14 Vowel harmony in the light of contrastive feature theories

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14.1 Introduction

This chapter addresses the relationship between vowel harmony and phonological contrast. Vowel harmony patterns have played an important role in the development of theories of contrast and these theories have, in turn, provided insight into the range of vowel harmony patterns found across languages. Contrast in inventories has long been recognized as a crucial factor governing which vowels participate in a given harmony system and which vowels they harmonize with. For example, in the often cited example of Finnish (Finno-Ugric; Halle 1964 is an early instance), vowels in a word are all front (/y, ø, æ/) or all back (/u, o, a/), with the exception of /i, e/, which are *neutral* and may co-occur with either set. The participating vowels form front-back contrasting pairs /y ~ u/, /ø ~ o/, and /æ ~ a/, whereas /i, e/, which are phonetically front, have no contrasting back partners */ɨ, ɘ/. Examples such as these have led to proposals that the harmonizing vowels have a contrastive backness feature that the neutral vowels lack. Thus, Halle (1964) proposes that the Finnish vowels in (1) have the features shown in (2), where the harmonizing vowels are specified for [±back].[1]

(1) Finnish vowel inventory

i	y		u
e	ø		o
æ		a	

(2) Features of Finnish vowels (Halle 1964)

	æ	a	e	ø	o	i	y	u
[round]	−	−	−	+	+	−	+	+
[low]	+	+	−			−		
[high]			−	−	−	+	+	+
[back]	−	+		−	+		−	+

The analysis in (2) has a certain intuitive appeal, but it raises a question: how are these contrastive specifications derived? We must have a way of deciding which features are contrastive within a system. There have been two main approaches to determining contrast in phonology. One designates a feature as contrastive if it is the only feature that distinguishes between at least two otherwise identical segments. The other generates contrastive features hierarchically, by successively dividing the inventory until all segments have been distinguished.

Another question that arises is whether contrastive features are universal or can vary from language to language. A third issue involving contrast is what has been called the 'Contrastivist Hypothesis'(Hall 2007): this is the hypothesis that *only* contrastive features are active in

[1] We have changed the names of Halle's features to ones we use elsewhere in this chapter. Halle's original features and our equivalents are: [flat] = [round]; [compact] = [low]; [diffuse] = [high]; [grave] = [back].

phonological processes. These issues—whether contrast is derived by minimal differences or hierarchically, whether it is universal or varies cross-linguistically, and whether all features are active or only contrastive ones—must be studied together, because an answer to one depends on how we answer the others.

We will argue that vowel harmony is consistent with the Contrastivist Hypothesis and supports a hierarchical approach to contrast in which feature hierarchies vary cross-linguistically. Conversely, we demonstrate that this theory of contrastive specification provides illuminating accounts of vowel harmony.

Vowel harmony has a number of properties that make it particularly informative for questions regarding the nature of contrast and its relationship to phonological activity. Compared to consonant harmony, vowel harmony is cross-linguistically common, providing ample empirical testing grounds for distinct theories of contrast and phonological activity. The restricted size and shape of vowel inventories, the limited set of vowel features, and the way in which they are distributed across inventories means that similar harmony processes can be examined across distinct inventories. Unlike local assimilation, vowel harmony can operate at a distance; thus, factors such as phonetic compatibility and coarticulation are less relevant to shaping assimilatory patterns of vowel harmony relative to phonological properties such as contrast and natural classes.

The behavior of individual segments in vowel harmony is also subject to well-attested variation. Vowels that are neutral with respect to harmony fall into distinct classes (see van der Hulst 2018; Krämer, chapter 21): *transparent* vowels fail to undergo harmony but allow the harmonizing feature(s) to pass through them, whereas *opaque* vowels block harmony from propagating. In still another pattern, some neutral vowels may act as targets of harmony but not as triggers. These varying behaviors of neutral vowels have been tied to contrast and feature specification.

To address the relationship between contrast and vowel harmony patterns, we begin in section 14.2 by discussing two approaches to contrast. Contrastive Hierarchy Theory posits that contrasts are generated by language-particular feature hierarchies and that phonology is governed by the Contrastivist Hypothesis. What we call the Minimal Difference approach posits that for a feature to be contrastive it must uniquely distinguish between segments. Supporters of the Minimal Difference approach generally do not adhere to the Contrastivist Hypothesis. We will compare the two approaches and argue in favour of Contrastive Hierarchy Theory.

In section 14.3 we consider tongue-root harmony systems, with a focus on Nilo-Saharan and Niger-Congo languages. We show that the typology of [ATR] harmony systems provides support for the Contrastivist Hypothesis, regardless of what theory of contrast is adopted. Also on the basis of [ATR] harmony patterns, we argue for Contrastive Hierarchy Theory by demonstrating that differences in feature ordering can account for differences in harmonic partners found in two languages with very similar vowel inventories and harmony patterns.

In section 14.4 we review rounding harmony in languages of Northeast Asia. We propose that feature hierarchies account for the restriction of rounding triggers to low vowels in Tungusic and Classical Manchu, and that changes in the feature hierarchy have allowed high vowels to also become triggers of rounding harmony in the modern Manchu languages. We show how a slight difference in feature ordering accounts for why the vowel /i/ is opaque to rounding harmony in Tungusic but transparent in Mongolic. Finally, we argue that the contrastive structure of Turkic leads to patterns of rounding harmony that differ from those of Tungusic and Mongolic. Section 14.5 is a brief conclusion.

14.2 Two approaches to contrast

We can find in the literature two different and incompatible ways of determining contrast. Related to this is a certain ambiguity in what is meant when it is asserted that a certain vowel does or does not have a contrastive feature [F]. Consider, for example, the common seven-vowel inventory in (3), which can be characterized in terms of the set of features in (4). These are not necessarily contrastive features; rather, they are features that are commonly used to characterize vowels like these, and from which we will try to pick out the contrastive ones.[2]

(3) Seven-vowel inventory

i		u
e		o
ɛ		ɔ
	a	

(4) Seven-vowel inventory: Features (not necessarily contrastive)

	i	e	ɛ	a	ɔ	o	u
[low]	−	−	−	+	−	−	−
[high]	+	−	−	−	−	−	+
[front]	+	+	+	−	−	−	−
[round]	−	−	−	−	+	+	+
[ATR]	+	+	−	−	−	+	+

Given the features in (4), the only feature that distinguishes /e/ from /ɛ/ and /o/ from /ɔ/ is [±ATR]. Therefore, by any conceivable theory of contrast, we would say that these vowels have a contrastive [±ATR] feature, or that [±ATR] is contrastive in /e, ɛ, ɔ, o/.[3]

Consider now the high vowels /i, u/, which have the phonetic value [+ATR]. Unlike [ATR] in the mid vowels, this feature does not by itself distinguish the high vowels from any other vowel, because the feature [high] would suffice to do that. The inventory in (3) lacks the vowels */ɪ, ʊ/ which would be the [+high, −ATR] counterparts of /i, u/, in the same way that /ɛ, ɔ/ are the [−high, −ATR] counterparts of /e, o/. Based on this fact, many would say that the feature [ATR] is not contrastive in /i, u/, by which they mean that /i, u/ do not have [−ATR] counterparts whose other feature specifications are identical. A definition of contrast along these lines is given in (5).

(5) Minimal Difference definition of contrast (Nevins 2010: 70)

A segment S with specification αF in position P is *contrastive* for F if there is another segment S′ in the inventory that can occur in P and is featurally identical to S, except that it is −αF.

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[2] We do not claim that the representations in (4) are universal: in some systems /ɛ, ɔ/ are characterized as [+low], for example. Nor are they complete: some systems might be better characterized with [±back] rather than [±front], [±RTR] rather than [±ATR], or [±open] as one of the height features. Further, some feature theories assume privative (single-valued) features or elements, not binary features as in (4). Our intention is not to prejudge these issues here, but simply to present a set of common feature values for purposes of this discussion.

[3] This conclusion would not hold if /ɛ, ɔ/ are specified as [+low].

This definition of contrast, which we call the 'Minimal Difference' approach, has a certain intuitive appeal, for there is no doubt that features that meet the condition in (5) are contrastive. Such a definition might also be suggested by Finnish backness harmony: the vowels that participate in harmony all have 'partners' that differ only in the harmonizing feature; the ones that do not (/i/ and /e/) are neutral. Nevertheless, Dresher (2009: 13–30, 2015) has argued that (5) is not a satisfactory general definition of contrast. We cannot review all the arguments here in detail, but will briefly indicate some of the problems.

First, in a typical inventory there are not enough minimal differences between segments if we assume that we start from reasonably full specifications.[4] For example, of the specifications in (4), the only ones that are contrastive according to Minimal Difference are the eight shown in (6). Specifically, /i/ ~ /e/ and /u/ ~ /o/ are distinguished from each other only by [±high], and /e/ ~ /ɛ/ and /o/ ~ /ɔ/ are distinguished only by [±ATR]. Every other pair of segments is distinguished by more than one feature. For example, /i, e, ɛ/ are distinguished from /u, o, ɔ/ by both [±front] and [±round]; each feature prevents the other from being contrastive according to the definition in (5).

(6) Features that are contrastive by the Minimal Difference definition

	i	e	ɛ	a	ɔ	o	u
[low]							
[high]	+	−				−	+
[front]							
[round]							
[ATR]		+	−		−	+	

The specifications in (6) are clearly inadequate as a set of contrastive specifications: /i/ and /u/ have the same specifications, as do /e/ and /o/ and /ɛ/ and /ɔ/, and /a/ has no specifications at all.[5] In practice, most phonologists would omit one of [front] or [round], which would result in a more reasonable-looking, though not necessarily correct, set of contrastive specifications. Omission of features, however, suggests that there is another procedure at work that puts at least some features (here, [front] and [round]) into a hierarchical order.

The empirical shortcomings of the Minimal Difference approach flow from a conceptual one: it neglects the multi-dimensional aspect of phonological contrast. That is, contrast involves more than pairwise comparisons of individual segments; rather, groups of segments may be put into contrast with other groups with respect to particular features or combinations of features. Consider, for example, the feature [±ATR] in (4). Taken by itself it divides the vowels into two sets: a [+ATR] set, /i, e, o, u/, and a [−ATR] set, /ɛ, a, ɔ/. Looked at this way, /i, u/ can be contrastively [+ATR] even though they have no minimally different counterparts: they are part of a group of vowels that is collectively [+ATR] in opposition to a group of vowels that is [−ATR]. Alternatively, we can consider [±ATR] in the context of other features and obtain different results. For example, in the scope of the [+high] vowels /i, u/ [±ATR] has no contrastive function, because both those vowels have the same value for this feature, [+ATR].

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[4] The notion of 'full specification' is defined only if we assume that there is a set of universal features that must all be specified. If there is no such set, it is not clear what full specification could mean.

[5] Recall that we are assuming binary-valued (±) features; a segment with no specifications is fine in a unary or privative system, but has no interpretation in a ± binary system.

Contrastive Hierarchy Theory, aka Modified Contrastive Specification (Dresher, Piggott, and Rice 1994, Dresher 2009, Hall 2011, Mackenzie 2011, 2013), recognizes this multi-dimensional aspect of contrast. Following a program initiated by Jakobson (1941), we propose that contrast is assigned hierarchically by branching trees according to the Successive Division Algorithm, given informally in (7):

(7) The Successive Division Algorithm (Dresher 1998, 2003, 2009)

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

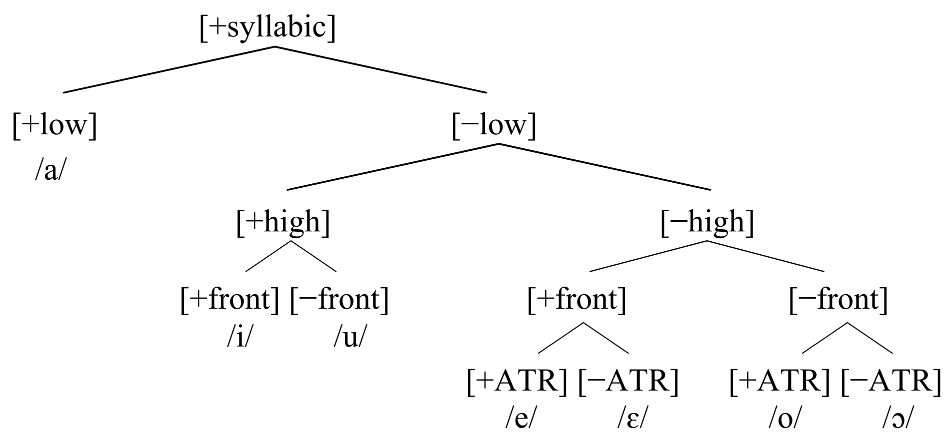
We also assume the Variable Order Hypothesis, that features, and their ordering, are not universal and can vary from language to language, and even dialect to dialect:

(8) Variable Order Hypothesis

The ordering of features in a hierarchy (and indeed the features themselves) is not fixed but can vary across dialects and languages.

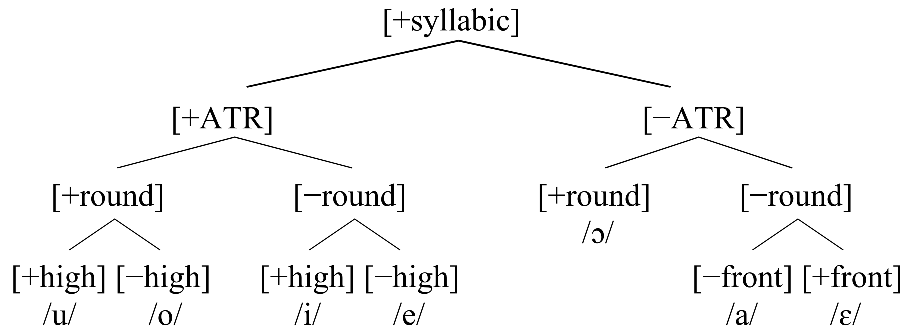
As is evident from the discussion above, varying the ordering of the features can give very different contrastive specifications even when the features and segments are held constant. We will illustrate this by considering two different orderings of the features for the inventory in (4): first we will look at the order of the features as they are in (4), with [±low] highest and [±ATR] lowest (9); then we will look at the opposite ordering (10).

(9) Contrastive hierarchy 1: [±low] >> [±high] >> [±front] >> [±round] >> [±ATR]



In (9), the first division divides the inventory into a [+low] set which contains only /a/, and a [−low] set that contains all the other vowels. As /a/ is now completely distinct, it receives no further features. The [−low] vowels are then divided by [±high], and each of those sets is subdivided by [±front]. The [+high] vowels are now individuated, and receive no further features. The next feature in the order is [±round], but it has no contrastive work to do: the vowel subsets that remain to be distinguished, /e, ɛ/ and /o, ɔ/, are either only [−round] vowels or only [+round] vowels. Therefore, this feature is not assigned in this inventory, and the final division is made by [±ATR], which in this ordering is limited to the mid ([−low, −high]) vowels; the [+high] and [+low] vowels have no contrastive value for [±ATR], in accord with what Minimal Difference would lead us to expect.[6]

(10) Contrastive hierarchy 2: [±ATR] >> [±round] >> [±front] >> [±high] >> [±low]



The other ordering, (10), yields a very different picture of the contrasts in this vowel inventory. Here, [±ATR] makes the first division, and so is contrastive for all vowels. The feature [±round] makes [±front] redundant among the [+ATR] vowels. [±front] is contrastive only among the [−ATR, −round] vowels /a/ and /ɛ/. After these vowels are designated as [−front] and [+front], respectively, all members of the inventory are uniquely specified and no additional contrastive features are assigned. Note that [±low], ordered lowest in the hierarchy in (10), is not contrastive for any segment in the inventory.

Unlike with Minimal Difference, in a hierarchical approach to contrast it is not the case that only unpredictable features are contrastive. In (9), for example, the [+high] vowels /i, u/ are predictably [−low]; however, their [−low] specification cannot be omitted, because it serves to indicate that the high vowels are part of the set of vowels that is [−low] in contrast to [+low] /a/. The creation of contrastive but predictable features is an inevitable consequence of a hierarchical approach to contrast, where contrasts created at lower levels of the hierarchy do not cancel contrasts created at higher levels.

The Successive Division Algorithm does not require minimal differences in the sense of (5) to produce a set of contrastive specifications. In a contrastive hierarchy, features make minimal differences, but these occur throughout the hierarchy and distinguish groups of segments as well as individual ones. For example, in both (9) and (10), [±ATR] makes a minimal difference between two sets that have not yet been differentiated at the point where it divides the inventory. In (9), [±ATR] is at the bottom of the hierarchy and so /e/ ~ /ɛ/ and /o/ ~ /ɔ/ are minimally different in the sense of (5); in (10), [±ATR] makes a minimal difference between the sets /i, e, o, u/ and /ɛ, a, ɔ/, but the individual vowels in these sets are not all minimally different according to (5) because of the effects of features lower in the hierarchy.

Even if we assume that the features of an inventory are known, the contrastive specifications depend on how they are ordered. With no limitations on what the ordering might be, there are *n*! orders for *n* features; for the five features in (4), that amounts to 120 different orderings.[7] How then do we determine what the contrastive hierarchy is for any given inventory? The answer is that

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[6] Other specifications, however, are not in accord with Minimal Difference: for example, [±low] is contrastive in (9) even though it does not uniquely distinguish /a/ from any other vowel.

[7] Not every feature ordering creates a unique set of specifications, however. In the case of the inventory and features in (4), the 120 different orderings yield 30 distinct feature assignments.

we must be guided by the evidence available to us, which is, particularly in the case of vowel harmony, phonological activity. Intuitively, out of the various possible contrastive hierarchies we would like to pick the one that best reflects the phonological patterning of the language in question. The Contrastivist Hypothesis, formulated in (11), makes explicit the connection between contrast and phonological patterning:

(11) 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.

To say that the phonology 'operates' only on contrastive features is to say that only contrastive features can be phonologically *active*, where feature activity is defined as in (12).

(12) 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.

Since by hypothesis only contrastive features can be active, it follows as a corollary (13) that if a feature is phonologically active, then it must be contrastive.

(13) Corollary to the Contrastivist Hypothesis

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

With respect to vowel harmony, phonological activity is most easily diagnosed where a vowel causes (or *triggers*) harmony of a feature [±F]: such a vowel must have an active feature, [αF], that it spreads or donates to eligible vowels (or *targets*) in its domain. The target vowels, being recipients of the feature [αF], do not necessarily have an 'active' feature in the sense of (12); therefore, it is less clear whether we should expect them to also be contrastive for the feature [±F]. We will see in the following sections that some harmony targets are contrastive for [±F] and some are not. The case is also less clear for neutral vowels that either block or are transparent to harmony. In the typical case, we might expect vowels that block [F] harmony (opaque vowels) to have a contrastive feature [±F] that is doing the blocking, and vowels that are transparent to harmony to lack such a feature. However, opacity and transparency may also be due to other factors. For example, in cases of parasitic harmony, vowels which interact must share some feature specifications, resulting in the failure of unlike segments to interact even if they contrast in the harmonic feature. Vowel harmony processes may also simply be restricted to a certain class, as in the case of Turkish rounding harmony which targets only high vowels. A vowel may also fail to undergo harmony if the result would violate a phonotactic restriction of the language or if it occurs in a loanword or other morpheme which resists harmony; a range of relevant factors are discussed in Krämer (chapter 21).

To investigate the Contrastivist Hypothesis, then, we will focus above all on harmony triggers, and only secondarily on harmony targets and neutral vowels. The Contrastivist Hypothesis makes a very clear prediction with respect to harmony triggers: since by (13) an active feature must be contrastive, the prediction is that every vowel that triggers [F]-harmony must have a contrastive feature [F]. If we find an [F]-harmony trigger that is not contrastive for [F], that is a counterexample to the Contrastivist Hypothesis.[8]

While it is perfectly straightforward that an [F]-harmony trigger must have an active feature [±F], we showed above that deciding whether this feature is contrastive is not always obvious. For example, if we find that a language with the vowel inventory of (3) has [ATR] harmony triggered by high vowels, a Minimal Distance analysis would consider this to be a counterexample to the Contrastivist Hypothesis, because high vowels cannot be contrastive for [±ATR]. In Contrastive Hierarchy Theory this conclusion does not follow: if the contrastive hierarchy of this language is as in (9), then this would indeed be a counterexample to the Contrastivist Hypothesis; but if the hierarchy is as in (10), it is not. In practice, we would conclude that phonological activity in the form of [F]-harmony supports the latter hierarchy, or something like it, and not the former one. In sum, features that are deemed non-contrastive in a Minimal Difference approach may turn out to be contrastive in a hierarchical one; the consequence is that apparent counterexamples to the Contrastivist Hypothesis may turn out to be consistent with it if we adopt a hierarchical approach to contrast.

To phonologists accustomed to the Minimal Difference approach to contrast, this might look like cheating: we hypothesize that only contrastive features are active, and then we use activity to find the contrastive features. In the Minimal Difference approach, once the segments and features have been selected, there is only one way to arrive at the contrastive features, not many ways. However, this apparent advantage of Minimal Difference is illusory. Leaving aside the fact that the Minimal Difference approach does not yield properly contrastive feature specifications, we have shown that this approach requires a pre-selection of features to weed out those that play no role in the phonology; this is to clear the way for the remaining features to make minimal contrasts. This weeding out amounts to using activity to select the relevant features, much like in Contrastive Hierarchy Theory.

Further, when Minimal Distance is used as a definition of contrast, other assumptions about the relationship between contrast and activity are needed. For example, Nevins (2010), building on work by Calabrese (1995), allows for 'parametric visibility' (2010: 80) of features to vary between rules. In this approach, some rules refer to only contrastive features whereas other rules can make reference to all features and still other rules refer to only marked feature values. The definition of contrast is restrictive, but predictions regarding the relationship between inventory shape and feature activity are not. Between languages, and even within a single language, rules may differ in terms of whether or not they can make reference to non-contrastive features. This makes empirical consequences of contrastive specifications difficult to evaluate. If a feature that is deemed non-contrastive by the Minimal Difference approach is phonologically active, this does not falsify the claims of Minimal Difference, given that the Contrastivist Hypothesis is not adopted. These comments hold for other proposals that use the Minimal Distance definition, such as Campos-Astorkiza's (2009) use of contrast-coindexing in Optimality Theory, which allows for constraints which refer only to features that have a contrast co-index as well as constraints which refer to "all elements with that feature or property regardless of their contrast-coindexing status" (2009: 13).

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[8] Note that the converse does not hold: if we find a vowel that is contrastive for [F] that is not a [F]-harmony trigger, that is not a counterexample to the Contrastivist Hypothesis. By hypothesis an active feature must be contrastive, but there is no hypothesis that a contrastive feature must be active in the sense of the definition in (12).

Turning to Contrastive Hierarchy Theory, it is important to underscore that the connection between contrast and activity it posits does not amount to cheating or vicious circularity. The cases discussed below will demonstrate that the contrasts in an inventory may indeed be drawn in different ways, and cannot be determined by a simple inspection of the inventory. That being the case, we need to find evidence that will help us choose which of the possible contrastive systems is the operative one in any given language.[9] Phonological activity is one important source of such evidence.

Second, that activity serves as evidence for what the contrastive features are does not detract from the fact that activity and contrast remain concepts which are not defined in terms of each other but have independent definitions: the definition of phonological activity in (12) does not mention contrast, and the procedure for assigning contrasts in (7) does not refer to activity. The Contrastivist Hypothesis thus posits a connection between two *independent* concepts, contrast and activity.

Third, the Contrastivist Hypothesis is demonstrably falsifiable. It can be falsified if we find patterns of activity that do not correspond to any possible contrastive hierarchy. For example, a three-vowel inventory requires exactly two contrastive features if evaluated separately as a group; if we find that these three vowels together have more than two active features, then this is a counterexample to the Contrastivist Hypothesis. Nevins (2015: 43) characterizes this as the "Oops, I Need That" Problem. The fact that this problem can arise demonstrates that the Contrastivist Hypothesis is indeed falsifiable. This hypothesis amounts to the empirical claim that one will always be able to find a contrastive feature hierarchy that accounts for the phonological activity in a language.

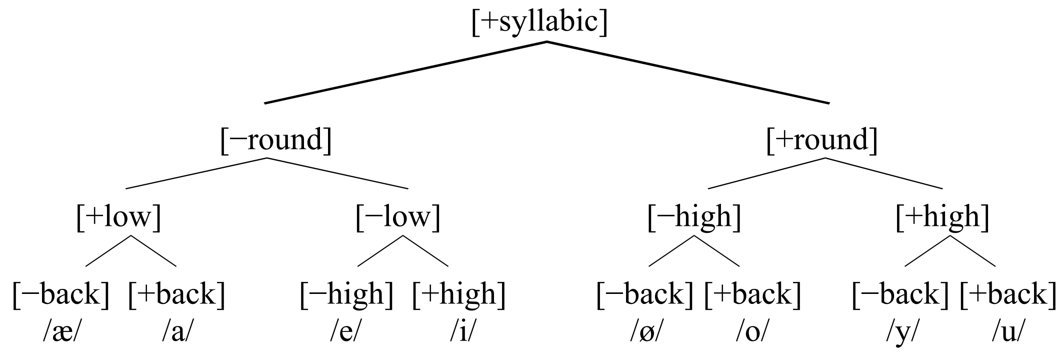
We are now in a position to see that Halle's contrastive specifications of Finnish in (2) cannot have been generated by Minimal Difference; though the specifications for [±back] and [±high] are what Minimal Difference would give, the specifications for [±round] and [±low] differ from a Minimal Distance analysis, as we can see from comparing (2) with the Minimal Distance specifications in (14). Rather, the feature specifications in (2) are generated by a contrastive hierarchy in the order given in (2), as shown in (15).

(14) Features of Finnish vowels (Minimal Difference)

	æ	a	e	ø	o	i	y	u
[round]			−	+		−	+	
[low]	+		−					
[high]			−	−	−	+	+	+
[back]	−	+		−	+		−	+

[9] Thus, Trubetzkoy ([1936] 2001: 20) remarks that the correct classification of an opposition [i.e., the type of contrast between a pair of phonemes] "depends on one's point of view"; but "it is neither subjective nor arbitrary, for the point of view is implied by the system".

(15) Finnish contrastive hierarchy: [round] >> [low] >> [high] >> [back]



14.3 Contrast and feature ordering in tongue-root harmony systems

14.3.1 The Contrastivist Hypothesis and the typology of tongue-root harmony systems

In tongue-root harmony systems, vowels within a domain must agree in some designated feature referring to tongue-root configuration, either the feature Advanced Tongue Root, [ATR], or Retracted Tongue Root, [RTR]. In this chapter we use [ATR] for the tongue-root feature; except where indicated otherwise, we treat [αATR] as equivalent to [−αRTR]. Common among Niger-Congo, Nilo-Saharan, and Northeast Asian languages, tongue-root harmony is considered in detail in several chapters in this volume, including those focusing on tongue-root harmony in general (Casali, chapter 7), the relation between tongue-root harmony and inventory structure (Casali, chapter 15), and several chapters focusing on particular language areas and language families such as those on Bantu (Boyd, chapter 52) and non-Bantu (Orie, chapter 51) Niger-Congo languages, languages of the Nuba mountains (Bashir and Rose, chapter 50), Nilo-Saharan languages (Kutsch Lojenga, chapter 49), languages of India (Mahanta, chapter 56), Tungusic languages (Bing and Smith, chapter 61), and Korean (Ko, chapter 63), among others.[10]

Extensive typological work on [ATR] harmony systems (e.g. Casali 2003, 2008, 2016; Leitch 1996; Rose 2018) has demonstrated a relationship between inventory shape and the patterning of [ATR] harmony. Specifically, the presence of an [ATR] contrast among high vowels has been shown to correlate with [+ATR] dominance in harmony systems (e.g. Casali 2003, 2008, 2016; Leitch 1996; van der Hulst 2018; Rose 2018), whereas a contrast in [ATR] among mid vowels with an absence of such a contrast among high vowels correlates with [−ATR] dominance. The details of this relationship are beyond the scope of this chapter and are addressed elsewhere in this volume (particularly in Casali, chapter 15).

The Contrastivist Hypothesis does not, in and of itself, make any predictions about the shape of the inventory and the dominance of one feature value over another. However, it does predict a relationship between inventory shape and the presence of [ATR] harmony in general, an issue addressed directly in Rose (2018). Of the 524 Niger-Congo and Nilo-Saharan languages included in Rose's (2018) typological survey, 451 languages have an [ATR] contrast among the high vowels, the mid vowels, or both. 302 languages have some form of [ATR] harmony. Of the 73 languages without any [ATR] contrast, none have [ATR] harmony. Rose's survey includes

[10] ATR harmony also occurs in Nez Perce (Sahaptian, Northwestern United States; Hall and Hall 1980); see Mackenzie and Dresher (2004) for a contrastive hierarchy analysis that shows it is consistent with the Contrastivist Hypothesis.

languages in which either the mid or high vowels lack a minimal contrast in [ATR] yet nonetheless participate in harmony, either resulting in allophonic outputs or mapping to members of the phonemic inventory that differ in both height and [ATR]. It is therefore possible that harmony could be observed among languages that lack a minimal [ATR] contrast for any vowel in the inventory. Indeed, Casali (2008) states that harmony is attested in some languages with five-vowel inventories which have a single set of [+ATR] high vowels and a single set of [−ATR] mid vowels. Of the languages Casali states as having this pattern, one, Pulaar, has been analyzed as having a seven-vowel inventory with a minimal contrast among mid vowels in subsequent work (e.g. Walker 2012; Hall and Hall 2016). Zulu and Tsonga are also cited by Casali (2008) as cases of five-vowel systems with [ATR] harmony, yet are not listed as such in Rose's (2018) survey. Regardless of the status of these languages, there is at minimum a strong correlation between a minimal contrast in [ATR] for some vowels in an inventory and the presence of [ATR] harmony.

Although the literature on inventory structure and tongue-root harmony does not, in general, provide a formal definition of contrast, a reading of these works suggests that authors refer to the Minimal Difference notion of contrast (e.g. Casali 2008, 2016; Rose 2018). As discussed above, the definition of contrast proposed in Contrastive Hierarchy Theory does not require a minimal contrast between some pair of segments in order for a feature to be specified as contrastive for those segments. However, if a minimal contrast is present, then the relevant feature must be contrastive for those segments, regardless of feature ordering. In other words, although a minimal contrast is not a necessary condition of contrastiveness in this approach, it is a sufficient one. We can conclude that all of the languages described as having an [ATR] contrast in this literature would also necessarily have some [ATR] contrast in a contrastive hierarchy analysis. The findings of typological studies of [ATR] harmony thus support the Contrastivist Hypothesis, regardless of what theory of contrast is adopted.

While the Contrastivist Hypothesis draws a connection between contrast and phonological activity, Contrastive Hierarchy Theory proposes that the contrastive status of a given feature depends on both its order in a language-specific hierarchy and the structure of the language's phonemic inventory. The possibility of variation in feature ordering predicts that languages with similar inventories may differ in terms of contrastive specifications.

14.3.2 [ATR] Harmony in Fur and Palor: The significance of feature ordering on harmonic partners

Through an analysis of [ATR] harmony in Fur and Palor, this section demonstrates the significance of feature ordering in shaping the patterning of harmony. Not only does the ordering of features influence which segments are active participants in harmony processes, it also influences which segments pattern together as harmonic partners. Both Fur (Nilo-Saharan) and Palor (Niger-Congo) have a phonemic [ATR] contrast among the high and low vowels but only a single set of mid vowels which are realized as [−ATR]. Although the unpaired mid-vowels participate in harmony in both Fur and Palor, the harmonic counterparts of the vowels differ between the two languages. In Fur, when the [−ATR] mid vowel /ɛ/ becomes [+ATR] it maps to the high [+ATR] vowel [i]; similarly, the back mid vowel /ɔ/ maps to [+ATR] [u]. In Palor, /ɛ/ also maps to [i] but the back vowel /ɔ/ maps to the low [+ATR] vowel [ə]. Differences in the feature hierarchies of the two languages can account for differences in which segments pattern as the harmonic counterpart of the mid-vowels /ɛ/ and /ɔ/.

Fur has the eight-vowel inventory shown in (16). All vowels participate in [ATR] harmony.

(16) Fur vowel inventory (Kutsch Lojenga 2012: 36)

i		u
ɪ		ʊ
ɛ		ɔ
	ə	
	a	

Kutsch Lojenga (2012) describes Fur as having both lexical vowel harmony, which is categorical, and post-lexical vowel harmony, which is gradient and dependent on speech rate. In the lexical harmony process, a dominant [+ATR] suffix triggers [ATR] agreement in preceding vowels. The process is illustrated below with the nominalizing suffix *-iŋ*. The data in (17) show alternations between paired vowels that differ in [ATR]. /ɪ/ alternates with /i/, /ʊ/ with /u/, and /a/ with /ə/. This is to be expected in a harmony system where the inventory contains vowels that differ minimally in [ATR].[11]

(17) Fur [ATR] harmony affecting /ɪ, ʊ, a/ (Kutsch Lojenga 2012: 39)

a.	sɪkk-â	'sharp'	sikk-iŋ	'sharpness'
	bíɾɲ-â	'smooth'	bíɾɲ-iŋ	'smoothness'
b.	kʊrr-â	'tall'	kurr-iŋ	'tallness'
	tʊll-ɛ̂	'good'	tull-iŋ	'goodness'
c.	app-â	'big'	əpp-iŋ	'bigness'
	bayy-â	'narrow'	bəyy-iŋ	'narrowness'

The data in (18) show that the mid-vowels participate in [ATR] harmony, although they lack partners that differ minimally in the harmonic feature. In harmonic contexts /ɛ/ alternates with /i/ and /ɔ/ with /u/. The Fur pattern is somewhat unusual among [ATR] harmony systems in that the unpaired mid-vowels participate, yet the harmony is structure-preserving; that is, the vowels map to [+ATR] segments that are members of the vowel inventory.[12]

(18) Fur [ATR] harmony affecting /ɛ, ɔ/ (Kutsch Lojenga 2012: 39–40)

a.	tɛyy-â	'clean'	tiyy-iŋ	'cleanness'
	lɛpp-ɛ̂	'thin, flat'	lipp-iŋ	'thinness, flatness'
	mɛrs-ɔ	'limping (adj.)'	mirs-iŋ	'limp (n.)'
b.	tɔy	'old'	tuy-iŋ	'oldness'
	bɔɔr-ɔ̂	'fat'	buur-iŋ	'fatness'
	ɲɔkk-ɛ̂	'weak'	ɲukk-iŋ	'weakness'

Intuitively, /i/ and /u/ may appear like obvious choices as [+ATR] partners of the mid-vowels, if structure-preservation is to be obeyed. However, the evaluation of what counts as the closest available [+ATR] vowel depends on phonological representations, rather than a surface inspection

[11] In this section we retain the consonant transcriptions of our sources.

[12] In the most common sort of non-structure-preserving harmony /ɛ/ would become [e] and /ɔ/ would become [o], where [e, o] do not occur in lexical representations. Both Fur and Palor are related to languages in which this occurs (Kutsch Lojenga 2012: 42; Drolc 2004: 41).

of the inventory. According to Contrastive Hierarchy Theory, representations depend on feature hierarchies which may vary between languages.

The Cangin (Niger-Congo) language Palor is similar to Fur in terms of inventory shape and in having [ATR] harmony in which the unpaired vowels participate. The harmonic partners of the mid vowels differ between the two languages, however. The Palor inventory is shown below.

(19) Palor vowel inventory (D'Alton 1987: 73)[13]

i		u
ɪ		ʊ
ɛ		ɔ
	ɐ	
	a	

Suffixes with [+ATR] vowels trigger regressive harmony, as illustrated with the causative *-iɗ*, reversive *-is*, imperative plural *-i*, and past tense *-i* suffixes in (20). The data in (20a) illustrate alternations between the paired low vowels, with /a/ harmonizing to /ɐ/ under the influence of the [+ATR] suffix. The paired high vowels show similar alternations, with /ɪ/ harmonizing to /i/ (20b, c) and /ʊ/ to /u/ (20c).

(20) Palor regressive [ATR] harmony affecting /a, ɪ, ʊ/ (D'Alton 1987: 93, 133, 142)

a.	jakat	'run'	jɐkɐt-iɗ	'run-CAUS' = 'cause to run'
	kal	'take'	kɐl-is	'take-REV' = 'throw away'
b.	sɪk	'wait.INF'	sik-i	'wait.IMP.PL'
c.	fʊlɪl	'spin (cotton)'	fulil-i	'spin.PST'

The examples in (21) show that the mid front vowel /ɛ/ alternates with the high [+ATR] vowel /i/, and the mid back vowel /ɔ/ is realized as /ɐ/ in [+ATR] contexts.

(21) Palor regressive [ATR] harmony affecting /ɛ, ɔ/ (D'Alton 1987: 93, 131, 142–143)

a.	nɛx	'draw.INF'	nix-i	'draw-IMP.PL'
	yɛɛl-ɛ	'look-IMP.SG'	yiil-i	'look-IMP.PL'
b.	pɔn	'fold'	pɐn-is	'fold-REV' = 'unfold'
	yɔɔn	'learn'	yɐɐd-iɗ	'learn-CAUS' = 'teach'

In addition to the regressive harmony triggered by the dominant suffixes illustrated above, Palor also has progressive harmony triggered by a [+ATR] stem vowel. This harmony, however, affects only /a, ɪ, ʊ/; /ɛ/ and /ɔ/ can follow a [+ATR] vowel in a word. Progressive harmony is illustrated in (22a) with the definite marker [-a/-ɐ]; in (22b) with the remote determiner [-ɪn/-in]; and in (22c) with the 2.pl suffix [-ʊ/-u].

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[13] We follow Drolc (2004: 40) in transcribing the unpaired mid vowels as /ɛ/ and /ɔ/. D'Alton transcribes them as /e/ and /o/, respectively, though she makes clear (D'Alton 1987: 92) that they pattern with /ɪ, ʊ, a/, not with /i, u, ɐ/. Drolc follows D'Alton in transcribing the Palor low ATR vowel as [ɐ], while transcribing the low ATR vowel in related languages (from other sources) as [ə]. It is not clear to us if this represents a phonetic difference or different transcriptions of the same vowel.

(22) Palor progressive [ATR] harmony affecting /a, ɪ, ʊ/ (D'Alton 1987: 104–5, 109, 123)

a.	ʄɛɛg-a	'song-DEF'	yiin-ɐ	'axe-DEF '
	xʊl-y-a	'star-PL-DEF'	ɓug-ɐ	'mouth-DEF'
b.	fanf-ɪn	'cow-REMDET'	kisif-in	'sea-REMDET'
c.	lad-ʊ	'clean-2.PL'	muj-u	'wait-2.PL'

As shown in (23a) with the remote determiner [-ɛ] and in (23b) with the nominalizer [-ɔx], /ɛ/ and /ɔ/ do not undergo progressive [ATR] harmony.

(23) Palor progressive [ATR] harmony does not affect /ɛ, ɔ/ (D'Alton 1987: 109, 142)

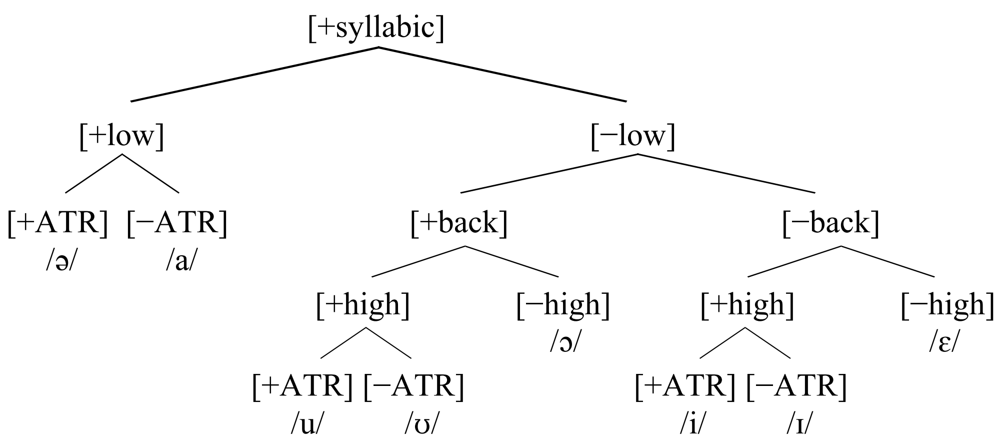
a. munm-ɛ 'flour-REMDET'
b. yik-ɔx 'own-NMLZ' = 'owner'

Fur and Palor have equivalent vowel inventories and both have [ATR] harmony systems in which the unpaired mid vowels participate. The harmonic counterparts of these vowels differ between the two languages as illustrated in (24).

(24) a. Fur b. Palor

We propose that the differences in harmonic partners between Fur and Palor follow from different feature orderings in the contrastive hierarchies of these languages. A feature hierarchy for Fur is illustrated in (25).

(25) Fur contrastive hierarchy: [low] >> [back] >> [high] >> [ATR]



In Fur, all vowels participate in [ATR] harmony, regardless of whether or not they have partners in the inventory that minimally contrast in this feature. This could suggest that [ATR] is contrastive for all vowels; however, this conclusion does not necessarily follow here. In a dominant harmony system, only one value of a feature, here [+ATR], triggers harmony. Thus, it is hard to distinguish between vowels that are [−ATR] and vowels that have no specification for [ATR]; both may be targets of harmony, depending on how harmony is formulated. We think that in the case of Fur and Palor there are reasons for leaving /ɛ, ɔ/ unspecified for [ATR].

In the hierarchy proposed in (25), [low] is the highest ordered feature and the inventory is divided into [+low] and [−low] sets with all vowels contrastively specified for this feature. The next feature in the hierarchy is [back], which divides the [−low] vowels symmetrically into two groups, as in the diagram in (24a). In each group, [high] separates the mid vowels from the high vowels, leaving [ATR] contrastive only on the latter. For the [+low] vowels, neither [back] nor [high] serve to differentiate the set of /a, ə/. [back] and [high] are therefore not contrastively specified for the low vowels. The [+low] vowels are distinguished from one another by contrastive specification of [ATR].

[ATR] harmony is very straightforward when the targets are /a, ɪ, ʊ/: in each case, [−ATR] is changed to [+ATR], leaving all other features as they are. When /ɔ, ɛ/ are the targets, more extensive adjustments are required. Simply adding [+ATR] to their lexical representations would result in vowels that are [−low, ±back, −high, +ATR]. This combination of features, which would be interpreted as [o, e] (as actually occurs in related languages), is not licit in Fur, which requires harmony to be structure-preserving. To arrive at a lexically occurring feature combination that includes [+ATR], we propose that features that are higher in the order are retained at the expense of features lower down. In this case, the features [−low] and [back] (either + or −) are retained, but [−high] has to change to [+high] to be compatible with [+ATR]. The result is that /ɔ/ becomes [u] and /ɛ/ becomes [i].

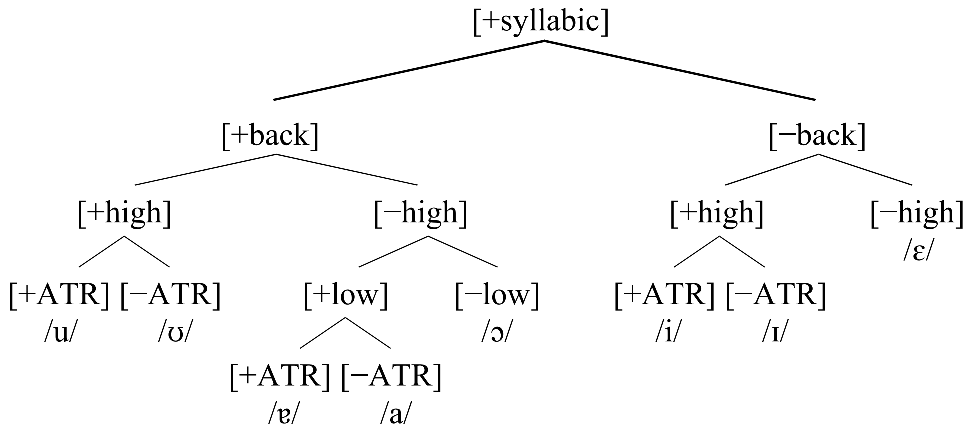
The symmetry in the patterning of the front and back mid vowels in Fur is intuitively natural, as the relationships between /ɛ/ ~ /i/ and /ɔ/ ~ /u/ appear to be equivalent from a superficial inspection of the inventory. However, this is not an inevitable result of the Fur inventory, and depends, in part, on how the vowels are analyzed. In Contrastive Hierarchy Theory, a different order of features has significant consequences for how these vowels relate to one another. An analysis of Palor requires a different feature hierarchy.

The data from Palor show that front and back mid vowels pattern differently in [ATR] harmony. Both segments undergo structure-preserving harmony, as in Fur, and, also as in Fur, the front mid vowel /ɛ/ maps to the high vowel /i/ in [+ATR] contexts. The patterning of the mid back vowel differs from that of Fur, however. In Palor, /ɔ/ maps to the low [+ATR] vowel /ɐ/ in harmonic contexts. We propose that this pattern of [ATR] harmony in Palor is consistent with the contrastive hierarchy illustrated in (26).

Contrary to Fur, [back] is the highest ordered feature in Palor. As a result, [back] is contrastive for all vowels in the inventory. This means that, unlike in Fur, the low vowels cannot be neutral for [back], but are assigned [+back]. The next feature, [high], is contrastive in all vowels. [back] and [high] divide the vowels into three sets: [+back, +high] (/u, ʊ/); [+back, −high] (/ɐ, a, ɔ/; and [−back] (/i, ɪ, ɛ/).

As in Fur, [ATR] harmony applies in straightforward fashion to /ɪ, a, ʊ/, the vowels that have [+ATR] contrastive partners. When /ɛ, ɔ/ are targets of [+ATR], we apply the same method as for Fur, finding a route that leads to the closest existing [+ATR] vowel. In the case of /ɔ/, the lowest feature [−low] needs to be changed to [+low], yielding [ɐ]; in the case of /ɛ/, adding [+ATR] forces the lowest feature to change to [+high], resulting in [i].

(26) Palor contrastive hierarchy: [back] >> [high] >> [low] >> [ATR]

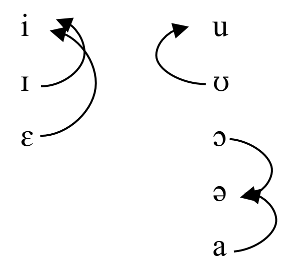


In Palor there is support for making a distinction between /ɪ, a, ʊ/ and /ɛ, ɔ/ as targets of [ATR] harmony: the former vowels undergo both regressive and progressive harmony, whereas the latter undergo only regressive harmony. We propose that the different strengths of these harmony processes derive from the different conditions they impose on potential targets. In regressive harmony a vowel to the left of a [+ATR] vowel must itself become [+ATR]; in progressive harmony, a vowel to the right of a [+ATR] vowel must become [+ATR] if this can be done without changing any other features. This condition is met by /ɪ, a, ʊ/, but not by /ɛ, ɔ/.

[ATR] harmony in Fur and Palor shows that feature ordering has non-trivial consequences for the detailed patterning of triggers and targets in harmony processes. This example also demonstrates how the operative phonological contrasts in a language cannot be deduced from a simple inspection of the segmental inventory. As we observed above, a superficial look at the inventory of both these languages might suggest that the vowels are divided into three sets based on tonality: a front set /i, ɪ, ɛ/, a back or round set /u, ʊ, ɔ/, and a neutral set of low vowels /ə/ or /ɐ/ and /a/. This is exactly how Fur patterns phonologically, but it is not correct for Palor. In this language, the three phonetic tonality categories are grouped into two phonological categories; as happens in many other languages, the low vowels pattern with the [+back] vowels.[14]

Therefore, the diagram for Palor given in (24b) does not reflect the phonological reality. A more accurate diagram, reflecting the contrastive hierarchy in (26), is shown in (25).

(27) Palor [ATR] counterparts



This section has explored the implications of some [ATR] harmony systems for the Contrastivist Hypothesis and Contrastive Hierarchy Theory. Taken as a whole, the typology of

[14] In other languages where the operative contrastive feature is [round], the low vowels pattern with the non-round front vowels as [−round].

[ATR] harmony supports the Contrastivist Hypothesis as it shows a strong correlation between contrasts in [ATR] in the inventory and the presence of [ATR] harmony (e.g. Casali 2008; Rose 2018). The shape of the inventory does not uniquely determine harmony patterning, however. The comparison of Fur and Palor demonstrates that the order of features in the contrastive hierarchy affects which segments pattern together as harmonic partners. Fur and Palor have the same phonemic inventory and the same set of vowels participate in harmony. How those vowels alternate in harmonic contexts differs between the two languages, however, and this difference can be accounted for with a difference in the order of features in the languages' contrastive hierarchies.

14.4 Rounding harmony in Northeast Asian languages

In this section, we consider the role of contrast, inventory shape, and feature hierarchies in the patterning of rounding harmony with a focus on languages of northeast Asia. Rounding harmony (also known as labial harmony) is addressed elsewhere in this volume, particularly in the chapter on general issues in rounding harmony (Kaun, chapter 5), and in chapters that consider the specific harmony systems discussed here, including chapters on Turkic languages (Washington, chapter 59), Mongolic languages (Svantesson, chapter 60), and Tungusic languages (Li and Smith, chapter 61). Dresher (2009: 182–4, 212–4), Dresher, Harvey, and Oxford (2018), and Ko (2018) argue that typological surveys of labial harmony in Manchu-Tungus, Mongolian, and Turkic languages support the Contrastivist Hypothesis that only contrastive features trigger harmony and that contrastive specifications may vary between similar inventories, as proposed in Contrastive Hierarchy Theory. In addition, they illustrate the consequences that diachronic changes in inventory structure can have on contrastive feature specifications. In this section we review and update their findings.

14.4.1 Tungusic

Eberhard, Simons, and Fennig (2020) classify the Tungusic languages into a northern and southern branch; the latter is divided into a southeastern and a southwestern branch (see Zhang 1996: 6–27 and Ko 2018: 161–2 for discussion and references to other classifications). In the northern branch, which includes Even (Ewen), Evenki (Ewenki), Oroqen, and Negidal, rounding harmony is clearly found in Evenki and Oroqen. As rounding harmony works similarly in these languages, we will look at Oroqen as exemplifying this type.

The vowel system of Oroqen (Zhang 1995, 1996; Li 1996) is shown in (28).[15]

(28) Oroqen vowel system (Zhang 1996)

/i/	/ii/			/u/	/uu/
				/ʊ/	/ʊʊ/
	/ee/	/ə/	/əə/	/o/	/oo/
	/ɛɛ/	/a/	/aa/	/ɔ/	/ɔɔ/

[15] Some writers give slightly different vowel systems. The differences have to do with dialect differences and different transcriptions and interpretations of marginal phonemes; see Dresher and Nevins (2017: 367n3) for discussion and references. We will return to /ee, ɛɛ/ below; the other variations are not relevant to our discussion.

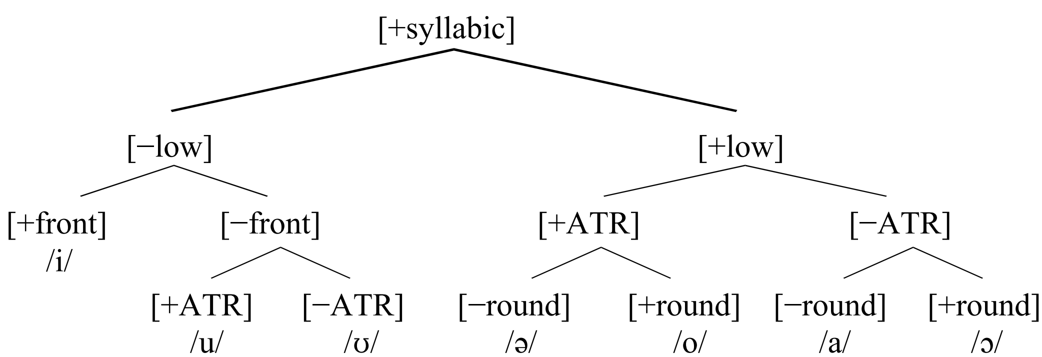
Following Dresher, Harvey, and Oxford (2018), we indicate vowels that are *triggers* of labial harmony in a solid box, and vowels that are *targets* of the harmony in a dashed box. In (29), we present examples showing the distribution of rounding harmony following [−ATR] stems; [+ATR] stems are entirely parallel. As shown in (29a), the definite object suffix following a stem with the vowel /a/ is -*wa* (or -*ma* when the stem ends in a nasal consonant). When a stem contains a non-initial /ɔ/, the suffix is rounded to -*wɔ* (29b); as (29c) shows, a single initial /ɔ/ or /ɔɔ/ does not trigger rounding.[16] High vowels do not trigger rounding harmony, as shown in (29d); harmony is blocked when a high vowel intervenes between an otherwise triggering sequence and the suffix (29e).[17]

(29) Rounding harmony in Oroqen (Zhang 1995, 1996)

a. bajta-wa	‘affair-DEFOBJ’	
b. ɔlɔ-wɔ	‘fish-DEFOBJ’	(*-wa)
c. mɔɔ-wa	‘tree- DEFOBJ’	(*-wɔ)
d. ʊrʊʊn-ma	‘hoof- DEFOBJ’	(*-mɔ)
e. tɔrɔki-wa	‘wild boar- DEFOBJ’	(*-wɔ)

Zhang (1996) proposes that Oroqen has the contrastive feature hierarchy [low] >> [front] >> [round] >> [ATR].[18] The relative ordering of [front] and [round] is motivated in part by the fact that /i/ triggers palatalization, indicating that it has a relevant palatalizing feature. Ko (2018) proposes to change the order of the bottom two features; we will follow his revision here, as in (30). In the trees in this section we present only the short vowels; the hierarchies for the long vowels are the same in the relevant respects except for /ee, ɛɛ/, which we discuss further below.

(30) Oroqen contrastive hierarchy: [low] >> [front] >> [ATR] >> [round]



[16] There has been much discussion of this condition on labial harmony, which is not due to contrast; see Dresher and Nevins (2017), whose formulation we follow, for discussion and references. See also Kaplan and Walker (chapter 23) on privileged positions in harmony.
[17] We have no examples parallel to (29e) with /ʊ/ followed by the definite object suffix, but /ʊ/ blocks rounding harmony in *dʒɔlɔ-dʊlaak* ‘stone-place of origin’ (Zhang 1996: 190).
[18] We have changed the feature names used by Zhang, Ko, and other authors to conform to those used in the rest of this chapter. Thus, we have changed [coronal] to [front], [labial] to [round], and [RTR] to [ATR]. For purposes of this chapter we regard these labels as interchangeable, with no empirical consequences, though there may be reasons unrelated to contrast for preferring one or another of these. Ko (2018) argues that [RTR] is the Tungusic tongue root feature.

The effect of the feature ordering in (30) is that only vowels that have a contrastive [±round] feature are involved in rounding harmony: /o, ɔ/ are [+round] and /ə, a/ are [−round]. As predicted by the Contrastivist Hypothesis, only vowels with contrastive [+round] can trigger rounding harmony. Ko (2018) accounts for the blocking effect of high vowels by proposing that rounding harmony is stratified by height (Mester 1988), being confined to vowels that are [+low].

The long vowels /ee, εε/, which are relatively rare, also block labial harmony in *ɔɔmɔlεε-sal* 'grandson-PL' (Zhang 1996: 180). Ko (2018: 185n26) suggests that the underlying representations of these vowels are /iə, ia/; Li (1996: 121) transcribes them as /ie, ɪε/. Given these representations, rounding harmony is blocked by the high vowel component of the underlying diphthong.

The observed asymmetry whereby only the low vowels can trigger rounding harmony is a direct consequence of the feature ordering in (30). We would not expect a language with the same vowel inventory to exhibit rounding harmony triggered only by the high round vowels without also having other differences in phonological patterning. For example, if [round] were to be ordered ahead of [front], then /i/ would lose its front feature and would not be able to cause palatalization. Some writers, such as Kaun (1995), have advanced perceptual explanations for rounding harmony asymmetries; for example, it has been proposed that [–high] vowels are better triggers and [+high] vowels are better targets of rounding harmony. Be that as it may, such factors can only make themselves felt if the contrastive structure of a vowel system allows them to.

The southeast Tungusic languages include Nanai, Orok, Ulch (Ulchi), Oroch, and Udihe. Oroch has been claimed to show the untenability of a contrastive hierarchy analysis (Tolskaya 2008; Nevins 2010). This is mainly due to the presence of a vowel [æː] in the Oroch inventory, whose behaviour causes problems for a contrastive hierarchy account. However, Ko (2018: 181–6, 239–42) argues convincingly that this vowel, like Oroqen /ee, εε/, is an underlying diphthong whose [+high] component patterns with the high vowels. With this revision, Ko shows that a contrastive hierarchy very much like that of Oroqen accounts well for rounding harmony and for other processes in Oroch.

Ko (2018: 181) proposes that Oroch has the vowel system in (31). As in Oroqen, rounding harmony is restricted to the low vowels. Because of [ATR] harmony and the lack of a low [+ATR] vowel /o/, /ə/ never occurs in a rounding environment. Rounding harmony is shown in (32b); as in Oroqen, it is blocked by any intervening non-low vowel (32c, d) including [æː] = /ia/ (32e); here, too, Ko proposes that rounding harmony is stratified by height, and confined to the low vowels.

(31) Oroch vowel system (Ko 2018)

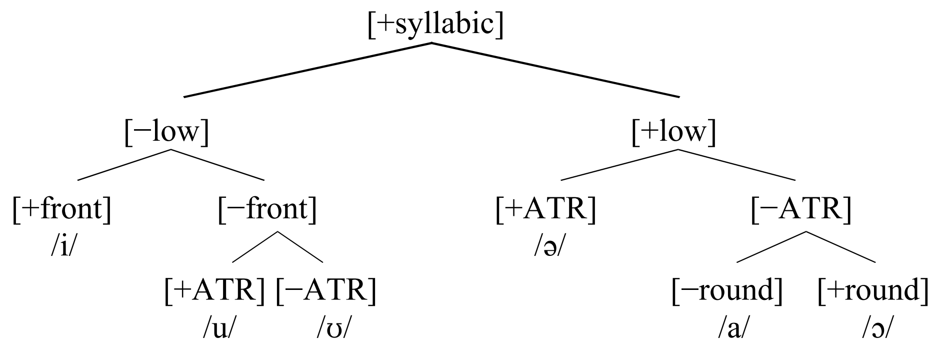
/i/ /ii/		/u/ /uu/
		/ʊ/ /ʊʊ/
	/ə/ /əə/	
	/a/ /aa/	/ɔ/ /ɔɔ/

(32) Rounding harmony in Oroch (Tolskaya 2008)

a. ʊgda-va-da 'boat-ACC-FOC'
b. ɔmɔɔ-vɔ-dɔ 'lake-ACC-FOC' (*-va-da)
c. ɔtɔŋgɔ-ɲi-da 'kayak-3SG-FOC' (*-dɔ)
d. ɔtɔŋgɔ-dʊ-da 'kayak-DAT-FOC' (*-dɔ)
e. sɔrɔdæː-da 'greet- FOC' (*-dɔ)

Ko (2018: 184) proposes that Oroch has the contrastive hierarchy in (33), which is very similar to that of Oroqen (30), except there is no [±round] contrast under [+low, +ATR], which is uniquely /ə/. Therefore, /ɔ/ is the only contrastively [+round] vowel, hence the only trigger of rounding harmony.

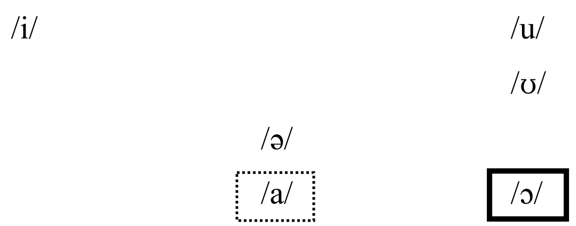
(33) Oroch contrastive hierarchy: [low] >> [front] >> [ATR] >> [round]



Of the other southeast Tungusic languages, Ko (2018) argues that Udihe, Ulchi, and Orok (Uilta) have similar contrastive hierarchies and patterns of rounding harmony, setting aside small differences in the inventories and various complications that need not concern us here. Nanai has lost [round] as a contrastive feature, and consequently has no rounding harmony.

The southwest Tungusic languages consist of Classical (or Written) Manchu, which is the language of the written documents of the Qing dynasty (1644-1911), and the modern languages Spoken Manchu and Xibe (or Sibe). The Classical Manchu vowel system is given in (34):

(34) Classical Manchu vowel system (Zhang 1996)



The Classical Manchu vowel system is much like that of Oroch, and the analysis of rounding harmony is similar. The contrastive hierarchy is the same as in (33).[19] As in Oroqen and Oroch, the restriction of rounding harmony to the [+low] vowels is consistent with a feature hierarchy that results in contrastive specification for [round] only in those vowels.

14.4.2 Modern Manchu: Diachrony and contrastive feature hierarchies

The modern Manchu languages, Spoken Manchu and Xibe, are notable exceptions to the prevailing Manchu-Tungusic pattern in which only low vowels participate in rounding harmony. These languages also illustrate the interaction between feature hierarchies and language change.

The vowel system of Xibe is given in (35):

[19] This hierarchy is based on Zhang (1996), with the reordering of [ATR] and [labial] (= [round]) proposed by Ko (2018). Ko also argues that [ATR] should be replaced by [RTR]; the distinction between [ATR] and [RTR] does not affect our discussion.

(35) Xibe vowel system (Zhang 1996)

/i/	/y/	/ə/	/u/
/ɛ/	/œ/	/a/	/ɔ/

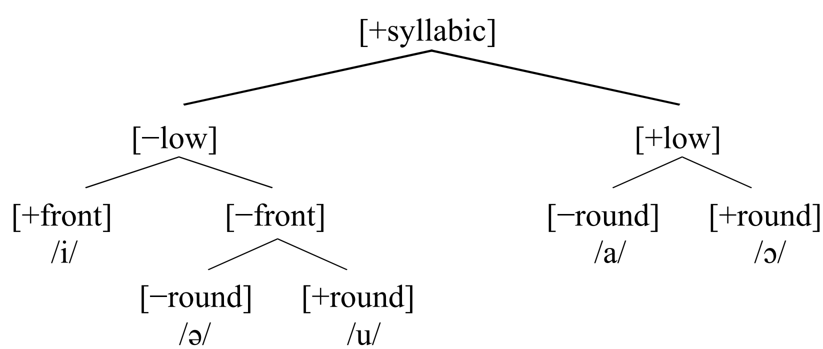
Following up on Zhang (1996), Dresher and Zhang (2005) propose a scenario for how the vowel system of Classical Manchu (or a closely related language) evolved into the Xibe system in (35). This evolution, whose main steps are summarized in (36), provides an illustration of the sort of trade-offs that are characteristic of a contrastive hierarchy approach to feature specification, and of how a change in a contrast in one part of a system can have repercussions for other parts.

(36) From Classical Manchu to Xibe (Dresher and Zhang 2005)

a. In Classical Manchu, the vowel /ʊ/ was neutralized to [u] in most contexts. At some point it was lost altogether and merged with /u/.
b. Once the /u/ ~ /ʊ/ contrast was lost, the sole remaining function of [ATR] was to distinguish between /ə/ and /a/. But this contrast could be reinterpreted in terms of height, causing [ATR], along with [ATR] harmony, to be lost.
c. The reinterpretation of /ə/ as a [−low] vowel, and its actual phonetic realization as a high vowel, in turn necessitated a new contrast between /ə/ and /u/; the feature [round], already in the system, was extended to the [−low] domain.

As a result of the changes in (36), the Classical Manchu feature hierarchy in (33) would look like (37).

(37) Result of the changes in (36): [low] >> [front] >> [round]



A consequence of /u/ acquiring a [+round] feature is that it participates in vowel harmony, whereby suffixal /ə/ (38a, c) alternates with /u/ (38b, d, e) when following a round stem-final vowel. The forms in (38) compare Xibe forms with their Classical Manchu cognates.

(38) Rounding harmony in Xibe (Li and Zhong 1986, cited in Dresher and Zhang 2005)

	Classical Manchu	*Xibe*	*Gloss*
a.	uli-xə	uli-xə	'string-PST'
	ana-χa	anə-χə	'push-PST'
b.	pu-xə	pu-xu	'give-PST'
	pɔtɔ-χɔ	pɔtu-χu	'think-PST'

c. ərtə-kən	ərtə-kən	'early-somewhat'
ampa-qan	am-qən	'big-somewhat'
d. xət'u-kən	xət'u-kun	'stocky-somewhat'
farχʊ-qan	farχu-qun	'dark-somewhat'
e. fɔχɔlɔ-qɔn	fœχulu-qun	'short-somewhat'
ɔsɔχɔ-qɔn	ɔsχɔ-qun	'small-somewhat'

In Classical Manchu rounding harmony creates an alternation between /a/ and /ɔ/. Dresher and Zhang (2005) observe that in Xibe, non-initial vowels tended to be raised—almost always in suffixes, frequently in stem vowels—so an original sequence of the form /a/–/a/ would become /a/–/ə/ or /ə/–/ə/, and a sequence of the form /ɔ/–/ɔ/ would become /ɔ/–/u/ or /u/–/u/. The rounding harmony observed in Xibe is not merely a holdover of Classical Manchu rounding harmony, however, for in Xibe, harmony is triggered not only by /u/ derived from older /ɔ/, but also by original /u/ and /ʊ/, as shown in (38d). The fact that /u/ triggers and results from rounding harmony supports the hypothesis that it has a [+round] specification in Xibe.[20]

Further evidence that /u/ has acquired a contrastive [+round] specification is the development of new phonemes /ɛ/, /œ/, and /y/ in Xibe. Zhang (1996) shows that Xibe and Spoken Manchu /ɛ/ often correspond to Classical Manchu /a/ when followed by /i/; in terms of features, this would follow from the [+front] feature of /i/ spreading to /a/, resulting in a vowel with the features [+low, +front, −round] = [ɛ]. Similarly, /œ/ corresponds to earlier /ɔ/ followed by /i/, creating a new vowel with the features [+low, +front, +round]. Most interesting for our purposes is the new vowel /y/, which Zhang (1996) shows derives from older /u/ followed by /i/. If /u/ were simply [−low, −front] with no [round] specification (as in Classical Manchu), then adding [+front] to /u/ would result in a vowel that is [−low, +front], i.e. [i]. The fact that the new vowel /y/ is round suggests that /u/ has acquired a [+round] feature, so that the first vowel in /u…i/ results in [y], parallel to the first vowel in /ɔ…i/ resulting in [œ].

The new phonemes /œ/ and /y/ also trigger rounding harmony, as shown in (39).

(39) Xibe rounding harmony triggered by /y, œ/ (Li 1986: 202)

a. tyty-xu	'rent-PST'	(*tyty-xə)
b. gœ-χu	'hit (the target) PST	(*gœ-χə)

Because the new vowels are constructed out of the existing contrastive features, the contrastive hierarchy shown in (37) remains unchanged; the new vowels fill in gaps in the tree in (37), as shown in (40).

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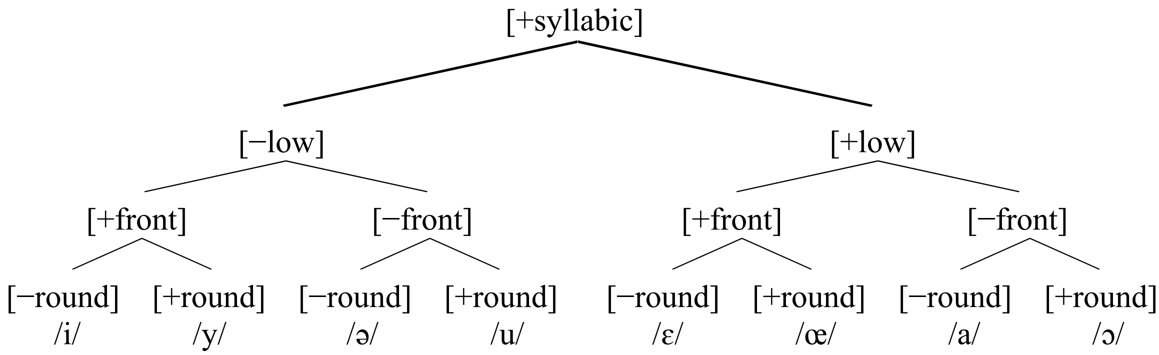
[20] The pervasive raising of non-initial vowels in Xibe accounts for the lack of alternations between /a/ and /ɔ/; in (38a–c), suffixal Classical Manchu /a/ appears as /ə/ in Xibe.

(40) Xibe contrastive hierarchy: [low] >> [front] >> [round]



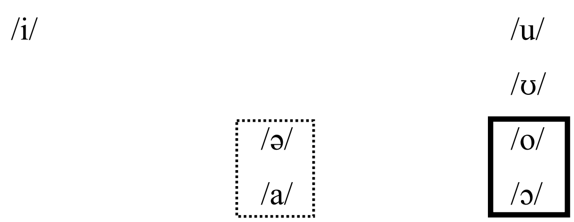
In our analysis, it is hardly a coincidence that the only Tungusic languages that show /u/ with an active [+round] feature are those in which the contrastive status of /u/ has changed so as to require it to have a contrastive [+round] feature.

14.4.3 Mongolic

In section 14.3.2 we showed how Fur and Palor make up a kind of 'minimal pair': two languages with similar inventories and contrastive features, where a change in the ordering of features results in a difference in which segments pattern as harmonic partners. In this section we will show how Tungusic and Mongolic form a 'minimal pair', as first pointed out by van der Hulst and Smith (1988), with respect to which vowels block rounding harmony. Ko (2018) shows that this case, too, can be accounted for by different orderings of contrastive features.

Ko (2018) presents an extensive synchronic and diachronic survey of the Mongolic vowel systems analyzed in terms of Contrastive Hierarchy Theory. Here we will focus on round harmony in Khalkha (Halh), whose vowel system is given in (41).[21] Van der Hulst and Smith (1988) called attention to an interesting difference between Tungusic and Mongolic languages: though they have similar vowel inventories and similar types of rounding harmony, in Tungusic /i/ blocks rounding harmony, as we saw in (29e) and (32c), whereas in Mongolic /i/ is transparent to rounding harmony, as shown in (42c).[22]

(41) Khalkha vowel system (Svantesson 1985; Kaun 1995; Dresher and Zhang 2005)



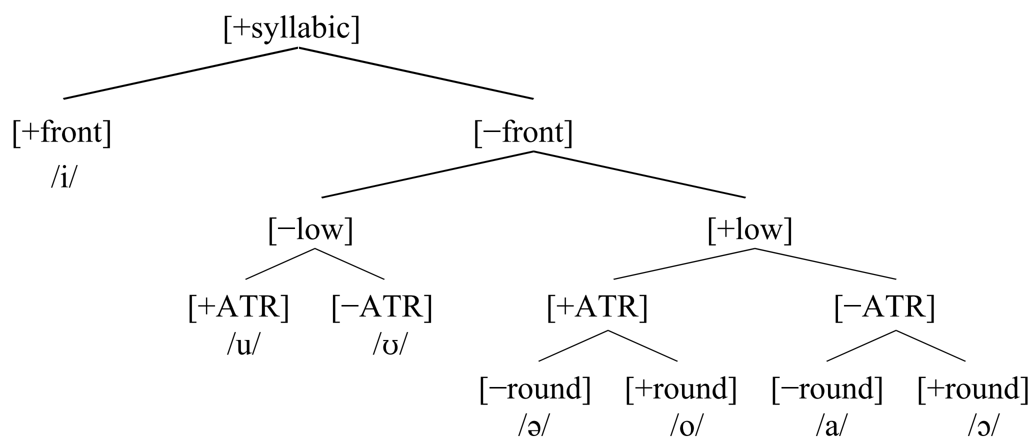
[21] The vowel we represent as /ə/ is given as /e/ by Svantesson (1985); see Dresher and Zhang (2005: 68n19) for discussion.
[22] For a recent account of this difference in terms of Radical CV Phonology, see van der Hulst (2018: 401).

(42) Rounding harmony in Khalkha (Svantesson 1985; Svantesson et al. 2005; Ko 2011)

a. ʊd-aas	‘willow-ABL’	
b. ɔd-ɔɔs	‘star- ABL’	(*-aas)
c. mɔrin-ɔɔs	‘horse- ABL’	(*-aas)

Ko (2013, 2018) proposes that this difference is due to a small variation in feature ordering. He proposes that Mongolic languages like Khalkha use the same features as Tungusic, but with [front] ordered ahead of [low], as in (43).

(43) Khalkha contrastive hierarchy: [front] >> [low] >> [ATR] >> [round]

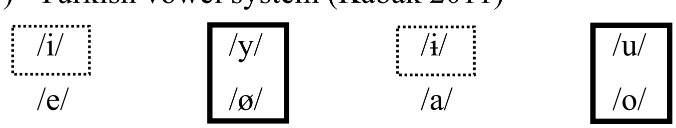


Because [front] is ordered highest, Khalkha /i/ has no height specification. Therefore, it does not block rounding harmony, which is only blocked by a [−low] feature. Khalkha /u, ʊ/, which have a height feature [−low], block rounding harmony just as /u, ʊ/ and /i/ do in Tungusic.

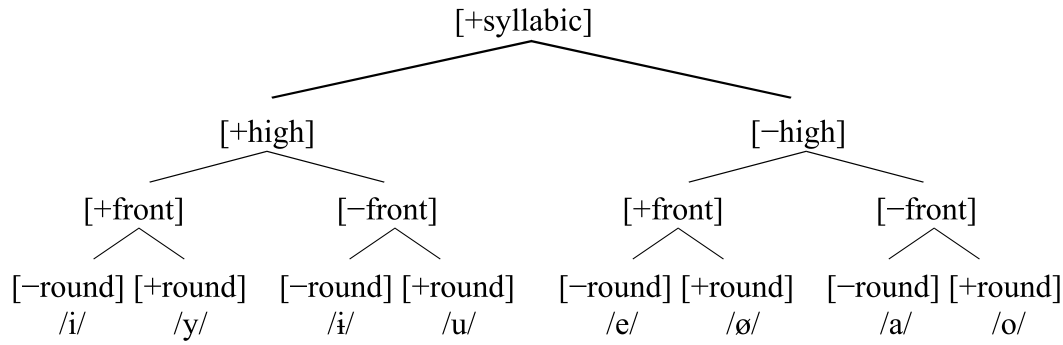
14.4.4 Turkic

In Turkic vowel systems, the feature [round] tends to be contrastive in all the vowels; consequently, rounding harmony in Turkic exhibits different patterns than those observed in Tungusic and Mongolic. An example of a Turkic vowel system is Turkish, shown in (44). As presented in (44), the vowel system looks symmetrical. Like other Turkic languages, Turkish is typically analyzed with three features: one height feature (usually [high]) and two place features ([front] and [round], or their equivalents); see Kabak (2011) for Turkish. As in Xibe, the symmetrical layout ensures that all three features are contrastive on each vowel. A possible ordering of the features of Turkish is given in (45); however, the same contrastive specifications would result from any ordering of these three features.

(44) Turkish vowel system (Kabak 2011)



(45) Turkish contrastive hierarchy: [high] >> [front] >> [round]



It should be noted that the symmetrical representation with three features is not dictated by the phonetics: phonetically, we could use [low] to distinguish the height of /a/ from the other [−high] vowels. However, a system with more than two heights would not give a satisfactory account of the patterning of Turkish vowels. That is, the restriction of Turkic vowel systems to a single height feature is itself a tacit acknowledgment of a contrastive feature hierarchy, in which [high], [front], and [round] are at the top, and no other features are required.

With respect to rounding harmony we predict, therefore, that all round vowels could potentially be triggers of rounding harmony in such languages. In Turkish, all round vowels are indeed triggers of rounding harmony, but only high vowels are targets. This latter restriction is not due to contrast, but to other factors. Other factors could also restrict the triggers of harmony. In Kachin Khakass (Korn 1969), with the same inventory and features as Turkish, both triggers and targets of labial harmony must be [+high], as shown in (46).

(46) Kachin Khakass vowel system (Korn 1969)

/i/	/y/	/ɨ/	/u/
/e/	/ø/	/a/	/o/

14.5 Conclusion

This chapter has examined the relationship between vowel harmony and contrastive feature specifications. Based on typological work on [ATR] harmony systems, we have argued that cross-linguistic variation in harmony patterning supports the Contrastivist Hypothesis, which proposes that only contrastive feature values are phonologically active. Examination of harmony in Fur and Palor has shown that differences in feature hierarchies can account for differences in harmonic partners found across languages, even in languages with similar phonemic inventories. Our survey of rounding harmony in Northeast Asian languages has further illustrated the role of contrastive feature orderings in accounting for variation in harmony patterning across languages. Here, too, we see cases where languages with similar inventories have distinct harmony patterns resulting from differences in feature ordering. Diachronic changes in rounding harmony show that changes in one part of a phonemic inventory may have consequences for the overall system of contrasts, with concomitant changes in the status of harmony triggers and targets.

By examining a range of vowel harmony systems, we have shown that Contrastive Hierarchy Theory, in conjunction with the Contrastivist Hypothesis, accounts for relationships between phonological activity, inventory shape, and phonological relations in vowel harmony processes, including relations between alternating harmonic partners and relations between harmonic targets, triggers, and blockers. The illustrated variation between languages shows that an understanding of these relationships requires reference to language-specific feature hierarchies. Such relationships are not evident from the surface inventory alone or from any notion of contrast, such as Minimal Difference, which follows from the surface inventory in a deterministic fashion.

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