

On Feature Spreading and the Representation of Place of Articulation*

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We propose in this paper a new theory of phonological representations and operations which incorporates insights from recent work on terminal feature spreading (Halle 1995) and Vowel-Place Theory (Ní Chiosáin and Padgett 1993, Clements and Hume 1995), as well as pre-feature-geometric work on articulator features (Chomsky and Halle 1968). The primary novel suggestions made here are that:

- i. **Feature spreading is autonomous.** Spreading of a node in the feature tree involves autonomous spreading of that node and of all its dependent nodes and features. The fact that an individual node or feature is blocked from spreading does not entail that the remainder of the propagating set is also blocked.
- ii. **Designated articulators are features.** Part of the complement of features specifying individual phonemes is a specification for the designated articulator(s) for that phoneme. Specifications of this type behave exactly like other more familiar features, and are distinct from the Articulator nodes in the feature tree.
- iii. **Vowel Place Theory is untenable.**

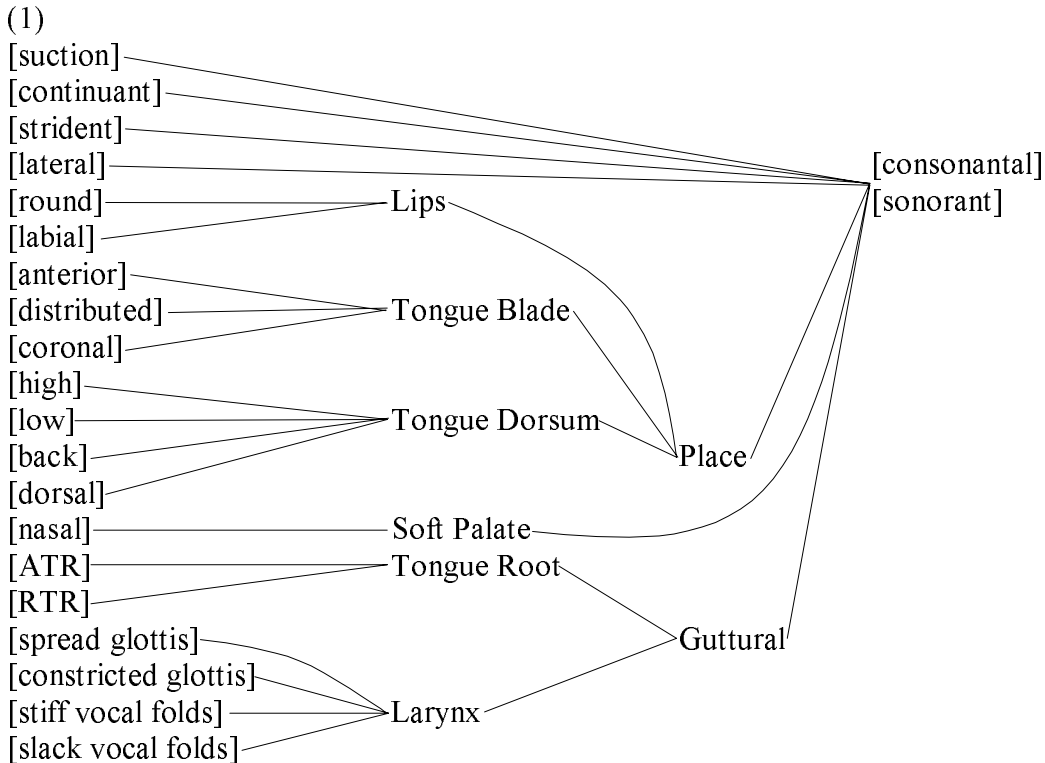
Our point of departure is the Sagey/Halle Articulatory model of feature geometry, illustrated in (1) (for details see Sagey 1986 and Halle 1995). The revisions we propose are set forth in response to a number of issues that have been uncovered in the course of recent research. Among these there are long-standing technical problems with the features and their organization for which only brute force solution have been available. Most notable among these is the treatment of “palatalization” processes which involve the replacement of a dorsal stop by a coronal continuant or affricate. Stem consonant alternations such as those in English *electri[k]* - *electri[s]-ity* and *analo[g]* - *analo[dʒ]-y* are typical examples of this phenomenon, which is documented in a strikingly large number of languages. Below we offer an account of palatalization processes that we believe to have better explanatory power than those available in the existing literature.

On the other hand, the attempts to deal with palatalization and related problems by revisions of the geometry of the feature tree, in particular by splitting the Place node into a Vowel-Place and a Consonantal-Place (cf. e.g., Clements and Hume 1995 and Ní Chiosáin and Padgett 1993) have not been successful. As detailed in section 2, they also entail a number of insurmountable problems. We believe that our model, presented in section 3, combines the advantages of both the Vowel-Place model and the Articulator model while avoiding their disadvantages.

* Many thanks to Ben Bruening, Andrea Calabrese, Nick Clements, Francois Dell, Máire Ní Chiosáin, and Jaye Padgett for helpful comments on earlier drafts of this paper.

1. Theoretical Assumptions

Since the publication of Clements' seminal 1985 paper, it has been generally agreed among researchers that the universal set of phonological features is organized into a hierarchy that is appropriately represented by a tree diagram, such as the one illustrated in (1).



The advantage of such tree models over a non-hierarchical feature matrix such as the one in Chomsky and Halle 1968 lies in their ability first to give certain types of assimilation, dissimilation, and neutralization precedence over arbitrary feature changes and second to constrain the number of possible assimilations allowed by Universal Grammar (see McCarthy 1988 for a fuller review).

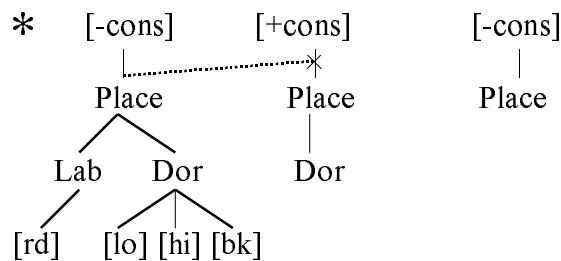
The central insight of the theory of Halle 1995, which we adopt here, is that speech is produced by actions of the six articulators manipulated in the human vocal tract: the lips, the tongue blade, the tongue dorsum, the soft palate, the tongue root, and the larynx. Each of the articulators is capable of a small set of actions of its own. The features that figure in discussions of phonetics and phonology are from this point of view instructions for specific actions of an articulator. This conception of the speaking process is formally implemented in (1), where features executed by the same articulator are grouped together under a common nonterminal node bearing the label of the articulator in question, whereas the higher nodes Place and Guttural group together anatomically contiguous articulators.¹

¹ As discussed below, we do not assume this tree structure to be included in the lexical representation of individual phonemes, since it is entirely predictable from the set of features specified for a given segment. Rather, we assume that

Implicit in (1), which we call Articulator Theory (AT), is the proposition that processes of assimilation, dissimilation, and neutralization are anatomically constrained. This implication has obvious appeal, for it unifies under a single heading two otherwise unrelated aspects of speech sounds: their articulatory implementation and their behavior in the phonological process of assimilation. AT stands in opposition to Vowel-Place Theory (VPT), a constriction-based model presented in two different versions by Clements 1993 and Ní Chiosáin and Padgett 1993 (see also Steriade 1987, Odden 1991, Clements and Hume 1995, and references therein). In VPT, consonant and vowel features are placed on separate tiers, the vowel place (V-place) features being grouped under a common node subordinate to the Place node.

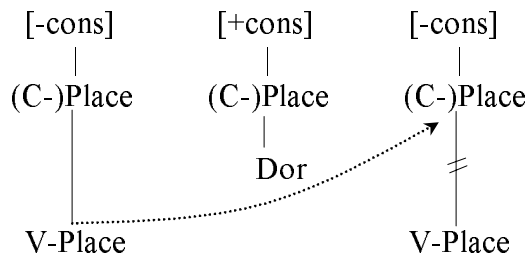
One of the arguments advanced by proponents of VPT is that vowel copy processes of the kind encountered in Barra Gaelic or Ainu (q.v. section 3) are incorrectly blocked in AT. Vowel copy involves spreading of the vowel's Place node, since the Labial feature [round] spreads simultaneously with the Dorsal features [high], [low], and [back]. As shown in (2), this would be incorrectly blocked by the Place node of an intervening consonant.

(2) Vowel Copy through a plain velar consonant: traditional autosegmental model



Proponents of VPT have therefore reconfigured the feature geometry as in (3).

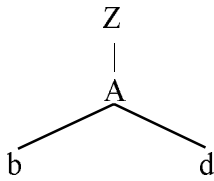
(3) Vowel Copy through a plain velar consonant: VPT
(terminal features omitted to avoid the issue of **unified** features, which we discuss later)



As the same 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 as distinct from their articulatory aspects. To avoid this undesirable move, Halle 1995 proposed that all assimilation processes are formally

tree structures are generated for individual segments when they are mapped onto morphemes during the course of the derivation.

ii. resulting structure of Z:



Another way in which the view presented in this paper differs from the proposals of VPT and of previous AT models is in its representation of underspecification. It is assumed in Clements 1985 that only contrastive features are specified in underlying phonological representations. As a consequence, not all features in (1) are specified in underlying representations of phonemes of every language, but only those features that are contrastive.

In contrast, we assume following Calabrese 1995 that segments are fully specified in all representations (see Mohanan 1991 for a fuller treatment of the problems with theories of underspecification). 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 of features in phonemes assigned to them in Calabrese's theory. To express formally the fact that each language has its own inventory of phonemes and to capture the cross-linguistic infrequency of certain feature combinations, Calabrese proposed that part of the innate knowledge that humans bring to the learning of a language consists of a set of marking statements prohibiting particular feature pairs from occurring in phonemes. Particular languages may deactivate a given marking statement but at a cost, which is high enough to prevent wholesale deactivation of marking statements.

(6) *[+round], [-back] in the environment [____, -cons]

In each marking statement there is a *marked* feature, which is underlined in (6).

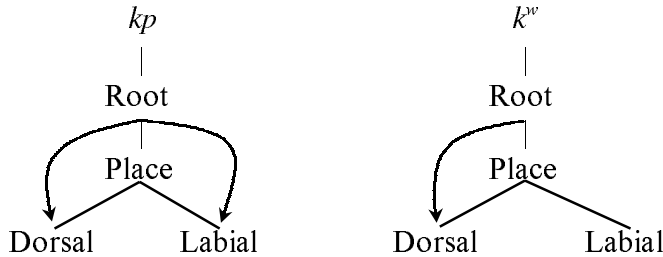
Naturally, marked features can only play a role in languages in which the filter prohibiting the marked feature complex has been deactivated. Thus, only in a language in which (6) has been deactivated will there be [-back] vowels that are [+round] as well as [-round]. Following Calabrese 1995, we shall 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 1995:413-8); a rule for which all features are visible is the English rule of coronal assimilation (as illustrated by the coronal stops in “*dream*,” “*hundredth*,” and “*hardship*”—see Clements 1985). A typical unmarked rule, for which only contrastive features are visible, is the Barra Gaelic rule discussed in section 3 below. We make only passing mention of this tenet in this paper, and refer the reader to Calabrese 1995 for detailed discussion.

One last theoretical assumption made here which will be relevant to subsequent discussion involves the representation of primary versus secondary articulations. In order

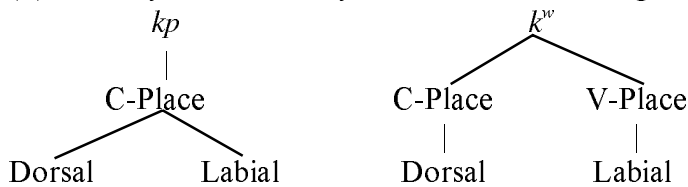
to distinguish phonemes with two or more primary articulations, such as *kp*, from phonemes involving the same articulators but only one primary articulation, such as *k^v*, we need some formal way of distinguishing primary articulations from secondary articulations. Sagey 1986 assumed that this distinction was implemented via a pointer, which extended from the root node to the articulator node that executed the primary articulation.

(7) Primary and secondary articulations according to Sagey 1986



Proponents of VPT encode the same distinction 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.

(8) Primary and secondary articulations according to VPT (irrelevant nodes omitted)



To deal with some of these problems we follow the suggestion in Halle 1995 that each phoneme has its own primary articulator(s), and for clarity of exposition we refer to such an articulator as the *designated* articulator. We differ from earlier approaches by explicitly taking account of the fact that the property of being a designated articulator shares important properties with phonological features:

- (i) In assimilation processes the designated articulator can spread, just like any other feature (cf. Irish Dorsal Assimilation in section 2.2).
- (ii) Like other features, the designated articulator must be specified in the list of features characterizing a given phoneme in underlying representations of morphemes.

To capture this formally, we supply each of the articulators with a feature indicating that the articulator in question functions as designated articulator. Specifically, we modify the tree in (1) by adding under each of the six articulators a terminal feature labelled with the name of the articulator. The so-called labio-velar stop */kp/*, for example, includes in its lexical representation the features [+dorsal, +labial] in addition to [+consonantal, -sonorant, -round, -continuant, ...]. By contrast, the labialized velar */k^v/* has the feature complement [+dorsal, +cons, -son, +**round**, -cont, ...] with no specification [+labial].

It is crucial not to confuse the terminal features [labial], [dorsal], etc. with the articulator nodes Lips, Tongue Dorsum, etc. 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 that the articulator plays in the production of the phoneme; the nonterminal articulator nodes, on the other hand, merely reflect the grouping of anatomically adjacent articulators, without regard to their phonological function. Furthermore designated articulators, being terminal features, are able to spread from one segment to another, without affecting the nonterminal articulator nodes. These distinctions will be crucial in sections 2 and 3, where we discuss respectively place assimilation of Irish nasals and labial assimilation in Igbo.

This revised AT not only accounts for the problems which VPT attempts to solve, but also preserves structural cohesiveness which VPT is forced to abandon. Specifically, we show that Clements' version of VPT critically redefines the notion of tier, whereas Ní Chiosáin and Padgett's version of VPT redefines the notion of features, while retaining the traditional concept of tier. As we demonstrate below, each of these redefinitions significantly weakens the predictive power of these aspects of feature geometry.

In section 2 we examine some of the evidence adduced in support of VPT, summarize its basic claims, and point out shortcomings internal to the theory. In section 3 we develop further certain arguments for autonomous spreading, reexamine the evidence adduced in support of VPT in light of autonomous spreading, and demonstrate that AT is preferable to VPT both in terms of internal consistency and in its ability to account for the data discussed here. Section 4 summarizes our main conclusions.

2. V-Place Theory (VPT)

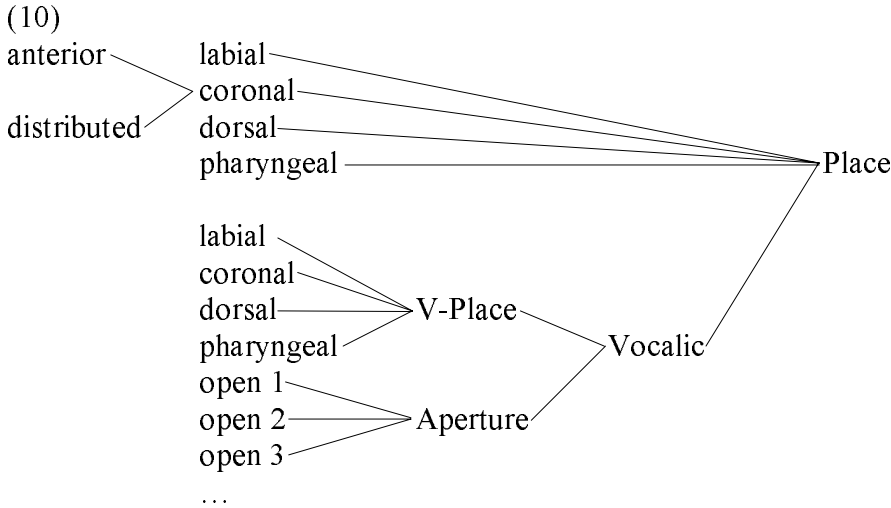
Central to both competing versions of VPT considered in this paper is postulate (9):

- (9) Transparency of consonants with respect to rules spreading vocalic features indicates that consonantal Place features must be segregated from vocalic Place features. If this were not the case, we would expect all consonants with Place specifications to block spreading of vocalic Place nodes.

The two versions of VPT differ with respect to their formalization of (9). Clements' Unified Feature Theory takes interactions between consonants and vowels of the type found in Turkish *armVd* → *armud* 'pear' to indicate that there must be a unified set of features encoding place of articulation for consonants and vowels. In his modeling of these interactions, however, he creates issues of tier inconsistency. Ní Chiosáin and Padgett repair this problem in their version of the theory, where all C-V interactions occur on the V-Place tier. While solving some problems, this proposal manufactures additional problems in feature consistency. Moreover, in spite of attempting to avoid the issue of **unified** features (features specifying both consonants and vowels), Ní Chiosáin and Padgett's working assumption, that there are no **unified** features, encounters problems within a VPT framework. We consider the two proposals in turn, and then turn to the issue of consonant harmony systems, which present difficulties for both V-Place theories considered in this paper.

2.1. Unified Feature Theory (UFT)

The interactions between labial consonants and round vowels, coronal consonants and front vowels, dorsal consonants and back vowels, and pharyngeal consonants and low vowels are taken by Clements' UFT as evidence that a single set of features characterizes place of articulation in both consonants and vowels. The relevant feature geometry he posits is as shown in (10) (irrelevant nodes omitted):



A phenomenon commonly cited in support of this unified set of features is the fronting of vowels by adjacent coronal consonants, as for example in the Agn dialect of Armenian, where the back vowels *o* and *u* become ϕ and *y* respectively after all coronal consonants (Maxudianz 1911:28-30)²:

(11) a. fronting by coronals

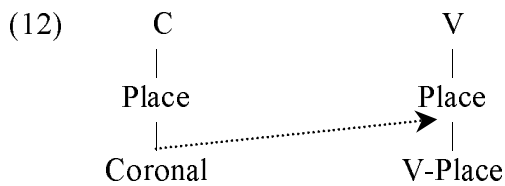
classical Armenian	Agn	gloss
<i>doł</i>	<i>d^hφβ</i>	tremor
<i>galt-uk</i>	<i>g^haκdyg</i>	secret
<i>at^hor</i>	<i>at^hφr</i>	chair
<i>mořat^hsot</i>	<i>mořt^hsφβ</i>	forgetting
<i>t^hfors</i>	<i>t^hfφrs</i>	four
<i>t^huxa</i>	<i>t^hfyχa</i>	cloth
<i>dzur</i>	<i>d^hzyr</i>	water
<i>nor</i>	<i>nφr</i>	new
<i>χofor</i>	<i>χofφr</i>	large
<i>soχ</i>	<i>sφχ</i>	onion
<i>galot</i>	<i>g^halφβ</i>	coming
<i>heru</i>	<i>hery</i>	last year

² *t* = [+back] *l*, *r* = trilled *r*.

b. non-coronals do not cause fronting

classical Armenian	Agn	gloss
<i>botʰs</i>	<i>bʰotʰs</i>	flame
<i>port</i>	<i>bord</i>	navel
<i>pʰotkʰ</i>	<i>pʰoχg</i>	throat
<i>Mufeł</i>	<i>Mufeχ</i>	a personal name
<i>kotʰs</i>	<i>gʰotʰs</i>	closed
<i>kʰor</i>	<i>kʰor</i>	unit of grain
<i>gud</i>	<i>gud</i>	grain
<i>χutʰs</i>	<i>χurtʰs</i>	room

Clements analyzes such ‘fronting’ phenomena as in (12) (intermediate nodes omitted):



The interactions between Coronal consonants and front vowels encountered in such palatalization processes cannot be adequately handled by the AT model in (1). To overcome this problem we have recourse to Calabrese’s 1995 suggestion that there is an equivalency between [+dorsal, -back] and [+coronal, -anterior], which favors substitution of the former by the latter. On the other hand, if in order to account for these phenomena front vowels are assumed to be Coronal and back vowels Dorsal, a host of new problems is created which do not arise in AT. For example, Clements assumes that in consonants Coronal dominates the features [anterior] and [distributed] (see (10)). This entails that in some cases these features must spread to the vowel as well. However, it is not clear within his system how these features are implemented in vowels, or even if they exist for vowels. Since in Clements’ framework Coronal in vowels is directly equivalent to traditional [-back], we must suppose that he treats Coronal as a terminal feature in vowels, whereas it behaves as a nonterminal node in consonants.

Proponents of UFT are also forced to assume that what appear to be unitary processes of [back] harmony found in Turkish, Hungarian, and numerous 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 /gʰɔnl-de/ ‘heart-dative’ becomes /gʰɔnlɪ-de/, which later harmonizes to [gʰɔnylde]. The three pairs of consonants that are contrastive for [back], however, (i.e., [kʰ, k], [gʰ, g], and [tʰ, t]) create their own harmonic domain which blocks the spread of [Coronal] and [Dorsal]. Thus in /vakʰt/ ‘time,’ where UFT predicts that the [Dorsal] specification of the [a] will spread across the Coronal V-place of the [kʰ] onto the epenthetic vowel, the /t/ surfaces as [i], not [ɨ]. In order to avoid an arbitrary rule to block Dorsal spread across Coronal V-Places, Clements 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'] onto the /I/, and a third rule to repair the resultant ill-formed Corono-Dorsal feature complex. While Clements could add an *ad hoc* statement prohibiting Corono-Dorsal segments, UFT would still have no way of accurately predicting then which of the two Corono-Dorsal specifications was 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 non-palatal consonants, the Coronal specification would delink, producing a back vowel.

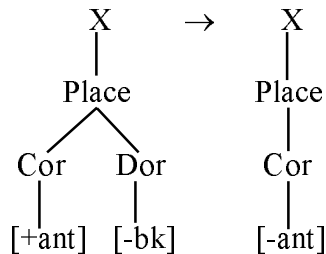
To account for these Coronal-Dorsal interactions, Clements and Hume 1995 propose that Coronal and Dorsal are dominated by an intermediate node, which they call *Lingual* (after Browman and Goldstein 1989), and that it is the Lingual node that is spreading in back harmony systems. Support for the Lingual node in the literature is quite sparse, however, and all of the common examples adduced in its support are easily dismissed or reanalyzed.

(i) In the first proposal of the node in the literature, Browman and Goldstein 1989 do no more than 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 ought also to be included in the [Lingual] node.

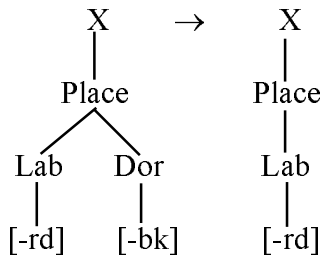
(ii) In her analysis of Tamil, Christdas 1988 claims that there is need to refer to a [-Labial] class of phonemes, which was later recast as a [+Lingual] class. She illustrates the alternations in only two target suffixes and supplies no example of a labial-initial suffix (Christdas 1988: 38-40, 333-339). In the remaining cases, /k/ becomes [kʰ], /t/ becomes [tʰ], and the labials surface without a secondary [-back] articulation. These facts are readily handled in AT by means of a single prohibition ruling out multiply-articulated stops (i.e. stops with more than one designated articulator). Consonants assimilating [-back] from an adjacent vowel trigger different repair strategies: No repair occurs in the case of Dorsal [kʰ], since this consonant does not violate the prohibition. The Coronal [tʰ] is repaired into the [-anterior] [tʰ] by the equivalence relationship between [-back] and [-anterior] consonants mentioned above. These Coronals and the Labials [pʰ, bʰ ...] involve two articulators and therefore violate the prohibition against multiple articulators, would be repaired by delinking the [-back] feature (see Calabrese 1995 for more details). This is illustrated in (13).

(13) palatalization and secondary articulation constraints in Tamil

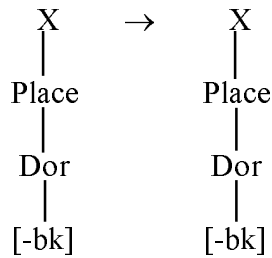
a. $t^h \rightarrow tʰ$ (via the equivalency relation between [-back] and [-anterior])



b. $p^j \rightarrow p$



c. $k^j \rightarrow k^j$



(iii) Clements 1976 cites a constraint of Mandarin which prohibits nonlabial obstruents before high front vowels $[i, y]$ unless they are laminal palatoalveolars. This excludes the dorsal, retroflex, and dental consonants $[k, k^h, \chi, \underline{t}\mathcal{S}, \underline{t}^h\mathcal{S}, s, t\mathcal{S}, \underline{t}^h\mathcal{S}, \mathcal{S}]$ from positions before high front vowels. The problem in this analysis rests in its inability to account for the dental stops $[t, t^h]$, which 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 constraint is an accidental gap. Clearly a fuller understanding of this phenomenon would require a more extensive study of Mandarin phonology.

(iv) That there are no [lateral] sounds executed by the Labial articulator is not evidence for the existence of a Lingual node. According to Halle 1995, [lateral] is an articulator-free feature. This means that the feature is not always executed by the same articulator. It does not mean, however, that every one of the six articulators may execute the feature. For example, the feature [continuant] may be executed by one of the three Place articulators (cf. (1)), but not by any of the other three articulators. We represent the cross-linguistic absence of labial laterals by means of a prohibition $*[+lateral, Labial]$, to be included in Calabrese's (1995) universal constraint system. (See Clements and Hume 1995:291 for arguments for the position of [lateral] under the root node.) Under close examination, then, the background support for Clements and Hume's proposed Lingual node treatment breaks down, leaving UFT with no viable explanation for the problems of [back] vowel harmony.

In addition to the difficulties UFT encounters in dealing with coronals and dorsals, it also 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], etc., which encode height differences between high, mid, and low vowels respectively. This proposal makes incorrect phonological predictions. By separating the aperture features from consonantal and vocalic Place features, Clements predicts that they will not show the same interactions between consonants and vowels that we find with

Place-dependent features such as Coronal, Dorsal, etc. The extensive evidence for interactions between consonant voicing and vocalic [ATR] values documented by Trigo 1987 and Vaux 1996 is thus problematic for Clements's theory, whereas it receives a straightforward account within an AT model (q.v. Vaux 1996).

Clements 1991 and Odden 1991 have argued that the AT model (1) has difficulty in 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. (For further arguments against Clements' theory of [open] features, see Zetterstrand 1995a, b, 1996, 1998.)

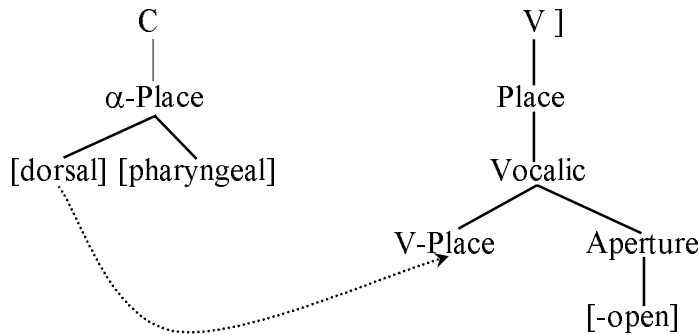
UFT also has problems with guttural specifications. While UFT can account for McCarthy's (1994) generalization that uvulars, pharyngeals, and laryngeals pattern together in rules of Semitic phonology, it cannot explain Elorrieta's (1991), Bessell and Czaykowska-Higgins's (1991), and Vaux's (1993) observation that in various languages uvulars and pharyngeals form a subgroup of this class, often patterning together as a class separate from laryngeals. Here UFT cannot appeal to the proposed terminal feature [radical] (Clements 1993:109), unless uvulars as well as pharyngeals are classified as [radical].

Note that Clements assumes that the Place and V-Place nodes of (10) are identical in every respect except for their position in the feature tree. In defense of this assumption Clements cites a process in Palestinian Arabic illustrated in (14) and analyzed by Herzallah 1990, where emphatic and uvular consonants cause the root vowel in the imperfective (normally *a* or *i*) to become *u*:

(14)	perfective	imperfective	gloss
a. regular verbs	<i>nidim</i>	<i>ji-ndam</i>	regret
	<i>kibir</i>	<i>ji-kbar</i>	grow up
	<i>katab</i>	<i>ji-ktib</i>	write
b. <i>u</i> -verbs	<i>qatal</i>	<i>ji-qtul</i>	kill
	<i>saxan</i>	<i>ji-sxun</i>	get hot
	<i>nabaʕ</i>	<i>ji-nbuʕ</i>	excel
	<i>ʔalab</i>	<i>ji-ʔlub</i>	ask for

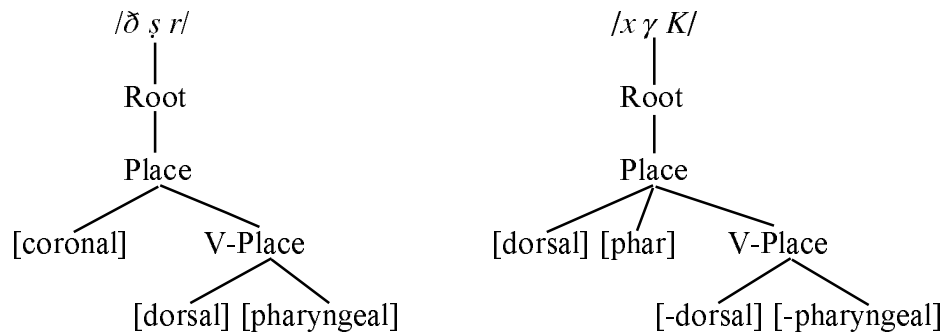
According to Herzallah, emphatics and uvulars are characterized by a [Dorsal, Pharyngeal] articulation. For emphatics, these features are dominated by the V-Place node, with [Coronal] as their primary (C-Place) articulation; for uvulars, Dorsal and Pharyngeal are their primary specifications and thus attach to the Place node. Consequently, Herzallah attributes the *-u-* in the forms in (14b) to a [Dorsal] feature spread from emphatics and uvulars within the root, as in (15).

(15) Herzallah's representation of "[–open] Dorsalization"³ (1990: 181)



Due to complications in another rule, however, she is forced to assign [–Dorsal] and [–Pharyngeal] V-Place articulations to the uvulars, as illustrated in (16).

(16) Herzallah's representation of emphatics and uvulars ("back velars")⁴ (1990:125)



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 (16). Since uvulars now have V-Place, and not simply redundant V-Place but a V-Place that opposes the segment's C-Place specifications, the formalization proffered in the alpha notation of (16) becomes less theoretically desirable. While UFT allows such rules, we note that this is the only spreading rule cited by Clements which cannot be adequately represented using Ní Chiosáin and Padgett's 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 here, since the negative specifications of the uvulars interfere. In the version of Clements' UFT which she uses, Herzallah might have had recourse to underspecification, had she not ordered the specification of the uvulars' [Dorsal,

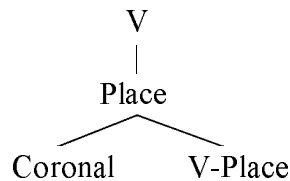
³ The "[–open]" means that the rule applies to [+high] vowels. Herzallah follows Clements (1991) in her use of the feature [open] to encode height differences.

⁴ Herzallah uses [K] to transcribe the Palestinian Arabic "back velar" analogue of Classical Arabic's uvular [q].

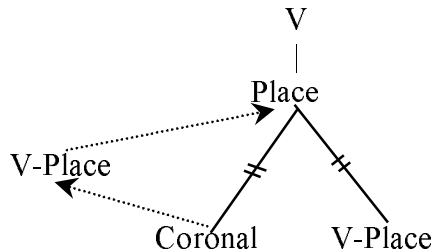
-Pharyngeal] V-Place before the dorsalization rule. In AT, this dorsalization rule is treated simply as spreading of [+back].⁵

Clements formalizes his C-V spreading rules by means of a demotion rule of the form in (17), which delinks the vowel's original V-Place and converts its new consonantal features into vocalic features.

(17) a. intermediate representation



b. demotion



To avoid the intermediate representation (17a), Clements might simply allow the consonantal feature to “dock” on the vocalic place node. 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 any second means of tier interaction besides the feature tree itself is to undermine the very purpose of the tree model of feature geometry. Clements leaves C- and V-Place in an unpredictable state where they remain separate tiers but interact as if on the same tier as needed. In order to decrease the theoretical power of such mechanisms, supporters of VPT must propose an ad hoc restriction of the use of docking and demotion to C-Place/V-Place interactions. Supporters of VPT may counter that no such restriction is needed since no two other superior nodes access the same set of features. This still fails to explain how UFT retains

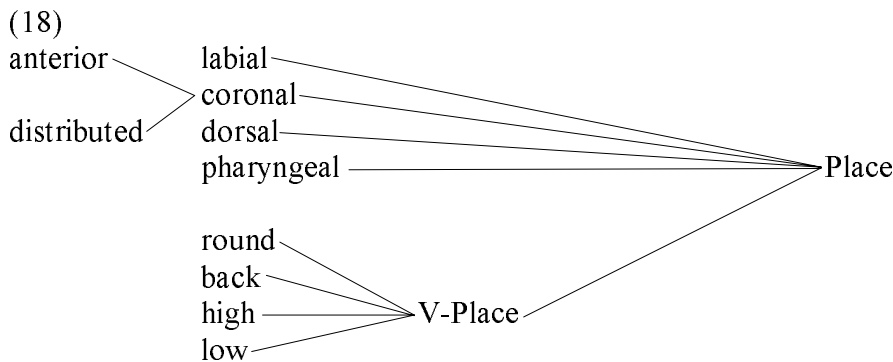
⁵ Other considerations of Herzallah’s dissertation also find simple explanations within an AT framework. For instance, she considers a rule of pharyngealization triggered by coronal emphatics wherein /æ/ (which she transcribes as /a/ for typing ease—Herzallah 1990:29) becomes /a/. AT treats this as consonantal [RTR] spread 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, ʌ] 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, but in addition [æ] shows the acoustic properties of [+ATR], such as a lowered F1 and raised F2 relative to its [-ATR] counterpart [a].

the ability both to overlook specifications for any given feature due to their differing superior Place nodes (i.e., vocalic [Labial] spread over Labial consonants) and to let them affect each other despite those superior Place nodes (i.e., Igbo [Labial] spread or Turkish Labial attraction). The notion of independent tiers as originally formulated remains breached. In the AT account, in contrast, the interaction or non-interaction of consonant and vowel places is determined solely by the contrastiveness or markedness of features; AT has no difficulties with sporadic tier independence, since in AT there is always only one Place tier.

To summarize thus far, UFT differs substantially from traditional AT models 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 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 readily manageable within an AT framework. In addition, the replacement of [ATR] and [high] with [open] makes incorrect predictions about the interaction of consonantal and vocalic [ATR] values. Most importantly, Clements' appeal to docking and demotion rules renders inoperative the notion of tier.

2.2. Consonantal transparency and 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- and V-Place in C-V interactions, as in (17) above. 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 the **unified** feature framework (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 propose the Place geometry in (18):



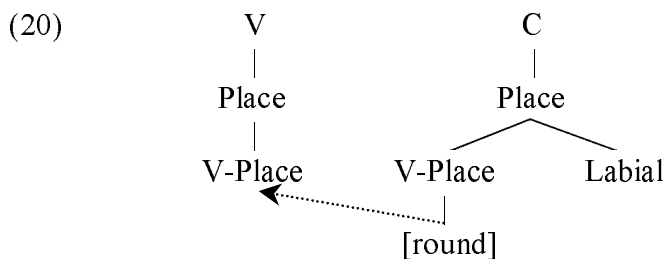
In order to account for cases where a consonant's C-Place specification spreads to vowels, Ní Chiosáin and Padgett postulate that plain consonants have inherent, redundant secondary V-Place specifications which parallel, according to the above equivalency relations, their primary C-Place features. It is then these inherent V-Place features which

spread onto the vowels. This allows them to retain their postulate that all C-V interactions occur on the V-Place tier.

In Igbo, the high vowel of the reduplicated syllable in the present participle surfaces as round before labial consonants, and non-round elsewhere (Hyman 1975:53):

(19)	verb stem	present participle	gloss
a.	<i>bè</i>	<i>ò-bù-bè</i>	cut
	<i>bà</i>	<i>ò-bù-bà</i>	enter
b.	<i>lé</i>	<i>ò-lí-lé</i>	look
	<i>lá</i>	<i>ò-lì-lá</i>	return

In Ní Chiosáin and Padgett’s system, Igbo Labial Assimilation would therefore be analyzed as follows:



This treatment of plain labials as having an inherent [round] specification does obviate the need for Clements’ docking and demotion rules. Nevertheless, some allowance must be made to distinguish plain from labialized labials, such as *p* and *p^w*, which are contrastive 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); i.e., they are specified for Labial alone and not for [round] (or possibly for [-round]). While the predictions this theory makes nearly match those of AT, Ní Chiosáin and Padgett’s theory invokes considerably more abstractness in its understanding of features than does AT. Features no longer have any inherent articulatory output, since a [+round] Labial surfaces as rounded in some languages but as plain in others. This theory thus provides the universal feature tree with some amount of language-specificity, increasing its theoretical power.

AT understands [round] as involving actual lip rounding, as opposed to simply some form of lip closure. Plain labials are therefore always [-round], and labialized labials are [+round]. Consequently, we do not think that it is possible that [+round] is the feature that is spreading in Igbo Labial Assimilation. Rather, we suggest that what spreads in this case is the articulator feature [labial]. Vowels specified for [labial] then automatically receive the specification [+round]. (For additional discussion, see section 3.3.)

Returning to our main point, 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 not **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-

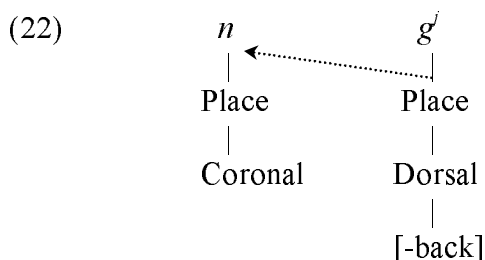
Place features act in parallel because they are identical. In Ní Chiosáin and Padgett's model, however, no internal structure motivates their particular "C-V affinities" except the statements themselves. While AT encounters similar problems regarding coronalization and lowering processes, it at least gives a straightforward account for labialization and dorsalization processes by linking them through the articulators Labial and Dorsal. Ní Chiosáin and Padgett's model not only has the same problems with coronalization and lowering processes that AT does, but it additionally has no structure-internal way to connect Labial with [round] nor Dorsal with [back].

Another major piece of evidence Ní Chiosáin and Padgett use to support their theory of V-Place-only interactions is the observation that, cross-linguistically, C-Place does not change due to the influence of a following vowel, thus $*[su] \rightarrow [fu]$, $[za] \rightarrow [ʰa]$, and $[fʰ] \rightarrow [xʰ]$. In the few cases where such changes have actually been observed, they posit a series of less dramatic historical steps, which remains in a telescoped form in morpho-lexical rules. Note, however, at some point in the chain of small steps, a change must occur for which Ní Chiosáin and Padgett's model cannot 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 consonantal articulation, 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 only applies 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 $[ku] \rightarrow [fu]$.

One final item of evidence invoked by Ní Chiosáin and Padgett in support of a V-Place node is the behavior of nasals in modern Irish (Ní Chiosáin and Padgett 1993:7), illustrated in (21):

- (21) a. $d'ek^h'in^j$ 'I would see'
 $d'ek^h'in^j \text{ gan } e:$ 'I would see without it'
- b. $d'i:l\grave{a}n$ 'a diary'
 $d'i:l\grave{a}n g^j i:v^r^j i$ '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 (21b) should produce $*d'i:l\grave{a}n g^j i:v^r^j i$, as depicted in (22):



Ní Chiosáin and Padgett assert that in order to account for the non-assimilation of the palatal secondary articulation in (21b) “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 cross-linguistically, at least elsewhere in Irish phonology. Moreover, Ní Chiosáin and Padgett’s analysis itself—i.e. that the phenomena in (21) are instances of Place assimilation—is not the only nor necessarily the best treatment of the data.

It is important to note in this connection that the data in (21) do not reflect the normal behavior of Nasal Place Assimilation in Irish, which spreads both primary and secondary articulations simultaneously. We must therefore distinguish two assimilation rules in Irish: Nasal Place Assimilation, which spreads both primary and secondary articulations, and Dorsal Spread (21), which spreads only the Dorsal primary articulation. It is true that Ní Chiosáin and Padgett 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. It is *not* true, however, that AT cannot account for the same data. In fact, the account we propose here is essentially equivalent to the one employed by Ní Chiosáin and Padgett. Like them, we assume that Nasal Place Assimilation involves spreading of the Place node, whereas Dorsal Spread 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 rather the feature [dorsal]. Since, as we mentioned in section 1, articulator features can spread like all other features, independently of the articulator nodes Lips, Tongue Dorsum, etc., spreading of the terminal feature [dorsal] does not entail spreading of the other features dominated by the Dorsal node. In effect, what is spreading is the designated articulator (dorsal) for the segment in question; the other features executed by the Dorsal articulator remain unaffected.

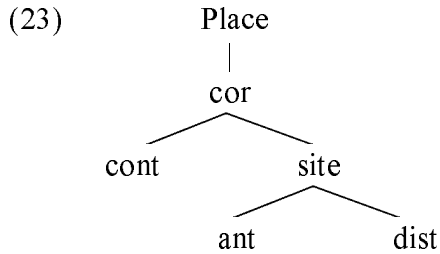
Like most languages, Irish does not admit phonemes with more than a single designated articulator. As a consequence, when the [dorsal] articulator feature of the following consonant is assimilated by the preceding nasal, the nasal loses its original [coronal] specification, resulting in the feature composition [dorsal, +nasal]; i.e. [ɲʲ] or [ɲ], depending on whether or not the nasal was originally [-back]. When the designated articulator is assimilated it is only this property—and none of the other features dominated by the articulator—that is assimilated.

2.3. *Consonant harmony and vocalic transparency*

Ní Chiosáin and Padgett (1993) note that vowel place theories in general have difficulty excluding such unattested interactions as *[nak]→[ɲak], where the Onset consonant assimilates the designated articulator of the Coda consonant, since individual consonantal place features can spread across vowels, so long as they do not require the involvement of the Place node. In order to account for this, Ní Chiosáin and Padgett introduce a constraint stating that “spreading of CPlace articulator features is strictly local” (1993:47). This locality condition does not draw much support. While tier theories have not stated that all tiers require the possibility of action-at-a-distance processes—such that some tiers could forgo that capability without destroying the mechanism’s explanatory power—the

introduction of said locality constraints departs without further explanation from the strong hypothesis that all tiers allow action-at-a-distance.

That aside, such locality constraints incorrectly predict the non-existence 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 (1991:47) postulate a “site” node subordinate to Coronal.



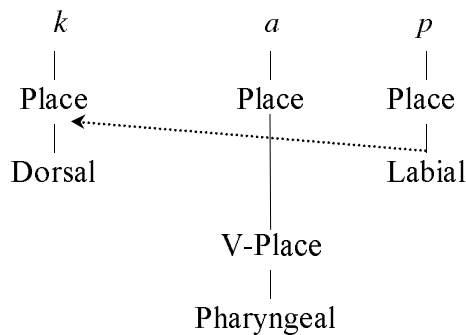
This is a purely *ad hoc* move, since no other evidence is cited in support of this site node. The existence of consonant harmony and the uniqueness of Coronal harmony are not a problem for the AT model, because vowels have contrastive Labial and Dorsal specifications to block the spreading of these consonantal features, but they have no similar specification for Coronal (for details see Halle 1995).⁶

Ní Chiosáin and Padgett’s version of VPT (see section 2.2), 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 unattested scenario in (24) is not prohibited by the geometry:

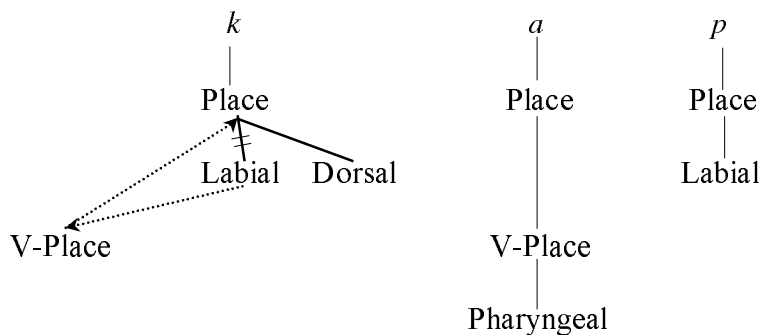
⁶ It has been noted (see e.g. McCarthy and Taub 1992) that AT holds a double standard here, in that it calls on an equivalency relation to explain palatalization rules, yet it claims that vowels have no Coronal specifications to block Coronal harmony. We resolve this apparent conflict by noting that the [-anterior] of our equivalency relation does not actually specify the vowel but applies later to the feature [-back], such that the vocalic Coronal specification does not block the Coronal consonant harmony.

(24) [kap] → [k^vap]

a. spreading



b. demotion



This type of process includes not only long-range labialization, but also long-range palatalization ($*[paf] \rightarrow [p^jaf]$) and long-range pharyngealization ($*[ti^c] \rightarrow [t^i^c]$). 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.

Interestingly, though, limited long-range consonant interactions other than Coronal harmony do occur. Herzallah (1990) notes a process in Palestinian Arabic whereby emphasis spreads leftwards from a Coronal emphatic onto other consonants throughout a word. Since Herzallah represents emphasis in coronals as a double 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 the emphasis spread then by ordering it before tier conflation, so that the intervening vowel's V-Place 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 non-morphological rule. In an AT framework, rather than appeal to tier conflation, this rule calls on the non-contrastiveness of vowels for the feature [RTR].

3. Autonomous Feature Spreading

Both VPT and conventional AT predict that there will be no cases of incomplete spreading of Place features, because of their shared assumption that only one node or feature can spread at a time, and that blocking of a spreading node entails blocking of all features

contained under that node. This issue of spreading formalization is distinct from the actual feature geometry, that is, the groupings of features which we discussed in section 2.

In this section we show first that incomplete spreading of nodes does exist, then that any model accounting for these facts obviates the initial motivation for the creation of Vowel-Place theories. In other words, when we correct for incomplete spreading in AT by allowing autonomous feature spreading, it also becomes possible thereby to adequately represent the phenomenon of vowel-copy over plain dorsal consonants which, as we discussed in section 1, was the motivation for V-Place Theory in the first place. In this way, the issue of spreading theories critically ties in with that of the feature geometries themselves. This section shows how autonomous spreading takes into account both incomplete and complete feature spreading, and lastly takes a brief look at the reasons for our proposal to adopt autonomous rather than terminal feature spreading.

3.1. Incomplete spreading

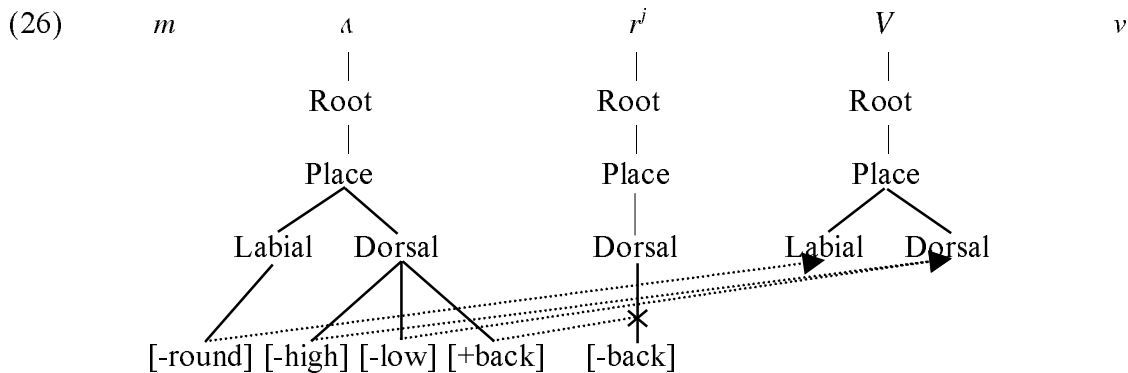
All theories of feature spreading to date have assumed that when more than one terminal feature spreads, only intermediate nodes in the feature tree can spread. Halle 1995 adduces evidence from a number of languages showing that this assumption must be modified. We examine one of Halle's more striking examples below.

Consider first the case of Barra Gaelic (Borgström 1937, 1940, Clements 1987, Sagey 1987). Barra Gaelic repairs certain sequences with an epenthetic vowel which 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 (25) (data from Clements 1987, Sagey 1987):

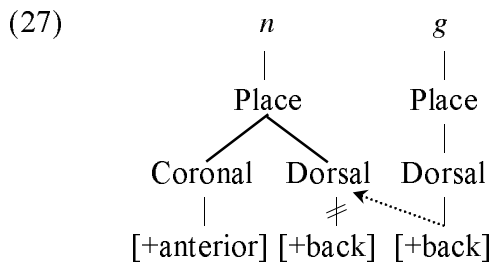
(25)	underlying form	surface form	gloss
a. after plain sonorants	<i>alpə</i>	<i>alapə</i>	Scotland
	<i>s^jærv</i>	<i>s^jærav</i>	bitter
	<i>s^jænxəs</i>	<i>s^jænoxəs</i>	conversation
	<i>dunxəγ</i>	<i>dunuxəγ</i>	Duncan
	<i>urpel</i>	<i>urupel</i>	tail
	<i>ɔrm</i>	<i>ɔɔm</i>	on me
	<i>marv</i>	<i>marav</i>	dead
	<i>færk</i>	<i>færak</i>	anger
b. after palatal sonorants	<i>mar^jv</i>	<i>mar^jev</i>	the dead
	<i>bul^jk^j</i>	<i>bul^jik^j</i>	bellows (g.sg.)
	<i>mer^jk^j</i>	<i>mer^jek^j</i>	rust
c. after non-contrastive sonorants	<i>t^jimx^jal</i>	<i>t^jimix^jal</i>	round about
	<i>æms^jir^j</i>	<i>æmæs^jir^j</i>	time

Both VPT and earlier versions of AT fail to account for the facts in (25). In earlier versions of AT, the Place node of every consonant blocks the spread of the vowel's Place

node, and in VPT, the V-Place node of contrastive consonants blocks the spread of the vowel's V-Place node. If, on the other hand, several terminal features can spread individually and simultaneously, as proposed by Halle 1995, a straightforward account is available within AT: all terminal Place features spread from a preceding vowel to the epenthetic vowel, except when a consonant for which backness is contrastive intervenes; in this case the vocalic [back] feature is blocked by the Line Crossing Prohibition (Sagey 1986). This process is illustrated in (26):



Strict terminal feature spreading as formulated in Halle 1995, however, encounters problems in the formulation of certain rules, such as nasal place assimilation in Irish (cf. the discussion below (21)). In nasal place assimilation rules cross-linguistically, Coronal nasals acquire the Place specifications of the following consonant, thus, for instance, in Irish /ng/ typically becomes [yg]. If we take this within a traditional terminal feature spreading framework, with full specification, this example appears as in (27):

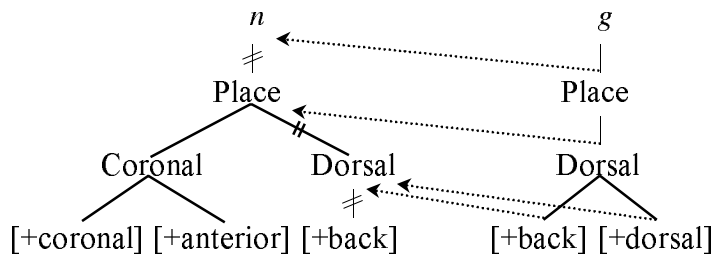


In this formulation, there is no reason for the Coronal [+anterior] to delink, since no new [anterior] specification is forcing it out. Furthermore, in Irish we cannot call on a repair rule to delink the Coronal specification because, as we saw in (21), double specifications for Coronal and Dorsal are legal and even required by the phonology.

In order to account for the Irish data, we crucially must assume that non-terminal nodes can spread. However, we do not want to return to the traditional non-terminal spreading model, which we just demonstrated to be unable to account for incomplete spreading. We suggest, therefore, that both terminal features and non-terminal nodes can spread, but that spreading is *autonomous*. In other words, as discussed in section 1, spreading of a node is implemented as autonomous spreading of that node and all nodes and features that it dominates. Crucially, blocking of one of these elements does not entail blocking of the remaining elements; rather, all elements spread successfully save

those that are blocked. Given this model, Irish nasal Place assimilation would therefore be represented as in (28):

(28) nasal Place assimilation with autonomous spreading



As we saw earlier, Irish does not admit phonemes with more than a single designated articulator; hence, the nasal loses its original [coronal] specification, resulting in the feature composition [+dorsal, +nasal].

The problem in the cases just reviewed is not the actual geometry supposed by AT and VPT, but rather the spreading theory they employ. Once we postulate that spreading is autonomous, though, we must reevaluate the data which led to the formulation of these two theories. In the following section we demonstrate that once we assume autonomous spreading, the arguments for VPT lose their force, whereas the problems with AT disappear.

3.2. Complete spreading

In section 1 we noted that AT encountered difficulties in accounting for the general transparency of consonants with respect to vowel copy processes. We showed there that these problems were avoided by VPT. In order to gain this advantage, however, VPT is forced to assume that plain consonants can *never* interfere with spreading of vocalic features. In section 3.1 we considered a case where plain consonants do in fact interfere with the spreading of vocalic features and showed how a theory of autonomous spreading was able to account for these facts. Since this and a number of other reasons presented in section 2 led us to abandon VPT in favor of AT, we now reconsider how AT might deal with consonantal transparency, given the restriction that only terminal features may spread.

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

(29)	verb	gloss	noun	gloss
	<i>mitfiru</i>	make shavings	<i>mitfiru-ku</i>	shavings
	<i>reme</i>	make tortillas	<i>reme-ke</i>	tortillas
	<i>patfi</i>	grow corn	<i>patfi-ki</i>	ear of corn
	<i>opatfa</i>	be dressed	<i>opatfa-ka</i>	garment

Tarahumara has the following phonemic inventory (Burgess 1984; only Place node and subordinate features shown):

Given that velars and uvulars contrast in Klamath, we might expect both series to block spreading of [back] and [high], if we accept the traditional representation of uvulars as [Dorsal, +back, -high]. However, we believe that the *snV-* morpheme is best treated as a reduplicative affix, which is linked to a minimal syllable template and the consonant sequence /*sn*/. Mapping of the base forms to the minimal syllable template produces intermediate forms *bo-bo:stgi*, *dʒi-dʒi:qjiq'a*, etc. The fixed /*sn*/ specification of the prefix then overwrites any initial consonant sequence that has been copied from the base, in a manner exactly parallel to the overwriting witnessed in English *schm*-reduplication (*table-schmable*, *dreadlocks-schmeadlocks*, etc.).

Several more complicated instances of vowel copy cited by Odden 1991 in which only the features [back] and [round] appear to spread have been dealt with by Halle 1995 and shown to be consistent with the analysis presented here. To the best of our knowledge, then, an AT model which employs autonomous spreading is able to account for all cases of complete and incomplete vowel copy, and is therefore to be preferred over VPT, which cannot account for incomplete vowel copy, and AT models employing non-terminal spreading, which cannot account for either type of vowel copy.

4. Conclusions

In this paper we have considered two models of feature geometry: Articulator Theory, where phonetic features are viewed as instructions for actions of the six articulators, and Vowel Place Theory, which also calls upon the notion of constriction degree to separate vocalic and consonantal place nodes in phonological processes. We have shown that AT's sole problem seems to be its account for palatalization, but that Clements' Unified Feature Theory 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 demonstrate that situations traditionally taken to support the proposed Lingual node revision of VPT can easily be explained without it. Furthermore, UFT incorrectly predicts that consonant voicing and vocalic [ATR] values will not interact. Most importantly, in order to explain C-V interactions UFT relies on processes of docking or demotion, which we claim significantly weaken the notion of tier and, moreover, allow unattested consonant harmonies such as *[*kap*]→[*k^wap*].

We then discussed Ní Chiosáin and Padgett's version of VPT, which in its attempt to remedy UFT's problem with tiers is required to invoke redundant secondary articulations in plain consonants. This, we contend, introduces excessive language-specificity in the interpretation of UG features. Moreover, Ní Chiosáin and Padgett's ban on C- and V-Place interactions is adequately supported neither by the Irish data, which we account for by reintroducing the traditional notion of articulator features, nor 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 to these shortcomings, both varieties of VPT have no means to account for the instances of consonant harmony described in section 2.3 above, most notably Shaw's Tahltan data. Attempts to account for these data have resulted in ad hoc proposals for a locality constraint and a Site node under Coronal.

We demonstrated that the two versions of VPT considered above and the original Halle/Sagey AT model are all unable to account for cases of incomplete vowel copy as discussed in section 3.1 (and in Halle 1995), because of their theory of spreading, which holds that only individual nodes can spread at any one time. We have shown that once we assume autonomous feature spreading, we not only gain an explanation for the cases of incomplete vowel copy, but we also acquire the machinery necessary to account for the instances of total vowel copy within AT. Since these cases, which were the original motivation for the postulation of VPT, are now manageable within AT, 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.

We have, therefore, gone some distance towards establishing that the anatomically motivated feature hierarchy in (1) also provides the structure required for formalizing the assimilatory processes encountered in languages. This is a result of considerable importance, since it connects two independent factors that play a role in language: the anatomic structures responsible for the phonetic actualization of language, and phonological processes.

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