Unexceptional Segments*

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Abstract

A famous perennial problem in Slavic phonology is yers: vowels that idiosyncratically alternate with zero (e.g., [mox] vs. [mx-a] 'moss (nom/gen sg)' alongside [nos] vs. [nos-a] 'nose (nom/gen sg)'). The widely accepted analysis of these "ghost vowels" is that they must be underlyingly marked as exceptional on a segment-by-segment basis. Moreover, usually they are assumed to be underlyingly representationally defective—either nonmoraic or lacking features (Kenstowicz and Rubach 1987, inter alia). In this paper, I revisit yers from a different perspective. Instead of treating the segments as special, I argue that exceptionality is a property of whole morphemes. This theory of exceptionality has many incarnations (Chomsky and Halle 1968 et seq.), but my version is formalized as Lexically Indexed Constraints in Optimality Theory: in any given language, a universal constraint can be indexed to individual morphemes in the lexicon and ranked in two different positions in the language's hierarchy (Pater 2000, 2006). In Russian, the relevant indexed constraint is *MID, which penalizes the peripheral mid vowels [e] and [o]. The general, non-indexed constraint is independently needed to explain vowel reduction in unstressed syllables. The indexed version explains why only mid vowels alternate with zero in Russian. This generalization about yer quality is lost in representational accounts, since any vowel can be labeled as non-moraic underlyingly. Another unsolved mystery about Russian yers is that only vowels in the final syllable of a morpheme can alternate with zero. This requires a phonological explanation—labeling only the alternating vowels as underlyingly special does not address the position problem.

1 Introduction

1.1 Exceptionality as a property of morphemes

Most languages appear to have some rules that apply to an arbitrary subset of eligible words, from English trisyllabic laxing alternations (Chomsky and Halle 1968) to French learned backing (Dell and Selkirk 1978). More peculiar are rules that affect a subset of eligible segments in a language. One of the best-known examples of such alternations is Slavic yers (jers): vowels that idiosyncratically alternate with zero. Some typical examples from Moscow Russian are given in (1) and (2). Comparing (1a) and (2a),[1] we see that in some words, the vowel [ə] disappears in suffixed

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[1]All transcriptions are in the IPA, and all data are from the author unless otherwise noted. The following abbreviations are used in glosses: "nom" for nominative, "acc" for accusative, "gen" for genitive, "dat" for dative, "inst" for instrumental, "prep" for prepositional, "voc" for vocative, "abl" for ablative, "sg" for singular, "pl" for plural, "fem" for feminine, "masc" for masculine, "neut" for neuter, "attr" for attributive or "long form," "pred" for predicative or "short form," "dim" for diminutive, "vulg" for vulgar, "adj" for adjective, "N" for noun, "V" for verb, "perf" for

forms. Interestingly, though, not all instances of [ə] can alternate with zero—for example, the schwa in words such as [ígərʲ] is always present. Identifying the conditions that affect the realization of yer vowels has become a perennial problem in Slavic phonology (Lightner 1972, Rubach 1986, Kenstowicz and Rubach 1987, Czaykowska-Higgins 1988, Szpyra 1992, Yearley 1995, Zoll 1996, Hermans 2002, Matushansky 2002, Steriopolo 2007, Jarosz 2008), but the pattern shares notable similarities with vowel-zero alternations in unrelated languages such as Itelmen (Bobaljik 1997), Hungarian (Siptár and Törkenczy 2000), and Salish languages (Kinkade 1997, van Eijk 1997, Blake 2001, Rowicka 2002, Gouskova 2003).

(1) Some typical yer alternations from Russian:

a.	úgə̲rʲ	ugrʲ-ú	'eel (nom/dat sg)'
b.	lʲó̲n	lʲn-á	'linen (nom/gen sg)'
c.	vʲétʲir	vʲétr-ə	'wind (nom/gen sg)'

(2) Lack of alternations in identical contexts:

a.	ígərʲ	ígərʲ-u	'Igor, a name (nom/dat sg)'
b.	lʲénʲ	lʲénʲ-i	'laziness (nom/gen sg)'
c.	mʲétr	mʲétr-ə	'meter (nom/gen sg)'
d.	kátʲir	kátʲir-ə	'motor boat (nom/gen sg)'

Even though there are many theories of non-automatic rules in generative phonology, the dominant approach to Slavic yers and other "ghost vowels" has been to mark them as special in the UR on a segment-by-segment basis. What makes yers special in the UR, however, varies from one account to the next. In the earliest treatment of Russian yers by Lightner (1965, 1972), they are marked in the UR with a segmental feature that is never found on the surface. More recently, the contrastive underspecification approach has become standard. Under this analysis, yer vowels are marked in the UR as representationally defective. For example, yers are assumed to have segmental features but not timing slots, so a mora or an X-slot must be inserted in order for the yer to be pronounced (Kenstowicz and Rubach 1987, Yearley 1995 et seq.). Others have posited that yers are timing slots without features (Szpyra 1992), and one proposal, Melvold (1990), even divides yers into three types: X-slots without features, features without an X-slot, and features and an X-slot not linked to each other. The key reason for the popularity of these approaches to yers is that it appears that vowels have to be marked as yers on a vowel-by-vowel basis. The same arguments, and very similar analyses, have been proposed for voicing alternations in Turkish (Inkelas et al. 1997) and spirantization in Modern Hebrew (Martínez 2008). I will argue that there are phonological generalizations about which segments alternate in all of these cases.

The idea that exceptionality is a property of individual segments has coexisted with an alternative, according to which exceptionality is a property of entire morphemes. It is this latter idea that I will explore and defend in this paper. My hypothesis can be stated as in (3):

(3) *Whole Morpheme Exception Hypothesis*: There are no lexically exceptional segments—only lexically exceptional morphemes.

perfective, "impf" for imperfective, "def" for definite, "imp" for imperative, "eccl" for ecclesiastic, "Lat" for Latinate, "Gr" for German, "Fr" for French.

I will argue that this approach has sufficient power to deal with apparent cases of segment-by-segment exceptions. Moreover, it forces us to confront certain previously unanswered questions that any analysis must answer. I will show that there are generalizations about which segments undergo special rules: only mid vowels can delete in Russian, and they must be in the last syllable of their morpheme. These generalizations are missed in theories that arbitrarily mark segments as exceptional. Once these generalizations are captured, the exceptional marking of individual segments becomes superfluous. These are arguments in favor of adopting the whole morpheme theory of phonological exceptions.

The idea that phonological operations can apply to a subset of morphemes is far from new in generative phonology—it has been around since its inception and formalized in a number of ways (Chomsky and Halle 1968, Dell and Selkirk 1978, Zonneveld 1978, Kiparsky 1982, Mohanan 1982, Benua 1997, and others). The approach that I adopt is Lexically Indexed Constraints (Pater 2000, 2006, 2008) in Optimality Theory (Prince and Smolensky 1993/2004, McCarthy and Prince 1993b, 1995). In this version of OT, any constraint in Con can be marked to apply to a subset of a language's morphemes, and the constraint can then be multiply instantiated in the hierarchy of a language, resulting in different subphonologies for the lexicon. I will apply this theory to a detailed case study of yers and show that they must be analyzed in terms of universal and independently motivated constraints.

1.2 Structure of the paper

I start by introducing some background on yers, focusing at first on the relatively uncontroversial aspects of the pattern. §3 discusses some outstanding problems in analyzing yers, namely, which vowels can alternate based on quality and position. My analysis, along with some necessary theoretical assumptions, is presented in §4. In §5, I compare my analysis with segment-by-segment alternatives, including Lightner's classic analysis and the contrastive underspecification analyses of yers. I then turn to two other cases that have been presented as arguments for segment-by-segment marking: Hebrew spirantization and Turkish laryngeal alternations. The Appendix addresses some issues in the phonology of Russian yers that my analysis does not attempt to solve.

2 What we know about yers

All modern Slavic languages have inherited some sort of vowel-zero alternations from Proto-Slavic. Since the patterns are complex and differ in interesting ways from one language to the next, there is a large body of literature on yers in generative phonology, especially on Polish (Gussmann 1980, Czaykowska-Higgins 1988, Rubach 1986, Szpyra 1992, Rowicka 1999) and Russian (Lightner 1972, Melvold 1990, Yearley 1995, Matushansky 2002, Halle and Matushansky 2006, Steriopolo 2007, Gribanova 2009a). The most important generalizations for Russian are well-established, and the goal of this section is to go over those that are largely uncontroversial and which I will assume in this paper.

First of all, it is well established that an account without some appeal to *lexical idiosyncrasy* is impossible. As the three examples in (4) show, in the same consonantal context, we find vowel-zero alternations (4a), non-alternating consonantal clusters (4b), and non-alternating vowels (4c).

(4) Lexical idiosyncrasy illustrated

a.	vʲétʲir	vʲétr-ə	‘wind (nom/gen sg)’
b.	mʲétr	mʲétr-ə	‘meter (nom/gen sg)’
c.	kátʲir	kátʲir-ə	‘motor boat (nom/gen sg)’

Second, in Russian, yer alternations must be analyzed as *deletion, not epenthesis* (Bethin 1992, Yearley 1995). The identity of the alternating vowel is not entirely predictable, so it must be posited in the underlying representation:

(5) Deletion, not epenthesis

a.	son	sn-a	‘sleep (nom/gen sg)’	d.	pʲenʲ	pnʲa	‘stump (nom/gen sg)’
b.	lʲef	lʲv-a	‘lion (nom/gen sg)’	e.	rof	rv-a	‘ditch (nom/gen sg)’
c.	lʲon	lʲn-a	‘linen (nom/gen sg)’	f.	lop	lb-a	‘forehead (nom/gen sg)’

Third is an insight due to Szpyra (1992) and Yearley (1995): *syllable structure* constraints matter for the distribution of yers, even if not all of the constraints are surface-true in Russian. In words that have vowel-zero alternations, the vowel shows up in two circumstances: (a) when the alternative is a word with no vowel at all, and (b) when the alternative is a word-final consonant cluster. The constraint against vowelless words is categorical in Russian: every syllable must be headed by a vowel. Thus, the vowel is obligatory in words such as [son] ‘sleep’ in (5), since the vowelless alternative [sn̩] is ruled out. As for word-final consonant clusters, the situation is more subtle. Yearley argues that word-final coda clusters are relatively restricted in Russian compared to word-initial clusters, but they are even more restricted in words with yers. As can be seen from examples such as (4b), final clusters are allowed in Russian in general, even if they are avoided in words such as (4a). In some cases, however, the presence of the underlined vowel is obligatory: without it the cluster would be unpronounceable (see (6)). Under Yearley's account, the syllable structure constraints simply apply more stringently to words with yers than to words with other vowels. There is quite a bit more to be said about the role of syllable structure in yer realization; I will return to the topic in §3.2.

(6) Coda cluster constraints require realization of yers

a.	xlópə̲k	xlópk-ə	‘cotton (nom/gen sg)’
b.	*xlopk		
c.	kórətə̲k	kəratk-á	‘short (masc/fem pred adj)’
d.	*kórətk		

Thus, the following three generalizations are well-established: yer alternations are lexically idiosyncratic, they must be analyzed as vowel deletion, and they are governed by discernible syllable structure constraints, some of which hold of the language as a whole, and some of which do not. Despite the considerable amount of attention devoted to yers in generative phonology, I will argue in the next section that some aspects of these patterns remain unexplained in widely accepted analyses. Specifically, I will concentrate on the “what” and “where” of yer deletion.

3 Some unexplained mysteries about yers

This section is devoted to problems presented by yers that in my view have not received a satisfactory solution. My primary goal here is to show that there are phonological generalizations as to which vowels can pattern as yers: they constitute a class both in terms of quality and their position in the morpheme. I will then present an analysis of yers that captures these generalizations without resorting to marking of individual segments in the UR.

3.1 Quality: why [e] and [o]?

Any account of yers must explain why only certain vowels participate in the alternations. In any given Slavic language, yers form only a subset of the vowel inventory: out of the five or more of the language's vowels, only some alternate with zero. In Russian, *only the mid peripheral vowels [e], [o] and their unstressed allophones can be yers.* This selective targeting of mid vowels and their allophones makes a lot of sense in the context of Russian phonology as well as a broader typological view of vowel markedness.

To understand the pattern, we need a bit of background on the vowel system of Russian. As shown in (7), the Moscow dialect of Russian contrasts five vowels in stressed syllables:[2]

(7) Russian: five-vowel system in stressed syllables

rʲis	'rice'		(rɨsʲ 'lynx')	rusʲ	'Russia'
lʲes	'forest'			ros	'grew'
		ras	'time'		

In unstressed syllables, there is only a three-way contrast, which is complicated by the position of the vowel. Generally, the peripheral mid vowels [e] and [o] are absent in unstressed syllables: the front vowels /i, e/ neutralize to [i], and the non-front vowels /o, a/ neutralize to [ə] in syllables that are not immediately before the stressed syllable. In the immediately pretonic syllable, the non-front vowels reduce to [a] (see (9)).[3] The examples in (9d, e, i, j) show evidence for the underlying quality of the vowels in the root /golov-/, which never surface faithfully all at once.

(8) Moscow Russian: vowel contrasts by stress position

pretonic σ	stressed σ	unstressed σ
i u	i u	i u
	e o	ə
a	a	

[2] I follow Padgett (2003), Padgett and Tabain (2005) in treating the i-ɨ distinction as allophonic. The quality of the vowel depends on whether the preceding consonant is palatalized or velarized. The non-high vowels also alternate in these contexts; for instance, what I transcribe as [a] can surface as [æ] after a palatalized consonant, and the mid vowel [e] has a noticeable back quality in words like [ɜtə] 'this'. I abstract away from these details here.

[3] The pretonic allophone of /o/ and /a/ is transcribed variously as [ʌ] (Avanesov 1968, Jones and Ward 1969), [a] (Crosswhite 1999), and [ɐ] (Barnes 2004). I use [a] for orthographic ease, since the exact phonetic characteristics of the vowel are not crucial here.

(9) Moscow Russian: vowel reduction by position

a.	/pokopala/	pəkapálə	'dug (fem)'	f.	/kukuʃka/	kukúʃkə	'cuckoo'
b.	/zakazalo/	zəkazálə	'ordered (neut)'	g.	/prʲitʃina/	prʲit͡ʃínə	'reason'
c.	/pʲerʲedʲelal/	pʲirʲidʲélə	'redid (masc)'	h.	/vʲetʃina/	vʲit͡ʃiná	'ham'
d.	/golov-a/	gəlavá	'head (nom sg)'	i.	/golov/	galóf	(gen pl)
e.	/golov-ɨ/	góləvɨ	(nom pl)	j.	/golov-o-lomka/	gələvalómkə	'puzzle'

Thus, the surface vowel inventory of Moscow Russian is {i, u, e, o, ə, a}. Of these vowels, [u] never alternates with zero at all, and for the remainder, the alternation patterns are determined by stress position. The surface-based generalization can be stated as follows:[4]

(10) Surface-based generalization for modern Moscow Russian:

a. In stressed syllables, only [e] and [o] can alternate with zero.

b. In unstressed syllables, only {i, ə, a} can alternate with zero.

There is a well-known historical reason for the first half of this generalization: modern yers used to be high lax vowels in the proto-language. These vowels were historically completely eliminated: they lowered to [e] and [o] in all the contexts where they did not delete (Lightner 1972, Kiparsky 1979, Vlasto 1986). As for the second half of the generalization, it is quite simple: as we have seen, [e] and [o] do not occur in unstressed syllables, and so their unstressed allophones {i, ə, a} alternate with zero. The examples in (11) show such unstressed yer alternations. The roots in (11a-b) never have stress on the yer. This means that practically speaking, Russian native speakers do not necessarily know the underlying quality of the vowel in such words.[5] In example (11c), the yer vowel fails to delete in the context of the suffix /-ok/ (discussed in §8.1). The stress is on the suffix, so the pretonic vowel /o/ maps to [a].

(11) Examples of unstressed vowels {ə, i, a} alternating with zero

			V	*Orthography*	Ø	
a.	/kukol/	[ə]	kúkəl	кукол	kúkl-ə	'doll (gen pl/nom sg)'
b.	/sosʲen/	[i]	sósʲin	сосен	sasn-á	'pine (gen pl/nom sg)'
c.	/rot-ok/	[a]	ratók	роток	rt-á	'mouth (dim nom sg/gen sg)'

Even though the underlying identity of these unstressed vowels is not always known, we can reasonably speculate that they are underlyingly /o/ and /e/, even if the orthographic clues were

[4] A handful of exceptions could be mentioned, all of them dubious. One is [kat͡ʃán] 'head of cabbage (nom sg),' which is reported to lose its second vowel [a] in suffixed forms (e.g., [kat͡ʃn-á] (gen sg)) in some dialects. In the Moscow dialect, the word does not have vowel-zero alternations. It should be noted that this word has also been reported to have an alternate nominative form, [kat͡ʃná] (Zaliznjak 1977:45). The other form Zaliznjak lists as exceptional is [zájət͡s]~[zájt͡sə] 'hare (nom sg)~(gen sg),' although he notes that the only surprise here is the orthography—the unstressed vowel is written as "a" (я). Finally, the words [jijt͡só] 'egg (nom sg)' has what is sometimes described as a vowel-zero alternation: [jiít͡s] 'egg (gen pl)'. This could be just as validly analyzed as a glide-vowel alternation, though, which Russian has in other contexts.

[5] In fact, children and even adult speakers often make spelling mistakes in words of this type (Rosenthal and Telenkova 2003:5). Russian orthography reflects the underlying quality of the vowel, which presents difficulties when the UR is unknowable. There is even a term used in Russian grammars for such non-alternating vowels and consonants: *непроверяемые*, or "uncheckable," meaning their UR cannot be established through phonemic analysis.

not there. The reason is that these vowels are allophones of /e/ and /o/, and vowels other than /e/ and /o/ do not alternate with zero in the language. This is the only way to explain why unstressed [i] can alternate with zero but stressed [i] cannot. None of the paradigms in (12) are found in modern Russian, even though there is nothing phonotactically wrong with any of the words in the examples:[6]

(12) Non-occurring patterns

a.	/mux/	mux	mx-a
b.	/sat/	sat	st-a
c.	/takir/	takír	takr-á
d.	/korux/	kórux	karx-á

Let's consider the relevance of this generalization to lexical exceptionality. If the principles governing yer deletion are encoded in the phonological grammar, as is assumed by all existing accounts, then the phonological analysis needs to *derive* the generalization that only the allophones of /e/ and /o/ pattern as ghost vowels in Russian. In §4, I will attribute this selective targeting of mid vowels to the high ranking of a constraint against mid vowels, tying the Russian pattern to a well-established observation that mid vowels are marked cross-linguistically. On the other hand, segment-by-segment marking accounts do not necessarily explain why only mid vowels can delete. This is especially an issue for accounts that mark yers as non-moraic in the UR: it is never explained why only mid vowels can be marked as non-moraic in Russian, and why there are systematic differences between Slavic languages as to which vowels pattern as yers (I return to this in §5, which critiques segment-by-segment accounts).

3.2 Position: can any vowel do it?

Just as there is a phonological generalization about the quality of alternating vowels in Russian, there is also a phonological generalization about their position. In any given morpheme, only the final vowel can alternate. Generally, most Russian roots have one or two vowels: C<u>V</u>C and CVC<u>V</u>C. Only the underlined vowels can alternate with zero. The generalization for Russian is as follows:

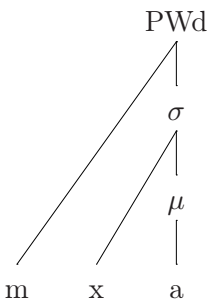
(13) *Positional Generalization*: only the vowel in the last syllable of a morpheme can alternate with zero. If a vowel alternates in the first syllable, it is also the last and only syllable.

As I will show shortly, proposals such as Yearley (1995) provide a partial phonological explanation for what unifies the alternating syllables. It is still a mystery, though, why the first vowel of CVCVC words does not alternate, and why the first vowel is even present in some of these words. I will start by summarizing Yearley's account and then giving some background on the historical development of yers, and then go on to show that the positional restriction can be derived from idiosyncratic constraints against certain types of clusters. Once again, no segment-by-segment labeling is needed to derive the positional generalization.

Yearley (1995) argues that yer deletion readily creates word-initial consonant clusters, but never word-final clusters. She explains this asymmetry by appealing to a structural difference: final clusters must be parsed into a coda, whereas initial ones can be prosodic word (PWd) appendices, as shown below for [mxá] 'moss (gen sg)'.

[6]Not only are these paradigms unattested—there is evidence that they are ungrammatical. See §5.3.

(14) Structure of [mxá]



There is independent phonotactic evidence for this structure (Yearley 1995, Steriopolo 2007): Russian allows a much wider variety of clusters word-initially than medially/post-consonantally. Steriopolo and Yearley note that Sonority Sequencing is more or less obeyed in Russian *syllables*, just not in PWd *appendices*.

(15) Medial post-consonantal clusters

a.	/tundr-a/	tún.drə	'tundra'	*tún.gdə
b.	/konkret-no/	kan.kré.tnə	'concretely'	*kan.ktét.nə
c.		gde	'where'	
d.		mgla	'haze, darkness'	

Here is how Yearley's account explains the asymmetry between word-initial and word-final yers. Yers are marked in the UR as non-moraic vowels (underlined in the tableau in (20)).[7] In general, yers are deleted by default, since realizing a yer requires violating Dep-μ, which is ranked above Max-V (see (20e-f)). If deleting a yer would create a word-initial cluster, then deletion wins (see (20a-b)): the first consonant in such a cluster can be parsed as a prosodic word appendix. This violates Align(PWd, L, σ, L), but it is ranked too low to matter. It is less costly to delete a moraless vowel and suffer a misalignment of a syllable and a prosodic word than to insert a mora. In a word-final syllable, however, the yer is kept: the constraint *ComplexCoda rules out complex coda clusters, and by dominating Dep-μ, it selects the winner with a yer, which costs an inserted mora. To complete the analysis, one can see that regular, non-yer vowels will not delete in non-yer words like /no$_\mu$s-a$_\mu$/ 'nose (gen sg),' since Max-V favors their retention, and Dep-μ is irrelevant.

(16) Align(PWd, L, σ, L) (*[$_\omega$C.C): 'The left edge of every prosodic word is aligned with the left edge of some syllable.'

(17) *ComplexCoda (*CC]$_\sigma$): 'Assign a violation mark for every branching coda.'

(18) Dep-μ: 'Assign a violation mark for every mora in the output that lacks a correspondent in the input.'

[7]The analysis has been translated into correspondence-theoretic terms (McCarthy and Prince 1995). I use comparative tableaux (Prince 2000). A constraint prefers the winner (W) over a losing candidate (L) if the loser violates it to a greater extent. A constraint assigns a (L) mark if it prefers a loser, i.e., if it is violated to the greater extent by the winner. If the constraint is neutral in a winner-loser comparison, nothing appears in its cell. To aid readers unfamiliar with this format, the first couple of tableaux are presented in the hybrid format with both W/L marks and violation marks.

(19) MAX-V: 'Assign a violation mark for every [-consonantal] segment in the input that lacks a correspondent in the output.'

(20) Yearley's analysis: asymmetry between initial and final clusters

	/mo̲x-a$_\mu$/	*CC]$_\sigma$	DEP-μ	MAX-V	*[$_\omega$C.C
a.	☞mxa$_\mu$			*	*
b.	mó$_\mu$xə$_\mu$		*! W	L	L
	/ku$_\mu$so̲k/				
c.	☞ku$_\mu$.só$_\mu$k		*		
d.	ku$_\mu$sk	*! W	L	* W	
	/ku$_\mu$so̲k-a$_\mu$/				
e.	☞ku$_\mu$s.ka$_\mu$			*	
f.	ku$_\mu$.so$_\mu$.ka$_\mu$		*! W	L	

The key insight of this analysis is that final CC clusters are more marked than initial ones in Russian, and I adopt this idea (with some elaborations) in my analysis as well. Yearley's analysis makes several previously unnoticed predictions, however, some of which are correct, and some of which are not. First is a correct prediction: vowel-zero alternations should never affect the first vowel of a longer CVCVC root. As shown in (21), a full vowel would never delete in such a word (see (21a)), and a yer would never surface there (see (21b)). The incorrect predictions are two. First, in an input with two yer vowels, /CV̲CV̲C/, both are expected to delete when a vowel-initial suffix is attached (see (21c)). As I will show later in the section, this does not generally happen. The second wrong prediction concerns inputs with a single vowel flanked on one side by a cluster, as in /CVCC/. Here, too, the vowel is expected to delete in affixed forms, as in (21d).

(21) Yearley's analysis: predictions

			*CC]$_\sigma$	DEP-μ	MAX-V	*[$_\omega$C.C
a.	/rogoʒ/ 'rag (gen pl)'	ro.goʃ∼r.goʃ			W	W
b.	/lo̲boz/ (hypothetical)	l.bos∼lo.bos		W	L	L
c.	/ko̲so̲t-a/ (hypothetical)	ks.ta∼ko.sta		W	L	L
d.	/so̲tr-a/ (hypothetical)	s.tra∼so.tra		W	L	L

To understand why these patterns do not occur, we need to explore positional restrictions on yer deletion in more detail. In the rest of this section, I will argue that Russian imposes a restriction on yer alternations that can be descriptively stated as follows:

(22) *Triconsonantal Cluster Blocking*: the deletion of a vowel cannot create a word-initial three-consonant cluster.

Triconsonantal Cluster Blocking applies in three environments. First, CVC stems retain the yer when a consonant-initial suffix is added: (e.g., [lóʒju]) when deletion would yield a three-consonant cluster. This is unexpected under Yearley's analysis—since initial prosodic word appendices are tolerated, it shouldn't matter whether there is one or two consonants in the appendix.

(23) Triconsonantal Cluster Blocking in inflectional paradigms: yer deletion blocked if CCC would result

a.	/lo͟ʒ/	loʃ	‘lie (nom sg)’		/vo͟ʃ/	voʃ	‘louse (nom sg)’	
b.	/lo͟ʒ-ju/	lóʒju	‘lie (inst sg)’	*lʒ͟iu	/vo͟ʃ-ju/	vóʃju	‘louse (inst sg)’	*fʃ͟iu
c.	/lo͟ʒ-i/	lʒɨ	‘lie (gen sg)’		/vo͟ʃ-i/	fʃɨ	‘lice (nom)’	
d.	/lo͟ʒ-am/	lʒam	‘lie (dat pl)’		/vo͟ʃ-am/	fʃam	‘lice (dat)’	

Triconsonantal Cluster Blocking also applies to derivational suffixes that contain yers themselves. As shown in (24), the suffix /-e͟t͡s/ displays vowel-zero alternations: when the genitive /-a/ is attached to a noun with this suffix, the suffix loses its vowel. Vowel deletion is blocked, however, when an unsyllabifiable cluster would result (see (25)).[8] When the suffix attaches to a CC- stem, as in (25a-b), the deletion of its vowel would create an initial CCC, and so the suffix retains its vowel.[9] Similarly, in medial position, as in (25c-e), the vowel is retained if the result would be unsyllabifiable. It also does not matter whether the CC- cluster at the end of the root was created by yer deletion (as in (25a, d)) or is underlying (as in (25b, c, e)).

(24) Nominalizing suffix /-e͟t͡s/: vowel-zero alternations

	UR	*Nom Sg*	*Gen Sg /-a/*	
a.	/vlad-el-e͟t͡s/	vla.dʲé.lʲi͟t͡s	vla.délʲ.t͡sə	‘owner’
b.	/ven-e͟t͡s/	vʲi.nʲé͟t͡s	vʲin.t͡sá	‘wreath’
c.	/bor-e͟t͡s/	ba.rʲé͟t͡s	bar.t͡sá	‘fighter’
d.	/komsomol-e͟t͡s/	kəm.sa.mó.lʲi͟t͡s	kəm.sa.mólʲ.t͡sə	‘a member of the Komsomol’

(25) Vowel-zero alternations blocked in suffix if CCC cluster would result

a.	/lo͟ʒ-e͟t͡s/	lʒ-e͟t͡s	lʒi͟.t͡sá	‘liar’	*lʒ͟t͡s-á
b.	/ʒr-e͟t͡s/	ʒr-e͟t͡s	ʒrʲi͟.t͡sá	‘priest’	*ʒr͟t͡s-á
c.	/mʲertv-e͟t͡s/	mʲirtvʲ-é͟t͡s	mʲir.tvʲi͟.t͡sá	‘dead man’	*mʲirt.ft͡s-á
d.	/orʲel-e͟t͡s/	arlʲ-é͟t͡s	ar.lʲi͟.t͡sá	‘rhodonite (from ‘eagle’)’	*ar.lt͡s-á
e.	/mokr-e͟t͡s/	makrʲé͟t͡s	ma.krʲi͟.t͡sá	‘midge (from ‘wet’)’	*mak.rt͡s-á

Triconsonantal Cluster Blocking is idiosyncratic, as we can see from the behavior of CVCC stems such as /mʲestʲ/ ‘revenge’ and /lʲestʲ/ ‘flattery’. These morphemes show a curious split: in nominal inflectional paradigms, the stem retains its yer in all forms (cf. [lʲé͟stʲi] vs. [lʒɨ] in (26)). In verbal forms, however, the yer is always lost, so there are no alternations (see (27)). The constraint on deleting the root yer in /lʲestʲ/ is lifted in (28): deverbal derivations of ‘flatter’ do lose their yer, creating three-consonant clusters: e.g., [lʲ͟stʲe͟t͡s] (note, though, that the suffix [-e͟t͡s] itself retains the yer before a vowel, as expected). There is even a minimal pair, [lʲéstʲi] ‘flattery (gen sg)’ ∼

[8] Examples such as /krest-e͟t͡s/ [krʲis.tʲé͟t͡s] vs. [krʲis.t͡sá] ‘sacrum (nom sg)/(gen sg)’ suggest that in contexts where one of the consonants can be safely deleted, vowel deletion can also proceed.

[9] Russian has a morphologically restricted alternation whereby stressed /e/ becomes [o] when followed by a non-palatalized consonant, and also a consonantal mutation known as First Velar Palatalization, whereby /k/→[t͡ʃ] when followed by certain affixes. See Iosad and Morén-Duolljá (2010), Padgett (2010) for recent discussion and references. The retention or loss of palatalization in the consonant that precedes a deleted yer depends on many factors, including type of consonant and morphological context: the lateral liquid tends to retain palatalization, whereas [r]/[rʲ] and [n]/[nʲ] do not contrast for palatalization in preconsonantal position.

[lʲstʲi] ‘flatter (verbal imperative)’. Minimal pairs such as [lʲéstʲi]∼[lʲstʲí] are not predicted under any existing analysis of yers. This suggests a descriptive generalization: Triconsonantal Cluster Blocking is a constraint on yer deletion in nominal inflectional paradigms, but it is relaxed in verbal contexts.[10]

(26) CVCC yer words retain their yers in vowel-affixed forms

a.	/lʲestʲ/	lʲestʲ	‘flattery (nom sg)’				
b.	/lʲestʲ-ju/	lʲéstʲju	‘flattery (inst sg)’	cf.	/loʒ-ju/	lóʒju	‘lie (inst sg)’
c.	/lʲestʲ-i/	lʲéstʲi	‘flattery (gen sg)’		/loʒ-i/	lʒɨ	‘lie (gen sg)’

(27) Verbal forms of ‘flatter’

a.	/lʲestʲ-itʲ/	lʲstʲitʲ	‘to flatter’
b.	/lʲestʲ-iʃ/	lʲstʲitʃ	‘you (sg) flatter’
c.	/lʲestʲ-i/	lʲstʲi	‘flatter (imp)’
d.	/lʲestʲ-il-a/	lʲstʲílə	‘flattered (fem sg)’

(28) Derivational forms of /lʲestʲ/ ‘flatter’

a.	/lʲestʲ-en-ij/	lʲés(t)nɨj	‘flattering (attr adj)’	cf.	lóʒnɨj	‘false (attr adj)’
b.	/lʲestʲ-en/	lʲéstʲin	‘flattering (pred adj)’			
c.	but:	lʲstʲe͡ts	‘flatterer (nom sg)’			
d.		lʲstʲi͡ts-á	‘flatterer (gen sg)’			
e.		lʲstʲívɨj	‘obsequious (attr adj)’			

Thus, there are several contexts where yer deletion is blocked if a three-consonant cluster would result. At the very least, then, Yearley’s account of Russian syllable structure must be extended to explain these facts. Indeed, it actually suggests a phonological explanation for Triconsonantal Cluster Blocking: vowel deletion cannot create a complex onset preceded by an PWd appendix, or, alternatively, that a PWd appendix in such a cluster cannot branch. As expected, medial three-consonant clusters can be created by vowel deletion (see (29)) if those clusters can be syllabified without violating sonority sequencing:

[10]There are a few possible explanations for this verb-noun asymmetry—it is possible that the verb ‘flatter’ has lost its yer altogether and the nominal and verbal forms are listed allomorphs, or more likely that nouns and verbs are subject to different constraints (Smith 2000), with Triconsonantal Cluster Blocking relaxed for verbs. Bobaljik (2008) suggests that phonological verb-noun asymmetries are due to inherent differences in how verbs are derived morphosyntactically: verbs are cyclic, whereas nouns are not. Yers are known to be retained with cyclic affixes (see §8.1), but the nominal plural [-i] is demonstrably non-cyclic, since it conditions deletion in two-consonant stems. It is not readily obvious to me how a cyclic solution would explain the Russian data given here, but since noun-verb asymmetries are pervasive in phonology, it is quite likely that there is a universal grammatical explanation for them. Note that there are proposals that allow diacritic exception marking at the level of the category node; see Dell and Selkirk (1978) for one. I leave the problem open here.

(29) Medial CCC clusters can be created by vowel deletion

a.	/kostʲer-Ø/	kʌ.stʲór	kʌs.tr-á	'fire (nom/gen sg)'
b.	/svʲist-ok/	svʲi.stók	svʲist.k-á	'whistle (nom/gen sg)'
c.	/dolʒ-en/	dól.ʒɨn	dʌl.ʒn-á	'must (masc/fem pred adj)'

An account of Triconsonantal Cluster Blocking should eliminate the problematic predictions in (21c-d): the reason that both vowels don't delete in a /CVCVC/ word is the same reason that a single vowel does not delete in a /CVCC/ word. I will present such an account in §4.4.

The next question is why only the last vowel of a morpheme can alternate. Just as there was a historical explanation for the quality generalization in §3.1, there is a historical explanation for this part of the positional generalization, although the picture here is more complicated. The main point here is to show that the "historical accident" story does not explain how Modern Russian ended up with the current positional generalization. Historical yers were often retained for what I will argue were phonotactic reasons. The same phonotactic generalization is still active today, albeit in a subset of words.

In older stages of the historical development of Russian, yers did delete in environments such as (21c) and (21d). The historical pattern of deletion is known as *Havlik's Law*: counting from the end of the word or the rightmost full vowel, delete every odd-numbered yer and vocalize every even-numbered one (Kiparsky 1979:97). Some of the most spectacularly marked initial clusters of modern Russian are in words that had yers which fell out with no trace, as shown below (I follow the Slavicist tradition and use ъ for the back yer and ь for the front one in Old Church Slavonic (OCS) words).

(30) Non-alternating roots with initial clusters (etymologies from Vasmer 1958)

	OCS	*Modern Russian*	
a.	rъtutь	rtutʲ	'mercury'
b.	mьrzъkъ	mrasʲ	'bastard'
c.	mъgla	mgla	'dusk, darkness'

In accordance with Havlik's Law, CVCVC words that had a non-yer in the first syllable and a yer in the second now have alternations in the second syllable only (see (31a-c)). It is not the case, however, that all alternating mid vowels of Modern Russian descend from yers in the proto-language. Later changes sometimes introduced yers in new positions (see (31d-f)), yet the positional generalization about alternating vowels is still respected in such words today.

(31) Second-syllable yers

	OCS	*Modern Russian*		*Alternation form*	
a.	kovьrъ	/kovʲer/	kavʲór	kóvr-ʲik	‘carpet (+dim)’
b.	okъno	/okon-o/	aknó	ókən-∅	‘window (nom/gen pl)’
c.	orьlъ	/orʲel/	arʲól	órl-ʲik	‘eagle (+dim)’
d.	ognь	/ogonʲ/	agónʲ	ógn-ʲinʲj	‘fire/fiery’
e.	větrъ	/vʲetʲer/	vʲétʲir	vʲétr-ə	‘wind (nom/gen sg)’
f.	bebrъ	/bobʲer/	babʲór	bóbr-ʲik	‘beaver (+dim)’

More puzzlingly, in some words, historical yers turned into non-alternating vowels where CC clusters are expected. Examples of such historical yers that failed to delete are in (32). Deletion of first-syllable yers in (32d-g) would yield an initial CCC cluster, which falls under the Triconsonantal Cluster Blocking generalization identified earlier. The generalization cannot explain why first-syllable yers are retained in (32a-c), however. Kiparsky (1979:99) speculates that yer deletion was blocked in these contexts because it would create “consonantal groups difficult for a Russian to pronounce.”[11] Thus, in Modern Russian, first-syllable mid vowels in some words are retained, whether or not they were yers historically.

(32) Historical first-syllable yers that failed to delete

	OCS	*Modern Russian*		*Alternations?*		
a.	rъpъtъ	rópət-ə	‘murmur of discontent (gen sg)’	yes	rapt-átʲ	‘to grumble’
b.	tъpъtъ	tópət-ə	‘tramp of feet (gen sg)’	yes	tapt-átʲ	‘to trample’
c.	sъtъ	sót-ɨ	‘honeycomb (nom pl)’	no		
d.	dъska	dask-á	‘board (nom sg)’	yes	dósək	(gen pl)
e.	tъska	task-á	‘boredom (nom sg)’	no	(paradigm gap in gen pl)	
f.	tьstь	tʲéstʲ-ə	‘wife’s father (gen sg)’	no		(gen sg)
g.	tьʃʃь	tʲóʃʃʲ-ə	‘wife’s mother (nom sg)’	no		

Under a segment-by-segment exceptionality analysis, the explanation for why the first vowel in a two-syllable word does not alternate in Modern Russian is that such vowels are simply not marked as exceptional. The historical background suggests another explanation, however, which does not require marking individual vowels as exceptions. The explanation I pursue is idiosyncratic phonotactics: in two-syllable roots, the first vowel is retained because deleting it would create an initial CC cluster. This constraint on deletion is not surface-true in Modern Russian: initial CC clusters are routinely created by yer deletion, but in some words, an initial CC cluster is banned. In §4.4, I analyze this generalization using an indexed version of Yearley’s alignment constraint against unsyllabified consonants.

Thus, there are phonological generalizations about the position of alternating vowels. Vowels do not alternate in contexts where deletion would yield an unsyllabifiable cluster. Vowels also do not alternate in the first syllable of a longer word. These observations suggest that Russian does not present a good case for segment-by-segment exceptionality. It would be easy enough to modify

[11] Dialects still differ in whether they preserved the yer in some of these words: cf. Moscow standard [daská] ‘board’ and dialectal [t͡ska] (thanks to Morris Halle, p.c., for pointing out this example). There is some speculation as to whether the accentual status of yers might have something to do with their retention (Zaliznjak 1985), but there are clear cases where yers were lost in accented positions (see Blumenfeld 2006 for discussion).

a segment-by-segment marking account so that it captures this generalization for Russian, but this move obviates the need to mark deletable vowels segment-by-segment in the UR. After all, the only reason to label individual vowels as alternating in the UR is that it would be otherwise impossible to predict which vowels will exhibit the special behavior. I have shown, however, that both the quality and the position of alternating vowels are predictable.

4 A whole morpheme analysis of Russian yers

In this section, I develop an analysis of Russian yers under the Whole Morpheme Exception Hypothesis. This analysis relies on two separate sets of assumptions. The first is a theory of lexical indexation, which I outline in §4.1, and the second is a theory of why vowels delete (§4.2). §4.3 and §4.4 take up the quality and position questions, respectively.

4.1 Part I: Lexically indexed constraints

Approaches to lexically idiosyncratic phonology can be divided into two categories based on the level at which exceptionality is marked: segment-by-segment or morpheme-by-morpheme. I pursue the latter approach, assuming that exceptionality is encoded at the level of the morpheme.[12] The hypothesis is repeated in (33):

(33) *Whole Morpheme Exception Hypothesis*: There are no exceptional segments—only exceptional morphemes.

The motivation for this view of exceptions is external to phonology: it is widely assumed (Lieber 1980 et seq.) that the lexicon must contain all kinds of idiosyncratic information about morphemes. This includes morphosyntactic information such as declension class and gender, as well as information about subcategorization and phonological selectional restrictions. Lexical marking for special phonology is no different.

My view of exceptions is moreover not new; indeed, it can be traced to Chomsky and Halle (1968). In *The Sound Pattern of English*, segments (or rather, feature matrices) can bear a diacritic feature [+D] that activates a phonological rule that mentions [+D]. By convention, however, the exceptionality of the segment is spread to the entire string (i.e., morpheme) containing the segment (Zonneveld 1978).

Following on the SPE tradition, provisions for exceptionality have been part of Optimality Theory since its earliest days, as well (Prince and Smolensky 1993/2004, McCarthy and Prince 1993a, Ito and Mester 1995a,b, Pater 2000, inter alia). Details of implementation of the whole morpheme approach in OT vary, but the two dominant approaches are co-phonologies and lexically indexed constraints (see Inkelas and Zoll 2007, Pater 2006 for overviews and arguments in favor of these opposing views). Here, I adopt the Lexically Specific Constraint theory of Pater (2006, 2008). Pater (2006) formalizes lexically indexed constraints in OT as indexed to morphemes, not to segments (although Pater's theory does not take a firm stand on this issue, leaving the issue ultimately open). Under this theory, any constraint in a language's hierarchy may be indexed to apply to a single morpheme or a set of morphemes. An indexed *faithfulness* constraint is violated

[12] Following Halle and Marantz (1993) and Wolf (2008), one could make a more rigorous distinction between the "morphs," or the phonological strings realizing the morphemes, and "morphemes," which are morphosyntactic feature bundles. If this distinction is made, then presumably idiosyncratic phonological information would be specified at the level of the morphs. With this move comes a prediction: if a morpheme is paired with more than one morph, then it is possible for only one of these allomorphs to exhibit exceptional phonology. This might be a possible solution for the problem of verbal roots and prefixes in §8.2.

when a segment affiliated with a morpheme is somehow unfaithful; for example, MAX-V$_L$ is violated when a vowel affiliated with a morpheme indexed L fails to make it to the output. An indexed *markedness* constraint is violated by any instance of the marked structure associated with the morpheme. Pater (2006) proposes the following locality convention for markedness:

(34) *X$_L$: 'Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as L.'

Under this locality convention, the hypothetical morpheme [bob]$_L$ would incur two violations of the indexed markedness constraint *VOICEDOBSTRUENT$_L$, since there are two voiced obstruents contained within the phonological string realizing the morpheme. In a more complex case, *COMPLEXCODA$_L$, the locus of violation is presumably a string rather than a single consonant. As long as the string contains part of the indexed morpheme, there will be a violation: thus, /bob$_L$+d/ →[bo<u>bd</u>] would violate the constraint, as the first consonant of the two in the coda belongs to the morpheme [bob].

An indexed constraint appears in the same hierarchy as its general counterpart, and it will only have an effect when it is crucially ranked higher than the general constraint. If our hypothetical example of an indexed markedness constraint *COMPLEXCODA$_L$ were ranked above DEP-V and the general *COMPLEXCODA were ranked below it, then the result is a system where there is in general no epenthesis in coda clusters except in some exceptional words. As shown in (35), non-exceptional stems such as /gog+d/ have no epenthesis, since DEP-V outranks *COMPLEXCODA. When certain exceptional stems are affixed, they get an epenthetic vowel, since otherwise the coda cluster would violate the higher-ranked indexed *COMPLEXCODA$_L$—it contains a portion of the indexed morpheme /bob$_L$/.

(35) Exceptional triggering of epenthesis (hypothetical example)

		*COMPLEXCODA$_L$	DEP-V	*COMPLEXCODA
a. /bob$_L$+d/	bobəd∼bo<u>bd</u>	W	L	W
b. /gog+d/	gogd∼gogəd		W	L

It is assumed in the work on lexical indexation that constraints are indexed to morphemes in the process of learning the ranking (Pater 2008, Becker et al. 2008, inter alia). Exceptions follow a pattern that is inconsistent with the rest of the grammar; when the learner encounters such an inconsistency, a uniform constraint ranking cannot be established without additional mechanisms. Pater proposes that the exceptional morphemes are indexed to a constraint that is then ranked differently from its non-indexed counterpart, and the inconsistency is resolved through constraint cloning. If this is done on a morpheme-by-morpheme basis, multiple versions of the same constraint can end up ranked in the same stratum, at which point they can be conflated into one. One morpheme can be indexed to several different constraints, and in principle, there is no lower or upper limit on how many morphemes can be exceptional.

An important feature of this approach to exceptionality is that indexing draws on the universal pool of constraints. Assuming that OT constraints are indeed universal (as is standard in most work on OT), this puts a burden on the analyst, since a constraint cannot be indexed in one language if there is no plausible case for its universal status. On the other hand, the theory predicts that a lexically idiosyncratic pattern in one language should be a plausible general pattern. I will take care throughout the analysis in next section to motivate indexed constraints with cross-linguistic evidence.

With this background on constraint indexation in place, I turn to the constraints relevant to vowel deletion.

4.2 Part II: Constraints that can favor vowel deletion

To ask "why do vowels delete?" is to ask "which markedness constraints can be satisfied by a MAX-V violation?". As some recent work has shown, the answer is that under the right circumstances, vowel deletion can be favored by a wide range of constraints. These constraints include constraints on metrical parsing such as STRESS-TO-WEIGHT and PARSE-σ as well as prominence-by-position hierarchical constraints such as *NUC/ə (Kager 1997, Gouskova 2003, Cable 2006, McCarthy 2008).[13] I attribute yer deletion in Russian to a context-free markedness constraint defined in (36): peripheral mid vowels are marked. Evidence for the markedness of mid vowels comes from vowel inventories of languages such as Arabic (Crothers 1978), vowel harmony systems (Kirchner 1993, Beckman 1997), and contrast-enhancing vowel reduction in languages like Russian and Portuguese (Crosswhite 1999). Thus, the reason why only mid vowels alternate with zero in Russian is the same reason certain languages lack mid vowels altogether. The constraint will do double duty in the analysis: it plays a role in yer deletion and in unstressed vowel reduction.

(36) *MID: 'Assign a violation mark for every peripheral vowel that is [-high] and [-low].'

Harmony scale (Beckman 1997:14): {high, low}≻mid

*MID and its lexically indexed variant will be key in the analysis of yer deletion as well as in the vowel reduction patterns. I will also call on an indexed version of IDENT as well as several phonotactic constraints against certain types of clusters, which will be introduced later. I next turn to the analysis itself. It has two parts: first, I lay out the basic analysis of lexically idiosyncratic deletion and the interaction of deletion with vowel reduction (see §4.3), and then I move on to the positional restrictions on vowel deletion (see §4.4).

4.3 Analysis of yer quality

A basic analysis of lexically idiosyncratic mid vowel deletion is sketched out in tableaux (37) and (38). Words that alternate, e.g., /mox/ 'moss' and /x^{j}it^{j}er/ 'clever, crafty (pred adj)' are lexically indexed to be subject to a *MID$_L$ constraint, which outranks MAX-V. This ranking favors deletion as long as the first consonant in the resulting cluster can be parsed into a prosodic word appendix, as in [mxá]. The mid vowel will not delete, however, when the alternative is a complex coda cluster, as in *[x^{j}itr]. I leave out constraints that are undominated in Russian, such as those that ensure that each word contains at least one vowel. The analysis of the prosodic conditions on deletion so far follows Yearley (1995).

[13] The only other whole-morpheme analysis of yers that I know of, Jarosz (2005), assigns a major role to metrical constraints in triggering vowel deletion in Polish. In brief, under Jarosz's analysis, yer deletion ensures a kind of metrical consistency for inflectional paradigms: stress is always non-final: e.g., [sféter]∼ [sfétr-a] 'sweater (nom sg∼gen sg)'. (Jarosz's analysis is discussed in more detail in §5). I will show that this kind of analysis cannot be extended to Russian, since Russian inflectional paradigms have very little in the way of metrical consistency, with or without yer deletion.

(37) Deletion of mid vowels in indexed morphemes in Russian

/mox$_L$-a/	*CC]$_\sigma$	*Mid$_L$	Max-V	*[$_\omega$C.C
a. mxá∼móxə		W	L	L
/x^{j}it^{j}er$_L$/				
b. x^{j}it^{j}ór∼x^{j}itr	W	L	W	

The indexed *Mid constraint does not apply to non-alternating morphemes of Russian. These are subject to a general *Mid, which is ranked below Max-V. The default then is not to alternate. This is shown in the following two winner-loser comparisons, [l^{j}ésə] vs. *[lsa] 'forest (gen sg)' and [b^{j}il^{j}étə] vs. *[b^{j}iltá] 'ticket (gen sg)'. An important feature of this analysis is that it isn't even necessary to stipulate that indexation applies only to forms with mid vowels, since *Mid is only relevant to words that have mid vowels. Even if *Mid were indexed to a morpheme that contains no mid vowels in any of its surface forms (e.g., [luk] 'onion'), it would be satisfied gratuitously by the fully faithful candidate.[14]

(38) No alternations in other morphemes

/l^{j}es-a/ 'forest (gen sg)'	Dep-V	*CC]$_\sigma$	*Mid$_L$	Max-V	*Mid
a. l^{j}ésə∼lsa				W	L
/b^{j}il^{j}et-a/ 'ticket (gen sg)'					
b. b^{j}il^{j}étə∼b^{j}iltá				W	L
/m^{j}etr/ 'meter (nom sg)'					
c. m^{j}etr∼m^{j}étər	W	L			

To round out the basic analysis, we must ensure that complex coda clusters are allowed to surface in the general case. For this, *ComplexCoda must be dominated by Dep-V, so epenthesis is blocked in words such as [m^{j}etr] 'meter'. Other ways to resolve clusters must be ruled out by high-ranked faithfulness constraints such as Max-C (not shown). Furthermore, in order to ensure that only [e] and [o] delete in Russian, all markedness constraints violated by non-mid vowels must also be ranked below Max-V. These include metrical constraints such as Parse-σ, which might favor deletion in longer words, and markedness constraints that ban syllable nuclei of low sonority, e.g., *Nuc/ə. Vowel deletion is not used in Russian even to avoid hiatus—witness [pʌ.úk] 'spider' (see Avanesov 1968 and Padgett 2008, inter alia).

The next step is to account for the interplay of yer deletion and vowel reduction. Deletion is not the only way to avoid a *Mid violation—there is also the option of changing the quality of the vowel without deleting it. Quality change might even seem like the default option, given how familiar and ubiquitous reduction rules are cross-linguistically. As we saw in (9), Russian has unstressed syllable vowel reduction, so mid vowels undergo feature change all the time—but only in unstressed syllables. In any working analysis of Russian, feature change must be ruled out for all mid vowels in stressed syllables. I assume that the relevant blocker here is the positional faithfulness

[14] Pater's (2008) algorithm for learning indexed constraint grammars is set up in such a way that it only clones a constraint when the grammar would be inconsistent without cloning. Since a faithful mapping /luk/→[luk] is fully consistent with both Max-V≫*Mid and *Mid≫Max-V, indexation would never apply to such morphemes.

constraint IDENT-$\acute{\sigma}$, which protects the quality of stressed vowels. Stressed mid vowels are therefore unavoidable in stressed position in indexed words (see (40a)), since IDENT-$\acute{\sigma}$[F] dominates *MID$_L$. In unstressed syllables, however, the general case is for mid vowels to reduce, as shown in (40b).[15]

(39) IDENT-$\acute{\sigma}$: 'Output segments in a stressed syllable and their input correspondents must have identical specifications for the feature F.' (Beckman 1998:131)

(40) Reduction, contrast, and stress

/mox$_L$/	IDENT-$\acute{\sigma}$[F]	*MID$_L$	*MID	IDENT[F]
a. mox∼mux	W	L	L	W
/lʲes-á/ (nom pl)				
b. lʲisá∼lʲesá			W	L

In indexed morphemes, reduction (as in (40b)) is not a way to avoid a *MID$_L$ violation—unless deletion is blocked by syllable structure constraints. Intuitively, the default for regular morphemes is "reduce rather than delete," but for lexically indexed morphemes it is "delete rather than reduce."[16] In order to derive this asymmetry between alternating and non-alternating morphemes, we need IDENT and MAX to be ranked differently for the two sets of morphemes. The ranking is shown in (41). For indexed words, deletion will apply where it is phonotactically possible, because reduction is ruled out by the lexically indexed faithfulness constraint IDENT$_L$, which outranks MAX-V (see (41a-b)). In contexts where syllable structure constraints block deletion, such as in CVC_C#, reduction will be the only option (see (41c-d)). In non-indexed words, reduction applies and deletion is blocked in unstressed syllables throughout (see (41e-f))—this follows from already established rankings.

(41) Blocking reduction of mid vowels in indexed morphemes

/vʲetʲer$_L$-a/ 'wind (gen sg)'	*CC]$_\sigma$	*MID$_L$	IDENT$_L$	MAX-V	*MID	IDENT
a. vʲé.tr-ə∼vʲé.tʲi.r-ə			W	L		W
b. vʲé.tr-ə∼vʲé.tʲe.rə		W		L		
/vʲetʲer$_L$/ 'wind (nom sg)'						
c. vʲé.tʲir∼vʲetr	W		L	W		L
d. vʲé.tʲir∼vʲé.tʲer		W	L		W	L
/kátʲer-a/ 'boat (gen sg)'						
e. ká.tʲi.r-ə∼ká.tr-ə				W		L
f. kátʲir-ə∼ká.tʲi.r-ə					W	L

Finally, in CVC$_L$-V indexed words, deletion will apply and feature change will be blocked, since the relevant structural constraint is ranked too low to matter:

[15] This is not the only way to analyze Russian vowel reduction—see Crosswhite's (1999) analysis in terms of positional licensing. It is now generally accepted that both positional markedness and positional faithfulness constraints are necessary to analyze such systems; see Beckman (1998), Zoll (1998) for discussion.

[16] "Delete rather than reduce" is how Urbanczyk (1996) analyzes unstressed [a] syncope in Lushootseed: [a] deletes wherever possible and reduces to schwa otherwise. Similarly, Hebrew deletes unstressed vowels by default, reducing only when deletion is blocked (Michael Becker, p.c.).

(42) Reduction not an alternative to deletion for indexed morphemes

	/mox$_L$-a/	*CC]$_\sigma$	*Mid$_L$	Ident$_L$	Max-V	*[$_\omega$C.C
a.	m.xá∼mó.xə		W		L	L
b.	m.xá∼ma.xá			W	L	L

Thus far, the analysis correctly derives both the reduction and the deletion patterns for exceptional and regular words. Before turning to the analysis of positional restrictions on deletion, however, I want to address the issue of using multiple indexed constraints in the same analysis. I have invoked two different lexically indexed constraints: the markedness constraint *Mid$_L$ and the faithfulness constraint Ident$_L$. One might ask whether there is a justification for invoking two separate indexed constraints to derive a single pattern. In Russian, the same set of yer morphemes is indexed to both constraints, but it need not be so in principle, as I mentioned in §4.1. As it turns out, Russian phonology provides some evidence of morphemes that are indexed just to Ident$_L$. Indexing a morpheme just to *Mid$_L$ produces no detectable effects: any unstressed mid vowels will always map to something other than [e] and [o] on the surface. Indexation to just Ident$_L$, on the other hand, will be detectable: the diagnostic is lack of reduction in unstressed syllables. In Russian, this happens mostly in loanwords and ecclesiastical vocabulary:[17]

(43) Idiosyncratic blocking of reduction (Avanesov 1968, Wade 1992)

a.	po̲ét	'poet'	d.	kanóe̲	'canoe'
b.	bláɣo̲	'good (eccl)'	e.	v$^{\text{j}}$éto̲	'veto'
c.	ro̲ko̲kó	'rococo'	f.	bo̲$^{\text{j}}$e̲ró	'bolero'

My analysis handles these exceptions to reduction without any additional provisions: as long as we assume that these words are indexed to Ident$_L$ but not to *Mid$_L$, the ranking established for yers will block reduction here without requiring deletion. The only refinement necessary is to separate the lexical indices into L1 and L2. Yer words are labeled as both L1 and L2, whereas the non-reducing words are only indexed to L2.[18]

(44) Reduction blocked in a different set of lexical exceptions

	/poet$_{L2}$/	Ident$_{L2}$	Max-V	*Mid
a.	poét∼paét	W		L
b.	poét∼pét		W	L

[17] Thanks to John McCarthy (p.c.) for noting this prediction. Pavel Iosad (p.c.) points out that only the older generation and perhaps the overeducated are likely to have rounded vowels here. Clearly, lexical idiosyncrasy is not shared by all speakers.

[18] Another issue is whether it is necessary to use both indexed markedness and faithfulness constraints. Following a considerable body of work (Pater 2000, 2006, Flack 2007, Inkelas and Zoll 2007, Gouskova 2007, Jurgec 2010), I take it as given that the theory of lexical constraint indexation requires both markedness and faithfulness to be available for indexing (though see Benua 1997, Ito and Mester 1999, Fukazawa 1999). Theoretical arguments aside, using both types of indexing might be argued to be necessary in order to capture what is exceptional and what is the phonological norm. In Russian, deletion is the exception rather than the rule: most morphemes do not have deletion, and neither do loanwords (unlike, say, in Polish). The only way to analyze a pattern of exceptional rule application (as opposed to exceptional rule blocking) in a faithfulness-only theory is to use a high-ranking Max-V constraint indexed to the words in which deletion does *not* apply, which are both the majority and the default in the Russian lexicon. While this analysis would in principle work, it puts the notion of exceptionality on its head. Thanks to Peter Jurgec (p.c.) for discussion of this point.

4.4 Analysis of positional restrictions on yers in Russian

Now that the analysis of the quality of yers is in place, we are ready to revisit the position question: why are alternations limited to morpheme-final syllables? The analysis I just presented allows us to put the question another way: why does Russian have *any* words with two mid vowels, only one of which alternates? The goal of this section would be to derive alternation possibilities without marking individual vowels as subject to *MID$_L$. The attested and unattested patterns are summarized below.

(45) Positional restrictions on deletion: attested and unattested patterns

a.	/vʲetʲer/	vʲétʲir	vʲétr-ə	*attested*
b.		*ftʲer	*ftr-á	*unattested*
c.		*ftʲer	*vʲétr-ə	*unattested*

The explanation for these gaps offered in this section is twofold. The hypothetical paradigm in (45b) fall under Triconsonantal Cluster Blocking. Paradigm (45c), on the other hand, violates an idiosyncratic prohibition on initial unsyllabified consonants.

My analysis of Triconsonantal Cluster Blocking builds on Yearley (1995) and Steriopolo (2007), who argue that Russian shows evidence of constraints on unsyllabified consonants. Under this view, Russian syllables contain at most two adjacent consonants; tautosyllabic onset clusters must obey sonority sequencing. If a cluster cannot be syllabified respecting these constraints, the stray consonants are appended somewhere above the syllable (either to the prosodic word or to the foot). Both the appendix itself and the appendix-syllable sequence are subject to constraints, which are active but violable in Russian.

Constraints on unsyllabified consonants are familiar in phonology. In many languages (including English), extrasyllabic consonants must be coronal and/or obstruent (Steriade 1982, Borowsky 1989, Clements 1990, Shaw 2002). Steriopolo (2007) shows that branching appendices in Russian are subject to OCP restrictions—no two labial or coronal fricatives are allowed in an appendix, though such sequences are fine across syllable boundaries (witness [va vrédnəm] 'in harmful' (not *[vv.rédnəm]) but [v.vidú] 'in sight' (not *[və vidú])).[19] To derive the Triconsonantal Cluster Blocking generalization for initial clusters, I formulate two additional constraints (46)-(47). The first of these constraints forbids an unsyllabified consonant from being followed by a tautosyllabic consonant cluster. The second is a constraint against appendices that branch. In general, Russian does allow four-consonant clusters word-initially, but tautomorphemically, clusters are at most three consonants, so the constraint can usually be obeyed by putting the last two consonants in the syllable rather than creating a branching appendix.

(46) *APP/COMPLEX (*[$_\omega$C.CC): 'Assign a violation mark for every unsyllabified consonant followed by a tautosyllabic consonant cluster.'

(47) *BRANCHINGAPPENDIX (*[$_\omega$CC.C): 'Assign a violation mark for every sequence of unsyllabified consonants.'

Note that a single constraint against appendices would not suffice to derive Triconsonantal Cluster Blocking. Recall that such appendices are tolerated routinely both in underived words such as /rtutʲ/→[r.tutʲ] 'mercury (nom sg)' and in forms that are derived by yer deletion: /loʒ-i/→[l.ʒɨ] 'lie

[19] See §8.2 for further discussion and analysis of prepositions.

(gen sg)'. The constraint against appendices is dominated by *MID$_L$; a candidate with multiple appendices such as /loʒ-ju/→*[lʒ.ju] 'lie (inst sg)' should not be a problem as long as mid vowels are avoided as a result (recall the problematic prediction of Yearley's analysis pointed out in tableau (21)). There needs to be a categorical distinction between a single appendix, which is fine (at least in some forms), and multiple appendices, which are not.[20]

The analysis is sketched in (48). The cluster constraints dominate *MID$_L$, correctly blocking the deletion of both mid vowels in words like /vʲetʲer$_L$-a/. Both the C.CC and the CC.C syllabifications are ruled out (see 48a-b). This ranking is independently required in order to explain why /CVCC/ words do not show yer alternations, and why /CVC$_L$/ words retain their vowels when followed by a C-initial suffix. Assuming that the stem /lʲestʲ$_L$/ 'flattery' is lexically indexed to *MID$_L$, deletion is correctly blocked in its affixed forms in (48c) (recall that this stem appears without a vowel in verbal and deverbal forms, so these constraints would not apply to verbs). Deletion is also blocked in stems that are uncontroversially yer stems, such as /loʒ$_L$/ 'lie' (cf. [lʒ-ɨ] 'lie (gen sg)'). This stem will lose its mid vowel when followed by a vowel-initial suffix, but it will be forced to retain it when followed by a consonant-initial suffix, as in (48d). For completeness, faithfulness must be ranked above the appendix constraints (see 48e), so that tautomorphemic CCC clusters may surface without modification. (Comparison (f) shows that as long as sonority permits, the second and third consonant of CCC will be syllabified together, establishing a ranking between the constraints on appendices). Thus, yer deletion is blocked when it would create a three-consonant initial cluster, but such clusters are not resolved by epenthesis.

(48) Analysis of Triconsonantal Cluster Blocking

	/vʲetʲer$_L$-a/	DEP-V	*[$_\omega$CC.C	*[$_\omega$C.CC	*CC]$_\sigma$	*MID$_L$
a.	vʲé.trə∼f.tra			W		L
b.	vʲé.trə∼ft.ra		W			L
	/lʲestʲ$_L$-i/					
c.	lʲes.tʲi∼lʲs.tʲi		W			L
	/loʒ$_L$-ju/					
d.	loʒ.ju∼lʒ.ju		W			L
	/mgl-a/					
e.	m.gla∼ma.gla	W		L		
f.	m.gla∼mg.la		W	L		

This analysis extends to examples of two yer morphemes in a sequence (an abbreviated summary of the pattern in (24) and (25) is given in (49)). Recall that the vowel in the suffix /-e$\widehat{\text{ts}}_L$/ does not alternate if an initial three-consonant cluster would result; likewise, deletion is blocked if a medial unsyllabifiable cluster would result:

[20] Likewise, one might ask why two constraints are needed instead of a single constraint *CCC against having three consonants in a row. Recall that Russian does actually have three-consonant clusters in medial position, and these can be the result of yer deletion. The position and nature of the cluster is relevant.

(49) Suffix vowel-zero alternations are blocked if CCC would result

	UR	*Nom Sg*	*Gen Sg /-a/*		
a.	/vʲen-et͡sL/	vʲi.nʲét͡s	vʲin.t͡sá	‘wreath’	
b.	/bor-et͡sL/	ba.rʲét͡s	bar.t͡sá	‘fighter’	
c.	/loʒL-et͡sL/	lʒ-et͡s	lʒɨ.t͡sá	‘liar’	*lʒt͡s-á
d.	/ʒr-et͡sL/	ʒr-et͡s	ʒrʲi.t͡sá	‘priest’	*ʒrt͡s-á
e.	/mʲertv-et͡sL/	mʲirtvʲét͡s	mʲirtvʲit͡sá	‘dead man’	*mʲirtfʲt͡sá

The analysis derives the blocking of deletion of the suffix yer in such words, as shown in tableau (50). It also correctly predicts that in the nominative, the last suffix yer should be retained—the alternative is a coda cluster, so an initial appendix or a coda is tolerated instead (see 50c-d):[21]

(50) Analysis of Triconsonantal Cluster Blocking in forms with a yer suffix

	/ʒr-et͡sL-a/	*[ωCC.C	*CC]σ	*MIDL	IDENTL	MAX-V	*[ωC.C
a.	ʒ.rʲi.t͡sá∼ʒr.t͡sá	W			L	W	
	/mʲertv-et͡sL-a/						
b.	mʲir.tvʲi.t͡sá∼mʲirt.fʲt͡sá		W		L	W	
	/loʒL-et͡sL/						
c.	l.ʒet͡s∼loʃt͡s		W				L
	/orʲelL-et͡sL/						
d.	ar.lʲét͡s∼a.rʲólt͡s		W				

The last step is to address yer morphemes that contain more than one mid vowel. A few such roots are shown below, along with proof from stress alternations that they do indeed contain two mid vowels in the UR.

(51) First vowels do not delete in disyllabic yer words

a.	/vʲetʲer/	vʲétʲir	vʲétr-ə	‘wind (nom/gen sg)’
b.	/bobʲer/	babʲór	bóbr-ʲik	‘beaver (+dim)’
c.	/kovʲer/	kavʲór	kóvr-ʲik	‘carpet (+dim)’
d.	/ogonʲ/	agónʲ	ógn-ʲinɨj	‘fire/fiery’
e.	/okon-o/	aknó	ókən-∅	‘window (nom/gen pl)’
f.	/orʲel/	arʲól	órl-ʲik	‘eagle (+dim)’

The analysis of Triconsonantal Cluster Blocking explains why both vowels do not delete in /vʲetʲer-a/→*[ftra], and *CC]σ explains why the second of two vowels does not delete in the unaffixed

[21] This situation is reversed in some other suffixes of Russian; see §8.1 for discussion. Likewise, if prefixes and prepositions are analyzed as containing yers, then the analysis would not work correctly; I suggest an alternative epenthesis analysis in §8.2.

The analysis in (50) does not explain why the vowel deletes in the stem and not in the suffix in vowel-affixed forms such as /loʒL-et͡sL-a/; both the attested [lʒɨt͡sá] and the ungrammatical *[laʃ.t͡sá] are syllabically well-formed. One possible account of this would be to derive the genitive form serially via lʒ-et͡s, a lá Wolf (2008).

form /vʲetʲer/→*[vʲetr]. There are ways to reduce the number of underlyingly mid vowels in such words in some cases without violating phonotactic constraints, however—for example, by deleting only the first vowel. Let us start with word-initial vowels in (51d-f). Their retention can be attributed to the positional faithfulness constraint MAX-RT-INITIAL (Casali 1997, Beckman 1998). In Russian, this constraint does not appear to be dominated—root-initial vowels do not delete under any circumstances, even in hiatus (see Padgett 2008, Gouskova in press for some relevant discussion). As long as this constraint is ranked above *MID$_L$ and IDENT$_L$, mid vowels will not be deleted in such words, and they will reduce as appropriate. This ranking also explains the absence of roots that alternate between VC and C-, as in the hypothetical /or/→[or] and /or-a/ [r-a].

(52) Medial Triconsonantal Cluster Blocking and sequences of yers

	/orʲel$_L$/	*[$_\omega$CC.C	*[$_\omega$C.CC	MAX-RT-INITIAL	*CC]$_\sigma$	*MID$_L$	IDENT$_L$
a.	a.rʲól∼rʲol			W			L
b.	a.rʲól∼orl				W		L
	/orʲel$_L$-ik/						
c.	ór.lʲik∼rʲó.lʲik			W			W

The retention of the first root vowel in roots such as /vʲetʲer/→[vʲétʲir] is taken up next. It should be possible to delete the first vowel in such words, since the only phonotactic constraint that would be violated by such deletion is the constraint against word-initial appendices, which is ranked too low to matter. I propose that CVCVC yer words are indexed to a higher-ranked version of this constraint, *[$_\omega$C.C$_L$. The constraint is ranked above *MID$_L$, blocking deletion of the first vowel in the unaffixed form of the word.

(53) Idiosyncratic blocking of first vowel deletion

	/vʲetʲer$_L$/	*[$_\omega$CC.C	*[$_\omega$C.CC	*CC]$_\sigma$	*[$_\omega$C.C$_L$	*MID$_L$	IDENT$_L$	MAX-V	*[$_\omega$C.C
a.	vʲé.tʲir∼f.tʲér				W		L	W	W
b.	vʲé.tʲir∼vʲétr			W			L	W	
	/vʲetʲer$_L$-a/								
c.	vʲé.trə∼f.tʲérə				W				W
d.	vʲé.trə∼f.trá		W			L		W	

Under this analysis, then, CVCVC yer roots are indexed to three constraints: *MID$_L$, IDENT$_L$, and *[$_\omega$C.C$_L$. On the other hand, CVC yer roots are indexed just to *MID$_L$ and IDENT$_L$. Indexing a CVC root to *[$_\omega$C.C$_L$ is harmless—it simply will not pattern as a yer root, always retaining its vowel in all contexts. This might explain the historical retention of the yer in OCS words such as *sɤtɤ* 'honeycomb' (recall (32)). Even if the learner of Modern Russian never has a reason to index a non-alternating CVC root to all three constraints, the analysis works for such hypothetical cases.[22]

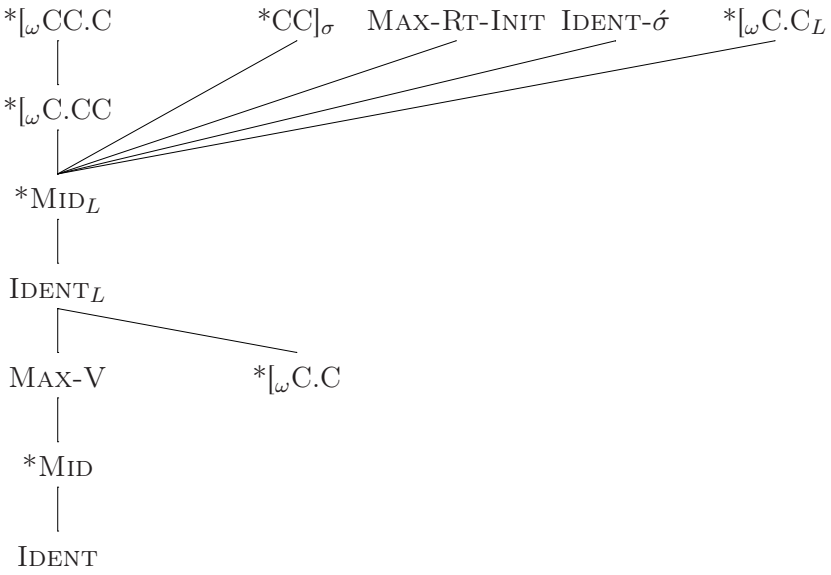
[22] A reviewer suggests to penalize final syllable mid vowels more directly, using a positional markedness constraint that penalizes morpheme-final mid vowels. This covers both CVC words and CVCVC words, but it doesn't explain why only the last vowel alternates in morphologically complex words such as /komsomol-e͡ts/, or why deletion is blocked altogether in CVCC words. There also needs to be independent cross-linguistic evidence for such a constraint. While there are several examples of mid vowels being limited to initial syllables (Turkish, Shona—see Bakovic 2000 and Beckman 1997), it is less clear that there is a cross-linguistic dispreference against morpheme-final syllables with mid vowels. The reviewer also suggests a similar alternative using a positional MAX constraint that protects stem-initial syllables that are not also final. This is impossible to implement in classic OT, as has often been noted (see,

I would like to return to the main point of this part of the analysis: there is a nontrivial phonological generalization to be made about the position of alternating vowels. Vowels alternate only in the last syllable of a morpheme, but they do not alternate in just *any* last syllable—deletion is blocked by a variety of constraints. Constraints on prosodic word appendices block deletion in simple two-consonant stems when they appear with a consonant-initial suffix (e.g., [lóʒ-ju]), and they also explain why deletion applies only to the second mid vowel of a disyllabic stem. The historical explanation (i.e., some vowels weren't yers to begin with) does not account for all of these exceptions.

4.5 Summary

Below is a summary ranking for the grammar of vowel deletion in Russian. Not shown are high-ranking constraints such as DEP-V, *$\acute{\sigma}$/ə, and so on, as well as inactive constraints such as PARSE-σ.

(54) Summary ranking



The analysis developed in this section focused on two aspects of idiosyncratic vowel deletion in Russian. First, the vowels targeted for deletion are invariably stressed mid vowels [e], [o] or the unstressed allophones of these vowels. I attributed deletion to the same constraint that motivates reduction in unstressed syllables, *MID. This constraint appears in two versions in the grammar

for example, McCarthy 2006), since a deleted segment does not have syllabic affiliation, and inputs are not reliably syllabified. This idea could be implemented in other versions of OT, such as Harmonic Serialism, but not without cross-linguistic evidence that initial syllables that are not also final are the site of special faithfulness. Finally, the reviewer points out a correct prediction of my analysis: in morphemes longer than /CVCVC/, medial vowels should delete in all members of the paradigm. I could not find any relevant test cases in Russian, since roots tend to be at most two syllables. For the few purported counterexamples, a case can be made that they are not monomorphemic. These include [pətalók]∼[pətalk-á] 'ceiling' and [ʒávərənək]∼[ʒávərənk-ə] 'skylark'. While written with mid vowels in the orthography ("потолок, "'жаворонок"), they lack the stress alternations that would reveal the underlying vowel quality of the vowels. The final /ok/ sequence is historically a diminutive suffix in both words (Vasmer 1958), and the words have other recognizable morphemes (e.g., the first syllable of 'ceiling,' /po/, is a prefix meaning 'on' or 'along', and [vórən] is 'raven'). Speakers very likely analyze these words as morphologically complex, with an /-ok/ suffix. The preceding string is either broken down further or treated as a cranberry morpheme without any vowel-zero alternations.

of Russian; the higher-ranked lexically indexed version compels deletion in exceptional morphemes, whereas the lower-ranked version compels reduction elsewhere. The subgrammars differ when it comes to deletion vs. reduction: in regular morphemes, reduction is the only option, whereas in exceptional "yer" morphemes, deletion is the preferred way of avoiding mid vowels and reduction is a last resort.

One of the novel aspects of the analysis is that it attempts to derive the distributional restrictions on alternating vowels without individually marking the vowels as exceptions—only morphemes need to be specified as exceptional. Vowel deletion is constrained: it cannot create three-consonant clusters word-initially. This restriction is enforced by constraints on extrasyllabic consonants. This analysis explains not only why there are no alternations in three-consonant stems (e.g., CeCC∼C_CC-V) but also why two-consonant stems such as /loʒ/ retain their yer when followed by a consonant-initial suffix. To my knowledge, no existing analysis of Russian yers has addressed the CeCC gap, since the problem would not have even arisen in a segment-by-segment framework. If exceptions can be marked on a segment-by-segment basis, it is never the goal to explain which vowels can alternate. As I have shown, it is possible to discover new generalizations about the complex pattern without positing an analytical distinction between deleting and non-deleting vowels. Only morphemes need to be distinguished as exceptional.

Admittedly, this account does not attempt to solve several well-known yer problems, including cyclicity in affixation and vowel-zero alternations in prefixes and prepositions (both discussed in the Appendix). While these problems obviously need to be resolved in a complete account of Russian morphophonology, they are separate from the core question about the need for segment-by-segment marking of yers, and they must be left for future work.

5 Alternatives

I discuss three alternatives to my account. First is a different kind of whole morpheme account, which assumes no representational difference between alternating and non-alternating vowels but uses different constraints to motivate deletion. Then I move on to two types of precedent accounts of Russian yers, which assume segment-by-segment marking. I start with Lightner's (1965, 1972) absolute neutralization account, which posits that yers are underlyingly represented as normal vowels that Russian lacks in its surface inventory. Then I discuss the contrastive underspecification accounts, whereby alternating vowels are underlyingly representationally defective: they lack a mora.

5.1 An alternative whole-morpheme account of yers

The analysis I presented for Russian is not the first analysis of yers that assumes whole-morpheme exceptionality, nor is it the only conceivable analysis of its type. Jarosz's (2008) analysis of Polish is in some ways similar to the one I proposed for Russian, but there are also some important differences. One similarity is that Jarosz does not posit representational distinctions between yers and other vowels; rather, entire morphemes have different phonologies.[23] When it comes to details of implementation, the analyses are quite different, however. The chief reason for this is that Polish phonology is different from Russian: Russian has a complex lexical stress system (Halle 1973 et seq.), whereas Polish has fixed penultimate stress, and unstressed vowel reduction does not play nearly as big a role in Polish as in Russian. Polish also has only one yer, [e], since historically,

[23] The analysis is cast in terms of co-phonologies (Anttila 2002, Inkelas and Zoll 2007) rather than lexically indexed constraints, though it is not an important difference for my current purposes. I have replaced Jarosz's (2008) [ɛ] with [e] in the transcriptions for orthographic ease and for consistency with Szpyra (1992) and Rubach (1986).

the back and front yers of Common Slavic merged into one front mid vowel in Polish (cf. Russian [son]∼[sna] 'sleep, dream (nom/gen sg)' vs. Polish [sen]∼[sna] 'sleep (nom/gen sg)'). Because of these differences, Jarosz's account cannot be extended to Russian.

Jarosz's main insight is that vowel-zero alternations have the effect of accomplishing a kind of uniformity in stress assignment throughout the paradigm: in most cases, stress is fixed on the same vowel in the penult even when an affix appears. The analysis is cast in the Optimal Paradigms framework of McCarthy (2005), where entire inflectional paradigms compete as candidates, and members of a paradigm stand in correspondence with each other. The crucial interaction is between faithfulness constraints against epenthesis and deletion of [e] and a constraint OPSTRESS, which requires stress to appear on the same vowel thoroughout the paradigm. In conjunction with the requirement for penultimacy (not shown), OPSTRESS favors paradigms where the last vowel of the stem disappears whenever a monosyllabic affix is added, as in <sféter, sfétr-a>. In non-yer words, the relative ranking of OPSTRESS and MAX-e is reversed, so stress is allowed to move around and no vowels delete.[24] A nice consequence of this analysis is that it derives the retention of yers in derived diminutives without additional stipulations: vowels surface exactly where expected in [sfetér-ek] 'sweater (dim nom sg)' vs. [sfetér-k-a] 'sweater (dim gen sg)'.

(55) An Optimal Paradigms account of Polish yers (after Jarosz 2008)

/sfeter-∅/, /sfeter-a/	DEP-e	OPSTRESS	MAX-e
a. <sfétr, sfétr-a>			**!
b. ☞<sféter, sfétr-a>			*
c. <sféter, sfetér-a>		*!	
d. <sfetére, sfetér-a>	*!		

This analysis cannot be extended to Russian for the simple reason that stress is anything but uniform in Russian paradigms. In Russian disyllabic yer stems, stress sometimes stays on the first vowel throughout the paradigm, e.g., [vʲétʲir]∼[vʲétr-ə] 'wind (nom/gen sg),' but it often shifts to the suffix: [babʲór]∼[babr-á] 'beaver (nom/gen sg)'. Stress isn't always on the first or the last syllable throughout the paradigm, either, as can be seen in the paradigms in (56). Even derivational paradigms with the diminutive suffix /-ok/, a cognate of the Polish /-ek/, exhibit the same behavior as in Polish, even though stress shifts (see §8.1).

(56) Yer deletion and stress in Russian

a.	xlópok	xlópk-ə	'cotton (nom sg/nom pl)'
b.	arʲól	arl-á	'eagle (nom sg/gen sg)'
c.	zajóm	zájm-ə	'debt, loan (nom sg/gen sg)'
d.	gúmʲin	gumn-á	'threshing floor (gen pl/nom sg)'

It has often been suggested that there are some paradigmatic leveling pressures at work in both Russian and Polish (Kraska-Szlenk 1995, Yearley 1995, Benua 1997, Hermans 2002). Even if these

[24] Some additional mechanisms are needed to force deletion in the context of the disyllabic affix [-ami], where stress moves to the affix but the yer deletes anyway: [sfetr-ámi] 'sweater (inst pl)'. This could be due to a leveling pressure from the majority of the words of the paradigm, where the affixes are monosyllabic. The analysis also requires some modifications to deal with monosyllabic stems, e.g., [pʲes]∼[psa] 'dog nom/gen sg,' since OPSTRESS actually favors the retention of yers in most of the words in the paradigm. Thanks to Gaja Jarosz (p.c.) for discussion of these cases.

pressures contribute to how yer deletion plays out in Polish and Russian, however, uniformity of stress placement cannot be the main factor. Yer deletion is in broad strokes quite similar between Russian, Polish, and Czech, yet the languages have very different stress patterns. The one common thread is that mid vowels are involved.

5.2 Featural segment-by-segment marking, Lower, and absolute neutralization

Lightner's (1965, 1972) analysis is the oldest and the most influential account of yers. Lightner posits that yers differ from other vowels in their featural specification: yers are underlyingly high lax vowels, whereas non-yer high vowels are tense. The choice of [tense] as the relevant feature is inspired by the history of yers rather than by synchronic evidence: in Proto-Slavic, the vowels were thought to be high and lax, [ɪ] and [ʊ] (see §3.1). Under this account, the underlying inventory of vowels in Russian is {i, u, ɪ, ʊ, ɨ, e, o, a}, and the underlying tense/lax distinction has consequences for how the phonology treats the vowels. The lax high vowels are eliminated by two rules in a bleeding order (see (57)). The first rule, known as Lower, lowers a lax high vowel to mid if another lax high vowel follows. The second rule unconditionally deletes all remaining lax vowels. Thus, on the surface, all high vowels are tense, and there is no featural distinction between mid vowels that are derived from yers and other mid vowels. The sample derivations in (57) demonstrate this analysis.[25]

(57) Lightner's analysis, in a nutshell

	UR	/sʊn-ʊ/ 'sleep (nom sg)'	/sʊn-a/ 'sleep (gen sg)'	/vetɪr-ʊ/ 'wind (nom sg)'
i.	$\begin{bmatrix} +\text{hi} \\ -\text{tense} \end{bmatrix} \rightarrow$ [-hi] /___C_0[-tense]	son-ʊ	—	veter-ʊ
ii.	[-tense] → Ø	son	sna	veter
	SR	[son]	[sna]	[vʲetʲir]

A few properties of this account are worth examining in detail. First, there is no need to assume that yer morphemes are exceptional. The phonology of Russian is treated as entirely regular—it just handles different input segments differently. There is a problem with this assumption, however: affixes differ in idiosyncratic ways in whether they require preceding yers to surface. The rule Lower predicts that in a sequence of yers, all but the last one will surface, regardless of the morphological makeup of the word. Thus, a /CVCɪC-ɪCɪ/ input should map to [CVCeC-eC]. As we saw in §4.4, this is incorrect: /orʲol$_L$-et͡s$_L$/, which would be underlyingly /orɪl-ɪt͡s-ɪ/ in the Lower analysis, is predicted to surface as *[arʲilʲét͡s] and not the actually attested [arlʲét͡s]. There are suffixes that behave as expected, notably /-ok$_L$/, but these can be analyzed in cyclic terms (see the Appendix, §8.1). The analysis also fails for many prepositions, which are traditionally analyzed as containing yers (though see §8.2, where I suggest that the vowels in prepositions should be treated as epenthetic).

[25] Note here that in order for the yer to be realized in [son] 'sleep,' this analysis must posit an abstract yer suffix in the UR. The argument for positing abstract yer suffixes for nouns is a kind of morphological uniformity: this ensures that case paradigms in Russian are uniform, albeit only in the UR (Matushansky 2002, Halle and Matushansky 2006). I assume, with Yearley (1995), that the case suffixes are there, but they are phonologically null. My account is even compatible with the assumption that these suffixes are mid vowels in the UR—as long as they are indexed to *Mid$_L$, they will delete in all contexts. The other argument for abstract yer suffixes is that historically, there were yers in these positions; accounts such as Rubach (2000) assume that these abstract yers palatalize or velarize the preceding consonant. I follow Padgett (2003, 2010), who argues that the palatalization-velarization contrast is underlying in some contexts and morphologically derived in others.

Moreover, there is a suffix, /-ik/, which triggers yer realization in the preceding stem even though it does not contain any yers itself (see (58)). This suffix does not exhibit any vowel-zero alternations itself, but it has a phonological selectional restriction: it must attach to a stem that is minimally monosyllabic. This is what requires yer realization in (58a-e); the Lower rule cannot explain the difference between (58a-e) on the one hand and (58f-g) on the other. There is no connection between yer retention and which vowel follows it in the UR.

(58) A yerless suffix conditions yer realization in monosyllabic stems: diminutive [-ik]

a.	/pʲes-a/	ps-a	'dog (gen sg)'		
b.	/pʲes-ʲik/	pʲósʲik	'dog (dim nom sg)'	not *psʲik	cf. ps-ʲín-ə 'dog (vulg
c.	/pʲes-ʲik-a/	pʲósʲikə	'dog (dim gen sg)'		nom sg)'
d.	/lob-ʲik/	lóbʲik	'forehead (dim nom sg)	not *lbʲik	cf. lb-a 'forehead (gen sg)'
e.	/rot-ʲik/	rótʲik	'mouth (dim nom sg)	not *rtʲik	cf. rt-a 'mouth (gen sg)'
f.	/osʲel-ʲik/	óslʲik	'donkey (dim nom sg)'	not *ósʲilʲik	
g.	/kozʲel-ʲik/	kózlʲik	'goat (dim nom sg)'		

The idea that yers are realized when they occur before other yers is assumed in many subsequent rule-based analyses influenced by Lightner (Pesetsky 1979, Kenstowicz and Rubach 1987, Matushansky 2002, Halle and Matushansky 2006, and others), but it is impossible to implement in OT. In order for the Lower rule to apply in Lightner's account, all Russian words must underlyingly end in either a full vowel or a yer—an assumption incompatible with Richness of the Base (see Yearley 1995 for critical discussion, though cf. Scheer 2006). Furthermore, it is impossible to state a markedness constraint that would compel an unconditional lowering or realization of a yer when it precedes another yer *in the UR*—the rule appears to be completely phonologically arbitrary. If yers are underlyingly mid vowels, as I argue, then a markedness-based account of yer deletion is available.

Another interesting property of Lightner's account is that it offers a take on a question that any account of Russian needs to answer: why lax vowels are not contrastive on the surface. In this analysis, [-tense] is essentially a diacritic feature that marks vowels for special treatment and ensures their elimination from the surface inventory of Russian. As it turns out, however, lax vowels do occur in Russian—the tense/lax distinction is allophonic. According to Jones and Ward (1969), [i] occurs in stressed syllables, [ɪ] in unstressed. Tense [e] occurs between two palatalized consonants, and [ɛ] occurs elsewhere. Surface [ʊ] has a distribution similar to [ɪ]. Given these surface distributions and alternations, it is hard to argue that underlying /ɪ/ and /ʊ/ map to [ɛ] and [ɔ]. In at least some contexts, underlying /i/ maps to [ɪ] (see (59)). It is possible to derive the allophonic distribution of tense and lax vowels in a rule-based framework by assuming late rules, but this does put a damper on the account. On the other hand, it is impossible to construct an OT account of Russian in which an allophonic surface distinction is used as a UR diacritic for lexical exceptionality.

(59) Distribution of [±tense] allophones in Moscow Russian

a.	lʲúbʲɪt	'loves (impf pres 3p)'	c.	dup	'oak'	e.	vʲɛs	'weight'
b.	lʲʊbʲítʲɪ	'love (pl imper)'	d.	dʊbʲítʲ	'to pound (impf)'	f.	vʲésʲɪt	'weighs'

Setting aside the specifics of Russian phonology, Yearley (1995) presents a more general ar-

gument against such analyses of idiosyncratic phonology: absolute neutralization analyses suffer from a high degree of abstractness. Even if the analyst is not disturbed by this, the learner should be, since such an analysis offers no evidence to guide the learner in establishing underlying representations (an argument echoed by Pater 2006). How does a Russian learner figure out that a non-contrastive, fully predictable featural distinction is crucially used in the phonology to explain yer deletion? Finally, absolute neutralization analyses face the same challenge as other segment-by-segment exception theories: arbitrarily labeling segments in a word as phonologically special misses generalizations about the position of alternating vowels. Deletion is constrained by identifiable phonological constraints; there is no need to label individual alternating segments in the input.

5.3 Segment-by-segment marking via contrastive underspecification: yers as moraless vowels

Lightner's account of yers is influential in the Slavic literature, but for most other purported cases of segment-by-segment exceptionality, the dominant approach is contrastive underspecification (for Slavic, Kenstowicz and Rubach 1987, Melvold 1990, Yearley 1995; for Turkish and Hebrew, see the discussion and references in §6; see also Zoll 1996). The idea is that some segments are underlyingly defective: they lack a feature, a timing slot, or some other aspect of normal segmental representation. When such underspecified segments surface, they are always unfaithful: realizing an underspecified segment requires either filling in the missing feature (often done by default rules related to markedness) or inserting a mora/timing slot. Deleting an underspecified segment, on the other hand, requires erasing the few parts of its representation that are present in the UR.

Yearley's (1995) account is an interesting departure from most contrastive underspecification analyses of Slavic yers, which assume something similar to Lightner's yer rule (for example, Kenstowicz and Rubach posit a rule that deletes a vowel without a timing slot before another vowel of the same kind). As I showed in §3.2, Yearley's account actually goes a long way towards explaining positional generalizations about yers, and it does so without positing underlying yers that are never seen on the surface. To the extent that the account makes the wrong predictions, it is fixable: it would be trivial to extend it so that it captures Triconsonantal Cluster Blocking and no longer makes the problematic predictions about deletion in various kinds of words. As I argued in §4.4, however, once a segment-by-segment account is expanded in this fashion, it is no longer necessary to label individual vowels as abstractly different in the UR. The key argument for segment-by-segment labeling is phonological unpredictability, but yers are predictable. The unpredictable aspect of Russian yer alternations is which morphemes participate in them.

The generalization about quality of yers is more troublesome for an account of yers as underlyingly moraless vowels. Under Richness of the Base, any vowel in the input can be labeled as moraless. Why is it, then, that only mid vowels alternate in Russian? Any contrastive underspecification account that does not provide a mechanism to limit alternations only to a subclass of vowels runs into this problem. The troublesome prediction is spelled out below.

(60) Non-occurring patterns are predicted to be possible if non-mid vowels are labeled as nonmoraic in the UR

a.	/m<u>u</u>x/	mux	mx-a
b.	/s<u>a</u>t/	sat	st-a
c.	/ta$_\mu$k<u>i</u>r/	takír	takr-á
d.	/ko$_\mu$r<u>u</u>x/	kórux	karx-á

It would be possible to rescue the moraless vowel account by elaborating the set of faithfulness constraints that protect different vowels from deletion or prohibit mora insertion (see Morén 1999, Tranel 1999, Gouskova 2003, Howe and Pulleyblank 2004 for discussions of theories of faithfulness along these lines). This comes with far-reaching typological consequences, however, that would need to be explored in this straw man version of contrastive underspecification theory. On the other hand, the markedness constraint *Mid is already well-motivated typologically (see §4.2). A more serious consequence of this extension to the underspecification analysis is that it defeats the argument for segment-by-segment marking of exceptions.

This discussion presupposes that it is the job of phonological theory to account for positional and quality generalizations about alternating segments in lexically idiosyncratic rules, but this assumption is not universally accepted. After all, exceptional patterns arise as a result of a sequence of historical changes, and the resulting "crazy rules" could very well be an arbitrary amalgamation of unrelated processes—yers have actually been characterized in this way more than once (Bach and Harms 1972, Blumenfeld 2006). In this view, the properties of any individual exceptional pattern are an accident of historical change, so it is not the job of a phonological account to explain why only some segments are affected. What we know about the history of yers does not support this view, however. Recall from (32) that some yers failed to delete in expected contexts. Likewise, some historical non-yer words have developed yer alternations (see (61)):

(61) Historical non-yer words that now have alternations

	OCS	*Modern Russian*	*Alternations*	
a.	ledъ	lʲot	lʲd-a	'ice (nom sg)∼(gen sg)'
b.	rovъ	rof	rv-a	'ditch (nom sg)∼(gen sg)'

Yer alternations are never extended to non-mid vowels in Russian. In Modern Russian, speakers are aware of the quality generalization, and this has been demonstrated experimentally. Gouskova and Becker (in preparation) conducted an experiment where 69 native Russian speakers were asked to rate inflected forms of 43 nonce forms. The inflected forms had deletion of either mid or non-mid vowels. There was a significant difference between mid and non-mid vowels: deletion of mid vowels was rated higher.

In other Slavic languages, the yer pattern even extends semi-productively to loanwords (Szpyra 1992, Zec 2002). For example, in Polish, both the back and the front yer merged to [e], which is now the only alternating vowel. Below are a few CeC-final loanwords that now follow the native yer alternation pattern:

(62) Polish yers in loanwords

a.	mebel	mebl-a	'furniture (nom/gen sg)'	c.	seter	setr-a	'setter (nom/gen sg)'
b.	puder	pudr-u	'powder (nom/gen sg)'	d.	stempel	stempl-a	'stamp (nom/gen sg)'

In order to extend the pattern to loanwords, Polish speakers have to be unconsciously aware of the generalizations in the exceptional substratum of the lexicon.

Pater (2006) notes a different problem with contrastive underspecification accounts: they often require positing arbitrary underlying distinctions. The learner of an exceptional system gets no guidance as to which underlying defect is responsible for the pattern at hand, and the space of possible underlying distinctions that neutralize on the surface is quite large. Similarly troubling is the diversity of uses to which the same structural distinction can be put in phonological theory. The

history of work on Russian vowel phonology brings this to light quite clearly. The moraic-nonmoraic distinction, so popular in accounts of yers, has also been proposed for at least two more phonological distinctions in Russian. First, Crosswhite (1999) uses the moraic-nonmoraic distinction to explain differences in how vowels reduce in immediately pretonic vs. other unstressed positions (recall (9)). Under this account, surface pretonic and stressed vowels are moraic, whereas other vowels are non-moraic. There are plenty of alternatives to this; see, for example, Bethin (2006), who links the different reduction patterns to tonal spreading from the stressed vowel, and de Lacy (2002), who posits different constraints on footed as opposed to unfooted unstressed syllables. Second, the same moraic-nonmoraic distinction has been posited to deal with the Russian vowel-glide contrast (e.g., [a.bo.i] 'wallpaper (nom pl)' vs. [a.boj] 'wallpaper (gen pl)'). Under this account, glides are underlyingly non-moraic, whereas high vowels are moraic (Rosenthall 1994, Rubach 2002).[26] Again, there are alternatives, such as Padgett's (2008) treatment of the Russian contrast in terms of segmental features rather than moraicity (see also Levi 2004 for additional arguments for a featural analysis of the glide-vowel distinction). Reconciling these different views of what it means for a vowel to be non-moraic is a challenge for both the analyst and the learner, but this problem is easily avoided in a non-representational account of yers.

In some cases, segment-by-segment marking by contrastive underspecification has even been used as a diacritic for morpheme rather than segment exceptionality. A typical case comes from Seri (Marlett and Stemberger 1983), where some vowel-initial stems seem to pattern with consonant-initial stems in several rules. As shown in (63), the vowel of the distal prefix /jo-/ fuses with the first vowel of the root in (63b), but not in (63c). Vowel-initial stems go both ways in allomorph selection, too. The passive prefix is realized as [a:ʔ-] with with consonant-initial stems (e.g., [-a:ʔ-kaʃni] 'be bitten') and as [p-] with vowel-initial stems (e.g., [p-eʃi] 'be defeated'), yet there are some vowel-initial stems that take [a:ʔ-] (e.g., [-a:ʔ-aχs] 'be hit'). Marlett and Stemberger posit an underlying consonant at the beginning of roots like (63c). This consonant is a null timing slot, not associated to segmental features, and it never makes it to the surface—its only job is to condition and block the application of rules and allomorph selection.

(63) Consonant vs. vowel-initial stems in Seri

	Neutral /t-/	*Distal* /jo-/	
a.	tmeke	jomeke	'be lukewarm'
	tpokt	jopokt	'be full'
b.	tataχ	jo:taχ	'go'
	teme	jo:me	'be used up'
c.	—	joamwx	'be brilliant'
	—	i-joenx	'play stringed instrument'

Despite the seeming diversity of the effects of Seri null consonants, there is actually a unifying theme to the patterns, which suggests a reanalysis. All of the phenomena in Seri point to a simple generalization: some vowel-initial stems have stronger left edges than others. These strong edges are protected from re-syllabification and from coalescence, which are familiar effects of Alignment constraints and positional faithfulness (McCarthy and Prince 1993a, Kawahara 2007, and others). This account explains something that a null consonant account cannot explain, namely, why these so-called null consonants are always word-initial in Seri. Even though historically, there

[26] Rubach (1986) criticizes Farina's proposal (which eventually appeared as Farina 1991) to treat yers as partially specified non-syllabic X-slots on the grounds that this would obliterate the distinction between yers and glides.

were consonants in these positions (cf. *h-aspiré* in French; Selkirk and Vergnaud 1973), the modern language provides no evidence of them for the learner. It is even clearer in Seri than in Russian that ghost segments are nothing more than representationally encoded diacritics for morpheme exceptionality—not segment exceptionality.

6 Other arguments for segment-by-segment marking of exceptions

I now move on to two purported cases of segment-by-segment marking: Modern Hebrew spirantization (Martínez 2008) and Turkish voicing alternations (Inkelas et al. 1997). I argue that Modern Hebrew is not a strong case because the pattern is highly variable, and there are phonological generalizations about which segments alternate. Turkish has already been analyzed from the whole morpheme perspective by Becker et al. (2008); I summarize and extend their account and suggest what kind of evidence would distinguish it from a segment-by-segment analysis.

6.1 Spirantization in Modern Hebrew

Martínez (2008) argues that Modern Hebrew presents exactly the kind of case that woud be predicted to be impossible under my theory: individual segments in the word have to be marked as either able or unable to undergo a rule. The evidence comes from alternations in (64)-(66). In Hebrew, labial and dorsal fricatives {f, v, χ} alternate with stops {p, b, k}. Typically, the fricative is found post-vocalically, and the stop is found elsewhere (see the underlined consonants in (64)). Alongside these alternations, there are both stops and fricatives that do not alternate; thus, stops are found postvocalically in (65a), and fricatives are found word-initially in (65b). This would be unexpected if the spirantization rule were fully general and automatic, so we have a clear case of lexical idiosyncrasy.

(64) Regularly alternating stops in Modern Hebrew

	Root	*3 pers sg past*	*Infinitive*	
a.	/Prs/	paras	lifros	'to spread'
b.	/Bnh/	bana	livnot	'to build'
c.	/Ktb/	katav	lixtov	'to write'

(65) Non-alternating stops and fricatives

a. Non-alternating stops

[kavar]	'buried'	[likbor]	'to bury'
[siper]	'told'	[lesaper]	'to tell'
[χibel]	'sabotaged'	[leχabel]	'to sabotage'

b. Non-alternating fricatives

[faʃla]	'mistake'	[lefaʃel]	'to make a mistake'
[viter]	'conceded'	[levater]	'to concede'
[χalam]	'dreamt'	[laχlom]	'to dream'

There are also words that have a mixed set of consonants: both alternating and non-alternating (see (66)). It is these words that arguably provide the evidence for segment-by-segment marking.

If we assume that the operative rule is postvocalic spirantiation (as it was historically), then it is impossible to know for any given segment whether it spirantizes.

(66) Words containing both alternating and non-alternating segments

	Root	*3rd pers sg past*	*Infinitive*	
a.	/kBr/	[kavar]	[likbor]	'to bury'
b.	/Bχr/	[baχar]	[livχor]	'to elect'
c.	/Kpr/	[kipur]	[leχaper]	'to atone'

Martínez's segment-by-segment analysis runs as follows. The alternating consonants are contrastively underspecified for [continuant], so that their distribution is completely predictable, whereas non-alternating consonants are fully specified as either [+cont] or [-cont] in the UR. (To explicate this analysis, the underspecified consonants are capitalized in the URs in the examples above; the URs for non-alternating forms are assumed to be equivalent to those in SRs.) This analysis is in broad strokes similar to the traditional treatment of yers: the consonants that display exceptional alternations are fatally defective in the UR, and faithfulness to [cont] has to be violated whether they surface as stops or fricatives.

The same facts are characterized somewhat differently in a detailed study by Adam (2002).[27] First of all, Adam establishes through a long-term study of many speakers that the pattern is highly variable: alongside the crucial example [kavar]∼[likbor] 'to bury,' there is a non-alternating variant [kavar]∼[likvor]. The alternation is normative, whereas the non-alternating pronunciation is colloquial. To verify the Hebrew data, I consulted four native speakers of approximately the same age (in their 30's). One of them strongly preferred the non-alternating innovative form [likvor], two liked the forms equally, and the fourth preferred the normative [likbor] but found [likvor] acceptable. This is consistent with Adam's hypothesis that alternations are on their way out: "... M[odern] H[ebrew] speakers tend to avoid alternation between stops and fricatives. The fact that not all types of variations exist in the language, in spite of the extensive occurrences of variation, points to a specific direction toward which the paradigms are moving" (Adam 2002:171).

Second, the possibilities for alternation are constrained by the place of articulation of the consonant as well as by the binyan (morphological class) of the verb. The binyanim are significant because the consonants do not end up in the same prosodic positions in the paradigms: in one binyan, consonants alternate between onset and coda, and in another binyan the alternation is between word-initial onset and intervocalic onset (cf. (66a-b) vs. (66c)). Thus, the differences in prosodic position alone can explain some of the alternation possibilities. Moreover, labials and dorsals pattern differently. Word-initial labial fricatives can be pronounced as stops—Adam attributes this to a sonority-based markedness constraint on word-initial onsets. Medial consonants sometimes alternate, but the non-alternating variant is apparently usually available, as well:

[27] My understanding of the facts of Hebrew was greatly helped by discussions with Michael Becker.

(67) Hebrew: variation possibilities in spirantization (from Adam 2002:162)

Prosodic Alternation	Past		Future		gloss
	normative	colloquial	normative	colloquial	
$V.C_2/C.C_2$	da.fak	*da.pak	jid.pok	∼jid.fok	'to knock'
	ka.var	*ka.bar	jik.bor	∼jik.vor	'to bury'
$\#C_1V/V.C_1$	pi.zer	∼fi.zer	je.fa.zer	*je.pa.zer	'to spread'
	bi.keʃ	∼vi.keʃ	je.va.keʃ	*je.ba.keʃ	'to request'
$\#C_1V/VC_1.$	pa.gaʃ	∼fa.gaʃ	jif.goʃ	*jip.goʃ	'to meet'
	ba.xar	∼va.xar	jiv.xar	*jib.xar	'to choose'

Dorsals are different: a stop variant is available for fricatives in all positions. Adam accounts for this difference by positing two place-specific markedness constraints, *V-STOP$_{Dor}$ and *V-STOP$_{Lab}$, the first of which is more free in its reranking possibilities. She also speculates that the language is currently in the process of change towards a system where dorsals will eventually end up patterning the same way as labials. Since the system is variable and changing, a snapshot of any one speaker's pronunciation will not be a fair representation of the entire pattern.

To establish an argument for segment-by-segment exceptionality, we would need roots that have two consonants with the same place of articulation, which differ in their alternation possibilities. As is quite well-known, however, in Semitic, roots are restricted such that C1 and C2 usually cannot both be dorsal or both be labial (Greenberg 1950 et seq.). There are a few cases in Modern Hebrew where historical change replaced a pharyngeal with a dorsal, such as [xakar]∼[laxkor] 'to investigate,' but in these forms, there are no alternations. Thus, the evidence for segment-by-segment marking of exceptions in Modern Hebrew is not convincing.

6.2 Laryngeal Alternations in Turkish

Another argument for segment-by-segment marking comes from Turkish laryngeal alternations, which have been the subject of many insightful studies (Lees 1961, Kopkalli 1993, Inkelas and Orgun 1995, Inkelas et al. 1997, Petrova et al. 2006, Becker et al. 2008). Inkelas and colleagues were the first to notice the relevance of the Turkish facts to the issue of segment-by-segment exceptionality. In Turkish, laryngeal contrasts are either preserved or neutralized, in an apparently unpredictable pattern: some obstruents retain their voicing in all contexts, others retain their voicelessness, whereas the third type alternates. They argue that Turkish requires contrastive underspecification: underlyingly, non-alternating consonants are either fully voiceless or fully voiced, whereas alternating consonants are underspecified for voicing. As I will show, however, there is no evidence that in any given morpheme, consonants are either alternating or not; the pattern is actually consistent with whole-morpheme exceptionality. Correspondingly, there are two recent analyses that do not assume contrastive underspecification. Petrova et al. (2006) argue that there is a three-way underlying contrast without underspecification, whereas Becker et al. (2008) assume whole-morpheme exceptionality. Both analyses are in principle consistent with my assumptions, although Becker et al.'s is closer in spirit to what I assume for Russian. Below, I summarize the facts of Turkish and briefly sketch out the two analyses. I also point out what kind of evidence would allow one to distinguish the two approaches.

The facts of Turkish are far too complex for a detailed discussion, so I can only give an abbreviated summary here. I follow the characterization in Becker et al. (2008), which is consistent for the most part with Petrova et al. (2006) and Kallestinova (2004). First, some basic phonotactics. As the following minimal pairs show, there is a robust laryngeal contrast both word-initially and

word-finally. (Sources differ in whether final voiceless consonants are aspirated).

(68) Contrast for voicing/aspiration in Turkish

a.	p͡ʰul	'stamp'	b͡ul	'find'
b.	at͡ʰ	'horse'	ad͡	'name'

Clusters of consonants do not have to agree in voicing in Turkish:

(69) Clusters of consonants do not have to agree in voicing

a.	mak͡ʰb͡ul	'accepted'
b.	eb͡k͡ʰem	'mute'
c.	kʰut͡ʰb͡u	'pole (acc)'
d.	tʰak͡ʰd͡im	'introduction'
e.	mat͡ʰb͡aa	'press'

When affixed, some root-final consonants retain their laryngeal specification (at^h∼at^h-ɨ), whereas others alternate: they are voiceless in coda position (k^hap, $k^hap^h.lar$) but voiced intervocalically (k^hab-ɨ).

(70) Alternation contrasts in affixed forms

a.	at͡ʰ	'horse'	at͡ʰ-lar	'horse (pl)'	at͡ʰ-ɨ	'horse (acc)'
b.	ad͡	'name'	ad͡-lar	'name (pl)'	ad͡-ɨ	'name (acc)'
c.	kʰap͡ʰ	'container'	kʰap͡ʰ-lar	'container (pl)'	kʰab͡-ɨ	'container (acc)'

Affix consonants can also alternate, but not all do. The ablative suffix (see (71a-c)) surfaces with a [d] intervocalically and after sonorants, and otherwise it agrees with the root-final obstruent. On the other hand, the relative suffix [-kʰɨ] (see (71d)) retains its aspiration throughout, and the suffix [-gen] '-sided' always retains its voicing.[28] The key examples here are (71b) and (71c): the voicing of the entire cluster depends on the voicing of the word-final consonant in the isolation form, whether it alternates intervocalically or not.

[28] One of the complications, undoubtedly relevant to the issue at hand, is that place of articulation determines the likelihood of alternating in Turkish (see Becker et al. 2008). Turkish affixes do not allow us to disentangle the effects of place of articulation, though: the alternators have coronal stops ([-dan]/[-tan]/etc. 'ablative', [-de]/[-te]/etc. 'locative'), and the non-alternators have dorsals, although they may be either aspirated or voiced ([-kʰɨ] 'relative', [-kʰen] 'adverbial', [-gen] '-gon'). The dorsal-initial suffixes are peculiar in that they do not undergo the famous intervocalic dorsal deletion rule (see various papers by Inkelas and colleagues).

(71) Laryngeal neutralization patterns in Turkish: suffixes

a.	masa-dan	'table (abl)'		
	gøl-den	'lake (abl)'		
	zaman-dan	'time (abl)'		
b.	k^hap-tan	'container (abl)'	k^hab-ɨ	'container (acc)'
	sap-tan	'stem (abl)'	sap^h-ɨ	'stem (acc)'
	at-tan	'horse (abl)'	at^h-ɨ	'horse (acc)'
c.	ud-dan	'oud (abl)'	ud-u	'oud (acc)'
	ad-dan	'name (abl)'	ad-ɨ	'name (acc)'
d.	masa-da-k^hɨ	'the one on the table'		
	køʃe-de-k^hi	'the one in the corner'		
e.	alt^hɨ-gen	'six-sided (hexagon)'		
	on-ik^hi-gen	'ten-two-sided (dodecagon)'		
	$ytʃ^h$-gen	'triangle'		

Inkelas and Orgun (1995) and Inkelas et al. (1997) argue for a contrastive underspecification account of these facts (see (72)). Non-alternating consonants are fully specified for voicing in the UR, and they retain their feature specifications in all forms. Alternating consonants, written in caps in the UR, are unspecified for voicing. Their laryngeal features get filled in by late rules: in intervocalic position, they become voiced, and elsewhere, they are voiceless, unless they are adjacent to a consonant that has an underlying specification, in which case the specification spreads (as in /ad-DAn/→[a<u>dd</u>an]).

(72) Contrastive underspecification analysis of Turkish

UR of root	Ablative /-DAn/	Plural /-lAr/	Accusative /-I/
/kaB/	kaptan	kaplar	kabɨ
/at/	attan	atlar	atɨ
/ad/	addan	adlar	adɨ

Becker et al. (2008) propose an alternative whole-morpheme account, which relies on reanalyzing the URs and the nature of the alternation. They assume that the alternating morphemes such as [k^hap] 'container' have underlying voiceless consonants, and the morphemes are indexed to a constraint banning intervocalic voiceless stops, *VC^hV. Although Becker et al. do not set out to analyze affixes specifically, their analysis can be extended to explain the behavior of affixes in (71), as well. The URs, mappings and rankings necessary for such an analysis are given below. For non-alternating morphemes, the ranking is IDENT≫*VC^hV; this simply preserves the contrast in all contexts. Alternating roots are treated as exceptions in the grammar, and they are indexed to a higher-ranked version of the markedness constraint *V$C^h$$V_L$.[29] Alternating suffixes fall under the same ranking, which ensures that they surface with voicing after vowels. They also surface voiced after sonorants, which suggests another high-ranked constraint, *R$C^h$$V_L$. This constraint is motivated not just by suffix behavior—Becker et al. found that roots that end in CC clusters (e.g., [renk] 'color') were more likely to alternate than VC-final roots. Finally, the lexically idiosyncratic ranking AGREE-voice$_L$≫IDENT requires alternations in some clusters so that they agree in voic-

[29] I am abstracting away from the effects of word size; see Becker et al. (2008) for full discussion.

ing. The direction of assimilation is from the root to the suffix, which implicates root faithfulness (Beckman 1998, Kallestinova 2004 and others).

(73) Summary of lexical indexation analysis of Turkish (inspired by Becker et al. 2008)

Non-alternators:	/at^{h}-ɨ/	[at^{h}ɨ]	by IDENT≫*VC^{h}V
	/ad-ɨ/	[adɨ]	(vacuous)
	/masa-ta$_{L}$-k^{h}ɨ/	[masadak^{h}ɨ]	by IDENT≫*VC^{h}V
	/ytʃ^{h}-gen/	[ytʃ^{h}gen]	by IDENT ≫AGREE-voice
Alternating roots:	/k^{h}ap^{h}$_{L}$-ɨ/	[k^{h}abɨ]	by *VC^{h}V$_{L}$≫IDENT
Alternating suffixes:	/masa-tan$_{L}$/	[masadan]	by *VC^{h}V$_{L}$≫IDENT
	/gøl-tan$_{L}$/	[gøldan]	by *RC^{h}V$_{L}$≫IDENT
	/ud-tan$_{L}$/	[uddan]	by AGREE-voice$_{L}$≫IDENT
Alt. roots+alt. sufixes:	/k^{h}ap^{h}$_{L}$-tan$_{L}$/	[k^{h}ap^{h}tan]	(vacuous)

Yet another analysis of these facts is developed by Kallestinova (2004) and Petrova et al. (2006), who argue that it is possible to analyze Turkish even without positing exceptions. They assume a three-way laryngeal contrast in the UR between [voice], [spread glottis], or plain obstruents. Spread glottis consonants retain their specification in all positions, respecting an undominated IDENT[sg] constraint. In word-initial position, the contrast between plain and voiced stops is neutralized such that both surface voiced. This is required by the positional markedness constraint SPECIFY-σ_1, which requires obstruents to be specified for some laryngeal feature in the first syllable. In intervocalic position, the contrast is phonologically retained, but phonetically, plain voiceless stops undergo passive voicing, so the surface contrast is preserved only for aspirates vs. voiced stops. The contrast between plain and aspirated stops primarily determines how affixes behave in assimilation. Plain consonants, as in the suffix [-dan]/[-tan]/[-den]/[-ten], assimilate to the root consonant, whereas aspirated ones do not—consistent with the high ranking of IDENT[sg] in the language.

(74) Three-way laryngeal contrast analysis (Petrova et al. 2006)

a. Initial two-way contrast

/pul/	bul
/bul/	bul
/p^{h}ul/	p^{h}ul

b. Final two-way contrast

/at/	at
/ad/	ad
/at^{h}/	at

c. Intervocalic neutralization

/at-ɨ/	at-ɨ → [adɨ]
/ad-ɨ/	ad-ɨ
/at^{h}-ɨ/	at^{h}-ɨ

d. Agreement in clusters

/kap-dan/	kaptan	by IDENT-ROOT
/ad-dan/	addan	
/at^{h}-dan/	at^{h}tan	
/at-k^{h}ɨ/	atk^{h}ɨ	

This analysis is somewhat similar to the contrastive underspecification account in that the alternations depend on a UR contrast that doesn't always make it to the surface (Inkelas and Orgun 1995, Inkelas et al. 1997). Unlike the absolute neutralization analyses such as Lightner (1972), however, the three-way laryngeal contrast analysis is supported by phonetic evidence: the consonants really do contrast three ways on the surface, especially in affixes.

In order to distinguish between these three analyses, we need to find morphemes that include both alternating and non-alternating consonants. Roots such as [kitap]~[kitab-ɨ] 'book (acc)' do

not unambigously support segment-by-segment marking, since it is possible that intervocalic voicing (assuming a Becker et al. analysis) is a derived environment effect. Although some proponents of lexical indexation see it as a theory of DEEs, other theories of DEEs allow for such a situation independent of how exceptions are encoded in phonology (see, for example, Wolf 2008). The only unambigous evidence for segment-by-segment marking would come from suffixes with identical consonants, of which only one alternates in the relevant context. A hypothetical example is given below. In this example, the suffix /-Dad/ has an alternating underspecified /D/ on the left, and a non-alternating /d/ on the right.

(75) Hypothetical evidence for segment-by-segment marking a là Turkish

a.	/at^{h}a-t^{h}at^{h}-u/	at^{h}adat^{h}u	*intervocalic voicing on the left but not on the right*
b.	/at^{h}ab-t^{h}at^{h}/	at^{h}abdat^{h}	*voicing agreement on the left*
c.	/at^{h}ap^{h}-t^{h}at^{h}-bu/	at^{h}ap^{h}t^{h}at^{h}bu	*no voicing agreement on the right*

Turkish does not have any suffixes of this kind—all either alternate or do not. Thus I conclude that Turkish does not provide clear evidence for segment-by-segment marking, and that it is consistent with a whole morpheme analysis.

7 Conclusion

I have argued that phonological exceptionality is encoded in the grammar at the level of the morpheme rather than at the level of the segment. The approach was formalized in terms of lexically indexed constraints in Optimality Theory. This and other diacritic theories of exceptional phonological behavior stand in opposition with approaches in which exceptionality is marked on a segment-by-segment basis. The whole morpheme approach requires asking questions about exceptional patterns that are usually not addressed: for example, why is it that in Russian, only mid vowels in the last syllable of a morpheme can alternate with zero? The whole morpheme approach seeks to answer these questions in terms of general, cross-linguistically motivated constraints rather than by arbitrarily marking the set of alternating segments in the UR. I argued that exceptional patterns have parallels in regular phonologies, because both arise from the interaction of the same constraints. For instance, mid vowels are the only ones to delete in Russian because they are marked with respect to a universal constraint *Mid, which happens to apply to only a subset of the lexicon in the language. Likewise, the positional restrictions on vowel-zero alternations follow from constraints on prosodic structure that are motivated elsewhere in the phonology of Russian and other languages.

The key argument for morpheme-level marking of exceptionality lies outside of phonology proper: the lexicon must store information about semantic and syntactic as well as phonological properties that are not fully predictable for any given morpheme. Approaching the old and famous problem of Russian yers from this perspective helps to advance our collective understanding of lexically idiosyncratic phonology.

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8 Appendix: Residual issues

While the analysis in §4.2 focused primarily on deriving generalizations about the quality and position of alternating vowels, yers are probably most famous for a different reason: their unexpected deletion or retention in the context of certain morphemes, originally brought to the attention of the field by Pesetsky (1979). First, Russian has suffixes that fail to condition yer deletion even though they are vowel-initial (see (76)). This kind of pattern might be familiar from the literature on cyclicity (Brame 1974, inter alia).[30] Second, Russian has vowel-zero alternations that affect vowels other than /e/ and /o/: all of them occur in verbal roots (see (77)). Third, the same verbal roots that have vowel-zero alternations also happen to condition vowel-zero alternations in verbal prefixes; compare the near-minimal pairs in (78).

[30]Cyclicity is a not an inherent feature of vowel-zero alternations, but it seems to be a common one: see, for example, the fully general vowel-zero alternations in Itelmen (Chukotko-Kamchatkan, Bobaljik 1997) and St'át'imcets (Salishan, van Eijk 1997).

(76) Underapplication of vowel deletion in the context of certain suffixes

a.	/vʲetʲe̲r-ok/	vʲitʲirók	'wind (dim nom sg)'	not *vʲitrók	cf. vʲétr-ə	'wind (gen sg)'
b.	/vʲetʲe̲r-o̲k-a/	vʲitʲirká	'wind (dim gen sg)'			
c.	/vʲetʲe̲r-e̲n-ɨj/	vʲétrʲi̲nɨj	'windy'			

(77) Vowel-zero alternations in verbal roots

a.	vɨ-br-átʲ	'to pick out (perf)'
b.	vɨ-bʲi̲r-átʲ	'to pick out (impf)'
c.	vɨ-sl-atʲ	'to send out (perf)'
d.	vɨ-sɨl-átʲ	'to send out (impf)'

(78) Vowel-zero alternations in prefixes and prepositions

a.	br-atʲ	'to take'		
b.	sa̲-br-átʲ	to gather up (perf)'	cf.	vɨ-bʲi̲r-átʲ (77b)
c.	brʲ-itʲ	'to shave'		
d.	z-brʲitʲ	'to shave off (perf)'		

I start with a discussion of the so-called cyclic effects in suffixation. I then move on to argue that the vowel-zero alternations in verbs and prefixes differ in many ways from yer alternations, to a point where a unified account is neither possible nor appropriate.

8.1 Cyclicity and suffixes

Pesetsky (1979), Melvold (1990), and Yearley (1995), among others, observe that some affixes fail to condition yer deletion, even though they are expected to do so based on their phonological shape. Compare, for example, (79a) and (79b): even though /vʲetʲe̲r-o̲k/ 'wind (dim)' could map to the perfectly pronounceable *[vʲitrók], the form is ungrammatical. To adopt the cyclic metaphor, the word behaves as though the affix was not considered when the stem was phonologized. Suffixes such as /-ok/ also differ from other suffixes in another way. Recall from (49) that in words such as /orʲel$_L$-et͡s$_L$-a/, it is the first eligible vowel that deletes. With the diminutive /-ok/, as in forms such as [vʲitʲirká], the outermost yer deletes, and the root vowel is preserved.

(79) idiosyncrasy in suffixes

a. Suffixes that condition yer deletion

/vʲetʲe̲r-a/	vʲétrə	'wind (gen sg)'
/vʲetʲe̲r-ov/	vʲitróf	'wind (gen pl)'
/vʲetʲe̲r-ʲan-ok-a/	vʲitrʲánkə	'chicken pox'

b. Suffixes that do not condition yer deletion

/vʲetʲe̲r-o̲k/	vʲitʲirók	'wind-dim (nom sg)'	*vʲitrók
/vʲetʲe̲r-o̲k-a/	vʲitʲirká	'wind-dim (gen sg)'	*vʲitʲrʲiká

In work on yers, there are two main lines of thought on such patterns. The first approach is that the suffix /-ok/ invokes output-output faithfulness to another surface form. Thus, an OO-MAX constraint requires that the root vowel in /vʲetʲer-ok/ be realized to match the unaffixed base form [vʲétʲir] (Hermans 2002). According to the second approach, all Russian suffixes are cyclic; the reason that yers are realized before some suffixes but not others is that some suffixes have yers themselves (Matushansky 2002, Halle and Matushansky 2006; see §5 for more detail and criticism). Yearley (1995) points out that there are yer suffixes that do not pattern cyclically, so her own cyclic analysis posits a different distinction between suffixes. Suffixes such as /-ok/ attach to already-prosodified stems, whereas suffixes such as /-e͡ts/ are prosodified with the stem they attach to. An account along these lines should be possible to formalize in more recent models of OT where morphological and phonological operations are serially interspersed (Wolf 2008). One advantage of such an account is that, unlike the OO-Faith account, it does not rely on the existence of a free-standing base form, which is in some cases hard to identify or define in a principled way based on morphological criteria (see Albright 2002).

8.2 Other vowel-zero alternations in Russian: the problem of prefixes and prepositions

There is a context, already alluded to in §4.4, where Russian vowel-zero alternations have a character different from the root and suffix alternations discussed so far: prepositions and prefixes. I will start with the simpler case of prepositions. Russian prepositions come in two varieties: those that are always vowel-final (e.g., [po] 'along', [na] 'on', [u] 'by', etc.) and those that have a vowel-final and a consonant-final form ([s/sə/sa] 'with', [v/və/va] 'in', [k/kə/ka] 'to', [bʲes/bʲezə] 'without', [tʃerʲis/tʃerʲizə] 'through', etc.). These morphemes have been the subject of a lot of recent attention (Matushansky 2002, Steriopolo 2007, Gribanova 2008, 2009a,b), so the properties of the alternations are fairly well-known. Steriopolo establishes two important generalizations: first, the realization of prepositions is highly variable, with younger speakers favoring consonant-final variants in more contexts, and second, the form of the preposition depends on the place of articulation of its final consonant and the features and prosodic role of the following consonant (see (80)). A vowel-final preposition is more likely before a sonorant-initial cluster: [sa lʲdom] 'with ice', not *[s lʲdom]. A vowel-final preposition is also all but required between two labials, the second of which is an appendix to the prosodic word. Thus, we get [va vrʲemʲə], never *[v vrʲemʲə]. Note the contrast in (80c): when the first consonant of the root is an onset, the two labials are not broken up by a vowel. There are other complications; see Steriopolo (2007) for more discussion and analysis.

(80) Examples of prepositional vowel-zero alternations

a.	sa̲ lʲ.d-óm	'with ice (inst sg)'	cf.	v(*a) lʲot	'ice (acc sg)'
b.	va̲ r.tútʲ-i	'in mercury (gen sg)'		f(*a) trut	'in labor (acc sg)'
c.	va̲ v.rʲémʲə	'during (in+time)'		v(*a) vidú	'in light of'
d.	va̲ f.sʲ-éx	'in all (acc pl)'		v(ə) vʲesʲ	'in all (acc sg)'
e.	va̲ mglʲe	'in darkness'		v(*a) mʲéstʲi	'in place (acc sg)'
f.	sə̲ s.tərʲikóm	'with an old man (prep sg)'		s(*a) psom	'with a dog (prep sg)'
g.	ka̲ m.n-é	'to me (dat sg)'		s(*ə) mʲinʲ-á	'from me (gen sg)'

For the purposes of this paper, the most important question is whether these alternations are the same as the yer alternations discussed earlier. If these prepositions underlyingly have yers (as in,

/vo-$_L$/, /so-$_L$/, etc.), then they violate the generalization I advocated earlier: yer deletion does not create initial CCC clusters. I think these alternations are quite different, however: even though historically, these prepositions clearly were yer-final, they have been reanalyzed in the modern language as consonant-final, and the alternating vowels are now epenthetic, inserted for phonotactic reasons.[31] The first argument for this analysis is that Russian lacks non-alternating consonant-final prepositions. Any analysis that assumes Richness of the Base must derive this generalization about Russian surface forms; positing fleeting vowels in all of the URs is not an acceptable solution. Along the same lines, all the alternating vowels in prepositions happen to be back—there are no alternating prepositions that end in [e] or unstressed [i]. This is again a suspicious coincidence under a deletion account, but it is straightforward under an epenthesis account—recall that one of the arguments for a deletion analysis of yers (given §2) is that the identity of the alternating vowel is unpredictable in Russian, but this is not the case in prepositions: the vowel is always either [ə] or [a], depending on stress position.[32] Yet another argument against a deletion analysis is that prepositions such as [s] and [v] cannot be realized with a vowel even in isolation—this is in stark contrast with lexical yer words, which surface with their vowels when there is no other vowel to carry the syllable.

Treating prepositional vowel-zero alternations as epenthetic allows us to explain these puzzles and to complete the account of Triconsonantal Cluster Blocking. In general, epenthesis is not used in Russian to break up triconsonantal clusters—DEP-V dominates the relevant constraints, as established in (48). C-CC clusters containing monoconsonantal prepositions provide additional evidence for this ranking (see (81a)). I assume that the preposition is inserted after the word has been phonologized (see Gribanova 2008, Wolf 2008 for possible implementations of this serial ordering), so the candidate [s pʲosəm] does not make it to this round of evaluation. Epenthesis is required by phonotactic constraints such as OCP-PLACE$_{unsyll}$: if the alternative to epenthesis is a sequence of unsyllabified consonants that have the same place of articulation, then an epenthetic vowel breaks up the sequence. Additional mechanisms would be needed to derive the variability and the differences between consonants with different place of articulation; see Steriopolo (2007) for discussion.

(81) Epenthetic account of vowel-zero alternations in prepositions

	/s-psom/ 'with dog'	OCP-PLACE$_{unsyll}$	DEP-V	*[$_\omega$CC.C
a.	sp.som∼sap.som		W	L
	/v-vrʲemʲə/ 'in time'			
b.	vavrʲémʲə∼vv.rʲémʲə	W	L	W
	/v-mglʲe/ 'in darkness'			
c.	vam.glʲé∼vm.glʲe	W	L	W

Prepositions in Russian have an etymological counterpart in verbal morphology: prefixes. These also have vowel-zero alternations, although the conditioning context is quite different from that of prepositions. The alternations are usually characterized as follows: the prefix is vowel-final if the following verbal root is vowelless (CC-) and participates in vowel-zero alternations (Pesetsky 1979, Yearley 1995, Rubach 2000, Matushansky 2002, Steriopolo 2007, Gribanova 2009a,b). The relevant examples are given in (82), with the alternating prefix vowels underlined. Compare the alternating

[31] One precedent for this epenthetic analysis is Katz (2005), although that analysis is not connected to vowel-zero alternations elsewhere in Russian.

[32] There are fixed archaic and idiomatic expressions where stress falls on the preposition (e.g., [só snu] 'from sleep'), in which case the vowel is always [o]. See Ukiah (1998).

verbs in (82a-c), with the verbs in (82d-e), which have the same types of consonant clusters but always occur with the consonant-final variants of the prefixes. Superficially, then, this is somewhat similar to the yer alternations we saw in root-suffix sequences.

(82) Examples of prefixal vowel-zero alternations

	Unprefixed imperfective		*V-final prefixed perfective*		*C-final prefixed imperfective*	
a.	ʒr-^{j}át^{j}	'to devour'	sa̲-ʒr^{j}-át^{j}	'to gobble up'	z-ʒir^{j}-át^{j}	'to devour'
b.	br-at^{j}	'to take'	pəda̲-br-át^{j}	'to pick up'	pəd-b^{j}ir-át^{j}	'to pick up'
c.	sl-at^{j}	'to send'	va̲-sl-át^{j}	'to send in'	f-sɨl-át^{j}	'to send in'
d.	gr^{j}is-t^{j}í	'to rake'	—		z-gr^{j}is-t^{j}í	'to rake up'
e.	bras-át^{j}	'to throw'	—		pad-brós^{j}-it^{j}	'to toss up'
f.	slúʃ-ət^{j}	'to listen'	—		f-sluʃ-ət^{j}-s^{j}ə	'to listen intently'

There are major differences between this pattern and the yer pattern, however, summarized in (83) and justified below.

(83) Characteristics of vowel∼zero alternations in verbal roots:

a. Deletion can affect vowels other than [e]/[o] and their unstressed allophones.

b. Deletion can create an initial cluster bigger than CC-, consisting of root and/or suffix but not prefix and root consonants.

c. Deletion is blocked by the requirement for a word to have at least one vowel-headed syllable, but Triconsonantal Cluster Blocking does not apply.

d. Deletion usually applies in a morphological context: it affects verbal roots in underived imperfectives (e.g., [br-at^{j}]) and secondary perfectives derived by prefixation (e.g., [pəda̲-br-át^{j}]).

Let's start with the quality of alternating vowels. In verbs, vowels other than /e/ and /o/ can alternate with zero: most notably, stressed [i]/[ɨ], as shown below. This is a clear departure from the generalization I established in §3.1, although it is not the case that just any vowel can alternate with zero here, either. For example, [u] is never affected, and examples of alternating [a] are marginal.[33]

(84) Quality of vowels that alternate with zero in verbs

a.	rv-át^{j}	'to rip (impf)'	s-rɨv-at^{j}	'to rip off (impf)'	pa-rɨ́f	'gust'
b.	mn-u	'I wrinkle (impf)'	s-m^{j}in-át^{j}	'to wrinkle up (perf)'	za-m^{j}ín-k-ə	'wrinkle, problem'
c.	br-át^{j}	'to take (impf)'	pad-b^{j}ir-át^{j}	'to pick up (impf)'	pa-bór	'tax, collection'
d.	sl-át^{j}	'to send (impf)'	pat-sɨl-át^{j}	'to send up to (impf)'	pa-sól	'envoy'
					pa-sɨl-k-ə	'package'

The vowel quality alternations seen in examples such as (84d) have to be seen in the larger context of Russian aspectual morphology. While many verbal roots do not alternate in different aspect

[33] Pairs such as [za-gár] 'tan' and [gr^{j}-et^{j}] 'to warm up (impf)' might be argued to show that [a] participates, as well, but this is arguable, as the vowel [a] could itself be derived by mutation in [zagár].

forms, aspectual distinctions often entail vowel mutation, which historically started out as vowel length alternations (Vlasto 1986). Russian also expresses aspectual distinctions through suppletive root allomorphy:

(85) Other aspectual alternations in verbal roots

a. Vowel mutation [o]∼[a]

xód-it	'he walks (impf)'	pa-xáʒ-iv-at^{j}	'to go now and then (impf)'
zə-maróz^{j}-it^{j}	'to freeze (perf)'	zə-maráʒ-iv-at^{j}	'to freeze (impf)'
zə-garód-it	'he will block (perf)'	zə-garáʒ-iv-at^{j}	'to block (impf)'

b. Suppletive root allomorphy

xad-íl-ə	'walked (fem impf past)'	ʃl-a	'walked (fem perf past)'
gavar-ít^{j}	'to say (impf)'	skaz-át^{j}	'to say (perf)'
klas-t^{j}	'to put (impf)'	pa-laʒ-it^{j}	'to put (perf)'

Second, the phonotactic constraints on vowel deletion in verbal roots are quite different from the constraints on vowels. Three-consonant clusters are created freely, as long as they consist of consonants affiliated with the root and, optionally, suffixes. Crucially, prefix consonants are never part of clusters created by deletion (see (86e)); I return to this shortly. This is again a departure from the pattern that true yer morphemes follow (recall §3.2). The one common thread is that deletion cannot create coda clusters or words without vowels—the latter of these restrictions holds of the language as a whole (see Gribanova 2009b on the latter point).

(86) Clusters created by vowel deletion in verbs

a.	/za-ʒeg-at^{j}/	zəʒɨgát^{j}	'to set on fire (impf)'	
b.	/ʒeg-l/	ʒok	'he burned (impf)'	cf. pad-ʒók 'he set fire to (perf)'
c.	/ʒeg-l-a/	ʒgla	'she burned (impf)'	cf. pəda-ʒgl-á 'she set fire to (perf)'
d.	/lest^{j}-it^{j}/	l^{j}st^{j}it^{j}	'to flatter (impf)'	
e.	/lest^{j}-n-ut^{j}/	l^{j}st^{j}nut^{j}	'to flatter once (perf)'	cf. pəda-l^{j}st^{j}-ít^{j} 'to smarm up to (perf)'

Third, the context for deletion is not phonological but morphological.[34] Recall that in nominal paradigms, yers delete when a vowel-initial suffix follows. In verbs, this generalization is routinely violated and even reversed (cf. (86a) vs. (86c)). Compare also forms such as [vɨ-b^{j}ir-át^{j}] 'to choose (impf)' and [vɨ́-br-ət^{j}] 'to choose (perf)'. The vowel is retained in the root in the prefixed imperfective form but not in the perfective form. More evidence against a yer analysis comes from deverbal nouns such as [pa-bór] 'tax, collection (nom sg)'. These never have alternations in the normal yer context, either: the genitive singular of 'tax, collection' is [pa-bór-ə], not *[pa-br-á]; the latter form would be expected if the root were a true yer root. Prefix alternations are likewise confined to the verbal domain; the very same prefixes in deverbal nouns do not alternate:

(87) Prefix alternations are confined to the verbal domain

a.	/pod-ʒeg-Ø/	padʒok	'arson (nom sg)'	pad-ʒog-ə	*pədaʒgá	'arson (gen sg)'
b.	/pod-ʒeg-l/	padʒok	'he set fire to (perf)'	padə-ʒg-l-á		'she set fire to (perf)'

[34] For a discussion of the various issues in the morphosyntax of Russian verbs, see Svenonius (2004), Gribanova (2009b).

All of these facts taken together suggest that something entirely different is happening in verbs and verbal prefixes than in nouns and other contexts. Space prevents a complete analysis, but here are some preliminary speculations. The form of the verbal root is determined by the morphosyntactic context; specifically, the vowelless form is preferred in the imperfective (e.g., [ʒg-l-a] 'she burned (impf)', not *[ʒɨg-l-á].[35] This vowelless default is overridden by phonotactic constraints such as HEADEDNESS and *COMPLEXCODA, which gives us [ʒok] 'he burned (impf)' and not *[ʒk]. The Triconsonantal Cluster Blocking constraints, on the other hand, do not play a role in imperfectives; if they were relevant, then [lʲstʲ-itʲ] 'to flatter (impf)' would be impossible. Let us assume that alternating prefixes are underlyingly C-final, whereas non-alternating prefixes are V-final. The alternating vowel is inserted in a phonologically well-defined context: at a morphological boundary between a consonant-final and a CC-initial root. Epenthesis does not apply in the context of verbs whose initial clusters are underived, so epenthesis must be a derived environment effect triggered only in the context of CC verbal roots (see Wolf 2008).

It should be noted that generalizations about prefix alternations in Russian are marred by exceptions. Vowel alternations in the verbal root do not guarantee that there will be vowel-zero alternations in the prefix. Conversely, the prefix can show up with a vowel even if the root does not alternate. This is exemplified in (88). The first mini-paradigm, (88a), shows typical alternations for reference. The mini-paradigm in (b) shows the root 'come, go,' which always appears with a vowel-final prefix—even though it exhibits vowel-zero alternations. In (c) is the root 'ask,' which appears with a vowel-final suffix in some cases and with a consonant-final suffix in others.

[35] How this is implemented is a bit of a mystery. Allomorphy is one possibility—some allomorphy mechanism is needed to account for suppletive allomorphy in verbs in any case. This seems to miss some generalizations, however—remember that some vowels do not participate in these aspectual vowel-zero alternations. Another alternative would be some kind of a "readjustment rule." This is fairly straightforward for vowel mutation, but not necessarily for segmental deletion (see Horwood 1999, Wolf 2007). Gribanova (2009b) suggests that the morphosyntactic differences are translated into a kind of diacritic feature [jerful] in the phonology, but this must be understood as shorthand for a more complex interaction.

(88) Prefixal vowel-zero alternations: lexical idiosyncrasy

a. Alternation in a verbal root conditions prefix alternation

z-ʒo̲k	'burned (masc perf)'
sa̲-ʒg-l-á	'burned (fem perf)'
pad-ʒo̲k	'set to fire (masc perf)'
pəda̲-ʒg-l-á	'set to fire (fem perf)'

b. Vowel alternation in the root fails to condition prefix alternation

va̲-ʃól	'came in (masc)'
va̲-ʃl-á	'came in (fem)'
pəda̲-ʃól	'came up to (masc)'
pəda̲-ʃlá	'came up to (fem)'

c. Unpredictable realization of vowel in prefix

s-pras^{j}-ít^{j}	'to ask (perf)'
s-práʃ-iv-at^{j}	'to ask (impf)'
və̲-praʃ-át^{j}	'to ask (impf, archaic)'
s-prós	'accountability'
va̲-prós	'question'

The source of these exceptions, especially the kind in (88c), is no mystery: many vowel-final forms of prefixes were retained or re-borrowed from OCS. The forms do present a challenge for any phonological account of vowel alternations in Russian, including the one I sketched above.