CHAPTER 2

DIAGONAL CORRESPONDENCE THEORY

2.1. INTRODUCTION

In chapter one I highlighted a number of observations for harmony and tonal interactions that are opaque. First, I argued that opacity is better defined as input-defined output, as contrasted with transparent, output-defined output. Second, I argued that the generalization captured by ordered alpha-rules or autosegmental rules for opaque interactions is one of non-equivalent correspondence among segments or features. Third, I showed that instead of being marked, opacity is quite common when it comes to tone and harmony and that certain types of feeding or bleeding relationships are non-existent. Finally, I showed that while some cases of opacity reflect the interaction of phonological processes that are at different domains, or strata, of application, there are myriad cases of within-strata opacity. In this chapter I introduce Diagonal Correspondence Theory (DCT), which captures these observations formally through a modification of existing Optimality Theory architecture.

The basic idea behind DCT is to expand the scope of faithfulness constraints. Normal faithfulness constraints (more detail in §1.3.3 on OT) express a relationship between equivalent segments in the input and output. For example, the phonological process A→B/C_D, creates an input-output pair of /CAD/→CBD. In OT, the C on the input corresponds with the C on the output, input A corresponds with output B and input D corresponds with output D. The change of A to B violates a constraint maintaining faithfulness among corresponding segments, presumably to decrease markedness of the string, while the input-output mapping of C→C and D→D does not violate any faithfulness constraints.

(1) Graphical representation of standard correspondence:

a) /CAD/
↓ ↓ ↓
[CBD]

In chapter one I showed that cases of opacity involving tone shifting and harmony reflect a different type of correspondence. Two representative examples from the first chapter, Jita tone shifting, and the interaction of harmony and lowering in Shimakonde are repeated here:

(2) Opaque interactions in Shimakonde and Jita

a) Shimakonde Vowel Height Harmony and Reduction:

/ku-pet-il-a/	kú-pa̲t-**éé**l-a	‘to sift for’

b) Jita tone shifting

/ku-β**ó**n-er-a/	ku-βon-**é**r-a	‘to get for’

The Shimakonde example reflects a process of vowel height harmony, where the applicative suffix, *-il-* surfaces as *–el-* because of height harmony to the verb root, *pet*, and reduction, where pre-penultimate mid vowels are reduced to *a*. The Jita example reflects a single phonological process of a one-TBU tone shift.

Both examples reflect the following correspondence relationship, which I term diagonal because it combines the vertical input-output correspondence, and a horizontal, syntagmatic relationships between segments:

(3) Graphical representation of

a) Jita tone shift	b) Shimakonde Harmony
/ku-β**ó**n-er-a/	/ku-p**e**t-il-a/
↘	↘
[ku-βon-**é**r-a]	[ku-pat-**ee**la]

DCT establishes this correspondence relationship among non-equivalent input-output segment pairs. As with input-output faithfulness (i.e. the vertical correspondence among equivalent segments in 1), DC faithfulness constraints incur violations when segments that are in diagonal correspondence are different. This can capture opaque generalizations as illustrated in (3), for example, where in (3a) output *ér* must agree with respect to high tone with input ***βón*** and in (3b) where the applicative suffix, *-el-*, must agree in height with the vowel in the input verb root, *pet*.

DCT builds on a number of existing concepts within OT, namely two-level markedness constraints (McCarthy, 1996), correspondence theory and the "full model" of reduplication (McCarthy & Prince, 1995) and harmony as correspondence (Bakovic, 2001; Hansson, 2001; Krämer, 2003; Rose & Walker, 2004). Therefore, I begin this chapter by describing these different theories in detail before providing a formal expression of DCT.

In §2.2 I explore the theoretical precursors to diagonal correspondence which include the full model of reduplication (McCarthy & Prince, 1995) and two-level constraints (McCarthy, 1996). In §2.3, I present a theory of vowel harmony based on correspondence that can also account for blocking, a phenomenon previously thought to be outside the scope of harmony via correspondence (Hansson, 2001; cf. Hansson 2007).

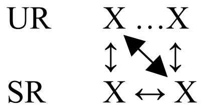
Section 2.4 shows how DCT can account for opacity involving tonal interactions and harmony in a number of languages. Finally, because of the limited empirical coverage of this approach, I discuss how DCT fits within a larger theory of opacity.

2.2. THEORETICAL PRECURSORS TO DIAGONAL CORRESPONDENCE

Identity constraints establish the agreement, or identity, of features among corresponding elements, with correspondence determined with respect to input-output pairs, base-reduplicant, output-output pairs, or across string-internal segments. For example, IDENT(F) is shorthand for a constraint that requires that corresponding input-output segments agree with respect to the feature F; IDENT(F)-BR incurs violations when corresponding segment in base and reduplicant differ for feature F; IDENT(F)-OO incurs violations when the same segment in different cells of a paradigm differ with respect to feature F; IDENT(F)-CC incurs a violation for output consonants that are in correspondence that do not agree with respect to feature F.

DCT establishes a new type of correspondence relationship among segments. The diagram below sketches the new relationship proposed by DC in the context of other established correspondence relationships in OT. The up-down arrow represents input-output correspondence while the left-right arrow represents syntagmatic correspondence of the sort in BR-correspondence or string correspondence in harmony (Bakovic, 2000; Krämer, 2001; Walker, 2000; Rose & Walker, 2004; Hansson, 2001), described in further detail in §2.3. The new correspondence is the diagonal arrow, establishing a correspondence between an output segment and a different input segment.

(4) Diagonal correspondence



Instead of seeing IO, BR, CC and OO correspondences as completely independent constraint sets, they can all be seen as subsets of a more general across-the-board correspondence. Input-output correspondence limits correspondence to one particular dimension, the input-output dimension; syntagmatic correspondence (S-IDENT, ID-CC) ignores the input-output dimension and establishes correspondence in the orthogonal output dimension; output-output correspondence holds the other dimensions constant and makes use of the paradigmatic dimension; BR correspondence is another kind of syntagmatic correspondence that holds all dimensions constant except for base-reduplicant relationship.

(5) Typology of correspondences

Correspondence	I/O	Paradigmatic	Syntagmatic	Reference
ONE-DIMENSIONAL				
Corr-IO	I~O	evaluated form	*n*	McCarthy & Prince (1995)
Corr-OO	output	eval ~ base	*n*	Benua (1996)
Corr-BR	output	evaluated form	$B_n \sim R_n$	McCarthy & Prince (1995)
Corr-CC S-IDENT	output output	evaluated form evaluated form	C_n (V) ~ C_{n+1} V_n (C_0) ~ V_{n+1}	Hansson (2001) Krämer (2001)
TWO-DIMENSIONAL				
Corr-IR	I~O	evaluated form	$B_n \sim R_n$	McCarthy & Prince (1995)
Diagonal	**I~O**	**evaluated form**	$\mathbf{X_n \ldots X_{n+1}}$	

In the above table, the correspondence relationship is shown by the cell with a tilde indicating which segments along the dimension specified are in correspondence, while the other cells indicate the variable along which the other dimensions are fixed. So, for input-output correspondence, the correspondence holds between input and output forms. Along the paradigmatic dimension, the only relevant form is the target form and in the syntagmatic dimension, the syntagmatic order of each segment is held constant, so segment 1 in the input string corresponds with segment 1 in the output string and so on. For CORR-CC, correspondence holds among each of the consonants in the evaluated output form; for output-output correspondence, the output of the evaluated form is compared to the output of the evaluated form in a segment-by-segment comparison; in CORR-BR, the first segment in the base corresponds with the first segment in the reduplicant for the output. In each of these relationships, correspondence varies only in one dimension.

If all of these dimensions of correspondence are parameters, then a potential correspondence exists between all segments in both input and output and all output forms in the same paradigm with each specific correspondence relationship identifying some subset of these correspondences. In DC the variation is along two dimensions – the input-output dimension and the syntagmatic dimension.

In this section, I discuss two precursors to this type of relationship: Input-Reduplicant correspondence and two-level markedness constraints, which establish markedness based on adjacency as determined by both input and output forms.

2.3.1. The full model of reduplication

There is precedence for this sort of two-dimensional correspondence. In the model of correspondence laid out in McCarthy and Prince (1995) there is a contrast between the basic model of reduplicative correspondence, which includes only BR and IO (or IB) correspondence and the full model, which includes the added diagonal dimension of IR correspondence, correspondence between input and reduplicant.

The basic model accounts for the relationship between base and reduplicant and input in many of the documented cases of reduplication. In base-reduplicant correspondence, agreement is established between the base and the reduplicant morpheme to copy phonological material from one to the other. In Javanese, for example, a reduplicant prefix is copied from the surface form of the base and is not a copy of the underlying form:

(6) Javanese reduplication (McCarthy & Prince, 1995)

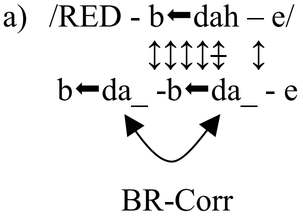
	Root	Redpulicated Form	Red. + V-initial suffix	
a)	b⬅dah	b⬅dah-b⬅dah	b⬅da-b⬅da-e	‘broken’
b)	daj←h	daj←h- daj←h	daj←-daj←-e	‘guest’

To enforce *h* deletion in the reduplicant to reflect intervocalic *h*-deletion in the base, a set of constraints establishing correspondence between the two may be used with the constraint DEP-BR establishes a correspondence relationship among elements in a syntagmatic string.

(7) Tableau for Javanese reduplication (McCarthy & Prince, 1995) showing BR-correspondence:

/RED-b⬅dah-e/	DEP-BR	*VhV	MAX-IO
a)→b⬅da-b⬅da-e			*
b) b⬅dah-b⬅dah-e		*	
c) b⬅dah-b⬅da-e	*!		

(8) Figure showing syntagmatic correspondence in Javanese:



The full model is required for a couple of special cases where there is greater faithfulness between the input and reduplicant than base and reduplicant or input and base. For example in Klamath (Clements & Keyser, 1983) the distributive morpheme is a reduplicant morpheme that is based on the input, rather than the base. This is evident in the examples in (9) where the first vowel of the base undergoes deletion or reduction following another syllable. The vowel in the reduplicant, instead of being based on the reduced or deleted base vowel in the output is instead faithful to the vowel of the input verb stem.

(9) Klamath RI faithfulness

a) Vowel deletion

/DIST+mbody'+dk/	mb**o**-mpditk	'wrinkeld up (dist.)'
/DIST+poli:+k'a/	p**o**-pli:k'a	'little policemen (dist.)'

b) Vowel reduction

/DIST+dmesga/	d**e**-dməsga	‘seize (dist.)’
/DIST+sipc+a/	s**i**-səpca	‘put out a fire (dist.)'

This can also be understood as a type of unorthodox opacity. A rule-based approach would require that reduplication precede vowel reduction/deletion but the traditional counter-bleeding and counter-feeding ordering analyses do not apply. First, reduplication feeds reduction since it creates the non-syllable-initial environment for reduction/deletion. Second, if reduction had applied first it would not have been applicable to the form since the verb stem vowel is not preceded by a syllable and so in this sense the rules are in a counter-bleeding relationship. This is not a traditional counter-bleeding relationship, however, because at issue is not the application of reduction (which could have applied based on, for example being in penultimate position), but rather the vowel of the reduplicant.

(10) Klamath rule ordering:

a)

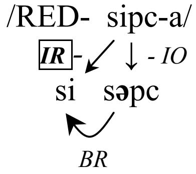
	/DIST+sipc+a/		/DIST+sipc+a/
reduplication	si-sipca	reduction	--
reduction	si-səpca	reduplication	si-sipca

In an OT approach, the inadequacy of the surface-based approach is clear from the tableau below: neither base-reduplicant identity nor input-output identity can account for the redpulicant’s vowel. To get the correct form, IR-faithfulness must exist and must be highly ranked so that the reduplicant’s vowel is [i]. The result is that an element on the output crucially depends on a non-identical element of the input:

(11) Necessity of IR-faithfulness in Klamath

/RED-sipc-a/	REDUCE	ID(H)-BR	ID(H)-IO	ID(H)-IR
sə-səpca			*	*
→si-səpca		*	*	
si-sipca	*!			
sə-sipca	*!	*		*

(12) Visual representation of IR correspondence for Klamath



2.3.2. Diagonal Correspondence as a Two-Level Constraint

The idea that constraints can refer to input forms is the hallmark of faithfulness and McCarthy & Prince (1995) note that there may be more to the notion of correspondence by alluding to other (non-faithfulness) constraints that could refer to both input and output:

> One topic worthy of future investigation is the potential for stating constraints other than the faithfulness variety on correspondent pairs in input and output. Developments along this line can produce the sane general effect as the ‘two-level’ rules introduced by Koskenniemi (1983) and further studied by Karttunen (1993), Lakoff (1993), and Goldsmith (1993) and others.

McCarthy (1996) lays out a framework wherein a markedness constraint can refer to either the underlying or surface form for any of the relevant elements of a markedness constraint. Building on Archangeli (1994), the components of a regular surface-based markedness constraint for harmony include a number of elements including two substantive components for context-dependent markedness constraints – the marked element and the context within which it is marked. Were harmony in Mafa (8 in §1.2.1: ð⬅k-a↴a vs. ʃid-e↴e) enforced using a markedness constraint, these two terms would be a back vowel following a palatal vowel. In many cases order is also crucial with respect to the two elements – because Mafa harmony targets suffixes, the order is left-to-right. Finally, further specification of the degree of adjacency may be necessary to refer to whether there is any intervening material between the two elements. For vowel harmony, 'V-to-V' adjacency is necessary; for local assimilation, immediate adjacency is necessary. When a constraint of this sort is ranked above the identity constraint maintaining the value for the underlying feature [BACK], this constraint (abbreviated HARMONY) selects the a surface-transparent form:

(13) Transparent Shimakonde harmony

/ʃid-a↴a/	ID[BACK]/ROOT	HARMONY	ID[BACK]
(a) →ʃid-e↴e			**
(b) ʃid-a↴a		*!	
(c) ʃ⬅d-a↴a	*!		

If, however, each of the substantive components of the constraint can refer to underlying forms, this constraint can be altered to account for the opaque Mafa vowel harmony with a near-identical tableau. The constraint would be as follows:

(14) IO markedness constraint for Mafa opacity

*	Condition	Level
α	[-back]	Underlying
β	[+back]	Surface
Order	α, β	Underlying
Adjacency	V-to-V	Indifferent

This markedness constraint would incur a violation whenever an input front vowel is followed by an output back vowel:

(15) Opaque Mafa harmony

/ɓ⬅-j-a↴a/	*⬅j	Harmony	Id[Back]
(a)→ɓi-j-a↴a			*
(b) ɓi-j-e↴e		*!	**
(d) ɓ⬅-j-a↴a	*		

The Harmony constraint is now evaluated as a two-level constraint and the α now refers to whether the vowel in the underlying form – not surface form – is front.

The main criticism that has been leveled against this account of opacity is the supposed problem of intermediate forms. Oft-cited cases of this include the inability to apply syllable-based phonotactic constraints on an unsyllabified underlying form, and so a syllabified intermediate form is required. In a common example, Bedouin Hijazi Arabic (Al Mozainy, 1981; McCarthy, 1999), open-syllable vowel raising interacts opaquely with glide vocalization and epenthesis (16). The failure of raising to apply in the forms in (b) represents a case of under-application and McCarthy (1999) cites this as a problem for two-level markedness. If underlying forms are unsyllabified the open-syllable vowel raising markedness constraint, *a]$_\sigma$, would be unable to reference a syllable boundary in the underlying form. If underlying forms are syllabified, this runs afoul of the principle of richness of the base.

(16) Opaque interaction of open-syllable raising with epenthesis and glide vocalization

a) Transparent vowel raising:

/katab/→kitab ‘he wrote’

b) Opaque vowel raising:

/badw/→ba.du ‘Bedouin’

/gabr/→ga.bur ‘grave’

A third alternative is possible, however, based on the idea that segmental phonotactic are best understood as string-based rather than syllable based (Steriade, 1999; Blevins, 2003). Both cite a diverse set of evidence including the lack of consistent judgments on word-medial syllabification, and the greater explanatory power provided by string-based licensing-by-cue grounding of these phonotactic constraints. Thus, the BHA constraint *a]$_{\sigma}$ can be restated as *aCV.

There is language-internal evidence supporting this formulation of the constraint. There are no cases of mono-syllabic vowel raising and the occurrence of word-final *a* in exceptions such as *ṛima* ‘antelope’ (Al Mozainy, 1981), *talaba* ‘student’ (Al-Hazmy, 1972) and *ha:ða* ‘palm’ suggest that this string-based constraint is more empirically accurate than the syllable-based one. There is also another phonotactic constraints in BHA that is clearly string based and is similar to the vowel-raising constraint. Low vowels are deleted before *CaCa* sequences (*shabat* ‘she pulled’ cf. *sahab* ‘he pulled’) motivated by a *aCaCa (or *aCa]$_\sigma$) constraint. An *aCV constraint would be formally similar.

(17) IO markedness constraint for BH Arabic opacity

*	Condition	Level
α	a	Surface
β	CV	Underlying
Order	α< β	Underlying
Adjacency	Strict	Indifferent

Restated thusly, (abbreviated *$a_O CV_I$) this markedness constraints can be incorporated as a two-level constraint, selecting the correct form given an unsyllabified input for both opaque and transparent forms.

(18) Transparent BHA vowel raising

/katab/	*CC#	*$a_O CV_I$	ID[LOW]	DEP
(a) →kitab			*	
(b) katab		*		

(19) Opaque BHA vowel (non-)raising

/gabr/	*CC#	*$a_O CV_I$	ID[LOW]	DEP
(a) →gabur				*
(b) gibur			*!	*
(c) gabr	*!			

The input-output constraint would fail to apply to *gabur* because the CV-component of the constraint is stated at the underlying level, and the underlying form /gabr/ lacks a vowel.

Other instances of the effect of the intermediate form are harder to come by, particularly within the domain of tone and harmony. Consider a hypothetical example, based on the Shimakonde data above, where harmony and reduction interact in the same way, but coalescence and harmony are in a feeding relationship:

(20) Shimakond-B

a) /vanda-ip-a/	vandeepa
b) /vanda-ip-il-a/	vandaapeela

The harmony in example (b), *vandaapeela*, is based on the intermediate form *vandeepeela* which would prove difficult for two-level constraints. I know of no cases like this, however, and so ideally, a formalization of opaque tonal interactions would rule out this sort of interaction.

Thus, there is evidence that two-level markedness constraints are an appropriate account for opaque interactions. DC is a two-level faithfulness constraint, however, and while the tableau in (15) showed the correct evaluation of opacity in Mafa, two-level markedness constraints are not rich enough to account for the full range of phenomena. In the next section, I argue that harmony is best accounted for through correspondence and faithfulness constraints, and so opacity involving harmony is therefore best accounted with with DC. The section after that also shows that this approach also has the benefit of unifying an analysis of opaque harmony with an analysis of opaque tonal interactions.

2.3. HARMONY AS CORRESPONDENCE

There is, at this time, no consensus on how to formalize harmony within OT, yet there is agreement that there are four descriptive elements of any harmony system that need to be accounted for, ideally with as few formal elements as possible:

(21) Harmony parameters

a) Harmonic feature(s)
b) Target segments
c) Directionality
d) Harmony-opaque and/or harmony-transparent segments

The harmonic feature is the simplest to describe and refers to the feature that the targeted segments must share in common. For example, in Yoruba, the harmonic feature is [ATR] since affixes must share the same featural specification with respect to [ATR] as the root:

(22) Yorbua [ATR] harmony

a) [+ATR]

/e-we/	[ewe]	‘lip’
/o-ge-de/	[ogede]	‘incantation’

b) [-ATR]

/e-gɛ/	[ɛgɛ]	‘cassava’
/o-ge-dɛ/	[ɔgɛdɛ]	‘banana’

More complex is the challenge of defining which segments are subject to harmony and which are not. In many OT accounts of harmony (e.g. Bakovic, 2001; Hayes & Londe,

2006) it is assumed, either implicitly or explicitly, that the phonology – presumably the representation – makes available a vowel projection (Vergnaud & Halle 1979) or tier (Archangeli & Pulleyblank, 1987) which expresses just the vowels of the string so that consonants can be ignored in the structural description of constraints.

Vowel harmony also often holds across some subset of vowels with non-participating vowels being either harmony transparent or harmony-opaque[1]. Harmony-transparent vowels allow agreement to hold between vowels on either side of it, as if the vowel did not exist. For example, Hungarian has backness harmony (a) that is not affected by neutral vowels (b), which are demonstrably neutral by virtue of the fact that they can take either suffix (c):

(23) Hungarian back harmony with harmony-transparent vowels:

a)	tœk-nek	'pumpkin (DAT.)'	haz-nak	'house (DAT.)'
b)			radir-nak	'eraser (DAT.)'
c)	viz-nek	'water (DAT.)'	hid-nak	'bridge (DAT.)'

Harmony-opaque vowels block agreement between vowels on either side of it. For example, in Shimakonde vowels that are [-low] agree with respect to the feature [-high] while vowels that are [+low], namely *a*, are harmony-opaque: they block harmony and are also unaffected by it:

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[1] The term "harmony-opaque" is used here to disambiguate from the use of them term opaque in the rest of this study.

(24) Basic Shimakonde vowel height harmony (VHH)

a) High/low vowel root

kú-pa̲t-**íí**l-a	‘to get for’
kú-píkí̲í̲t-**íí**l-a	‘to play for’
ku-pu̲t-**íí**l-a	‘to wash for’

b) Mid vowel root

kú-pé̲t-**éé**l-a	‘to sift for’
ku-to̲t-**éé**l-a	‘to sew for’

c) *a*-blocking

ku-pe̲t-**a̲**n-**íí**la	‘to sift for each other’	(*lek-an-ééla)

Crucially, *a* has the same feature specification as the harmonic feature, [-high], which proves challenging for many formalizations of harmony.

Thus, a theory of harmony should be able to account for both harmony-transparent and harmony-opaque vowels..

2.2.2. Precursors to vowel harmony as correspondence

Within the OT framework, a number of different constraints have been suggested to account for harmony that essentially capture the same idea as harmony via correspondence including AGREE (Bakovic, 2000), S(YNTAGMATIC)-IDENT (Krämer, 2001) and MATCH (McCarthy, 2003), which all essentially require that surface segments share the same relevant feature specification.[2] The phonetic and cognitive underpinning of natural patterns of harmony is likely a combination of phonetic precursors such as co-articulation (Gafos, 1996; Ohala, 1994) and a cognitive bias for phonologizing relationships among like elements (Moreton, 2008). While harmony is sometimes modeled through markedness constraints (Pulleyblank, 2002), the similarity of constraints like AGREE to the identity faithfulness constraint (McCarthy & Prince, 1995) is striking and made explicit with Krämer's (2001, 2003) syntagmatic identity:

(25) Formalization of AGREE (Bakovic, 2001), S-IDENT (Krämer, 2001) and IDENT (McCarthy & Prince, 1995) constraints:

a) IDENT(F): Let A be a segment in S_1 and B be any correspondent of A in S_2. If A is [αF], then B is [αF].

b) AGREE[±*hf*]: Adjacent segments have the same value of [±*hf*].

c) S-IDENT[F]: Let *x* be an entity of type T={segment, more, syllable, foot} in domain D={Pwd, foot, syllable} and *y* be an adjacent entity of type T in domain D, if *x* is [αF], then *y* is [αF]

Bakovic (2001) and Krämer (2003) account for harmony-opaque segments by defining AGREE and S-IDENT as holding over adjacent vowels. A vowel that cannot accommodate the harmonic feature because of feature co-occurrence constraints (e.g. *[+high, +low] or

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[2] There is also an approach to harmony based on the alignment of some harmonic feature with either the left or right edge of a domain (Archangeli & Pulleyblank, 1993; Kirchner, 1993; Cole & Kisseberth, 1995; Pullyblank, 1996). The adoption of Correspondence Theory obviated the need for alignment constraints, however. This approach is also flawed because it stipulates directionality (ALIGN-R, ALIGN-L) whereas it is generally predictable (Hyman, 2002; Bakovic, 2000) and it also creates a too-many-repairs problem where alignment constraints could theoretically be satisfied by deletion of a vowel. Finally, an alignment approach implicitly assumes that intervening consonants are also affected by the the harmonic feature despite evidence to the contrary (Ettlinger, 2004; Kim, 2007).

*[+high, -ATR] for Yoruba) establishes a new harmonic domain, blocking the harmonic feature from spreading further. This cannot account for the behavior of harmony in Shimakonde, however, because the featural representation of the opaque vowel, *a,* is [+low, -high] which agrees with respect to [high] with a mid [-high, -low] vowel to its left and should therefore spread [-high] to its right according to their theories. This incorrectly yields a harmony-transparent *a* where */ku-pet-an-il-a/*→**kupetaneela* as opposed to the correct *kupetaniila*:

(26) Transparency of *a* using AGREE

/e C a C i/ [-h] [-h] [+h]	AGREE(HI)	ID(HI)
←e C a C e [-h] [-h] [-h]		*
☹ e C a C i [-h] [-h] [+h]	*¡	

Instead, agreement must be required to hold only for vowels that are [-low] in Shimakonde or, indeed, for any other languages displaying prototypical 5-vowel Bantu VHH. This can be implemented through the further use of tiers and feature geometry by positing that the [high] feature depends on the [low] feature (Clements & Hume, 1985).

Alternatively, the harmony constraint itself can be reformulated such that it holds only among vowels that are [-low]. This is the essence of the approach argued for in Archangeli and Suzuki (1997) and others where the constraint would be articulated as [LOW]/[HIGH]: segments that agree with respect to the feature [LOW] must agree with respect to [HIGH]. These constraints are ad hoc, however. The empirical pattern embodied by all of these approaches is preferably generalized such that harmony is defined as syntagmatic identity of some harmonic feature holding among segments sharing some other feature.

2.2.3 Vowel Harmony as Agreement by Correspondence

The most straightforward way to formalize the agreement of certain vowels with respect to a certain feature is to use Agreement by Correspondence (ABC; Walker, 2002; Rose & Walker, 2004; Hansson, 2001), originally suggested for consonant harmony, to account for vowel harmony as well. ABC establishes correspondence amongst segments that share a particular feature or set of features and enforce agreement among corresponding segments. For example, in Aymara, homorganic consonants must agree with respect to laryngeal features:

(27) Aymara

a) Homogranic w/ lanyngeal agreement

tunti	‘arid’
k’ask’a	‘acid to the taste’
$k^h usk^h u$	‘common’
$*k^h aka$	
*kak’a	

b) Heterorganic

qotu	‘group, pile’
t’aqa	‘flock’
$t’alp^h a$	‘wide’

To formalize this, Rose and Walker (2004) and Hansson (2001, 2004) argue that there is a fixed hierarchy of consonantal correspondence correlated with degree of similarity and that segments in correspondence must by the same with respect to the harmonic or agreeing feature. Thus, correspondence amongst the most similar consonants (i.e. identical) is ranked highest (Corr-T↔T), followed by correspondence among homorganic stops (Corr-T↔D), followed by stops with identical voicing (Corr-T↔K) followed by all oral stops (Corr-K↔D). The ranking of the relevant identity constraint with respect to this hierarchy establishes the threshold of similarity required for segment to correspond and another constraint requires that segments that correspond agree with respect to a feature. For the Aymara data, for example, highest ranked is Id-CC(sg): segments in correspondence must agree with respect to their laryngeal specification. Then, ranked below Corr-T^h↔T (homorganic segments must correspond independent of laryngeal specification) but above Corr-K↔T (all voiceless consonants must be in correspondence), is the faithfulness constraint Id-IO(sg). This has the effect of requiring that homorganic consonants have the same laryngeal specification.

(28) Agreement by Correspondence

/k'aska/	Id-CC(sg)	Corr-T↔T	Corr-T^h↔T	Id-IO(sg)	Corr-K↔T
→k_x'ask$_x$'a				*	
k_x'ask$_x$a	*				
k_x'ask$_y$a			*!		
/t'aqa/					
t_x'aq$_x$'a				*	
→t_x'aq$_y$a					*
t_x'aq$_x$a	*				

The two other properties of harmony (and tone) systems that must also be specified are locality and directionality.

Tone shifts and harmony can proceed in either an anticipatory (left) or preservative (right) manner as the above examples show: Shimakonde reflects rightward spreading, while Icelandic umlaut (§1.4.1, e.g. kalla 'I call'; kœllum 'we call') proceeds leftward. There has been significant discussion as to whether the directionality of spreading is predictable from other facts in the language, or has a default. Hyman and Schuh (1974), for example, argue that tone is predominantly preservative, as the above tone examples show. On the other hand, Beckman (1997), Krämer (2001), Bakovic (2001) and others argue that directionality in vowel harmony systems is epiphenomenal of more basic principles of root or stem dominance, so constraints need not explicitly refer to directionality. Instead, directionality is driven by the fact that affixes are the target of root triggers, while cases like Icelandic are part of a different empirical domain consisting of umlaut and metaphony, which are locally bounded and are affix→stem driven. In addition to these example, there are several counterexamples to the observation (Punu: Hyman, 2003; Mafa: Ettlinger, 2005) so, the convention of Rose and Walker (2004) is used by specifying directionality in correspondence as either CORR-XX$_R$ for left-to-right spreading or CORR- XX$_L$ for right-to-left spreading.

Finally, Walker (2000) and Hansson (2004) discuss the necessity of specifying the distance allowed between corresponding segments. With respect to consonant harmony, for example, many Bantu languages restrict nasal harmony to consonants separated by a single vowel (Hansson, 2004), while the tone shifts above are limited to a shift between adjacent TBUs. This can be accounted for by relativizing the correspondence constraints with respect to what may come between corresponding segments:

(29) Locality-specified correspondence constraints

a) CORR-XX, CORR-X-Y-X, CORR-X-σ-X, CORR- X-∞-X

CORR-XX establishes correspondence among strictly adjacent segments, CORR-X-Y-X establishes correspondence between segments of class X separated maximally by a segment of another type, Y, (e.g. two vowels separated by a consonant, two consonants separated by a vowel), and so on, to CORR- X-∞-X, requiring correspondence between segments of class X at any distance.

2.3 FORMALIZATION OF DIAGONAL CORRESPONDENCE

In this section, I formally articulate the definition of DCT. The new set of DC constraints is essentially the same as that in ABC except that the first term refers to the input string while the second term refers to the output string. Enforcing identity of some feature F among these diagonally-corresponding segments is IDENT[F]-D, which is the analog of S-IDENT or IDENT[F]-CC. The formal statements of the new constraint is as follows:

(30) Diagonal Correspondence:

a) CORRD-XY: Let R be an input string of segments and S be an output string of segments and let X and Y be segments that share a specified set of features. If X∈R and Y∈S and if there is no segment Z intervening between X and Y, then X is in diagonal correspondence with Y.

b) CORRD-X-τ-Y: Let R be an input string of segments and S be an output string of segments and let X and Y be segments that share a specified set of features and let τ specify some metrical unit. If X∈R and Y∈S and if there is at most the metrical unit τ intervening between X and Y, then X is in diagonal correspondence with Y.

c) CORRD-XY_{δ}: Let R be an input string of segments and S be an output string of segments, let X and Y be segments that share a specified set of features and let δ specify a direction, L or R. If X∈R and Y∈S and if Y is to the direction of X specified by δ, then X is in diagonal correspondence with Y.

d) CORRD-X-Z-Y_{δ}: Let R be an input string of segments and S be an output string of segments, let X and Y be segments that share a specified set of features and let δ specify a direction, L or R and let δ specify a direction, L or R. If X∈R and Y∈S and if there is no segment Z not sharing the specified set of features intervenes between X and Y and if Y is to the direction of X specified by δ, and if there is a most the metrical unit τ separating X and Y, then X is in diagonal correspondence with Y.

A shown above, the basic notion of DC may be augmented by parameters specifying directionality and locality. In the next two sections, §3.2 and §3.3, I show how this constraint can account for opaque interactions involving tone and harmony, respectively.

2.4 DC AND TONE SHIFTING

This section presents a DC analysis of the opaque tonal phenomena discussed above, namely tone shift. Kikuyu (Clements, 1984) reflects a tone shift similar to Jita. Underline indicate the underlying placement of high tone:

(31) Kikuyu tone shift

a)	to rɔr aɣa	‘we look at’
b)	to to̲m áɣa	‘we send’
c)	to ma̲ rɔ́r aɣa	‘we look at them’
d)	to ma̲ tó̲m áɣa	‘we send them’

The examples in (c,d) show that the tonal shift is not definable with respect to a particular position (e.g. first affix) and that the tone shift occurs for adjacent underlying tones, a problem for an account based on the OCP, binary tonal domain (Cassimjee & Kisseberth, 1998), or peak delay (Myers, 1999; Kaplan, 2008).

The DC in effect here is between each input TBU and its right-adjacent output TBU, effected by a constraint CORR-μ-C-μ$_R$, abbreviated DC. Subscripts indicate segments that are in correspondence.

(32) Tone shift in Kikuyu using DC

/to$_x$-tó$_y$m-a$_z$ɣa/	ID-DC(T)	DC	ID-IO(T)
(a) →to-to$_x$m-á$_y$ɣa			**
(b) to$_x$-tó$_y$m-a$_z$ɣa		*!**	
(c) to-to$_x$m-a$_y$ɣa	*!		

For tone spreading the markedness constraint against single high tones, discussed above, can now be evaluated based on surface forms alone with DC taking care of directionality, an element missing from the earlier account:

(33) Tone spreading in Kikewere using DC

/ku$_w$-bó$_x$h-e$_y$l-a$_z$n-a/	*MONO	ID-DC(T)	DC	ID-IO(T)
(a) ku-bó$_w$h-e$_x$l-a$_y$n-a$_z$	*	**!		
(b)→ku-bó$_w$h-é$_x$l-a$_y$n-a$_z$		*		*
(c) kú-bó$_w$h-e$_x$l-a$_y$n-a$_z$		**!		*
(d) ku-bo$_w$h-é$_x$l-a$_y$n-a$_z$	*			**

Note that these evaluations yield the correct output form without the benefit of autosegmental representation. Autosegmental notation constitutes an abstract representation of forms wherein the language learner has no way of determining the difference between, say, a doubly-linked high tone and two adjacent high tones. As such, the analysis here represents an improvement. Further discussion of the relationship between correspondence theory and autosegmental representation of tonal processes is discussed in chapter 2.

2.5. DC AND HARMONY

This section provides an analysis of several well-known and lesser-known cases of opacity involving vowel harmony using DC – namely Yowlumne, Mafa with Shimakonde addressed in chapter three. Particular attention is paid to the predictions the theory makes with respect to how an opaque interaction between harmony and one process dictates that harmony will interact opaquely with other processes. For example, the opaque over-application of harmony with respect to reduction in Shimakonde predicts the opaque under-application of harmony with respect to vowel coalescence, or the opaque interaction of harmony with vowel deletion in Icelandic predicts the opaque interaction of harmony with epenthesis. Ultimately, the data suggest that opaque interactions are in fact that unmarked process interaction with harmony, a prediction made with DC, but not with any other theory of opacity.

There are a number of other issues relating to harmony and opacity that are also taken up in Chapter 3, in particular a discussion of the shortcoming and some remedies for the correspondence-theory based approach to harmony adopted here.

2.5.1 Yowlumne Yokuts

A discussion of opacity, particular opacity as it relates to harmony, would not be complete without an analysis of Yowlumne Yokuts as there is a long tradition of generative studies of the language. The original source data is Newman (1944) and other treatments of the opacity in Yowlumne include Kuroda (1967), Kisseberth (1969, 1970, 1973), Kenstowicz and Kisseberth (1977, 1979), Archangeli (1984, 1991), Archangeli & Suzuki (1997; AS), McCarthy (1999) and Bye (2003; B03). Of particular interest here is the accounts in Archangeli and Suzuki which adopts two-level constraints.

The crucial data are as follows. First, long vowels lower from high to mid with vowel length determined by a morphological template (CVVC for perfective, CVC for imperfective) (34). Furthermore, there is rightward-spreading round harmony on vowels that are the same height (35).

(34) Yokuts vowel lowering   (from A&S)

	CVVC-t	CVC-aa?aa	
a)	d**oo**s-it	dus-oo?oo	‘was reported’/’is reporting’
b)	m**ee**k’-it	mik’-aa?an	‘was swallowed’/’is swallowing’
c)	?**oo**t’-ut	?ut’-aa?aan-it	‘stolen’

(35) Yokuts vowel harmony   (from A&S)

a)	/xat-hin/	xathin	‘ate’
	/xat-al/	xatal	‘might eat’
b)	/dub-hin/	dubhun	‘led by the hand’
	/bok’-al/	bok’ol	‘might find’
c)	/hud-al/	hudal	‘might recognize’
	/bok’-hin/	bokhin	‘found’

The forms in (a) show the underlying or unharmonized form of two different suffixes, which are targeted by round harmony triggered by the root in (b), but only when the vowels are the same height (c).

Finally, there is a process of closed-syllable vowel shortening:

(36) Yokuts vowel harmony (Kenstowicz & Kisseberth, 1977):

a)	sa:p-al	‘burn-DUB’	sap-hin	NONFUT
	do:s-en	‘report-FUT’	dos-k’o	IMP
b)	pana:-hin	‘arrive-NONFUT’	pana-l	DUB
	c’uyo:-hun	‘urinate-NONFUT’	c’uyo-l	DUB

Vowel lowering and vowel harmony interact opaquely in that roundness spreads to the suffix based on whether the suffix has the same height as the underlying form of the root vowel and not based on the height of the surface vowel. This results in both over-application (a) and under-application (b) opacities:

(37) Yokuts opacity (from A&S)
  a) /c’uum-it/ c’oomut ‘destroyed’ *c’oomit
  b) /c’uum-al c’oomal ‘might destroy’ *c’oomol

In (a), the *-it* suffix is subject to round harmony despite the height disagreement in the surface because the vowel heights agree in the input, while in (b), round harmony does not spread to the suffix despite the height agreement in the surface because the heights disagree in the input.

Vowel shortening also interacts opaquely with vowel lowering, and while these data include examples also involving opacity with vowel harmony, a solution to this particular opacity framed in terms of DC is not offered since the interaction does not include the harmony process directly.

(38) Opaque interaction of vowel lowering and vowel shortening:
  a) /ʔilii+l/ ʔilel

For theories of opacity that attempt to account for all data, the interaction of all three processes proves particularly difficult for a form such as:

(39) Opaque interaction of vowel lowering and vowel shortening and vowel harmony:

a) /c’uum-hin/ c’omhun ‘destroy’

To account for the data in (75) and (76), a correspondence can be established between the affix vowel and root vowel based on their heights in the output and input respectively. Thus, based on the correspondence constraints above, the DC constraint for Yowlumne is as follows:

(40) Yowlumne Correspondence

a) CORRD-E-O$_R$: Let R be an input string of segments and S be an output string of segments and let X and Y be vowels that are the same height [αHIGH] . If X∈R and Y∈S, and if Y is to the right of X, then X is in diagonal correspondence with Y.

This constraint (abbreviate DC below), combined with an identity constraint requiring that vowels in diagonal correspondence agree with respect to rounding (ID-[RND]-DC) yields the correct forms for Yowlumne:

(41) Opaque interaction vowel harmony and vowel lowering in Yowlumne

/c’uu$_x$m-i$_y$t/	*HI/μμ	DC	ID(RND)-DC	ID-IO(RND)
(a)→c’oomu$_x$t				*
(b) c’oo$_x$mi$_y$t		*!		
(c) c’oom-i$_x$t			*!	
(d) c’uum-u$_x$t	*!			

This formulation of rounding harmony also yields the correct output form for transparent cases where harmony spreads and cases where is does not, as well:

(42) Transparent vowel harmony in Yowlumne

/du$_x$b-hi$_y$n/	DC	ID(RND)-DC	ID-IO(RND)
(a)→dubhu$_x$n			*
(b) du$_x$bhu$_y$n	*!		*
(c) dubhi$_x$n		*!	

(43) Transparent vowel non-harmony in Yowlumne

/du$_x$b-a$_y$l/	DC	ID(RND)-DC	ID-IO(RND)
(a)→dubo$_x$l	*!		*
(b) duba$_z$l			
(c) duba$_x$l	*!	*!	

In the transparent form, *dub-al*, the output suffix vowel is not in correspondence with the input verb root vowel because the suffix is not the same height as the root vowel, and so no identity of roundness is required.

The last crucial set of data reflects the interaction between harmony and epenthesis. Most analyses (Archangeli, 1982; McCarthy, 1999) describe epenthesis as feeding harmony:

(44) Yokuts epenthesis feeds harmony

a) ʔugunhun	ʔugnal	‘drank / might drink’
b) luk’ulhun	luk’lal	‘buries / might bury’
cf. logiwhin	logwol	‘pulverizes / might pulverize’

While this counts as feeding in the sense of rule-ordering, the DC approach suggests that the relationship is not precisely feeding in that epenthesis does not either create a trigger for vowel harmony nor does it establish the conditioning environment for a target. Rather, epenthesis creates a target in a way that can still be accommodated by DC despite being transparent:

(45) Transparent interaction of epenthesis and vowel harmony in Yowlumne

/lu$_x$k'l-hi$_y$n/	*CCC	DC	ID(RND)-DC	ID-IO(RND)
(a)→luk'u$_x$lhu$_x$n				*
(b) luk'lhu$_x$n	*!			*
(c) luk'i$_x$lhu$_x$n			*!	

This example does raise the question of how correspondence is assessed, particularly with respect to locality when the proximity of the segments in question is not the same in input and output forms, i.e. when there is epenthesis or deletion. For example, in the example below, the question arises whether the *i* in the suffix is adjacent to the underlying *u* in the verb stem, or the epenthetic *u*:

(46) Yowlumne correspondence

a)	l	u	k'		l	-	h	i	n
	↕	↕	↕	↕	↕		↕	↕	↕
	l	u	k'	u	l	-	h	i$_y$	n

For cases where proximity and harmony-blocking are not applicable, this is not an issue, as in the above example, but for instances where certain vowels block the spreading of harmony, (e.g. Shimakonde, Yowlumne) this becomes a crucial issue. Because epenthesis can counter-bleeds or bleed harmony on environment (§1.4) then adjacency must be an independently specified parameter referring to input (epenthesis counter-bleeds opacity) or output (epenthesis bleeds opacity).

(47) Harmony blocking examples:

a) Shimakonde:

/kú-pet-an-il-a/ kúpátán**íí**la (cf. kúpátééla)

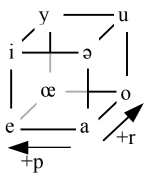
b) Yowlumne

/logw-ʔas/ logiwʔas ‘pulverize’

2.5.2. Mafa

Mafa has palatal harmony that under-applies with respect to local glide assimilation. There are eight vowels in Mafa defined by three distinct features: rounding, frontness and height:

(48) Mafa vowel space



All vowels are subject to fronting (/ə/→[i], /u/→[y], /o/→[œ] and /a/→[e]), as well as a the alveolar consonants ([s⬅]~[ʃi], [z⬅]~[⇦i], [ts⬅]~[tʃi], [dz⬅]~[d⇦i]:

(49) Mafa front harmony affix allomorphy:

a) ðək-aʔa ‘He sows it’ ʃi̲d-**eʔe** ‘He thanks it’

b) pəz-aʔa ‘He cultivates it’ piʒ-**eʔe** ‘Cultivate it!’

Mafa also has high-vowel palatal assimilation such that /⬅/ and /u/ front to [i] and [y] respectively (50) and when the two interact, assimilation counter-feeds harmony, which under-applies (51):

(50) High vowel glide assimilation

a) gudzə ‘to tremble’ gudz**i**j ‘tremble!’

b) sə ‘to drink’ s**i**-j ‘drink!’ *ʃi-j

(51) Opaque interaction of harmony and palatal assimilation:

a) si̲-j-**a**ʔ**a**‘drink it!’ *ʃij-eʔe

b) ɓi̲j-**a**ʔ**a** ‘big (DEF)’ *ɓij-eʔe

This can be accounted for via diagonal correspondence with the constraint formulated in the following manner:

(52) Mafa Correspondence

a) CORRD-V-V_R: Let R be an input string of segments and S be an output string of segments and let X and Y be two vowels. If X∈R and Y∈S, and if Y is to the right of X, then X is in diagonal correspondence with Y.

There are no neutral vowels in Mafa and all vowel participate in harmony, so all that is required for a front affix is a front vowel somewhere in the stem in the input. A fron vowel in the output, the results of assimilation is not adequate to trigger harmony, however:

(53) Mafa under-applications

/sə$_x$j-a$_y$ʔa$_z$/	*əj	DC	ID(BACK)-DC	ID-IO(BACK)
(a)→sij-a$_x$ʔa$_y$				*
(b) sij-e$_x$ʔe$_y$			**	***
(c) səj-a$_x$ʔa$_y$	*!		*!	
(d) sij-a$_y$ʔa$_z$		*!		

Thus, DC can account for tone shifts and under- and over-application of harmony in Jita, Mafa and Yowlumne. Chapter three also presents a detailed case study of DCT and Shimakonde.

2.6. Further Implications of Diagonal Correspondence

One of the great insights of OT is that all of the myriad possible constraint rankings should yield possible languages. If some phenomenon in a language is found that can not be accounted for with a certain constraint ranking, this suggests the universal constraint set has been incorrectly specified; similarly, if a constraint ranking yields a language that seems impossible, then a pathology is said to exist. This pathology suggests a grammar that it too permissible and the constraint set must be modified to rule out this impossible language.

For example, given two constraints, a *VOICEDCODA markedness constraint and an ID[VOICE] faithfulness constraint, two types of languages are possible: M»F languages where there is coda devoicing and F»M languages where voicing is retained and both voiced and voiceless consonants are possible in syllable codas. Absent from this typology are coda voicing languages, which are argued to not exist (Kiparsky, 2004; but see Yu, 2004 and Blevins, 2004). This is therefore considered an appropriate statement of UG constraints, with *VOICELESSCODA correctly absent from the inventory of constraints.

Using the constraints argued for above, we can establish a typology of languages with respect to opacity and harmony by permuting the rankings of these constraint. If examples of each exist and no languages are unaccounted for, then the constraint set can be said to be both adequately restrictive and descriptive. If we start with the /eCi/ input, the three faithfulness constraint – input-output faithfulness, syntagmatic output faithfulness, and diagonal faithfulness – can be permuted with a markedness constraint targeting the initial, or unstrssed syllable. The following language types are possible:

(54) Factorial typology

a) Fully faithful: ID-IO » M, ID-D, ID-S

A language without harmony or reduction: /eCi/→[eCi] (55a)

e.g. Punu: [-ded-il-a]

b) Transparent harmony: ID-S » ID-IO » M, (ID-D)

A language with transparent VH: /eCi/→[eCe] (55b)

e.g. Kisa (Sample, 1976): /rek-il/→[rekel]

c) Opaque harmony: M, ID-D » ID-IO, ID-S

Harmony rendered opaque by a markedness process: /eCi/→[aCe] (55c)

e.g Shimakonde: /pet-il/→[-patel-]

d) Reducing language: M » ID-IO » ID-D, ID-S

A language with just reduction: /eCi/→[aCi] (55d)

e.g. Belorussian (Crosswhite, 2001): /p^{j}okú/→[p^{j}akú][3]

e) Triggered-harmony language: M, ID-S » ID-IO, ID-D

A markedness-indiced alternation triggers harmony: /eCi/→[aCa] (55e)

N/A

(55) Incompatibility of a level-based approach with

/e C i/	REDUCE	ID-D	ID-IO	ID-S
a) e C i	*	*		*
b) e C e	*		*	
c) a C e			**	*
d) a C i		*	*	*
e) a C a		*	**	

The one problematic ranking is (64e), where some markedness constraint motivates an alternation in a vowel that in turn triggers harmony among other vowels. I am not aware of any language that has this sort of relationship and indeed, this is problematic for any theory of harmony.

The reason for this typological is likely as follows: Markedness violations, by definition, are repaired by resorting to some less marked segment or feature. Harmony, on the other hand, as articulated by Beckman (1997) and others, involves the licensing of

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[3] No Bantu language was found though Ruwund (Nash, 1991) reflects a historic change of *o>a and *e>i.

some marked structure by some other marked structure in the output. Thus if markedness is eliminated to satisfy a constraint, the resulting segment, being unmarked, should not be able to trigger harmony. The discrepancy between this observation and the constraints in (63) is based on the conflation of multiple input-output faithfulness constraint into one ID-IO constraint. In reality, there should be two – one for preserving a marked feature for the prominent (here, second) vowel, which is ranked higher than a second for the initial vowel. The markedness constraint should only be able to be ranked below highly ranked prominent-syllable faithfulness constraint if it triggers an alternation in the language.

Interestingly, this possibility can also be ruled out by always ranking ID-D over ID-S. This fixed ranking does not limit the ability to produce any of the other attested language patterns and captures this same generalization in a slightly different way. This essentially amounts to saying that no harmony pattern can be triggered by something that is not in the input – a generalization that seems well supported by typological evidence and agrees with the general spirit of an input-based approach to phonology.

This modification still manages to be restrictive in terms of the type of rule interaction that is allowed in that it does not admit a counter-feeding or counter-bleeding process to be counter-bled or –fed by another process.

2.7 CONCLUSION

In this chapter, I showed that Diagonal Correspondence Theory is able to account for the opaque interactions found in a number of languages as well as account for the other observations in chapter one.

Thus, DCT can account for the input form having a greater role by expanding the role of faithfulness to include opaque harmony and tonal interactions. This formal approach makes the correct prediction that certain forms of opacity involving tone shifts and harmony are not found.

This chapter also provided a theoretical justification for DCT by showing its relationship to a number of other accepted theories within OT including the full model of reduplication and two-level markedness constraints.

If DCT is, indeed, appropriate for certain kinds of opacity – namely the empirical domain that is amenable to insights through Autosegmental Phonology - the question them becomes what to do with other instances of opacity.

Some instances of opacity clearly reflect the interaction of different phonological at different levels, or strata, and so there is certainly a justification for stratal OT. As I showed, however, this is inadequate by itself to account for all instances of oapcity. Thus a combination of a number of solutions may be warranted, dependent on the particular empirical domain. DCT therefore is a piece in the larger puzzle of the myriad sources of opacity and suggests that all opaque data should not be treated the same.