# On Feature Spreading and the Representation of Place of Articulation

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Since Clements (1985) introduced feature geometry, four major innovations have been proposed: Unified Feature Theory, Vowel-Place Theory, Strict Locality, and Partial Spreading. We set out the problems that each innovation encounters and propose a new model of feature geometry and feature spreading that is not subject to these problems. Of the four innovations, the new model—Revised Articulator Theory (RAT)—keeps Partial Spreading, but rejects the rest. RAT also introduces a new type of unary feature—one for each articulator—to indicate that the articulator is the designated articulator of the segment.

*Keywords:* phonology, phonetics, feature geometry, Unified Feature Theory, Vowel-Place Theory

## 1 Introduction

### *1.1 Background*

Since the introduction of feature geometry (Clements 1985, McCarthy 1988), four major innovations in the theory have been proposed:

1. *Unified Feature Theory,* which employs a single set of Place features for both consonants and vowels (Clements 1989);
2. *Vowel-Place Theory,* which maintains that vocalic and consonantal Place features are segregated (Clements 1989, 1991, 1993, Ní Chiosáin and Padgett 1993, Clements and Hume 1995);
3. *Partial Spreading,* which allows spreading of two or more features that are not exhaustively dominated by a common node (Sagey 1987, Halle 1995, Padgett 1995);
4. *Strict Locality,* which prohibits spreading from skipping segments (Ní Chiosáin and Padgett 1993, 1997, Gafos 1998, Flemming 1995).

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However, no consensus has been reached concerning which of these innovations should be incorporated into the theory of feature geometry. Ní Chiosáin and Padgett (1993) employ 2–4 but not 1; Clements and Hume (1995) employ 1–2 but not 3–4; Halle (1995) employs 3 but not 1–2, 4; and so on.

The purpose of this article is to set out the empirical and theoretical problems each of the innovations encounters and to propose a new model of feature geometry and feature spreading that avoids these problems. The new theory of phonological representations and operations that we propose, *Revised Articulator Theory,* keeps Partial Spreading, but rejects Unified Feature Theory, Vowel-Place Theory, and Strict Locality.

### *1.2 Outline of Revised Articulator Theory*

Like other theories of phonetics/phonology, the Revised Articulator Theory (RAT) views utterances as acoustic signals actualizing sequences of words, each of which is itself made up of one or more morphemes. The morphemes are stored in speakers' memories as sequences of discrete phonemes. It is widely assumed that phonemes are not the ultimate constituents of speech; rather, phonemes themselves are complexes of features. The features have a dual function. On the one hand, they serve as mnemonic devices that distinguish one phoneme from another and hence one morpheme from another in speakers' memories. At the same time, each feature also serves as an instruction for a specific action of one of the six movable portions of the vocal tract: Lips, Tongue Blade, Tongue Body, Tongue Root, Soft Palate, and Larynx. Each articulator is capable of a restricted set of actions of its own, and each one of these actions is associated with a particular feature. Following Halle (1992, 1995), we distinguish two kinds of feature: *articulator-bound* and *articulator-free.* Articulator-bound features such as [round] and [back] are necessarily executed by one and the same articulator; articulator-free features such as [continuant] and [consonantal] are executed by different articulators in different phonemes. The articulator executing the articulator-free feature(s) of a phoneme is called its *designated articulator.* Given that the articulator-free feature [consonantal] must be specified for every phoneme—it is in this way that consonants are distinguished from vowels and glides—every phoneme must have a designated articulator.

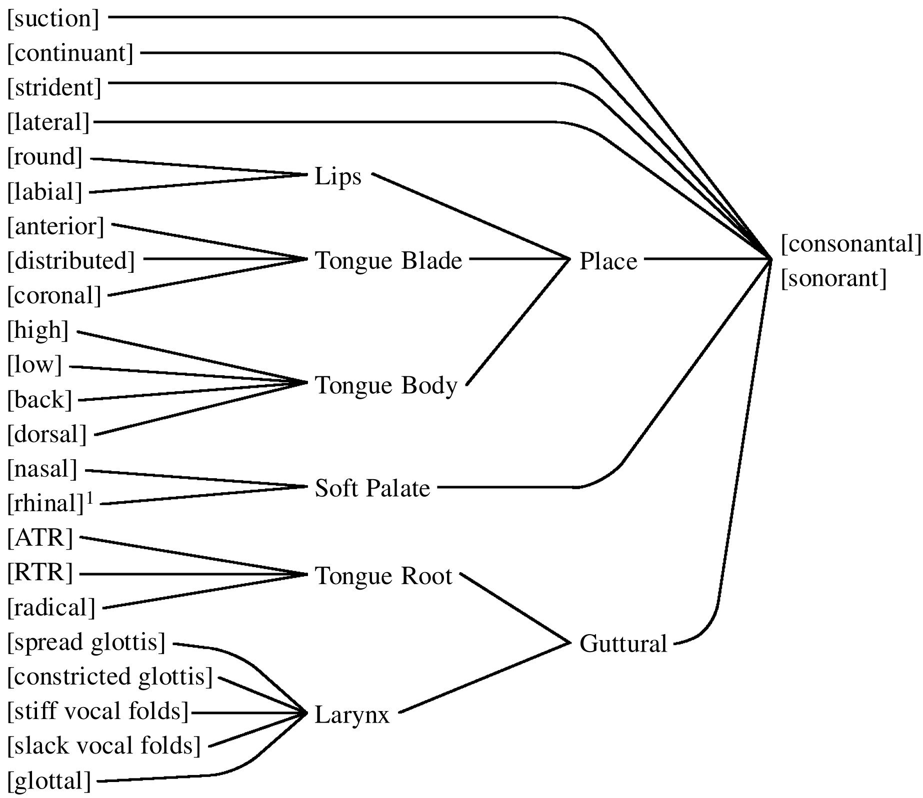
Among the major postulates of the Revised Articulator Theory are these:

1. Designated articulators are indicated by features, rather than nodes in the geometry (Chomsky and Halle 1968, Halle 1989, 1992, 1995, Sagey 1986, Clements 1989, 1991, 1993, Clements and Hume 1995).
2. Spreading is implemented as operations on terminal nodes in the feature tree (Halle 1995, and in a somewhat different sense Padgett 1995).
3. Features are fully specified in underlying representations, and rules and constraints can be indexed for marked, contrastive, or all feature specifications (Calabrese 1995).

We sketch each of these postulates in turn after first outlining the basic feature geometry that we employ.

*1.2.1 Basic Geometry* We follow Mascaró 1983, Mohanan 1983, Clements 1985, and much subsequent work in assuming that the universal set of phonological features is organized into a hierarchy that is appropriately represented by a tree diagram. The particular structure that we propose is given in (1).

(1)




Theories of phonetics/phonology differ regarding the naturalness of the constituents that make up the feature tree. RAT and some of its predecessors such as the theories of Sagey (1986) and Halle (1988, 1989, 1992) base the organization of the tree on anatomical properties of the articulators. Such theories draw a sharp line between tree *nodes,* which are always nonterminal, and *features,* which, with one important exception, always occupy terminal positions in the feature tree. We refer to such theories as *Articulator Theories* (AT). (The tree (1) is typical of this type of theory.) In Articulator Theories the groupings of features in the tree reflect aspects of the anatomy of the vocal tract. Thus, in (1) the lowest constituents (nodes) are made up of features

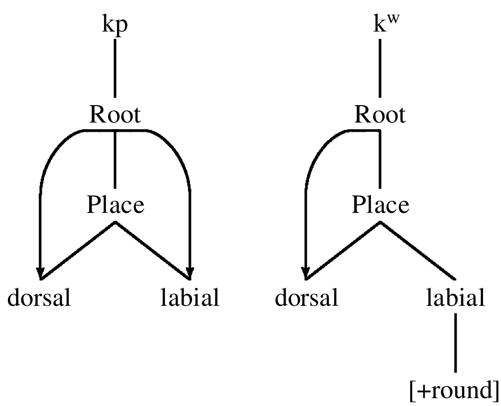
[1] The articulator feature executed by the soft palate, corresponding to [labial] and the lips, [dorsal] and the tongue body, and so on.

executed by each of the six articulators, and the next highest constituents (nodes)—Place and Guttural—refer to articulator groups that are anatomically adjacent. The exception noted above is the features [consonantal] and [sonorant], which (following McCarthy 1988) are assigned to the Root node of the tree.

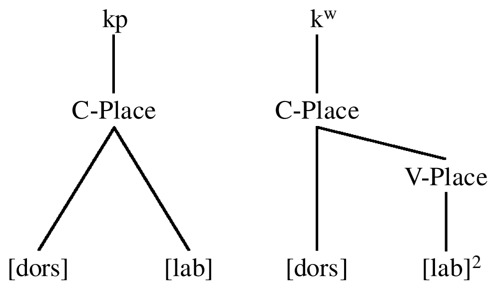
Articulator Theories stand in opposition to Vowel-Place Theories (VPT), which admit trees where features dominate other features and where the nonterminal nodes of the tree are not directly related to the anatomy of the vocal tract. For example, in most VPT accounts the feature [coronal] dominates the features [anterior] and [distributed] (see Clements and Hume 1995:270), and the tree geometry is based partly on the anatomy of articulators and partly on the degree of constriction in the vocal tract. Moreover, in VPT the Place features of vowels and of consonants are grouped under separate tree nodes, even though both groups involve the same articulators. In particular, the V(owel)-Place features are grouped under a node that is subordinate to the C(onsonantal)-Place node. It is the absence of a direct connection between anatomy and feature organization that makes VPT less natural and hence more arbitrary than Articulator Theories.

The differences between the feature geometries assumed by AT and VPT are well illustrated by their respective representations of secondary and complex articulations. In order to distinguish phonemes with two or more primary articulations, such as *kp,* from phonemes involving the same articulators but having only one primary articulation, such as $k^w$, we need some formal way of distinguishing primary articulations from secondary articulations. The Halle-Sagey AT model (Sagey 1986, Halle 1988, 1989, 1992) assumed that this distinction was implemented via a pointer, which extended from the Root node to the articulator node that executed the primary articulation. This is illustrated in (2a). The problem with this device is the formal nature of the pointer itself, which stands outside the normal inventory of primitives in feature geometry—features, nodes, and association lines. Proponents of VPT avoid the problem of the pointer by encoding the distinctions it makes within the feature tree itself: the primary articulator is dominated by the C-Place node, whereas secondary articulations are dominated by the V-Place node, as shown in (2b).

(2) a. *Primary and secondary articulations according to Sagey (1986:91, 207)*



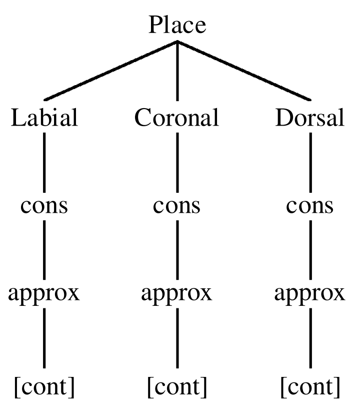
b. *Primary and secondary articulations according to VPT* (irrelevant nodes omitted)




*1.2.2 Articulator Features* The model of feature geometry that we develop here also discards the pointer, but its method of encoding distinctions between primary and secondary articulations does not require the radical step of separating consonantal and vocalic Place features. Instead, we accept the proposal in Halle 1992, 1995 that the underlying feature specification of every phoneme includes an indication of the designated articulator(s) of that phoneme. Since the designated articulator executes the articulator-free features of the phoneme such as [consonantal] and [continuant], a phoneme for which no designated articulator is indicated is incompletely specified; crucial information for the realization of its articulator-free features is missing.

Padgett (1995) recognizes that stricture features must be supplied with information about the articulator that is to execute them, but chooses to implement this formally by supplying a set of stricture features to each of the Place articulators. Thus, for Padgett the Place nodes in the feature tree are labeled with a set of features ([consonantal], [approximant], and [continuant]) that he calls the ''articulator group.'' We reproduce Padgett's scheme in (3) (1995:17, figure (15)).

(3)




This is not a viable proposal, for it implies among other things that there may be two kinds of labiodorsal phonemes, one like the widely attested *kp* and *gb,* where both articulators are assigned

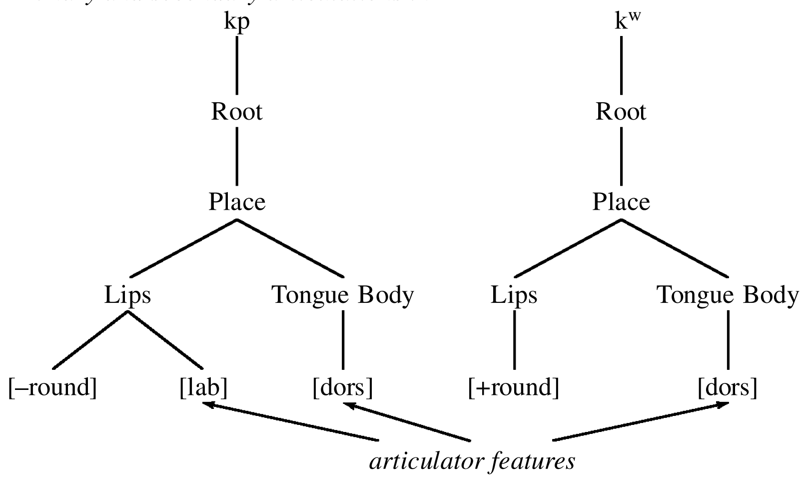
[2] This [labial] specification would be [round] in the model of Ní Chiosáin and Padgett (1993).

[+consonantal], and an undocumented one in which (e.g.) the Lips execute a [+consonantal] articulation while the Tongue Body executes a [−consonantal] articulation.

We propose instead that the articulator that executes the stricture features of a given segment is encoded in the form of a feature that behaves much like the other more familiar features. What differentiates articulator features from the other features in the list is that articulator features are unary (cf. Clements and Hume 1995:252), whereas the rest are binary. There is one articulator feature for each of the six articulators; hence, the inventory of articulator features consists of [labial], [coronal], [dorsal], [rhinal], [radical], and [glottal].

The use of articulator features to distinguish primary and secondary articulations is illustrated in (4).

(4) *Primary and secondary articulations in RAT*




The idea of articulator features is not new. To the best of our knowledge it was first proposed in Chomsky and Halle 1968 and was subsequently developed in Sagey 1986, Clements 1989, 1991, 1993, and Clements and Hume 1995. What has not been previously recognized is the special character of articulator features and the vastly different roles played by articulator features and by articulator nodes in the feature tree. It is the formal recognition of this distinction that differentiates our framework from those of Sagey (1986) and Clements and Hume (1995). We believe that the model in (4) is preferable to the V-Place model in (2b) because (along with other reasons to be discussed in sections 2 and 3) it makes a formal distinction between entities that are empirically different—features and nodes—and it does not postulate the abstract nodes C-Place and V-Place (not to mention Vocalic and Aperture, which are not considered here).

Proponents of VPT justify the greater abstractness of their theory by referring to a body of empirical phenomena, the most important of which are scalar assimilation of vowel height, long-distance spreading, and consonant-vowel interactions. The scalar assimilation of vowel height has been addressed in detail by Zetterstrand (1998a), who demonstrates that AT provides a more satisfactory analysis of the facts than VPT. We summarize some of her more compelling arguments in section 2.1.2. Discussion of the remaining two topics, long-distance spreading and consonant-vowel interactions, forms the core of section 2. We conclude that attempts to deal with the problems that these three phenomena pose by splitting the Place node into a V-Place node and a C-Place node give rise to insurmountable problems.

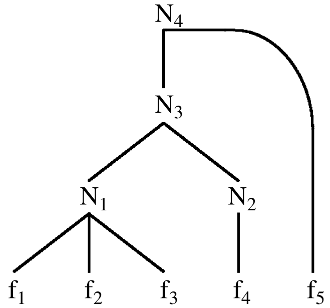
As we demonstrate in section 3, RAT not only accounts for the problems that VPT attempts to solve and avoids the problems that VPT creates; it also preserves structural cohesiveness, which VPT is forced to abandon. Specifically, we show that Clements's (1989, 1991, 1993) version of VPT (section 2.1) critically redefines the notion of tier, whereas Ní Chiosáin and Padgett's (1993) version of VPT (section 2.2) redefines the notion of feature. As we demonstrate in section 2, each of these redefinitions significantly weakens the predictive power of these aspects of feature geometry.

*1.2.3 Terminal Spreading* Perhaps the most important innovation of RAT is the idea that only terminal nodes in the feature tree are allowed to spread. Many versions of terminal spreading have been proposed in the literature (see Steriade 1987, Selkirk 1991, Goldsmith 1990, Padgett 1995); we adopt the interpretation proposed in Halle 1995, on which we elaborate below.

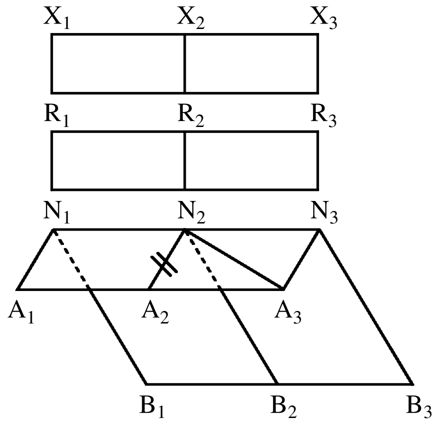
All versions of terminal spreading are proposed in response to the apparent existence of partial spreading, that is, spreading of a group of features that do not constitute a natural class in the feature tree in (1). Partial spreading of this sort is problematic for theories that allow only one node or feature to spread at a time and that assume that blocking of a spreading node entails blocking of all features contained under that node. One such case of partial spreading that has received much attention is Barra Gaelic Vowel Copy, which spreads the contents of the Place node even if the feature [back] is blocked by an intervening consonant. (We consider the Barra Gaelic facts in detail in sections 2 and 3.)

In order to account for the Barra Gaelic facts as well as for other problems, Halle (1995) proposes that all assimilation processes are formally characterized by spreading terminal nodes in the tree hierarchy. According to this proposal, assimilation processes involving more than one feature are limited to feature sets dominated *exhaustively* by a nonterminal node in the tree. A set of features $\{f_1\ f_2\ f_3\}$ is exhaustively dominated by a node N if N dominates *all of* and *only* those features. For example, node $N_1$ exhaustively dominates the set $\{f_1\ f_2\ f_3\}$ in (5), but does not exhaustively dominate the set $\{f_2\ f_3\}$ or the set $\{f_1\ f_2\ f_3\ f_5\}$. In RAT the only sets of features in (5) that would be allowed to spread together are $\{f_1\ f_2\ f_3\}$, which is exhaustively dominated by $N_1$, $\{f_1\ f_2\ f_3\ f_4\}$, which is exhaustively dominated by $N_3$, and $\{f_1\ f_2\ f_3\ f_4\ f_5\}$, which is exhaustively dominated by $N_4$. As shown in (1) and (5), the tree representing the features of a phoneme is a two-dimensional object. A sequence of phonemes is therefore a three-dimensional object where the third dimension stands for sequential order or time. To take explicit account of this fact, each phoneme is supplied with a timing slot, represented in (6) by a capital X, which is linked to the tree comprising the features that make up the phoneme. In a sequence of such trees each feature (terminal node) is assumed to fall on a single straight line, and the same is true of each nonterminal node and each timing slot. As a result, a sequence of trees constitutes a set of planes of the kind illustrated in (6). In phonological discussions it is common to refer to planes whose bottom line

(5)



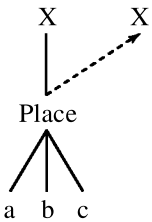

(6)



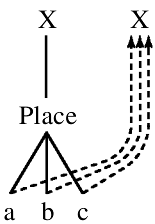

connects instances of a particular feature as the *tier* of that feature. Thus, the two bottom planes in (6) are tiers of the features A and B, respectively. When a feature is spread from a given phoneme to an adjacent one—for example, when feature A is spread from the third phoneme in (6) to the second—a line is drawn on the plane $A_1$ $A_3$ $N_3$ $N_1$ connecting $A_3$ to $N_2$, and the line connecting $A_2$ to $N_2$ is erased. The situation becomes somewhat more complex when instead of a single feature a group of features is spread from one phoneme to another. The theory underlying feature geometry (see, e.g., Clements 1985) dictates that what is specified as spreading in assimilation rules is a single element, be it a single (terminal) feature or a single nonterminal node. As noted in Halle 1995, in the case of multiple feature spreading identical effects can be notated in two distinct ways: either we can spread the subtree dominated by the spreading node so that adjacent phonemes share this part of the tree, or we can spread the terminal features that are dominated by the nonterminal node in question and leave the rest of the tree structure intact. These two methods of feature assimilation are illustrated in (7). A number of compelling examples in favor of the second method of feature spreading were discussed in Halle 1995. A particular advantage of this formalization is that it allows for partial spreading of the features grouped under a nonterminal node. Since only terminal features are spread, all spreading takes place on the tiers (or planes) at the bottom of the different trees. When a single feature is assimilated, spreading takes place only on one of these bottom tiers; when a set of features is assimilated, spreading takes place on several of the bottom tiers. In cases of spreading on multiple tiers, it is natural to posit that when spreading is blocked on one of the tiers, the blocking does not affect the spreading of the features on the other tiers. This is illustrated in (8), where the blocking of spreading of feature b does not prevent features a and c from being spread.

(7) *Two versions of spreading*

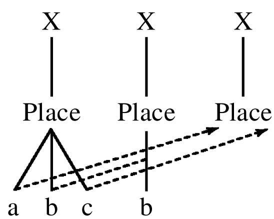
a. *Traditional constituent spreading*
Target: the Place node
Implemented as: spreading of the Place node




b. *Terminal spreading in RAT*
Target: the Place node
Implemented as: spreading of the terminal features dominated by the Place node




(8)




In section 3 we show how terminal spreading accounts for Vowel Copy in Barra Gaelic and Complete Vowel Copy in Tarahumara.

*1.2.4 Full Specification* RAT differs from other theories of feature geometry in its representation of underspecification. Clements (1985) assumes that only contrastive features are specified in underlying phonological representations. As a consequence, not all features in the tree in (1) are specified in underlying representations of phonemes of every language; only contrastive features are. However, Mohanan (1991), McCarthy and Taub (1992), Steriade (1995), and others have pointed out a number of serious theoretical and empirical problems with existing theories of underspecification. In this section we illustrate one of the problems for traditional underspecification-based treatments of vowel harmony, drawn from the Turkic language Uyghur.

Treatments of vowel harmony (Clements 1976 and elsewhere) commonly assume that vowels showing harmonic alternations are underlyingly unspecified for the harmonic feature, and that disharmonic vowels are underlyingly prespecified for the harmonic feature (Clements and Sezer 1982 and elsewhere). To take a concrete example, the forms in (9ai) show that the Turkish high-vowel suffix *-kI* alternates for the harmonic feature [round]; therefore, it is assumed to be underlyingly underspecified for [round] (9aii). On the other hand, the suffix invariably surfaces with a [−back] vowel (e.g., *jarɨn-ki,* not **jarɨn-kɨ*) and therefore is assumed to be underlyingly specified as [−back]. This differs from the behavior of all other high-vowel suffixes—for example, the first-person possessive *-Im,* which alternates for backness (9bi) and is therefore underlyingly unspecified for the feature [back] (9bii). (Data and analysis are taken from Hahn 1991.)

(9) a. i. ʃimdi ‘now’ ʃimdi-ki ‘current’
bugyn ‘today’ bugyn-ky ‘today’s’
jarɨn ‘tomorrow’ jarɨn-ki ‘tomorrow’s’

ii. [round] tier
k I
|
[back] tier [−back]

b. i. eʃ ‘partner’ eʃ-im ‘my partner’
aʃ ‘food’ aʃ-ɨm ‘my food’

ii. [round] tier
I m
[back] tier

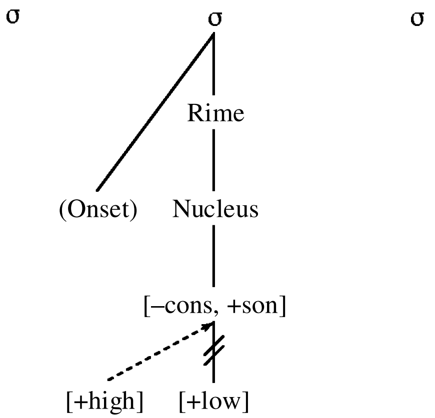
Vowel harmony in the Turkic language Uyghur works like vowel harmony in Turkish, with a few minor differences. Like Turkish, Uyghur possesses a small number of disharmonic suffixes; one of these is the modal suffix *-ʧæ*, which invariably surfaces as [−back] regardless of the [back] specification of the root to which it attaches (10) (Hahn 1991:93–94). Since the vowel in *-ʧæ* does not alternate for backness, it should be underlyingly specified as [−back] according to the assumptions above, as shown in (11).

| (10) | | *Surface form* | *Gloss* |
|---|---|---|---|
| a. | [−back] roots | tyrk-ʧæ | ‘(in the) Turkish (manner/language)’ |
| b. | [+back] roots | ujɢur-ʧæ | ‘(in the) Uyghur (manner/language)’ |
| | | taɢ-ʧæ | ‘(one) as big as a mountain’ |
| | | kitap-ʧæ | ‘booklet’ |
| | | on-ʧæ | ‘about ten’ |

(11) ʧ æ
|
[−back]

Uyghur also possesses a rule, formalized in (12), that changes low vowels into high vowels in medial open syllables (Hahn 1991:84); illustrative alternations are provided in (13).

(12) *Uyghur Raising*




| (13) | | Underlying form | Surface form | Gloss |
|---|---|---|---|---|
| a. | /a/ | bala | bala | 'child' |
| | | bala-lAr | balilar | 'children' |
| | | bala-lAr-I | baliliri | 'his/her/its children' |
| b. | /æ/ | iʃæG | iʃæk | 'donkey' |
| | | iʃæG-lAr | iʃæxlær | 'donkeys' |
| | | iʃæG-I | iʃiγi | 'his/her/its donkey' |
| | | iʃæG-I-GA | iʃiγiγæ | 'to his/her/its donkey' |

As expected, Raising applies to the suffix *-ʧæ-* when followed by a suffix that places it in a medial open syllable (14a); when a following suffix places *-ʧæ-* in a closed syllable, it does not undergo Raising (14b).

| (14) | Underlying form | Surface form | Gloss |
|---|---|---|---|
| a. | næj-ʧæ-DA | næjʧidæ | 'child' |
| | kita:b-ʧæ-DA | kitapʧida | 'in the booklet' |
| b. | næj-ʧæ-m-DA | næjʧæmdæ | 'in my little flute' |
| | kita:b-ʧæ-m-DA | kitapʧæmdæ | 'in my booklet' |

The forms in (14b) show that *-ʧæ-* is disharmonic and spreads its own [−back] specification to following vowels. Given prespecification, we predict that when *-ʧæ-* undergoes Raising it should maintain its disharmonic status, since its underlying [−back] specification (see (11)) is unaffected by Raising. The form *kitapʧida* in (14a) shows that this prediction is incorrect: when the *æ* raises to *i,* it becomes transparent to [back] harmony, allowing the [+back] specification of the preceding *a* to spread through it to the harmonic vowel in the following *-DA* suffix.

In the prespecification analysis of disharmony sketched above, the transparency of the raised output of *-ʧæ-* requires postulation of an ad hoc rule that deletes the [−back] specification of the *i*. The problem here is that the prespecification analysis misses the connection between *i* that results from Raising and *i* that comes from underlying *i,* which is transparent to [back] harmony in Uyghur (see *iʃiγiγæ* in (13b)). What is called for is a theory of harmony that takes into consideration the role of the *i* in the vowel system as a whole, regardless of its origins. The system of sensitivity and full specification that we adopt in our theory does exactly this, as we demonstrate below.

We follow Calabrese (1995) and Halle (1995) in assuming that segments are fully specified in all representations. It is not the case, though, that all features are visible to all rules. These differences in feature visibility, which account for phenomena previously explained by underspecification, derive from the different status assigned to features in Calabrese's theory, which we sketch briefly here.

To express formally the fact that each language has its own inventory of phonemes and to capture the crosslinguistic infrequency of certain feature combinations, Calabrese proposes that part of the innate knowledge that humans bring to the learning of a language consists of a set of marking statements or filters prohibiting particular feature pairs from occurring in phonemes. The marking statement limiting the occurrence of front rounded vowels is given in (15).

(15) *[$\underline{+\text{round}}$, −back] in the environment [____, −cons]

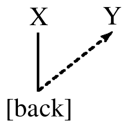
Particular languages may deactivate a given marking statement based on exposure of language learners to positive evidence of their violation.

In each marking statement there is a *marked* feature, which is underlined in (15). It goes almost without saying that marked features can play a role only in languages in which the filter prohibiting the marked feature complex has been deactivated. Thus, only in a language in which (15) has been deactivated will there be both [+round, −back] and [−round, −back] vowels. Following Calabrese (1995), we will say that in such languages the two values of the feature [round] are *contrastive.* These distinctions among features play a fundamental role in the operation of the phonological rules.

Unless specifically noted, only contrastive features are visible to a phonological rule. In addition to such ordinary rules there are two kinds of special rules: rules for which only marked features are visible, and rules for which all features are visible. An example of a rule for which only marked features are visible is Rendaku in Japanese (see Calabrese 1995:413–418); a rule for which all features are visible is coronal assimilation in English (as illustrated by the coronal stops in *d̲ream, hundred̲th,* and *hard̲ship;* see Clements 1985:235–236). A typical unmarked rule, for which only contrastive features are visible, is the Barra Gaelic rule discussed in section 2.

Let us now consider how this theory of full specification and sensitivity allows us to make sense of the behavior of the Uyghur -*ʧæ*- suffix. As noted, the problem is that the vowel of the suffix becomes transparent to harmony after Raising changes it to *i,* when the prespecification analysis predicts that it should remain disharmonic. This problem arises because the prespecification analysis misses the relation between the *i* produced by Raising and the *i* derived from underlying *i,* which is transparent. The theory of full specification and sensitivity that we adopt captures this relation directly, because it derives the behavior of vowels in harmony systems from their role in the phonemic inventory of the language, rather than from their derivational history.

Uyghur [back] harmony, for example, is analyzed as rightward spreading of contrastive [back] specifications (16). (See Vaux 1993b and Calabrese 1995 for further elaboration of the treatment of vowel harmony within a theory of sensitivity and full specification.)

(16)



where X = a segment contrastively specified for [back]
Y = a segment that can bear a [back] specification

Since the rule is sensitive only to contrastive [back] specifications, it ignores segments that are not contrastive for [back], such as the neutral vowel *i*. Crucially, this holds for *i* whether it results from underlying *i* or from underlying *a* or *æ* that have undergone Raising. Our theory therefore predicts (correctly) that the *-ʧi-* allomorph of *-ʧæ-* should be transparent to [back] harmony, because its *i* is not contrastive for the feature [back]. Furthermore, it predicts that there is no language that is exactly like Uyghur, save that the output of raising a disharmonic suffix remains disharmonic. This option is simply not available in our model, because it ignores the derivational history of segments. We take the fact that the known data conform to our prediction, and fail to conform to the prediction of the prespecification analysis, to support the full specification approach adopted here.

Each of the theoretical postulates set out in the preceding sections—articulator features, terminal spreading, and full specification—finds ample independent support in the phonological literature. In section 3 we show how a theory incorporating these postulates enables us to account for the difficulties encountered by theories that segregate vocalic and consonantal Place features. It is to these theories that we now turn.

## 2 Vowel-Place Theory

We begin our evaluation of Vowel-Place Theory (VPT) by examining the weaknesses that have been observed in the Halle-Sagey model of feature geometry and by arguing against the remedies that have been proposed for these weaknesses by adherents of VPT. We confine our attention to the two varieties of VPT that we consider to be the most promising: Unified Feature Theory (Clements 1989, 1991, 1993, Clements and Hume 1995) and Redundant Vowel-Place Theory (Ní Chiosáin and Padgett 1993). In sections 2.1 and 2.2 we present the two theories individually, considering problems with each as they arise; in section 2.3 we examine how the two versions of VPT deal with long-distance assimilation. In section 2.4 we summarize our arguments concerning the viability of VPT.

### *2.1 Unified Feature Theory*

The primary motivation for Unified Feature Theory (UFT) lies in the observation that the Halle-Sagey model has difficulty accounting for (a) interactions between consonants and vowels in terms of place of articulation and (b) scalar assimilation of vowel height. UFT deals with these problems by reorganizing the geometry of Place features in two ways. First, it proposes a unified set of features encoding place of articulation for consonants and vowels, in which [dorsal] subsumes [+back], [coronal] subsumes [−back], [labial] subsumes [+round], and [pharyngeal] subsumes [+low]. Second, it replaces the features [high] and [ATR] with a set of [open] features. We consider these two proposals in sections 2.1.1 and 2.1.2, respectively. In section 2.1.3 we examine a case study from Arabic in order to determine how UFT deals with more complicated consonant-vowel (C-V) interactions, and we demonstrate that in its modeling of these interactions, UFT creates severe problems of tier inconsistency.

*2.1.1 Consonant-Vowel Interactions* Many linguists have observed that interactions between labial consonants and round vowels, coronal consonants and front vowels, dorsal consonants and back vowels, and pharyngeal consonants and low vowels are fairly common in human languages. A typical example involves the fronting of vowels by adjacent coronal consonants, as in the Agn dialect of Armenian (17a), where the back vowels *o* and *u* become *ø* and *y,* respectively, after all coronal consonants (Maxudianz 1911:28–30, Vaux 1993a).[3] Noncoronals do not cause fronting (17b).

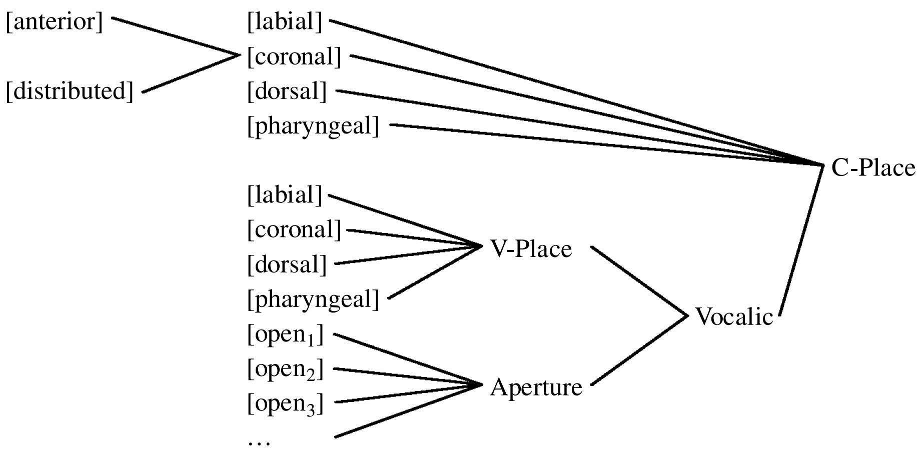
| (17) | *Classical Armenian* | *Agn* | *Gloss* |
|---|---|---|---|
| a. | doł | d$^{h}$øʁ | 'tremor' |
| | gałt-uk | g$^{h}$aʁdyg | 'secret' |
| | at$^{h}$oṙ | at$^{h}$øṙ | 'chair' |
| | moṙats$^{h}$oł | moṙts$^{h}$ øʁ | 'forgetting' |
| | ʧ$^{h}$ors | ʧ$^{h}$ørs | 'four' |
| | ʧuχa | ʧ$^{h}$yχa | 'cloth' |
| | ʤur | ʤ$^{h}$yr | 'water' |
| | nor | nør | 'new' |
| | χoʃor | χoʃør | 'large' |
| | soχ | søχ | 'onion' |
| | gałoł | g$^{h}$aløʁ | 'coming' |
| | heru | hery | 'last year' |
| b. | bots$^{h}$ | b$^{h}$ots$^{h}$ | 'flame' |
| | port | bord | 'navel' |
| | p$^{h}$ołk$^{h}$ | p$^{h}$oχg | 'throat' |
| | Muʃeł | Muʃeχ | a personal name |
| | kots$^{h}$ | g$^{h}$ots$^{h}$ | 'closed' |
| | k$^{h}$oṙ | k$^{h}$oṙ | 'unit of grain' |
| | gud | gud | 'grain' |
| | χuts$^{h}$ | χurts$^{h}$ | 'room' |

The C-V interaction documented in (17) poses a problem for the Halle-Sagey model, insofar as it is not clear from their formalism why coronal consonants should cause vowels to become

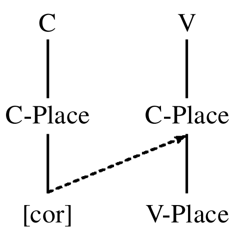
[3] *ł* = [+back] *l*, *ṙ* = trilled *r*.

[−back]. Coronality in consonants and backness in vowels are represented with distinct features, and therefore interaction between the two falls outside the notion of assimilation as spreading of a feature.

UFT proposes to solve this problem by replacing the Halle-Sagey geometry of Place features with a single set of features characterizing place of articulation in both consonants and vowels (see Clements and Hume 1995:275ff.). The relevant feature geometry that UFT posits is shown in (18) (modified slightly from Clements and Hume 1995:292; irrelevant nodes omitted).

(18)


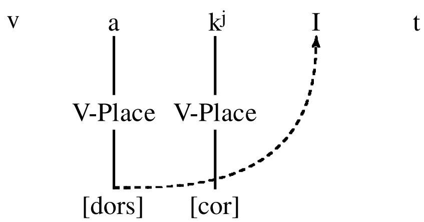

Armed with this feature geometry, UFT analyzes coronal fronting of the Agn type as in (19) (intermediate nodes omitted).

(19)



As noted above, the Halle-Sagey model does not adequately handle the interactions between coronal consonants and front vowels encountered in such palatalization processes. To deal with this problem, RAT has recourse to Calabrese's (1993) ''equivalency relations.'' This idea is implemented formally by positing that Universal Grammar includes a special set of rules whose adoption, though not obligatory, is favored over the adoption of other rules. One such rule (modified slightly from Calabrese's original formulation) states that there is an equivalency between [dorsal, −back] in vocalic contexts and [coronal] in consonantal contexts. When the [coronal] specification of a consonant spreads to a vowel, creating a vocalic [coronal] segment, this new configuration is subjected to the equivalency relation, yielding a [dorsal, −back] segment. The same interaction holds in the opposite direction for palatalization processes that convert dorsal consonants into coronals before front vowels. Equivalency relations avoid the host of new problems created by UFT's attempt to deal with the above phenomena by assuming that front vowels are [coronal] and back vowels are [dorsal].[4]

2.1.1.1 Coronal Dependents For example, UFT assumes that in consonants the feature [coronal] dominates the features [anterior] and [distributed] (see (18)). This entails that in some cases these features must spread to the vowel as well. However, it is not clear within this system how these features are implemented in vowels, or even if they exist for vowels (diagram (40) on page 276 of Clements and Hume 1995 implies that they do not; diagram (62) on page 292 implies that they do). Since in Clements's framework [coronal] in vowels is directly equivalent to traditional [−back], we must suppose that he treats [coronal] as a terminal feature in vowels, but as a nonterminal node in consonants.

2.1.1.2 The Lingual Node UFT (in the form represented by the feature tree in Clements and Hume 1995:292) is also forced to assume that what appear to be unitary processes of [back] harmony found in Turkish, Hungarian, and other languages actually involve two distinct harmonic phenomena, of which one spreads [coronal] and the other spreads [dorsal]. Similarly, it is not clear in UFT why segments with lexical [dorsal] or [coronal] specifications block harmony in such languages. For example, in Turkish vowel epenthesis (Lees 1961) certain consonant clusters are broken up with a high vowel except when followed by a vowel-initial morpheme. Harmony then applies to the epenthetic vowel; thus, *g*$^j$*ønl-de* 'heart-dat' becomes *g*$^j$*ønIl-de,* which harmonizes to *g*$^j$*ønylde.* However, the three pairs of consonants that are contrastive for backness (or coronality/dorsality)— *k*$^j$*-k, g*$^j$*-g,* and *l*$^j$*-l*—create their own harmonic domain that blocks the spread of [coronal] and [dorsal]. Thus, in *vak*$^j$*t* 'time' the UFT geometry in (18) predicts that the [dorsal] V-Place specification of the *a* will spread across the [coronal] V-Place of the *k*$^j$ onto the epenthetic vowel (20), yielding the incorrect surface form **vak*$^j$*ɨt.*

(20)



In reality, the [+high] vowel *I* surfaces as [−back]/[coronal] *i,* rather than [+back]/[dorsal] *ɨ.* In order to avoid an arbitrary rule that would block [dorsal] spread across [coronal] V-Places, UFT would be forced to posit three rules: one spreading the [dorsal] specification of the *a* onto the *I,* a second spreading the [coronal] V-Place of the *k*$^j$ onto the *I,* and a third to repair the

[4] Calabrese actually assumes that the equivalency between dorsality and coronality holds only for coronals that are laminal (i.e., [+distributed]). This theory predicts that coronal fronting can only be caused by [+distributed] coronal consonants; languages like English whose coronal stops are [−distributed] should not trigger vowel fronting. The Agn coronal consonants are therefore expected to be [+distributed], but this can no longer be tested since the dialect is now dead.

resultant ill-formed corono-dorsal feature complex. Although UFT could add an ad hoc statement prohibiting corono-dorsal segments, it would still have no way of accurately predicting which of the two corono-dorsal specifications is to delink in this third rule. Such a prediction would depend on the specification of the preceding consonant: after palatal consonants the [dorsal] specification would delink, producing a front vowel, whereas after nonpalatal consonants the [coronal] specification would delink, producing a back vowel.

To account for these coronal-dorsal interactions, Clements and Hume (1995:290ff.) propose that [coronal] and [dorsal] are dominated by an intermediate node, which they call *Lingual* (after Browman and Goldstein 1989); they then postulate that it is the Lingual node that spreads in backness harmony. Support for the Lingual node in the literature is quite sparse, however, and all of the main examples adduced to support it are easily dismissed or reanalyzed, as we now show.

(i) In the first proposal of the Lingual node in the literature, Browman and Goldstein (1989) simply offer the idea and leave the burden of proof to later researchers. They base their proposal on the simple anatomical observation that the tongue tip and the tongue body both belong to the tongue organ; but by this logic the tongue root should also be included in the Lingual node. Instead, as shown in (1), we have grouped the tongue root with the larynx under the node Guttural. This grouping is supported in part by the fact that the movement of the tongue root is controlled by the inferior pharyngeal constrictor muscles, which are closely related to the muscles of the larynx rather than to muscles that control the movement of the tongue body. More importantly, the grouping of the tongue root and the larynx is supported by the fact that they pattern together in phonological processes, as documented extensively by Vaux (1999a) and McCarthy (1994).

(ii) Christdas (1988) claims that there is need to refer to a [−labial] class of phonemes, later recast as a [+lingual] class, in order to deal with the facts of palatalization and secondary articulation in Tamil.[5] She considers two suffixes that manifest alternations between ‘‘palatal’’ and ‘‘nonpalatal’’ allophones, in which underlying *k* becomes $k^j$, *t* becomes *ʧ*, and the labials surface without a secondary [−back] articulation (Christdas 1988:38–40, 333–339; unfortunately, she supplies no example of a labial-initial suffix).

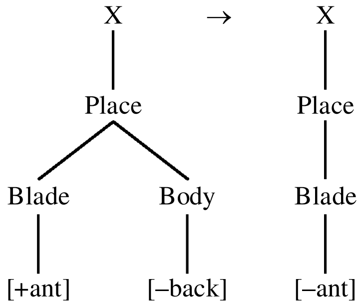
These facts are readily handled in RAT by means of a single prohibition against multiply-articulated segments (i.e., segments with more than one articulator). Consonants assimilating [−back] from an adjacent vowel come to violate this prohibition, and trigger different strategies in order to repair the violation. No repair occurs in the case of the dorsal consonant $k^j$ (21c), since this consonant has only one articulator. The coronal $t^j$ and the labials $p^j$, $b^j$, . . . involve two articulators and therefore violate the prohibition against multiply-articulated segments. The coronal consonant $t^j$ is subject to repair, which turns it into the [−anterior] *ʧ* (13a), by Calabrese's (1993) equivalency relation between [dorsal, −back] and [coronal, −anterior]. In this case the [dorsal, −back] specification of the palatal secondary articulation in the $t^j$ triggers the equivalency

[5] Clements (1989:37ff.) also invokes a [−labial] specification, in order to account for Igbo Labial Assimilation (cf. section 2.2). However, his reasons for doing so are flawed: he claims that the assimilation rule must refer to the root vowel, but in fact it only refers to the vowel of the reduplicant prefix.

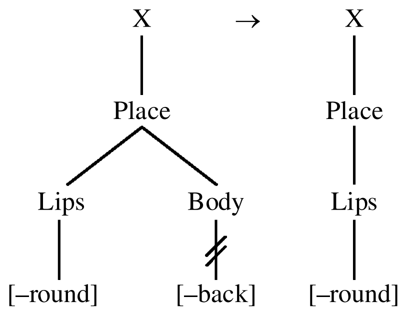
relation, producing the [coronal, −anterior] segment *ʧ*. The labials $p^j$, $b^j$, . . . also violate the prohibition against multiply-articulated segments; they are repaired by delinking the [−back] feature ((21b); see Calabrese 1993 for more details).

(21) *Palatalization and secondary articulation constraints in Tamil*

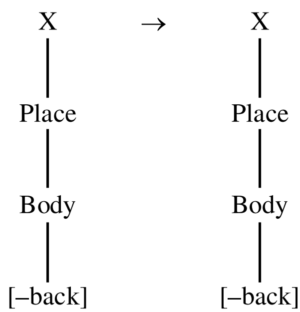
a. $t^j$ → ʧ (via the equivalency relation between [–back] and [–anterior])




b. $p^j$ → p




c. $k^j$ → $k^j$




(iii) Clements and Hume (1995:291) (following Clements 1976) cite a constraint of Mandarin that prohibits nonlabial obstruents before high front vowels *i, y* unless the obstruents are laminal and palatoalveolar. This excludes the dorsal, retroflex, and dental consonants *k*, $k^h$, *χ*, *ts*, $ts^h$, *s*, *ʈʂ*, $ʈʂ^h$, *ʂ* from positions before high front vowels. One could argue that this set constitutes the natural class of linguals.

The problem with this analysis lies in its inability to account for the fact that the dental stops *t*, $t^h$ occur freely in this position. Without these two phonemes, the remaining consonants do not constitute a natural class. We offer no reanalysis other than the possibility that the apparent constraint on linguals before high front vowels is actually an accidental gap, resulting from historical changes that have subsequently been obscured. Clearly a fuller understanding of this phenomenon would require a more extensive study of Mandarin phonology.

(iv) That no [lateral] sounds are executed by the lips is not evidence for the existence of a Lingual node. According to Ladefoged and Maddieson (1996), Northern Waghi (a language of New Guinea) has, in addition to laminal and apical laterals, laterals executed by the Dorsal articulator. This establishes that [lateral] is articulator-free, since the feature can be executed by several articulators. Although an articulator-free feature can be executed by different articulators, it is not the case that each of the six articulators may execute each articulator-free feature. Halle (1995:7, 12) proposes that for [+consonantal] phonemes the choice of designated articulator is limited to the Lips, Tongue Blade, and Tongue Body, and that articulator-free features other than [consonantal] are not available to [−consonantal] phonemes. Since, as we have just shown, [lateral] is articulator-free, it is available only to [+consonantal] phonemes, and the choice of designated articulator for these phonemes is limited to the three articulators dominated by the Place node. The feature [lateral] is furthermore subject to the prohibition *[+lateral, labial], which is included in the set of universal constraints on feature cooccurrence. (See Clements and Hume 1995:291 for arguments for the position of [lateral] under the Root node.)

To recapitulate the discussion in this section: Clements and Hume (1995) are required to postulate a Lingual node dominating [coronal] and [dorsal] in order to account for the many instances of what is traditionally considered to be [back] harmony. However, the independent arguments adduced in support of the Lingual node break down under closer examination, leaving UFT with no viable explanation for the problems of [back] vowel harmony. (This may be the reason why Clements and Hume abandon the Lingual node in the feature tree that they finally adopt on page 292.)

*2.1.2 The Replacement of [high] and [ATR] by [$open_n$]* In addition to the difficulties UFT encounters with coronals and dorsals, it runs into problems with the traditional features [high] and [ATR]. Clements (1991) replaces vocalic [high] and [ATR] with the family of aperture features [$open_1$], [$open_2$], [$open_3$], and so on, which encode height differences between high, mid, and low vowels, respectively. This proposal makes several incorrect phonological predictions. By separating the aperture features from consonantal and vocalic Place features, and by asserting that these aperture features characterize only vowels and not consonants, Clements predicts that they will not show the same interactions between consonants and vowels that are found with Place-dependent features such as [coronal] and [dorsal]. The extensive evidence for interactions between consonant voicing and vocalic [ATR] values documented by Trigo (1991) and Vaux (1996) is thus problematic for UFT, whereas it receives a straightforward account within AT (see Vaux 1996).[6]

Clements (1991) and Odden (1991) have argued that the AT model (1) has difficulty in

[6] In many languages vowels become [+ATR] adjacent to voiced obstruents, a phenomenon that Trigo and Vaux attribute to a [+ATR] specification in voiced obstruents. This sort of interaction is not readily captured in Clements's [ATR]-less model.

accounting for cases where [ATR] and [high] values apparently spread together in Bantu languages such as Kimatuumbi, Kinande, and Esimbi (data and arguments summarized in Kenstowicz 1994: 476ff.). Halle (1995:62ff.) has shown that these data can be interpreted without recourse to the feature [ATR] and therefore do not pose a problem for AT.

Several compelling arguments against the multivalued [open] feature family have been presented by Zetterstrand (1996a,b, 1998a,b). We briefly rehearse two of her arguments here. The first argument involves the problem of constraining vowel height features: it is necessary to have enough features to distinguish all of the height contrasts attested in natural languages, yet one must avoid postulating so many height features that unattested height contrasts are predicted. This is not a problem in AT, where Calabrese's (1995) theory of marking statements makes explicit, articulatorily grounded claims about the sets of possible and impossible height contrasts. No such theory of constraints limits the set of possible height contrasts in Clements's [open] model, however; even a straightforward constraint like *[+high, +low] would have to be stated in terms of an arbitrary statement *[$+\text{open}_1$, $-\text{open}_2$], which has no articulatory or acoustic basis (Zetterstrand 1998b).

Zetterstrand's second argument concerns the interaction between height in vowels and uvularity in consonants. It is well known that nonhigh vowels often trigger uvularization of consonants (e.g., in Yakut (Vaux 1999a) and Sibe (Li 1996:202)), and conversely that high vowels often impede or undo uvularization of adjacent consonants (e.g., in Turkana (Zetterstrand 1996b)). In AT these sorts of interactions are easily explained in terms of the feature [high]. Following Chomsky and Halle's suggestion (1968:305) that dorsal consonants are [+high] and uvular consonants are [−high], we can analyze uvularization of consonants by nonhigh vowels as spreading of [−high] from the vowel to the consonant. Similarly, de-uvularization by high vowels can be analyzed as spreading of [+high] from vowel to consonant.

In Clements's model, on the other hand, these interactions have no natural sense, because the feature that characterizes nonhigh vowels, [$+\text{open}_2$] in the case of the Turkana vowel system (Zetterstrand 1996b:485), does not and cannot characterize uvular consonants, whose distinctive property is either a [dorsal] secondary articulation (Zetterstrand 1996b) or a combined [dorsal] and [pharyngeal] secondary articulation (Herzallah 1990). The reason that uvulars cannot be [$+\text{open}_2$] lies at the very heart of the logic of Clements's model: the idea that the organizing principle of feature geometry is constriction. In this view, in consonants the degree of constriction is expressed in terms of the feature [continuant], whereas in vowels it is expressed in terms of the multivalued feature [open]. For Clements, this distinction between consonantal and vocalic constriction is essential; consonants can *never* bear vocalic [open] strictures, and vowels can *never* bear consonantal [continuant] strictures. It is therefore impossible for uvulars, which are consonantal, to contain specifications for the vocalic feature [open].

The result of our discussion in this section is that the features [high] and [ATR] are essential to any viable theory of feature geometry. The UFT attempt to replace [high] and [ATR] with a family of [open] features is unconstrained, fails to capture well-known articulatory constraints in a principled way, and sacrifices the ability to explain a host of relatively straightforward C-V interactions.

*2.1.3 Problems of Tier Interaction* In the preceding two sections we demonstrated that UFT creates problems in its attempts to deal with C-V interactions and scalar assimilation of vowel height. In this section we argue that UFT also runs into theory-internal difficulties involving interactions between the C-Place and V-Place tiers. We first exemplify some of these problems by considering a rule of dorsalization in Palestinian Arabic, and we then discuss UFT's problems with tier interactions in more general terms.

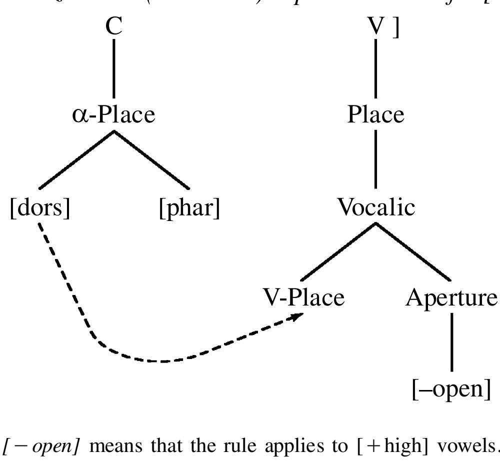
2.1.3.1 Palestinian Arabic Dorsalization UFT assumes that the C-Place and V-Place nodes of (18) are identical in every respect except for their position in the feature tree and the fact that the C-Place node dominates the V-Place node. In defense of this assumption Clements (1993), drawing on an analysis by Herzallah (1990), cites a process in Palestinian Arabic illustrated in (22). Closer examination of Herzallah's analysis reveals problems that severely undermine her claim (and Clements's).

According to Herzallah (1990), emphatic and uvular consonants in Palestinian Arabic cause the root vowel in the imperfective (normally *a* or *i*—(22a)) to become *u* (22b).

| (22) | | *Perfective* | *Imperfective* | *Gloss* |
|---|---|---|---|---|
| | a. Regular verbs | nidim | ji-ndam | 'regret' |
| | | kibir | ji-kbar | 'grow up' |
| | | katab | ji-ktib | 'write' |
| | b. *u*-verbs | qatal | ji-qtul | 'kill' |
| | | saχan | ji-sχun | 'get hot' |
| | | nabaʁ | ji-nbuʁ | 'excel' |
| | | ṭɑlab | ji-ṭlub | 'ask for' |

According to Herzallah, emphatics and uvulars are characterized by a [dorsal, pharyngeal] articulation. For emphatics, these features are dominated by the V-Place node, with [coronal] as their primary (C-Place) articulation; for uvulars, [dorsal] and [pharyngeal] are the primary specifications and thus attach to the (C-)Place node. Consequently, Herzallah attributes the -*u*- in the forms in (22b) to a [dorsal] feature that spreads from emphatics and uvulars within the root, as in (23).

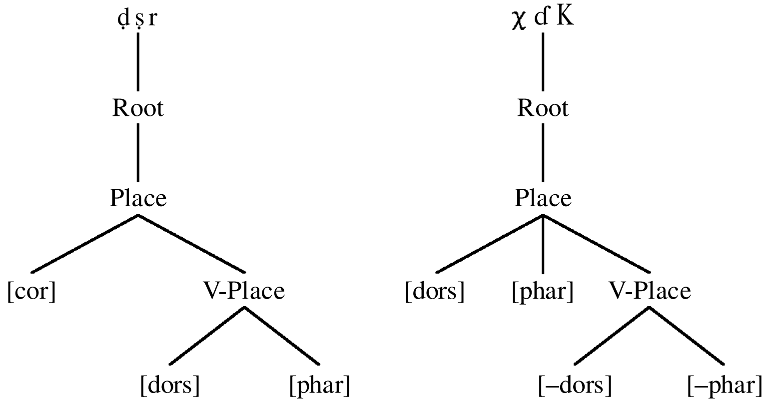
(23) *Herzallah's (1990:181) representation of "[—open] Dorsalization"*[7]




[7] The *[ − open]* means that the rule applies to [+high] vowels. Herzallah follows Clements (1991) in her use of

Because of complications in another rule, however, she is forced to assign [−dorsal] and [−pharyngeal] V-Place articulations to the uvulars, as illustrated in (24).

(24) *Herzallah's (1990:125) representation of emphatics and uvulars ("back velars")*[8]




Besides weakening the UFT position that vocalic features are privative, this makes it unclear which set of specifications is spreading to the vowel in the dorsalization rule (23). Since uvulars now have V-Place, and not simply redundant V-Place but a V-Place that contrasts with the segment's C-Place specifications, the formalization proffered in the alpha notation of (23) becomes questionable.

Although UFT allows rules of the sort in (23), we note that this is the only spreading rule cited by Clements that cannot be adequately represented using Ní Chiosáin and Padgett's (1993) more robust account of C-V interactions (see section 2.2), in which all C-V interactions occur on the V-Place tier. It cannot be V-Place that spreads in the Palestinian Arabic case, since the negative specifications of the uvulars interfere. In the version of Clements's UFT that she adopts, Herzallah might have had recourse to underspecification, had she not ordered the specification of the uvulars' [−dorsal, −pharyngeal] V-Place before the dorsalization rule.

In AT, on the other hand, the Arabic facts are explained as the result of spreading [+back] (25c).[9] In (25) we illustrate how this works for the imperfective form in (22b), *ji-sχun* (irrelevant structure is omitted in what follows). First, we assume that the underlying form is *ji-sχin* ((25a); cf. *ji-ktib* in (22a)) and that uvulars and emphatics in Palestinian Arabic contain the features [+back, −high] ((25b); see Chomsky and Halle 1968). We can then state that the rule responsible

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the feature [open] to encode height differences. The term *α-Place* means that the node in question can be either C-Place or V-Place.

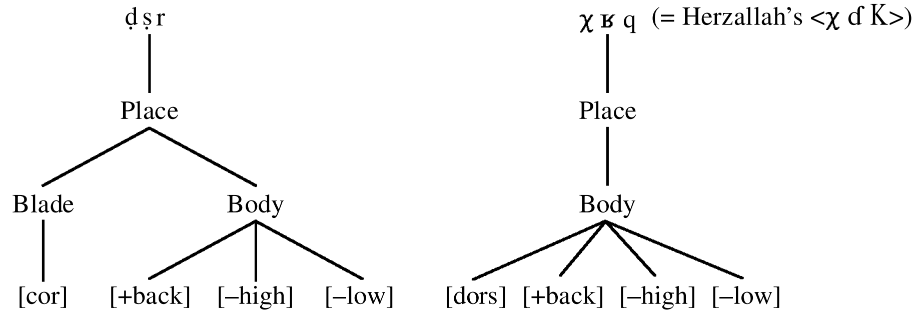
[8] Herzallah uses *K* to transcribe the Palestinian Arabic "back velar" analogue of Classical Arabic's uvular *q*.

[9] Other considerations in Herzallah 1990 also find simple explanations within an AT framework. For instance, Herzallah considers a rule of pharyngealization triggered by coronal emphatics wherein the sound *æ* (which she transcribes with the letter *a* for typing ease; Herzallah 1990:29) becomes *a.* AT treats this as spreading of consonantal [RTR], which through a prohibition *[+RTR, +ATR] changes the [+ATR] of the *æ* to [−ATR], producing *a.* For evidence that *æ* is specified as [+ATR], consider the three-way unrounded low vowel distinction *æ*, *a*, *a* found in various dialects of English (e.g., Boston): *bæt* 'bat', *ba* 'bar', *baθ* 'bath'. Not only is [ATR] the only vowel feature left to account for this distinction; in addition, *æ* shows the acoustic properties of [+ATR], such as a lowered $F_1$ and raised $F_2$ relative to its [−ATR] counterpart *a.*

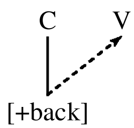
for the forms in (22b) spreads [+back] from a consonant to a following vowel (25c); the application of this rule to *ji-sχin* is shown in (25d). Spreading of [+back] to the underlying *i* produces a [+back, −low] vowel, which triggers a redundancy rule that ensures that all back vowels are [+round] (25e).

(25) a. *Underlying form*
ji-sχin

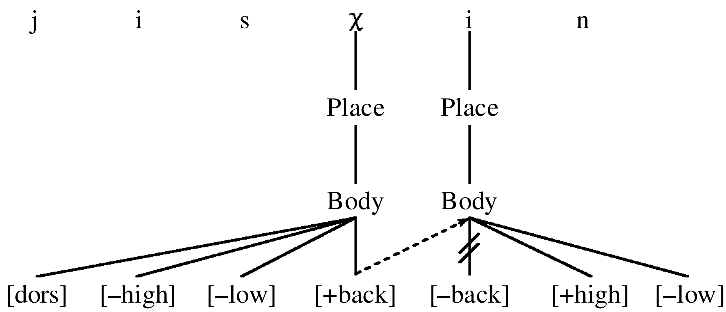
b. *Underlying form of emphatics and uvulars*



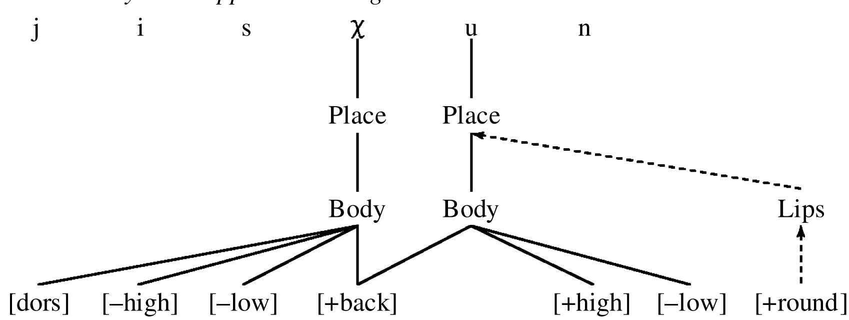

c. *[+back] spread*




d. *[+back] spread in* ji-sχun




e. *Redundancy rule supplies rounding in back vowels*

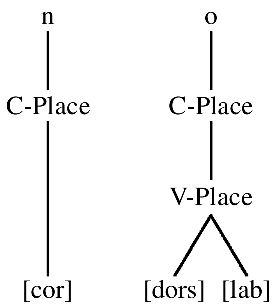


By hypothesis, plain dorsal consonants contrast with uvulars by being [−back]; for this reason, they do not trigger the [+back] spreading rule in (25c).

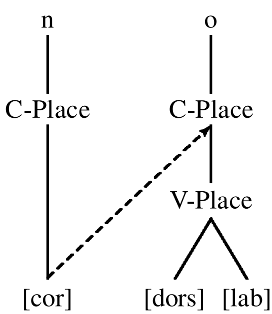
2.1.3.2 Demotion UFT formalizes C-V spreading by means of demotion rules of the form in (26), which delinks the vowel's original V-Place and converts its new consonantal features into vocalic features. The rule is exemplified in (26) for the Agn form *nor* 'new' > *nør* in (9a) (irrelevant nodes omitted).

(26) *Palatalization (coronalization) according to UFT*

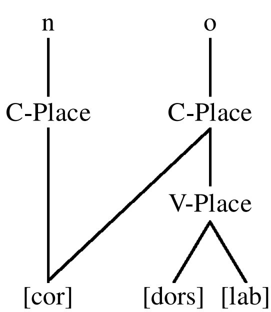
a. *Underlying representation*



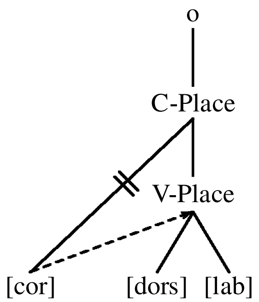

b. *[coronal] spreads from the consonant to the vowel*



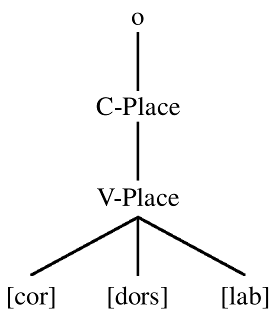

c. *Intermediate representation*



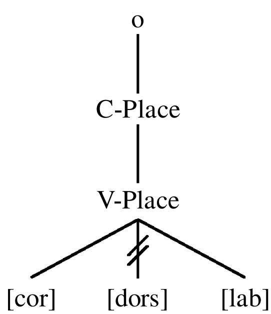
d. *Demotion (ignoring the* n*)*



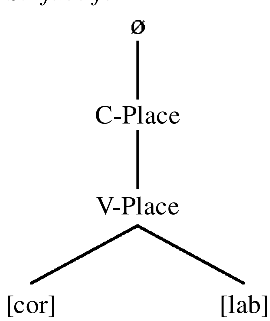

e. *Intermediate representation*




f. *Delinking of incompatible features*




g. *Surface form*



To avoid the theory-internal intricacies of (26b–d), UFT might simply allow the consonantal feature to ‘‘dock’’ onto the V-Place node (as implied, but not stated directly, by figure (44) in Clements and Hume 1995). Both demotion and docking, however, present the same problem: if C-Place and V-Place are truly separate, then these procedures violate the notion of tier separation, in that two tiers are interacting without referring to a common superior node. To introduce a second means of tier interaction besides the one allowed by the feature tree itself is to undermine the very purpose of the hierarchical model of feature geometry. UFT leaves C-Place and V-Place in an indeterminate state where they remain on separate tiers but interact as if on the same tier as needed. In order to decrease the theoretical power of such mechanisms, UFT must propose an ad hoc restriction on the use of docking and demotion to C-Place/V-Place interactions.

Supporters of UFT may counter that no such restriction is needed, since no two superior nodes other than C-Place and V-Place access the same set of features. This still fails to explain how UFT retains the ability *both* to overlook specifications for any given feature owing to their differing superior Place nodes (e.g., spreading of V-Place [labial] over the intervening C-Place [labial] specifications of labial consonants in rounding harmony) *and* to let these specifications affect each other even though they are not dominated by the same node (as in Agn coronal fronting, where C-Place [coronal] interacts with V-Place [coronal]). The notion of independent tiers as originally formulated remains breached.

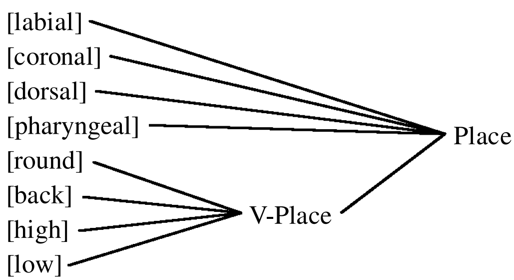
In contrast, in the AT account the interaction or noninteraction of consonant and vowel places is determined solely by the contrastiveness or markedness of features. AT has no difficulties with sporadic tier independence, since it admits only one Place tier.

*2.1.4 Interim Summary* To summarize the discussion thus far: UFT differs substantially from AT in its treatment of the features [−back], which it interprets as [coronal], and [ATR] and [high], which it interprets as a family of [open] aperture features. We have shown in this section that replacing [ATR] and [high] with [open] makes incorrect predictions about the interaction of consonantal and vocalic [ATR] and [high] values. In the domain of Place features, we demonstrated that the [coronal] representation of front vowels creates more problems than it solves, that the proposed Lingual node remedy draws little support, and that the problems that [coronal] representations of frontness intend to solve are easily managed within an AT framework. Furthermore, to the extent that the same anatomical articulators are involved in the production of both consonants and vowels, the introduction of two Place nodes—V-Place and C-Place—treats phonological aspects of speech sounds (in this case, the feature-geometric nodes dominating the place of articulation) as distinct from their articulatory aspects (in this case, the place of articulation). In the absence of compelling evidence to the contrary, we prefer a theory of feature geometry to maintain as close a mapping as possible between the phonetic and the phonological properties of speech, and UFT fails to provide this compelling evidence. Finally, and perhaps most importantly, UFT’s appeal to docking and demotion rules renders the notion of tier inoperative.

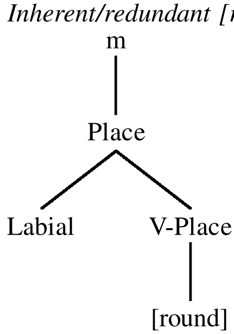
### *2.2 Redundant Vowel-Place Theory*

In their version of VPT, Redundant Vowel-Place Theory (RVPT), Ní Chiosáin and Padgett (1993) address UFT’s problems with tiers by postulating that all C-V interactions occur on the V-Place tier. In this section we present the basic tenets of RVPT and demonstrate that this model, though it solves some problems, creates additional problems in feature consistency and is incapable of accounting for some of the data sets that it invokes to support its postulates. Moreover, despite attempting to avoid the issue of unified features (features specifying both consonants and vowels), RVPT's working assumption, that there are no unified features, encounters problems within a VPT framework.

*2.2.1 Redundant V-Place* As mentioned above, some advocates of VPT, and Clements (1993) in particular, use docking or demotion rules to bridge the gap between C-Place and V-Place in C-V interactions, as illustrated in (26). Ní Chiosáin and Padgett (1993) take a more conservative position. Within their theory C-V and V-V interactions alike are interpreted as operations on the V-Place node, so that there are no relations between consonantal Place features and vocalic Place features and thus no need for docking or demotion. Furthermore, in view of problems they see in UFT (notably the bifurcation of the feature [back]), they assert only that there are equivalence relations between [labial] and [round], [coronal] and [−back]/[+high], [dorsal] and [+back]/[+high], and [pharyngeal] and [+low]/[+back], and they propose the Place geometry in (27) (Ní Chiosáin and Padgett 1993:4).

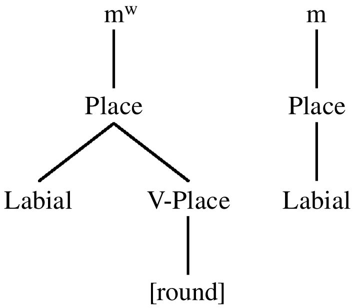
(27)



In order to account for cases where a consonant's C-Place specification spreads to vowels, Ní Chiosáin and Padgett postulate that plain consonants have inherent, redundant secondary V-Place specifications that parallel, according to the above equivalency relations, their primary C-Place features. In this theory the plain labial *m* would have the representation in (28), provided that the language does not also contain a $m^w$ phoneme.

(28) *Inherent/redundant [round] in* m (Ní Chios in and Padgett 1993:2)


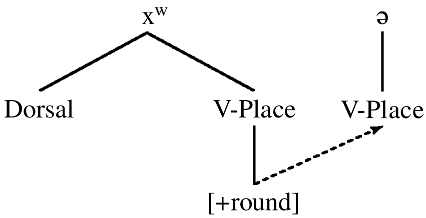
In a language that contrasts *m* and *m*$^{w}$ phonemes, on the other hand, *m* would not have a redundant [round] specification (Ní Chiosáin and Padgett 1993:12); if it did, of course, it would be indistinguishable from *m*$^{w}$. This is illustrated in (29).

(29) *[round] in an* m : m$^{w}$ *system* (Ní Chios in and Padgett 1993:2)




Ní Chiosáin and Padgett employ the representations in (28) and (29) to distinguish between two types of C-V interactions, which they call *type I* and *type II* (1993:8–9). Type I interactions involve the activity of distinctive V-Place features, as in Abaza (and many other Caucasian languages), where vowels become round after labialized consonants, as in *x*$^{w}$*əc* 'small' → *x*$^{w}$*uc* (Ní Chiosáin and Padgett 1993:9).[10] Ní Chiosáin and Padgett analyze this process as spreading of the consonant's distinctive [+round] V-Place secondary articulation to the following vowel, as in (30).

(30) *Type I interaction in Abaza*



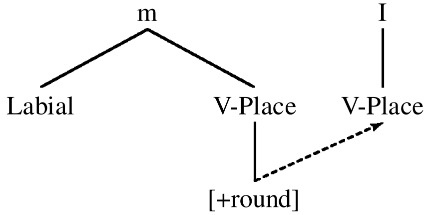

Type II interactions involve a change in the place of articulation of a vowel under the influence of a neighboring *plain* consonant, as in Turkish Labial Assimilation, in which, according to Ní Chiosáin and Padgett, "labial consonants cause the rounding of a following high back vowel if preceded by *a*" (1993:10), as in *armId* 'pear' → *armut.*[11] Ní Chiosáin and Padgett assert that this phenomenon involves spreading of the redundant/inherent [round] V-Place specification of the *m* to its neighbor *I,* as depicted in (31).

[10] We assume on the basis of the Abkhaz cognate *χ*$^{w}$*ətʃ*$^{j}$*ə* that the *c* employed by Ní Chiosáin and Padgett is actually a palatalized affricate *tʃ*$^{j}$.

[11] The capital *I* here represents a high vowel unspecified for rounding and backness.

Zimmer (1969), van der Hulst and van de Weijer (1991), and several others argue against Labial Assimilation being an active generalization in the synchronic phonology of Turkish; we employ it here only because it is one of Ní Chiosáin and Padgett's main examples and serves to illustrate their point.

(31) *Type II interaction in Turkish*




Note that the Turkish plain *m* is allowed to have a redundant [round] specification, unlike Abaza *x,* because Turkish contains no phoneme $m^w$ with which *m* contrasts for rounding.

The assumption that plain consonants can contain redundant V-Place specifications enables RVPT to postulate that all C-V interactions occur on the V-Place tier, thereby avoiding the problems of tier interaction faced by UFT. This assumption takes on an interesting character in Igbo, where both plain labials and labialized consonants trigger a rule of Labial Assimilation, contrary to what we might expect.

In Igbo the gerund is formed by prefixing a VCV sequence to a CV root. The initial V- of the prefix is *o* or *ɔ,* depending on the [ATR] specification of the root vowel. The consonant of the prefix is a copy of the root consonant, and the second prefixal vowel is [+high] and again shares the [ATR] value of the root vowel. What is of interest here is a process of assimilation that targets the second prefixal vowel when the root vowel is [−high]; in this case the vowel of the reduplicated syllable surfaces as round before labial (32a), labiovelar (32b), and labialized (32c) consonants, and as nonround elsewhere (32d) (Hyman 1975:53, Clements 1989:35).[12]

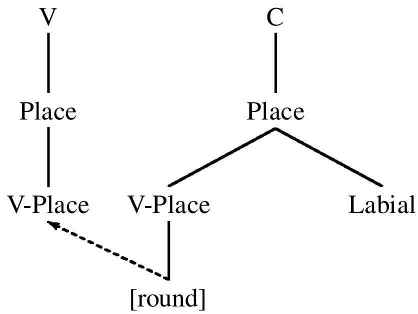
| (32) | | *Verb stem* | *Gerund* | *Gloss* |
|---|---|---|---|---|
| | a. Plain labial | bè | ò-bù-bè | 'cut' |
| | | bà | ɔ̀-bʊ̀-bà | 'enter' |
| | | fè | ò-fù-fè | 'cross' |
| | b. Labiovelar | gbé | ò-gbú-gbé | 'crawl' |
| | c. Labialized | $k^w$é | ò-$k^w$ú-$k^w$é | 'agree' |
| | d. Elsewhere | lé | ò-lí-lé | 'look' |
| | | lá | ɔ̀-lì-lá | 'return' |
| | | mì | ɔ̀-mì-mì | 'dry' |

In Ní Chiosáin and Padgett's system, Igbo Labial Assimilation would be interpreted as spreading of the redundant [round] specification of the root consonant to the prefixal vowel, as in (33). This treatment of plain labials as having an inherent [round] specification does obviate the need for UFT's docking and demotion rules. Nevertheless, as we mentioned above, some allowance must be made to distinguish plain from rounded labials, such as *p* and $p^w$, which are contrastive

[12] Though Clements (1989:35) states that ''whether the prefix vowel is labial (rounded) or not depends on the nature of both the *following* consonant and vowel'' (our italics), the data do not actually make clear whether the assimilation process is triggered by the *preceding* or the *following* labial consonant. Since this is not relevant for the point we are making here, we have simply followed Clements in assuming that the spreading is leftward.

in the Melanesian language Nambakaengo (Maddieson 1984), Nupe (Smith 1967), Ponapean, and Mokilese (Mester 1986), or *m* and $m^w$, which are contrastive in Washkuk (Maddieson 1984), Nupe, Ponapean, and Mokilese. In such cases Ní Chiosáin and Padgett posit that plain labials do not receive the redundant specification (1993:17); that is, they are specified for (consonantal) Labial alone and not for V-Place [round] (or possibly they are specified for [−round]).

(33)




The interesting fact about Igbo is that it has both plain and labialized consonants: *k* contrasts with $k^w$, *g* with $g^w$, and so on. However, the Igbo labials happen not to be contrastive for [round]; there is an *m,* for example, but there is no $m^w$ with which it contrasts. In Ní Chiosáin and Padgett's theory *m* can therefore be redundantly specified for [round], since it does not contrast with a $m^w$ phoneme. This allows Ní Chiosáin and Padgett to account for the fact that both rounded consonants and plain labials spread rounding in (32).

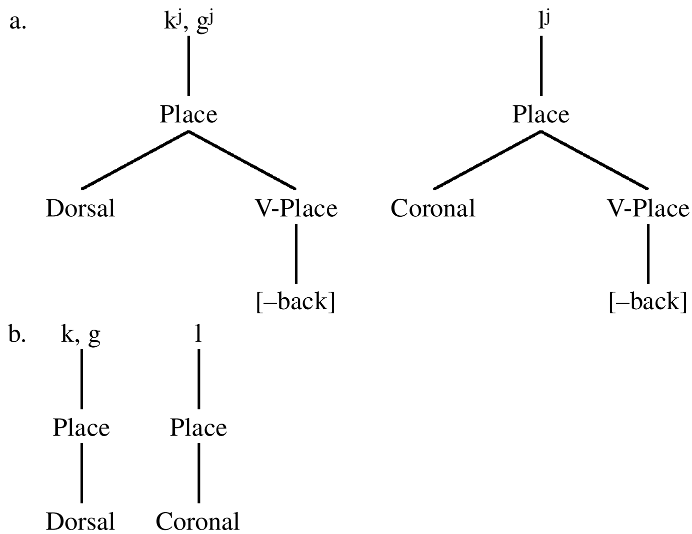
Although the predictions made by RVPT nearly match those made by AT, RVPT invokes considerably more abstractness in its understanding of features than does AT. Features no longer have a unique articulatory characterization, since a [+round] labial surfaces as rounded in some languages but as unrounded in others. In fact, this mismatch between the phonology and the phonetics can occur even within a single language, as in Igbo, where the phonologically [+round] labialized consonants are phonetically [+round], but the phonologically [+round] plain labial consonants are phonetically [−round]. (Ní Chiosáin and Padgett (1993:16–17) discuss a similar case in Berber.) RVPT thus provides the universal feature tree with some amount of language-specificity, increasing its descriptive power.

RAT accounts for the Igbo facts in a manner that avoids the phonetics-phonology mismatches and language-specificity required by RVPT. In RAT, Igbo Labial Assimilation involves leftward spreading of the contents of the Lips node from the consonant to the preceding vowel. Given the theory of terminal spreading that we set out in section 3, propagation of contents of the Lips node is implemented as spreading of the terminal features dominated by that node: the articulator feature [labial] in the case of labials and labiovelars, and the feature [round] in the case of labialized consonants. (See figure (1) for the relevant details of the feature geometry we assume.) The results of spreading [+round] to a preceding vowel are straightforward. Spreading of the articulator feature [labial] to a vowel produces a vocalic [labial] segment; by an equivalency relation of the sort discussed in section 2.1.1, this becomes [+round]. (For further discussion of the theoretical machinery involved in this sort of process, see section 3.)

Let us now return to RVPT's prediction about type II languages (see (31)), namely, that plain consonants that are contrastive for a given feature will never act as if they have a positive specification for that feature. Ní Chiosáin and Padgett (1993:17) provide the following instantiation of this prediction: "in a language with distinctive palatalization (represented say by [−back] . . .) we do not expect to find fronting . . . of vowels around plain coronals, segments which normally could be redundantly specified for these features." This prediction works nicely for Abaza and several other languages considered by Ní Chiosáin and Padgett, but does not hold true for all languages. Ironically, one such language is Turkish, which is one of the keystones of Ní Chiosáin and Padgett's argument.

Turkish manifests a contrast for the feature [back] in three consonants: *k, g,* and *l;* we represent the [−back] counterparts of these consonants as $k^j$, $g^j$, and $l^j$, respectively. The fact that these consonants are contrastive for [back] entails in RVPT that $k^j$, $g^j$, and $l^j$ have [−back] specifications under the V-Place node (34a), and *k, g,* and *l* do not (34b).

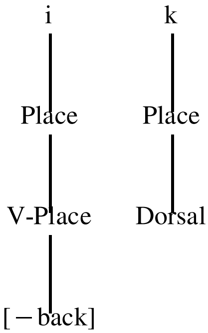
(34) *Turkish [back] contrasts in RVPT*




Given these representations, we adapt Ní Chiosáin and Padgett's proposal to the Turkish case as follows: "in a language with distinctive palatalization (represented say by [−back] . . .) we do not expect to find fronting . . . of vowels around plain coronals, *or backing of vowels around plain dorsals,* segments which normally could be redundantly specified for these features." However, Turkish displays just such a process, wherein vowels are backed by plain dorsal consonants.

The data, which have already been discussed by Clements and Sezer (1982) and Clements and Hume (1995), involve "exceptional" [+back] *k.* This exceptional *k* sometimes appears after [−back] vowels, where we expect its [−back] counterpart $k^j$ because members of the set *k, g, l* normally agree in backness with neighboring vowels. A typical example of exceptional *k* occurs in the word *tasdik* 'confirmation' (Clements and Hume 1995:290), where we would expect **tas-dik$^j$*.[13] Now, in RVPT the last two segments in this word should take the form in (35).

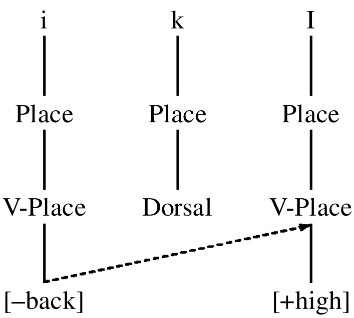
(35)




The tenets of RVPT presented thus far require that the *k* be unspecified for [back], because it contrasts with the [−back] *k$^j$*. Crucially, we cannot stipulate that the *k* is specified as [+back], for in doing so we would invalidate the prediction quoted above by allowing this [+back] feature to interact with neighboring vowels.

Given our assumption that this *k* is unspecified for [back], we expect that it should neither block propagation of [−back] in Turkish vowel harmony nor be able to spread [+back] (or [−back], for that matter) to neighboring vowels. When we add to *tasdik* the accusative singular suffix *-I,* for example, we expect that the [−back] specification of the *i* of the root should spread through the *k* to the harmonic vowel of the suffix, yielding *tasdiki* (or *tasdik$^j$i,* if the [−back] feature of the following *i* is allowed to spread to the *k*). This process is formalized in (36).

(36)



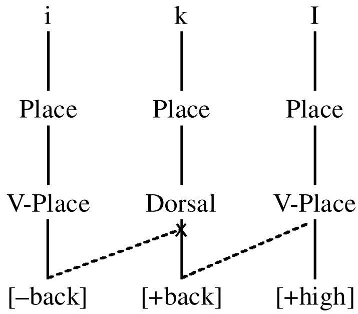

Both of the above predictions are wrong; the attested surface form *tasdikɨ* demonstrates not only that the [−back] specification of the *i* fails to spread to the suffix, but also that the *k* itself spreads [+back] to the suffix.

Both of these facts are easily explained by assuming that the *k* is in fact specified as [+back]; it is then expected to block [−back] spread from the preceding *i,* and to spread its own [+back] specification to the suffixal *I,* as depicted in (37). As illustrated in (37), this is thoroughly unproblematic in RAT. RVPT could easily employ the same solution by abandoning its analysis of

[13] Exceptional *k*s appear in loanwords involving Persian or Arabic *q,* or French dorsals in consonant clusters (e.g., French *crédit* → Turkish *kɨredi,* not **k$^j$iredi*).

contrastive phonemic oppositions, but this would entail abandoning one of the central advantages that Ní Chiosáin and Padgett attribute to their theory. Furthermore, it would invalidate the VPT analysis of Vowel Copy, which we discuss in section 2.3.2.

(37)



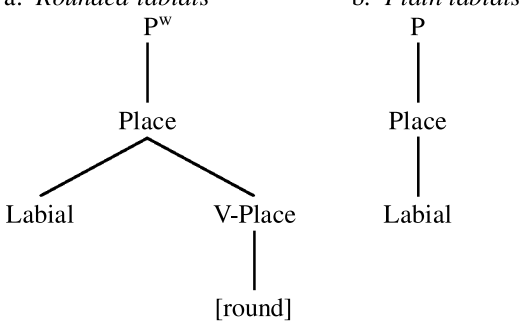

RVPT encounters similar problems with rounding harmony in the Kwa language Nawuri, as already noted by Casali (1995). According to Casali (1995:651), the vowel of the Nawuri singular noun-class prefix *gI-* becomes round before a round vowel in a following syllable (38a); this process is blocked in careful speech by intervening plain labial consonants (38b).

(38)

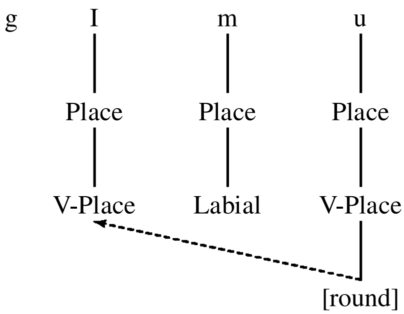
| | *Underlying form* | *Surface form* | *Gloss* |
|---|---|---|---|
| a. | gI-sU | gUsU | 'ear' |
| | gI-lɔ | gUlɔ | 'illness' |
| | gI-jo | gujo | 'yam' |
| | gI-ku: | guku: | 'digging' |
| b. | gI-mu | gɨmu | 'heat' |
| | gI-fufuli | gɨfufuli | 'white' |
| | gI-pula | gɨpula | 'burial' |
| | gI-bo:to: | gɨbo:to: | 'leprosy' |
| | gI-kpo: | gɨ-kpo: | a type of dance |

Crucially, Nawuri contrasts plain and rounded labial consonants in its phonemic inventory: *p* contrasts with $p^w$, *b* with $b^w$, *f* with $f^w$, and *m* with $m^w$ (Casali 1995:650). Given these contrasts, RVPT requires that the rounded labials have a [round] secondary articulation under the V-Place node (39a) and that the plain labials have no secondary [round] articulation (39b).

(39) a. *Rounded labials* b. *Plain labials*



Since RVPT's analysis of contrastive secondary articulations prevents the plain labial consonants in Nawuri from having a redundant V-Place [round] specification, RVPT predicts incorrectly that rounding should spread through plain labials, as shown in (40).

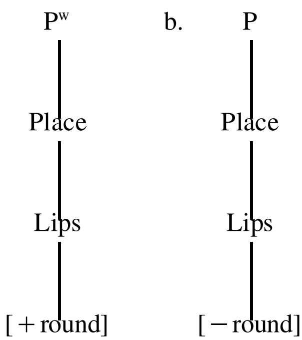
(40)



Predicted output: **gumu*

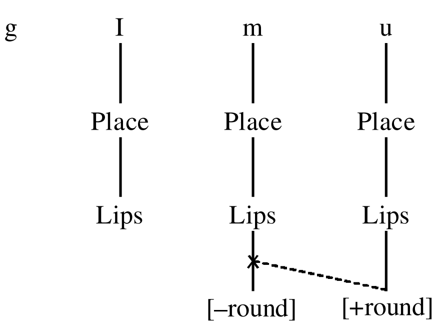
The blocking of rounding propagation by plain labial consonants is easily explained in RAT. Let us assume that the rule responsible for the changes in (38a) takes the form in (41) (ignoring the morphophonemic restrictions on the process, which are not relevant here).

(41) Spread contrastive [round] right to left from a [−consonantal, +sonorant] segment.

Given our theory of full specification (section 1.2.4), rounded labials are contrastively specified as [+round] (42a), and plain labials are contrastively specified as [−round] (42b). (For the sake of clarity, we omit irrelevant nodes.)

(42) a.



Since the rule in (41) is sensitive to contrastive [round] specifications, it is blocked by the contrastive [−round] value of plain labials, as exemplified in (43).

(43)


The result of the discussion in this section is that the proposal of redundant V-Place features creates a major problem for RVPT—loss of parallelism between phonology and phonetics—and fails to solve one of the central problems that the theory claims to account for.

*2.2.2 C-V Affinities* Returning to our main point, we note that Ní Chiosáin and Padgett also question the existence of unified features, commenting that they ''believe the issue requires more thought'' (1993:3). We point out that if, as they suggest, there are no unified features in V-Place theory, then the concept mentioned above that inherent V-Place specifications ''parallel'' their C-Place articulatory counterparts becomes meaningless. In UFT, V-Place and C-Place features act in parallel because they are identical. In Ní Chiosáin and Padgett's model, however, no internal structure motivates their particular ''C-V affinities'' except the statements themselves. AT encounters similar problems regarding coronalization and lowering processes, which it resolves by recourse to Calabrese's (1993) equivalency relations, as discussed in section 2.1.1. However, RAT gives a straightforward account for labialization and dorsalization processes, by linking them through the articulators Lips and Tongue Body, as we show in section 3. Ní Chiosáin and Padgett's model not only has the same problems with coronalization and lowering processes that AT does, but also has no structure-internal way to connect Labial with [round] or Dorsal with [back].

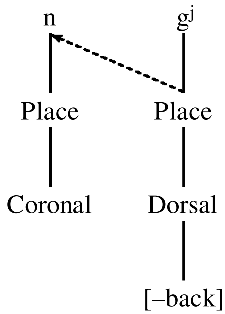
*2.2.3 Changes in C-Place* Another major piece of evidence Ní Chiosáin and Padgett (1993) use to support their theory of V-Place-only interactions is the observation that, crosslinguistically, C-Place does not change under the influence of a following vowel; thus, **su* → *fu,* **za* → *ʕa,* and **fɨ* → *xɨ*. In the few cases where such changes have actually been observed, Ní Chiosáin and Padgett posit a series of less dramatic historical steps, which remain in a telescoped form in morpholexical rules. Note, however, that at some point in the chain of small steps a change must occur for which Ní Chiosáin and Padgett's model has no account. Take, for instance, the Bantu chain they cite from Hyman 1976 (Ní Chiosáin and Padgett 1993:28): $pi \rightarrow p^hi \rightarrow p^si \rightarrow t^si \rightarrow si$. Between the aspirated $p^h$ and the affricate $p^s$ something of the vowel's articulation must become a coronal articulation in the consonant, unless the coronality is accounted for by a default rule calling on the underspecification of Coronal. Such an account, however, could not easily explain why the rule applies only before *i* and not before other vowels. Ní Chiosáin and Padgett might attempt to account for the weak link of this historical chain with a restructuring rule specific to palatalizations, but this would not explain the other Bantu data they cite, such as *ku* → *fu,* or Japanese *hu* → *fu.*

*2.2.4 Place Assimilation* One final item of evidence invoked by Ní Chiosáin and Padgett to support a V-Place node is the behavior of nasals in modern Irish (Ní Chiosáin and Padgett 1993: 7). As illustrated in (44), word-final coronal nasals assimilate the primary place of articulation of a following stop, but crucially do not assimilate the secondary articulation of the stop. Thus, in (44a) the palatalized $n^j$ assimilates the Dorsal primary articulation of the following *g,* but does not assimilate its [+back] secondary articulation. In (44b) the [+back] *n* assimilates the Dorsal primary articulation of the following *g,* but does not assimilate its [−back] secondary articulation. (In the discussion below, it is important to bear in mind that Irish contrasts plain and palatalized versions of most consonants in its inventory. This contrast is formally expressed by assigning these consonants the feature [±back].)

| (44) | *Form* | *Gloss* |
|---|---|---|
| a. | d$^j$ek$^j$h$^j$in$^j$ | 'I would see' |
| | d$^j$ek$^j$h$^j$iŋ$^j$ gan e: | 'I would see without it' |
| b. | d$^j$i:lən | 'a diary' |
| | d$^j$i:ləŋg$^j$i:v$^j$r$^j$i | 'a winter's diary' |

According to Ní Chiosáin and Padgett, this is an instance of Place assimilation. Hence, if we assume that palatalization in dorsals is represented as a [−back] specification under the Dorsal node, we expect that Place assimilation in (44b) should produce **d$^j$i:ləŋ$^j$g$^j$i:v$^j$r$^j$i,* as depicted in (45).

(45)




Ní Chiosáin and Padgett assert that in order to account for the nonassimilation of the palatal secondary articulation in (44b), ''we must adopt a structure in which the V-Place feature representing palatalization is independent of Dorsal'' (1993:7).

Ní Chiosáin and Padgett offer no support other than these Irish data for their assertion that Dorsal and [back] are not connected in the feature tree, a position that would surely have repercussions, if not crosslinguistically, at least elsewhere in Irish phonology. Moreover, Ní Chiosáin and Padgett's analysis itself—that the phenomena in (44) are instances of Place assimilation—is not the only, or necessarily the best, treatment of the data.

It is important to note in this connection that the data in (44) do not reflect the normal behavior of Nasal Place Assimilation in Irish, which spreads both primary and secondary articulations simultaneously. In (44) the Dorsal primary articulation of the second consonant spreads *without* simultaneously spreading its [back] secondary articulation. We must therefore distinguish two assimilation rules in Irish:

1. *Nasal Place Assimilation,* which spreads both primary and secondary articulations;
2. *Dorsal Assimilation* (44), which spreads only the Dorsal primary articulation.

It is true that Ní Chiosáin and Padgett's theory can account for both of these processes efficiently: the former would involve spreading of the Place node, and the latter would involve spreading of the Dorsal node.

A similarly efficient account is available in RAT. Like Ní Chiosáin and Padgett, we assume that Nasal Place Assimilation involves spreading of the features dominated by the Place node, whereas Dorsal Assimilation involves spreading of the Dorsal articulation. However, our account differs from theirs in that the Dorsal component that spreads is not the Dorsal node in the feature tree, but the feature [dorsal]. Since, as we stated in section 1, articulator features can spread like all other features, independently of the articulator nodes Lips, Tongue Body, and so on, spreading of the terminal feature [dorsal] does not entail spreading of the other features dominated by the Tongue Body node. In effect, what is spreading is the designated articulator [dorsal] for the segment in question; the other features executed by the Tongue Body articulator remain unaffected. (See section 3.3 for further elaboration of this analysis.)

Like most languages, Irish does not admit phonemes with more than one designated articulator. As a consequence, when the [dorsal] articulator feature of the following consonant is assimilated by the preceding nasal, the nasal loses its original [coronal] specification, resulting in the feature composition [dorsal, +nasal]—that is, *ŋ*$^{j}$ or *ŋ,* depending on whether or not the nasal was originally [−back]. When the designated articulator is assimilated, it is only this feature—and no other feature dominated by the articulator—that is assimilated.

The Irish facts are therefore crucial to a proper understanding of feature geometry, as Ní Chiosáin and Padgett rightly observe. However, these facts are crucial not because they point exclusively at a VPT analysis—the same data are equally compatible with the RAT presented here—but because they demonstrate the correctness of the traditional notion of articulator features. We return to this point in more detail in section 3.

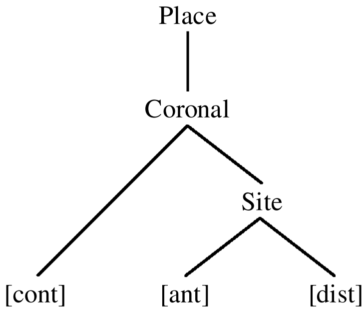
### *2.3 Long-Distance Assimilation*

Recall from section 1 that the proponents of VPT have claimed that AT cannot account for long-distance assimilation. In this section we examine how VPT treats the two logical types of long-distance assimilation, involving consonants and vowels, respectively. We argue that both versions of VPT fail to provide a satisfactory account of the former, and that RVPT is unable to reconcile its account for the latter with the explanation it was forced to adopt for the Turkish facts discussed earlier. The alternative RAT account of these facts encounters none of these difficulties.

*2.3.1 Consonant Harmony, Vocalic Transparency, and Strict Locality* Ní Chiosáin and Padgett (1993) note that V-Place theories in general have difficulty excluding such unattested interactions as **nak* → *ŋak,* where the Onset consonant assimilates the designated articulator of the Coda consonant. This sort of interaction is expected in VPT, since individual consonantal Place features can spread across vowels, as long as they do not require the involvement of the Place node. In order to exclude this class of unattested interactions, Ní Chiosáin and Padgett introduce a constraint stating that ‘‘spreading of C-Place articulator features is strictly local’’ (1993:47). This is an undesirable move, since the factual evidence for the constraint is weak and, more importantly, since the introduction of such locality constraints greatly weakens the strong hypothesis that all tiers allow action at a distance.

That aside, such locality constraints incorrectly predict the nonexistence of consonant harmony systems. Cases of cross-vocalic Coronal harmony have been documented in Sanskrit (Steriade 1986, Schein and Steriade 1986) and Tahltan (Shaw 1991, Halle 1995:39–42). In order to account for the ability of the Coronal node to harmonize across vowels, and to disallow other types of unattested consonant harmonies (e.g., Dorsal, Labial), Ní Chiosáin and Padgett (1993: 47) postulate a Site node subordinate to Coronal, as shown in (46).

(46)

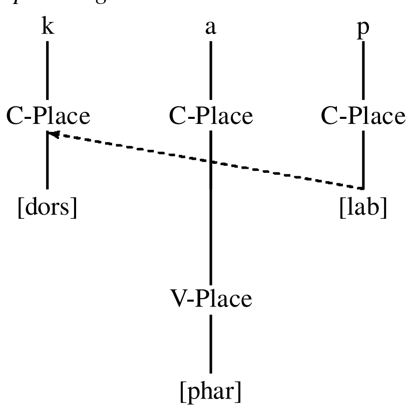



Since no other evidence is cited to support this Site node, this is a purely ad hoc move. The existence of consonant harmony and the uniqueness of Coronal harmony are not a problem for AT, because vowels have contrastive Labial and Dorsal specifications to block the spreading of these consonantal features, but they have no similar specification for Coronal (for details see Halle 1995).

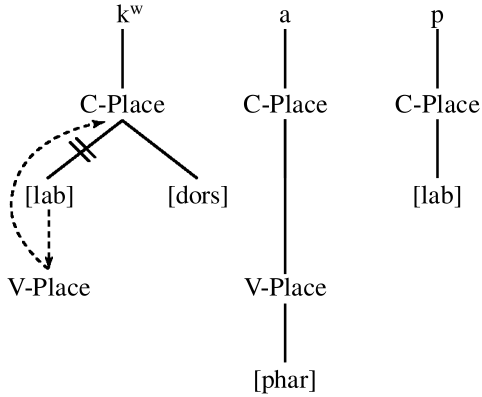
Ní Chiosáin and Padgett's version of VPT, which has no demotion rules, allows no further possibilities for long-range consonant interactions. In UFT, however, demotion rules allow C-Place specifications to become V-Place specifications. Thus, the geometry does not prohibit the unattested scenario in (47). This type of process includes not only long-range labialization, but also long-range palatalization (*paʃ → $p^j$aʃ) and long-range pharyngealization (*tiʕ → $t^ʕ$iʕ). In Ní Chiosáin and Padgett's version of VPT, where demotion does not occur, and especially in AT, where there is no C-/V-Place separation, these interactions are not allowed.

(47) *[kap] → [$k^w$ap]*

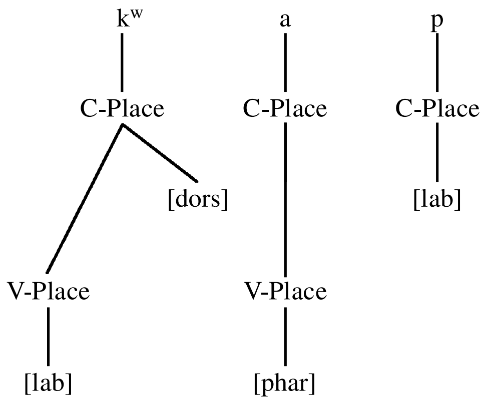
a. *Spreading*



b. *Demotion*



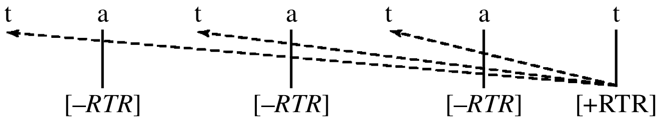

c. *Output*



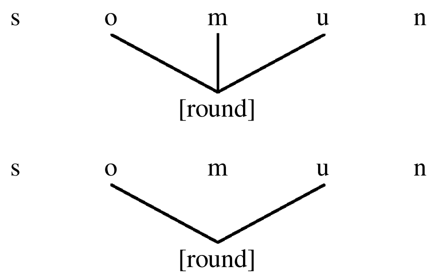

Limited long-range consonant interactions other than Coronal harmony do occur. Herzallah (1990) notes a process in Palestinian Arabic whereby emphasis spreads leftward from a Coronal emphatic onto other consonants throughout a word. Since Herzallah represents emphasis in Coronals as a combined [dorsal, pharyngeal] V-Place specification, she must posit that Emphasis Spread involves the entire V-Place node, which cannot spread through the V-Place of intervening vowels. She formalizes Emphasis Spread by ordering it before tier conflation, so that the intervening vowels' V-Place nodes cannot interfere. It should be noted, however, that of the four rules that she orders before tier conflation, this rule of Emphasis Spread is oddly the only nonmorphological rule.

In the RAT framework developed here, appeal to tier conflation and extrinsic rule ordering is not necessary. We instead account for Emphasis Spread in Palestinian Arabic by calling on the noncontrastiveness of vowels for the feature [RTR], which we assume to be the feature involved in the rule. Say that we have a hypothetical word *tatatatֹ*, where the last consonant is a Coronal emphatic that spreads emphasis onto the three preceding consonants, ignoring the intervening vowels; the surface result is *ṭaṭaṭaṭ*. If we postulate that Emphasis Spread spreads *con-*

*trastive* [RTR] specifications leftward, then we expect the [RTR] of vowels to be ignored, since vowels are not contrastive for this feature. We illustrate this scheme in (48), omitting irrelevant details; noncontrastive [RTR] specifications are shown in italics.

(48)



In the last few years a number of researchers have adopted a different strategy for dealing with long-distance consonant interactions. Flemming (1995), Gafos (1996), Walker (1996, 1998), Ní Chiosáin and Padgett (1997), and others assert that nonlocal spreading does not exist at all, and therefore consonants cannot interact at a distance unless intervening segments are also affected by the process. In the words of Ní Chiosáin and Padgett (1997:2), ''[S]egments are either blockers or participants in spreading; there is no transparency.'' This theory of Strict Locality requires that a word involving rounding harmony such as Turkish *somun* 'loaf' has the surface structure in (49a), not (49b).

(49) a.
b.



Vaux (1999b) demonstrates that Strict Locality encounters fatal difficulties with processes that spread a feature through segments that are contrastive for that feature. Space considerations prevent us from repeating the arguments here, but we present one illustrative case from the Tungusic language Sibe.

In Sibe the velar segments *k* and *x* (which are [+high]; see Vaux 1999a) become respectively the uvulars *q* and χ (which are [−high]) when preceded anywhere in the word by a [−high] vowel (Li 1996:201–202). In (50a), for example, the suffixal dorsal consonant in the word for 'long' becomes uvular by virtue of the fact that it is preceded by the [−high] vowel *ö*; contrast this with the forms in (50c), where the same suffix surfaces with a *k,* because it is not preceded by a [−high] vowel. This type of uvularization, which is also found in the Turkic language Yakut, can be analyzed as spreading of [−high] from a vowel to a dorsal consonant.

| (50) | | *Form* | *Gloss* |
|---|---|---|---|
| | a. | ɢölmi(n)-qɨn | 'long' |
| | | ʤalu-qun | 'full' |
| | | aʤi(g)-qɨn | 'small' |

b. bɔdu-χu — 'to consider'
lavdu-χu — 'to become more'
ömi-χɨ — 'to drink'
c. ɨldɨ(n)-kɨn — 'bright'
ulu-kun — 'soft'
tɨ-xɨ — 'to sit'
tyry-xu — 'to rent'

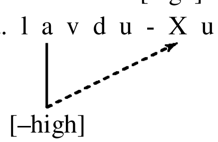
Much like Turkish, Sibe has two series of vowels that contrast for the feature [high].

(51) [+high] i y ɨ u
[−high] ɛ ö a ɔ

Given this vowel system, the uvularization facts in (50) are counterexamples to Strict Locality: in the word for 'long', for example, spreading of [−high] from the *ö* to the suffixal consonant should cause the intervening *i* to become its [−high] counterpart ɛ. In fact, Strict Locality leads us to expect all vowels intervening between a [−high] vowel and a uvular to become [−high], but the forms in (50a–b) show that this is not what happens. The problem for Strict Locality here is that strictly local spreading would incorrectly neutralize phonemic contrasts in intervening segments. As long as Strict Locality is required, this problem will not go away.

In RAT we analyze the Sibe uvularization process as rightward spreading of marked [high] specifications to eligible consonants. Given the structure of the Sibe vowel inventory, we can assume that [−high] is marked in vowels, and [+high] is unmarked. The uvularization rule therefore spreads the height specification of nonhigh vowels, but not of high vowels. By the same token, only marked feature specifications are visible to the rule, and intervening [+high] specifications are thus ignored. The bare bones of this analysis are sketched in (52).

(52) a. Spread marked [high] rightward to dorsal consonants.
b. [high] is only marked in [–high] segments.
c. Unmarked [high] specifications are not visible to the rule.
d.




*2.3.2 Vowel Copy* The final major argument advanced against AT by proponents of RVPT is that vowel copy processes of the kind encountered in Barra Gaelic are incorrectly blocked in the Halle-Sagey model. In this section we describe the Barra Gaelic facts and consider how they are dealt with in the two versions of RVPT. We conclude that RVPT is unable to account for the Barra Gaelic data, because of its assumptions about the nature of feature spreading.

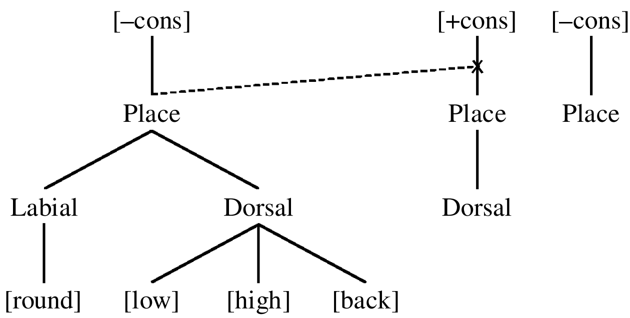
Barra Gaelic (Borgstrøm 1937, 1940, Clements 1987, Sagey 1987) repairs certain sequences with an epenthetic vowel that is an exact copy of the preceding vowel, except when the intervening consonant has a contrastive [back] specification (in this dialect backness is contrastive for all consonants except Labials and the Coronals *n, R*), in which case the epenthetic vowel agrees in backness with this consonant. The basic facts are given in (53) (data from Clements 1987, Sagey 1987).

(53)

| | Underlying form | Surface form | Gloss |
|---|---|---|---|
| a. After [ + back] sonorants | alpə | alapə | 'Scotland' |
| | s$^{j}$ærv | s$^{j}$ærav | 'bitter' |
| | s$^{j}$ænxəs | s$^{j}$ænaxəs | 'conversation' |
| | dunxəγ | dunuxəγ | 'Duncan' |
| | urpel | urupel | 'tail' |
| | ɔrm | ɔrɔm | 'on me' |
| | marv | marav | 'dead' |
| | færk | færak | 'anger' |
| b. After [ − back] sonorants | mʌr$^{j}$v | mʌr$^{j}$ev | 'the dead' |
| | bul$^{j}$k$^{j}$ | bul$^{j}$ik$^{j}$ | 'bellows (gen.sg.)' |
| | mer$^{j}$k$^{j}$ | mer$^{j}$ek$^{j}$ | 'rust' |
| c. After noncontrastive sonorants | t$^{j}$imx$^{j}$al | t$^{j}$imix$^{j}$al | 'round about' |
| | æms$^{j}$ir$^{j}$ | æmæs$^{j}$ir$^{j}$ | 'time' |

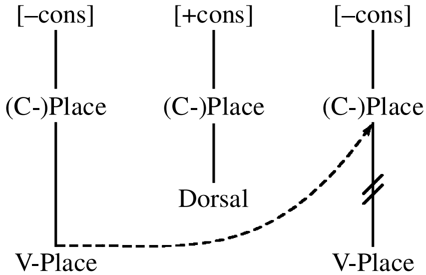
Proponents of RVPT have noted that the Halle-Sagey model fails to account for facts of the sort in (53) (see Ní Chiosáin and Padgett 1993:4–5). The reason for this failure is that Vowel Copy in the Halle-Sagey model involves spreading of the vowel's Place node, since the Labial feature [round] spreads simultaneously with the Dorsal features [high], [low], and [back]. As shown in (54), this would be incorrectly blocked by the Place node of an intervening consonant. (We return to this topic in section 3.1.)

(54) *Vowel Copy through a plain velar consonant: Halle-Sagey*



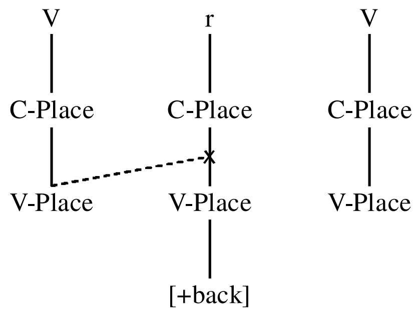

RVPT proposes to resolve this dilemma by segregating the Place features of consonants and vowels in the manner described above. This change enables the V-Place node of one vowel to spread safely through an intervening consonant to the next vowel, as depicted in (55). However, this scheme only works if we assume that plain consonants do not have redundant V-Place specifications in such cases. If, for example, the Barra Gaelic pair *r* and *r*$^{j}$ were specified as [ + back] and [ − back], respectively, the V-Place node of both consonants would block the spread of the vowel's V-Place node, as shown in (56a–b). In the RVPT account depicted in (56), Vowel Copy will never apply through a contrastive consonant, because its V-Place node will always block the propagation of the vowel's V-Place node.

(55) *Vowel Copy through a plain velar consonant: RVPT*

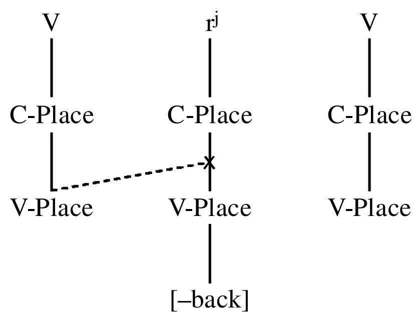



(56) *V-Place spreading from vowel to vowel blocked by intervening consonant with contrastive V-Place specification: RVPT*

a.




b.




The requirement that the plain consonants be unspecified for [back] in Barra Gaelic does not appear at first glance to pose any problems for RVPT; Ní Chiosáin and Padgett (1993) state explicitly that plain consonants do not bear redundant V-Place specifications in such situations. The problem for this proposal is the Turkish facts discussed earlier: in order to account for the behavior of exceptional *k,* RVPT must postulate that the plain members of contrastive pairs *are* specified for the contrastive feature. In short, RVPT cannot have its cake and eat it too: by invoking redundant V-Place, it accounts for Turkish but not for Barra Gaelic; and by rejecting redundant V-Place, it accounts for Barra Gaelic but not for Turkish.

One might object at this point that it is possible to stipulate within RVPT that the instances of exceptional *k* in Turkish are prespecified as [+back], but ‘‘unexceptional’’ occurrences of

[ + back] *k* are underlyingly unspecified. This approach to exceptionality, advocated by Inkelas and Cho (1993) and Inkelas, Orgun, and Zoll (1997), is reasonable within the phonological frameworks espoused in those papers. However, this sort of variable prespecification deprives Ní Chiosáin and Padgett's framework of any predictive power. Recall that Ní Chiosáin and Padgett state that their theory predicts that ''in a language with distinctive palatalization (represented say by [ − back] . . .) we do not expect to find fronting . . . of vowels around plain coronals, segments which normally could be redundantly specified for these features'' (1993:17). By extension, we should not expect to find backing of vowels around plain Dorsals. If we allow ourselves to account for exceptions to this prediction by specifying just those exceptional segments with the necessary feature specification, the prediction becomes meaningless.

An even more severe problem for the RVPT account is that no version of RVPT can account for Vowel Copy through palatalized consonants. Since these consonants are assigned a [ − back] V-Place specification regardless of one's theory of underspecification, they will invariably block propagation of the preceding vowel's V-Place node.

RAT, on the other hand, is able to account for both phenomena, as we show in section 3.

### *2.4 Interim Summary*

We have shown in section 2 that the two versions of VPT fall short of their goals on every front. They fail to demonstrate in many cases that AT is unable to account for the relevant data, and the solutions they propose for the same problems sometimes fail, and almost always create more problems than they solve. For these reasons, it is preferable to maintain AT, provided we can demonstrate that it is able to account in a satisfactory manner for all of the objections raised by proponents of VPT. Establishing that the modified version of AT developed here, RAT, is able to account for these objections is the task of the next section.

## 3 Revised Articulator Theory

Our demonstration that RAT can account for all of the objections raised by advocates of VPT consists of several parts. We organize our presentation according to the problematic facts that remain to be accounted for: Partial Vowel Copy (section 3.1), Complete Vowel Copy (section 3.2), Irish Nasal Place Assimilation (section 3.3.1), and Irish Dorsal Assimilation (section 3.3.2).

### *3.1 Partial Vowel Copy*

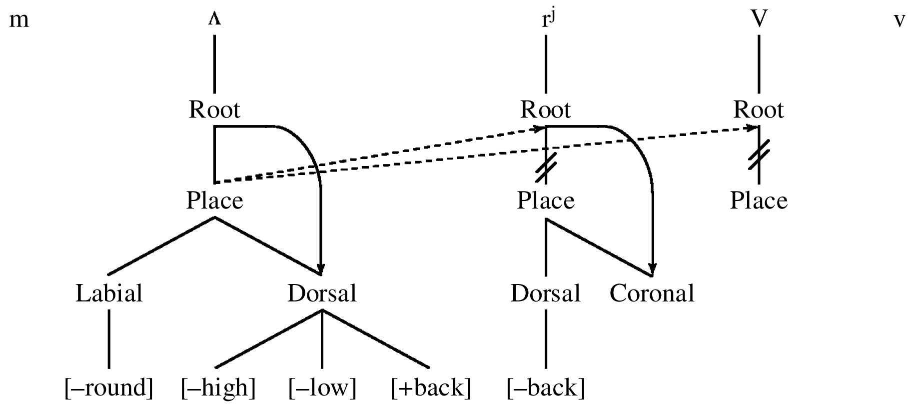
Recall from section 2.3.2 that in certain situations Barra Gaelic inserts an epenthetic vowel that is an exact copy of the preceding vowel, except when the intervening consonant has a contrastive [back] specification, in which case the epenthetic vowel agrees in backness with this consonant. The relevant facts are repeated in (57). The problem that these data pose for the Halle-Sagey model is that in (57a–b) the vocalic features [round], [back], [high], and [low], whose minimal common mother node is the Place node, spread without [back], which is also dominated by the Place node. According to the Halle-Sagey model, propagation of the Place node in this case should either override the [back] specification of intervening consonants (58a) or be blocked (58b). (Note that the solid arrows are pointers in Sagey's (1986) sense, not spreading nodes.)

(57)

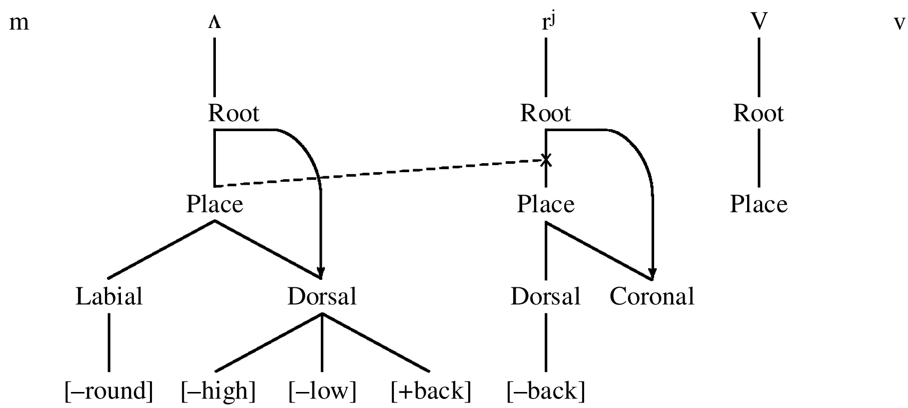
| | | *Underlying form* | *Surface form* | *Gloss* |
|---|---|---|---|---|
| a. | After [ + back] sonorants | alpə | alapə | ‘Scotland’ |
| | | s$^{j}$ærv | s$^{j}$ærav | ‘bitter’ |
| | | s$^{j}$ænxəs | s$^{j}$ænaxəs | ‘conversation’ |
| | | dunxəγ | dunuxəγ | ‘Duncan’ |
| | | urpel | urupel | ‘tail’ |
| | | ɔrm | ɔrɔm | ‘on me’ |
| | | marv | marav | ‘dead’ |
| | | færk | færak | ‘anger’ |
| b. | After [ − back] sonorants | mʌr$^{j}$v | mʌr$^{j}$ev | ‘the dead’ |
| | | bul$^{j}$k$^{j}$ | bul$^{j}$ik$^{j}$ | ‘bellows (gen.sg.)’ |
| | | mer$^{j}$k$^{j}$ | mer$^{j}$ek$^{j}$ | ‘rust’ |
| c. | After noncontrastive sonorants | t$^{j}$imx$^{j}$al | t$^{j}$imix$^{j}$al | ‘round about’ |
| | | æms$^{j}$ir$^{j}$ | æmæs$^{j}$ir$^{j}$ | ‘time’ |

(58) *Vowel Copy in the Halle-Sagey model*

a. *Feature-changing Vowel Copy: intervening features are overridden*

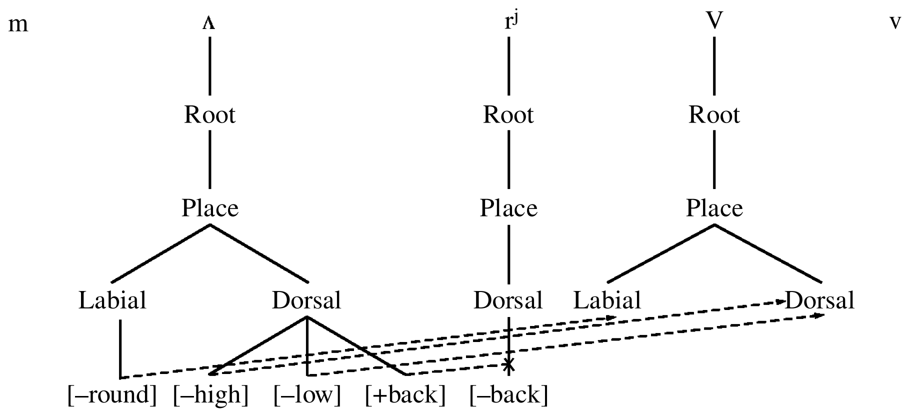



b. *Feature-filling Vowel Copy: intervening features block spreading*



However, once we assume that several terminal features can spread individually and simultaneously (recall section 1.2.3), a straightforward account for the Barra Gaelic facts becomes available. This account states that the set of terminal features dominated by the Place node spreads from a preceding vowel to the epenthetic vowel, except when a consonant intervenes for which backness is contrastive; in this case the vocalic [back] feature is blocked by the Line-Crossing Prohibition (Sagey 1986). This process is illustrated in (59).

(59)




Though terminal spreading represents a radical departure from previous theories of feature interaction, we strongly believe that it is required to account for the Barra Gaelic facts. As it turns out, terminal spreading also helps us to make sense of most of the objections raised by VPT that have so far remained unanswered. We consider these points in the remainder of this section. (For additional evidence illustrating the need for terminal feature spreading, see Halle 1995.)

### *3.2 Complete Vowel Copy: Tarahumara*

In section 2 we mentioned that the phenomenon of Complete Vowel Copy over plain Dorsal consonants is problematic for the Halle-Sagey model. In fact, it was this problem that provided the initial motivation for VPT. With terminal spreading, though, a straightforward account for Complete Vowel Copy is available.

A typical example of Vowel Copy is found in the Uto-Aztecan language Tarahumara, where the vowel of the deverbal suffix *-kV* is an exact copy of the final vowel of the root (Nida 1949: 23).

(60)

| *Verb* | *Gloss* | *Noun* | *Gloss* |
|---|---|---|---|
| mitʃiru | ‘make shavings’ | mitʃiru-ku | ‘shavings’ |
| reme | ‘make tortillas’ | reme-ke | ‘tortillas’ |
| patʃi | ‘grow corn’ | patʃi-ki | ‘ear of corn’ |
| opatʃa | ‘be dressed’ | opatʃa-ka | ‘garment’ |

Tarahumara has the following phonemic inventory (Burgess 1984):

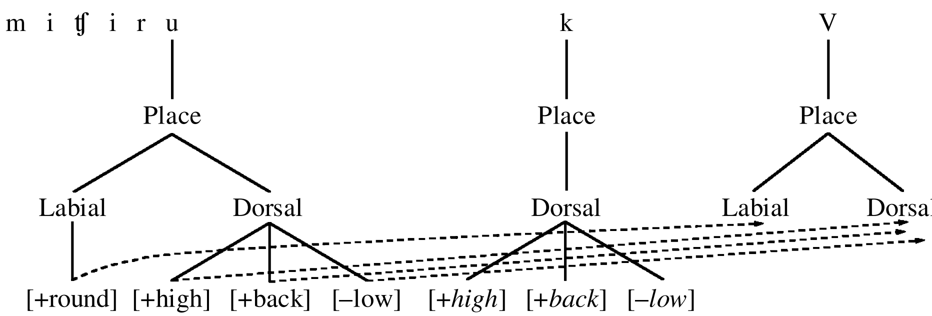
(61) *Consonants*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| [labial] | p | b | | m | | | w | | |
| [cor, +ant] | t | | s | n | l | r | | | |
| [cor, −ant] | tʃ | | | | | | j | | |
| [dorsal] | k | g | | | | | | | |
| [glottal] | | | | | | | | ʔ | h |

*Vowels*

| | [−back] | [+back] |
|---|---|---|
| [+high], [−low] | i | u |
| [−high], [−low] | e | o |
| [−high], [+low] | | a |

In the Tarahumara consonantal system, the only contrastive features subordinate to the Place node are the articulator features and the Tongue Blade feature [anterior], which distinguishes [+anterior] *t* from [−anterior] *tʃ*. Crucially, *k* and *g* do not contrast with any other Tongue Body consonants and therefore have no contrastive features that are dependents of the Tongue Body node other than [dorsal]. Given these facts, we can now represent the Vowel Copy process as spreading of the Place node of the root-final vowel to the vowel of the suffix. In accordance with (7b), the spreading of the Place node is implemented as spreading of the terminal features it dominates, as shown in (61). Note that only contrastive features are visible to the harmony rule; noncontrastive features—shown in italics—are transparent to this spreading process.

(62)



We conclude that once terminal spreading is assumed, AT is readily able to account for the observed consonantal transparency in the case of Vowel Copy.[14]

Several more complicated instances of Vowel Copy cited by Odden (1991) in which only the features [back] and [round] appear to spread have been shown by Halle (1995) to be consistent with the analysis presented here. To the best of our knowledge, then, RAT is able to account for all cases of complete and Partial Vowel Copy and is therefore to be preferred over both VPT,

[14] The Klamath case discussed by Ní Chiosáin and Padgett (1993:4–5) should be treated as an instance of partial reduplication rather than of Vowel Copy; Gafos (1998) makes similar arguments for Temiar.

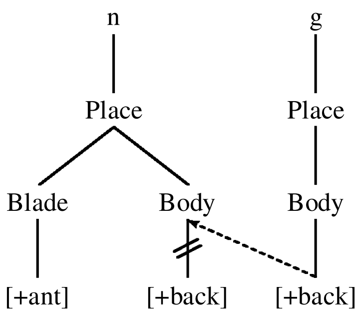
which cannot account for Partial Vowel Copy, and AT models employing nonterminal spreading, which cannot account for either type of Vowel Copy.

### *3.3 Articulator Features*

RAT must still account for one problem, which involves delinking of secondary articulations. In this section we argue that this problem is best dealt with by reintroducing traditional privative articulator features. We base our discussion on the two Irish assimilation phenomena discussed in section 2: Nasal Place Assimilation (section 3.3.1) and Dorsal Assimilation (section 3.3.2).

*3.3.1 Irish Nasal Place Assimilation* Terminal feature spreading encounters problems in the formulation of certain rules, such as Nasal Place Assimilation in Irish (see the discussion below (44)). In nasal place assimilation rules, [coronal] nasals acquire the Place specifications of the following consonant; for instance, in Irish coronal *n* typically surfaces as Dorsal *ŋ* when followed by *g*. Within a terminal-feature-spreading framework, with full specification, this example must be formalized as in (63).

(63)




In this formulation there is no reason for the [ + anterior] feature to delink, since no new [anterior] specification is forcing it out. Furthermore, in Irish we cannot call on a repair rule to delink the Tongue Blade specification because, as we showed in (44), double specifications for Tongue Blade and Tongue Body are legal and even required by the phonology of the language, which contrasts plain and palatalized consonants.

We propose to account for the problem raised in (63) by postulating the existence of *articulator features*. The idea of articulator features dates back at least to Chomsky and Halle 1968 and survives to this day in the articulator features employed by Clements and Hume (1995) (though they assume that these features can dominate other features, whereas we do not).

The notion of articulator features is well grounded in the general architecture of speech, besides being motivated by phonological evidence. We adopt Halle's (1992) insight that all speech is produced by actions of the six articulators manipulated in the human vocal tract: Lips, Tongue Blade, Tongue Body, Soft Palate, Tongue Root, and Larynx. Each articulator is capable of a small set of actions of its own. From this point of view the features that figure in discussions of phonetics and phonology are instructions for specific actions of an articulator. This conception of the speaking process is formally implemented in the RAT tree structure in (1), where features executed by the same articulator are grouped under a common nonterminal node, whereas the higher nodes Place and Guttural group anatomically contiguous articulators, and the articulator-free features are directly dominated by the Root node of the tree.

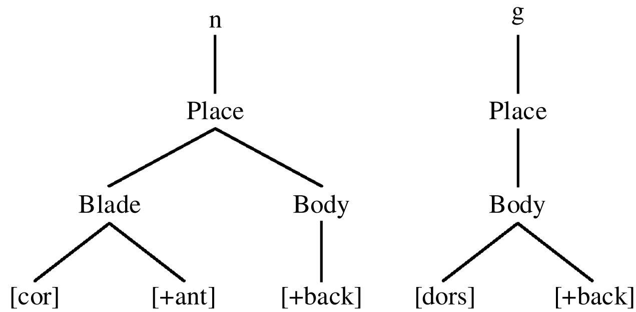
The property of being a designated articulator shares all important characteristics with phonological features. In particular, in assimilation processes the designated articulator can spread, just like any other feature, leaving all other features intact (this is the case in Irish Dorsal Assimilation, discussed in section 2.2 and below). This type of assimilation process cannot be readily expressed in Sagey's pointer notation. Like other features, the designated articulator must be specified in the list of features characterizing a given phoneme in underlying representations of morphemes. It is in this way that we capture the primary Place distinctions among consonants, such as that between the labial nasal *m* and its coronal and dorsal counterparts *n* and *ŋ*.

To express this role of the articulators in formal terms, we supply each articulator with a feature indicating that it functions as designated articulator. We have therefore included in (1), under each articulator node, a terminal feature assigning designated articulator status to this articulator. Although every phoneme has at least one designated articulator, a phoneme may (rarely) have more than one such articulator. The labiovelar stop *kp,* for example, includes in its lexical representation the articulator features [dorsal] and [labial] in addition to [+consonantal, −sonorant, −round, −continuant, . . .]. By contrast, in most languages the labialized velar $k^w$ has the feature complement [dorsal, +consonantal, −sonorant, +round, −continuant, . . .], with no specification for the feature [labial] (see Halle 1995).

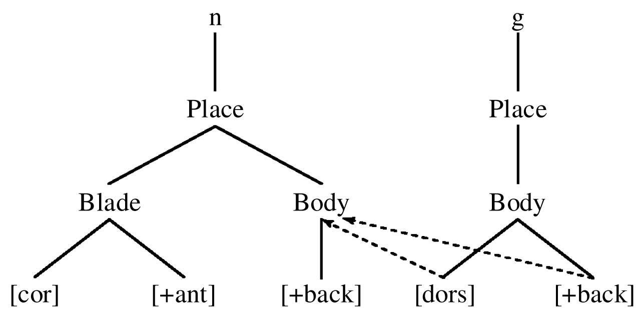
It is crucial not to confuse the terminal articulator features [labial], [dorsal], and so on, with the articulator nodes Lips, Tongue Body, and so on, dominated by the Place node in the feature tree in (1). Though they refer to the same component of the articulatory apparatus, the terminal articulator features encode information about the role of an articulator in the production of a particular phoneme. The nonterminal nodes, on the other hand, characterize groups of features that can pattern together in phonological processes (spreading and delinking), and are generated in an entirely predictable manner from the feature complement of a given phoneme. Furthermore, as noted above, designated articulators, being terminal features, are able to spread from one segment to another, without affecting other nodes and features. These distinctions are crucial in accounting for Irish Nasal Place Assimilation and Dorsal Assimilation, as we now show.

Let us return first to the Irish Nasal Place Assimilation facts. Given our new theory of articulator features, the Irish *ng* sequence would begin with the underlying representation in (64a); note that the *n* contains the articulator feature [coronal], and the *g* contains the articulator feature [dorsal]. Nasal Place Assimilation then spreads the contents of the Place node of the *g*—including its [dorsal] articulator feature—to the preceding *n* (64b). Since Irish does not allow segments to contain more than one articulator feature, the [coronal] articulator feature of the *n* delinks (64c), which in turn entails delinking of the [+anterior] feature, which is not a valid secondary articulation in Irish (64d). These two procedures yield the correct surface representation *ŋg* (64e). By postulating articulator features, then—which are motivated on independent grounds—we are able to account for the recalcitrant subtleties of Nasal Place Assimilation in Irish.

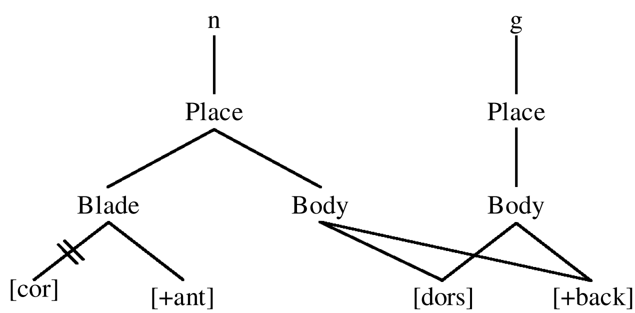
(64) a. *Underlying representation*



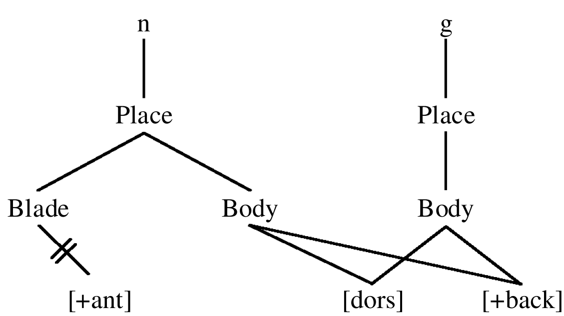

b. *Spreading of the contents of the Place node of the* g



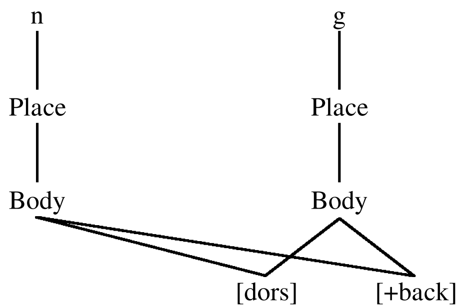

c. *Delinking of the [coronal] articulator feature*




d. *Delinking of [+anterior]*

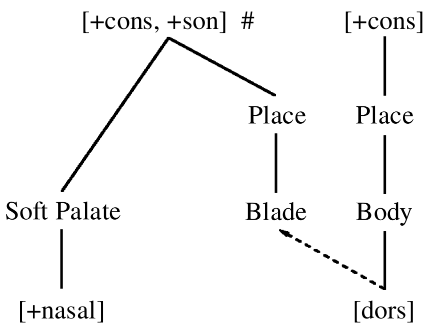


e. *Surface representation*



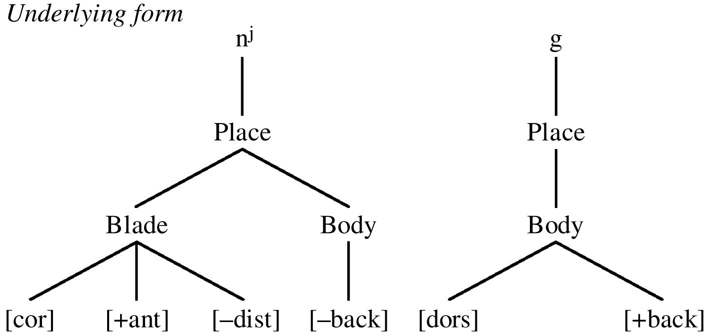

*3.3.2 Irish Dorsal Assimilation* The striking facts of Irish Dorsal Assimilation that we discussed in section 2.2 also fall into place once we equip AT with articulator features. Recall that without articulator features, AT was unable to account for the fact that Dorsal Assimilation does not affect Dorsal secondary articulations; we expect forms like **d$^j$i:ləŋ$^j$g$^j$i:v$^j$r$^j$i* rather than the attested *d$^j$i:ləŋg$^j$i:v$^j$r$^j$i,* from underlying *d$^j$i:lən + g$^j$i:v$^j$r$^j$i.* With articulator features, though, we can simply state that Dorsal Assimilation involves spreading of the articulator feature [dorsal], as depicted in (65). The derivations of ‘I would see without it’ and ‘a winter’s diary’ then proceed as in (66) and (67), respectively.

(65) *Dorsal Assimilation*
Spread [dorsal] to a word-final coronal nasal from a right-adjacent consonant.

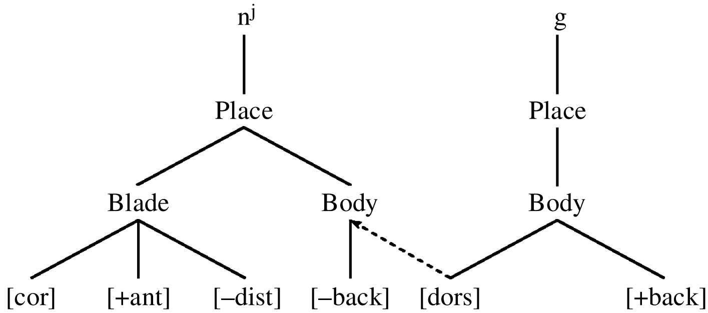



(66) d$^j$ek$^j$h$^j$in$^j$ + gan e: → d$^j$ek$^j$h$^j$iŋ$^j$ gan e:

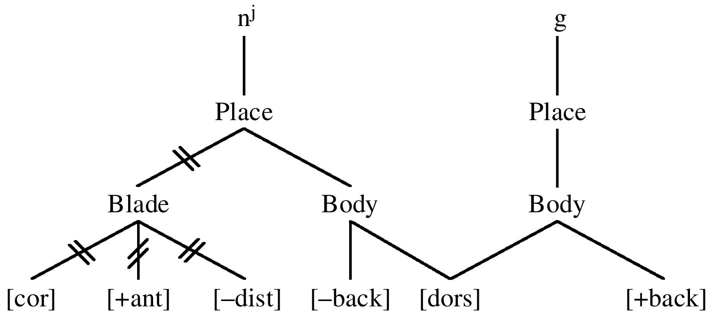
a. *Underlying form*



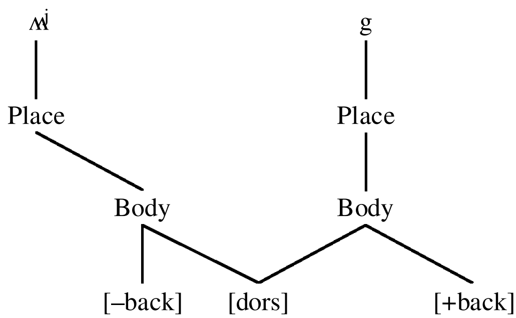
b. *Dorsal Assimilation*




c. *Delinking of disallowed second articulator feature, together with attendant features*

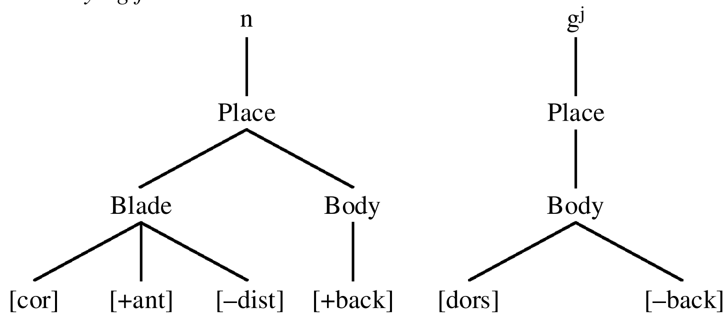



d. *Surface form*

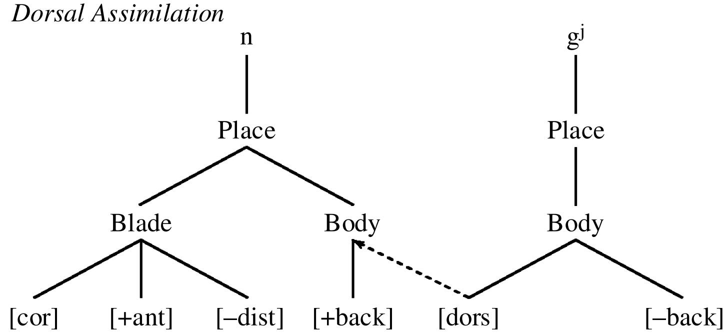


(67) d$^j$i:lən + g$^j$i:v$^j$r$^j$i $\rightarrow$ d$^j$i:ləŋg$^j$i:v$^j$r$^j$i

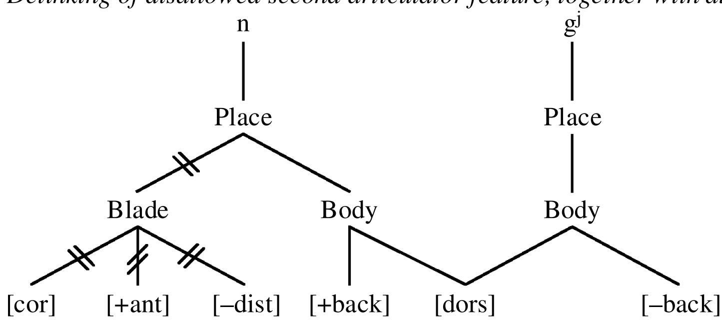
a. *Underlying form*



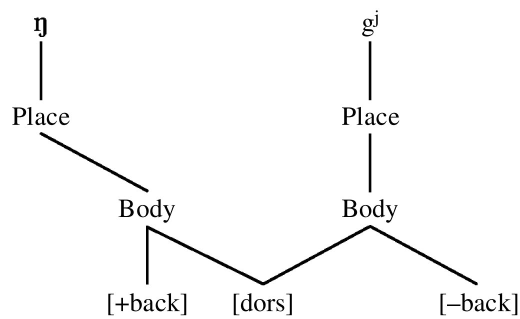

b. *Dorsal Assimilation*




c. *Delinking of disallowed second articulator feature, together with attendant features*




d. *Surface form*



## 4 Conclusions

In this article we have considered two models of feature geometry: Articulator Theory (AT), which views phonetic features as instructions for actions of the six articulators, and Vowel-Place Theory (VPT), which calls upon the notion of constriction degree to separate vocalic and consonantal Place nodes in phonological processes. We have shown that RAT, our proposed revision of AT, accounts in a principled manner for all of the objections that have been raised by proponents of VPT. We have also shown that Unified Feature Theory (UFT; Clements 1989, 1991, 1993, Clements and Hume 1995) fails to capture the unitary behavior of [±back], which plays a role in many phonological systems, and does not explain how its unified-feature Coronal dependents behave in vowels. In addition, we have demonstrated that data traditionally taken to support the proposed Lingual node revision of VPT can easily be explained without it. Furthermore, UFT incorrectly predicts that consonantal and vocalic [ATR] and [high] values will not interact. Most importantly, in order to explain C-V interactions, UFT relies on processes of docking or demotion, which significantly weaken the notion of tier and allow unattested consonant harmonies such as **kap* → *k$^w$ap.*

Ní Chiosáin and Padgett's (1993) version of VPT is just as problematic as UFT. In their attempt to remedy UFT's problem with tiers, Ní Chiosáin and Padgett must invoke redundant secondary articulations in plain consonants. This introduces excessive language-specificity in the interpretation of Universal Grammar features and fails to account for certain Turkish and Barra Gaelic facts. Moreover, Ní Chiosáin and Padgett's ban on C- and V-Place interactions is not supported adequately either by the Irish data discussed here, which RAT accounts for by reintroducing the traditional notion of articulator features, or by their reference to the absence of articulator changes such as *su* → *fu,* which we have shown to be untenable. Further, in rejecting unified features, they have considerably weakened VPT's structure.

In addition, neither variety of VPT considered here is able to account for the instances of consonant harmony described in section 2.3, most notably Shaw's (1991) Tahltan data. Attempts to account for these data have resulted in ad hoc proposals for a locality constraint and a Site node under the Coronal node.

The two versions of VPT considered above and the Halle-Sagey version of AT (Halle 1992, Sagey 1986) are all unable to account for cases of Partial Vowel Copy as discussed in section 3.1, because their theory of spreading holds that all and only nodes in the feature tree can spread at any one time. We have shown that once we limit spreading to terminal feature nodes in the tree, we not only gain an explanation for the cases of Partial Vowel Copy, but also acquire the machinery necessary to account for the instances of Complete Vowel Copy within AT. Since these cases, which were the original motivation for postulating VPT, are now manageable within RAT, there is no longer any reason to maintain VPT.

Finally, we have clarified the special role of articulator features and their behavior in various assimilation processes. Of particular note is the result that all assimilation processes involve the spreading of terminal features. This establishes a sharp distinction between terminal and nonterminal nodes in the tree. Whereas the terminal feature nodes participate fully in the implementation of phonological rules and in the determination of the conditions under which feature assimilation is blocked, the nonterminal nodes are limited to defining the allowable sets of features that may be spread by a single rule.

Since the structure of nonterminal nodes in a phoneme is entirely predictable from the set of terminal features that make up the phoneme, the speaker need not remember this structure. This suggests that the representations of individual morphemes in speakers' memories are composed solely of feature bundles, and that the nonterminal tree structure is constructed as needed in each derivation or computation. This marks a return—albeit in a more abstract and sophisticated form—to the older view of phonemes as unstructured feature bundles. RAT therefore represents an amalgam of very solid notions that have stood the test of time with more novel concepts whose validity has been established by rigorous confrontation with complex data from a variety of languages. It is our hope that this article will lead others to explore our proposals further, so as to correct them where necessary and confirm and extend them where possible.

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