odds with the Substance Free Phonology perspective I adopt. See Reiss (2017) for an attempt to clarify these murky issues.

Since segments are sets of valued features, natural classes of segments are sets of sets of valued features. For example, the set of voiced obstruents is the set of segments all of which have both + VOICED and - SONORANT as members. In other words, the natural class in question consists of all the segments that are supersets of {+ VOICED, - SONORANT}:

(12) Natural class of *segments*

$X = \{x : x \supseteq \{+ \text{ VOICED, - SONORANT }\}\}$

When referring to natural classes like this, we adopt standard phonological square bracket notation, so after all this, we just denote the natural class in question thus:

(13) Natural class of voiced obstruents as a set of *segments*

[+ VOICED, - SONORANT]

When denoting a structural change, we are not referring to a set of segments, but just to a set of features that are involved in the rule mapping, so here we use normal set brackets.[2]

(14) Structural Change—a set of *valued features*: {- VOICED}

In (11), we use the symbol '%' to denote word final position, as opposed to the usual use of '#' for all word boundaries. We won't discuss here our reasons for differentiating the two here. Below, we will need to refer to environments defined by natural classes of segments, so the same convention as used to define targets will apply. For example, the environment 'before a high vowel' refers to the environment before all segments that contain, say, + SYLLABIC and + HIGH, so '___[+ SYLLABIC, + HIGH]'.

5.3 Feature changing final devoicing in two steps

For reasons discussed in Bale et al. (2014), I adopt an approach to feature-changing processes suggested by Poser (1993, 2004) that is widely adopted (for example by Wiese, 2000; Samuels, 2011). Instead of the one-step process suggested by (11), I adopt a two-step process by which first a valued feature is deleted, and then its opposite value is inserted.[3] In order to be explicit about the nature of these two processes, I model deletion as set subtraction and insertion as unification.

The first step in modeling Russian final devoicing of obstruents is to remove the specification of + VOICE. There are at least two options: we can either

[2] Obviously not in the curly brackets notation of traditional phonology, which denotes disjunction.

[3] Note that the proposal is not to keep track of what valued feature gets deleted, then insert the opposite. The idea is that since the rules happen to involve opposite values of the same feature, we can refer to the two rules together as a 'feature-changing process', but such 'processes' have no status in the model.

target only voiced obstruents or we can target all obstruents. This distinction is not critical to our discussion (and the right answer is not clear), so we'll go with the second, more general version.

(15) DELETION:
[- SONORANT] − {+ VOICE} / ___%

Since we have formalized segments as sets, we can immediately make use of well-understood operations from set theory in our phonology. A simple way of deleting elements from a set is to use the operation of set subtraction, which is symbolized with either '\' or '−'. I use the latter symbol. Here are some examples of set subtraction:

(16) Set subtraction examples

- {a,b,c} − {a,b} = {c}
- {a,b,c} − {a,b,d} = {c}
- {a,b,c} − {d} = {a,b,c}
- {a,b,c} − {a,d} = {b,c}

Examining these examples, you can probably recall that for two sets A and B, $A - B = C$, where C is the set of all members of A that are not members of B. The interpretation of the rule in (15) is thus what we see in (17):

(17) For all segments x, if x is a superset of {- SONORANT} and x appears at the end of a word, then $x \mapsto x - \{+ \text{ VOICE}\}$. (Otherwise $x \mapsto x$.)

Read the symbol '$\mapsto$' as 'maps to' or 'is assigned the new value'. This is like an assignment operation in a computer language that updates the value of variable, for example, '$x = x + 1$'. Because of the nature of set subtraction, rule (17) will only apply non-vacuously to segments that are + VOICED and - SON.

It should now be apparent why we made the distinction between square and curly brackets above. A rule applies to a natural class of segments, and each segment is a set of valued features. So, we intend for our rule to delete {+ VOICE} from each member of the target natural class. That is, we don't intend to subtract the set of valued features from the set of segments. So, we need to clarify that we are extending the '−' symbol slightly. If A and B are sets of the same type t, (say, sets of valued features), then $A - B$ is just the set difference of A and B. However, if $\mathcal{A}$ is a set of sets of type t and B is a set of type t, then $\mathcal{A} - B$ is the set $\{C : C = A - B, \forall A \in \mathcal{A}\}$. In other words, subtraction of B gets mapped over the members of the set $\mathcal{A}$.[4]

[4]This dual use of an operator symbol is called 'operator overloading' or 'operator *ad hoc* polymorphism,' in the programming language world. The idea is that a symbol is interpreted in a manner appropriate to the types of the arguments it is given. For example, the '+' symbol can be used both to add numbers and concatenate strings. It is important to note, however, that this overload of the '–' operator is only present in the metalanguage I am using. The grammar itself uses only one interpretation of the operator, the one that maps over sets of segments. Simple set subtraction, as in (16), does not appear to be necessary.

The next rule we need will fill the value - VOICE in obstruents in the same position, word-finally. We achieve this with unification, for reasons discussed in Bale et al. (2014), rather than simple set union.[5] Once again, we extend a simple symbol, the unification '⊔', to denote a mapping of unification over each member of a natural class:

(18) [- SONORANT] ⊔ {- VOICE} / ___%

The interpretation of the rule in (18) can be broken down as follows:

(19) Feature-filling rule via unification (where ↦ represents the mapping of one segment to another)

IF ...	Comment:
a. $x \supseteq$ {- SONORANT} AND	If x is an obstruent ...
b. x is word-final AND	...
c. $x \sqcup$ {- VOICE} is defined	If x and {- VOICE} are consistent ...
THEN $x \mapsto x \sqcup$ {- VOICE}	Then **replace** x with $x \sqcup$ {- VOICE} ...
ELSE $x \mapsto x$	If any conditions fail, leave x alone.

We know that when this rule applies all word-final obstruents will be consistent with - VOICE because they will have lost their specification + VOICE by rule (15), or else they were underlyingly - VOICE. Keep this in mind for our discussion of /v/ below.[6]

5.4 Feature-changing assimilation in two steps

Now let's look at the simple cases of voicing assimilation:

(20) Obstruent voicing assimilation (from Padgett 2002)

a.	ot-jexat^{j}	'to ride off'	s-jexat^{j}	'to ride down'
b.	ot-stupit^{j}	'to step back'	s-prosit^{j}	'to ask'
c.	od-brosit^{j}	'to throw aside'	z-delat^{j}	'to do'
d.	pod-nesti	'to bring (to)'	iz-lagat^{j}	'to state; set forth'
e.	pot-pisat^{j}	'to sign'	is-kl^{j}utʃat^{j}	'to exclude; dismiss'
f.	pod-ʒetʃ	'to set fire to'	iz-gnat^{j}	'to drive out'

The underlying segment in each prefix surfaces before a sonorant such as /j,n,l/, because sonorants do not trigger voicing assimilation (just like in our toy languages). So, the prefixes are /ot-, pod-, s-, iz/, and we see reciprocal neutralization of either /t/ and /d/ or /s/ and /z/ in the surface alternants of each prefix.

Again using the 'delete then insert' approach to feature changing, these cases are modeled via the following two rules. We use Greek letter variables in

[5] For any two sets, A and B, the unification of A and B, $A \sqcup B$, is defined iff $A \cup B$ is consistent. When defined, $A \sqcup B = A \cup B$.

[6] The rule in (18) can actually be simplified to this: '[ ] ⊔ {- VOICE} / ___%', because the only word-final segments at this point in the derivation that are not - SONORANT are all + VOICED, so unification will fail with all of them. The rule means "unify every segment with { - VOICE}", since '[ ]' denotes the set of segments that are supersets of the empty set. Of course that refers to every segment.

our phonology, not just as meta-language variables (*pace* McCawley, 1971), for reasons outlined in Bale and Reiss (Forthcoming).

(21) Voice deletion before another obstruent:

[- Sonorant] - {α Voice} / ___[- Sonorant, -α Voice]

Note that the segment that defines the environment has been specified not only as - Sonorant, but also as having a value for Voice that differs from that of the target. The reason for this will become clear later.

The feature deletion rule in (21) has been stated as a simple interaction between adjacent segments. However, the examples seen thus far are just a special case of a more general phenomenon. In brief, adjacency in such cases is just a special case of a long-distance phenomenon, and the rule we will ultimately need follows the model of long-distance interaction developed in Mailhot and Reiss (2007); Shen (2016); Samuels (2011). Here we give just an informal version of the rule we need:

(22) Long distance feature deletion (LDFD): Starting from each segment ς that is - Sonorant, α Voice search right, and if the first voicing value encountered is on a segment τ, such that τ is - Sonorant, $-\alpha$ Voice, map ς to $\varsigma - \{\alpha$Voice$\}$

This long-distance version of the rule allows the search to terminate at anything which is specified for voicing, regardless of whether it is $\pm$Sonorant.

Next we need to insert the correct value for Voice by unifying the target segment with the voicing from the triggering segment. Here is the simple, adjacency version.

(23) [- Sonorant] $\sqcup$ {α Voice} / ___[α Voice]

This rule provides a Voice specification for the segments that lost theirs by the rule in (21). However, this rule can be simplified if we suppose that only obstruents affected by (21) or (22) are missing voice specifications:

(24) [ ] $\sqcup$ {α Voice} / ___[α Voice]

As discussed in Bale et al. (2016), the target of this rule is the set of segments that are each a superset of the empty set, so, all segments. However, at this point in the derivation, each target segment will (i) have the same value of voice as the triggering value, and thus unify with that value vacuously; (ii) have no value for voice and thus unify with the triggering value; or (iii) have the opposite value from that on the trigger, and thus fail to unify, because of the consistency requirement (for example, if the target is a vowel or sonorant, and the trigger is - Voice).

We'll need a long-distance version of this rule later:

(25) Long distance voicing assimilation (LDVA): Starting from each segment ς, search right, and find the first segment τ that is specified for voicing. If τ is α Voice, map ς to $\varsigma \sqcup \{\alpha$Voice$\}$

The data in (26) show that the two rules of the final devoicing process feed the two rules of the voicing assimilation process:

(26) FD feeds voicing assimilation

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

Consider a form like *pojest*, from /pojezd/. First, + VOICE is deleted from the /d/ by rule (15). Then - VOICE is inserted on the same segment, making it [t] by rule (18). Then + VOICE is deleted from the /z/ by rule (22). Finally, - VOICE is copied into that segment by rule (25).

6 'Inconsistent' /v/ is really /V/

The copious literature on the inconsistent behavior of Russian /v/ tends to focus on its putative status as a segment between an obstruent and a sonorant. Jakobson (1978), for example, says the segment "occupies an obviously intermediate position between the obstruents and the sonorants". Of all people, Jakobson should not have made such a statement. As one of the architects of distinctive feature theory, he knew that features give us the tools to transcend the vague traditional phonetic categories. Given a binary feature system, there are no "intermediate positions" (other than 'unspecified'). There are just points in a discrete multidimensional space, each defined by sets of valued features. A set of valued features can be specific enough to define a natural class containing a single segment, or it can be incomplete with respect to some features and thereby define larger sets of segments. That is the whole point of the combinatoric feature system—each combination is different from the others. Because of the complex, context-dependent phonetic correlates of the features, we expect a range of phonetic interactions among feature values in a segment. Lip rounding in a high vowel is physiologically different from lip rounding in a low vowel, for example. We may, therefore find rounding more likely to spread to other segments from vowels of one height than from vowels of another. But such an observation has absolutely no bearing on the fact that the two kinds of vowels are members of a single class, say, those that contain the specification + ROUND. It is completely expected that a valued feature will sometimes be 'enhanced' or more phonologically 'active' in some segmental contexts and 'suppressed' or less 'active' in others. This is exactly why the SV node proposal mentioned above makes no sense—it already follows from a combinatoric feature system that + VOICE combined with + SONORANT might behave differently from + VOICE combined with - SONORANT.

The extreme case of this segment-internal context sensitivity is found when a single segment behaves in an idiosyncratic manner. That is what happens with Russian /v/. Two issues then arise. One is the question of why it is /v/ that tends to behave in an idiosyncratic manner, not just in Russian, but in

many languages (see Bjorndahl, 2015, for discussion and references). But this is a matter for *phonetics* and *historical phonology.* The second question is *Given phonological the behavior of this segment, what should we posit as its* **phonological** *representation in terms of features?* Depending upon one's theory, different principles apply. For example, most phonologists do not allow statements like this: *An obstruent assimilates to the voicing of a following obstruent,* **unless** *that following obstruent is a voiced, labiodental, fricative.* We don't allow this, because we don't allow the logical equivalent of **unless** in our rules. But since that forbidden statement is exactly what we seem to want to say, we have to be tricky. Once way to be tricky is to say that /v/ in Russian is not really an obstruent. This is a common strategy in the literature on Russian /v/, but I find it strange since the reasoning appears to reduce to something like this:

(27) Strange reasoning: "With respect to voicing assimilation, /v/ acts sometimes like an obstruent, and sometimes like a sonorant, so even though it always surfaces as an obstruent, it must actually be a sonorant"

For example, Hayes (1984) proposes that Russian /v/ is actually /w/, in other words, it is not an obstruent underlyingly, but rather a sonorant. Hayes is forced to posit derivations that (a) turn *all* of his labiodental sonorants into obstruents, (b) create then destroy the segment [w̥], which is surely highly marked by any normal criteria, and (c) devoice and revoice many sonorants in Duke of York fashion (see p.320).

Even if we accept all these complexities, Hayes' solution remains unsatisfying, because Russian /v/ does not behave like the segments that definitely are sonorants—/v/ shows up as a voiceless fricative [f] sometimes and [v] the rest of the time. Instead of going through various clever accounts of /v/ that fiddle around with the specification of the feature SONORANT, I propose a simple solution that instead fiddles around with the feature VOICE. In brief, I propose that /v/ is indeed a labiodental fricative, and thus specified - SONORANT, but that it is underlyingly unspecified for VOICE. I'll denote this segment /V/. This simple appeal to underspecification allows us to derive the special behavior of /V/ straightforwardly.

6.1 /V/ is a target of final devoicing

The segment /V/ (whether palatalized or not) is subject to final devoicing—that is, it surfaces as - VOICE—so it looks like the other obstruents in this regard. The reason it undergoes final devoicing, that is, insertion of - VOICE, is that it has no voicing specification when the feature-filling-by-unification rule (18) applies. I propose that the lack of a voicing specification on the derivative of /V/ at this point in the derivation is *not* due to the subtraction of {+ VOICE} by rule (15). This rule removes the voicing from underlying segments like /z/ and /d/. However, /V/ is *underlyingly* unspecified for VOICE. Once (15) applies to the other voiced obstruents, however, they are like /V/ in being specified - SONORANT, but having no value for VOICE. All of the - SONORANT segments,

including /V/, can now be unified with {- VOICE} in final position. We can see in (28) that /V/ does indeed undergo final devoicing, *qua* unification with - VOICE after the neutralization effected by rule (15).

(28) Final Devoicing affects /V/ (and [V^{j}])

prava	'right (fem.)'	praf (masc.)
l^{j}ubvi	'love (gen.)'	l^{j}ubof^{j} (nom.)
krovi	'blood (gen.)'	krof^{j} (nom.)

So, /V/ neutralizes with the voiceless obstruent /f/ to [f] in final position.

For clarity, in (29) I give the application of final devoicing to final /g,k,V,f/.

(29) Final devoicing applied to various segments

	g%	k%	V%	f%
UR	[+Voi, −Son, ⋮]	[−Voi, −Son, ⋮]	[−Son, ⋮]	[−Voi, −Son, ⋮]
Deletion of + VOI (Rule 15)	[−Son, ⋮]	[−Voi, −Son, ⋮]	[−Son, ⋮]	[−Voi, −Son, ⋮]
Insertion of - VOI (Rule 18)	[−Voi, −Son, ⋮]	[−Voi, −Son, ⋮]	[−Voi, −Son, ⋮]	[−Voi, −Son, ⋮]
SR	k	k	f	f

So, with respect to the feature VOICE, /g/ and /V/ start out different, but that difference is neutralized by rule (15). Then these two segments each neutralize with their corresponding underlying - VOI segment.

6.2 /V/ is not a trigger of voicing assimilation

Unlike the other surface voiced obstruents, [v] from /V/ does not *trigger* voicing assimilation. This follows naturally from the fact that a preceding obstruent, whatever its value for VOICE, cannot lose that value *via* rule (21), because the absence of VOICE on /V/ prevents the rule conditions from being met. Now we see why the 'opposite value' condition was needed in the two versions of the rule deleting voicing values (21,22). With no value for VOICE, underlying /V/ can't trigger deletion in the segment to its right.

The failure of /V/ to trigger assimilation is seen in (30), taken from Padgett (2002, p.11):

(30) Failure of /V/ to trigger assimilation

a.	tver^{j} 'Tver'	dver^{j} 'door'
	sverx 'above'	zverj '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.)'

The cases in (a) are within a morpheme; the cases in (b) cross a morpheme boundary; and the cases in (c) are across a preposition-pronoun boundary. We'll see below in section 6.4 that when another obstruent occurs to the right of the /V/, the /V/ does appear to trigger assimilation.

6.3 /V/ is a target of voicing assimilation

Although, /V/ does not trigger voicing assimilation, it does undergo that process. This also follows from our analysis of /V/ as lacking a specification for VOICE. The copying of a VOICE value from a following segment is handled by rule (23). This rule requires only that the target be specified - SONORANT and be able to unify with the following VOICE value. Despite not having been affected by the preceding rule (21), /V/ will always be able unify with any VOICE value, since it has none of its own. If /V/ unifies with {- VOICE}, it surfaces as [f]. If it unifies with {+ VOICE}, it surfaces as [v], by which we of course mean a segment that is - SONORANT, + VOICE, as opposed to the underlying segment /V/ that lacked a VOICE specification.

The form in (31) shows in a single form that /V/ undergoes voicing assmilation but fails to trigger it:

(31) /V skVaʒine/ → [f skvaʒine] 'in the chink'

The first /V/ becomes [f] by assimilation to /s/. The second /V/ does not induce voicing in the preceding /k/.

6.4 Transmission of voicing via /V/

Padgett's lucid presentation of the Russian facts include a discussion of clusters consisting of a sonorant between two obstruents: "Sonorants have been said famously not only to devoice, but to be transparent to voicing assimilation in constructions" like [od mzd] from /ot mzd/ and [is mtsenska] from /iz mtsenska]. These were the transcriptions adopted by many scholars including Jakobson (1978); Hayes (1984); Kiparsky (1985). However, Padgett points out that this view has "always been a controversial claim" and that some scholars such as Shapiro (1993), deny it altogether. He cites recent phonetic studies of some constructions that show no voicing assimilation whatsoever through some sonorants (Burton and Robblee, 1997). I follow Padgett in assuming that there is no phonological—"categorical and obligatory"—voicing assimilation through sonorants.

Before we return to these three-segment clusters, recall the tradition of treating /V/ as underlyingly a sonorant in Russian and relating its failure to trigger voicing assimilation to its + SONORANT status, as Hayes (1984) did. Superficially, (32) shows that /V/ behaves like other sonorants, like /n/:

(32) No triggering by /V/ or /n/
(a) ot-vesti 'to lead away' (b) pod-vesti 'to lead up'
(c) ot-nesti 'to carry away' (d) pod-nesti 'to bring (up to)'

Both /t/ and /d/ surface unchanged before either /V/ or /n/.

However, the parallelism falls apart when another obstruent appears to the right of the /V/ or /n/, as in (33), that is, when we come back to the three-segment clusters mentioned above:

(33) A difference between /V/ and sonorants
(a) /ot VdoVɨ/ → odvdovɨ'from the widow'
(b) /k Vzdoxam/ → gvzdoxam 'to the sighs'
(c) /pod Vsemi/ → potfsemi 'underneath everyone'
(d) ot mzdɨ 'from the bribe'
(e) iz mtsenska 'from/out of Mcensk'

In (a) and (b), the leftmost voiceless obstruent ends up voiced, by the 'transmission' of + VOICE through the /V/. Form (c) shows that - VOICE also can be transmitted through /V/, which surfaces as [f]. In (d) and (e), where there is a 'real' sonorant /m/, there is no featural assimilation through the cluster—we have t___zd in (d) and z___ts in (e).

This outcome is completely expected from our model so far, but it is unexpected if /V/ is treated as + SONORANT. There is no reason to assume that /V/ is + SONORANT at any level of representation, *pace* Hayes (1984); Kiparsky (1985) and others. Let's compare what happens in the clusters /kVz/ vs. /tmz/.

Voicing assimilation appears to propagate through clusters from right to left. Kiparsky 1985, for example, takes this phenomenon as evidence that rules can apply iteratively to their own output. This is because /V/ looks like it *can* trigger voicing assimilation once it has undergone the process itself. In order to avoid the necessity for iterative rule application, I adopt instead the view that the value on the rightmost member is deleted simultaneously to all the targets of set substraction, then inserted simultaneously on all targets of unification, adopting the Search and Copy mechanisms of Mailhot and Reiss (2007); Shen (2016); Samuels (2011) and others, introduced informally in the long-distance versions of the rules formulated above (22, 25).

The tables in (34) show how voicing assimilation works in various three segment clusters. The symbol 'T' denotes a voiceless obstruent; the symbol 'n' denotes a sonorant; the symbol 'D' denotes a voiced obstruent; and 'V' denotes our labiodental fricative that lacks a specification for VOICE:

(34) TnD vs. TVD

	TnD → TnD	TVD → DvD
UR	[−Voi, −Son][+Voi, +Son][+Voi, −Son]	[−Voi, −Son][−Son][+Voi, −Son]
Del (22)	—	[−Son][−Son][+Voi, −Son]
Assim (25)	—	[+Voi, −Son][+Voi, −Son][+Voi, −Son]
SR	TnD	DvD

Rule (22) searches rightward from each obstruent ς for a segment τ that has a value for VOICE. If τ is an obstruent, the voice value on each corresponding ς is deleted. In the case of an input like TnD (- VOICE-+ VOICE-+ VOICE), the deletion does not apply, because the first value of VOICE to the right of T is on a segment that is + SONORANT.

In the case of input TVD, the search for a VOICE value from T to the right terminates at D, because V, by hypothesis, is underspecified. The - VOICE on underlying T can be deleted, but the deletion applied to underlying V is vacuous.

The next rule (25) starts at each segment, and searches to the right for the first voicing value in the string, and copies it via unification, whatever it is.[7]

Now switch the underlying voicing values on the obstruents:

(35) DnT vs. DVT

	DnT → DnT	DVT → TfT
UR	[+Voi, −Son][+Voi, +Son][−Voi, −Son]	[+Voi, −Son][−Son][−Voi, −Son]
Del (22)	—	[−Son][−Son][−Voi, −Son]
Assim (25)	—	[−Voi, −Son][−Voi, −Son][−Voi, −Son]
SR	DnT	TfT

[7] I have chosen to formulate the rule in a way that allows /V/ to becomes voiced by assimilation to a following sonorant consonant or vowel. This formulation vitiates the need for a default voicing rule for prevocalic /V/ in say, [sverx] 'above' or [volk] 'wolf'.

These derivations yield the desired results—everything works the same as in (34), except it is now - VOICE that is unified with the searchers. Voicing assimilation propagates through /V/, but not through a sonorant.

7 Conclusions

Halle famously argued that the distinction between morphophonemic (neutralization) rules and phonemic (allophone) rules should be rejected. I argued that Halle's example shows that the traditional distinction in rule types reduces to a question of what segments happen to be in the lexicon. Accepting Halle's argument is tantamount to accepting that phonology does not 'look at' the segment inventory in the lexicon, and thus phonology cannot make reference to contrast. Thus, the typical behavior of sonorants, as opposed to obstruents, with respect to rules involving voicing should not be explained by reference to the typical absence of voiceless sonorants.

The sketch of Tangale showed that there are cases of unmatched segments that nonetheless behave exactly like ones that are matched. The - ATR low vowel of Tangale has no + ATR twin, and yet it behaves like the other - ATR vowels with respect to vowel harmony processes. Such examples show that contrastiveness cannot be invoked as an explanation in general, so scholars like Nevins (2010) have to 'parameterize' reference to contrastiveness—contrastiveness only matters some of the time. Interestingly, our study of Russian /v/ (what we called /V/) shows a segment that *does* have a contrastive 'twin'—there are surface [v]'s and [f]'s—and yet the segment under analysis still behaves in a non-parallel fashion with respect to the feature that determines the contrast. In other words, Tangale shows that lack of contrast with respect to a feature F is not a sufficient condition to predict irregular behavior with respect to F, and Russian shows that lack of contrast with respect to F is not a necessary condition to predict irregular behavior with respect to F. This result is reworded in (36):

(36) Contrast with respect to a feature F is neither a necessary nor a sufficient condition for predicting phonological behavior.

Combining Halle's argument concerning the non-distinction between neutralization and allophone rules with the observations from Tangale and Russian expressed in (36), we are driven to reject a role for contrast in phonological computation and phonological theorizing.

I presented a fairly explicit account of the behavior of Russian /V/, a problem that has been been addressed by many scholars. Depending on the process, this segment sometimes patterns with obstruents and sometimes with sonorants. I set aside the issue of why Russian /V/, like 'v' in many languages, behaves somewhat idiosyncratically, as a matter for phoneticians and historical linguists. Because I reject lack of contrast as an explanatory mechanism for the behavior of sonorants with respect to voicing in general, there was no motivation to explain the behavior of Russian 'v' as a sonorant. I instead argued that the

problematic behavior of Russian 'v' can be accounted for by assuming that the segment is underlyingly unspecified for VOICE, a segment denoted /V/. My two step analysis of voicing assimilation accounted for /V/ undergoing assimilation, because all the other obstruents lose their voice specification in the relevant context, and then /V/ can receive a value by the unification based feature filling process that affects other obstruents, too. This underspecification property also accounts for the failure of /V/ to trigger assimilation—at the crucial point in the derivation, it lacks a value for VOICE.

If my conceptual arguments against contrast are valid, and if I have somewhat successfully analyzed a longstanding puzzle in which contrast has been argued to play a role, then given the connections between contrast and markedness discussed by Odden (this volume), the paper perhaps constitutes an argument against markedness as a useful notion.

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