

Contrastive feature hierarchies as a new lens on typology

B. Elan Dresher^a, Christopher Harvey^a, & Will Oxford^b

University of Toronto^a & University of Manitoba^b

Abstract: We propose a way of looking at phonological typology that is based on a fundamental distinction between a phonetic and phonological analysis of the sound systems of languages. We build on approaches to phonology pioneered by Sapir and the Prague School (Jakobson and Trubetzkoy), instantiated within a generative grammar. We view phonemes as being composed of contrastive features that are themselves organized into language-particular hierarchies. We propose that these contrastive feature hierarchies shed light on synchronic and diachronic phonological patterns, and therefore offer a new lens on phonological typology. Thus, on this view the subject matter for typological investigation is not a phonetic sound (e.g., [i]) or a phoneme (/i/), or even a phonemic inventory (/i, a, u/), but an inventory generated by a feature hierarchy: for example, /i, a, u/ generated by the hierarchy [low] > [round]. This yields a different set of representations from the same terminal symbols generated by the hierarchy [round] > [low].

We will illustrate this approach to phonological representations with a synchronic analysis of Classical Manchu, and then show how it accounts for the results of typological surveys of rounding harmony in Manchu-Tungusic, Eastern Mongolian, and Turkic, and for the distribution of palatalization in Yupik-Inuit dialects. We will then propose that contrast shift should be recognized as a type of phonological change, and show how it applies to diachronic developments of the Algonquian and Ob-Ugric vowel systems. We find that feature hierarchies can be relatively stable, but contrast shifts do occur, for various reasons, and these can result in dramatic differences in patterning. Harvey's analysis of Ob-Ugric also shows that elements of feature hierarchies can spread and be borrowed, like other aspects of linguistic structure. As Sapir (1925) proposed, languages whose phonemes line up in similar ways (i.e., have similar contrastive feature hierarchies) show similar phonological patterning, though they may differ considerably in their phonetic realizations. We conclude that contrastive feature hierarchies provide an interesting level of representation for typological research.

1 Introduction

This article addresses a question raised in the proposal for the Workshop on Phonological Typology (Oxford University, August 2013): Phonological typology vs. phonetic typology—same or different? We will propose a way of looking at phonological typology that is clearly *different* from phonetic typology. In particular, we will propose that *contrastive feature hierarchies* offer a new lens on typology, while also shedding light on synchronic and diachronic phonological patterns.

We will begin in Section 2 with some general remarks on typology, phonological contrast, and contrastive feature hierarchies. Section 3 illustrates the relation between contrast and phonological activity, as exemplified by the Classical Manchu vowel system. We then show how contrastive hierarchies can lend insight to synchronic, diachronic, and areal typology, with examples drawn from a typological survey of rounding harmony and the relative ordering of features [round] and [front] (Section 4), the diachrony of Algonquian vowel systems (Section 5), and areal typology of Ob-Ugric vowel systems (Section 6), respectively. Section 7 is a brief conclusion.

2 Typology, phonological contrast, and contrastive feature hierarchies

2.1 Phonological typology and contrast

Following Hyman (2007), the kind of typology we will be concerned with is “an underlying one, based on phonological analysis, not on surface inventories”. Hyman cites Vajda’s (2001) view of phonological typology: “. . .it is possible to classify languages according to the *phonemes* they contain. . .Typology is the study of *structural features* across languages. Phonological typology involves comparing languages according to the *number or type of sounds* they contain” [emphasis added]. We will build on this view by advancing a specific notion of the terms ‘phonemes’, ‘structural features’, and ‘number or type of sounds’.

In the same article, Hyman (2007) cites Sapir’s (1925: 43) “intrinsically typological” idea that “two languages, A and B, may have identical sounds but utterly distinct phonetic [read: phonological] patterns”. Sapir also constructs two languages C and D that illustrate the converse situation: phonetically their sounds are different, but their ‘pattern alignments’ are isomorphic. Sapir (1925) arranges the phonemes as in (1).

(1) Different phonetics, similar patterning (Sapir 1925)

a. Pattern of C

a	ε	i	u			
a:	ε:					
	h	w	j	l	m	n
p	t	k	q			
b	d	g	ɠ			
f	s	x	χ			

b. Pattern of D

æ	e	i	y			
æ:	e:					
	h	v	ʒ	r	m	ŋ
p ^h	t ^h	k ^h	q ^h			
β	ð	ɣ	ɤ			
f	ʃ	ç	ħ			

The phonemes /v/ and /ʒ/ appear to be out place in the chart of language D, but Sapir justifies their positions by their phonological behaviour, in that their places in the pattern are parallel to those of language C’s /w/ and /j/, respectively. Sapir (1925: 47–48) allows that the “natural phonetic arrangement” of sounds is a useful guide to how they pattern, but he goes on, “And yet it is most important to emphasize the fact, strange but indubitable, that a pattern alignment does not need to correspond exactly to the more obvious phonetic one.”

The isomorphic alignments in C and D can be understood as indicating that corresponding phonemes have the same *contrastive* values. The chart in (2) represents one possible way of suggesting what the

contrastive specifications might be for the consonants in (1). In each cell, the first sound is from C, the second from D. The differences between them do not involve contrastive specifications.

(2) Contrastive specifications suggested by the charts in (1)

			Labial	Coronal	Dorsal	Post-dorsal
Sonorant	Obstruent	Voiceless Stop	p/ p ^h	t/ t ^h	k/ k ^h	q/ q ^h
		Spirant	f/f	s/ʃ	x/ç	χ/ ħ
		Voiced	b/β	d/ð	g/ɣ	ɠ/ɣ
		Nasal	m/m	n/ŋ		
		Liquid	l/r			
		Glide	w/v	j/ʒ	h/h	

It was observed that the language D phonemes /v/ and /ʒ/ appear to be in the ‘wrong place’, which in (2) translates into their having incorrect specifications. In generative grammar, this mismatch can be resolved by assigning them different underlying specifications, matching those of their counterparts. These types of examples have been much discussed in connection with how abstract Sapir’s theory of phonology was (cf. McCawley 1967). Less attention has been paid to the other examples, which do not appeal to abstractness, but which show the importance of establishing the contrastive properties of segments. For example, the obstruents in the third row in (2) are contrastively voiced and redundantly stops or spirants. No abstractness is at issue here, but we have to distinguish between contrastive and non-contrastive properties.

It follows that for Sapir the pattern alignment of a phoneme amounts to its contrastive status, which is not determined by its phonetics, but is a function of its phonetic and phonological behaviour. Thus, a synchronic analysis of the phonology should, among other things, give an account of the contrastive features of each phoneme.

Turning to diachrony, Prague School phonologists have argued that the contrastive properties of phonemes also play an important role in phonological change. The insight that phonological change may involve a reorganization of the phonemes of a language goes back to an article by Roman Jakobson first published in 1931 (Jakobson 1972 [1931]): “Once a phonological change has taken place, the following questions must be asked: What exactly has been modified within the phonological system?...has the structure of individual oppositions [contrasts] been transformed? Or in other words, has the place of a specific opposition been changed...?”

It should be noted that phonological theories that put the emphasis on contrast have not been unproblematic. In pre-generative structuralist theories, synchronic grammars were composed of contrasting elements locked into systems of oppositions. If one takes too literally Saussure’s (1972 [1916]: 166) dictum that “dans la langue il n’y a que des différences . . . sans termes positifs” then grammars become incommensurable, and one has no way to relate successive stages of a language, or even closely related dialects (Moulton 1960). Generative grammar (Chomsky & Halle 1968) solves this problem by construing phonology as a system of rules that mediate between underlying (lexical) and surface (phonetic) forms. Now, grammar change takes the form of the addition, loss, reordering, or restructuring of rules.

Kiparsky (1965) demonstrated that a series of sound changes in Armenian dialects, shown in (3), can be understood in terms of the spreading of three rules, described informally in (4). Kiparsky (1965) points out that these sound changes spread from one dialect to another, regardless of how many contrasts they contained. If we were to classify the dialects in terms of oppositions, we would arrive at meaningless groupings for explaining any synchronic or diachronic facts. He writes (1965: 17): “An incidental feature of the present example is that it highlights the pointlessness of a structural dialectology that . . . distinguishes dialects according to points of structural difference rather than according to the innovations through which they diverged . . . If in the present example we were to divide the dialects into those with two stop series and those with three, we would be linking together dialects that have nothing to do with each other and separating dialects that are closely related.”

(3) Armenian dialects (Kiparsky 1965)

Old Armenian	th	t	d		
				<i>Contrasts</i>	<i>Sound changes</i>
East Central	th	t	dh	2	Aspiration
West Central	th	d	dh	2	Voicing, aspiration
Northern	th	t	d	2	—————
Eastern	th	t	t	1	Devoicing
Western	th	d	d	1	Voicing
Northwestern	th	d	th	1	Voicing, aspiration
Southern	th	d	t	2	Voicing, devoicing

(4) Armenian sound changes (Kiparsky 1965)

- a. Aspiration: /d/ aspirates to [dh] (or [th]) in the Central and Northwestern dialects.
- b. Voicing: /t/ voices to [d] in the Western, West Central, Northwestern, and Southern dialects.
- c. Devoicing: /d/ devoices to [t] in the Eastern and Southern dialects.

The above considerations show the inadequacy of a phonology that deals *only* in structural points of contrast (‘differences’), without also including substantive properties (‘positive terms’), including features and a system of rules or constraints. However, we believe that generative grammar went overboard in jettisoning the structuralist notion of language-particular contrast. We will argue that contrast plays a crucial role in synchronic and diachronic phonology, and hence in phonological typology.

2.2 A theory of phonological contrast

To implement contrast in an explicit theory, we assume first that contrastive features are assigned hierarchically, using a method that was called ‘branching trees’ in the literature of the 1950s and 1960s (Jakobson, Fant, & Halle 1952; Jakobson & Halle 1956), stated in (5). We call it the Successive Division Algorithm (Dresher 1998; 2003; 2009), given informally in (6):

- (5) The contrastive feature hierarchy (based on Jakobson, Fant, & Halle 1952, among others)
 Contrastive features are assigned by language-particular feature hierarchies.

(6) The Successive Division Algorithm

Assign contrastive features by successively dividing the inventory until every phoneme has been distinguished.

As a first approximation we assume further that phonology computes *only* contrastive features, in keeping with the Contrastivist Hypothesis in (7).

(7) The Contrastivist Hypothesis (Hall 2007)

The phonological component of a language L operates only on those features which are necessary to distinguish the phonemes of L from one another.

That is, only contrastive features can be *phonologically active*, where feature activity is defined as in (8):

(8) Phonological Activity (adapted from Clements (2001: 77))

A feature can be said to be active if it plays a role in the phonological computation; that is, if it is required for the expression of phonological regularities in a language, including both static phonotactic patterns and patterns of alternation.

If the Contrastivist Hypothesis is correct, it follows as a corollary (9) that if a feature is phonologically active, then it must be contrastive.

(9) Corollary to the Contrastivist Hypothesis

If a feature is phonologically active, then it must be contrastive.

This corollary suggests a working heuristic: assume that active features are contrastive, and find, if possible, a feature ordering that fits the observed patterns of activity. We believe that this heuristic represents the practice of many descriptive phonologists, minus the requirement that all active features are necessarily contrastive. That is, phonologists typically limit their analyses to those features that are *relevant* to the workings of the language, and these active features also serve as the contrastive features, as far as possible.

A further assumption is that features are binary, and that every feature has a *marked* and *unmarked* value. We assume, as in (10), that markedness is language particular (Rice 2003; 2007) and accounts for asymmetries between the two values of a feature, where these exist.¹ Where the asymmetry is substantial, a feature may appear to act in a privative manner, so that the unmarked value may appear to be absent. In other cases, both values of a feature may be referred to by the phonology (Mackenzie 2011; 2013). We will designate the marked value of a feature F as [F], and the unmarked value as (*non-F*).²

¹ We do not exclude the possibility that there may be universal tendencies concerning markedness; for example, we do not know of a language where [-nasal] is marked. However, Rice (2003; 2007) shows that a number of presumed universals of markedness are not empirically supported. Therefore, we adopt the conservative position that all markedness relations are language specific, but are prepared to modify this view where evidence exists in favour of a stronger position.

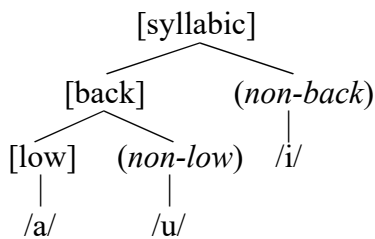
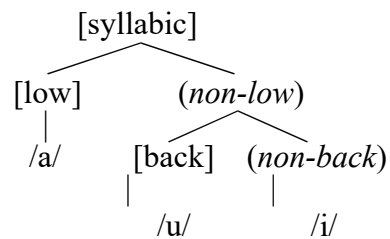
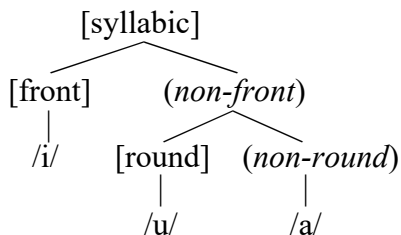
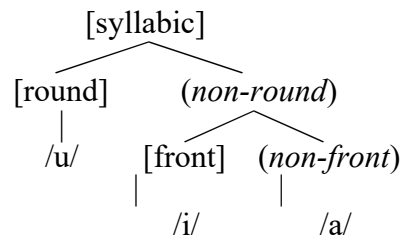
² Markedness considerations thus dictate whether we name a feature [back] or [front]: if a language has backing triggered by a back vowel but no fronting triggered by a front vowel we call the harmony

(10) Feature markedness

Each feature F has a marked value, $[F]$, and an unmarked value, $(non-F)$. Where these values function asymmetrically, the marked value is the more active one.

Finally, this theory of contrast does not need to make any assumptions as to where features come from: the Successive Division Algorithm works equally well if features are universal, as supposed by Chomsky & Halle (1968), or emergent, as suggested by Mielke (2008) and Samuel (2011). Dresher (2014) observes that the contrastive hierarchy itself ensures that phonological representations across languages will look rather similar even in the absence of a universal set of features.

To illustrate the workings of the feature hierarchy and the Contrastivist Hypothesis, consider a hypothetical vowel inventory $/i, u, a/$. The Successive Division Algorithm requires that an inventory of three phonemes must be characterized by exactly two features, though both the choice of features and their ordering may vary. In (11), we illustrate two possible contrastive hierarchies that use the features $[back]$ and $[low]$; in (12), we give two more hierarchies using the features $[front]$ and $[round]$. Other combinations of features are also possible, but these examples should suffice to illustrate the concept.

(11) Two contrastive hierarchies for $/i, u, a/$ based on $[back]$ and $[low]$ a. $[back] > [low]$ b. $[low] > [back]$ (12) Two more contrastive hierarchies for $/i, u, a/$, based on $[front]$ and $[round]$ a. $[front] > [round]$ b. $[round] > [front]$ 

The feature hierarchy constrains phonological activity in a number of ways. First, it follows from (7) that both $/a/$ and $/u/$ can potentially trigger backing in (11a), because both are contrastively $[back]$; in (11b), only $/u/$ is contrastively $[back]$, so that is the only potential phoneme that could cause backing. In (12), the feature $[back]$ is not contrastive in the vowel system at all, and we do not expect any vowel to cause backing.

feature $[back]$; conversely, we attribute fronting or palatalization to a feature $[front]$. In some cases the phonetic ranges of vowels might influence the choice of label.

Second, the hierarchy constrains neutralization and merger: we make the hypothesis in (13). In (11a) and (12a), we expect that /u/ could merge with /a/, whereas in (11b) it would more likely merge with /i/. Note that this restriction does not apply to ordinary synchronic processes. For example, in both languages in (12) /i/ is contrastively [front] and /u/ is contrastively [round]; therefore, both languages may have harmony processes whereby /a/ is fronted in the environment of /i/ and rounded in the environment of /u/, whether or not /a/ is a contrastive sister of /i/ or /u/. Though /a/ can alternate synchronically with both /i/ and /u/, depending on position, it can only merge diachronically with one of these vowels.³

- (13) Hypothesis concerning diachronic mergers
Mergers affect phonemes that are *contrastive sisters*.

The typological generalizations we will be discussing can thus not be found by looking at inventories alone (say, /i, a, u/), or at individual phonemes (say, /a/), or phones ([a]), without also considering the relevant contrastive feature hierarchy. Notice also that a consequence of this hierarchical method for assigning contrastive features is that a contrastive specification need not be unpredictable. For example, in (11a) /a/ is the only [low] vowel, so its [back] feature is predictable; but it is still contrastive, for it distinguishes between /a, u/ and /i/.

3 Example of contrast and activity: The Classical Manchu vowel system

In this section we will illustrate the connection between contrast and phonological activity, taking as an extended example the Classical Manchu vowel system, following the analysis of Zhang (1996) and Drescher & Zhang (2005). Classical Manchu has six vowel phonemes, as shown in (14).

- (14) Classical Manchu vowel system (Zhang 1996)

/i/	/u/
	/o/
/ə/	
	/ɔ/
/a/	

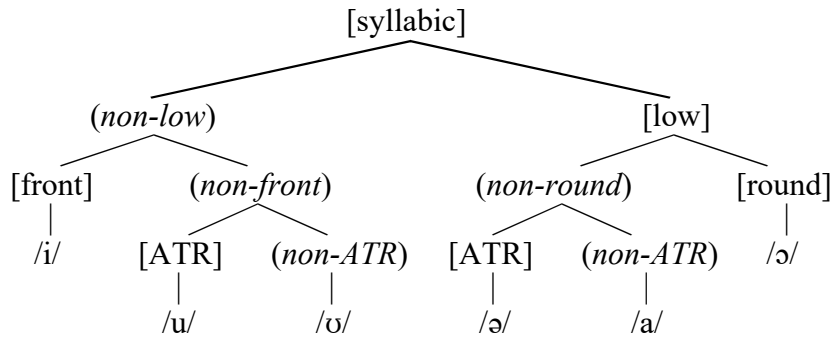
3.1 Contrastive feature hierarchy for Classical Manchu

Based on the phonological patterning of the Classical Manchu vowels, Zhang (1996) proposes the feature hierarchy in (15), which yields the marked feature representations in (16).⁴

³ For example, in dialects descending from Proto-Eskimo that retain a four-vowel system (either overtly or in underlying representations), the reflex of Proto-Eskimo */ə/ can assimilate to different vowels depending on context, but diachronically this vowel has only merged with Proto-Eskimo */i/; see Compton & Drescher (2011) and §4.2 below.

⁴ Zhang (1996) labels the features [labial] rather than [round], and [coronal] rather than [front]. For our purposes these names are interchangeable and do not imply any differences in the substance of these features.

- (15) Classical Manchu vowels (Zhang 1996): [low] > [front] > [round] > [ATR]



- (16) Classical Manchu vowels: Marked contrastive featural representations

/i/	/u/	/ʊ/	/a/	/ə/	/ɔ/
[front]	[ATR]		[low]	[low]	[low]
				[ATR]	[round]

The three most notable kinds of phonological activity involving vowels are ATR harmony, rounding (labial) harmony, and palatalization. We will briefly discuss each in turn, and show how the patterns of activity motivate the hierarchy in (15).

3.2 ATR harmony

The vowels /ə/ and /u/ trigger ATR harmony within a word: /ə/ alternates with /a/ (17a) and /u/ alternates with /ʊ/ (17b).

- (17) ATR harmony

- a. /ə/ alternates with /a/

[ATR]	xəxə	‘woman’	xəxə-ŋgə	‘female’
(non-ATR)	aga	‘rain’	aga-ŋga	‘of rain’

- b. /u/ alternates with /ʊ/

[ATR]	xərə-	‘ladle out’	xərə-ku	‘ladle’
(non-ATR)	paqt’a-	‘contain’	paqt’a-qu	‘internal organs’

An apparent exception is caused by the fact that /ʊ/ changes to [u] everywhere except after dorsal (velar ~ uvular) consonants; however, the underlying contrast between /ʊ/ and /u/ emerges in the way they participate in ATR harmony (17): underlying /u/ co-occurs with ATR vowels (18a), underlying /ʊ/ co-occurs with non-ATR vowels (18b).

(18) ATR harmony and the neutralization of /u/ and /ʊ/

a. Underlying /u/: ATR harmony

[ATR]	susə	‘coarse’	susə-tə-	‘make coarsely’
[ATR]	xət’u	‘stocky’	xət’u-kən	‘somewhat stocky’

b. Underlying /ʊ/: non-ATR vowels

(non-ATR)	tulpa	‘careless’	tulpa-ta-	‘act carelessly’
(non-ATR)	tat’ʂun	‘sharp’	tat’ʂu-qan	‘somewhat sharp’

The vowel /i/ is neutral and co-occurs in stems with both ATR (19a) and non-ATR vowels (19b). Similarly, suffix /i/ freely occurs with both types of vowels (19c).

(19) /i/ is neutral with respect to ATR harmony

a. /ə/ ~ /a/ suffix

[ATR]	pəki	‘firm’	pəki-lə	‘make firm’
(non-ATR)	paqtʂ’in	‘opponent’	paqtʂ’i-la-	‘oppose’

b. /u/ ~ /ʊ/ suffix

[ATR]	sitərə-	‘hobble’	sitərə-sxun	‘hobbled/lame’
(non-ATR)	panjin	‘appearance’	panji-sʂʊn	‘having money’

c. /i/ suffix

[ATR]	əmt’ə	‘one each’	əmt’ə-li	‘alone; sole’
(non-ATR)	taʂa-	‘follow’	taʂa-li	‘the second’

Perhaps unexpectedly, when /i/ is in a position to trigger harmony, it occurs only with non-ATR vowels (20).

(20) Stems with only /i/ co-occur with non-ATR vowels

a. /ə/ ~ /a/ suffix

(non-ATR)	ili-	‘stand’	ili-ʂa	‘stood’
(non-ATR)	fili	‘solid’	fili-qan	‘somewhat solid’

b. /u/ ~ /ʊ/ suffix

(non-ATR)	tʂ’ili-	‘to choke’	tʂ’ili-qʊ	‘choking’
(non-ATR)	sifi-	‘stick in the hair’	sifi-qʊ	‘hairpin’

The evidence from activity, therefore, is that /ə/ and /u/ have an active feature in common, that we are calling [ATR], that is not shared by the other vowels; by hypothesis, this feature must be contrastive. The same is evidently not the case with /i/, though /i/ is phonetically ATR. In the representations proposed in (15) and (16), /ə/ and /u/, but not /i/, are contrastively [ATR].

3.3 Round (labial) harmony

Two successive /ɔ/ vowels cause a suffix /a/ to become /ɔ/ (21a); a single /ɔ/, short or long, does not trigger rounding (21b).⁵ Note that /u/ and /ʊ/ do not trigger round harmony (22).

(21) Round (labial) harmony

a. Two successive /ɔ/ vowels trigger round harmony

ɔ...ɔ	pətʂ'ɔ	'colour'	pətʂ'ɔ-ŋɔ	'coloured'
Compare	aga	'rain'	aga-ŋɔ	'of rain'

b. A single /ɔ/, short or long, does not trigger rounding

Single ɔ	tɔ-	'alight (birds)'	tɔ-na-	'alight in swarm'
Single ɔɔ	tɔɔ-	'cross (river)'	tɔɔ-na-	'go to cross'

(22) No round harmony triggered by high vowels

a. After /u/

gulu	'plain'	gulu-kən	'somewhat plain'
kumun	'music'	kumu-ŋɔ	'noisy'

b. After /ʊ/ (/ʊ/ becomes [u] except after a back consonant)

χʊtun	'fast'	χʊtu-qan	'somewhat fast'
tursun	'form'	tursu-ŋɔ	'having form'

The evidence from activity here, then, is that /ɔ/ must have an active, therefore contrastive, feature that causes rounding, which we are calling [round]; the same is not the case with /u/ and /ʊ/, though they are also phonetically rounded. The feature ordering in (15) has the result that /ɔ/ is contrastively [round], but /u/ and /ʊ/ are not.

3.4 Palatalization

The vowel /i/ uniquely causes palatalization of a preceding consonant, which suggests that it alone has a contrastive triggering feature we call [front]. There is no evidence that it has any other active features.

3.5 Height contrast

The alternations /ə/ ~ /a/ ~ /ɔ/ and /u/ ~ /ʊ/ are limited to a height class, and we still need to distinguish /ə/ from /u/ and /a/ from /ʊ/. It is simplest to assume one height contrast, which we call [low] (as there are only two height classes, [high] would also be possible here). As shown in (15), no more features are

⁵ Various proposals have been offered to account for why a single /ɔ/ does not cause rounding harmony; a similar restriction occurs in Oroqen (Zhang & Dresher 1996; Walker 2001; 2014). Based on the observation that a single irregular stem-internal /ɔ/ does cause harmony in Baiyinna Oroqen (Li 1996; Walker 2014), Dresher & Nevins (2017) propose that the restriction may actually be that a low suffix vowel may obtain a [round] feature from a stem-internal /ɔ/, but not from an /ɔ/ that is stem initial.

required in order to make each vowel distinct from every other, and there is no evidence that any other feature is active in this vowel system.

4 Synchrony: Typology with contrastive feature hierarchies

Contrastive feature hierarchies allow us to update Sapir’s approach to phonological systems and view phonological typology in a new way. Rather than considering only the number of segments in an inventory, or their geometrical arrangement, we can look at inventories in terms of their active/contrastive features and how they are ordered. As with Sapir’s languages A–D, this approach reveals unexpected similarities between inventories that do not superficially look very similar; conversely, inventories that look quite similar may turn out to have different patterns of phonological activity because they have different contrastive hierarchies.

To illustrate, we will consider a number of vowel systems which have contrasts between front and back round vowels. Two features that could potentially play a role in such inventories are [front] and [round]. We have seen that both of these features are contrastive and active in Classical Manchu vowels, but in asymmetrical ways: whereas /i/ is contrastively [front], [round] is restricted to /ɔ/, and is not contrastive in /u/ and /ʊ/. This is a result of ordering [front] > [round]; if the ordering were [round] > [front], then /u/ and /ʊ/ would be contrastively [round], and /i/ would not be assigned [front]. If the orderings of these features is allowed to vary cross-linguistically, we expect to find vowel systems that manifest each ordering. What the specific consequences of these orderings are in any given language depends on the number of segments in the inventory, and the ordering of other contrastive features.

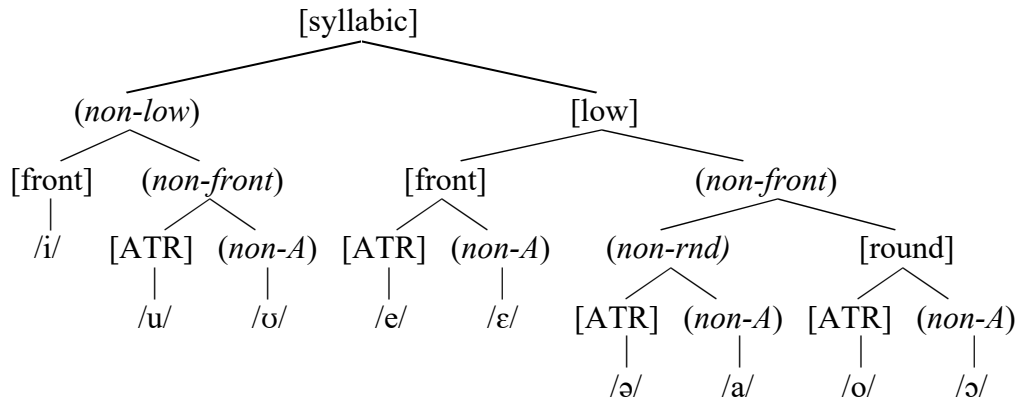
4.1 Vowel systems with [front] > [round]

Contrastive feature hierarchies shed new light on the results of typological surveys of rounding (labial) harmony in Manchu-Tungusic, Mongolian, and Turkic (Korn 1969; Kaun 1995). We have seen that round harmony in Classical Manchu is limited to the [low] vowels. On our account, only the low vowel /ɔ/ is contrastively [round] in this inventory, because of the ordering of [front] > [round]. The same holds for most Manchu-Tungusic languages, which have similar vowel inventories. A Tungusic example is Oroqen (Zhang 1996), shown in (23): again, only low vowels are triggers (in the solid box) and targets (in the dashed box) of harmony. Oroqen has both ATR and non-ATR low vowels. We assume it has the same feature hierarchy as Classical Manchu (plus a length contrast that we omit from the tree), as shown in (24).

(23) Oroqen (Tungusic) vowel system (Zhang 1996)

/i/	/ii/		/u/	/uu/
			/ʊ/	/ʊʊ/
/e/	/ə/	/əə/	/o/	/oo/
/ɛ/	/a/	/aa/	/ɔ/	/ɔɔ/

(24) Oroqen vowels: [low] > [front] > [round] > [ATR]



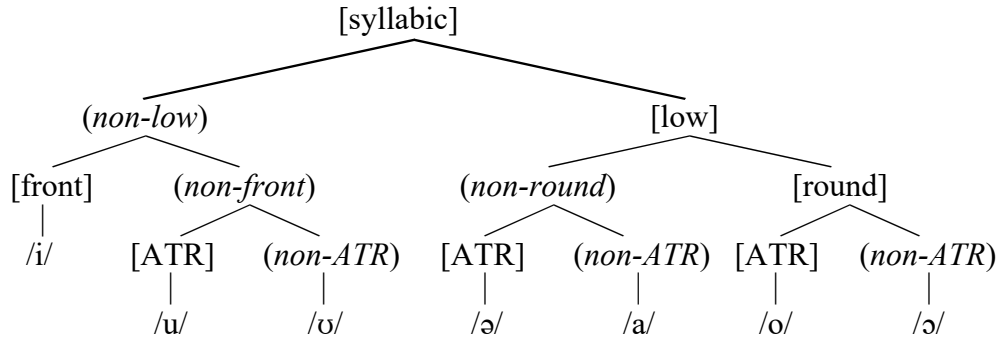
The schematic representation of the Oroqen vowel system in (23) might suggest a different explanation for the fact that [round] is active only in the [low] part of the inventory. One might suppose that one could simply read off this display that rounding is not contrastive in the high vowels, because there is no /i/ in the inventory. That is, one might think that the contrasts between /o, oo, ɔ, ɔɔ/ and /ə, əə, a, aa/ are more minimal than the ones between /u, uu, ʊ, ʊʊ/ and /i, ii/. The notion of ‘minimal contrast’ or ‘minimal difference’ (Padgett 2003; Calabrese 2005; Campos Astorkiza 2009; Nevins 2010) or ‘crowding’ (Kaun 1995) has been proposed as the principle governing contrast. This approach is correct in one direction: if there is only one phonetic property that distinguishes between two phonemes, then that property *must* be contrastive. However, the converse does not hold: a feature may still be contrastive in a phoneme even if it is not the only phonetic property that distinguishes that phoneme from any other. Minimal contrast has been shown to be incorrect on both conceptual and empirical grounds (Archangeli 1988; Dresher 2009; 2015; 2016); the latter will become apparent when we look at Yowlumne Yokuts in the next section. One of the merits of the hierarchical approach to contrast is that it can operate smoothly even when minimal phonetic differences between phonemes are lacking, as they often are.

Eastern Mongolian languages have round harmony, that, as in the majority of Manchu-Tungusic languages, is limited to low vowels. A typical example is Khalkha Mongolian (Svantesson 1985, Qinggertai 1982), with the vowel inventory in (25). We assume that they have similar feature hierarchies as most of the Manchu-Tungus languages (26). In these languages, harmony triggers are non-high because only non-high vowels are contrastive for [round], a limitation that follows from the fact that [front] (as well as a height feature) is higher in the hierarchy than [round].

(25) Khalkha Mongolian vowels (Svantesson 1985, Qinggertai 1982)



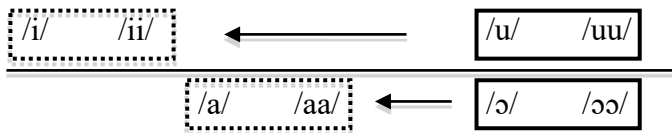
(26) Khalkha Mongolian vowels (Dresher & Zhang 2005): [low] > [front] > [round] > [ATR]



4.2 Vowel systems with [round] > [front]

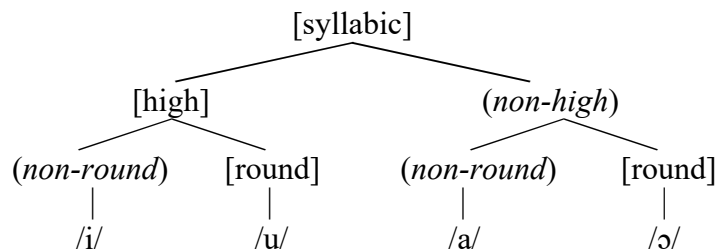
It is interesting to compare the above languages with Yowlumne Yokuts (Southwestern USA; Newman 1944), which has an underlying vowel inventory whose basic configuration looks similar (minus the ATR contrasts); but it is a completely different type of language. In Yokuts, both /u/ and /ɔ/ trigger height-bounded round harmony: /u/ rounds only /i/, and /ɔ/ rounds only /a/ (27). Why can /u/ trigger harmony here, but not in Manchu-Tungusic and Eastern Mongolian?

(27) Yowlumne Yokuts vowel system (Newman 1944)



A simple solution is available in terms of the contrastive hierarchy: in Yowlumne, [round] is ranked over [front]. Hence, both /u/ and /ɔ/ are [round], and [front] is not a contrastive feature in this language, as shown in (28) (we omit the length contrast in the tree).

(28) Yowlumne Yokuts vowels: [high] > [round]



In support of this analysis, we note that /i/ in Yowlumne is phonologically inert, and serves also as the epenthetic vowel. This is in sharp contrast to the [front] /i/ in Manchu-Tungusic and many Mongolian languages.

Another language family in which [round] is typically ordered ahead of [front] are the Yupik and Inuit languages that descend from Proto-Eskimo, which is reconstructed to have vowels */i/, */a/, */u/, and a fourth vowel assumed to be */ə/ (Fortescue et al. 1994). In most dialects this vowel has merged

with /i/. In some of these dialects merger is total, resulting in a three vowel system; other dialects retain a trace of the distinction between */i/ and */ə/.

Original */i/ could cause palatalization of consonants, and some Inuit dialects show palatalization (or traces of former palatalization) (Dorais 2003: 33). In parts of Baffin Island, for example, the word ‘foot’ is pronounced [isiyak], where *i* has caused a following original *t* to change to *s* (29a). This assibilation is the most common manifestation of palatalization in Inuit. In such dialects, it is traditional to distinguish between ‘strong *i*’, which descends from */i/ and causes palatalization (29a), and ‘weak *i*’, which descends from */ə/ and does not (29b). In some dialects the two types of *i* exhibit other kinds of distinct behaviour as well.

(29) ‘Strong’ and ‘weak’ *i* in some Inuit dialects

- | | | | | |
|------------------------|---------|---|--------|----------------|
| a. Strong ‘ <i>i</i> ’ | *itəɣaɾ | > | isiyak | ‘foot’ |
| b. Weak ‘ <i>i</i> ’ | *ətəmay | > | itimak | ‘palm of hand’ |

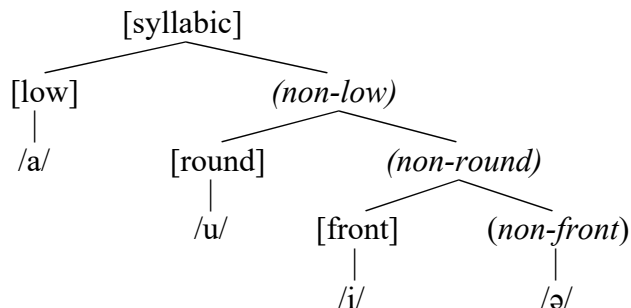
Compton & Dresher (2011) observe the generalization in (30) about dialects in which /i/ causes or once caused palatalization:

(30) Generalization about Inuit palatalization (Compton & Dresher 2011)
 Inuit /i/ can cause palatalization (assibilation) of a consonant *only* in dialects where there is evidence for a (former) contrast with a fourth vowel; where there is no contrast between strong and weak *i*, /i/ does not trigger palatalization.

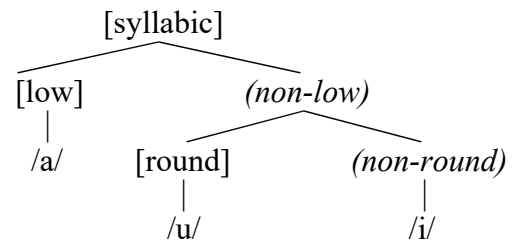
This generalization follows if we assume that the feature hierarchy for Inuit and Yupik is [low] > [round] > [front] as in (31). When the fourth vowel is in the underlying inventory, /i/ has a contrastive [front] feature that enables it to cause palatalization (31a). But in the absence of a fourth vowel, [front] is not a contrastive feature (31b).

(31) Inuit and Yupik vowels (Compton & Dresher 2011): [low] > [round] > [front]

a. Four underlying vowels



b. Three underlying vowels



4.3 Vowel systems where ordering of [round] and [front] is not crucial

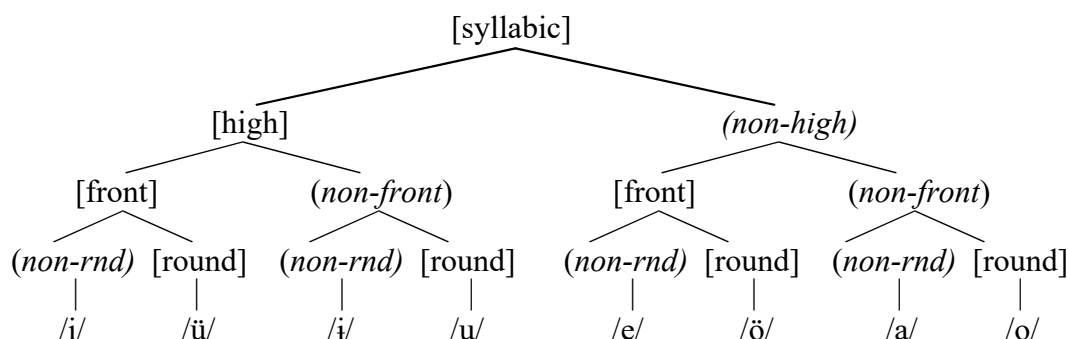
Turkic languages have symmetrical inventories. They are typically analyzed with three features: one height feature and two place features, as in (32) (see Kabak 2011 for Turkish). Here, every feature specification is contrastive in any order; the vowels completely fill the eight-cell vowel space defined by three binary features. A possible ordering of the features of Turkish is given in (33); however, the same

contrastive specifications would result from any ordering of these three features.⁶ We predict, therefore, that all round vowels could potentially be triggers of round harmony in such languages. This prediction is correct, though harmony observes limitations that are not due to contrast, but to other factors.

(32) Turkish vowel system

	[front]		<i>(non-front)</i>	
	<i>(non-round)</i>	[round]	<i>(non-round)</i>	[round]
[high]	/i/	/ü/	/i/	/u/
<i>(non-high)</i>	/e/	/ö/	/a/	/o/

(33) Contrastive feature hierarchy for Turkish vowels: [high] > [front] > [round]

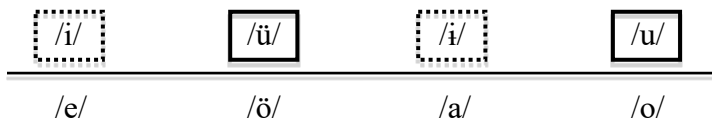


In Turkish, harmony triggers can be high or low, but targets are typically limited to high vowels (34). In Kachin Khakass (Korn 1969), both triggers and targets of round harmony must be high (35), the opposite of the Manchu-Tungus-Eastern Mongolian pattern. Because all vowels have contrastive [round] and [front] features, however they are ordered, these restrictions cannot be due to considerations of contrast, but to other factors.

(34) Turkish round harmony triggers and targets



(35) Kachin Khakass round harmony triggers and targets



This way of classifying phonological systems allows us to account for two Manchu languages that are notable exceptions to the prevailing Manchu-Tungusic pattern of round harmony. Spoken Manchu and Xibe are modern Manchu languages in which [ATR] has been lost and /ə/ has become a *(non-low)*

⁶ This is not to say that there can be no other empirical evidence, for example from synchronic alternations or diachronic mergers, that can choose between these orderings.

vowel (Zhang 1996; Dresher & Zhang 2005). The vowel system of Xibe, for example, is given in (36). The reclassification of /ə/ as a (*non-low*) vowel necessitates a new contrastive feature to distinguish it from /u/. The most natural modification is to extend the feature [round], already in the system, to /u/.

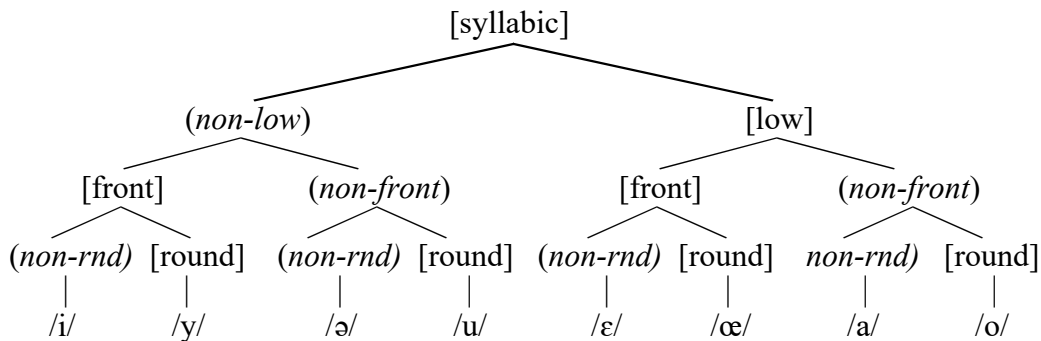
(36) Xibe (based on Li and Zhong 1986)

/i/	/y/	/ə/	/u/
/ɛ/	/œ/	/a/	/ɔ/

Evidence that /u/ is in fact contrastively [round] in Xibe can be found in the creation of new phonemes /y/ and /œ/. The latter derives from sequences of /ɔ/ and /i/, where the [front] feature derives from /i/ and the [round] feature from /ɔ/. Similarly, the new phoneme /y/ derives from sequences of /u/ and /i/, showing that /u/ had acquired a [round] feature. More evidence that /u/ is contrastively [round] in Xibe comes from a new form of round harmony that arose in Xibe, whereby /ə/ alternates with /u/ in suffixes: /u/ occurs if the stem-final vowel is round, /ə/ occurs otherwise.

The participation of /u/ in triggering round harmony, rare in the Manchu-Tungusic family, is accounted for by the extension of the contrastive [round] specification to /u/. The phonological patterning of the vowels in Xibe points to a contrastive hierarchy and branching tree as in (37). This tree very closely resembles the Turkish feature hierarchy in (33).

(37) Contrastive feature hierarchy for Xibe vowels (Zhang 1996): [low] > [front] > [round]



4.4 Summary

To sum up, we can classify languages into types based on the contrastive scopes of the vowel features [front] and [round] as in (38). Whether a feature is contrastive on a given vowel depends on the feature hierarchy and the size and structure of the phonological inventory.

(38) Typology of contrastive [front] and [round]

- a. If [front] > [round], /i/ can cause palatalization, but /u/ may or may not trigger round harmony.
- b. If [round] > [front], /u/ may trigger round harmony, but /i/ may or may not cause palatalization.
- c. In languages where [round] and [front] are contrastive for all vowels, both these features may be active in all vowels.

5. The Diachrony of Algonquian vowel systems: Contrast shift as a type of change

Understanding the role of contrastive hierarchies in phonological patterning allows us to implement the program for diachronic phonology set out by Jakobson (1972 [1931]), which we alluded to in §2. That is, when a phonological change occurs in a language we need to look at what effect the change has had on the system of contrasts.

For example, we have seen a number of differences between the vowel system of Classical Manchu in §3.1 and that of Xibe (§4.3); on the assumption that Xibe descends from a language whose vowel system is essentially the same as that of Classical Manchu, we can assume that the Xibe vowel system derives from the Classical Manchu one by a series of phonological changes (Zhang 1996; Dresher & Zhang 2005). Some of the changes are overt at a phonetic level, such as the loss of /ʊ/ and the raising of /ə/. These phonetic changes are accompanied by a change in phonological features, namely, the loss of [ATR] as a contrastive feature and change of /ə/ from a [low] vowel to a (*non-low*) vowel. Less overt, but just as consequential for the phonological patterning of Xibe, is the change in contrastive status of /u/ from lacking a specification for [round] in Classical Manchu to being [round] in Xibe.

We will designate as a *contrast shift* any change in the contrastive feature hierarchy or in the contrastive status of a phoneme. A contrast shift can involve a reordering of features, or a change of features. A contrast shift may come about as a result of an overt phonetic change, such as the loss of a phoneme or a change in its phonetic realization. Of particular interest are ‘silent’ changes like the one involving Xibe /u/, whereby a segment that does not appear to change phonetically from one synchronic stage to the next nevertheless take on different contrastive features, with consequences for its synchronic patterning.

We propose that contrast shift is an important type of diachronic phonological change that can have far-reaching effects on the phonology of a language.⁷ As should by now be evident, contrast shift can only be understood with reference to a particular feature hierarchy.

5.1 The vowel system of Proto-Algonquian

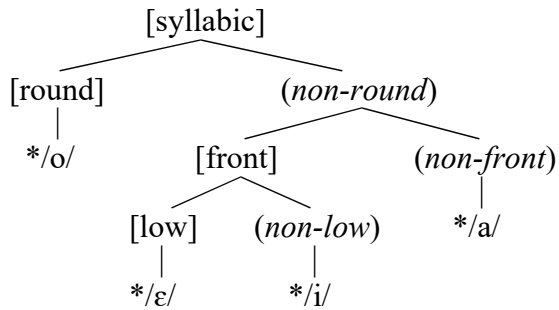
In a survey of the historical development of Algonquian vowel systems, Oxford (2012a; 2015) identifies persistent patterns in vowel changes. In an attempt to make sense of these patterns, Oxford posits the feature hierarchy in (39) for Proto-Algonquian (the length contrast is omitted for ease of exposition).

The hierarchy in (39) is motivated by feature activity that can be recovered as having been present in Proto-Algonquian. Thus, */o/ triggers rounding, an indication that it has an active, hence contrastive, [round] feature. Similarly, */i/ triggers palatalization, indicating a contrastive feature we call [front]. Patterns of partial neutralization relate */ε/ and */i/, suggesting that they are contrastive sisters by (13). Finally, */a/ does not trigger any processes, consistent with its being assigned no positive (marked) contrastive features. This evidence is summarized in (40).⁸

⁷Analyses that exploit the contrastive hierarchy in accounting for diachronic change include: Zhang (1996) and Dresher & Zhang (2005) on Manchu; Barrie (2003) on Cantonese; Rohany Rahbar (2008) on Persian; Dresher (2009: 215–225) on East Slavic; Compton & Dresher (2011) on Inuit; Gardner (2012), Roeder & Gardner (2013), and Purnell & Raimy (2013) on North American English vowel shifts; Purnell & Raimy (2015) and Dresher (2017) on Old English; and large-scale studies by Harvey (2012) on Ob-Ugric, Ko (2010; 2011; 2012) on Korean, Mongolic, and Tungusic, and Oxford (2011; 2012a; 2015) on Algonquian.

⁸ See Oxford (2015) for the sources of these observations.

(39) Proto-Algonquian vowels (Oxford 2015): [round] > [front] > [low]



(40) Proto-Algonquian feature activity

- a. */o/ is [round]: triggers rounding
- b. */i/ is [front]: triggers palatalization
- c. */i, ε/ are sisters: partial neutralization
- d. */a/ has no marked contrastive features: is never a trigger

5.2 The Central Algonquian languages and Blackfoot

The Proto-Algonquian vowel feature hierarchy continues unchanged in the Central Algonquian languages and in Blackfoot. It accounts for two recurring patterns: (a) palatalization always includes */i/ as a trigger; and (b) */ε/ regularly merges with */i/. Examples of these processes are listed in (41). The patterns in (41a) support the view that palatalization is triggered by a contrastive [front] feature, and favours vowels that are (*non-low*); the mergers in (41b) are consistent with the idea (13) that mergers tend to involve terminal nodes in the feature tree.

(41) Central Algonquian and Blackfoot feature activity

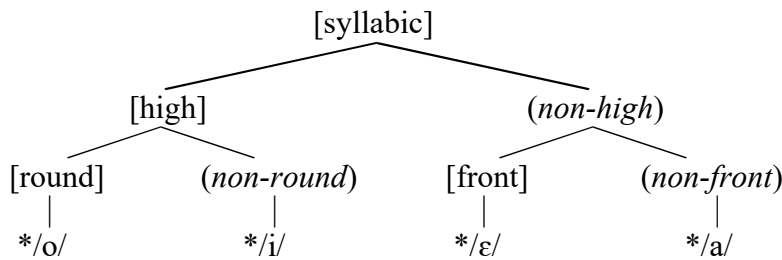
- a. Palatalization always includes */i/ as a trigger
 - i. Proto-Algonquian */t, θ/-palatalization is triggered by */i, i:/;
 - ii. Innu */k/-palatalization is triggered by */i, i:, ε:/;
 - iii. Betsiamites Innu /t/-palatalization is triggered by /i:/;
 - iv. Blackfoot */k/-assibilation is triggered by PA */i, i:/;
 - v. Blackfoot /t/-assibilation is triggered by Blackfoot /i, i:/.
- b. */ε/ regularly merges with */i/
 - i. Partial or complete mergers of short */ε/ > /i/ occur in Fox, Shawnee, Miami-Illinois, Cree-Innu, Ojibwe, and Blackfoot;
 - ii. long */ε:/ > /i:/ in Woods Cree, Northern Plains Cree, and Blackfoot.

5.3 The Eastern and Western Algonquian languages

On the eastern and western edges of the Algonquian area, developments diverge from the predictions of the Proto-Algonquian hierarchy: in particular, the high vowels, derived from Proto-Algonquian */o/ and */i/, begin to pattern together. In the east, Proto-Eastern Algonquian lost the length contrast only in the high vowels (i.e., the reflexes of */o/, */i/), and in the west, Proto-Arapaho-Atsina and Pre-Cheyenne merged */o, o:/ with */i, i:/.

Under the hierarchy inherited from Proto-Algonquian, however, [high] is not a contrastive feature, and the old height feature, [low], is ordered at the bottom of the vowel feature hierarchy. The result is that the high vowels derived from */o/ and */i/ are not a natural class. If the hierarchy constrains patterning, then a new height contrast with the feature [high] must have come to outrank the place contrasts. That is, the Proto-Algonquian feature [low] is reinterpreted as [high] and moves to the top of the hierarchy, creating the new hierarchy and contrastive feature tree in (42).

(42) Eastern and western proto-languages (Oxford 2015): [high] > [round] > [front]



Subsequent developments in the eastern and western daughter languages follow the predictions of the new hierarchy. The patterns consistently differ from those of Central Algonquian: (a) palatalization in these languages is triggered by */ε/ but *excludes* */i/; and (b) */ε/ merges with or shifts to */a/ (not */i/). Instances of these processes are listed in (43).

(43) Eastern and Western Algonquian feature activity

- a. Palatalization is triggered by */ε/ but excludes */i/
 - i. Massachusett */k/-palatalization is triggered by Proto-Eastern Algonquian */ε:/ but not */i:/;
 - ii. Cheyenne “yodation”, where */k/ > /kj/, is triggered by */ε(:)/ only.
- b. */ε/ merges with or shifts to */a/
 - i. Partial or complete mergers of PA short */ε/ and */a/ occur in Abenaki, Mahican, Mi’kmaq, and Maliseet-Passamaquoddy;
 - ii. Proto-Eastern Algonquian long */ε:/ shifts to /a:/ in Massachusett and merges with */a/ in Western Abenaki;
 - iii. long and short */ε(:)/ shift to /a(:)/ in Cheyenne;
 - iv. vowel harmony involves */ε(:)/ and */a(:)/ in Arapaho.

Again, these patterns support the view that palatalization is triggered by a contrastive [front] feature: only /ε/ is contrastively [front] in these languages.⁹ The mergers in (43b) follow from the sisterhood of

⁹ However, they are a counterexample to a proposed implicational universal to the effect that “in a given language, low and mid front vowels apparently only trigger palatalization if high front vowels trigger it too” (Kochetov 2011). Kochetov notes, however, that “Bhat (1978) mentions some cases where mid front vowels palatalize velars to the exclusion of high front vowels.” The typological rarity of such cases may be due to the rarity of feature hierarchies like (42). More expected is the fact that the palatalizations in question involve dorsal consonants, which, according to Kochetov (2011), are “almost

*/ɛ/ and */a/ under the new hierarchy. A single contrast shift thus accounts for the patterning of a large number of phonological changes across the Algonquian family.

6. Areal isoglosses: Borrowing contrast shifts in the Ob-Ugric Mansi and Khanty languages

The Algonquian languages have relatively simple vowel systems, and the types of phonological activity we observed follow from the contrastive trees in a rather straightforward manner. To see how alternations work in the context of more complex and asymmetric feature trees, we need to look at languages with larger vowel systems. Harvey (2012) shows that the principles of contrast shift can be used to describe the sound changes which have occurred over time in the vowel systems of the Ob-Ugric languages, from the reconstructed Proto-Ob-Ugric up until modern times, starting approximately 3400 years ago when Hungarian split from Ob-Ugric. Moreover, he shows that contrastive shifts in the Ob-Ugric Mansi and Khanty languages show clear isoglosses and are borrowed between languages.

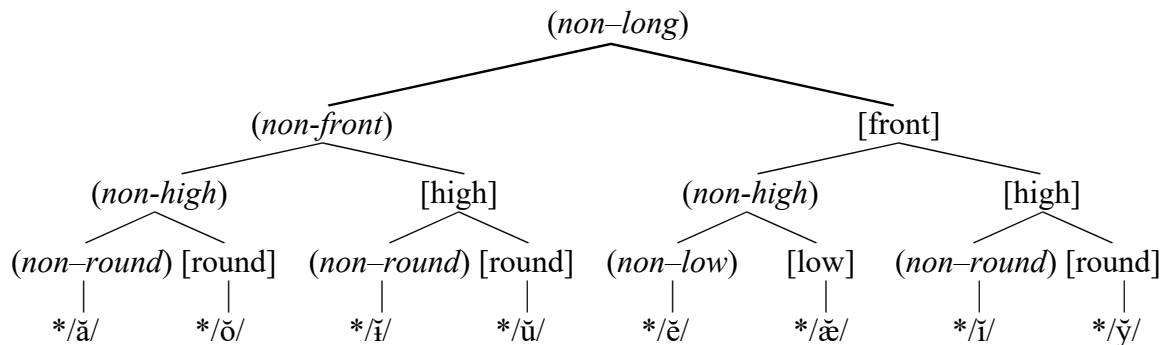
The Ob-Ugric languages are found in central Russia, to the east of the Ural mountains along the Ob river system. The two branches of Ob-Ugric are the Mansi languages, in the southwest, and the Khanty languages, to the east and north. The Ob-Ugric languages inherited a complex vowel system: Proto-Ob-Ugric has been reconstructed to have nineteen vowel phonemes (Harvey 2012, based on Sammallahti 1988). Also characteristic of Ob-Ugric was a pervasive front-back vowel harmony that affected all vowels; we assume that the relevant feature is [front].

6.1 Proto-Mansi

We will focus here on Mansi. Starting from the Proto-Mansi first-syllable vowel system reconstructed by Steinitz (1955), and taking into account the phonological patterning attributed to that period, Harvey (2012) posits the Proto-Mansi contrastive hierarchy in (44).

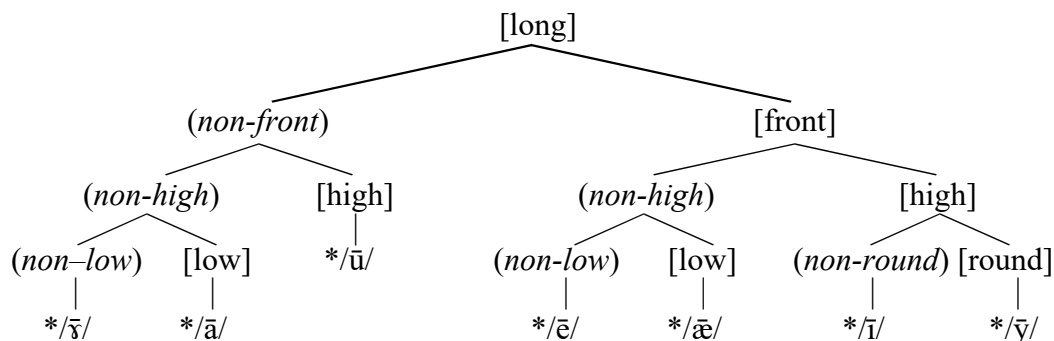
(44) Proto-Mansi (Harvey 2012): [long] > [front] > [high] > [round] > [low]

a. Contrastive feature hierarchy for the (*non-long*) vowels



exclusively targeted by /i/ and other front vowels”, unlike coronals which may be targeted by high vocoids.

b. Contrastive feature hierarchy for the [long] vowels



A major type of phonological activity that provides evidence for this hierarchy is front vowel harmony (45a), which we suppose to be governed by the feature [front]. The Ob-Ugric languages have no neutral vowels, therefore all vowels must have a contrastive value for this feature. Proto-Mansi also had a system of productive ablaut-like root-vowel alternations (Honti 1988a:149; 1988b:174), where a certain set of suffixes causes roots with long vowels to shorten, as in the Western Mansi examples in (45b).

(45) Feature activity reconstructed for Proto-Mansi

a. Front vowel harmony

Suffix vowels harmonize with root vowels in the feature [front]; thus, the vowel in the 1st person future suffix in Southern Mansi is front or back depending on the root vowel: e.g. *jām-ām* ‘I will go’ ~ *wēr-ēm* ‘I will make’.

b. Root vowel alternations

A [long] vowel in a monosyllabic root becomes (*non-long*) when it occurs with specific lexically-defined inflectional or derivational suffixes, as well as appearing in certain compound environments: e.g. Western Mansi *tyæls* ‘I will sit down’ ~ *talt-* ‘put into (a boat)’, where WM /yœ/ ~ /a/ derives from Proto-Mansi */ā̄/ ~ */ā̄̄/; *w̄ȳm* ‘I see’ > *wāj* ‘he/she sees’.

Both front vowel harmony and root vowel alternations have been reconstructed for the proto-languages (Honti 1988a:149; 1988b:174). Any contrastive hierarchy for Proto-Mansi must account for both of these processes. Moreover, changes to the hierarchies leading from Proto-Ob-Ugric to the modern languages must remain consistent with them in languages where they remain productive. That is, the features active in harmony and vowel alternation must remain contrastive.

The examples in (45) also illustrate the importance of markedness in the operation of these alternations. In front vowel harmony (45a), the suffix *-ām* changes to *-ēm*. Simply changing *ā* to be [front] yields the features (*non-long*), [front], (*non-high*), (*non-round*), a combination that does not exist in (44). In the branch of the tree under (*non-long*), [front], and (*non-high*), there is no contrastive (*non-round*); rather, we must choose between *non-low* */ē/ and [low] */ā̄/. The correct outcome is obtained by choosing the unmarked branch, */ē/. In (45b), the alternation */ā̄/ ~ */ā̄̄/ is straightforward (as is a similar alternation */ī/ ~ */ī̄/), but */̄/ ~ */ā̄/ again shows the effects of choosing the unmarked value of an unspecified feature; in this case, we choose (*non-high*) */ā̄/ rather than [high] */ī̄/.

One might question the inclusion of [long] as a feature in the hierarchy in (44). A currently widespread view represents the difference between long and short vowels in structural terms, rather than

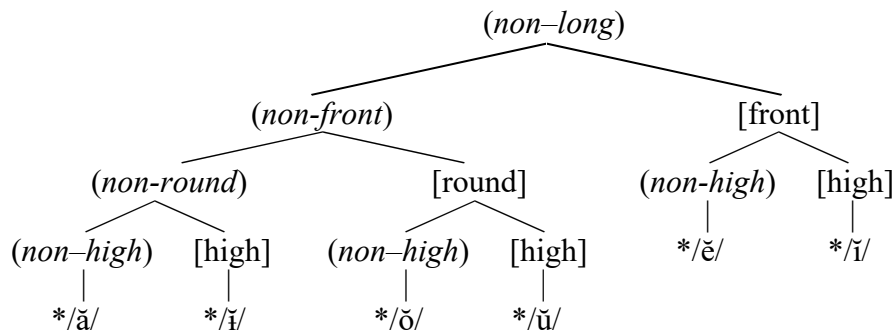
as a feature: a short vowel associates to a single timing unit, and a long vowel associates to two such units (see Odden 2011 for discussion). However, the long/short contrast interacts with other features, and therefore has to be represented somewhere in the contrastive tree.¹⁰ Moreover, Oxford (2012b) shows how a length contrast can be easily reinterpreted as a tense ~ lax contrast, which is often represented in featural terms, depending on where in the feature hierarchy the relevant contrast is located. Therefore, including [long] in a contrastive feature hierarchy does not preclude representing length differences in structural terms.

6.2 Western Mansi

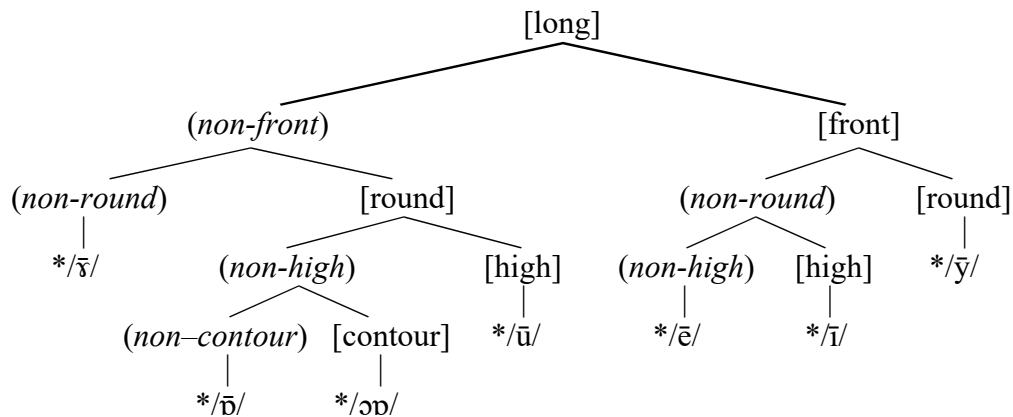
Early Western Mansi (~600 ybp) has been reconstructed to have thirteen vowels (Steinitz 1955:154; Sammallahti 1988:504, Honti 1998:330). Harvey (2012) details the changes by which the Proto-Mansi vowel system in (44) evolved into that of Early Western Mansi. In addition to some mergers, at the Proto-Eastern-Western Mansi stage a new feature [contour] becomes contrastive for two vowels. Then in Early Western Mansi, [round] is promoted one step above [high]. These changes cause [low] to be non-contrastive, and yield the hierarchy in (46), where [contour] is realized as a diphthong (as with Proto-Mansi, the hierarchies are for vowels in initial syllables, which exhibit the full range of contrasts).

(46) Early Western Mansi (Harvey 2012): [long] > [front] > [round] > [high] > [contour]

a. Contrastive feature hierarchy for the (*non-long*) vowels



b. Contrastive feature hierarchy for the [long] vowels



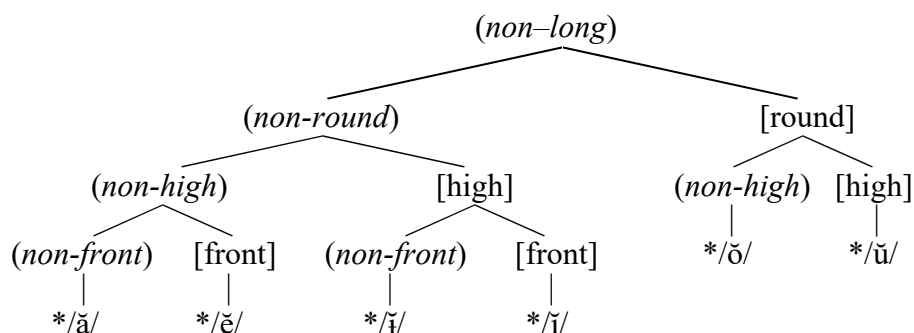
¹⁰ See, for example, analyses of Lithuanian vowel length in Campos Astorkiza 2009 and Dresher 2009.

At some point a contrastive shift occurred whereby [front] dropped to the bottom of the hierarchy (47). As a result, five vowels, over one third of the inventory, no longer contrast for [front]. This change had important consequences for phonological activity in Western Mansi. The first consequence is that front harmony is lost. Ob-Ugric front/back harmony does not have neutral vowels: either all vowels participate in harmony, or none do. The loss of the front/back contrast in a significant portion of vowels thus caused the demise of harmony.

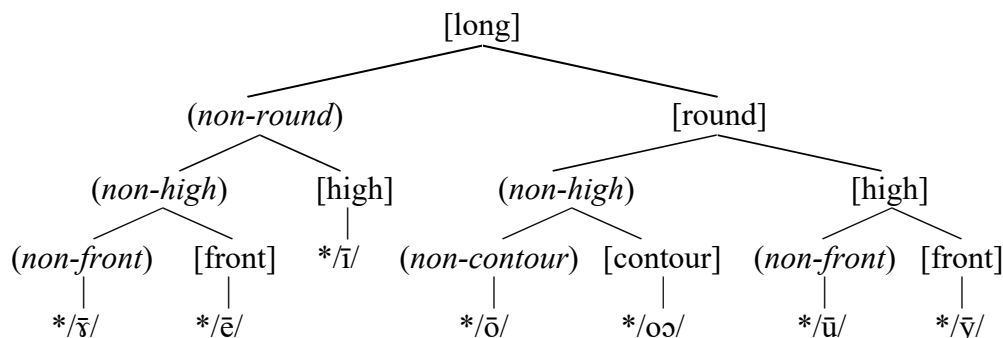
Second, the shift rearranges the pairs of vowels that participate in root vowel alternations. Previously, */ī/ could alternate with */ĩ/ by changing [long] to (*non-long*). Now, however, there are two short counterparts of */ĩ/ with features (*non-round*) and [high]; of these, */ĩ/, not */i/, is unmarked. One would predict that root vowel alternation would be lost as a productive process when a pair like Southern Mansi *ɫĩχ* ‘wedge’ ~ *ɫĩχt* ‘wedges’ is no longer derivable by the phonology. Loss of productivity indeed occurs in the modern language.

(47) Western Mansi (Harvey 2012): [long] > [round] > [high] > [contour] > [front]

a. Contrastive feature hierarchy for the (*non-long*) vowels



b. Contrastive feature hierarchy for the [long] vowels



A third consequence has to do with sub-phonemic drift. This can be illustrated by the diachronic changes that vowels with contrastive [contour] underwent. The (*non-contour*) vowel */ō/ in (46b) developed from an earlier */ā/, and the [contour] vowel */oɔ/ developed from earlier */ā/. Both vowels underwent rounding, an *enhancement* of their contrastive features (Stevens, Keyser, & Kawasaki 1986; Hall 2011). The addition of phonetic rounding may have contributed to the promotion of [round] as a contrastive feature, with the consequence that [low] is no longer contrastive. Lacking [low] the vowels are free to raise to */ō/ and */oɔ/, respectively. When [front] is demoted as in (47), it no longer

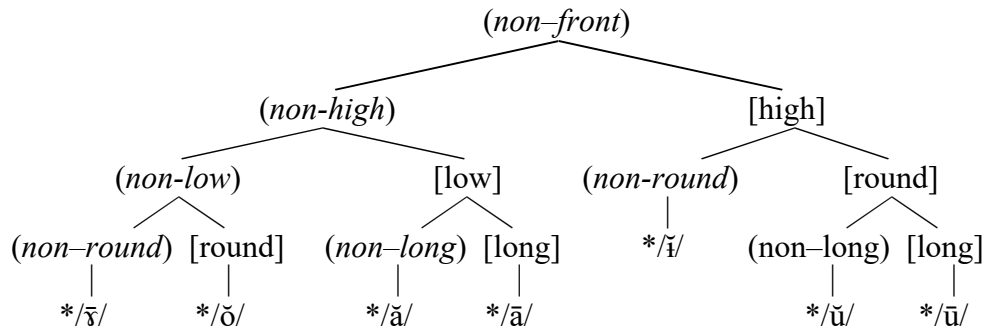
constrains the vowels' contrastive space. The result is that */oɔ/ is able to front to /øœ/ (e.g., Modern Western Mansi /øœmp/ 'dog'), while */ō/ is also fronted, though not as far (/ō̄tər/ 'prince').

6.3 Northern Mansi

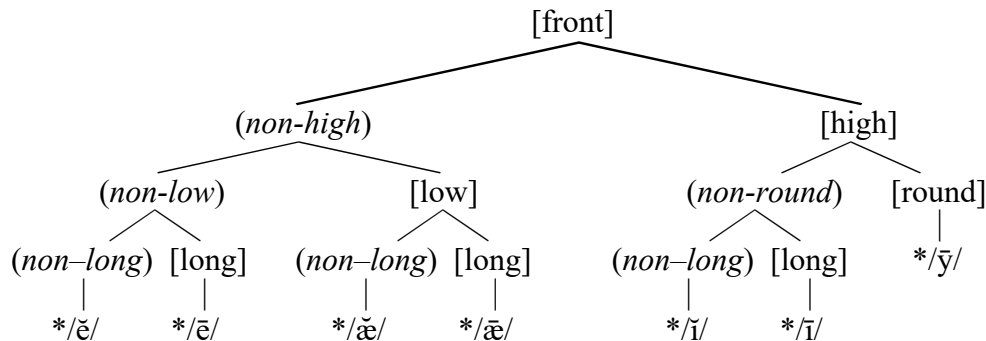
Northern Mansi has reduced phonological complexity more than any other Mansi dialect group, to the extent that front harmony and productive root-vowel alternations have been completely lost. As in the Western dialect, all vowels in Early Northern Mansi were contrastive for [front], and as in that dialect, [front] was demoted over time. Starting from the Proto-Mansi vowel system in (44), Harvey (2012) posits that [long] dropped to the bottom of the hierarchy, and [round] was demoted below [low], yielding the tree in (48).

(48) Early Northern Mansi (Harvey 2012): [front] > [high] > [low] > [round] > [long]

a. Contrastive feature hierarchy for the (*non-front*) vowels



b. Contrastive feature hierarchy for the [front] vowels

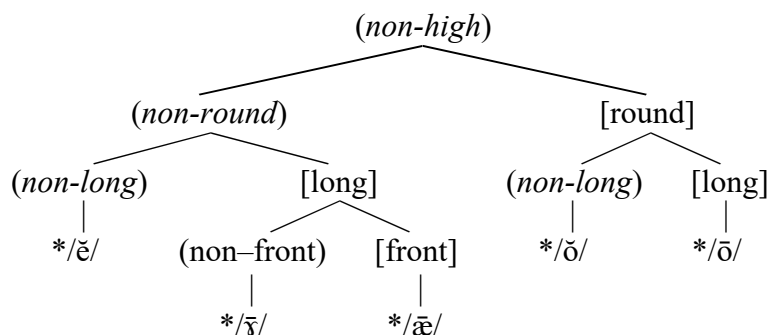


At a stage just prior to the modern Northern Mansi dialects, [front] was demoted as in (49). When the front feature is dropped to the lowest rank, about half of the vowels lose their contrastive [front] feature. In the next stage the three remaining [front] vowels are merged to their back counterparts: */ǣ̄/ > */ɤ̄/, */ĩ̄/ > */ĩ̄/, and */ȳ̄/ > */ū̄/. Once complete, these mergers leave no vowels with a contrastive [front] feature at all. As expected, front harmony is no longer viable, and has disappeared from Northern Mansi.

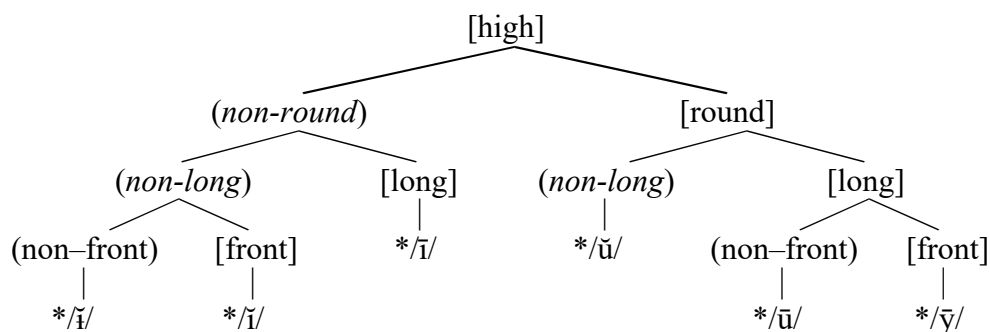
We also expect that root-vowel alternation would become untenable. For instance, in Proto-Mansi, /ū̄/ alternated with /ũ̄/. After */ȳ̄/ has merged with */ū̄/, there is no way for a speaker of the modern language to tell which /ū̄/ should alternate and which should not. As predicted, vowel alternation has almost completely vanished in Northern Mansi.

(49) Pre-Modern Northern Mansi (Harvey 2012): [high] > [round] > [long] > [front]

a. Contrastive feature hierarchy for the (*non-high*) vowels



b. Contrastive feature hierarchy for the [high] vowels

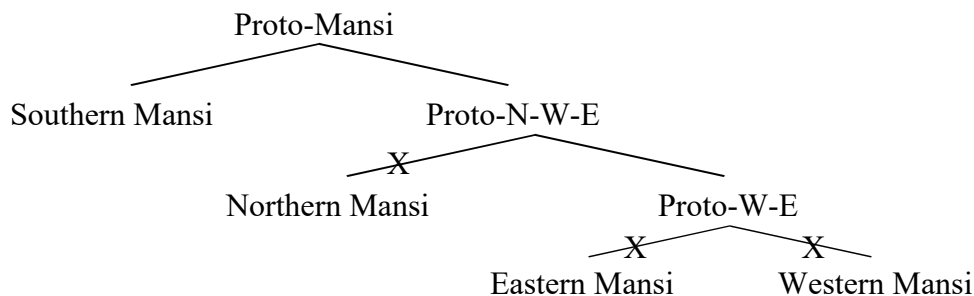


Although the evolution of the vowel systems of Western and Northern Mansi differ in their details, in both the feature [front] was demoted, and in both front harmony and root-vowel alternations were adversely affected. Interestingly, the dropping of [front] has also produced two very different results. In Western Mansi, front dropping has caused some back vowels to become more front; in Northern Mansi, the loss of the same contrast has caused some front vowels to merge with their back counterparts.

6.4 Contrastive isoglosses

The dropping of [front] occurred in three of the four Mansi languages, and all three have lost front harmony. However, [front] dropping did not occur in the early history of Mansi. It can be shown that the shift occurred later in the daughter languages, as illustrated in (50), where X indicates when [front] dropping occurred.

(50) Chronology of [front] dropping in the Mansi languages



If [front] dropping is not a genetic inheritance common to the non-Southern Mansi languages, could it have been spread by areal diffusion? That is, can contrast shift show areal patterning, like other elements of linguistic systems? To investigate this question, Harvey (2012) plotted a number of contrast shifts on a map, and the results are shown in (51). It is clear that the contrast shifts have occurred in a way that is not at all random.

The map in (51) shows the Ob-Ugric language area, in central Russia to the east of the Ural mountains along the Ob river system. A key to the dialect groupings and language name abbreviations is in (52). Mansi languages (M) are in the southwest, and the Khanty languages (K) are east and north. The dashed (red) line labelled *ft dropped* shows all the languages which had the [front] dropping contrast shift.

It appears that the innovative dialect from which [front] dropping radiated is Northern Mansi. Northern, Western, and Eastern Mansi all participate in the shift. Interestingly, two of the Khanty languages, Kazym and Obdorsk Khanty, *also* had a phase where [front] dropped. Those languages that are geographically and culturally farther away from the likely innovation centre have not borrowed the shift. The (blue) arrows indicate the Ob river and its tributaries, which are the main routes for cultural contact and communication.

We conclude that there is a pattern to these contrastive changes: they follow routes of cultural contact. Contrast shifts show clear isoglosses and can be borrowed between languages. The contrastive analysis of the Ob-Ugric languages presented here is also consistent with earlier dialect studies (Honti 1998; Steinitz 1955), and matches earlier observations about which dialects are conservative or innovative.

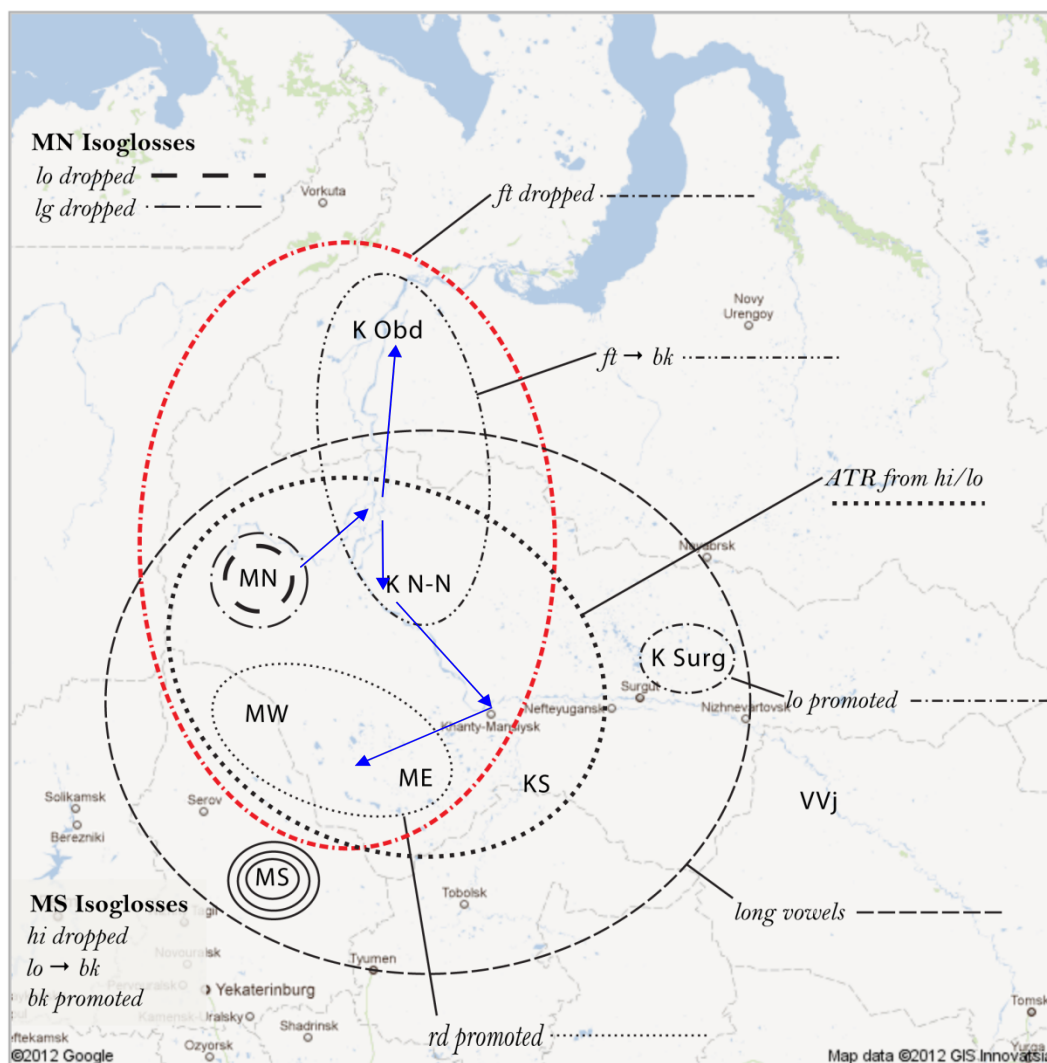
7. Conclusions

The approach to phonological typology we have sketched here is based on a fundamental distinction between a phonetic and phonological analysis of the sound systems of languages. This view builds on approaches to phonology pioneered by Sapir and the Prague School (Jakobson and Trubetzkoy), instantiated within a generative grammar. More specifically, it views phonemes as being composed of contrastive features that are themselves organized into language-particular hierarchies. Because of the hypothesized connection between contrast and activity, we expect languages with similar hierarchies and inventories to exhibit similar patterns.

In some of the language families we have surveyed here, feature hierarchies appear to be relatively stable, as exemplified by Manchu-Tungusic, Eastern Mongolian, Yupik-Inuit, and branches of Algonquin. Contrast shifts can occur, however, for various reasons, and these can result in dramatic differences in patterning, as shown by the modern Manchu languages, Eastern and Western Algonquin as compared with Central, and extensive changes in Ob-Ugric vowel systems viewed over a relatively long period of time. Finally, Ob-Ugric shows that elements of feature hierarchies can spread and be borrowed, like other aspects of linguistic structure.

We have seen that, like Sapir's languages C and D, languages with similar contrastive structures may show varying phonetic realizations. For example, the breakdown of the front-back contrast had different phonetic results in Western and Northern Mansi: in the former it resulted in some back vowels fronting, and in the latter a series of vowels that used to be front retracted and merged with back vowels. What the two dialects have in common is the dropping and subsequent loss of [front] as a contrastive feature; thus, it no longer constrained the phonetic ranges of the vowels. In Algonquian, the various palatalizations and mergers show phonetic differences, and the phonetic descriptions of the vowels vary from dialect to dialect. But dialects sharing the same contrastive hierarchy show similar patterns at that level.

(51) *Ob-Ugric isoglosses of feature contrasts and contrast shifts (Harvey 2012)*



(52) Key to dialect groups and abbreviations

- | | |
|------------------------------|----------------------------|
| KN: Northern Khanty | MN: Northern Mansi |
| K Obd: Obdorsk | |
| K N-N: Kazym | MW: Western Mansi |
| KE: Eastern Khanty | |
| K Surg: Surgut | ME: Eastern (Konda) Mansi |
| VVj: Vach-Vasjugan | |
| KS: Southern (Irtysk) Khanty | MS: Southern (Tavda) Mansi |

We hope to have demonstrated that contrastive feature hierarchies provide an interesting and fruitful level of representation for typological research in phonology.

Acknowledgements: This article is a revised and expanded version of Dresher, Harvey, & Oxford (2014). For comments we are grateful to Larry Hyman, and to audiences at the CRC Summer Phonetics/phonology Workshop, University of Toronto, July 2012; NELS 43, CUNY Graduate Center, October 2012; the GLOW 36 Workshop on Diachronic Workings in Phonological Patterns, Lund University, April 2013; the annual meeting of the CLA, Victoria, B.C., June 2013; and the Workshop on Phonological Typology, Somerville College, University of Oxford, August 2013. We would also like to thank members of the project on Markedness and the Contrastive Hierarchy in Phonology at the University of Toronto (Dresher and Rice 2007): <http://homes.chass.utoronto.ca/~contrast/>. This research was supported in part by grants 410-2003-0913 and 410-08-2645 from the Social Sciences and Humanities Research Council of Canada.

References

- Archangeli, Diana. 1988. Aspects of underspecification theory. *Phonology* 5. 183–207.
- Barrie, Mike. 2003. Contrast in Cantonese vowels. *Toronto Working Papers in Linguistics* 20. 1–19.
- Bhat, D. N. S. 1978. A general study of palatalization. In Joseph H. Greenberg, Charles A. Ferguson, & Edith A. Moravcsik (eds.), *Universals of human language*, vol. 2: *Phonology*, 47–92. Stanford: Stanford University Press.
- Calabrese, Andrea. 2005. *Markedness and economy in a derivational model of phonology*. Berlin: Mouton de Gruyter.
- Campos-Astorkiza, Judit Rebeka. 2009. 2009. *The role and representation of minimal contrast and the phonology – phonetics interaction*. Munich: Lincom Europa.
- Chomsky, Noam & Morris Halle. 1968. *The sound pattern of English*. New York: Harper & Row.
- Compton, Richard & B. Elan Dresher. 2011. Palatalization and “strong” *i* across Inuit dialects. *Canadian Journal of Linguistics/Revue canadienne de linguistique* 56. 203–228.
- Dorais, Louis-Jacques. 2003. *Inuit uqausiqatigiit: Inuit languages and dialects (second, revised edition)*. Iqaluit: Nunavut Arctic College.
- Dresher, B. Elan. 1998. On contrast and redundancy. Paper presented at the annual meeting of the Canadian Linguistic Association, May, Ottawa. Ms., University of Toronto.
- Dresher, B. Elan. 2003. Contrast and asymmetries in inventories. In Anna-Maria di Sciullo (ed.), *Asymmetry in grammar, volume 2: Morphology, phonology, acquisition*, 239–57. Amsterdam: John Benjamins.
- Dresher, B. Elan. 2009. *The contrastive hierarchy in phonology*. Cambridge: Cambridge University Press.
- Dresher, B. Elan. 2014. The arch not the stones: Universal feature theory without universal features. *Nordlyd* 41(2). 165–181, special issue on Features ed. by Martin Krämer, Sandra Ronai, & Peter Svenonius. University of Tromsø — The Arctic University of Norway.
- Dresher, B. Elan. 2015. The motivation for contrastive feature hierarchies in phonology. *Linguistic Variation* 15. 1–40.
- Dresher, B. Elan. 2016. Contrast in phonology 1867–1967: History and development. *Annual Review of Linguistics* 2. 53–73.
- Dresher, B. Elan. 2017. Contrastive feature hierarchies in Old English diachronic phonology. *Transactions of the Philological Society*, doi:10.1111/1467-968X.12105.
- Dresher, B. Elan, Christopher Harvey, & Will Oxford. 2014. Contrast shift as a type of diachronic change. In Hsin-Lun Huang, Ethan Poole, & Amanda Rysling (eds.), *NELS 43: Proceedings of the*

- Forty-Third Annual Meeting of the North East Linguistic Society, The City University of New York, Volume One*, 103–116. Amherst, MA: GLSA.
- Dresher, B. Elan & Andrew Nevins. 2017. Conditions on iterative rounding harmony in Oroqen. *Transactions of the Philological Society* 115(3). 365–394.
- Dresher, B. Elan & Keren Rice. 2007. Markedness and the contrastive hierarchy in phonology. <http://homes.chass.utoronto.ca/~contrast/>.
- Dresher, B. Elan & Xi Zhang. 2005. Contrast and phonological activity in Manchu vowel systems. *Canadian Journal of Linguistics/ Revue canadienne de linguistique* 50. 45–82.
- Fortescue, Michael, Steven A. Jacobson, & Lawrence D. Kaplan. 1994. *Comparative Eskimo dictionary with Aleut cognates*. Fairbanks: Alaska Native Language Center.
- Gardner, Matt Hunt. 2012. Beyond the phonological void: Contrast and the Canadian Shift. Ms., Department of Linguistics, University of Toronto.
- Hall, Daniel Currie. 2007. The role and representation of contrast in phonological theory. Doctoral dissertation, University of Toronto.
- Hall, Daniel Currie. 2011. Phonological contrast and its phonetic enhancement: Dispersedness without dispersion. *Phonology* 28. 1–54.
- Harvey, Christopher. 2012. Contrastive Shift in Ob-Ugric Vowel Systems. Ms., University of Toronto.
- Honti, László. 1988a. Die ob-ugrischen Sprachen I: Die wogulische Sprache. In Sinor (ed.) 1988, 147–171.
- Honti, László. 1988b. Die ob-ugrischen Sprachen II: Die ostjakische Sprache. In Sinor (ed.) 1988, 172–196.
- Honti, László. 1998. Ob Ugrian. In Daniel Abondolo (ed.), *The Uralic languages*, 327–357. London: Routledge.
- Hyman, Larry M. 2007. Where's phonology in typology? *Linguistic Typology* 11(1). 265–271.
- Jakobson, Roman. 1972 [1931]. Principles of historical phonology. In Allan R. Keiler (ed.), *A reader in historical and comparative linguistics*, 121–138. New York: Holt, Rinehart and Winston. Translation of Prinzipien der historischen Phonologie. *Travaux du cercle linguistique de Prague* 4. 247–267. Copenhagen, 1931.
- Jakobson, Roman, C. Gunnar M. Fant, & Morris Halle. 1952. *Preliminaries to Speech Analysis*. MIT Acoustics Laboratory, Technical Report, No. 13. Reissued by MIT Press, Cambridge, Mass., Eleventh Printing, 1976.
- Jakobson, Roman & Morris Halle. 1956. *Fundamentals of language*. The Hague: Mouton.
- Kabak, Barış. 2011. Turkish vowel harmony. In van Oostendorp et al (eds.) 2011.
- Kaun, Abigail Rhoades. 1995. The typology of rounding harmony: An Optimality Theoretic approach. Doctoral dissertation, University of California, Los Angeles.
- Kiparsky, Paul. 1965. Phonological change. Doctoral dissertation, MIT.
- Ko, Seongyeon. 2010. A contrastivist view on the evolution of the Korean vowel system. In Hiroki Maezawa & Azusa Yokogoshi (eds.), *MITWPL 61: Proceedings of the Sixth Workshop on Altaic Formal Linguistics*, 181–196.
- Ko, Seongyeon. 2011. Vowel contrast and vowel harmony shift in the Mongolic languages. *Language Research* 47. 23–43.
- Ko, Seongyeon. 2012. Tongue root harmony and vowel contrast in Northeast Asian languages. Doctoral dissertation, Cornell University.
- Kochetov, Alexei. 2011. Palatalization. In van Oostendorp et al. (eds.) 2011.
- Korn, David (1969). Types of labial vowel harmony in the Turkic languages. *Anthropological Linguistics* 11. 98–106.

- Li, Bing. 1996. *Tungusic vowel harmony*. The Hague: Holland Academic Graphics.
- Li, Shulan & Qian Zhong. 1986. *Xiboyu Jianzhi* [A brief introduction to the Xibe language] Beijing: Minzu Chubanshe.
- Mackenzie, Sara. 2011. Contrast and the evaluation of similarity: Evidence from consonant harmony. *Lingua* 121. 1401–1423
- Mackenzie, Sara. 2013. Laryngeal co-occurrence restrictions in Aymara: Contrastive representations and constraint interaction. *Phonology* 30. 297–235.
- McCawley, James D. 1967. Edward Sapir's 'phonologic representation'. *International Journal of American Linguistics* 33. 106–111.
- Mielke, Jeff. 2008. *The emergence of distinctive features*. Oxford: Oxford University Press.
- Moulton, William G. 1960. The short vowel systems of Northern Switzerland: A study in structural dialectology. *Word* 16. 155–182.
- Nevins, Andrew. 2010. *Locality in vowel harmony*. Cambridge, Mass.: MIT Press.
- Newman, Stanley. 1944. *Yokuts language of California* (VFPA 2). New York: The Viking Fund Publications in Anthropology.
- Odden, David. 2011. The representation of vowel length. In van Oostendorp et al. (eds.) 2011.
- Oostendorp, Marc van, Colin J. Ewen, Elizabeth Hume, & Keren Rice (eds.). 2011. *The Blackwell companion to phonology*. Blackwell Publishing. Blackwell Reference Online.
- Oxford, Will. 2012a. "Contrast shift" in the Algonquian languages. In A. McKillen & J. Loughren (eds.), *Proceedings from the Montreal-Ottawa-Toronto (MOT) Phonology Workshop 2011: Phonology in the 21st Century: In Honour of Glyne Piggott*. *McGill Working Papers in Linguistics* 22(1).
- Oxford, Will. 2012b. On the contrastive status of vowel length. Presented at the MOT Phonology Workshop, University of Toronto, March 2012.
http://home.cc.umanitoba.ca/~oxfordwr/papers/Oxford_2011_MOT.pdf.
- Oxford, Will. 2015. Patterns of contrast in phonological change: Evidence from Algonquian vowel systems. *Language* 91. 308–357.
- Padgett, Jaye. 2003. Contrast and post-velar fronting in Russian. *Natural Language and Linguistic Theory* 21. 39–87.
- Purnell, Thomas & Eric Raimy. 2013. Contrastive features in phonetic implementation: The English vowel system. Presented at the CUNY Phonology Forum Conference On The Feature, January 2013.
- Purnell, Thomas & Eric Raimy. 2015. Distinctive features, levels of representation and historical phonology. In Patrick Honeybone & Joseph Salmons (eds.), *The handbook of historical phonology*, 522–544. Oxford: Oxford University Press.
- Qinggertai (Chingeltei). 1982. Guanyu yuanyin hexielü [On the vowel harmony rule]. *Zhongguo Yuyanxue Bao* 1. 200–220.
- Rice, Keren. 2003. Featural markedness in phonology: Variation. In Lisa Cheng & Rint Sybesma (eds.), *The second Glot International state-of-the-article book: The latest in linguistics*, 387–427. Berlin: Mouton de Gruyter.
- Rice, Keren. 2007. Markedness in phonology. In Paul de Lacy (ed.), *The Cambridge handbook of phonology*, 79–97. Cambridge: Cambridge University Press.
- Roeder, Rebecca & Matt Hunt Gardner. 2013. The phonology of the Canadian Shift revisited: Thunder Bay and Cape Breton. *University of Pennsylvania Working Papers in Linguistics: Selected Papers from NAWAV* 41, 19(2). 161–170.
- Rohany Rahbar, Elham. 2008. A historical study of the Persian vowel system. *Kansas Working Papers in Linguistics* 30. 233–245.

- Sammallahti, Pekka. 1988. Historical phonology of the Uralic languages. In Sinor (ed.) 1988, 478–554.
- Samuels, Bridget D. 2011. *Phonological architecture : A biolinguistic perspective*. Oxford: Oxford University Press.
- Sapir, Edward. 1925. Sound patterns in language. *Language* 1: 37-51. Reprinted in Martin Joos (ed.), *Readings in linguistics I*, 19–25. Chicago, IL: University of Chicago Press, 1957.
- Saussure, Ferdinand de. 1972 [1916]. *Cours de linguistique générale*. Publié par Charles Bally et Albert Sechehaye; avec la collaboration de Albert Riedlinger. Éd. critique préparée par Tullio de Mauro. Paris: Payot.
- Sinor, Denis (ed.). 1988. *Handbuch der Orientalistik: Handbook of Uralic studies*, vol 1: *The Uralic languages*. Leiden: E. J. Brill.
- Steinitz, Wolfgang. 1955. *Geschichte des wogulischen Vokalismus*. Berlin: Akademie-Verlag.
- Stevens, Kenneth N., Samuel Jay Keyser, & Haruko Kawasaki. 1986. Toward a phonetic and phonological theory of redundant features. In Joseph S. Perkell & Dennis H. Klatt (eds.), *Symposium on invariance and variability of speech processes*, 432–469. Hillsdale, NJ: Lawrence Erlbaum.
- Svantesson, Jan-Olaf. 1985. Vowel harmony shift in Mongolian. *Lingua* 67. 283–327.
- Vajda, Edward. 2001. Test materials dated August 17, 2001. Posted at <http://pandora.cii.wvu.edu/vajda/ling201/test2materials/Phonology3.htm>.
- Walker, Rachel. 2001. Round licensing and bisyllabic triggers in Altaic. *Natural Language and Linguistic Theory* 19. 827–878.
- Walker, Rachel. 2014. Nonlocal trigger-target relations. *Linguistic Inquiry* 45. 501–523.
- Zhang, Xi. 1996. Vowel systems of the Manchu-Tungus languages of China. Doctoral dissertation, University of Toronto.
- Zhang, Xi, & B. Elan Dresher. 1996. Labial harmony in written Manchu. *Saksaha: A Review of Manchu Studies* 1. 13–24.

B. Elan Dresher
 Department of Linguistics
 100 St. George Street, Rm. 4073
 University of Toronto
 Toronto, Ontario
 Canada M5S 3G3

Christopher Harvey
 Department of Linguistics
 100 St. George Street, Rm. 4073
 University of Toronto
 Toronto, Ontario
 Canada M5S 3G3

Will Oxford
 Department of Linguistics
 534 Fletcher Argue Building
 University of Manitoba
 Winnipeg, Manitoba
 Canada R3T 5V5

dresher@chass.utoronto.ca

c.harvey@mail.utoronto.ca

oxfordwr@cc.umanitoba.ca