

CHAPTER 5

ADJACENCY IN VOWEL HARMONY

5.1 Introduction

Warlpiri has been described as a language with two vowel harmony processes, progressive and regressive (Nash 1986). In both types of harmony high vowels undergo harmony. In progressive harmony, high vowels in suffixes and clitics attached to stems ending in /i/ become /i/. Unless otherwise indicated, examples are from Nash.

- (1) maliki-kirli-rli=lki=ji=li 'as for the dogs, they are with me'
 dog- PROP-ERG=now=1sNS=3pS
 (cf. minija-kurlu-rlu=lku=ju=lu 'as for the cats, they are with me'
 cat- PROP-ERG=now=1sNS=3pS)

wanti-mi=jiki '(something) is still falling'
 fall-NPST=still
 (cf. wanti-ja=juku '(something) still fell'
 fall-PST=still)

Regressive harmony is morphologically restricted, only applying in the presence of a verbal suffix containing /u/ causing preceding /i/ vowels to become /u/.

- (2) pangu-rnu dig-PST 'dug (something)'
 (cf. pangi-ka dig-IMP 'dig!')
 kuju-rnu throw-PST 'threw (something)'
 (cf. kiji-ka throw-IMP 'throw!')

Previous to OT, vowel harmony has been analysed in the theory of autosegmental phonology. Autosegmental analyses of vowel harmony in Warlpiri include Nash (1979,1986), Steriade (1979), Sagey (1990), Cole (1991), van der Hulst and Smith (1985), Kiparsky (ms). Many autosegmental analyses of vowel harmony advocate some form of underspecification where one value for a feature may be filled in by spreading. If this does not occur, then the default value for the feature may be inserted by redundancy rules.

Following the principles of OT, the emphasis here is on the output form and the constraints that determine well-formedness of outputs rather than on the representation of the input form. The analysis does not rely on underspecified segments where correspondence constraints assessing the relationship between inputs and outputs is required, but rather argues that harmony is an output phenomenon where exactness is required of particular vowels in outputs.

In an underspecification analysis, vowel harmony is viewed as a feature filling process. A feature spreads because of the lack of full feature specification in surrounding vowels (discussed in 5.5.1). A contrary view is to suppose that vowel harmony is a consequence of adjacency requirements on certain features in outputs and not a consequence of underlying representations. In the analysis presented here, segments are fully specified in underlying representations. Whether all underlying features are parsed or not depends on higher ranking identity constraints. A constraint

on adjacent high vowels ensures that they harmonise for a particular place feature, and this place feature is determined by other constraints. Harmony is then a result of adjacency requirements.

This outcome underlies one of the goals of the chapter, which is to show that harmony is achieved under adjacency rather than alignment. Another goal is to provide explanations for harmony and the blocking of harmony which are expressed through general constraints.

The data on vowel harmony presented in this chapter are largely from Nash (1986), supplemented with examples from the Warlpiri dictionary (1990;DIC), Laughren (ML) and Simpson (1991;JS).

The chapter is outlined as follows. Section 5.2 discusses the role of the OCP in OT and notions of adjacency. I introduce a constraint on the adjacency of features and propose that this constraint can adequately account for many processes of assimilation. The vowel harmony data from Warlpiri is presented in 5.3. In 5.4, I provide an analysis of the data. An account for the blocking behaviour of labial consonants is given in 5.4.1. In progressive harmony, labial consonants block the spread of /i/, but they do not block the spread of /u/ in regressive harmony. I argue that the blocking behaviour is best understood as an identity and homorganicity requirement on adjacent labial consonants and vowels which overrides vowel assimilation. In this section I also argue that vowel harmony is a simultaneous not derivational process given the interaction of reduplication and vowel harmony. In 5.5, I consider alternative analyses. This is followed by a discussion in 5.6 of transparency and opacity in OT and I argue that under feature identity these can receive a different interpretation compared to previous analyses. Some concluding remarks are given in 5.7.

5.2 Theoretical Issues

In stress systems, it is fairly straightforward to establish the parameters which contribute to the range of stress patterns. For instance, there are two basic foot types which may or may not be quantity sensitive, and generally feet align to the left or right of a word. However, establishing the parameters in vowel harmony appears not to be as clear cut. For instance, elements that undergo harmony such as the kinds of vowels and morphemes vary widely, as well as the elements that trigger harmony. In addition, the direction of harmony and the number of elements that undergo harmony vary across languages.

Despite the number of elements involved in vowel harmony, two factors have been well-established; these are iteration and direction. Iteration is the extent of feature spreading, whether it is unbounded across a domain or confined to a single adjacent element. Harmony is directional, spreading either left or right, or in some instances bidirectionally. I agree with Beckman (1998) in the main that spreading and the direction of spreading are characteristics of harmony which can be generated through identity constraints. Under the notion of identity, directionality is a result of suffixes or prefixes, but not roots, to undergo feature alternation. However, I also find that some notion of directionality must be captured in constraints to avoid regressive suffix-to-suffix harmony.

Iterative harmony and the constraints on identity are discussed below.

5.2.1 Adjacency

An uncontroversial view in phonology is that phonological processes are local. The ramifications of this view are reflected in various principles and processes. One of these is a principle on the formal representation of features, known as the OCP (Obligatory Contour Principle), originally due to

Leben (1973). The OCP prohibits adjacent identical elements. For instance, if there is a sequence of high vowels then by the OCP they must both be linked to a single instance of [high].

In OT, the effects of the OCP can be achieved by featural markedness constraints which value multiply linked features over singly linked ones. Featural markedness constraints are those which rule out parsing of features, eg *[COR] which says do not parse [COR]. Thus the representation in (a) involving multiple linking is better than (b) with singly linked features.



In vowel harmony, an adjacency constraint on particular features is required. I assume that vowels in adjacent syllables are adjacent and vowels in non-adjacent syllables are not adjacent. This is expressed in the following statement.

- (4) Adjacency: vowels are structurally adjacent iff they are associated with syllables which are adjacent.

The notion of adjacency captures the fact that, in vowel harmony, consonants are generally transparent to the process. In section 5.6 the issue of transparency is discussed with relevance to adjacency as not only consonants can be transparent but also vowels.

As previously mentioned, it is acknowledged in generative phonology that rules are local in application (including Sagey 1990, Clements 1991, Archangeli and Pulleyblank 1986,1994, among others). In other words, the operation of rules is dependent on the elements involved being adjacent; some elements are close enough for operations, while others are not.

The processes of assimilation and dissimilation involve features that are adjacent on some tier and are not expected to 'skip over' the features involved in these processes. Instances of skipping, shown in (5a), are not possible. Assimilation of a feature (F) is acceptable when those elements undergoing the process are adjacent, as in (5b).



In vowel harmony in Warlpiri, adjacent high vowels must have the same place of articulation. This accounts for the fact that high vowels undergo harmony in either frontness or roundness when adjacent to vowels with these features, as seen in (6).

- (6) kiwinyi-rli=ji (cf minija-rlu-ju 'cat-ERG=1sNS)
 'mosquito-ERG=1sNS'
 yurrpu-rnu (cf yirрпи-rni 'insert-NPST')
 'insert-PST'

I will assume the place features [LAB] and [COR] for the corresponding features [+round] and [-back]. A sequence of vowel-place features [COR] and [LAB] is not permitted. I propose a constraint, called Harmonic Adjacency, to ensure that adjacent vowels share the same place feature.

same place features as consonants, following Clements (1992), Ni Chiosáin and Padgett (1993), Selkirk (1988, 1991) among others¹.

(10) Surface feature specifications for vowels

	i	u	a
[high]	+	+	
[low]	-	-	+
[LAB]		*	
[COR]	*		
[PHAR]			*

/a/ is specified as [+low] and not also [-high], following information on this vowel from researchers including Schane (1984), van der Hulst (1988), McCarthy (1991), Selkirk (1991a,b).

5.3 Data

As mentioned in the introduction, two kinds of vowel harmony processes, progressive and regressive, exist in Warlpiri involving the high vowels /i,u/. In progressive harmony, suffixes with high vowels attached to a stem ending in /i/ surface with [i], as shown in (11). The vowels in the morphemes bound by '/' represent underlying forms.

- (11) a. maliki-kirli-rli=lki=ji=li 'as for the dogs they are with me now'
 dog -PROP- ERG=now=1sNS=3pS
 /maliki-kurlu-rlu=lku=ju=lu/
- b. maliki-kirlangu-kari-kirli 'with another's dog'
 dog-POSS-another-PROP
 /maliki-kurlangu-kari-kurlu/
- c. jinta-kari-ki 'at one another'
 one-another-DAT
 /jinta-kari-ku/
- d. kiwinyi-rli=ji 'mosquito (did something) to me'
 mosquito-ERG=1sNS
 /kiwinyi-rlu=ju/
- e. wangka-mi=lki=ka=rna 'I am really speaking now'
 speak-NPST=still=IMPF=1sS [ML]
 /wangka-mi=lku=ka=rna/
 (cf wangka-mi=rra=lku=ka=rla 'he is speaking away to him now'
 speak-NPST=still=IMPF=2sS [ML])

¹ This is also proposed in other frameworks such as Dependency Phonology and Particle Phonology and include Anderson and Ewen (1987), van der Hulst (1986,1989), Kaye, Lowenstamm and Vergnaud (1985), Schane (1984,1987).

- f. kapi=ji=rla FUT=1sNS=3DAT [JS339]
kapi=ju=rla
- g. paji-ki cut-FUT² 'will cut'
/paji-ku/ (cf paka-ku strike-FUT 'will strike')

Regressive harmony only involves verb roots with underlying high vowels and contrasts with progressive harmony in that the harmonising feature is [LAB]. Harmony occurs when suffixes with back vowels are attached. These suffixes are the past tense and agentive (nomic) suffixes **-rnu**, **-ngu** and **-nu**.

- (12) a. pangu-rnu dig-PST 'dug'
/pangi-rnu/ (cf. pangi-ka dig-IMP 'dig!')
- b. kuju-rnu throw-PST 'threw'
/kiji-rnu/ (cf. kiji-ka throw-IMP 'throw!')
- c. kupu-rnu winnow-PST '(something) winnowed'
/kipi-rnu/ (cf. kipi-rni winnow-NPST '(something) is winnowing')
- d. kuju-rnu-nju-nu '(someone) began to throw (something)'
throw-INCEP-PST
/kiji-rnu-nji-nu/
(cf. kiji-rni-nji-ni throw-INCEP-NPST '(someone) is beginning to throw (something)')
- e. miyi-kupu-rnu 'food winnower'
food-winnow-NOMIC
/miyi-kipi-rnu/

Regressive harmony is morphologically restricted, occurring only when verb tense suffixes with back vowels, except for **-ku** FUT, attach to the verb root³.

In progressive and regressive harmony, the low vowel /a/ does not undergo harmony and harmony does not propagate through it; it is opaque. This is shown in (13).

- (13) a. minija-kurlu-rlu=lku=ju=lu 'as for the cats, they are with me now'

² The future tense forms are rare and are used by speakers in the west.

³ There are two verb roots ending in /u/ (the only verb roots to end in /u/) which undergo assimilation to /i/ before lamino-alveolars:

- a. pi-nyi 'hit, kill bite-NPST'
/pu-nyi/ (cf pu-ngka 'hit, kill, bite-IMP')
pi-nja 'hit, kill, bite-INF'
- b. yi-nyi 'give-NPST'
/yu-nyi/

Along with Nash I assume that this latter assimilation process is local in contrast with assimilation of vowels to [u] under the influence of suffixes with /u/ which will be referred to as vowel harmony.

cat-PROP-ERG=now=1sNS=3pS

- b. jurdi-ma-nu 'mounted'
mount-CAUS-PST [JS361]
- c. yirra-rnu 'put'
put-PST

The following examples show that progressive harmony is blocked by labial consonants:

- (14) a. ngamirni-puraji 'your mother's brother'
mother's brother-your
- b. milpirri-puru 'during cloud'
cloud-during
- c. ngali=wurru 'you and I'
you and I=EMPH
- d. miyi-kipurda 'in search of, wanting food'
food-DESIDCOMP

In contrast, the labial consonants are not active in blocking regressive harmony as shown in (15).

- (15) a. yurpu-rnu insert-PST 'inserted'
/yirpi-rnu/ (cf yirpi-rni insert-NPST 'inserting')
- b. kupu-rnu winnow-PST 'winnowed'
/kipi-rnu/ (cf kipi-rni winnow-NPST 'winnowing')

There are some examples where labial harmony spreads to the right. Although it is reported in Nash that this process is restricted to certain dialects of the west and north of the Warlpiri region, data from Simpson (1991) and Laughren (recordings) indicate that it has become more widespread. The spreading of round to the right is confined to the directional clitic **-rni** 'HITHER' and the pronominal agreement clitics **-rli** 2dS, **-rli**pa 1piS, **-rlijarra** 1deS⁴.

- (16) a. muku=rnu /muku=rni/

⁴ Nash (1986) analyses the clitics with initial **rli** as comprising the morpheme **rli** 2dS and thus that 1piS and 1deS clitics are analysed as **rli-pa** and **rli-jarra** respectively.

all=HITHER [JS399]

- b. ya-nu=rnu=ju=lu 'they came' /ya-nu=rni=ju=lu/
 go-PST=HITHER=1sNS=3pS [JS361]
 (cf pina=rni ya-nu 'he came back hither'
 transfer back to original location=HITHER go-PST)
- c. ya-nu=rlupa=jana=rla 'we went to them for it' /ya-nu=rlipa=jana=rla/
 go-PST=1piS=3pNS=DAT [ML]
 (cf wangka-ja=rlipa=jana=rla 'we spoke to them for it'
 speak-PST=1piS=3pNS=DAT [ML])

Other clitics with /i/ in the initial syllable do not undergo round harmony. This includes **pinki** 'etc', **wiyi** 'prior, first', **mipa** 'only', and **kirli** 'exactly'.

With the exception of verb roots, harmony is restricted to suffixes and clitics, and there is no harmony across compound boundaries. For example, in preverb-verb compounds, vowels in the preverb (PVB) do not agree in backness with the vowels in the verb, as (17b) shows.

- (17) a. pirri-kiji-rni 'scatter'
 PVB -throw-NPST
- b. pirri-kuju-rnu 'scattered'
 PVB - throw-NPST
- c. miyi-kupu-rnu 'food winnower'
 food-winnow-NOMIC

Similarly, in nominal reduplication involving full word reduplication, harmony does not apply across the boundary.

- (18) a. yukiri-yukiri 'green'
 b. kurdiji-kurdiji 'shoulder blade'

The two harmony processes can be summed up in the following table. Progressive harmony where [COR] is the harmony feature is the most general process, while the other harmony processes are morphologically restricted.

(19)	target	trigger	blockers	domain
progressive u > i	u	i	/a/, labial C's, word & compound boundaries	suffixes, clitics
i > u	specific clitics with /i/	u	as above	clitics
regressive i > u	/i/ in verb roots	u	/a/, word & compound boundaries	verb roots

5.3.1 Distribution of high vowels in roots

Within nominal and verbal roots, adjacent high vowels may occur which do not share the same place feature. While somewhat rare, sequences of iCu, where C=p/w, can be found in nominal roots, as shown in (20). Such sequences are not found in verb roots.

- (20)
- | | | |
|----|-------------|------------------------------|
| a. | yirriwu | 'Acacia ancistrocarpa (bush) |
| b. | kajipu | 'inside of bush coconut' |
| c. | yuriwurrnyu | 'kindling wood' |

Some loan words may consist of a sequence of iCu, as in:

- (21) miyurlu 'mule (English loan word)' (Hale 1966:764)

The examples in (22) show that in verbs and noun roots, sequences of uCi can be found.

- (22)
- | | | |
|-------|-----------------|--------------------------------|
| Verbs | | |
| a. | ngurntirri-mi | 'scold, growl at' |
| b. | nyunji-rni | 'kiss' |
| c. | yurirri-mi | 'move, stir (intrans)' |
| d. | yururri-mi | |
| Nouns | | |
| a. | jalurti | 'crest-tailed marsupial mouse' |
| b. | kurriji | 'wife's mother' |
| c. | punjungiyingiyi | 'incipient beard' |
| d. | pukurdi | 'pigeon's top-knot; hair-bun' |

A sequence uCi suggests that vowel harmony is directional where frontness spreads to the right and roundness to the left. However, as I argue later, this is due to the tendency of suffixes rather than roots to undergo feature alternation.

5.3.2 Discussion

In sum, there are two harmony processes in Warlpiri involving high vowels, progressive front harmony and regressive back harmony. The low vowel blocks both harmony processes, while labial consonants block progressive harmony. Back harmony is morphologically restricted in contrast to front harmony, which applies whenever possible.

It has often been noted that vowel harmony is stem/root controlled (Clements 1980, among others). In other words, harmony typically spreads from stem to affixes rather than from affixes to stems. Warlpiri exhibits the typical pattern in progressive harmony, but an atypical spreading pattern in regressive harmony.

One aim in accounting for segmental harmony is to establish the motivation for its occurrence. As has been noted, when segments are articulated, certain features may be neutralised. Feature neutralisation occurs when changes from a neutral state of the articulators are minimised. In Warlpiri, neutralisation of features is responsible for progressive harmony.

In verbs, a distinction between past and nonpast tense is carried by the high vowels; the past tense suffixes **rnu**, **nu** have round vowels and the nonpast suffixes **rni**, **ni** have front vowels. The only difference between these two sets of suffixes is the quality of the vowels. Given this fact,

it is likely that the motivation for round harmony in verb roots is to maintain this distinction in tenses. We have seen that progressive harmony applies wherever possible. If this occurred in verbs, then the past tense form of the verb **pangi-rnu** dig-PST, would be **pangi-rni**, which is exactly the form for the present tense. Whenever verbal suffixes with round vowels are present, progressive harmony is overridden.

In the absence of the past tense suffixes, high vowels harmonise in frontness. In these contexts, maintaining a distinction between the front and round high vowels is unnecessary. Note that maintaining the vowel distinction is not crucial in the future tense suffix **-ku**, where the vowel is either /u i/ depending on the preceding vowel. Changing the vowel in **-ku** does not change the tense, but it would do in **-rnu** 'PST' or **-rni** 'NPST'.

We could argue that the asymmetry in vowel harmony (round harmony in verbs involving certain suffixes and front harmony elsewhere) is necessary to maintain past and present tense distinctions; that the asymmetry is a result of a morphological requirement overriding a prosodic one. Thus vowel harmony in this context is not neutralising but instead expresses a contrast. Featural agreement is forced if maintaining contrastiveness would otherwise be difficult. On the other hand, progressive harmony is neutralising, as maintaining a contrast is unnecessary.

We might also argue that featural contrasts are neutralised in certain positions, eg affixal, because such contrasts are not crucial in these positions (Steriade 1994). Other morphemes, ie roots, are in positions of prominence and are less likely to undergo featural alternation. This could explain the predominance of stem/root controlled harmony noted by Clements.

In support of the view of positional prominence, note that stems/roots are typically the subject of alignment constraints in prosodic operations such as stress, and the base for reduplication. Thus in terms of these processes, stems/roots have a significant role to play, which suggests that the prosodic status of stems/roots is higher than that of affixes. This status means that they are less likely to undergo vowel harmony, unless a morphological distinction is to be maintained, or there is a phonological distinction that is not crucial.

Previous analyses accounting for positional prominence use the notion of prosodic licensing (Itô 1986, Goldsmith 1990, Itô & Mester 1993, Itô, Mester & Padgett 1994). For a particular contrast to be maintained, the contrast has to be licensed by a prosodic position or category. However, as Steriade (1994) points out, this is problematic because it misses the distributional generalisation that it is the position and not just prosodic structure which ensures the maintenance of a contrast. Steriade cites examples of distributions which are not dependent on prosodic licensing of prosodic structure. For instance, in Klamath a contrast in glottalisation and aspiration is licensed only when a sonorant follows regardless of where syllable boundaries are. Similarly, syllable boundaries are irrelevant for contrastive retroflexion in Australian languages, which is licensed only when a vowel precedes.

In Warlpiri, all featural contrasts within nominal roots are maintained while certain contrasts in suffixes are not. Characterising roots and suffixes is not possible in prosodic terms.

Expanding on Selkirk (1994), who introduced positional Parse(F) constraints, Beckman (1998) proposes to account for positional prominence through identity constraints expressed in terms of position. An Ident-Position(F) constraint is ranked above a general identity constraint and a constraint (call it X) requiring featural alternation. This ranking generates positional asymmetries:

(23) Ident-Position(F) >> X >> IDENT(F)

Beckman argues for an Ident-Position(F) for languages where harmony is triggered by a vowel in a root initial syllable, as in Shona.

(24) **IDENT- σ_1 (F)**

Let β be an output segment in the root-initial syllable and α its input correspondent. If β is $[\gamma F]$ then α must be $[\gamma F]$

This is interpreted as “an output segment in σ_1 and the input correspondent of that segment must have identical feature specification” (1998:56). The ranking of this constraint will ensure alternation of features in everything except those in the root-initial syllable.

To account for the Warlpiri data, identity constraints on roots and verbal suffixes are required to express the fact that feature contrast is essential in roots (unsuffixed nominals are considered roots) and in specific verbal suffixes.

(25) **IDENT-Root(F)**

The output features of a segment in a root must be identical to the input features of that segment.

(26) **IDENT-VSfx(F)**

Features which ensure the syntactico-semantic identity of suffixes must be exact in outputs to those in inputs.

The constraint on suffixes will ensure that the distinction between past tense and non-past tense is maintained, but it will not affect featural alternation in other verbal suffixes, eg **-ku** in **paji-ki** vs **paka-ku**, since this alternation is not distinctive and thus does not change semantic interpretation.

P&S (1993) discuss place features with regard to markedness and based on cross-linguistic evidence claim that the feature [COR] is favoured over other place features. The data from Warlpiri support this claim, as shown in the following section, and motivates separate identity constraints for parsing [COR] and [LAB] in vowels.

(27) **IDENT[COR]:** Correspondent segments in S_1 and S_2 have identical values for [COR](28) **IDENT[LAB]:** Correspondent segments in S_1 and S_2 have identical values for [LAB]

Harmony is typically thought of as a process where features are spread across a particular domain. Here the view is that positional prominence and neutralisation determine harmony, which is governed by the Identity constraints. The evident directionality in harmony systems is determined by Identity.

5.4 Analysis

A number of facts are to be accounted for in vowel harmony in Warlpiri. These are:

1. COR harmony occurs freely and spreads to the right
2. LAB harmony occurs only when verbal suffixes with round vowel specification are present and only spreads to the right to certain clitics.
3. Both harmony processes are blocked by the low vowel
4. COR harmony is blocked by labial consonants
5. Harmony only occurs upon suffixation

Following early analyses (including Nash 1979, Steriade 1979), I propose an analysis of vowel harmony in Warlpiri where vowels are fully specified in underlying representations. This analysis better captures the two harmony processes and better accounts for the surface high vowels in the absence of harmony, as discussed in 5.5.1. Cole (1991) also allows harmony to be a feature-changing operation where harmony operates on vowels specified for [round].

Harmony is domain specific: round harmony in verbal roots and front harmony in nominal and verbal suffixed stems, as well as particles. [COR] may spread in a verbal domain, as for example, in **wanti-mi=jiki**, where the clitic surfaces as **juku** in the absence of harmony. In a domain, the vowel that surfaces in the absence of harmony is not the same as the harmonising vowel. The harmony domains can be summarised as follows:

(29) High vowels in harmony domains

Domain	Verbal Roots	Stems
Harmony	LAB	COR (limited LAB)
No harmony	COR	LAB

High vowels in verbal roots surface as [u] under harmony and as [i] in suffixes in stems. Where there is no harmony, high vowels in suffixes surface as [u] and in verbal roots as [i].

As discussed in 5.2.1, Harmonic Adjacency (HA) requires adjacent high vowels to share the same place feature. A violation to HA is incurred if high vowels do not share a place feature, as shown in (30).

- (30)
- | | |
|------------------------------|----|
| /maliki-kurlu-rlu=lku=ju=lu/ | HA |
| maliki-kurlu-rlu=lku=ju=lu | * |
| maliki-kirli-rlu=lku=ju=lu | * |
| maliki-kirli-rli=lki=ju=lu | * |
| % maliki-kirli-rli=lki=ji=li | |

Harmony is motivated by HA and any sequence of iCu will incur a violation of HA. However, IDENT-Root(F) will ensure that sequences of uCi in monomorphemic roots, eg **jalurti** 'crest-tailed marsupial mouse'; **nyunji**- 'kiss', do not undergo harmony. The ranking is:

- (31) IDENT-Root(F) >> HA

(32) jalurti

	IDENT-Root(F)	HA
%a. jalurti		*
b. jalirti	*!	

c. jalurtu	*!	
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Another output is conceivable where all vowels are parsed as /a/, but this would also violate IDENT-Root(F).

In some words, the number of constraints against HA will determine the optimal candidate, as illustrated in the following tableau, which evaluates the input form **yukiri-rlu** 'green-ERG'.

(33) yukiri-rlu	IDENT-Root(F)	HA
a. yukiri-rlu		**!
b. yikiri-rli	*!	
c. yukuru-rlu	**!	
%d. yukiri-rli		*

The two HA violations to (a) decide in favour of (d) as the optimal output. The featural markedness constraints are ranked below the constraints considered in this section; nonetheless they ensure that features are multiply linked.

HA is ranked above the identity constraints on the features [COR] and [LAB]. IDENT[COR] is ranked above IDENT[LAB]. The evidence for this ranking is in forms where the trigger and target of harmony are high vowels in suffixes. An example is given in the next tableau.

(34) jinta-kari-ku	HA	IDENT[COR]	IDENT[LAB]
%a. jintakariki			*
b. jintakaruku		*!	
c. jintakariku	*!		

The final vowel in the suffix /-kari/ triggers harmony in the following suffix and the optimal form is that in (34a). It is therefore better to parse the input feature [COR] which enables this harmony to occur. Where the input feature [LAB] is parsed, and to avoid violating HA, round harmony occurs as in (34b), but since this means COR is not parsed, it fails as an optimal output. When input features for both the high vowels have been parsed as in (34c), HA is violated.

A small number of clitics with /i/ in the first syllable undergo rounding harmony when attached to roots ending in /u/, as shown in the following tableau, where IDENT-Root(F) and HA determine the optimal candidate:

(35) muku=rni	IDENT-Root(F)	HA	IDENT[COR]
%a. mukurnu			*
b. mukurni		*!	
c. mikirni	**!		

Since other clitics with underlying /i/ do not undergo rounding harmony, we can assume that input and output features must be identical in such clitics and include them in the constraint requiring identity in verbal suffixes. An alternative is to have an identity constraint on these clitics

and rank it above HA. This seems unnecessary for a very small number of forms and it would be preferable that they be specified in the IDENT-VSfx(F) constraint.

As discussed in the section on alternatives, underspecifying the clitics that do undergo harmony is not a satisfactory solution since it would be necessary to specify what the surface vowel would be in the absence of harmony and it would also give rise to inconsistencies in the grammar. In other words, if these clitics were underspecified, then all other forms showing feature alternation should be underspecified. The problem with this is that the ‘default’ vowel (the one that surfaces in the absence of harmony) is different in the verb roots, suffixes and clitics that show alternation.

As noted previously, suffixes or clitics may trigger [COR] harmony in following, but not preceding, suffixes. However, harmony in preceding suffixes cannot be ruled out by the constraints introduced so far, since vowels in suffixes may undergo feature alternation. Conditions for a regressive [COR] harmony could arise because there are some clitics, eg **mipa**, **pink**i, which can follow any grammatical category. Thus, some way to prevent regressive [COR] harmony must be explored.

The fact that [COR] harmony proceeds from left to right is a consequence of suffixes undergoing neutralisation and of feature enhancement across a span of segments. If [COR] harmony is to extend the quality of a particular vowel feature, then conceivably it does so when that vowel feature has been encountered. Thus the [COR] trigger occurs to the left of the target vowels, and not to the right. HA needs to be modified to incorporate the fact that neutralisation is not regressive.

(36) **HA** (modified): Adjacent high vowels following [COR] share [COR].⁵

This constraint also reflects the fact that suffixes, and not just roots or tense suffixes, can trigger harmony in following suffixes. Under Beckman's (1998) model, regressive harmony involving suffixes cannot be ruled out.

5.4.1 [LAB] harmony

So far constraints have assessed nominal forms in which suffixes, but not roots, undergo feature alternation. However, feature alternation within verb roots must be allowed when the harmony triggering suffixes are present. Currently, IDENT-Root(F) rules out any feature change within roots, and IDENT-VSfx(F) will ensure that verbal suffixes with input round vowels surface with these vowels. These constraints will lead to a lack of harmony within roots and violation of HA, eg ***kipi-rnu**, because featural identity is demanded by both Identity constraints. As previously discussed, it is not possible to rank HA above IDENT-Root(F) because feature alternation would occur in nominal roots, which is not attested. The solution is to introduce a specific root harmony constraint allowing for round harmony within roots when suffixes with round vowels are present. This constraint is:

(37) **Root Harmony (RootHA)**: Adjacent high vowels agree in place in verb stems.

To ensure that harmony occurs due to the [LAB] place feature of verbal suffixes, IDENT-VSfx(F) must be ranked above Root Harmony. Compare the optimal outputs in the following two

⁵ The general constraint is universal but it allows for specification of the harmonising features in a language, in the same way that alignment constraints allow for specification of certain edges.

tableaux where in (38) harmony occurs in the suffix **-ku**, and in the root in (39) but not in the suffix **-rnu**.

(38) paji-ku	IDENT-VSfx(F)	RootHA	IDENT-Root(F)	HA
%a. paji-ki				
b. paju-ku			*!	
c. paji-ku		*!		*

The identity constraint on verbal suffixes only holds of the suffixes **-rnu**, **-ngu**, and **-nu**; thus vowel alternation in other suffixes is not ruled out. This allows for (38a) to be optimal, violating only the lower ranked feature, identity constraint, IDENT[LAB] (not shown in the tableau). RootHA and IDENT-Root(F) rule out (38b,c) and so force harmony to occur in the suffix. In the next tableau, it is IDENT-VSfx(F) and RootHA that register fatal violations.

(39) kipi-rnu	IDENT-VSfx(F)	RootHA	IDENT-Root(F)	HA
%a. kupu-rnu			*	
b. kipi-rnu		*!		*
c. kipi-rni	*!			

Without RootHA, which ensures that harmony occurs, (39b) would be the optimal output. It is therefore an important constraint and must be ranked above IDENT-Root(F).

The word **kiji-rnu-nji-nu** 'throw-PST-INCEP-PST' contains the inceptive **-nji-**. As discussed in Chapter 3, the inceptive is categorised as a verb root and must be suffixed by a tense marker. The inceptive undergoes harmony as a result of being suffixed by the past tense suffixes. The constraint IDENT-VSfx(F) will ensure that the verbal suffixes are the triggers and not the targets in the harmony process when ranked above IDENT-Root(F).

(40) kiji-rnu-nji-nu	IDENT-VSfx(F)	RootHA	IDENT-Root(F)	HA
%a. kiju-rnu-nju-nu			**	
b. kiji-rnu-nji-nu		***!		***
b. kiji-rni-nji-ni	**!			

(40a) is the optimal candidate, which has no violations of the two higher ranked constraints present in the tableau. Violations to RootHA are incurred in (40b) because the root vowels do not agree in place with the suffixes. In (40c) [COR] has spread rather than the input feature [LAB], violating the requirement that input feature identity must be the same in outputs in verbal suffixes.

In words such as **minija-kurlu** harmony is blocked by the presence of the low vowel between the high vowels. Since the high vowels are not adjacent, there is no violation to HA and thus no motivation for harmony. If the high vowels in the suffix surface as front in the suffix, IDENT[LAB] will rule these forms out. Since the analysis allows for feature changing, an identity constraint for /a/ like that for the other place features is required.

(41) **IDENT[PHAR]**: Correspondent segments in S1 and S2 have identical values for [PHAR].

IDENT[PHAR] must be ranked above Root Harmony to ensure there is no change to the feature [PHAR] in any context including verb roots. The rankings of the constraints introduced so far is:

- (42) IDENT[PHAR], IDENT-VSfx(F) >> RootHA >> IDENT-Root(F) >> HA >> IDENT[COR] >> IDENT[LAB]

It is generally agreed that vowel harmony is a device for extending vowel qualities which might otherwise be difficult perceptually (including Steriade 1994, Cole & Kisseberth 1994, Kaun 1995). Thus, it is better that a string containing a mixture of underlying front and back high vowels enhance only one of those vowel types in outputs. However, articulatory factors also play a role in harmony processes; it is easier to maintain articulation for a single vowel type, ie round high, than it is for many, ie round high then front high etc. Thus, harmony also facilitates articulation. The question of articulation arises when considering consonant blocking in Warlpiri, discussed below.

5.4.2 Consonant Opacity

In this section, an explanation for the blocking role of labial consonants is presented. I show that an underlying factor in blocking is the preference for some adjacent consonant and vowel sequences to be homorganic, thus maintaining feature identity.

The blocking behaviour of the low vowel in vowel harmony is explained by adjacency. When the low vowel intervenes between two high vowels, the high vowels are not adjacent and thus harmony cannot occur. Accounting for the blocking behaviour of labial consonants is more difficult. Typically, consonants are invisible or transparent to the spreading of vowel features. The challenge is to determine why consonants block harmony.

In previous accounts of consonantal blocking, blocking is generally held to occur when the blocker is specified for the spreading feature. This analysis would not be possible for Warlpiri because labial consonants block the spread of [COR] and not [LAB].

The fact that labial consonants are opaque to [COR] spreading could mean that adjacent high vowels are in fact not adjacent. This would require a statement such as: high vowels are not adjacent when a labial consonant intervenes; but this would not be effective because labial harmony occurs in such contexts. The statement would have to be more specific, but it would not provide an explanation for blocking.

Given the different role labial consonants play in both harmony processes, it would appear that there is a particular relationship between a labial consonant and an immediately following labial vowel. Under the identity analysis given here, this relationship can be explained as one where maintaining a labial distinction is crucial to morphological distinctiveness. We know that HA is not violated in verbs under suffixation of the suffixes containing /u/ because distinguishing [LAB] is necessary for morphological distinctiveness. If the input feature [LAB] is always parsed in outputs, meaning there is no vowel feature alternation, then it could be assumed that this is to maintain a distinction.

Sequences of iCu where C is a labial are permitted in roots where high ranking IDENT-Root(F) ensures that HA does not win out and, consequently, that labial is parsed. As these sequences are also found in suffixes, we can likewise assume that identity ensures exactness in input and output correspondence of such sequences.

- (46) *pu, bu, tu, du, ku, gu > fu (Bemba)
 *tu > vu, du > fu (Songe)
 *ku > fu (Punu, Swahili, Sango)

Janson's research contrasts with Kawasaki (1982), who found that maximal acoustic contrast is preferred in consonant and vowel sequences. Sequences which are least preferred across languages are sequences of palatalized consonant and palatal vocoid, eg *Cyi*, labialized consonant and labial vocoid, eg *Cwu*, and homorganic glide and vowel sequences, eg *yi, wu*. The difference in these research findings is due to the fact that Janson's research is articulator- or gesture-based, while Kawasaki's research is acoustically-based. In summing up these two perspectives, Clements states that the tendency is for consonant and vowel sequences to exhibit acoustic dissimilation but gestural assimilation.

The relevance of homorganicity or affinity for a degree of homorganicity for the Warlpiri data is significant. While research from Kawasaki indicates that sequences such as *yi, wu* are strongly disfavoured cross-linguistically, this is not the case in many Australian languages, including Warlpiri. This would back the gesture-based research by Janson supporting CV homorganic sequences. Thus, the presence of *yi, wu* and *pu* sequences, as well as the evident preference to maintain labial consonant and vowel sequences, indicates a preference for labial homorganicity. The interaction between labial consonants and vowels cross-linguistically also supports this research.

Other assimilatory phenomena involving consonants are attested in Warlpiri. We have looked at iterative harmony, but a non-iterative type involving consonants is also attested. Assimilatory phenomena involving consonants typically affect a single immediately adjacent segment; ie assimilation is non-iterative. This phenomenon is shown in preverb-verb compounds in Warlpiri. Regressive nasal assimilation occurs when consonant-final preverbs are prefixed to verbs with initial nasals. Examples are from Laughren (1990).

- (47) /puuly-mardarni/ [puuny-mardarni] 'grab'
 (cf. *puulyparni mardarni* [puulyparni])
 /puurl-ngarni/ [puurn-ngarni] 'set out'
 (cf. *puurlparra ngarni* [puurlparra])
 /yiily-ngarni/ [yiiny-ngarni] 'use up'
 (cf. *yiilyparra ngarnu* [yiilyparra])

Manner assimilation occurs in C1-C2 sequences, where C2 is a nasal. No other assimilation, place or manner, occurs in this context. Nasal assimilation is analogous to the situation where labial consonants prefer homorganicity with following vowels. In each case, a single adjacent segment is affected, which is typical of consonant assimilation. The fact that CV homorganicity is a non-iterative phenomenon indicates that a consonant is a factor in assimilation⁷.

The vowel harmony data show, firstly, a requirement that high vowels share the same place feature, and secondly, a requirement that adjacent labial consonants and vowels share the same place feature under input/output identity requirements. When these requirements are in conflict the

⁷ Another example of assimilation involving consonants is found in the two verb roots **pu-** and **yu-** whose vowels undergo fronting when the following consonant is palatal (see fn3). Since this does not occur elsewhere, I assume the process is exceptional. I also assume that the process overrides many of the constraints introduced here.

latter requirement wins. A constraint is necessary to ensure harmony is blocked under certain conditions. This will be an Identity constraint requiring that labial CV sequences are exact in outputs, thus blocking of harmony is achieved if a change to features in such sequences is ruled out. This is stated as follows:

- (48) **IDENT- σ (F)**: Output features of a syllable containing a labial CV sequence are identical to their corresponding input features.

IDENT- σ (F) is in conflict with HA and is ranked above it to ensure CV labial sequences maintain their input identity.

- (49) IDENT- σ (F) >> HA

The effect of this ranking is demonstrated in (50) with the word **ngali-wurru** 'you and I are the ones'.

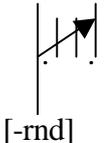
(50) ngali-wurru	IDENT- σ (F)	HA
%a. ngali-wurru		*
b. ngali-wirri	*!	

Interestingly, it is less important to parse [LAB] for vowels in contexts other than CV labial sequences, suggesting that the features of labial CV sequences have to be maintained for contrastiveness.

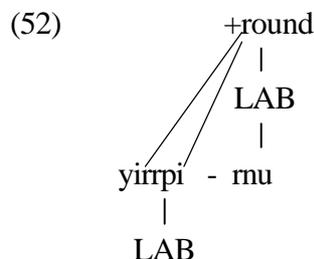
The reason that labial consonants do not block labial harmony in verb roots is because underlyingly they precede a front vowel and vowels in these sequences show alternation, unlike underlying labial CV sequences.

I have claimed that labial CV sequences are homorganic, in which case it is likely that they share the same vowel place feature. Therefore, changing the feature of the vowel could change that of the consonant. A high ranking Identity constraint on features in consonants would rule out any change to consonants in outputs. This analysis relies more or less on representation and, given that the kind of representation is not clear, it would be better to avoid constraints that make reference to it. The bond between labial CV sequences can adequately be captured by an Identity constraint demanding exactness of such sequences.

In their analysis of harmony in Warlpiri, both Sagey (1990) and Cole (1991) describe progressive harmony as the spreading of the labial class node which dominates [-round]. It is argued that the labial node of consonants is responsible for blocking the spread of labial, as in (51). | = blocked

- (51) i p u

 labial node

Sagey and Cole's analyses for the lack of labial blocking of regressive harmony differ. In Sagey, labial consonants do not block regressive harmony, as it is the feature [round] that spreads and [round] is not blocked by labial nodes. In contrast, Cole argues that labials are transparent in regressive harmony because labial spreading occurs from specific morphemes which are on a different tier from roots, as shown below.



The analysis involving homorganic blocking does not rely on autosegmental representation, as in Cole, or on feature geometry, as in Sagey, but captures a cross-linguistic preference for consonant/vowel homorganicity, which in Warlpiri is reflected as a high ranking constraint on feature identity. This enables a straightforward explanation for the blocking of harmony by labial consonants and for the asymmetry in blocking in the two harmony processes.

Warlpiri shows a preference for homorganic labial CV sequences above dorsal and coronal sequences. Labial CV sequences are not altered by COR neutralisation. In contrast, coronal CV sequences may be altered by LAB spreading. Round harmony conveys a relevant distinction, while front harmony is a neutralising process eliminating feature differences if they are not relevant. IDENT- σ (F) serves to maintain a distinction in suffixes which would otherwise be overridden. It is an identity constraint, which is different from IDENT-Root because the latter is a requirement on grammatical categories in positions of prominence, while IDENT- σ (F) is a requirement on the identity of certain segment sequences regardless of position.

In sum, CV homorganicity provides an explanation for the blocking of vowel harmony. This is an advantage over analyses which can formally account for blocking, but are unable to explicate why this should be the case.

5.4.3 Reduplication and vowel harmony

In this section, the role of OT to account for the interaction between harmony and reduplication is shown. The analysis of reduplication relies on two crucial constraints, IDENT-VSfx(F) and the

reduplicative Identity constraint MAX_{BR}⁸.

The general reduplicative constraints require correspondence between the reduplicative element and the base. Reduplicated words are indicated as /RED-base/ in underlying representation, where RED is phonologically unspecified. RED is a prefix whose output is determined by constraints on segmental and syllabic well-formedness, in addition to reduplicative constraints. The

⁸ There are other constraints on the correspondence between the base and the reduplicant, including ANCHORING and CONTIGUITY. These constraints ensure that segments are not skipped and that segments occur in the same sequence in both the base and the copy. These constraints are discussed in more detail in Chapter 6. Outputs in tableaux do not violate these constraints.

reduplicative constraints are essential as the reduplicative morpheme, RED, has no phonetic specification and anything could serve as RED. An important constraint is MAX_{BR} (M&P 1995) which requires that the elements in RED correspond to the elements in the output base. This is stated as:

(53) MAX_{BR}:Correspondents in RED and the output base are identical.

The base and RED are correspondents which must be phonologically identical. The phonological content of the reduplicative element is dependent on the content of the base. If harmony between two high vowels is required in an input containing RED, we would expect the reduplicant to show vowel harmony effects because of the requirement for RED and the base to be identical.

Verbal reduplication involves copying a foot, in contrast to the nominal reduplication pattern where the full root is copied (Nash 1986). A more specific constraint for verbal reduplication is necessary, requiring verbal RED to be equivalent to a foot. Neither this constraint nor the ones on identity can be violated and therefore they comprise the set of dominating constraints. The set of outputs in the tableau are restricted to those involving reduplication of a foot.

The following tableau evaluates the word **RED-pangi-rnu** 'dig-PST' where MAX_{BR} is ranked above IDENT-Root(F) ensuring that feature identity is the same for the base and the reduplicant rather than ensuring exactness of input and output base. The reduplicant is underlined.

(54) RED-pangi-rnu

	IDENT-VSfx	RootHA	MAX _{BR}
%a. <u>pangu</u> -pangu-rnu			
b. <u>pangi</u> -pangi-rnu		*!	
c. <u>pangi</u> -pangu-rnu			*!
d. <u>pangu</u> -pangi-rnu		*!	*
e. <u>pangi</u> -pangi-rni	*!		

Since harmony does not occur between the adjacent high vowels in (b) and (d), RootHA is violated. When there is harmony, but the reduplicated portion does not reflect this, then MAX_{BR} is violated as in (c). (e) violates the IDENT-VSfx. (a) does not violate these constraints and is thus the optimal candidate. (a) violates IDENT-Root because of the vowel change in the output base, but if there was no change then violations to other constraints as shown by the candidates in the tableau would be incurred.

MAX_{BR} effectively ensures that a verb root marked for past tense reflects this marking in the reduplicative element. This maintains the distinction of past tense. Outputs such as ***pangi-pangu-rnu** and ***pangu-pangi-rnu** reflect conflicting tense markings, ie /i/, representing present tense, and /u/, which represents past tense.

Reduplicative examples such as **pangu-pangu-rnu** could suggest that harmony was a result of a domain requirement, ie where harmony is not blocked and not sensitive to adjacency. For instance, it could be that harmony occurs in verb roots not because of adjacency, but because the requirement is for high vowels in the verb domain to agree in place regardless of what intervened between these vowels. The fact that domain harmony does not apply in Warlpiri is

illustrated in examples such as **yirra-rnu** ‘put-PST’, which clearly shows that adjacency is required for harmony in verbs.

5.4.4 Summary

In the account of vowel harmony given in this section, I have provided an explanation for the motivation, as well as for the blocking of harmony. Harmony is dependent on the presence of the feature [high] when adjacent. The low vowel blocks harmony and does not undergo harmony due to the fact that it is specified for [low], not [high]. By combining the insights of adjacency and height dependency, iterativity is mirrored in OT by HA.

Iterativity is restricted by the Identity constraints and so accounting for the absence of harmony in nominal roots, verb suffixes and particular clitics. IDENT-Root(F) reflects the universally attested fact that suffixes not roots undergo harmony. The language specific constraints are IDENT-VSfx(F) and RootHA. When morphological aspects are involved in harmony, we would expect these aspects to be language specific. We would also expect this when the vowel inventory is small and that there would be some contexts where distinguishing the two high vowels is crucial. The interesting feature is that maintaining featural identity is absolute in nominal roots, verbal suffixes, some clitics and certain sequences of segments, but not in verb roots, nominal suffixes, certain clitics. This complicates the harmony processes and contrasts with many other languages where all roots are impervious to feature alternation.

The constraints IDENT[*COR*] and IDENT[*LAB*], including their ranking with respect to each other are compatible with markedness claims (P&S 1993).

The explanation for blocking by labial consonants is due to homorganicity and identity requirements on underlying labial CV sequences. Evidence for homorganicity rests on cross-linguistic research and observations on consonant and vowel interaction. IDENT- σ (F) requires feature identity of particular segment sequences and is different from IDENT-Root(F), which requires exactness within a particular morpheme.

HA is a universal constraint, which is given further support in 5.6. The specification of the features involved is language specific, although there is little variation in what these features are. HA is similar to universal constraints such as FtForm, where the specification for the kind of foot is language specific. The crucial constraints in Warlpiri are:

- (55) IDENT- σ (F), IDENT-VSfx >> RootHA >> MAX_{BR} >> IDENT-Root(F) >> HA >> IDENT[*COR*] >> IDENT[*LAB*]

This constraint ranking where HA is ranked between Identity constraints is predicted in languages with harmony. Where there was no Harmony, all the Identity constraints would be ranked higher than HA.

5.5 Alternative Analyses

In this section, alternative analyses are considered. Firstly, an analysis involving feature underspecification is examined, followed by an analysis involving feature alignment.

5.5.1 Underspecification

In vowel harmony, the kinds of constraints and their ranking are dependent on whether harmonising vowels are underspecified or fully specified in underlying representation. In an underspecification analysis, input vowels that undergo harmony may lack a feature value for place, and so, if the underspecified vowel does not undergo harmony, a place feature has to be inserted. In a derivational (rule-based) analysis, vowels surface with place features by a redundancy or default rule.

In an underspecification analysis for Warlpiri, the relationship between feature spreading and insertion would be intertwined. The feature that spreads in one domain cannot also be the default feature in that domain. For instance, the default feature in the [COR] domain (ie nominals) is [LAB], while [LAB] is the spreading feature in the verb domain and [COR] is the default. Thus, features have to be specified as to which domain they can be inserted into if harmony does not occur.

Problems for an underspecification analysis in Warlpiri arise because there are two harmony processes involving different harmonising features, and it is necessary to specify what feature is inserted when harmony does not occur.

Typically, segments that show feature alternation are underspecified and, while this will account for the majority of forms, there are some segments which undergo feature alternation which cannot be underspecified. For instance, the clitics **-rni** and the pronominal clitics with initial **rli-** surface with [i] when adjacent to stems ending in /i/ or /a/, eg **pina=rni** (from 20b), but when attached to stems ending in /u/ they undergo harmony, eg **muku=rnu**. This is almost the reverse compared to all other suffixes which surface with [u] when adjacent to stems ending in /u/ or /a/, but harmonise when adjacent to stem final /i/, eg **minija-rlu** vs **maliki-rli**. If a form of underspecification were used for all these clitics and suffixes, there would be no way to predict whether [i] or [u] would surface. This is because there are two ‘default’ vowels which surface in the absence of harmony [i] or [u].

These clitics present two problems for the underspecification analysis: (1) the harmonising feature is [LAB] (typical of verb roots) and not [COR] (expected of non-verb root morphemes); (2) the default feature for the clitic is [COR], but the typical default feature outside of verb roots is [LAB]. To account for this either an exceptional constraint is required or the clitics have to be fully specified in underlying representations. The latter option would give rise to an inconsistency as to what is and what is not under- or fully-specified. For instance, the clitics which show harmony are fully specified, but all other forms with vowels that show harmony are underspecified. An exceptional constraint or separating harmonising forms into two representational types, fully or underspecified, provide no explanation for the harmony patterns.

In my analysis, feature change in suffixes is expected as feature identity among high vowels is typically non-distinctive, while in nominal roots input/output feature identity must be exact. The reason for this is that roots, not suffixes, are in positions of prominence. Identity constraints are able to capture this asymmetry as well as account for the instances of round harmony in the clitics and front harmony in some verb roots. While these instances of harmony are not typical, nonetheless they can still be accounted for in a straightforward manner.

An underspecification theory is designed to deal with languages which have a single default feature and this is typically [COR]. In Warlpiri, the ‘default’ in nominals is [LAB] and the feature in triggering harmony is [COR]. In verbs, on the other hand, the trigger is [LAB] and the ‘default’ is [COR]. Thus, harmony is either neutralisation or a distinctiveness process. Even if domains were specified for default features this is not a formal expression of the harmony processes in Warlpiri. It relies on representation, which, while it may account for spreading, does not provide an explanation.

Continuing on with this line of argument, another objection to an underspecification analysis is that feature insertion is required, which seems counterintuitive for a neutralisation process such as [COR] harmony. In fact, it would appear that an underspecification analysis cannot appeal to neutralisation because underlyingly there would be no place features to neutralise.

In another alternative analysis, we might consider floating features in underlying representations (eg Kiparsky ms; Archangeli and Pulleyblank 1994). In Kiparsky's analysis of vowel harmony in Warlpiri, he suggests that for suffixes showing vowel alternation, vowels are specified only as high and are associated with a floating [+round] feature in underlying representation. In the absence of [COR] spreading, the floating feature links to high vowels. In the analysis presented here, the featural identity constraints allow for featural change in suffixes in a straightforward manner without the need for unusual representations. Positing a floating feature in underlying representation is similar to underspecification and would require the same constraints, and for this reason has similar disadvantages as well.

5.5.1.2 Summary

I have argued that vowel harmony involves feature adjacency and identity which can be better captured and explained in an analysis with full specification in the underlying representation.

In rule-based theories of vowel harmony using underspecification, the focus is on the form of the input representation. In OT, on the other hand, concern is on the forms of the outputs and not with the issue of whether underspecification or the form of underspecification is justifiable. This difference between rule-based and OT theories is further emphasized by the fact that well-formedness constraints are inviolable in rule-based theories but violable in OT. It is the constraints in OT and not the representational forms of the input that determine the well-formedness of outputs.

In the analysis in this chapter, underspecification is not relied upon to provide explanations for why harmony occurs. This notion is independent of the issue of underspecification. Harmony is motivated by HA which is an adjacency constraint on features and is not predicated on the presence or absence of certain features. However, I have argued that full specification is more successful in capturing the phenomenon of harmony in Warlpiri.

The fact that verb roots and not noun roots undergo labial harmony is due to specific verbal suffixes. These suffixes must be allowed to dominate otherwise coronal harmony would apply across the board. Labial harmony is morphologically restricted; there are no nominal suffixes which trigger labial harmony.

Coronal harmony applies whenever possible, being blocked in specific contexts, morphological and phonological. The direction of coronal spread reflects the suffixation system of the language and the fact that vowels in suffixes are more likely targets for harmony than vowels in roots.

5.5.2 Feature Alignment

In this section I consider two analyses of vowel harmony as alignment, one by Kirchner (1993) and another by Cole & Kisseberth (1994). In Kirchner, the motivation behind feature spreading has been interpreted as the alignment of a feature to a particular edge. To align a feature, two processes are involved, spreading and the direction of the spread. In Warlpiri, two alignment constraints on features would be required, Align[COR] and Align[LAB].

(56) Align[**COR**]: The feature [**COR**] aligns to the right edge of a prosodic word.

(57) Align[**LAB**]: The feature [**LAB**] aligns to the left edge of a prosodic word.

The feature alignment constraints are gradient. Under gradient assessment, a feature is noted for its distance (ie how many syllables or segments) from a particular edge. In contrast, outright assessment indicates whether or not a feature is aligned.

The advantage of HA over constraints on alignment of features is demonstrated in examples such as **maliki-kurlangu-kari-kurlu** 'dog-POSS-other-PROP'. Consider the following outputs:

- (58) a. maliki-kirlangu-kari-kirli
 b. maliki-kurlangu-kari-kirli

In both (58a) and (b), the feature [**COR**] is aligned to the right edge of the word. The final suffix in the word **-kurlu** has undergone harmony and thus would satisfy an alignment requirement for [**COR**] in both examples. In (58b) the initial vowel in the medial suffix **-kurlangu** has not undergone harmony. It is instances such as these that the align constraints are not able to decide upon. As a result, the two outputs in (58) would be optimal candidates under these constraints.

In contrast, HA would rule out (58b), which the alignment constraint Align[**COR**] is unable to do. The alignment constraint demands that a feature align to an edge and if that feature has aligned to that edge then there is no align violation.

While Cole & Kisseberth (1994) appeal to alignment of features, this alignment is motivated by a constraint requiring certain anchors (segments) in a domain to be 'affiliated' with a particular feature. However, in order to ensure that affiliation occurs up to a certain point or edge, alignment is required. This analysis faces the same criticisms voiced here.

The question of adjacency in harmony is ignored in alignment analyses. HA is an adjacency constraint and as such it provides an explanation for the blocking role of /a/. Whenever /a/ intervenes, high vowels are no longer adjacent. Under the featural alignment constraints, this is given no explanation and would have to be expressed in a separate constraint.

An alignment analysis can guarantee that a particular feature will occur or be aligned at an edge but cannot guarantee that a feature spread elsewhere. This is an instance of where adjacency constraints are more suited to account for word-internal processes.

Consider also an alignment analysis of reduplication. To account for the lack of spreading across prosodic words, feature alignment is confined to prosodic word edges. Recall that vowel harmony does not apply across prosodic words, as for example in [[kurdi¹ji]-[kurdi²ji]] 'shoulder blade'. Spreading to the copied portion of a reduplicated verb would be blocked because it is in a different prosodic word from the root and suffix, as shown in (59).

- (59) [pangi [pangi-rnu]
 |
 LAB

Since the default vowel in verb roots is /i/, the output would be [pangi[pangu-rnu] from **RED-pangi-rnu**. In an Identity analysis, the optimal output is due to MAX_{BR}. This can also be appealed to by an alignment analysis, but the problem would be that harmony is due to alignment as

well as a particular identity requirement. A more cohesive analysis considers harmony as an identity phenomenon.

Another problem for an alignment or spreading analysis is fast speech phenomena. In Chapter 4, I argued that the parsing of the prosodic word is an option under fast speech conditions.

If prosodic word boundaries are not present, this could entail that features spread unconditionally across word boundaries up to the edges of an IP. Since this is not attested in the data analysed it would appear that prosodic word boundaries do not in fact constrain vowel harmony. An Identity analysis can account for the absence of harmony across words due to IDENT-Root(F). Other arguments against alignment can be found in Beckman (1998) and Kaun (1995).

5.5.3 *Vowel Opacity*

In some analyses of blocking it is argued that blocking occurs because of incompatibility of the feature spreading with the blocking segment. Cole & Kisseberth (1994) argue that the low vowel /a/ blocks round harmony because of a clash constraint ruling out segments with the features *[Rd,Low]. They claim that this constraint prevents the insertion of features on an inappropriate segment.

The requirement that harmony depends on adjacency can account for the opacity of the low vowel, as well as harmony. Where output features are different from input ones, the identity constraints on features determine whether this is acceptable or not. Clash constraints are not needed to rule out inappropriate combinations of features.

5.6 *Other Issues*

The remaining issues to be addressed are the universality of HA and transparency. The section closes with a summary on round harmony.

5.6.1 *Universality of HA*

HA is a constraint where place spreading is dependent on height. Kaun (1995) notes that the preference for rounding harmony is when the trigger and target agree in height. There are numerous languages where such dependency exists. One example is Tiv, where round spreading is reliant on the height of the vowel (Pulleyblank 1988, Archangeli and Pulleyblank 1994). If vowels are specified for [+high] then round spreading occurs.

Another example is Turkish, where [round] spreads rightwards across high vowels and is blocked by the presence of low vowels (Clements and Sezer 1982), as shown in (73). U=high front round; i=back unround

(60)	gen.sg.	gen.pl	
	ip-in	ip-ler-in	'rope'
	yUz-Un	yuz-ler-in	'face'
	kiz-in	kiz-lar-in	'girl'
	pul-un	pul-lar-in	'stamp'

The failure of high vowels to harmonise in the suffix **-in** in the genitive plural is due to adjacency. Non-adjacent high vowels do not harmonise in place. The failure of the low vowel /a/ to harmonise is attributed to the fact that it lacks the feature [high].

Yawelmani is another language where feature spreading is dependent on the presence of other features. [round] spreads rightwards onto vowels of similar height but not onto vowels of different height (Archangeli and Pulleyblank 1994).

HA is formulated in the analysis here to capture the interaction between the place features [COR] and [LAB] and the feature [high]. Essentially, HA is a constraint which expresses a dependency relationship between features, and can be utilised to capture dependency relations in other languages.

In her extensive survey on rounding, Kaun (1995) finds that, in six of the nine rounding patterns, harmony is either unconditioned or dependent on vowel height. In the remaining patterns, harmony is unrestricted among front vowels, but for back vowels the pattern is similar to the other six patterns, that is, the trigger and/or target must be high. Some examples are given in the following table modified from Kaun (1995:61-2).

(61) Rounding Typology

Target must be [+high]	Nawuri (Casali 1993), Southern Paiute (Sapir 1930), Sierra Miwok dialects (Callaghan 1987), Turkish (Clements & Sezer 1982), Tuvan (Krueger 1977)
Trigger and target must both be [-high]	Eastern Mongolian dialects (Svantesson 1985, Riialand & Djamouri 1984), Murut (Prentice 1971), Tungusic languages (Ard 1981, Sunik 1985, Avrorin & Lebedeva 1978), Galab (Steriade 1981)
Trigger and target must both be [+high]	Hixkaryana (Derbyshire 1979), Kachin Khakass (Korn 1969), Tsou (Hsu 1993)
Trigger and target must agree in height or target must be [+high]	Yakut (Krueger 1962)
Trigger and target must agree in height	Yokuts (Newman 1944, Kuroda 1967, Archangeli 1984, Gamble 1978)
Harmony unrestricted among [-back] vowels; among [+back] vowels, target must be [+high]	Kazakh (Korn 1969), Chulym Tatar (Korn 1969), Karakalpak (Menges 1947)
Harmony unrestricted among [-back] vowels; among [+back] vowels trigger and target must both be [+high]	Kyzyl Khakass (Korn 1969)

Given that a number of languages have a dependency on height features, HA would serve as a height-dependency constraint. The features that are dependent on height are language specific. For those languages where back vowels undergo rounding harmony, then backness will be the dependent feature.

In some languages, certain vowels are transparent to harmony, which means that an adjacency requirement would be too specific. A general harmony constraint with a dependency requirement would be sufficient to account for harmony in such cases. Transparency is discussed in the following section.

HA accounts for the absence of skipping behaviour because it requires adjacency. Other analyses in OT appeal to a constraint called NOGAP (Archangeli & Pulleyblank 1994, Kirchner 1993, Beckman 1995) to prevent features skipping over potential anchors. The constraint is expressed in (62).

(62) NOGAP: * F


*nOir-i:xa:
 tomr-i:xo: ‘iron’ (REFL GEN)
 *tomr-i:xe:

- (66) Opaque U, u in rounding harmony
 Or ‘enter’
 Or-O:d ‘enter’ (PERF)
 Or-U:l ‘enter’ (CAU)
 Or-U:l-a:d ‘enter’ (CAU,PERF)
 *Or-U:l-O:d

tor ‘be born’
 tor-o:d ‘be born (PERF)’
 tor-u:l ‘be born (CAU)’
 tor-u:l-e:d ‘be born’ (CAU,PERF)
 *tor-u:l-o:d

The generalisation is that [-high] vowels agree in place except when right adjacent to high round vowels. There is no adjacency requirement, but rather harmony is general to the suffixal domain. This can be expressed as:

- (67) **Round Harmony:** [-high] vowels agree in place.
 (68) **IDENT-Sfx(F):** When U, u are in a suffixal domain, output features must be identical to input ones in that domain.

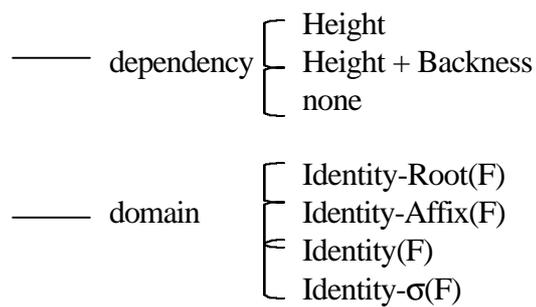
An IDENT-Root constraint would ensure that feature changes to inputs in the roots is ruled out, and thus only [-high] vowels in suffixes undergo harmony.

Kaun argues that rounding only occurs between non-high vowels in Mongolian because the distance between these vowels is much less than for the high vowels, harmony would then assist in identifying a vowel quality accurately. Rounding of high vowels occurs if this vowel space is relatively crowded. Building on this claim we could say that rounding harmony is unnecessary when a high round vowels occurs because it is sufficiently distinct from the non-high.

5.6.3 A Rounding Summary

At the beginning of this chapter, I mentioned that the apparent characteristics of harmony, direction and iterativity can be interpreted differently under OT with adjacency and the Identity constraint family. Direction is due to Identity constraints on roots, and iterativity due to feature Identity requirements of certain output segments, which involves adjacency of features. In fact, we can establish with some certainty that there are three characteristics of harmony: the motivation of harmony, the harmony dependency feature and the harmony domain. Each of these characteristics has specific requirements expressed as constraints.

- (69) *harmony characteristics*
- | | | |
|------------|---|--------------------|
| motivation | { | Harmonic Adjacency |
| | } | Domain Identity |



Concern with the output of certain features motivates harmony in terms of adjacency or within a domain. Just what the feature output is is dependent on another feature, or, in the case of epenthetic vowels, there is no feature dependency. Where the harmony occurs is dependent on what is permitted to undergo feature alternation. The ranking of the constraints will determine whether harmony will occur or not, what will harmonise and where.

(70) Constraint Typology

No harmony: Identity >> HA

Harmony in affixes: Identity-Root >> HA >> Identity(F)

It is expected that language specific constraints supplement the general harmony constraints as in Warlpiri, where IDENT-VSfx and a specific Root Harmony constraint is required.

5.7 Concluding Remarks

In this chapter I have argued that vowel harmony can be attributed to adjacency and that adjacency can be expressed as a constraint. While adjacency in vowel harmony is not a novel conception of harmony (Archangeli and Pulleyblank 1986, Sagey 1990, Cole 1991), my contribution is to show how adjacency can be formally expressed in a full specification analysis within OT. In addition, I have expanded on adjacency by combining it with height dependency, which is able to account for the two vowel harmony processes in Warlpiri.

Furthermore, an adjacency analysis supports my claim that some processes are better captured under adjacency rather than under alignment constraints.