Unconditional neutrality: Vowel harmony in a two-place model *

Alex D'Arcy  
_University of Toronto_

*Thank you to my committee, Keren Rice, Elan Dresher, and Peter Avery, for generously giving so much of their time and for asking all the hard questions. I cannot thank Keren enough for supervising this work and providing guidance, suggestions, and support through its many incarnations. I also thank audience members at the 2003 Montreal-Ottawa-Toronto Phonology Workshop, as well as Chiara Frigeni, Daniel Currie Hall, Milan Rezac, and the members of the Research Group on Contrast and Complexity in Phonology at the University of Toronto for their insightful comments on past versions of this work.

*When embedded within contrastive specification, a two-place model of vowel features has far-reaching consequences for the description of harmonic phenomena, as well as for the roles of segments within harmonic systems. These consequences are explored here, and it is argued that cross-linguistic evidence supports the predictions of this approach. Crucially, the analysis reveals that neutrality in place harmony can be made to fall out of the structure and configuration of inventories.*

0 Introduction

This paper is concerned with the phonological description of place harmony among vowels. The basic premise is that the harmonic behaviour of individual segments is crucially dependent on the structure of the vowel system of which they are a part. Specifically, harmonic behaviour is constrained by underlying representations. This approach to vowel harmony is not unique (e.g., van der Hulst & Smith 1988; Kiparsky & Pajusalu 2002; Li 1996), nor is it uncontroversial (e.g., Cole & Kisseberth 1994). However, this paper seeks to contribute to our understanding of harmonic phenomena by systematically examining the predictions of such an approach when it is framed within a two-feature model of vowel place.

During the past two and a half decades in particular, North American feature-driven models since Sagey (1986) and Clements (1991) have generally assumed the need for three vowel place features: one to mark palatality, one to mark labiality, and one to mark velarity. Extensive cross-linguistic evidence indicates, however, that only two places are ever active in the phonology (Rice 1995, 2002; see also Ewen & van der Hulst 1988; Harris & Lindsey 1995; van der Hulst 1989; Schane 1984). Consequently, Rice (1995, 2002) proposes that while Labial and Dorsal are salient phonetic features, they can be subsumed in the phonology by a single feature which she calls Peripheral, equivalent to the Jakobson, Fant, and Halle (1969) feature [+grave]. Palatality, meanwhile, can continue to be marked by the feature Coronal, as proposed, for instance, by Clements (1991). This model is adopted here.

I argue that Coronal and Peripheral are sufficient to account for cross-linguistic harmony patterns, and that a model incorporating just these place features for vowels makes correct predictions about the types of place harmony phenomena found in natural languages. The proposed analysis captures the generalization of why certain types of place harmony occur in
certain systems, and provides a structural account of the types of segments found in these systems (e.g., trigger, target, neutral). This analysis also has implications for our understanding of neutral vowels, since it is argued that their behaviour falls out of the structure and configuration of inventories.

The paper is organized as follows. The first section provides an overview of the theoretical foundations that underlie my analysis. I then discuss the predictions regarding harmonic phenomena these assumptions entail in §2. In §3, I present a cross-linguistic examination of systems in which place harmony is attested, and argue that the predictions discussed in the preceding section are borne out by the facts. Finally, in §4 I present a brief conclusion.

1 Theoretical Foundations

This section sets the stage for the proposed analysis of vowel harmony, outlining the theoretical assumptions on which it is based. As most broadly understood, vowel harmony refers to any process in which a vowel takes on a feature from some other vowel. Harmony is used here in this epiphenomenal sense, referring to any situation in which feature [x] targets some segment, so that both trigger and target share property [x]. The approach is autosegmental; harmony is formally equated with the operation of spreading.

1.1 A Two-Place Model

Labial (marking labiality), Coronal (marking palatality), and Dorsal (marking velarity) have been argued to be phonological primitives in the description of vowel place (e.g., Clements 1991; Clements & Hume 1995; Sagey 1986; Steriade 1995). However, alternative approaches employing two features rather than three are available (e.g., Harris & Lindsey 1995; Kaye, Lowenstamm, & Vergnaud 1985, 1990; Rice 1995, 2002; Schane 1984). The model adopted here is that of Rice (1995, 2002), in which Coronal marks palatality and Peripheral is posited to mark non-centrality (i.e., the articulatory peripheries of the oral cavity). In this model, Labial and Dorsal are not phonological features for vowels. Instead, they are restricted to the phonetic module, where they may serve to enhance the perceptual saliency of an underlying contrast. Thus, the phonological structure of place features is that in (1).

(1) The phonological structure of vowel place features

\[
\begin{array}{c}
V-\text{Place} \\
\text{Coronal} \\
\text{Peripheral}
\end{array}
\]

This approach captures several important generalizations. First, no language appears to have more than four phonological place contrasts at any given height. In a two-place model, this is the maximum number of possible contrasts, as shown in (2). Taking the features of Clements and Hume (1995) as a point of comparison, three-place models – even after stipulating a co-

---

1 What follows is a brief overview of Rice 1995, 2002. The reader is referred to these articles for detailed empirical and descriptive argumentation in favour of this model of vowel place features.
occurrence restriction on the features Coronal and Dorsal – overgenerate the number of possible phonological contrasts to six. These are outlined in (3).

(2) Phonological specifications in a two-place model

<table>
<thead>
<tr>
<th>Coronal</th>
<th>Coronal/Peripheral</th>
<th>Peripheral</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>y</td>
<td>i</td>
</tr>
<tr>
<td>/7011</td>
<td>/7027</td>
<td>/1117</td>
</tr>
<tr>
<td>u</td>
<td></td>
<td>u</td>
</tr>
</tbody>
</table>

(3) Phonological specifications in a three-place model

<table>
<thead>
<tr>
<th>Coronal</th>
<th>Coronal/Labial</th>
<th>Labial</th>
<th>Dorsal</th>
<th>Labial/Dorsal</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>y</td>
<td>i</td>
<td>u</td>
<td>u</td>
</tr>
</tbody>
</table>

Second, only the front vowels admit a phonological opposition for labiality at a given height; the central and back vowels do not. That is, no language contrasts /i/ and /u/ or /ui/ and /ui/ underlyingly. A three-place model allows for this possibility. A two-place model does not.

A third generalization captured by a two-place model is the tendency of Labial and Dorsal to pattern together, with one frequently predictable from the other. Models relying on three places of articulation often depend on stipulative mechanisms such as dependency relations (e.g., Mester 1986) or redundancy rules (e.g., Archangeli 1984) in order to capture this relationship. A two-place model elegantly handles the facts of languages in which Dorsal and Labial are interdependent, since they cannot be phonologically distinguished. Consequently, however, arguments for distinct dorsal and labial processes within a single language (e.g., Turkish) are potentially problematic. Yet, as will be seen in §3 below, the current model readily accounts for the harmonic facts in such languages.

1.2 Contrastive Specification

The main thrust of this analysis originates in the assumption that phonological processes are constrained by segmental representations, which are themselves assumed to be dependent on the structure of the inventory to which they belong. Thus, if a language has a rule of 'spread [x]', the choice of [x] is bound by the feature configuration of the inventory of that language (Frigeni, in press). Moreover, I assume that phonology is rooted in contrast, so that predictable or redundant information is barred from appearing in lexical representations. Consequently, featural minimality is taken to be a requisite of phonological specifications, with features entering representations strictly to mark contrasts in the system. This results in abstract representations, because phonetic detail is excluded. The implications to this approach are extremely interesting, since what is contrastive in one system may not be in another. Two 'similar' segments may behave differently either phonetically or phonologically based on the system of which they are a part. Indeed, it will be argued below that inventories identical on the surface may in fact derive from distinct underlying structures, and therefore exhibit disparate phonological processes.

In accordance with these theoretical assumptions, I adopt an inventory-driven approach to feature specification. The model upon which I base my analysis is Modified Contrastive Specification (MCS), first outlined in Avery and Rice 1989 (see also Dyck 1995; Frigeni in
A keystone of MCS is featural monotonicity, with privative features entering representations one at a time to mark contrasts in the system. In the arguments that follow, I assume that place contrasts are established within height domains rather than across them as this makes the correct predictions about feature specifications in asymmetric systems and about place harmony phenomena in general (cf. Jakobson & Halle 1956). Nonetheless, I do not rule out that place may take scope over height (e.g., Ghini 2001).

MCS has typically entailed a markedness scale along which feature specification progresses monotonically. I make no a priori assumptions about markedness in the languages discussed here. Rather, I appeal to the notion that the inventory is the phonological primitive and argue that feature specification is better considered implicational rather than universal. That is, the invocation of a feature such as Coronal or Peripheral is not based on a fixed relationship between the two, but rather results from the structure of the inventory in question. Despite abstracting away from markedness considerations, the analysis of place harmony presented below raises important questions about what markedness entails, and so this topic is touched upon in §4.

I concern myself here strictly with the specification of Coronal and Peripheral. Following Rice (2002) (also Cho & Iverson 1997, Clements & Hume 1995, and Pham 1998), I use the terms CENTRAL and UNSPECIFIED interchangeably to refer to any vowel not phonologically marked for place. In the spirit of Steriade, I treat all phonologically central vowels (i.e., i, ə, a, etc.) as "permanently unspecified" (1995:117). According to the principle of minimality, a single segment within a height domain will be unspecified for place, as there is no opposition to be marked. If two segments are present, either Peripheral will be invoked to mark a phonological central/back opposition, or Coronal will be invoked to mark a front/central opposition.

The presence of a third vowel can have one of two configurational results. If the third vowel is a front rounded vowel, I assume, following van der Hulst (1989), Harris & Lindsey (1995), Ghini (2001), Rice (2002) and others, that it will be marked with both Coronal and Peripheral. Only one other vowel need be specified, either as Coronal (4a) or Peripheral (4b), in order to contrast the three segments. If the third vowel is not a front rounded vowel (i.e., if it is non-peripheral), then one vowel will be marked as Coronal, one as Peripheral, and one will be placeless (5). Finally, in a system with four place contrasts at a given height, then only the configuration given in (2) is possible.

(4) Feature specifications in a three-place system with a front rounded vowel

<table>
<thead>
<tr>
<th>a. i y u</th>
<th>b. i y u</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>C</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>P</td>
</tr>
</tbody>
</table>
Feature specifications in a three-place system without a front rounded vowel

\[
\begin{array}{ccc}
\text{i} & \text{i} & \text{u} \\
\text{C} & \text{P}
\end{array}
\]

This implicational approach makes a strong claim about feature specifications. Specifically, whether or not a feature is present is dependent on the makeup of the inventory as viewed through the selected contrasts. Because I assume phonological processes are constrained by underlying segmental representations, this approach has implications for the description of place harmony phenomena. I explore these next.

2 Predictions

A two-place model of vowel features, particularly when considered in conjunction with a representational theory such as MCS, makes some robust predictions regarding the harmonic phenomena languages may display. These extend to typological issues, the types of segments we may expect to find in vowel harmony systems, as well as to behaviour such as transparency and opacity. In this section, I discuss these issues.

2.1 On the Typology of Place Harmony

Assuming privativity, a three-feature model of vowel place predicts three types of place harmony: coronal, dorsal, and labial. Each is well-attested, though coronal and dorsal harmony are usually subsumed under the rubric of palatal harmony, a cover-term for any kind of backness harmony.

A two-feature model, on the other hand, admits just two types of place harmony. These are coronal harmony and peripheral harmony. Distinct labial and dorsal processes are ruled out. Under this model then, labial harmony is reanalyzed as peripheral harmony, while coronal and dorsal harmony are merged as coronal harmony. This last point draws on the intuition that coronal and dorsal harmony are instantiations of a single phenomenon, mitigating the critique of Halle, Vaux, and Wolfe (2000) against considering them distinct processes. As the analyses in §3 demonstrate, a typology that permits only coronal harmony and peripheral harmony is empirically supported by data from diverse language families.

2.2 On Triggers and Targets

Implicit to the discussion in §2.1 above is the notion that if feature [x] is specified, harmony of type [x] may be manifested. Recall that in the current approach, feature specification depends not just on the number of contrasts present at a given height, but on their configuration as well. Consequently, it stands to reason that the role of individual segments depends on the system of which they are a part, since any vowel that is specified for [x] may function as a trigger, but one that is not, may not.

With two important caveats, a target is potentially any segment not specified for the harmonic feature. First, I assume spreading to be feature-building and not feature-changing;
spreading cannot trigger delinking (Kiparsky 1982, 1985; also Avery & Rice 1989; Lindblad 1990; Piggott 1992; Steriade 1987). Second, I assume spreading to be structure preserving, so that only lexically contrastive vowels may participate and no new vowels may be introduced (Kiparsky 1982, 1985; Kiparsky & Pajusalu 2002). In short, underlying contrasts must be preserved. If spreading is non-structure preserving, harmony is blocked.

**TABLE 1. Predictions of contrastive specification and a two-feature model of vowel place**

<table>
<thead>
<tr>
<th>Type</th>
<th>Configuration</th>
<th>Possible Harmony</th>
<th>Types</th>
<th>Trigger</th>
<th>Target</th>
<th>Transparent</th>
<th>Opaque</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>i</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>II</td>
<td>a) i</td>
<td>u</td>
<td>Peripheral</td>
<td>u</td>
<td>i</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) i</td>
<td>u</td>
<td>Coronal</td>
<td>i</td>
<td>u</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>a) i</td>
<td>i,u</td>
<td>Coronal</td>
<td>i</td>
<td>i,u</td>
<td>i</td>
<td>u</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Peripheral</td>
<td>y</td>
<td>i,u</td>
<td>u</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>Both</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) i</td>
<td>y,u</td>
<td>Coronal</td>
<td>y,u</td>
<td>i</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Peripheral</td>
<td>y,u</td>
<td>i</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>Both</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) i</td>
<td>y,u</td>
<td>Coronal</td>
<td>y,u</td>
<td>i</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Peripheral</td>
<td>y,u</td>
<td>i</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>Both</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>i</td>
<td>y,u</td>
<td>Coronal</td>
<td>i,y</td>
<td>i,u</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Peripheral</td>
<td>y,u</td>
<td>i</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>Both</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 summarizes the predictions of the current approach to place harmony. The system type is determined by the number of contrastive places at a given height, and the configurations fall out of the implicational approach to contrastive feature specification discussed in §1.2 above. The first five columns summarize the link between contrastive specification and the type of harmony that a system may exhibit, as well as the role of individual segments as targets or triggers, while the final two columns indicate the places of articulation that are predicted to exhibit neutrality in place harmony within each system. Note the use of symbols. The symbol /i/ represents a vowel without any phonological place features; it may surface in other ways. In type II languages, the vowels I show as /i/ and /u/ might be better written as /i/’. I choose /i/ and

---

4 See the appendix for a summary of languages with each configuration and harmony type.
/u/ here because this is how these segments are typically treated in the literature. Type III vowels surface with the features that are specified on them.

2.3 On Transparency and Opacity

In the previous section, it was argued that the structure of individual systems constrains the status of the segments within them. In this sense, potential triggers and targets are entirely predictable from the configuration of the inventory of which they are a part. Neutrality, I argue, is also predictable.

First, we must be clear on what constitutes neutrality. Traditionally, a neutral vowel is one that does not alternate. This failure to visibly undergo harmony is often attributed to the observation that neutral vowels lack a harmonic counterpart (e.g., van der Hulst & Smith 1986; van der Hulst & van de Weijer 1995). For this to be the case, there must be an odd number of vowels at the same phonological height as the segment in question because this is the only configuration in which a vowel may be unpaired. Since no theory predicts one-place systems to exhibit place harmony, we may rule these out. The only systems expected to exhibit neutrality, therefore, are those contrasting three places of articulation.

There are two types of neutrality: opacity and transparency. Traditionally, opaque segments interrupt harmony, failing to propagate the harmonic feature to adjacent vowels. In the current approach, opacity is derived solely by the structure-preserving condition on targets. As discussed in §2.2, if targeting a certain vowel will derive a new segment, then spreading is blocked. I refer to this manifestation of opacity as CONTRASTIVE OPACITY, since opacity in this case is driven by the underlying contrasts of the system. In (6a,b), for example, no contrastive opacity is manifested. Spreading is structure preserving, deriving in both cases segments belonging to the phonemic inventory. In (6c) (corresponding to type IIIa in Table 1), on the other hand, spreading is non-structure preserving, since there is no segment specified as both Coronal and Peripheral underlyingly. Here harmony is blocked for contrastive (i.e., structure preserving) reasons, deriving contrastive opacity.

(6) Peripheral harmony and contrastive opacity

a. X Y b. X YZ c. * X YZ

P C P C

no contrastive opacity no contrastive opacity contrastive opacity

---

5 In some cases, a segment that has a harmonic counterpart may also fail to alternate. These segments are sometimes referred to as pseudo-neutral (van der Hulst & Smith 1986). When a paired vowel fails to alternate in affixes, I consider this evidence that this vowel is underlyingly specified for place. In some cases, this feature will be the harmonic feature (e.g., Yowlumne); in others, it will not be the harmonic feature but harmony will be blocked for structure preserving reasons (e.g., Nyangumarda). See below for discussion.

6 It has been argued that opaque segments may initiate their own harmonic domain, spreading their lexical value to adjacent segments (e.g., Clements & Sezer 1982).

7 In this approach, contrastive opacity is distinguished from more general manifestations of opacity in which harmony is blocked across certain domains such as height classes (e.g., Turkish, in which the target of peripheral harmony must be high).
Transparent segments are traditionally those that appear to be skipped by harmony, with vowels on either side agreeing for the harmonic feature. A common assumption regarding transparent vowels is that they are lexically specified for the harmonic feature, and so cannot alternate (e.g., van der Hulst & Smith 1986; Välimaa-Blum 1999; Vaux 2001). Since transparency is accounted for in a novel way here, I set the issue aside until §3.4, where I illustrate the analysis with data.

Other things being equal, some type of neutral behaviour is predicted in inventories with three contrastive places. Which kind is exhibited, be it opacity or transparency, is dependent on the configuration. For example, both (6b) and (6c) contrast three places of articulation. Only the latter, however, is predicted to exhibit contrastive opacity. In this sense, the number of contrasts is secondary to the way the inventory is configured because the actual manifestation of neutrality falls out of the segmental configuration.

3 A New Perspective

To this point, I have argued for a new perspective on place harmony among vowels. Specifically, I have claimed, based on Rice's (1995, 2002) two-feature model, that only two kinds of place harmony are extant in natural language. Further, I have posited that the behaviour of individual segments as trigger, target, or neutral is predictable based on the configuration of the system to which they belong.

I turn now to the examination of cross-linguistic data as support for the proposed analysis of place harmony. I focus largely on the Altaic and Uralic families. Although place harmony is not restricted to these families, much theoretical work in this vein has focussed on them (e.g., Clements 1977; Clements & Sezer 1982; Demirdache 1988; Goldsmith 1985; van der Hulst 1985; Kaun 1995; Kiparsky & Pajusalu 2002; Korn 1969; Polgárdi & Rebrus 1998; Ringen 1978; Vago 1975 et seq.; Vaux 2001; etc.). However, in order to establish the broader context of the generalizations captured by the current approach, languages from other families are discussed as well.8

The discussion proceeds as follows. I first present languages contrasting two places of articulation (§3.1). I then examine languages contrasting three places of articulation (§3.2), setting aside for the time being type IIIc languages. Turning next to four contrastive places, I show that although harmony has traditionally been accounted for in these languages by appealing to distinct dorsal and labial processes, a solution that is not available here, the current model straightforwardly captures the facts (§3.3). It is languages with a type IIIc configuration that present some interesting challenges to the analysis of place harmony developed here. These languages exhibit transparency in place harmony. I discuss them last (§3.4).

I abstract away from both aperture and tongue root features, as these are secondary to my point. Furthermore, I focus on harmonic alternations in affixes, rather than root-internal processes. I simply assume feature specifications to be lexically present within roots.

3.1 Two Contrastive Places

---

8 There are a number of languages with a single place of articulation. As expected, these systems do not exhibit place harmony, and accordingly, are not discussed here.
In this section, I present evidence from languages contrasting two places of articulation. Two of the systems to be discussed are symmetrical in that the feature configurations are the same in all height domains (Yowlumne §3.1.1.1 and Chamorro §3.1.2). One system is asymmetrical: the place specifications in the low domain are different from those in the non-low domain (Classical Manchu §3.1.1.2). This type of configurational asymmetry is predicted by the theoretical model adopted here. Once aperture features are given hierarchical scope over other vocalic features, it is possible that place features should enter representations differently in one domain than they do in another. Throughout the coming discussion, this type of asymmetry will be argued to be responsible for the asymmetric patterning of certain segments in harmony processes. By way of introduction, however, I first present a symmetric inventory.

3.1.1 Peripheral Harmony in Two-Place Systems

3.1.1.1 Yowlumne

Yowlumne (formerly Yawelmani) is a dialect of Yokuts, a language of California belonging to the Penutian family (Dixon & Kroeker 1919). I focus on this dialect – as described in Newman 1944 – because it has been the topic of considerable linguistic research (e.g., Archangeli 1984, 1991; Archangeli & Suzuki 1997; Cole & Kisseberth 1995; Kuroda 1967; McCarthy 1996; Zoll 1996). Moreover, Yowlumne's harmony process is largely representative of that of the language more generally.

The underlying vocalic inventory is composed of four segments, /i,a,o,u/, each of which has a long counterpart. These are traditionally divided into two height classes based on the facts of vowel harmony, which is considered to spread labiality (and redundantly, dorsality) rightward within a harmonic set (Archangeli 1984, 1991; Kuroda 1967; Newman 1944). In sum, /i/ becomes [u] after /u/, and /a/ becomes [o] after /o/. Under the current model, this type of harmony can only be analyzed as peripheral since the back vowels appear to be triggering alternations in the front ones, suggesting the configuration in (7) in which the underlying place opposition is Peripheral. Note that I omit height and tongue root features when representing place configurations. In these drawings, vertical lines denote place contrasts, of which there will be minimally two and maximally four. Solid horizontal lines are to be understood as marking height domains, while dotted ones mark tongue root oppositions.

---

9 This treatment assumes that a single mechanism is responsible for the spread of peripherality within the harmonic sets. See Hansson 1999 for a different perspective based on the synchronic facts.

10 The symmetrical configuration in (7) is based on the assumption that Lowering, which lowers /ii/ to [ee] and /uu/ to [oo], is post-lexical, a position that is forced in a contrastive framework (see D'Arcy, in press).
(7) Underlying place configurations of Yowlumne vowels

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>u</th>
<th>Peripheral</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>a</td>
<td>o</td>
<td>Peripheral</td>
</tr>
</tbody>
</table>

The data in (8), from Archangeli 1984, demonstrate the operation of place harmony in Yowlumne.

(8) a. /i ~ u/ alternations

<table>
<thead>
<tr>
<th>Root</th>
<th>Alternation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>hiwiit + hin</td>
<td>[hiwethin]</td>
<td>'walk'</td>
</tr>
<tr>
<td>p'axaat' + hin</td>
<td>[p'axat'hin]</td>
<td>'mourns'</td>
</tr>
<tr>
<td>?opoot + hin</td>
<td>[?opothin]</td>
<td>'arises from bed'</td>
</tr>
<tr>
<td>duj + dij + hin</td>
<td>[dujdj unh]</td>
<td>'stung (repetitive)'</td>
</tr>
</tbody>
</table>

b. /a ~ o/ alternations

<table>
<thead>
<tr>
<th>Root</th>
<th>Alternation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>hiwiit + al</td>
<td>[hiweetal]</td>
<td>'might walk'</td>
</tr>
<tr>
<td>p'axaat' + al</td>
<td>[p'axaat'al]</td>
<td>'might mourn'</td>
</tr>
<tr>
<td>suug + al</td>
<td>[soogal]</td>
<td>'might pull out'</td>
</tr>
<tr>
<td>?opoot + al</td>
<td>[?opootol]</td>
<td>'might arise from bed'</td>
</tr>
</tbody>
</table>

As predicted for systems with two contrastive places, no vowels are transparent, nor are any contrastively opaque as defined in §2.3 above. However, as illustrated by forms like dujdjh unh | 'stung' (8a) and ?opootol | 'might arise from bed' (8b), harmony is only manifested among vowels of the same phonological height. Additionally, the realization of the suffix vowel as [i] in forms like coomaahin | 'destroy (continuative)' (/cuum + (?aa + hin/), indicates that an intervening low vowel blocks the spread of peripherality. Thus, opacity is manifested in Yowlumne, but since it is dependent on aperture specifications and does not derive from Structure Preservation, it is not contrastive opacity. Rather, the restriction on peripheral harmony to application within height domains is representative of a broader constraint on this process.

The crucial point for now is that Peripheral appears to be the active, and therefore contrastive, place feature in the inventory. Further support for this position comes from three sources. First, as seen in (8), it is only after round root vowels that harmonic alternations are manifested. Second, if the harmonic feature were Coronal, we would not expect forms such as p'islu? | 'mouse' and gaadoo | 'cat' (Archangeli 1984), since harmony would be predicted to front the final vowels. Note also that forms of the shape [u...i] and [o...a] do not surface, unless in the latter case they derive from underlying /u...a/ (cf. [soogal] in (8b) above). Finally, Yowlumne possesses one non-alternating suffix, the durative auxiliary -xoo. As laid out in §2.3 (fn.5), a form that does not alternate is assumed to be underlingly specified for place. Since the durative auxiliary can only be marked as Peripheral, the fact that it does not alternate follows
from the fact that Peripheral is both the contrastive and the harmonic feature. Conversely, all front vowels alternate under the appropriate conditions. When these factors are considered, there is no need to specify Coronal underlyingly in Yowlumne.

3.1.1.2 Classical Manchu

While the contrastive feature is the same in both height domains in Yowlumne, this does not have to be the case, even when the number of place contrasts is the same in both domains. For example, in Classical Manchu (also known as Written or Literary Manchu), Zhang (1996) and Dresher and Zhang (2000) have argued that Peripheral (labial) marks the opposition between the low vowels, while Coronal does so between the non-low vowels. This argument is based on the operation of peripheral harmony, which is only triggered by successive low labial vowels (9a) and never by successive high labial vowels (9b).

\[ \text{(9) Peripheral harmony in Classical Manchu} \]

\[
\begin{align*}
a. & \quad \text{bọcọ + ngga} \rightarrow \text{bọcọnggọ} \quad \text{'coloured'} \\
& \quad \text{fọhọn + kan} \rightarrow \text{fọhọkọn} \quad \text{'somewhat short'}
\end{align*}
\]

\[
\begin{align*}
b. & \quad \text{kumun + ngga} \rightarrow \text{kumunggọ} \quad \text{'noisy'} \\
& \quad \text{họdọn + kan} \rightarrow \text{họdọkan} \quad \text{'somewhat fast'}
\end{align*}
\]

As in Yowlumne, harmony is restricted to application within height domains, applying only among low vowels in this case. Ignoring tongue root features, the underlying vocalic configuration of Classical Manchu is given in (10) below.

\[ \text{(10) Underlying place configurations of vowels of Classical Manchu} \]

\[
\begin{array}{c|c}
\text{i} & \text{u} \\
\hline
\text{Coronal} & \text{u} \\
\text{ } & \text{u} \\
\text{ } & \text{a} \\
\text{ } & \text{a} \\
\text{Peripheral} & \text{a} \\
\end{array}
\]

The harmonic evidence suggests that Peripheral is not contrastive among the non-low vowels, and additional support for (10) comes from secondary articulations. Labialization is not reported before either /u/ or /i/, yet consonants are palatalized before /i/ (Ard 1984; Hayata 1980; Odden 1978). Following Zhang (1996), I assume that because only the high front vowel triggers

---

11 See Zhang and Dresher 1996 for details on the bisyllabic condition on peripheral harmony in Classical Manchu.
12 Due to the height stratification of peripheral harmony, we might expect low vowels to be opaque when the potential triggers are high. No examples of a suffix with /i/ affixed to a form of the shape /u...u/ could be found; however, Zhang (1996) lists all suffixes with /i/ as non-alternating (for both tongue root and labiality). Further, Classical Manchu does have roots of the shape [u...u...i], which would not be expected if peripheral harmony were active among the high vowels (e.g., untuxuri 'vain', muduri-ngga 'regarding dragons').
this effect, /i/ must be uniquely specified for some place feature. It is reasonable to posit that this feature is Coronal and that spreading is responsible for the palatalization of preceding consonants.

In sum, both vocalic height domains contrast two places, but the feature marking this opposition is not constant across both domains. This pattern will be seen in many of the languages discussed below, though in the majority of cases, configurational differences are due to differences in the number of contrasts at each height. As in Classical Manchu, however, it will be argued that these configurational differences within inventories are responsible for asymmetries in harmonic phenomena.

3.1.2 Coronal Harmony in Two-Place Systems Among many languages contrasting two places of articulation, Coronal marks the opposition rather than Peripheral. For now, I restrict the discussion to Chamorro, an Austronesian language of the Philippines.\(^{13}\)

(11) Fronting in Chamorro (data from Topping 1968 and Klein 2002)

a. /i/ in prefix: harmony\(^{14}\)

\[
\begin{align*}
\text{risibi} & > \ [r-\text{-isinib}] \ 'to \ receive, \ goal \ focus' \ & \text{cf.} \ [r-\text{-um-sibi}] \ (\text{singular}) \\
\text{tujo} & > \ [t-\text{-injo}] \ 'to \ know' \ & \text{cf.} \ [t-\text{-um-tujo}] \\
?\text{espiha} & > \ [?-\text{-in-espiha}] \ 'to \ seek' \ & \text{cf.} \ [?-\text{-um-espiha}] \\
\text{konne} & > \ [k-\text{-in-enne}] \ 'to \ take' \ & \text{cf.} \ [k-\text{-um-onne}] \\
?\text{æjek} & > \ [?-\text{-in-æjek}] \ 'to \ choose' \ & \text{cf.} \ [?-\text{-um-æjek}] \\
\text{haga?} & > \ [\text{mi-hægæ}] \ 'lots \ of \ blood'
\end{align*}
\]

b. /e,æ/ in prefix: harmony

\[
\begin{align*}
\text{en # tujo} & > \ [\text{en tjo}] \ 'you (pl) \ know' \\
\text{sæn + hulo} & > \ [sænhilo] \ 'in \ the \ direction \ up' \\
\text{sæn + lagu} & > \ [sænlægu] \ 'towards \ north'
\end{align*}
\]

Chamorro has six vowel phonemes, /i,u,e,o,æ,a/ (Seiden 1960; Topping 1968), which divide equally into three height domains (high, mid, low) and two places (front, back). As the data in (11) demonstrate, initial root vowels are fronted when immediately preceded by a front vowel. In fact, front vowels trigger harmonic alternations in all non-front vowels, suggesting the symmetrical configuration in (12) below.

\(^{13}\) Because the target of fronting in Chamorro is localized to the first syllable of the root, this process is generally classified as umlaut rather than as harmony. Although metrical structure interacts crucially with umlaut in Chamorro, I abstract away from that here and focus on the mechanism of assimilation.

\(^{14}\) The majority of available data on Chamorro does not systematically differentiate between the low vowels /a/ and /æ/ unless they are under primary stress. This has resulted in a bias toward the non-low vowels in discussions of umlaut (see Klein 2000 for discussion).
(12) Underlying place configurations of Chamorro vowels

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td></td>
<td>u</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td></td>
<td>o</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>æ</td>
<td></td>
<td>a</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Back vowels do not trigger any place assimilatory processes (11a), supporting the hypothesis that they lack a place feature underlyingly. Past analyses of Chamorro have had to explain why /u/ and /o/ lose their value for labiality when umlauted (e.g., Klein 2000). Given (12), this is a non-issue. Since the back vowels are unspecified for place, they have nothing to lose when they undergo fronting. Rather, the phonological alternations are straightforwardly captured here through the spreading of Coronal to any bare place node.

3.2 Three Contrastive Places

The foci of this section are systems contrasting three vocalic places, but only one of the three possible configurations outlined in Table 1 is discussed (these are repeated in (13) below). This is configuration IIIa (13a). Because some particularly interesting issues are raised by systems with configuration IIIc (13c), I set these aside for now and return to them in §3.4. Configuration IIIb (13b) is unattested.

(13) Possible three-place configurations

<table>
<thead>
<tr>
<th>a</th>
<th>i</th>
<th>i</th>
<th>u</th>
<th>b</th>
<th>i</th>
<th>y</th>
<th>u</th>
<th>c</th>
<th>i</th>
<th>y</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.2.1 Peripheral Harmony in Three-Place Systems

3.2.1.1 Oroqen  Oroqen, a Tungusic language, displays similar constraints on the application of harmony as does Classical Manchu. Unlike Classical Manchu, however, the low vowels contrast three, not two, places of articulation. This predicts that harmony will pattern differently in Oroqen than in Classical Manchu, a prediction that holds.

As is typical of Manchu-Tungusic languages, peripheral harmony in Oroqen is restricted to the low domain (Zhang 1996:185). As in Classical Manchu, the bisyllabic condition applies, so that harmony is only triggered by subsequent low labial vowels; the targets are low central /a,a/ (14b). High vowels do not participate in harmony, neither triggering it (14a), nor targeted by it (14c). Note that Oroqen also has tongue root harmony, in this case triggered by RTR, which leads to the realization of /ø/ as [a] in RTR contexts (Zhang 1996).
Peripheral harmony is derived when the place specifications on /o,ɔ/ spread to the low central vowels. However, the coronal specification on the low front vowels blocks them from participating, as the inventory does not contrast front rounded vowels. Consequently, /ee,ɛə/ are

15 The only suffixes that alternate for labiality (plus their RTR counterparts) are those comprised uniquely of low non-front vowels (e.g., -səl/sol (present); -jo/jo (indirect object); cf. -dulək/*dulook (place of origin)).
predicted to be contrastively opaque to peripheral harmony, which is exactly what we find in the plural form of 'grandson' [əməleursə] in (14c) above. These vowels also fail to alternate for peripherality when they occur in suffixes (e.g., -lbeen/-lbeen, denoting lesser degree, participates only in RTR harmony (Hu 1986)).

The configuration in (15) is also supported by evidence from secondary articulations and glide formation. Among the low vowels, these are triggered by all long vowels except the central ones (Hu 1986; Zhang 1996). This is to be expected if only the central vowels are unspecified for place. For example, word-medial low front vowels trigger palatalization of a preceding non-velar consonant (e.g., [ɕεɛn] /ˈser/, [ujoɬee] /ujoɬee/ 'cousin'). Word-initially, they trigger the insertion of a palatal glide (e.g., [jeelu] /eelu/ 'charcoal'). Similarly, low labial vowels trigger labialization of the preceding consonant (e.g., [n̪w̪oʊ] /doo/ 'mince', [n̪w̪oʊtəa] /n̪oʊdəa/ 'throw') and the insertion of a labial glide when occurring word-initially (e.g., [wɔnxii] /wɔnxii/ 'how many'). Among the non-low set, front vowels, like their low counterparts, trigger palatalization (e.g., [aɬi] /asi/ 'now', [ii] /siː/ 'you, sg.'). The non-low labial vowels, on the other hand, do not trigger labialization of either kind (e.g. nul/*n̪ul 'light', oon/*woon 'saw').

3.2.1.2 Hixkaryana

Hixkaryana has a five vowel surface inventory consisting of [e, æ, u, u, ə]. Derbyshire (1985) reports that these derive from the underlying inventory in (16). I propose that it is in fact (17), where the phonetic symbols are constant between the two but the phonological configuration differs.

(16) Derbyshire's (1985) analysis of Hixkaryana vocalic phonemes

| i [u]       | u [u]       |
| e [ɛ]       | o [ɑ]       |
| a [æ]       |

(17) Proposed underlying configuration of Hixkaryana vowels

<table>
<thead>
<tr>
<th>i [ɛ]</th>
<th>i [u]</th>
<th>u [u]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronal</td>
<td>Peripheral</td>
<td></td>
</tr>
<tr>
<td>æ [æ]</td>
<td>o [ɔ]</td>
<td></td>
</tr>
<tr>
<td>Coronal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The configuration in (17) is based on three morphophonemic alternations. Two of these are harmonic: one is peripheral harmony, the other is coronal harmony. The third process is palatalization, which I assume to be triggered by an underlying coronal specification (cf. Oroqen above). I will address each of these in turn. First, a note on the quality of the vowels in (17). The vowel Derbyshire gives as /a/ is always realized as [æ]; I assume this to be its underlying value. It is my contention that Hixkaryana has just two phonological heights, which I arbitrarily refer to as High and Low. Based on the phonological properties exhibited by the vowel represented as /ɛ/ in (16), I argue that it is better considered a high vowel in this system. Consequently, I represent as /i/ in (17).
Peripheral harmony only targets affixal /i/, and is triggered by an adjacent /u/ in the root:\(^{16}\)

(18) Peripheral harmony in Hixkaryana

\[
\begin{align*}
mi + hutjukæ + no & \Rightarrow [muhutjukæno] \text{ 'you took off the skin'} \\
jo + ðnu + ri & \Rightarrow [ronuru] \text{ 'my eye'} \\
\end{align*}
\]

Coronal harmony targets prefixal /æ/, triggered strictly by /æ/ in a stem initial syllable:\(^{17}\)

(19) Coronal harmony in Hixkaryana

\[
\begin{align*}
œ + kæmsuku + ri & \Rightarrow [ækæmsukuru] \text{ 'your blood'} \\
œ + mænho + no & \Rightarrow [æmænhono] \text{ 'you danced'} \\
\end{align*}
\]

In order to account for these alternations, /u/ must be underlyingly Peripheral, while the /œ/ to [æ] alternation can only be explained if the low front vowel is underlyingly specified as Coronal. The fact that peripheral harmony fails to target /i/ is predictable if it is assumed that, like /æ/, this vowel is underlyingly Coronal (though it does not trigger corona1011l harmony).

A Coronal specification on both /i/ and /æ/ is supported by evidence from palatalization, which targets consonants located at the edges of affixes. Demonstrated in (20), /i/ triggers palatalization on initial /n/ and final /r/, and as shown in (21), both /i/ and /æ/ trigger palatalization of an initial /s/ or /t/.

(20) Palatalization triggered by /i/

\[
\begin{align*}
ni + æmomi + no & \Rightarrow [æmompo] \text{ 'he rolled it up'}^{18} \\
r + iðj + ni & \Rightarrow [rjerjenu] \text{ 'my liver'} \\
\end{align*}
\]

(21) Palatalization triggered by /i/ and /æ/

\[
\begin{align*}
w + ðni + tæno & \Rightarrow [wønetære] \text{ 'let me go see it'} \\
ø + inkæ + ðæ & \Rightarrow [enkætæ] \text{ 'go take it out'} \\
ki + intækma + si & \Rightarrow [kemtækmafe] \text{ 'let me take a meal'} \\
\end{align*}
\]

In the final form in (21), Coronal spreads not just to the /s/ but also to the /i/ of the imperative marker, deriving [øe]. This vocalic alternation is predicted by the configuration in (17), since the central vowel will merge with the high Coronal vowel. In fact, the alternations exhibited by [i] are reminiscent of Nyangumarda, to be discussed next, in which a central vowel alternates with both /i/ and /u/.

3.2.2 Peripheral and Coronal Harmony in Three-Place Systems

In Oroqen and Hixkaryana, configuration IIIa yields only peripheral harmony. The coronal harmony exhibited in

\(^{16}\) Derbyshire does not provide any data showing that /œ/ does not trigger peripheral harmony, but there are many examples of morpheme internal /œ...i/ sequences (e.g., [rømuːn] /rømini/ 'house', [sku] /ski/ 'eat').

\(^{17}\) The application of corona1011l harmony appears to be limited to the low vowels, so that only /œ/ and /æ/ participate.

\(^{18}\) /i/ is syncopated after it causes palatalization of the following alveolar nasal (Derbyshire 1985:183).
Hixkaryana is active only in the low domain, which contrasts two places, while the non-low vowels are the only ones to participate in peripheral harmony. In this section, I provide evidence of both place harmonies among vowels of the same phonological height.

In configuration IIIa, the central vowel, being unspecified, may be targeted by Coronal and merge with the underlying front vowel. Or, the central vowel may be targeted by Peripheral and merge with the underlying back vowel. This configuration does not include complex vowels. Consequently, in no case is Coronal predicted to target a peripheral vowel, nor is Peripheral predicted to target a coronal vowel, as this would create a non-contrastive segment and so is banned by Structure Preservation. As a result, vowels that are lexically specified for place are predicted to be contrastively opaque to harmony. These conditions are found in the Australian language Nyangumarda.

Nyangumarda, which is argued to have the phonemic inventory /i,a,u/, has been analyzed as having two processes that condition vowel alternations (Hoard & O'Grady 1976; van der Hulst & Smith 1985). One is generally known as progressive vowel assimilation, and it is the focus here. The other is a palatalization process whereby /a/ becomes [i] in the environment of a palatal consonant. Since the trigger in this instance is a consonant and not a vowel, I set it aside (see van der Hulst & Smith 1985 for a discussion of palatalization phenomena in Nyangumarda), but it should be noted that the treatment of progressive assimilation proposed in the following paragraphs is consistent with this [a ~ i] alternation.

The following examples demonstrate Nyangumarda progressive assimilation:

(22) Nyangumarda progressive assimilation (data from van der Hulst & Smith 1985)

<table>
<thead>
<tr>
<th></th>
<th>1st singular, future</th>
<th>1st singular, unrealized actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>jurpa-lama-rna</td>
<td>jurpa-rna-ma-rna</td>
</tr>
<tr>
<td></td>
<td>wirri-limi-rni</td>
<td>wirri-rni-mi-rni</td>
</tr>
<tr>
<td></td>
<td>kalku-lumu-rnu</td>
<td>kalku-rnu-mu-rnu</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1st dual, unrealized actual</th>
<th>2nd singular indirect object, remote actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>b.</td>
<td>jurpa-rna-ma-li</td>
<td>wurra-rna-lpa-ų</td>
</tr>
<tr>
<td></td>
<td>wirri-rni-ma-li</td>
<td>wirri-rni-lpa-ų</td>
</tr>
<tr>
<td></td>
<td>kalku-rnu-ma-li</td>
<td>kalku-rnu-lpa-ų</td>
</tr>
</tbody>
</table>

Focussing first on (22a), the alternations show that suffix vowels harmonize with the final vowel of the stem. They also show that all three vowels may surface. Following Hoard and O'Grady (1976), I assume that the underlying vowel in these suffixes is /a/. Thus, /a/ harmonizes to [i] following /i/ and to [u] following /u/. I also assume that place is the relevant trigger, since neither tongue root nor aperture features can account for the allophones of /a/. This raises two crucial points. First, the current framework assumes privativity, which means that the alternations can only be explained if there are two harmonic features. Second, the principle of minimality requires that all three vowels must be of the same phonological height if two features

---

19 Progressive assimilation is not triggered by the initial vowel of the stem, suggesting that the first syllable is extraharmonic (van der Hulst & Smith 1985:292).
are to be specified. Consequently, I propose that the underlying configuration of Nyangumarda vowels is as given in (23).

(23) Underlying place configuration of Nyangumarda vowels

```
i           a           u
Coronal     |          Peripheral
```

Two kinds of evidence support this configuration. The first is less satisfactory, as it is based on negative evidence. The central vowel is generally assumed to be phonologically low because it is phonetically low, but there is in fact no phonological evidence for stipulating contrastive heights. Rather, without further evidence, we may posit that the central vowel receives its aperture feature through enhancement.

Fortunately, better evidence exists in the form of non-alternating vowels. As demonstrated in (22b), /i/ and /u/ do not alternate. This is predicted by the configuration in (23) because these vowels are underlingly specified for place. The interesting thing is that we must infer their contrastive opacity from their failure to alternate, as the place specifications of /i/ and /u/ enable them to trigger a new harmonic domain (e.g., muwar-pi-li/muwar + pi + la/ 'speak, singular simple imperative'). We may also infer their contrastive opacity from the fact that an otherwise alternating vowel immediately preceding /i/ or /u/ surfaces as [a]. This "regressive dissimilation" (O'Grady 1963:39) can be observed in the forms in (22b), and can be considered the result of an OCP-type constraint, as it mediates not only between Coronal and Peripheral segments, but also between two segments with the same specifications:

(24) OCP-driven dissimilation in Nyangumarda

```
a. * w i r r i - r n i - m i - l i
   \          /  \       
   Coronal   Coronal

b. w i r r i - r n i - m a - l i  'put (1st dual, unrealized actual)'
   \          /  
   Coronal   Coronal
```

In short, we find in Nyangumarda exactly what we predict we should find in a type IIIa system in which both coronal and peripheral harmony are active. The underlingly specified vowels trigger harmony but do not function as targets, and indeed, are contrastively opaque. The only target is a central vowel. The additional condition on place harmony that we find, namely the existence of buffer vowels, can be considered to fall out of a general phonological constraint on well-formedness.

3.2.3 Summary  In §3.2, I have presented data from languages with configuration IIIa. These languages display the predicted harmonic phenomena, including contrastive opacity. As mentioned in the introduction to this section, configuration IIIb is unattested, while configuration
IIIc presents some interesting challenges to this approach. Therefore, I first discuss languages with four contrastive places, as they are straightforwardly accounted for in this theory, and return to the intriguing cases in §3.4 below.

3.3 Four Contrastive Places

Analyses of harmonic systems contrasting four places of articulation provide a potential challenge for a two-place model of vowel features because they tend to rely on autonomous Labial and Dorsal specifications in the phonology. Although some three-place languages like Nyangumarda exhibit two types of place harmony, it is the four-place languages that are better known for this property, particularly those belonging to the Turkic branch of the Altaic family. I present two of these here.

3.3.1 Kirgiz  Kirgiz has a symmetrical vowel inventory, contrasting four vowels in both the low and the non-low domains. These vowels exhibit two kinds of harmony, agreeing for both palatality and labiality. This is most easy to observe in suffixes, which have four alternants:

(25) Kirgiz harmony (data from Comrie 1981)

a. high vowel alternants: ordinative suffix

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>bir-intʃi</td>
<td>'first'</td>
<td>toguz-untʃu</td>
</tr>
<tr>
<td>beʃ-intʃi</td>
<td>'fifth'</td>
<td>on-untʃu</td>
</tr>
<tr>
<td>dʒiʃirma-ntʃi</td>
<td>'twentieth'</td>
<td>yʃ-ʃntʃy</td>
</tr>
<tr>
<td>altʃ-ntʃi</td>
<td>'sixth'</td>
<td>tɔrt-ʃntʃy</td>
</tr>
</tbody>
</table>

b. low vowel alternants: ablative suffix

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>if-ten</td>
<td>'work'</td>
<td>tuz-don</td>
</tr>
<tr>
<td>et-ten</td>
<td>'meat'</td>
<td>tokoj-don</td>
</tr>
<tr>
<td>dʒil-dan</td>
<td>'year'</td>
<td>yj-don</td>
</tr>
<tr>
<td>alma-dan</td>
<td>'apple'</td>
<td>kɔl-don</td>
</tr>
</tbody>
</table>

c. multiple suffixes

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ene-sin-de</td>
<td>'at his mother'</td>
<td>tuz-un-do</td>
</tr>
<tr>
<td>ata-sin-da</td>
<td>'at his father'</td>
<td>kɔz-yn-dɔ</td>
</tr>
</tbody>
</table>

The data in (25) suggest an underlying inventory such as that in (26), in which only two heights are contrastive. Assuming the underlying vowel to be central in suffixes, all the alternations in (25) can be accounted for based on this configuration. Spreading Coronal to a placeless vowel will derive [i,e], while spreading Peripheral to such a vowel will derive [u,o]. Finally, spreading both Coronal and Peripheral will derive [y,ø]. There is no need for distinct Labial and Dorsal features; Coronal and Peripheral are sufficient to capture the facts of Kirgiz vowel harmony.
(26) Underlying place configurations of Kirgiz vowels

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>y</th>
<th>i</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coronal</td>
<td>Coronal Peripheral</td>
<td>Coronal</td>
<td>Peripheral</td>
</tr>
<tr>
<td>e</td>
<td>Coronal</td>
<td>Coronal Peripheral</td>
<td>a</td>
<td>o</td>
</tr>
</tbody>
</table>

3.3.2 Turkish  Like Kirgiz, Turkish exhibits both coronal and peripheral harmony. Likewise, its vowel inventory contrasts four vowels in two height domains. I therefore assume their underlying configurations to be identical. Accordingly, we expect Turkish harmonic phenomena to mirror those of Kirgiz. Yet, the data in (27) demonstrate a slightly different pattern.

(27) Turkish harmony (data from Clements & Sezer 1982)

a. high vowel alternants: genitive singular suffix

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ip-in</td>
</tr>
<tr>
<td></td>
<td>el-in</td>
</tr>
<tr>
<td></td>
<td>kiz-in</td>
</tr>
<tr>
<td></td>
<td>sap-in</td>
</tr>
<tr>
<td></td>
<td>pul-un</td>
</tr>
<tr>
<td></td>
<td>son-un</td>
</tr>
<tr>
<td></td>
<td>jyz-yn</td>
</tr>
<tr>
<td></td>
<td>køj-yn</td>
</tr>
</tbody>
</table>

b. low vowel alternants: nominative plural suffix

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ip-ler</td>
</tr>
<tr>
<td></td>
<td>el-ler</td>
</tr>
<tr>
<td></td>
<td>kiz-ler</td>
</tr>
<tr>
<td></td>
<td>sap-ler</td>
</tr>
<tr>
<td></td>
<td>pul-lar</td>
</tr>
<tr>
<td></td>
<td>son-lar</td>
</tr>
<tr>
<td></td>
<td>jyz-ler</td>
</tr>
<tr>
<td></td>
<td>køj-ler</td>
</tr>
</tbody>
</table>

High vowel suffixes pattern like those of Kirgiz. The vowel harmonizes with any vocalic Coronal and/or Peripheral specification in the root, resulting in four allophonic variants. When the target of harmony is a low vowel, as in (27b), however, only coronal harmony applies. There are therefore just two low alternants.

The opacity of low vowels in peripheral harmony is evident from forms with multiple morpheme concatenations, such as pul-lar-in 'stamps, genitive' and jyz-ler-in 'faces, genitive', in which Peripheral fails to spread beyond the low vowel. Note that this opacity is not contrastive opacity. When the target is high, the place harmonies apply symmetrically: low vowels trigger the same harmonic alternations as do high vowels. This tells us that the place features of the low vowels are identical to those of the high vowels and that the two sets are differentiated strictly on the basis of aperture specifications. Consequently, place cannot be the cause of the opacity of low vowel targets in peripheral harmony. Rather, this opacity must be dependent on height.

Padgett (2002) presents an alternative analysis of Turkish in which the harmony processes are argued to result from either complete or partial spreading of a node he calls Colour.
3.3.3 Summary  The discussions of Kirgiz and Turkish have shown that Coronal and Peripheral are able to capture the harmony processes exhibited by four-place languages, and that there is no need for distinct Dorsal and Labial features in the phonology. I have therefore demonstrated that these languages do not challenge the two-feature model of vowel place proposed in Rice 1995, 2002.

The theory proposed here makes a strong prediction regarding the types of neutrality that may be manifested in four-place systems, ruling out transparency and contrastive opacity. As seen, this class of languages does not exhibit contrastive opacity. Rather, the opacity we encounter results from various constraints on the application of peripheral harmony. These constraints are well documented and Korn (1969) has classified the Turkic languages according to which conditions they exhibit (see Kaun 1995 for analysis). The current analysis does not contradict these classifications in any way. Since the application of peripheral harmony tends to hinge on the height of the trigger, the target, or both, as demonstrated in the discussion of Turkish, these conditions are independent of the proposals made here. On the other hand, Lindblad (1990) and Hahn (1991) have argued that Uyghur exhibits transparency in coronal harmony. This is not expected. In a recent analysis, however, Vaux (2001) rejects the claim that Uyghur has four underlying high vowels, and argues for a three-way opposition in this domain. The language is therefore predicted to exhibit transparency, since it would be a type IIIc system; see the discussion of Uyghur in §3.4.5. Since this purported counterexample is the only one I can find, it seems the predictions of the current approach are upheld.

3.4 Three-Place Languages: Configuration IIIc

In this section, I return to languages with three contrastive places because configuration IIIc raises some interesting challenges for the theory proposed here. This is the configuration in which transparency in coronal harmony is predicted. The challenges derive not from the neutral vowels themselves, but from the unpredicted patterning of stems whose vowels are all neutral. Throughout the discussion I attempt to answer two separate yet related questions. First, why is it that /i/ and /e/ are transparent in coronal harmony? Second, are vowels predictably transparent?

3.4.1 Finnish  Finnish is from the Balto-Finnic branch of the Uralic family. Its vocalic inventory is comprised of eight segments which are divided into the harmonic sets displayed in Table 2 below.21 In the native vocabulary, root vowels must be uniquely from one of these sets; front and back harmonic vowels do not co-occur (e.g., pøytæ 'table', pouta 'fine weather').22 Conversely, the neutral vowels are not restricted in any way. They may co-occur with vowels from either harmonic set (e.g., kesv 'tame', verho 'curtain'), or they may occur alone in the root (e.g., neiti 'miss').

21 Note that I diverge from tradition and represent all segments using phonetic symbols rather than graphemes.
22 Loanwords create many problems for phonological accounts of Finnish, since harmony tends to be violated in these forms (e.g., konduktøøri 'ticket collector'). A number of proposals have been made to account for disharmony (e.g., L. Anderson 1980; Campbell 1980; Duncan 1999; Halle & Vergnaud 1981; Ringen & Heinämäki 1999; Välimaa-Blum 1986), but the issues have yet to be fully resolved. As the explanation is sure to go beyond the features used and constraints on their specification, I focus here on the native vocabulary.
Table 3 demonstrates how these sets condition harmonic alternations in suffixes. Suffix vowels are front if the root contains front harmonic vowels, and are back if the root contains back vowels. As forms like 'action' and 'entity' demonstrate, an intervening neutral vowel does not impede harmony. Data of this sort have been considered strong evidence that the neutral vowels are transparent. Note, however, that neutral stems take front vowel suffixes.

The Finnish inventory is asymmetrical, with three contrastive places in the non-low domains, but just two in the low ones. As the high and mid vowels behave identically in harmony, both are assumed to have the same configuration, of which there are three possibilities. Configuration IIIa in Table 1 must be ruled out: regardless of which place feature is active, contrastive opacity is predicted, yet no segments are opaque in Finnish harmony. Configuration IIIb must also be ruled out. In this system, if Peripheral were the active feature, the front unrounded vowels would be predicted to be targets, yet these do not alternate in Finnish. On the other hand, spreading Coronal to the back vowels wrongly derives [i] not [y], and [e] not [ø]. The underlying configuration of the non-low vowels must therefore be IIIc.

Among the low vowels, there are two configurational possibilities. If the harmonic feature is Peripheral, this reflects configuration IIa. If this feature is Coronal, the configuration must be IIb. In fact, the relevant feature cannot be Peripheral, since both harmonic sets include peripheral vowels.
Following Goldsmith (1985), Rose (1993), and Demirdache (1998), I assume the active feature is Coronal. I therefore assume the underlying configuration in (28) above. Spreading Coronal to /u/ and /ø/ will derive [y] and [ø] respectively, and spreading Coronal to /a/ will derive [æ], thus accounting for all the harmonic alternations.

The stem structures summarized in Table 3 are derived as follows. A Coronal specification in the root will spread to the suffix, deriving a front vowel. In roots with back vowels, there is no Coronal to spread; the suffix surfaces as a back. Note that when a harmonic vowel follows a neutral one, as in (29), the neutral vowel is irrelevant to the transmission of harmony.

(29) Neutral vowel followed by a harmonic vowel

a. i s A + A [isæ-æ]  
   Coronal

b. i s o + A [iso-a]  
   Peripheral

However, when a neutral vowel follows a harmonic one, we are forced to consider what it means to be transparent. In the literal sense, a transparent segment is one that does not impede spreading from an adjacent segment to another flanking segment, while not alternating itself. In the current framework, we can derive transparency in one of two ways. Either spreading can be non-local in that it may skip transparent segments, or it may target them in a way that does not trigger an alternation. The first option conflicts with locality conditions (e.g., Bakovic 2000; Ní Chiosáin & Padgett 2001), and puts an extra burden on the grammar, since the idiosyncratic behaviour of transparent segments must be learned. Transparency is in this sense stipulative. The second option, targeting without an alternation, is therefore tempting because if transparent segments can be targeted by harmony, they cease to hold any special status in the grammar.

We have seen that a segment that is underlyingly specified for place may exhibit two harmonic behaviours, neither of which involves transparency. It can be a target and harmony will derive a complex segment (e.g., Finnish /u~y/ alternations), or it will be contrastively opaque and will block harmony (e.g., Nyangumarda /i,u/). A segment that is unspecified for...
place may also be a target. In this case, harmony will partially neutralize an underlying contrast (e.g., Yowlumne /i/ to [u]). I propose a second option: an unspecified segment may be targeted by harmony and exhibit no alternation if and only if the harmonic feature is contrastively redundant for that segment. By this, I mean that the harmonic feature is entirely predictable on that segment based on the underlying configuration of the inventory. This may be seen in Finnish, where the neutral segments are front unrounded vowels. They are therefore redundantly (and predictably) Coronal. Consequently, when a neutral vowel follows a harmonic one, as in (30), Coronal spreads as before. A strength of this approach is that all vowels are viable targets, eliminating the need for non-local spreading that has hitherto been accepted as a required element of Finnish vowel harmony (e.g., S. Anderson 1980; Välimaa-Blum 1999).23

(30) Harmonic vowel followed by a neutral vowel

\[
\begin{array}{c}
\text{a. } s\ U\ U\ t\ e\ +\ t\ t\ A \\
\quad \text{Coronal}
\end{array}
\]

\[
\begin{array}{c}
\text{Peripheral} \\
\text{[syyte-ttæ]}
\end{array}
\]

\[
\begin{array}{c}
\text{b. } s\ U\ U\ r\ e\ +\ t\ t\ A \\
\quad \text{Peripheral}
\end{array}
\]

\[
\begin{array}{c}
\text{[suure-tta]}
\end{array}
\]

One set of forms, those with only non-low front vowels, appears to be problematic. Recall from Table 3 that these stems exhibit front harmony (e.g., pienæ 'small, partitive'). This is unexpected under my analysis because the neutral vowels are not specified for place. Consider the forms in (31):

(31) Neutral stems

\[
\begin{array}{c}
\text{a. } p\ i\ e\ n\ +\ t\ A \\
\quad \text{Coronal}
\end{array}
\]

\[
\begin{array}{c}
\quad \text{*[pien-ta]}
\end{array}
\]

\[
\begin{array}{c}
\text{b. } p\ i\ e\ n\ +\ t\ A \\
\quad \text{Coronal}
\end{array}
\]

\[
\begin{array}{c}
\text{[pien-tæ]}
\end{array}
\]

The representation in (31a) assumes the analysis as developed to this point. Coronal is not present underlyingly, and so cannot spread to the suffix. This derives the wrong surface form. If a default rule assigning Coronal to any bare place node is stipulated (cf. Rose 1993), as in (31b), we achieve the correct result. However, if Coronal could indiscriminately target any bare place node, the contrast between /æ/ and /a/ would be completely neutralized; any /a/ would activate the default rule. A default Coronal specification is also plagued by a more serious problem. Once Coronal is introduced into a representation, some further mechanism blocking its spread in forms containing both a neutral and a back harmonic vowel is required. Consider a word like iso

\[\text{\textsuperscript{23}}\text{Ni Chiosáin and Padgett (2001) argue for an analysis of locality wherein all segments are legitimate targets. The analysis here therefore constitutes relativized adjacency because the targets are restricted to the vocalic tier.}\]
'father' (29b) above). The initial neutral vowel will trigger the default Coronal specification, which will then spread to the final vowel, deriving *iso. Stems in which a neutral vowel follows a back one are subject to this same problem, since the suffix must surface as back (e.g., suure-tta/*suure-ťæ 'entity'). Consequently, this solution is not feasible. Yet, it is clear that the suffix vowel of neutral stems must be specified as Coronal at some point.

3.4.2 Explaining the Harmonic Behaviour of Neutral Stems I have argued that neutral vowels, when they behave as transparent, are not phonologically specified for place. By extension, roots consisting uniquely of transparent vowels have no underlying vocalic place features. Despite lacking these features, however, neutral stems exhibit harmonic behaviour in Finnish; suffixes surface as front. We must, therefore, account for this unpredicted outcome.

One solution to this puzzle is through complexity. Following Dresher and van der Hulst (1993, 1999), Rice and Avery (1993), and Walker (1993), I assume the following complexity scale for phonological representations:

(32) Complexity scale

<table>
<thead>
<tr>
<th>a. X</th>
<th>b. X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Z</td>
<td></td>
</tr>
</tbody>
</table>

The structure in (32a) is the least complex; that in (32c) is the most complex. The complexity of (32b) is relative: it is more complex than (32a), but less so than (32c). These structures can be related to each other through implication, so that the presence of a more complex structure in an inventory implies the presence of a less complex one. It is possible, however, for languages to demand a certain amount of complexity, ruling out at some level structures like (32a) (e.g., Causley 1999; Goldsmith 1985).

It is my contention that Finnish requires a certain amount of complexity in lexical representations: if a root would be free of vowel place features, one is forced to appear. This cannot, however, be a constraint on segmental representations. In theoretical terms, transparent vowels are not lexically specified for place. In empirical terms, we have seen that when Coronal is present underlyingly, it spreads, yet we must be able to derive forms like suuretta 'entity' in which the suffix vowel is not fronted. Further, this structural requirement must refer strictly to place features because /i/ and /e/ pattern identically. Regardless of which neutral vowel is in the root, the suffix surfaces as front (e.g., piiri-ssæ 'circle, inessive', kene-ssæ 'who, inessive'; cf. talo-ssa 'house, inessive'). Accordingly, I propose the parameter in (33) below.

(33) The Minimal Complexity Parameter

24 If we assume extrinsic rule ordering, we could derive the correct surface form of words like iso by ordering harmony before the application of default place specifications. However, since /a/ is also unspecified for place, this still makes the wrong prediction for any form containing this vowel underlyingly (e.g., pouta 'fine weather').

25 Though not discussed, the problems raised by a default Coronal specification are faced by the analysis presented in Rose 1993. Välimaa-Blum (1999), who argues that both Coronal and Dorsal spread and that the neutral vowels are lexically specified as Coronal, avoids the issue by implementing a "back precedence" constraint which stipulates that if both place features are underlyingly present, Dorsal takes precedence in spreading over Coronal.
If there is no vocalic place feature in the lexical representation of the root, assign the contrastively redundant one.

This parameter, which I will refer to as Complexity, states that if all vocalic place nodes in a root are bare, then a feature must be implemented in order to give it sufficient structural complexity. This will result in the specification of Coronal on neutral segments in Finnish, and in type IIIc languages more generally, because this is the contrastively redundant feature in these systems. In type IIIb languages, which are also predicted to exhibit transparency, the relevant feature would be Peripheral. Since this configuration is unattested, I leave the issue open.

Crucially, the application of (33) derives the form in (31b) without recourse to problematic default specifications. It also correctly derives forms in which the suffix vowel is non-low, since Complexity will be invoked regardless of the place specification of the suffix vowel:

(34) The Minimal Complexity Parameter and non-low suffix vowels

   a. k i e l i i + k o
      \___________/
        \      \     \     \      \     \     \      \     \     \      \  
       \ Coronal Peripheral

      [kieli-kø]   'a/the language?'

   b. i t k e + n u t
      \___________/
        \      \     \     \      \     \     \      \  
       \ Coronal Peripheral

      [itke-nyt]   'cried'

What about roots in which /a/ occurs alone or with neutral vowels (e.g., makkara 'sausage' and paltinna 'linen cloth')? Since these forms lack vocalic place specifications, the parameter would seem to predict that they will invoke Complexity. Note, however, that /a/ is a central vowel which contrasts with a phonologically front vowel, /æ/, while the neutral segments /i/ and /e/ do not contrast with such a vowel. Consequently, though Coronal is contrastively redundant for the neutral vowels, it is not for /a/. As such, this vowel is not a target for any place specification through the implementation of Complexity.

In short, Complexity is a well-formedness constraint stipulating that roots must have some vocalic place feature. In order to satisfy the complexity requirements of a language, it can only assign a feature that is contrastively redundant on a root whose vowels are underlyingly placeless. Thus, forms like pien 'small' and kiel 'language' will always invoke Complexity, while forms like vanha 'old' and arpaiaiset 'lotteries', in which no feature in contrastively redundant, will not.

Complexity also explains cases of variation in the application of harmony. Consider the following forms:

---

26 Working within the framework of Government Phonology, Demirdache also analyzes the harmonic behaviour of neutral stems as a well-formedness condition; when the governor is i, its domain is exhaustive and so it must spread to all free vowel positions (1988:71).

27 Although some derivational suffixes fail to undergo fronting on neutral stems, the cause cannot be attributable to the place features of root vowels, since even when these are identical, both front and back allomorphs may surface (e.g., pes-u 'bath', but hel-y 'trinket') (Duncan 1999). Kiparsky (1973) has analysed the behaviour of these suffixes as deriving from the structure of the root, since it is only on monosyllabic forms that harmony may be impaired. When the root is disyllabic, the suffixes pattern as predicted (e.g., im-u 'suction', imeskel-y 'sucking away (at something)').
(35) Variable harmony in native forms (data from Campbell 1981)

<table>
<thead>
<tr>
<th>Form</th>
<th>Meaning</th>
<th>Source Form</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>hiljempææ ~ hiljempaa</td>
<td>'quieter'</td>
<td>hilja</td>
<td>'quiet'</td>
</tr>
<tr>
<td>illemmællæ ~ illemmalla</td>
<td>'later in the evening'</td>
<td>ilta</td>
<td>'evening'</td>
</tr>
<tr>
<td>liiemmæltaæ ~ liiemmlata</td>
<td>'excessively'</td>
<td>liika</td>
<td>'excess'</td>
</tr>
</tbody>
</table>

The roots in (35) are all forms in which Complexity would be banned, since no feature is contrastively redundant for both /i/ and /a/. Yet, the affixed forms have undergone internal change, with root-final /a/ becoming [e]. This results in a stem that would normally induce Complexity, since the vowels are all neutral. The variable harmony can be seen to arise from the resultant clash between the insufficient complexity of the root and its morphologically derived form.

3.4.3 Hungarian

From the Ugric branch of the Uralic family, Hungarian exhibits harmonic phenomena that is often thought of as extremely similar to that of Finnish. This is true in that both have coronal harmony, transparent segments, and three place contrasts among non-low vowels. There is, however, a certain aspect of Hungarian harmony that differs from the Finnish facts. In this section, I offer a brief sketch of Hungarian and argue that the difference between the two languages derives from their configurations.

Hungarian has a seven vowel inventory, /i,y,u,e,ø,o,a/, and all segments have both long and short forms.28 Not all pairs, however, display parallel behaviour in either the phonological or the phonetic module (Vago 1975, 1976, 1978). Long /ee/ is traditionally analyzed as a mid front unrounded vowel, while its short counterpart is considered to be phonologically low. I represent it here as /e/. Further, long /aa/ surfaces as an unrounded low back vowel, while the short one surfaces as rounded [o]. Following Vago, I assume that the surface distinctions of the /a/ pair are the result of phonetic enhancement features, but that the difference between /ee/ and /e/ is phonological. This assumption is critical, as it accounts for the disparate behaviour of these two vowels in Hungarian coronal harmony.

(36) Hungarian place harmony

<table>
<thead>
<tr>
<th>Case</th>
<th>Dative</th>
<th>Adessive</th>
<th>Ablative</th>
</tr>
</thead>
<tbody>
<tr>
<td>front</td>
<td>-nek/nak</td>
<td>-neel/naal</td>
<td>-tøøl/tool</td>
</tr>
<tr>
<td>fyst-nek</td>
<td>fyst-neel</td>
<td>fyst-tøøl</td>
<td>'fume'</td>
</tr>
<tr>
<td>fółd-nek</td>
<td>fółd-neel</td>
<td>fółd-tøøl</td>
<td>'earth'</td>
</tr>
<tr>
<td>tömeg-nek</td>
<td>tömeg-neel</td>
<td>tömeg-tøøl</td>
<td>'crowd'</td>
</tr>
<tr>
<td>szegeén-nek</td>
<td>szegeén-neel</td>
<td>szegeén-tøøl</td>
<td>'poor'</td>
</tr>
<tr>
<td>back</td>
<td>-n/aa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mookus-nak</td>
<td>mookus-naal</td>
<td>mookus-tool</td>
<td>'squirrel'</td>
</tr>
<tr>
<td>vaaros-nak</td>
<td>vaaros-naal</td>
<td>vaaros-tool</td>
<td>'city'</td>
</tr>
</tbody>
</table>

28 As with Finnish, I diverge from traditional orthography and represent the vowels using phonetic symbols.
The harmonic phenomena displayed in (36) largely resemble those of Finnish. Back harmonic stems take back vowel suffixes, and front harmonic stems take front vowel suffixes, as do neutral stems.\(^29\) Crucially, while both /i,ii/ are transparent, only /ee/ is; its short counterpart is harmonic (Ringen & Vago 1998). Also unanticipated, /ee/ alternates in suffixes with /aa/, an alternation we do not expect if /ee/ is neutral. These last two observations are explicable, however, if we assume the underlying configuration in (37), into which I admit, following Vago (1975 et seq.), three phonological heights.

(37) Underlying place configuration of Hungarian vowels

\[
\begin{array}{ccc}
\text{i/ii} & \text{y/yy} & \text{u/uu} \\
\text{Coronal} & \text{Peripheral} & \text{Peripheral} \\
\text{ee} & \text{o/øø} & \text{o/oo} \\
\text{Coronal} & \text{Peripheral} & \text{Peripheral} \\
\varepsilon & \text{a/aa} \\
\text{Coronal} \\
\end{array}
\]

The harmonic status of /ε/ is predictable if we consider it akin to Finnish /æ/, specified as Coronal to mark a two-way opposition in the low domain. This analysis accounts for its harmonic alternation with /a/. The transparency of /ee/, on the other hand, just like that of /i,ii/, is attributable to its redundant Coronal specification in a three-way contrast.

An unusual aspect of Hungarian is that /aa/ surfaces as [ee] when targeted by harmony. In the proposed configuration in (37), neither vowel is specified for place. When Coronal spreads to /aa/, the result is a long coronal vowel; long /ee/ is redundantly coronal. Its height specification, however, differs. Rather than delete a mora, which would derive [ε] and merge the underlying contrast between /a/ and /aa/, I propose that the aperture feature is repaired, deriving [ee]. Harmony in this instance is ultimately structure preserving, though it does involve a non-

---

\(^29\) There are approximately 50 monosyllabic neutral roots that take back vowel suffixes. Under the current framework, the quality of these suffix vowels cannot be attributed to a floating [+back] feature on the root morpheme (e.g., Clements 1977; van der Hulst 1985; Kiparsky 1981; Nadasdy & Siptar 1994; Ringen & Vago 1998), since this feature is not available. Similarly, I cannot posit an abstract vowel analysis as does Vago (1975 et seq.), because this would add another place to the system of contrasts, rendering an account of the harmonic processes impossible. Notably, monosyllabic "antiharmonic" forms also occur in Finnish (cf. footnote 27 above). I leave the issue open.
structure preserving phase. The following discussion highlights the tenacity of Hungarian in maintaining underlying moraic structure in affixes.

Suffixes with short mid rounded vowels have three forms, alternating between [o], [ø], and [e]. Using the allative suffix /-hoz/, this pattern of "rounding assimilation" (Vago 1975, 1976) is exemplified in (38). The [e] alternant only surfaces under one condition: the suffix must have undergone coronal harmony and the final vowel of the root must be a front unrounded vowel. Simply following a front unrounded vowel will not trigger unrounding (cf. radir-hoz), nor can it be the case that the suffix vowel simply remains round following a round vowel (cf. haaz-hoz).

(38) "Rounding assimilation" in Hungarian

haaz-hoz  'house'  viiz-hez  'water'
radir-hoz  'eraser'  kørét-hez  'side dish'
flød-høz  'earth'

Based on (38), I assume, following Ringen and Vago (1998) and Polgárdi and Rebrus (1998), that there is no peripheral harmony in Hungarian. Rather, the [e] variant results from a phonotactic or licensing constraint banning complex monomoraic vowels in suffixes unless they are multiply-linked (e.g., Ringen & Vago 1998). A possible response to these violations would be to insert a mora, yet Hungarian does not opt for this solution. A simple delinking of the feature Peripheral will not, however, derive the unrounded variant because its height differs from that of the rounded vowels (cf. (37) above). I propose that in order to satisfy licensing requirements, the grammar is forced to implement a repair mechanism in these cases. Peripheral is delinked, deriving a short vowel that is specified simply as Coronal. Since the inventory contrasts a short Coronal vowel, the aperture feature is adjusted to match this segment, deriving /e/.

3.4.4 Classical Mongolian

Classical Mongolian, from the Altaic family, also has coronal harmony. Like Hungarian, it contrasts seven vowels. However, only high front /i/ is neutral in Classical Mongolian.

(39) Coronal harmony in Classical Mongolian (data from Svantesson 1985)

a. Front harmonic roots

<table>
<thead>
<tr>
<th>Root</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ydże-gyl</td>
<td>'see, causative'</td>
</tr>
<tr>
<td>mede-gyl</td>
<td>'know, causative'</td>
</tr>
<tr>
<td>ire-lyge</td>
<td>'come, narrative past'</td>
</tr>
<tr>
<td>yker-etʃe</td>
<td>'ox, ablative'</td>
</tr>
<tr>
<td>itʃegyri-etʃe</td>
<td>'shame, ablative'</td>
</tr>
<tr>
<td>møren-etʃe</td>
<td>'river, ablative'</td>
</tr>
</tbody>
</table>

b. Back harmonic roots

<table>
<thead>
<tr>
<th>Root</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>jabu-yl</td>
<td>'go, causative'</td>
</tr>
<tr>
<td>oro-yl</td>
<td>'enter, causative'</td>
</tr>
<tr>
<td>oirata-yl</td>
<td>'approach, causative'</td>
</tr>
<tr>
<td>jirga-luya</td>
<td>'live happily, narrative past'</td>
</tr>
<tr>
<td>ulus-atʃa</td>
<td>'nation, ablative'</td>
</tr>
<tr>
<td>aman-atʃa</td>
<td>'mouth, ablative'</td>
</tr>
<tr>
<td>morin-atʃa</td>
<td>'horse, ablative'</td>
</tr>
</tbody>
</table>

c. Neutral roots
The data in (39) demonstrate that /e/ only co-occurs with front vowels, suggesting that it is a front harmonic vowel. /i/ may co-occur with either front or back vowels, and does not impede harmony, indicating that it is transparent. The transparency of /i/, coupled with the observation that [u] alternates with [y], suggests that there is a three-way contrast among the high vowels and that they are configured the same way as in Finnish (i.e., IIc). The low vowel alternations, however, are identical to the Turkish facts: [o] alternates with [ø] and [a] alternates with [e]. Consequently, I assume the underlying configuration in (40).

(40) Underlying place configurations of Classical Mongolian vowels

```
   i          y          u
   |          |          |
   Coronal   Peripheral Peripheral
      e          ø      a          o
      |          |          |
      Coronal   Coronal Peripheral Peripheral
```

Crucially, the transparent vowel is again unspecified for place. Notice also that just like Finnish and Hungarian, neutral stems take front vowel suffixes (39(c)). This receives a straightforward explanation if we assume that Minimal Complexity is operative in Classical Mongolian. As before, /a/ is exempt because the well-formedness condition inserts only contrastively redundant specifications.

3.4.5 Uyghur

It is not the case, however, that all languages with a type IIc configuration will invoke Minimal Complexity. I illustrate this point with Uyghur, a Turkic language. Although the high vowels are typically assumed to contrast four places of articulation (e.g., Hahn 1991; Lindblad 1990), I follow Vaux (2001) in assuming that only three phonological oppositions hold in this domain. I also follow Vaux (2001) in assuming that /i/ and /e/ are transparent in Uyghur. Consequently, I posit the underlying configuration in (41).
(41) Underlying place configurations of Uyghur vowels

```
<table>
<thead>
<tr>
<th>i</th>
<th>y</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coronal</td>
<td>Peripheral</td>
</tr>
<tr>
<td>e</td>
<td>ø</td>
<td>o</td>
</tr>
<tr>
<td></td>
<td>Coronal</td>
<td>Peripheral</td>
</tr>
<tr>
<td>æ</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coronal</td>
<td></td>
</tr>
</tbody>
</table>
```

The configuration in (41) is identical to that of Finnish in (28) above. We therefore expect that Finnish and Uyghur will exhibit parallel behaviour in Coronal harmony. As demonstrated in (42), this is largely the case, but with one notable exception.

(42) Coronal harmony in Uyghur (data from Lindblad 1990)

<table>
<thead>
<tr>
<th>plural -lar</th>
<th>dative -ga</th>
<th>plural poss. -imiz-</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Front harmonic stems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>jyz-lær</td>
<td>jyz-gæ</td>
<td>jyz-imiz-gæ</td>
</tr>
<tr>
<td>køl-lær</td>
<td>køl-gæ</td>
<td>køl-imiz-gæ</td>
</tr>
<tr>
<td>xæt-lær</td>
<td>xæt-kæ</td>
<td></td>
</tr>
<tr>
<td>b. Back harmonic stems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pul-lar</td>
<td>pul-κa</td>
<td>pul-imiz-κa</td>
</tr>
<tr>
<td>jol-lær</td>
<td>jol-κa</td>
<td>jol-imiz-κa</td>
</tr>
<tr>
<td>at-lær</td>
<td>at-κa</td>
<td></td>
</tr>
<tr>
<td>c. Neutral stems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>til-lær</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sinip-ta</td>
<td></td>
<td></td>
</tr>
<tr>
<td>deŋiz-κa</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Like Finnish, front harmonic stems take front vowel suffixes, and back harmonic stems take back vowel suffixes. As the forms in (42c) indicate, however, neutral stems take back vowel suffixes.

---

30 Uyghur also exhibits peripheral harmony, though the process is highly constrained and is not discussed here (see Hahn 1991). One suffix that appears to be targeted by both Coronal and Peripheral is the first person singular possessive suffix, -im. Following a round vowel, this suffix surfaces as -um (e.g., pul-um 'money'), after a complex vowel, it surfaces as -ym (e.g., køl-ym 'lake'), and elsewhere it surfaces as -im (e.g., xæt-im /xæt-im/ 'letter').
This is exactly what this model predicts. Since no vocalic Coronal specification is available in the underlying representation of the root, there is no feature to spread and the suffix surfaces as back. The difference between Finnish and Uyghur, therefore, is that Uyghur does not demand a minimum amount of complexity in the lexical representation of roots; (32a) is fine.31

An interesting aspect of harmony is the way in which it applies to derived [i]. Uyghur has a rule that raises the low vowels to [i] in (unstressed) medial open syllables. When it applies root internally, only the aperture feature is affected, so that raised /æ/ triggers harmony but raised /a/ does not (e.g., [iʃiʃiæ]/iʃæ-g-i-gə/ 'to his donkey', but [balaʃ]/balaʃar/ 'children'). In the case of suffixes with an underlying low Coronal vowel, such as the nominal enclitic -tʃæ- (Vaux 2001), the facts initially seem less clear. We expect that when raised, these forms will always trigger coronal harmony. This is not the case; suffixes following raised -tʃæ- only surface as front if this morpheme is cliticized to a front harmonic root:

(43) Coronal harmony and raised /-tʃæ-/ (data from Lindblad 1990)

\[
\begin{array}{ll}
\text{kitab} + \text{tʃæ} + \text{dA} & > [\text{kitaptʃida}] \quad \text{'in the booklet'} \\
\text{oʃl} + \text{tʃæ} + \text{lA} + b & > [\text{oʃultʃilap}] \quad \text{'done a boy's way'} \\
\text{ziʃ} + \text{tʃæ} + \text{gA} & > [\text{ziʃtʃiʃa}] \quad \text{'to/for the skewer'} \\
\text{næj} + \text{tʃæ} + \text{dA} & > [\text{næjʃtʃidæ}] \quad \text{'child'} \\
\end{array}
\]

We can account for the data in (43) if we assume that the vowel in -tʃæ- loses its coronal specification when it undergoes raising. Once placeless, the harmonic patterning it exhibits is completely regular. This explanation is perhaps not so unusual. Recall that the behaviour of raised vowels is entirely predictable when raising applies within roots. In this sense these vowels are harmonic, triggering harmony between root and suffix. When /æ/ occurs in suffixes, however, it creates disharmonic forms. In becoming placeless, the enclitic ceases to be disharmonic, participating in harmony and creating harmonic stems.

Thus, with the exception of minimal complexity requirements, Finnish, Hungarian, Classical Mongolian, and Uyghur all exhibit identical harmonic phenomena. The status of /e/ as either

31 When we look at other languages with systems like the ones discussed in this section, we find that the locus of differentiation between these languages comes in exactly what is relevant for triggering the presence of Coronal on what would otherwise be a neutral vowel. My concern here is the relationship between processes and the inventory on which they are operative. Kiparsky and Pajusalu (2002) survey a number of Finno-Ugric languages with the same system, focusing on the patterning of neutral vowels in these inventories. The languages they look at include Finnish and Uyghur as well as Eastern Khanty and Vepsian. The languages have the same surface inventories and roots with harmonic vowels pattern identically. However, the facts around roots containing a harmonic vowel followed by a neutral one differ. How does this happen? I have argued that whether or not a neutral stem triggers coronal harmony is attributable to the minimal complexity requirements of the languages, which may appeal to the Minimal Complexity Parameter in (33) if these are not met. Thus, while Finnish invokes Complexity, Uyghur does not. Based on Kiparsky and Pajusalu (2002), we may add that Eastern Khanty also invokes Complexity, but Vepsian, like Uyghur, does not. The interesting case is raised by Khanty (also Northeast Estonian), which seems to force Coronal to be present on a stem of the shape [[a i] a], where a represents a back harmonic vowel and i a transparent one. In these cases, the suffix vowel is fronted, resulting in [[a i] a], where a represents a front harmonic vowel (Kiparsky & Pajusalu 2002:11). In Finnish, Vepsian, and Uyghur, suffix vowels on these types of stems surface as back. This is exactly the patterning we expect, since Complexity does not apply. Yet, it must in Khanty, since the neutral vowel spreads Coronal to the suffix. The Complexity Parameter can account for these forms if its scope in Khanty is not the entire root, but rather, root-final vowels. Consequently, root internal [i a] sequences will not invoke Complexity, since the transparent vowel is not final, but any root with a final neutral vowel will, deriving front vowel suffixes. This is exactly the pattern we find in this language.
harmonic or neutral in these systems is a direct consequence of the configuration in which it finds itself. In both Finnish and Uyghur, it is in a three-way opposition in which it is unspecified for place. As a result, it patterns transparently in Coronal harmony, since this feature is contrastively redundant on /e/. In Classical Mongolian, /e/ is in a four-way contrast and must be marked as Coronal. It is therefore a harmonic trigger. The Hungarian case is different again. Due to its Coronal specification, which marks a two-way opposition in the low vowels, short /e/ is harmonic. Long /ee/, on the other hand, is akin to the Finnish situation. This vowel, which is in a three-way contrast, is unspecified for place and so behaves transparently.

3.4.6 The Structure of Inventories I have argued that transparent vowels may be targeted by a contrastively redundant harmonic feature (and exhibit no alternations) because this feature is predictable based on the underlying configuration of the inventory to which they belong. It is this redundant specification that enables local spreading to adjacent vocalic segments, and explains the harmonic behaviour of neutral stems. But, how do we know that Coronal is predictable and redundant in three-place configurations like those of Finnish and Classical Mongolian?

In the current model, transparency is only predicted in inventories with front rounded vowels.\footnote{In Table 1, /u/ is predicted to be transparent in peripheral harmony in type IIIb systems. No system with this configuration was found, and so peripheral transparency remains unattested. This begs the question: is peripheral transparency attestable, and a language with the factors needed to produce this property has yet to be found, or, is peripheral harmony unattestable, ruled out by some universal principle of language (Hyman 2001:174)? It is beyond the scope of this paper to examine this issue in detail, but I raise it as a point for future consideration.} I have assumed these to be phonologically complex, underlyingly specified as both Coronal and Peripheral. If we consider the inventories in Maddieson (1984), phonologically front rounded vowels never occur in inventories with fewer than three vocalic places of articulation. Moreover, when they do occur, it is always with [i] and [u].

(44) Unattested systems

\[\begin{align*}
\text{a.} & \quad * \ y \ i \ - \\
\text{b.} & \quad * \ - \ y \ u \\
\text{c.} & \quad * \ i \ y \ i \ - \\
\text{d.} & \quad * \ - \ y \ i \ u
\end{align*}\]

The unattested systems in (44) suggest something fundamental about the structure of inventories. Specifically, I propose that these systems are unattestable (Hyman 2001), ruled out by Universal Grammar because complex vowels, being composites of coronal and peripheral elements, may not occur unless the inventory also includes phonologically Coronal and Peripheral segments. Simply put, you cannot have /y/ without both /i/ and /u/.

This has implications for contrastive specification, because once /y/ is present in a three-way opposition, only /i/ or /u/ need be marked for place in order to contrastively specify the segmental inventory (see Ghini 2001 for a similar assumption). Any further specification is redundant because the unspecified value is entirely predictable based on what is marked. In this sense /y/ is like a pivot, its presence implying both a coronal and peripheral segment in the inventory even though they may not be marked as such.

At the start of this section, I stated that I would attempt to answer two questions. First, why are /i/ and /e/ transparent in coronal harmony? Second, are vowels predictably transparent? The
short answer to the second question is 'yes'. In three-place systems with complex vowels, the unspecified vowel will behave transparently in place harmony because its predictable value is the harmonic feature. This also answers the first question. When lexically unspecified for place, /i/ and /e/ will not trigger harmony. They may, however, propagate it.

3.5 Summary

If we assume that phonological processes are not products of the inventory, but rather that they are independent of it, simply making use of what is there, then while our analyses may be empirically adequate, they lose a certain degree of descriptive adequacy. Thus, although we may account for the data, we have not begun to address the larger issues. Specifically, why is it that a certain phonological process is manifested in a given language, and more broadly, why is it that this process may be manifested differently in different languages? \(^{33}\) If, on the other hand, we assume that the inventory informs the phonology, we can begin to address these questions.

In this section, I have explored the consequences and predictions of this assumption within a model of segmental specification into which, following Rice (1995, 2002), I admit only two contrastive place features for vowels. I have endeavored to show that a two-feature model of vowel place readily accounts for cross-linguistic place harmony phenomena. Strikingly, the predictions laid out in §2 were met by the data presented here. Individual segments patterned as expected, and the manifestations of neutrality were encountered where it was predicted they should be. What is more, no unexpected configurations were found (though configuration IIIb remains unattested).

The only surprise for the analysis proposed here was raised by languages contrasting three vocalic places of articulation, languages exhibiting transparency in coronal harmony. Specifically, the harmonic behaviour of neutral stems presented a paradox, since despite lacking an underlying coronal specification, suffix vowels on these forms may surface as front. In order to account for this unexpected patterning, I have proposed the Minimal Complexity Parameter, a well-formedness constraint that inserts Coronal into the phonological representation of the root when it lacks vocalic place features, thus ensuring that root vowels contain the minimal amount of structural complexity that a language may require.

4 Conclusion

My goal in this paper has been to demonstrate that a two-place model of vowel features is able to account for cross-linguistic place harmony phenomena. I have also sought to show that such a model, when conjoined with contrastive specification, correctly predicts both the various manifestations of place harmony as well as the behaviour of individual segments in harmonic systems. Yet, this analysis has important implications beyond these goals. One of these concerns markedness.

Markedness is a slippery notion, sometimes referring to structural issues like segmental representations, sometimes referring to substantive issues like the features themselves, and sometimes referring to universality issues such as the relationships that hold between features

\(^{33}\) A separate though related question is what gives rise to various phonological phenomena such as vowel harmony in the first place. Although interesting, it seems this issue is independent of feature and specification theories, and consequently, it has not been addressed here (for discussions of this issue, see Kaun 1995 and Suomi 1983).
and features classes. As Rice (1999) points out, even the diagnostics often used to define markedness are vague. The current analysis of place harmony has accented the saliency of these points. Consider, for example, representational markedness. If we correlate structural complexity with markedness, a peripheral segment is no more marked than is a coronal one. Recalling the relative complexity scale discussed above, both types of segments will have a single phonological dependent. In a two-place model therefore, /u/ is no more complex than is /i/. Conversely, in a three-place model /u/ is more complex, having two dependents (Labial and Dorsal). What about the features themselves? In terms of substantive markedness, a peripheral segment is as likely to be unmarked (i.e., unspecified) as is a coronal one. This type of markedness is dependent on the structure and configuration of the inventory, rather than on the feature itself. Not even the cross-linguistic behaviour of coronal and peripheral classes is particularly helpful in circumscribing markedness. Coronal and peripheral segments alike trigger place harmony (as well as other processes such as secondary articulations, etc.). In the case of Finnish and Classical Mongolian, we have seen that Coronal, whether lexically specified or not, may be a pervasive feature in the phonology. The sum of these facts seems to counter the universally unmarked status of Coronal for vowels (e.g., Hume 1992, 1996; Rose 1993). They also highlight the need to examine critically the notion of markedness and what it can tell us about phonological processes more generally.

Finally, the current approach to place harmony has raised the issue of what it means for a vowel to be neutral. Neutrality is not a stipulative aspect of the phonology; rather, I have argued that it falls out of the structure and configuration of inventories. Neutral vowels are simply vowels that do not alternate. When harmony is blocked for structure preserving reasons, contrastive opacity is derived. Transparency is manifested when the harmonic feature is contrastively redundant on the segment in question. In this way, local spreading is maintained and conditions on the grammar are rendered unnecessary. Consequently, transparency becomes a purely descriptive term with no formal status. It is not a phonological property in the sense that transparent segments are skipped over or passed through. Instead, they are targets of harmony just like any other target.

References


Ewen, Colin and Harry van der Hulst. 1988. [high], [low] and [back] or [I], [A] and [U]? In P. Coopmans and A. Hulk (eds.), 49-57.


UNCONDITIONAL NEUTRALITY


Appendix: Place Harmony Classifications

TYPE I

<table>
<thead>
<tr>
<th>Configuration</th>
<th>i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abelam</td>
<td>Ndu (Foley 1986; Laycock 1965)</td>
</tr>
<tr>
<td>Boikin</td>
<td>Ndu (Laycock 1965)</td>
</tr>
<tr>
<td>Iatmul</td>
<td>Ndu (Foley 1986; Laycock 1965)</td>
</tr>
<tr>
<td>Manambu</td>
<td>Ndu (Laycock 1965)</td>
</tr>
<tr>
<td>Kabardian</td>
<td>Northwest Caucasian (Colarusso 1992)</td>
</tr>
</tbody>
</table>

TYPE II

IIa

<table>
<thead>
<tr>
<th>Configuration</th>
<th>i</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Algonquian    | (Goddard 1974) |
| California Yokuts | (Archangeli 1984; Newman 1944) |
| Manchu-Tungus | (Dresher & Zhang 2000; Zhang 1996) |
| Australian    | (Chadwick 1975; Pensalfini 1997) |
| Coronal       | (Evans 1995) |

IIb

<table>
<thead>
<tr>
<th>Configuration</th>
<th>i</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Chamorro      | Austronesian (Seiden 1960; Topping 1968) |
| Balto-Finnic  | (Goldsmith 1985; Välimaa-Blum 1986) |
| Guiana Carib  | (Derbyshire 1985) |
| Ugric         | (Ringen 1978; Vago 1975 et seq.) |
| Western Mongolian | (Svantesson 1985) |
| Eastern Turkic| (Hahn 1991; Lindblad 1990; Vaux 2001) |
| Isolate       | (Ethnologue 2003; Sohn 1987) |
TYPE III

IIIa

<table>
<thead>
<tr>
<th>Configuration</th>
<th>i</th>
<th>i</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coronal</td>
<td>Peripheral</td>
<td></td>
</tr>
</tbody>
</table>

i. *Peripheral harmony*

Oroqen, low Manchu-Tungus (Hu 1986; Zhang 1996)
Baiyinna Orochen, low Manchu-Tungus (Li 1996)
Southern Paiute, non-low Plateau Shoshonean (Sapir 1930)
Hixkaryana, non-low Guiana Carib (Derbyshire 1985)

ii. *Coronal harmony*

Korean, non-low Isolate (Ethnologue 2003; Sohn 1987)

iii. *Both Peripheral and Coronal harmony*

Nyangumarda Pama-Nyungan (O'Grady 1963; Hoard & O'Grady 1976)
Mandarin Chinese (Wu 1994)

IIIb – Unattested

<table>
<thead>
<tr>
<th>Configuration</th>
<th>i</th>
<th>y</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coronal</td>
<td>Coronal</td>
<td>Peripheral</td>
</tr>
</tbody>
</table>

IIIc

<table>
<thead>
<tr>
<th>Configuration</th>
<th>i</th>
<th>y</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coronal</td>
<td>Peripheral</td>
<td>Peripheral</td>
</tr>
</tbody>
</table>

i. *Peripheral harmony* – Unattested

ii. *Coronal harmony*
Finnish, non-low Balto-Finnic (Goldsmith 1985; Välimaa-Blum 1986)
Hungarian, non-low Ugric (Ringen 1978; Vago 1975 et seq.)
Cl. Mongolian, non-low Mongolian (Svantesson 1985)
Buryat, non-low Western Mongolian (Comrie 1981; Walker 1993)

IIIc, Coronal harmony cont'd …
Kalmyk, non-low Western Mongolian (Svantesson 1985)
Khalkha, non-low Eastern Mongolian (Walker 1993)
S. Sierra Miwok, non-low California Miwok (Broadbent 1964)

iii. Both Peripheral and Coronal harmony
Uyghur Eastern Turkic (Vaux 2001)

TYPE IV

<table>
<thead>
<tr>
<th>Configuration</th>
<th>i</th>
<th>y</th>
<th>i</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peripheral</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peripheral</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

i. Peripheral harmony
Shuluun Höh Eastern Mongolian (Svantesson 1985)

ii. Coronal harmony
Vakh Kanty Ob'-Ugric (Comrie 1981)
Classical Mongolian, low Mongolian (Svantesson 1985)
Turkish, low Southern Turkic (Clements & Sezer 1982)

iii. Both Peripheral and Coronal harmony
Azerbaydzhan, high Southern Turkic (Comrie 1981)
Turkish, high Southern Turkic (Clements & Sezer 1982)
Kirgiz Northern Turkic (Comrie 1981)
Shor Northern Turkic (Korn 1969)
Tuva Northern Turkic (Krueger 1977)
Buryat, low Western Mongolian (Comrie 1981; Walker 1993)
Khalkha, low Eastern Mongolian (Walker 1993)