Inherent VPlace

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1. Introduction

In work on phonological feature organization, few areas seem so puzzling as consonant and vowel place interaction. The problem is not that little is known about possible interactions; rather the opposite. Yet the facts, or our understanding of them, are such that the literature is fraught with a complex assortment of often contradictory proposals about both the nature of vowel place features and their organization in feature geometry. In this paper, we are concerned with one particular paradox: in some respects, vowel and consonant place features appear to interact directly; in other respects, they emphatically fail to interact.

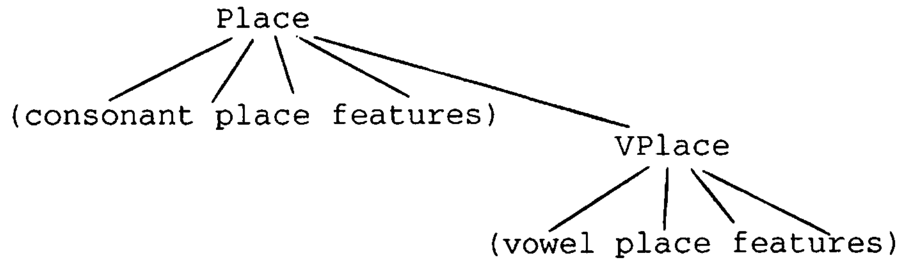
Examples of interaction, moving beyond the more prosaic roundings of consonants by round vowels and palatalizations by front/high vowels, include cases like Turkish *armVd* → *armud* 'pear' or Arabic *radVʕ* → *radaʕ* 'prevent', where the major place of a consonant (in this case, Labial and Pharyngeal, respectively) seems to affect that of a vowel. These facts, and others, have led many researchers to advocate *unified feature theories*, in which consonants and vowels (at least in part) share one set of place features. In this view, the examples just mentioned receive an appealingly direct account:

```
(1)  a.  m  V   →   m  u        b.  V  ʕ    →   a  ʕ
         |/                          \ |
        Lab                          Phar
```

Examples of the **absence** of interaction include many well-known instances of consonant transparency to vowel place assimilation. Of particular interest here are cases where all vowel place features spread through consonants together, motivating their geometrical grouping, separate from consonant place features, a notion we refer to as *VPlace theory* (Steriade 1987a, Clements to appear, Odden 1991, inter alia):

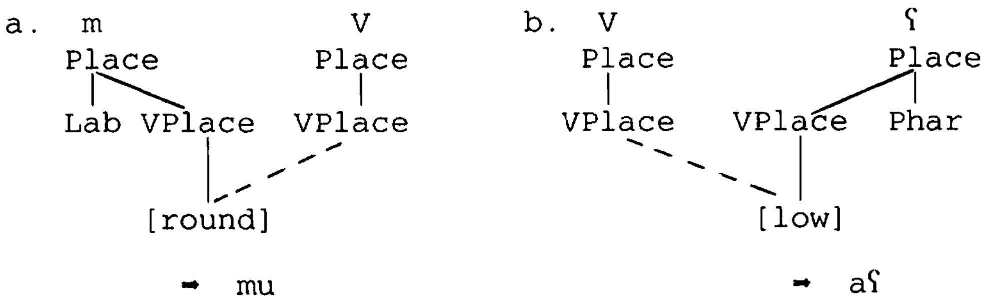
[*]<Acknowledgements>

(2)



The problem lies in reconciling these ideas. If vowel place (henceforth: *VPlace*) features are segregated from consonant place (henceforth: *CPlace*) features, arrayed on separate tiers, how can the two interact? We claim that facts like those in (1) involve the workings of **redundant** secondary VPlace features borne by the (plain) consonant. In (3)a, it is this redundant 'roundness' (and not **distinctive** [round], **nor** CPlace Labial) that spreads from consonant to vowel:

(3) Turkish *mV* → *mu* and Arabic *Vʕ* → *aʕ* as redundant VPlace feature spreading



In the sense that a consonantal constriction contains a necessarily vocalic onset and/or offset, the consonant can be said to bear *inherent VPlace*. These redundant VPlace features, like all redundant features, are sometimes active in the phonology of a language. This idea, along with the notion that vowels cannot bear CPlace features (by definition), and the separation of C- and VPlace features, entails an important generalization, as we will see: consonant-vowel (henceforth: *C-V*) interaction involves only VPlace features. This conclusion in turn explains an interesting asymmetry in the cross-linguistic data: though facts like those of Turkish and Maltese are relatively common, the reverse scenario, in which a vowel effects a change in the major place of a consonant, e.g. *su* → *fu*, *za* → *ʕa*, is strikingly absent. Counterexamples are only apparent, and shed significant light on the issue, as we will see.

Thus Inherent VPlace theory allows us to reconcile a strict separation of C- and VPlace features with facts like those of Turkish and Maltese. Furthermore, it permits an account of C-V interaction that is consistent with independently motivated ideas concerning place-stricture relations. The theory achieves these explanations while invoking (and shedding light on) familiar concepts of feature redundancy and underspecification.

The paper is organized as follows. §2 summarizes arguments for VPlace theory, while §3 clarifies the relevance of this theory to questions of C-V interaction, and introduces a typology of interactions. §4 lays out inherent VPlace theory and presents the basic arguments for it; various consequences are explored, bearing on e.g. the understanding of the behavior of redundant features, and the representation of palatalization. §5 considers alternative accounts, and pursues questions of place-stricture relations. §6 turns to the implications of inherent VPlace theory for the treatment of consonant harmonies, and the question of unified place features for consonants and vowels.

This last possibility, of a unified feature theory, would seem to be rendered immaterial by our claim that all C-V interaction involves only VPlace features. This is not entirely true, as we will see. However, most of our discussion does not presuppose unified features, and we believe the issue requires more thought. When not considering the unified feature view, we assume the familiar VPlace features [high], [low], [back] and [round].

2. VPlace

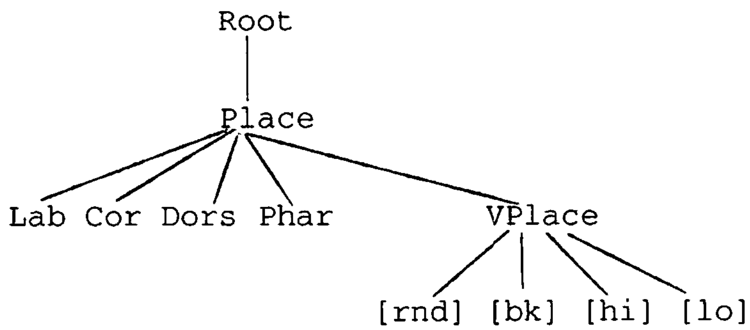
It has been recognized for some time now that certain features pattern together independently of others in processes of assimilation, dissimilation, neutralization, and so on. In generative phonology, such classes of features acquire explicit formal status within Feature Geometry Theory (Clements 1985, Sagey 1986, McCarthy 1988 and references therein).[1]

We are concerned in particular with the predictions made by VPlace theory, in which VPlace features are grouped together, segregated from CPlace features, as in (4). Clements (1985) and Archangeli and Pulleyblank (1986) both suggest that VPlace features form a class independently of CPlace features, an idea with an interesting parallel in work in phonetics positing independent 'channels of articulation' (Öhman 1967 and much following work; see e.g. Keating 1988, Browman and Goldstein 1990). However, explicit arguments within phonology for the geometrical separation emerge only in later work, especially Steriade (1987a), Prince (1987), Clements (1989, to appear), Ní Chiosáin (1989, 1993), Odden (1991), Hume (1992) and references therein. The collective import of these proposals is that not all cases involving C-V place feature independence can be seen as the result of total planar C-V segregation along the lines of McCarthy (1981, 1989a), a point articulated quite clearly by Steriade (1987a) in a survey of 'laryngeal transparency' effects. Beyond this, existing claims differ to a great degree in ways that are not immediately relevant; in particular, we do not attempt to detail the stages in thought that lead to the position presented here. The sections below constitute a necessarily brief review and clarification of the arguments for VPlace, followed by a discussion of the implications for a theory of C-V interaction. We follow Odden (1991) in calling this grouping V(owel)Place; it corresponds roughly to Clements' (to appear) *Vocalic*. The most obvious claim made by this representation is that VPlace features

[1]Within the framework of Dependency Phonology, formal status has been given to classes of features since the mid-seventies, for example laryngeal and supralaryngeal 'gestures'. See Lass and Anderson (1975), Lass (1976), and Anderson and Ewen (1987).

can spread or otherwise behave together to the exclusion of CPlace features. We turn to this prediction in §2.1 below.[2]

(4) The VPlace grouping



(4) also entails that individual CPlace features can behave independently of VPlace features. (CPlace features can pattern **together** only if any (secondary) VPlace features present are involved as well, if we assume no separate grouping of CPlace features, following Clements to appear).[3] Though processes affecting single articulators are not common, they do exist, and provide support for the independence of VPlace, as argued in §2.2 below.

2.1 Total Vowel Assimilation and Consonant Transparency

The prediction that VPlace features can behave together, independently of CPlace features, is supported by rules of total vowel place assimilation across consonants. Such cases are explored in Steriade (1987a), Clements (to appear), Odden (1991), Hume (1992), among others, extending proposals of Sagey (1986) (though see Halle 1993 for a different view). One instance discussed by Odden is found in Klamath: in Klamath, the vowel in the causative prefix *snV-* is a copy of the stem vowel. Other prefixes behave in this way as well. (Klamath has the vowels *i*, *e*, *a*, *o*; data from Barker 1963, 1964):

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[2]Here and later we often abbreviate feature names in ways that should be clear, for example Phar = Pharyngeal, [rnd] = [round]. A further clarification: the geometry in (4) abstracts away from other possible groupings that are not of immediate concern here, for example a CPlace grouping *Oral* vs. *Pharyngeal* (McCarthy 1991), or a VPlace grouping *Height* vs. *Color/Place* (Clements to appear, Odden 1991).

[3]We note here some differences in node labeling: Clements' *CPlace* grouping corresponds to *Place* in (4); Clements' *V-Place* denotes a grouping of VPlace features that excludes height/aperture features - compare Odden's 1991 *[back]/[round]* node. Like Odden we let *VPlace* refer to all vowel features under Place.

(5)

sna-batgal	'gets someone up from bed'
sna-čk'a:Wa	'makes cold'
sne-l'e:mlem'a	'makes someone dizzy'
sne-ɢe:ǰiga	'makes tired'
sno-bo:stgi	'causes something to turn black'
sni-ǰi:qjiq'a	'makes someone ticklish'
sni-nklilk'a	'makes dusty'
sni-ɢičtgi	'makes tight'

Since this spreading involves multiple VPlace features (Odden implicitly assumes [high], [low] and [back]), and since it occurs across consonants of all places, the VPlace features involved must be represented together independently of any consonant place features. Like Steriade (1987a), Odden uses such data to illustrate the inadequacy of the organization of place features proposed in Sagey (1986), where the vowel features [high, low, back] are dependents of Dorsal; spreading occurs across velars (*k*, *k'* and *g*) and uvulars (*q*, *q'* and ɢ), a state of affairs allowed by VPlace but not by Dorsal-dependency:

(6) a. VPlace across Dorsals b. Dorsal-dependency

```
Place Place Place        Place Place Place
  `-.   |     |             |       |
     `-Dor    |             |-+/-.._|
         `-.  |            Dor     Dor
          VPlace
```

Odden discusses additional facts from a number of languages where [back] and [round] pattern together in harmony processes, for example Eastern Cheremis, Tunica and Wikchamni. He argues that these processes constitute single spreading rules and that the features involved therefore form a constituent (called *[back]/[round]*, subordinate to VPlace). Taken together with data like that of Klamath, these facts require that **all** vowel place features, including [round], be organized together under one node - a VPlace node.

Unlike Odden, Steriade follows Sagey in locating [round] under the Labial articulator. Odden's arguments against this position, and for locating [round] under VPlace, are persuasive. Of particular relevance is the following point: while roundness in vowels is found to interact with Labial in consonants (a fact that lead Sagey to her proposed structure), it is no less true that other C-V 'affinities' exist, for example between pharyngeal consonants and low/back vowels, coronal consonants and high front vowels; we turn to these in the following section. We cannot therefore conclude, however, that [-back] is grouped with Coronal, and [+low] with Pharyngeal, etc., since we would then have no account for the facts motivating VPlace theory. We turn to more such facts in the following section.[4]

[4]It is worth mentioning here another sort of argument for the VPlace grouping, one that has received scant attention, though see Hume (1992). Among the (many) known cases of root structure constraints prohibiting consonants of the same major place (Semitic cases

2.2 The Independence of CPlace Features

VPlace theory entails a complementary independence of CPlace features from VPlace features. There is no CPlace grouping by which these features might behave **together**, apart from any (secondary) VPlace present in the consonant; yet any **single** consonantal articulator can behave independently in this way. This view runs counter to that of theories in which VPlace features are seen as dependents of one or more of these articulators. Features representing palatalization, for example, have been located directly under Dorsal by some researchers (for example Sagey 1986, Halle 1986, Schein and Steriade 1986), and under Coronal by others (for example Mester and Itô 1989, Broselow and Niyondagara 1991, Lahiri and Evers 1991). (Cf. the more varied dependency structures of Selkirk 1991a).

Data from Irish involving processes that affect single CPlace features provide further support for the structure adopted here. These processes can only be accounted for if the VPlace feature representing palatalization - which is distinctive throughout the consonant system of Irish - is independent of both Coronal and Dorsal, the two CPlace features most likely to dominate it. Our analysis follows Ní Chiosáin (1991, 1993), to which we refer the reader for full discussion. The process of Coronal Delinking shows that palatalization is independent of Coronal: voiceless coronal obstruents /t,t',s,s'/ when lenited result in voiceless laryngeal fricatives. (*C'* is palatalized). Lenition of coronal obstruents is a rule that delinks Coronal word-initially, yielding the placeless segment *h*, as formulated below.

(7) Coronal Delinking

$$\begin{array}{ll} [_{wd} & \text{-son} \\ & \ \ \nmid \\ & \text{Cor} \end{array}$$

Of greatest interest is the following: a palatalized coronal that undergoes Coronal Delinking retains its palatalization, as illustrated in (8).

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perhaps being best-known, see for example McCarthy 1988), are cases in languages with no planar C-V segregation. Russian is one (Padgett 1991a,b), while a more mysterious example exists in English (Davis 1990, 1991, Lamontagne 1993): $*sC_1VC_2$, where C_1 and C_2 are of the same major place. Lack of planar C-V segregation requires an explanation along some other lines for the transparency of intervening vowels to these OCP effects. For example, any theory that represents roundness in vowels by Labial (with or without [round]) must explain why **spoop* is as non-existent as **spip* - the Labial node of the vowel in **spoop* does not intervene and render the consonants invisible to one another. (Nor can we assume that adjacent C-V Labial specifications themselves cause the violation, since both *poo* and *spoo* are possible English words). In our terms, failure of C-V interaction follows from tier segregation as detailed above.

(8) t', s' → h'

a.	s'o:l	'sail'	h'o:l	'sailed'
b.	s'u:l	'walk'	h'u:l	'walked'
c.	t'ɑ:n	'tighten'	h'ɑ:n	'tightened'
d.	t'u:	'thicken'	h'u:	'thickened'

The past tense of verbs is expressed by leniting the initial consonant of the verb. The resulting segments in (8) are realized as palatalized *h'*. Lenition of a voiceless palatalized coronal is illustrated below, with palatalization (for present purposes represented by [-back]) crucially independent of Coronal.

(9)

```
Root
 |
Place
 ‡
Cor     VPlace
          |
       [-back]
```

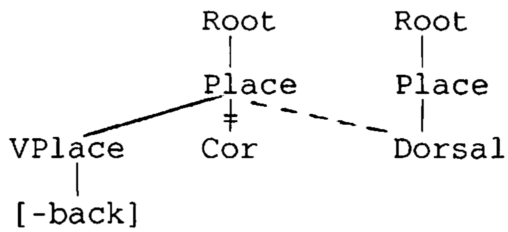
A second process involving coronal segments, Coronal Fusion, involves the fusion of Coronal nodes at the junctures of prefixed and compound forms - without fusion of palatalization. (See Ní Chiosáin 1991, 1993).

The facts of Coronal Delinking and Coronal Fusion entail that features representing palatalization are not dependents of Coronal. Another process, Nasal Place Assimilation, shows that the palatalization features are also independent of Dorsal. A coronal nasal can assimilate to a Dorsal segment, acquiring a primary Dorsal place specification while retaining its original secondary place specification, as in (10).

(10)	a.	d'ek'h'in'	'I would see'
		d'ek'h'iŋ' gan e:	'I would see without it'
	b.	d'i:lən	'a diary'
		d'i:ləŋg'i:v'r'i	'a winter's diary'

In order to account for the retention of palatalization in (10), we must adopt a structure in which the VPlace feature representing palatalization is independent of Dorsal:

(11)



3. C-V Interactions: A Typology

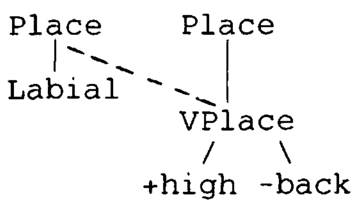
We present here a brief typology of C-V interactions, viewing them from the perspective of VPlace theory. From this perspective, the data divide naturally into two classes, the second of which poses particular challenges to the theory. Our goal in this section is to clarify the data, and the nature of the challenge. We turn to our main theoretical proposals, in §4.

Consider first rules that involve only the activity of **distinctive VPlace** features. We call all such C-V interactions *Type I* interactions. Observe the alternations before the vowel *i* (a gerundive suffix) in the Japanese data below:[5]

(12)	a.	hakob-u	'carry' (pres.)	b.	hakob^y-i
		tatak-u	'hit'		tatak^y-i
		kat-e	'win' (imper.)		kač-i

Palatalization by a neighboring front vowel or glide is a well-known process in languages. (See Bhat 1978 for a comprehensive survey of palatalization cross-linguistically). We take the standard view that rules such as this simply involve the superimposition of the place features of a vowel onto the consonant, creating a consonant with a secondary vocalic articulation. This rule therefore has a straightforward characterization in VPlace theories:

(13) VPlace features from V to C - Japanese



We ignore for the moment some questions about palatalizations (e.g. the analysis of palatalizations more drastic than what is seen in Japanese, for example Slavic $k \rightarrow \check{c}$), but return to them in §4.

[5]See e.g. McCawley (1968). Thanks to Junko Itô and R. Armin Mester for examples and discussion.

Other C-V interactions in which the consonant acquires a secondary place feature from an adjacent vowel are widely attested; they include labializations like $k + u \rightarrow k^w u$, and similarly (though less commonly, see Maddieson 1984:38) velarizations, uvularizations and pharyngealizations. All of these processes can be represented, assuming the structure adopted in this paper, as spreading of (one or more) VPlace features from the vowel to the Place node of a consonant.

When a consonant bears distinctive secondary vocalic features, then the reverse can also be seen - the secondary articulation of the consonant affects the quality of a neighboring vowel. Thus we commonly find effects like that of Abaza /x^w*ic*/ → x^w*uc* 'small', where the vowel becomes round following a rounded consonant (O'Herin 1991), or Irish /*muk'*/ → *mik'* 'pig', where the vowel is fronted before a palatalized consonant (Ní Chiosáin 1991). These rules are again straightforwardly treated as VPlace feature spreading, this time from consonant to vowel:

(14) VPlace features from C to V: Abaza

```
          Place    Place
         /   |        |
    Dors     |        |
          VPlace   VPlace
             | - - '
          [+round]
```

Next to these these Type I interactions, which involve distinctive VPlace feature spreading, consider interactions we call *Type II*, involving a change in the place of articulation of a vowel under the influence of a neighboring **plain** consonant. These interactions have received a fair amount of attention in recent work, and are fairly common, though significantly less so than Type I, it seems, a point we return to later. They reveal C-V *affinities* like those sketched below.

(15) Consonant-Vowel Affinities

Consonant	Vowel
Labial	and roundness
Coronal	and frontness and height
Dorsal	and backness and height
Pharyngeal	and backness and lowness

That is, there is some 'affinity' between labial consonants and roundness in vowels, etc., as evinced by Type II processes we turn to directly. (15) is not an exhaustive summary by any means, but merely illustrates some observed affinity types, abstracting away for now from certain complexities. We exemplify each affinity type below with examples involving assimilation.

3.1 Type II Interactions

Labial and roundness

In Turkish, roots are subject to a rule of 'Labial Attraction' (Lees 1961, Lightner 1972, Itô, Mester and Padgett 1993): within a root, the sequence aC_0u occurs, but not aC_0i, where C_0 contains a labial. That is, labial consonants cause the rounding of a following high back vowel if preceded by *a*. Examples are given below (relevant segments highlighted).

(16)

armud	'pear'
kabuk	'rind'
karpuz	'watermelon'
yavru	'cub, chick'
samsun	'mastiff'
avlu	'courtyard'

In *yavru*, for example, rounding of the final high vowel is due to the preceding *v*, the relevant spreading feature propagating through intervening *r*. We discuss these Turkish facts in more detail in §4. Other languages displaying this sort of labial-round affinity are discussed in Hyman (1973), Campbell (1974), Sagey (1986), Yip (1988), Clements (to appear), Selkirk (1988, 1993), and Cho (1993), among others. As these researchers argue, such facts require that labial consonants and round vowels share some feature. This is illustrated in (17) for the form *yavru*. Putting aside for the moment questions of structure and feature content, we employ the theory-neutral designation 'labiality'.

(17)

```
y a v r V
     \ /        =  yavru
  labiality
```

Coronal and frontness/height

In Maltese, the prefix vowel of first measure imperfect verbs is generally a copy of the stem vowel. Thus we have examples like *jo + ktor* 'it abounds' but *ja + ʔsam* 'it breaks'. When the verb stem begins with a coronal obstruent, however, the prefix vowel is not assimilated to the stem vowel, but rather surfaces as *i* (Brame 1972, Hume 1992):

(18) a. ji + šrob 'he drinks'
b. ji + skot 'he is silent'
c. ji + dalam 'it grows dark'

As is true of Turkish, the place features of the Maltese prefix vowel are determined by a neighboring plain consonant.

Dorsal and backness/height

Palestinian Arabic has a class of *a/i* ablaut verbs, in which underlying *a* surfaces as *i* in first measure imperfect verbs by a morphological rule (Herzallah 1990):

(19)	Perfect	Imperfect	
a.	katab	ji + ktib	'write'
b.	fatan	ji + ftin	'bewitch'

If there is either an emphatic or uvular ('back velar') consonant in the stem, the imperfect stem vowel is not *i* but *u*:

(20) a.	naðam	ji + nðum	'compose'
b.	saχan	ji + sχun	'get hot'

Building on McCarthy (1989b), Herzallah argues that emphatics and uvulars are both **dorso-pharyngeal**, a type of complex segment. The dorsal component affects an adjacent high vowel, causing it to be back. (Rounding follows by redundancy). Palestinian Arabic then exemplifies the affinity between dorsal consonants and backness and height in vowels, an affinity also seen in e.g. !Xóõ (Traill 1985), Yoruba (Pulleyblank 1988) and Quechua (Gorecka 1989).

Pharyngeal and backness/lowness

Classical Arabic has a number of ablaut verb classes, where vowel quality indicates (im)perfective aspect (Wehr 1971, McCarthy 1989b, 1991). The so-called *a/a* class, in which both verb forms retain the low back vowel, are virtually entirely characterized by the presence of a guttural consonant adjacent to the relevant vowel. Compare (21)a to (21)b (*D* is emphatic):

(21)	*a/u*, *a/i* classes			*a/a* class	
a.	katab/ktub	'write'	b.	faʕal/fʕal	'do'
	Darab/Drib	'beat'		radaʕ/rdaʕ	'prevent'

Instances of vowel assimilation to a guttural consonant are documented in McCarthy (1989b, 1991), Herzallah (1990), Hume (1992) and references therein for Arabic-related dialects, and occur also in Northwest Caucasian languages (e.g. O'Herin 1991).

3.2 Discussion

A notable characteristic of Type II interactions is the lack of any apparent secondary articulation on the triggering consonants. In all of the examples seen above, a vowel assimilates in place to an adjacent **plain** consonant. Yet our geometry asserts a fundamental separation of CPlace and VPlace features. Given this premise, how is spreading of 'labiality' from consonant to vowel in Turkish *yavru* possible? The question is illustrated in (22); we emphasize that the issue is not about feature content, i.e. use of [round] versus Labial under VPlace, but rather about the geometrical separation of CPlace and VPlace features.

(22) Separation of CPlace and VPlace features

```
y     a     v          r     V
          Place             Place
            |                 |
            |               VPlace
            |                 :
           Lab    =??=>    [round]/Lab
```

Sagey (1986) accounts for a similar process in Tulu by means of a rule spreading the major place Labial (with dependent [round]) from consonant to vowel. More recent interpretations of this view, characterized by the sharing of the major place of the consonant with the vowel, are found in e.g. Selkirk (1988, 1993) and Clements (to appear). Before discussing these proposals, which in our view face formidable difficulties, we set out a theory of *inherent VPlace features*.

4. Inherent VPlace

Let us consider in more detail the difference between Type I and Type II C-V interactions. The former are defined as involving only the activity of distinctive VPlace features. In the Abaza example noted earlier, for instance, a vowel is rounded by a distinctively [round] Dorsal consonant, e.g. */x^{w}ɨc/* → *x^{w}uc* 'small':

(23) VPlace features from C to V: Abaza

```
        Place    Place
       /  |        |
  Dors    |        |
        VPlace   VPlace
          |_ _ _ /
        [+round]
```

On the other hand, the plain consonants implicated in Type II interactions seemingly cannot affect adjacent vowels in this way, since by definition they lack such distinctive VPlace features; in order for a plain consonant and a vowel to interact, some feature(s) compatible to both must be involved.

Our proposal is that Type II interactions, just like Type I, do in fact involve only VPlace features; but in constrast to Type I interactions, the features involved are not **distinctive** but **redundant** - what we term *inherent VPlace features*. We motivate this as follows: a consonant, plain or not, involves an articulation that begins and/or ends with a constriction that is **less** than consonantal - and that is therefore vocalic - as illustrated below.

(24)
```
  onset                                offset
 -->-->-->-->maximum constriction-->-->-->-->-->
 (vocalic)       (consonantal)         (vocalic)
```

Vocalic onsets and offsets inevitably reflect the basic place of articulation of the consonant. That is, in the instants preceding and following a consonantal Labial constriction, for example, there is a Labial constriction that is less than consonantal. Since every consonant has either an onset, an offset, or both, this vocalic labial constriction may be considered *inherent*; in VPlace theory, this means an inherent VPlace feature. Finally, inherent features are by definition redundant, and just as other redundant features can sometimes function in the phonology, inherent VPlace is similarly available.

Type II effects such as Turkish Labial Attraction (16) can now be accounted for as follows (see the more detailed discussion in §4.1.2): the feature involved is the inherent VPlace feature of the (plain) labial consonant, i.e. inherent [round], as illustrated below for *yavru* 'cub, chick'. For concreteness, we analyze this morpheme structure condition in terms of an assimilation rule, following much of the generative tradition. This rule is therefore nearly identical to that seen in (23) for Abaza: instead of CPlace Dorsal, though, we have here CPlace Labial; and [round] is inherent in the labial, not distinctive.

(25) VPlace features from C to V: Turkish

```
        Place    Place
       /  |        |
   Lab    |        |
        VPlace  _VPlace
          |  _ -
          L-
        [+round]
```

A consequence of our proposal is thus highlighted: Type I and Type II interactions differ only in the status of the active VPlace feature - distinctive or redundant. More broadly, we are claiming that **all** C-V interactions involve only VPlace features. It is precisely the proposed inherent VPlace that makes this claim possible of Type II interactions, which otherwise seem to require an account fundamentally different from that of Type I. This claim about C-V interactions has an obvious restrictive appeal, but needs further motivation, to which we turn below in §4.2.

Inherent features reflected in the C-V affinities exemplified by Type II interactions include the ones illustrated here:

(26) Inherent VPlace Features

```
  p           t              k             ʕ
  |          / \            / \           / \
[rnd]   [-bk] [+hi]    [+bk] [+hi]    [+bk] [+lo]
```

That is, since inherent VPlace features reflect the basic place of the consonant itself, we expect the C-V affinities noted earlier and repeated here, this time employing feature terminology:

(27) Consonant-Vowel Affinities

Labials	and [round]
Coronals	and [-back]/[+high]
Dorsals	and [+back]/[+high]
Pharyngeals	and [+low]/[+back]

By parallel to the Turkish case, Maltese *Vs* → *is* (18) is seen as involving the spreading of [-back, +high], inherent in the coronal, to the vowel; in Arabic *Vʕ* → *aʕ* (21) we see inherent [+low, +back] spreading; and so on.

This conception of inherent VPlace theory requires refinement in several important respects. First, (27) does not reflect all possible affinities, since it does not reflect all consonantal places of articulation. Hence we find an affinity between uvulars and mid-back vowels, to give one more example, as in Shuswap (Kuipers 1974), and Greenlandic Eskimo (Kenstowicz and Kisseberth 1979:43, citing Schultz-Lorentzen 1945).

Second, it is important to note that 'plain' consonants may bear other redundant vocalic features besides those in (26), features that may in fact predominate and give affinities different from those listed. For example, Stevens et al. (1986) discuss a correlation between dentality in coronal consonants and a **back** tongue body articulation, for various languages; alveolar consonants, on the other hand, can evince a front tongue body articulation. Such behavior is reflected in the phonology of numerous languages, for example Lardil (Wilkinson 1988), and various Dravidian languages (Gnanadesikan 1992). Indeed, this may help to explain the apparent infrequency of Type II effects involving coronals - cases like Maltese *Vs* → *is* do not seem so common as effects involving e.g. labials and [round]. A dental that is redundantly [+back] presumably cannot simultaneously be [-back], and is likely to show [+back] affinities, if any.

Third, we are not in a position to discuss the relative 'strengths' of the various inherent features, and therefore the relative likeliness of vowel fronting versus (or in combination with) raising around coronals, or the likeliness of these effects compared to vowel rounding by labials.

Returning to the basic proposal: it is clear that there is some abstractness implicit in our use of the inherent features in (26). It is true that a plain coronal, say, does not involve the sort of tongue raising and fronting seen in true palatalization, or in high front vowels. Nor are plain labials round in the sense that distinctively round consonants or vowels are. Rather, inherent features, as the name suggests, simply denote the tongue raising/fronting implicit in (some) plain coronals, in comparison to other places of articulation, or vocalic lip constriction implicit in plain labials, in comparison to other places of articulation. There is then some language- and/or context-dependency in the implementation of these place features. This sort of abstractness is an inevitable characteristic of any theory, of course: whatever feature we choose to express assimilation as in (28) (here it is denoted by F), that feature must represent plain labiality in the consonant and roundness in the vowel.[6]

(28)

```
p   u
| /
F
```

The issue may be further pursued as follows: consider voicing in sonorant consonants, termed 'inherent' by Stevens et al. (1986). There is an important sense in which such voicing is phonetically less salient than voicing in obstruents, familiar from discussion of 'spontaneous voicing', as in Chomsky and Halle (1968). The import of spontaneous voicing is that it is in the nature of sonorants to be voiced (hence 'inherently'), while the presence of voicing in obstruents on the other hand is subject to specific articulatory control. The 'uncontrolled', phonetically redundant status of sonorant voicing translates into phonological redundancy. By 'inherent' [round], for example, we intend something similar: a property of labial consonants that is not 'controlled', and that is therefore less salient phonetically than distinctive rounding. Support for this notion is found in Goldstein (1992), who surveys the implementation of [round] in various languages and concludes that the only invariant articulatory correlate is contact between the upper and lower lips at the sides. By this criterion, all labial consonants involve some inherent 'rounding'. (See also Stevens et al. p. 431 on the acoustic similarities between rounding and labial consonants).

In the following sections we further set out and motivate inherent VPlace theory. We begin in §4.1 by elaborating on the role of inherent features in phonology, clarifying questions concerning their activity, or their underspecification. We then turn in §4.2 to our major empirical arguments for the theory, which concern fundamental asymmetries in segmental inventories and assimilation processes.

[6]For extensive discussion of the abstractness issue in this context, and of the necessarily complex relation between phonology and phonetic implementation, see Selkirk (1993).

4.1 Inherent VPlace in Action

How extensive is the role of inherent VPlace features in phonology? When are they active? Alternatively, when are they unspecified, as redundant features often are? Here we address these questions, in the context of two processes involving inherent [round]. One is a dissimilation effect of Berber; the other involves a more detailed examination of Turkish Labial Attraction. While the questions posed open up large areas of investigation, our aim here is mainly to clarify certain important implications of the proposal.

4.1.1 Distinctive and Inherent VPlace: Labial Dissimilation in Berber

Selkirk (1993), building on Jebbour (1985), Elmedlaoui (1985) and Boukous (1987), analyzes data involving Labial dissimilation in the Tiznit and Tidli varieties of Tashlhiyt Berber. Especially interesting are cases of what Selkirk terms 'disparate rank' dissimilation in prefixed forms - that is, dissimilation between a plain labial and a distinctively rounded consonant. In particular, a rounded velar loses its secondary rounding when immediately preceded by a labial consonant:

(29) 'Disparate rank' dissimilation in Berber

pret.	agent sg.	agent pl.	
g^wra	amgru	imgra	'glean'
gg^wa	tamggant	timgganin	'do the wash'
k^wra	amkray	imkrayn	'rent'

Thus the rounding in preterite *g^wra* is lost in agentive *amgru*, etc. Here we have a Type II OCP interaction; in our terms, it is the inherent [round] of a plain labial that interacts with distinctive [round], and so dissimilation is actually 'within rank' - involving two VPlace (secondary) features.

(30) [round] dissimilation: Berber

```
a     m                    g^w  r   a      →     amgra
      |                    |
    Place                 Place
      |\                   |\
    Lab  VPlace           Dor  VPlace
           |                     ǂ
        [round]               [round]
```

Selkirk poses a question in relation to these facts: why is it that the secondary rounding of the dorsal consonant is lost rather than the primary labiality of the nasal? In inherent VPlace theory, all C-V interaction is via VPlace features; hence, the distinctive [round] of the dorsal cannot interact with the CPlace Labial, and so cannot trigger delinking of that feature.[7]

Berber demonstrates that both distinctive and inherent instances of a feature can be active in the phonology of a language, and furthermore can interact. Given the consonant inventory of the language, shown below, we expect this result. [round] is distinctive in Berber only among dorsal segments:

(31) Consonant Inventory of Tashlhiyt Berber

Labial:	b, f, m
Coronal:	t, d, s, z, š, ž, n, l, r, and their pharyngealized counterparts
Dorsal:	k, g, x, ɣ, q, k^w, g^w, x^w, $ɣ^w$, q^w

Since the labial consonants do not have rounded counterparts, inherent [round] can be active in the phonology.

There is an interesting question implicit in the previous claim: what role can there be for inherent [round] in a language with both plain and rounded labial consonants? In fact, there can be no place for inherent [round] in the phonology of such a language, since such a role is inconsistent with the hypothesized contrast. A defining characteristic of any redundant feature, including inherent VPlace features, is its predictability. This predictability is encoded by means of the familiar redundancy rules of generative phonology. Therefore, behind the notion 'inherent [round]' is the rule Labial → [round], a rule that states an untruth about a language with distinctively rounded (and unrounded) labials. In the absence of such a rule, there is no redundant feature assignment - no inherent [round].[8]

Similarly, in a language with distinctive palatalization (represented say by [-back] (and perhaps [+high])) we do not expect to find fronting (and raising) of vowels around plain coronals, segments which could normally be redundantly specified for these features. More generally, inherent VPlace theory predicts the absence of Type II interactions where the VPlace feature involved is already distinctive for the relevant consonant(s). For the cases we

---

[7]There are further questions regarding this illustrative example that we do not address. As Selkirk notes, for example, the plain labial does not interact with *w* or rounded vowels (though such interactions *among* such VPlace features are rife). Like Selkirk, we must therefore explain why the deleting VPlace feature must be associated to an obstruent segment. R. Armin Mester (p.c.) suggests that a constraint against the loss of all place feature material is at work, a constraint that must 'outrank' the OCP, in the terminology of Prince and Smolensky (1993) (see Itô and Mester (1993a) on 'headedness' of a segment). Further, we must stipulate the order of the segments, since e.g. $g^w m$ occurs. The strict adjacency requirement on this OCP effect deserves more investigation; see §5.2.

[8]Of course, if [round] is a binary feature, then plain labials in such a language are [-round], and the point is even clearer.

are familiar with, this prediction seems borne out; to the extent that this remains true, it is an argument for inherent VPlace.[9]

4.1.2 Inherent VPlace and Underspecification: Turkish Labial Attraction

Inherent VPlace theory is in its essence dependent on notions of feature redundancy and underspecification, and so we must give some attention to these issues. To a large extent our claims in this area are hardly controversial; rather they simply follow widely-held views. However, there are some rather suprising implications, as we will see.

Underspecification theory in any guise - i.e. radical (Kiparsky 1982, Archangeli 1984, inter alia), contrastive (Clements 1988, Steriade 1987b, Mester and Itô 1989), or other - attempts to reconcile facts like the following, speaking quite broadly: on the one hand, redundant features are often inactive in languages. On the other hand, they are not always inactive. Further, though their activity is often seen to be confined to 'late' levels of the phonology, (culminating in a phonetic representation in which many redundant features may be specified), sometimes redundant features play a role 'early' in the derivation or even underlyingly. (On this last claim see most recently Archangeli and Pulleyblank in press).

In passing we note that the involvement of redundant features in Type II effects might help explain why such effects appear to be significantly less common across languages than Type I effects, the latter including e.g. the interaction of vowels and glides (for a small language survey highlighting this discrepancy, see Maddieson and Precoda 1992). They are

[9] One apparent counterexample we know of involves a seemingly phonetic process. Short vowels in Irish assimilate to the distinctive secondary [back] of an adjacent consonant (Ó Siadhail & Wigger 1975, Ní Chiosáin 1992). In the case of short low vowels **flanked** by consonants, front *æ* occurs in C'_C' (C' is palatalized); central *a* occurs in C_C. In the mixed environment C__C' the plain preceding consonant also becomes relevant: where it is coronal, we find the front variant *æ*, e.g. *dæŋ'ən* 'tight', *kræk'ən* 'skin'; where it is labial or dorsal, we find central *a*, e.g. *ban'i* 'milk', *kan't'* 'talk'. (Data from the western dialect; see also de Bhaldraithe 1945). Given distinctive palatalization, assumed here to be [-back, (+high)], then (redundant) [-back] on coronals should not be phonologically active. However, the two-sided environment required (compare also *dat* 'swelled' vs. *dæt'i* 'coloured', showing that the following palatalization is crucial) has no obvious phonological characterization in any case; on the other hand, it finds a natural account as a matter of phonetics: given C_1VC_2, properties of the vowel may well be influenced by the C_1-C_2 transition. In fact, this C-V interaction occurs postlexically (compare *dat* 'swelled' to *dæt' s'e* 'it swelled'), suggesting that it is indeed late-level. Other examples of two-sided environments as phonetic processes: in Japanese, high vowels devoice when both preceded and followed by voiceless consonants, a process characterized by Jun and Beckman (1993) in phonetic terms. Ponapean vowel coloring similarly depends on consonants on both sides, and according to the description of Rehg and Sohl (1981) involves the sort of gradient/partial implementation typical of phonetic processes.

less common, we might suppose, for the same reason that assimilations involving sonorant voicing are less common than those involving obstruent voicing - sonorant voicing tends to be inactive early in (and often throughout) the derivation.

As a means of exploring the question of inherent VPlace (under)specification, consider a typical case of vowel-to-vowel rounding harmony, in which labial consonants (like other consonants) are transparent to the spreading. As shown below, the spreading of [round] is possible only if no inherent [round] is specified on the intervening labial consonant:

(32) Consonantal transparency: inactive inherent feature

```
   V        C        V
 Place    Place    Place
   |        |        |
 VPlace    Lab     VPlace
   |_ _ _ _ _ _ _ _ _/
[round]
```

Given underspecification theory, the typical absence of this feature is what we should expect, at least for rules that are 'early' or 'lexical' etc., and so consonant transparency to vowel harmony - the usual scenario - is also expected.

Languages evincing Type II effects, then, are those in which inherent VPlace features are instead active at some stage. Now what of languages with Type II effects **and** vowel harmony involving the relevant feature(s)? If inherent features are active, can vowel harmony obtain? Unless vowel harmony precedes inherent feature activity, spreading from vowel to vowel should be blocked:

(33) Blocking: active inherent feature

```
 Place    Place    Place
   |        |        |
 VPlace    Lab     VPlace
   |_ _ -||- - |
[round]  [round]
```

However, there are other possibilities to consider. First, it might happen that harmony is simply triggered by either a vowel or a plain consonant - and so [round] might spread from the consonant in (33), if it is active.[10]

Nevertheless, we must allow for the possibility of spreading triggered only by vowels (involving distinctive [round]), or only by plain consonants (involving inherent [round]), and

[10]Tulu (Bright 1972), a Dravidian language, might offer such a case (though more examination is required, see Selkirk 1993, note 49), since next to cases like *morod-i* → *morod-u* 'empty (acc.)', derived by vowel-to-vowel spreading, we have Type II *kapp-i* → *kapp-u* 'blackness (acc.)', where spreading is said to be from the consonant. For analyses and discussion see Sagey (1986), Selkirk (1988, 1993), Odden (1991).

therefore we must allow for the possibility of two such different rules coexisting. Again, where there is evidence for the derivational precedence of inherent specification, do we predict that consonants must be blockers of vowel harmony? The answer to this question is more complex than it might seem, as argued in recent work by Itô, Mester and Padgett (1993). Borrowing from this work, we pursue further the analysis involving [round] in Turkish. For more complete discussion and justification of the analysis we refer the reader to the work cited.

Turkish is well-known for its rounding harmony, by which high vowels agree in this feature with a vowel to the left (Zimmer 1969, Lightner 1972, Clements and Sezer 1982). Examples of roots showing agreement in [round] are given below:

(34)	somun	'loaf'
	öküz	'ox'
	iyi	'good'
	adɨm	'step'

We include the vowel inventory of Turkish in (35), according to [round] specification:

(35) Turkish vowel inventory

Round:	ü, u, ö, o
Unround:	i, ɨ, e, a

Harmony is then a rule spreading [round] rightward from vowel to vowel:

(36)

```
s  o  m  V  n
   |
[round]
```

somun 'loaf'

Turkish roots also undergo the rule of 'Labial Attraction' seen earlier (Lees 1961, Lightner 1972): recall that within a root, labial consonants trigger the rounding of a following high back vowel if preceded by *a*. The examples are repeated below. Notice that Labial Attraction takes precedence over harmony, since the resulting forms are disharmonic in [round] (compare *adɨm* 'step'):[11]

[11]Clements and Sezer (1982) treat roots as essentially exceptions to both vowel harmony and Labial Attraction, since there are many (originally borrowed) forms that do not obey one or the other. Instead we take them to be living generalizations over the relevant subpart of the vocabulary. For discussion of this issue, and of the precise conditions on Labial Attraction (which do not affect the argument here) see Itô, Mester and Padgett (1993).

(37) **armud** 'pear'
kabuk 'rind'
karpuz 'watermelon'
yavru 'cub, chick'
samsun 'mastiff'
avlu 'courtyard'

The notion of redundant features involved in constraints on the form of morphemes is in itself not surprising; an analogous example (discussed in Itô, Mester and Padgett) is seen in a constraint requiring obstruents after nasals to be voiced in morphemes in Yamato Japanese - though nasal voicing is redundant.

More intriguing, however, are the relative roles of Labial Attraction and rounding harmony. Labial consonants, it turns out, **must** be transparent to harmony in many forms we have not yet considered: harmony affects front vowels as well as back, while Labial Attraction targets only back vowels, as seen above; compare the form *taviz* 'concession' with a front unrounded vowel after the labial. Consider then roots like *kömür* 'charcoal', and *köprü* 'bridge': rounding in (front) *ü* can only have come from the previous vowel - though it spans a labial consonant.

The seemingly paradoxical conclusion is that inherent round is active only for those labials involved in Labial Attraction; compare (38)a to (38)b and c.

(38) Inherent VPlace No Inherent VPlace

```
a. y a v r u          b. t a v i z     c. k ö p r ü
       \ /                                    \   /
      [rnd]                                   [rnd]
```

Itô, Mester and Padgett (1993) discuss a paradox involving the nasal voicing in Yamato Japanese mentioned above, one that is parallel in all relevant respects - voicing is present only in nasals that trigger post-nasal voicing, and not in other nasals. They propose an account for such paradoxes cast in the recent Optimality Theory framework of Prince and Smolensky (1993), cf. McCarthy and Prince (1993). For our purposes here the crucial proposal is that redundant features are present in just the segments triggering assimilation, in both Turkish and Japanese, because they are *licensed* by the **target** segment. That is, it is the double linking itself in (39)a that allows the labial to bear [round], because the feature is licensed by the vowel (which crucially can bear such a feature contrastively). There is no licenser in (39)b - [round] is redundant in labials - and so [round] must be absent. This use of licensing parallels that seen to explain the behavior of codas in Japanese and other languages, following Itô (1986, 1989), Goldsmith (1990) and Lombardi (1991).

(39) Licensed [round] Unlicensed [round]

```
a.     p     u            b.     *p
        \   /                     |
       [round]                 [round]
```

The important conclusion for our purposes is that the existence of a Type II effect in a language is no evidence for the presence of inherent features in all consonants of the relevant class - it is evidence only for inherent features in the consonants that actually spread the feature. This scenario, not predicted by any usual assumptions about feature fill-in, must be borne in mind when the question of inherent feature behavior is addressed.

4.2 Motivating Inherent VPlace Theory: Asymmetries in Inventories and Assimilations

To this point, inherent VPlace theory has been based on the following reasoning: given the separation of CPlace and VPlace features, there is no obvious account for Type II C-V interactions; one can be found if we a) allow C-V interaction only within VPlace tiers, and b) explain Type II interactions by means of inherent VPlace. In this section, we motivate the constraint in a). As we will see, inherent VPlace theory correctly predicts some fundamental asymmetries in both segment types and assimilation processes. In fact, the major argument for the theory lies in its ability to address these cross-linguistic facts.

4.2.1 Gaps in Segment Types

We begin with the following fact about segment inventories: possible segment types include consonants, vowels and consonants with distinctive secondary vocalic articulations (the latter denoted by C^V); however, there seem to be no vowels with 'secondary consonantal articulations' (V^C):

(40) Types of Segment in Language

a. C c. C^V
b. V d. V^C ???

'V^C', a logical possibility, in fact has not been a category recognized by phonologists.[12] This gap in the inventory of possible segment types is entirely expected, as we will see.

From a functional point of view, we might say that the contrast C^V versus V^C is not possible due to the nature of consonants and vowels themselves. A superimposed vocalic articulation is consistent with basic consonantality, since in any case a consonantal articulation begins and/or ends with a constriction that is less than consonantal, i.e. one that is vocalic. On the other hand, a vowel with a consonantal constriction, and with the resulting change in the nature of the airflow, is by definition no longer a vowel. This is a particular instance of the 'bottleneck effect': the nature of a flowing system is determined by the place of greatest constriction (cf. the discussion of 'tube geometry' in Browman and Goldstein 1989). From this perspective, a C^V versus V^C contrast can have no meaning.

We must therefore ensure that our representations posit no such contrast. In fact, the absence of such a contrast is already implicit in VPlace theory: what it means to be a CPlace feature (and thus directly under Place) is to be a consonantal constriction, while to be a VPlace feature is to be a vocalic constriction. Thus, (41)a can only be a consonant (with or without a secondary VPlace specification); a vowel must be as in (41)b, bearing no CPlace feature.

(41) a. CPlace entails C b. V entails no CPlace

```
   Root                    Root
    |                       |
   Place                   Place
   /   \                    |
  X   (VPlace)             VPlace
         |                  |
         Y                  Z
```

There is therefore some redundancy in the theory, since the feature [consonantal] can be defined structurally, as Hume (1992) notes.

---

[12]Though see Clements (to appear), who argues that (40)d exists, and employs it to distinguish two front rounded vowels of Swedish. Hume (1992:130) tentatively suggests the same, though for different reasons. We discuss the assumptions on which these claims are made in §5. These cases merit further investigation (see Selkirk 1993 and references therein for alternative analyses of Swedish). We of course do not deny the existence of syllabic nuclei of consonantal stricture - we discuss such cases from Bantu later. It is a **further** distinction involving vowels with a CPlace articulation that we are questioning.

4.2.2 Gaps in Assimilation Processes

We are now in a position to motivate our assertion that C-V interactions occur only via VPlace features. Consider the logically possible interactions involving place features illustrated below.

(42) C-V interaction must be within VPlace

```
            C                  V
            |                  |
          Place              Place
           /|                  |
          / X    <--?-->       |
         /                     |
   VPlace                   VPlace
     |                         |
     Y      <-------->         Z
```

VPlace features can of course interact, and Type I C-V interactions (represented by interacting Y and Z) are relevant instances. On the other hand, what interactions are possible on CPlace tiers, the only other locus of interaction? Vowels have no features on these tiers and so are incapable of affecting CPlace features directly. We focus below on this result, which entails important empirical predictions.

As for the reverse possibility of a CPlace feature spreading from consonant to vowel, such spreading is structurally possible, but presumably highly disfavored in terms of syllable wellformedness. To see this, consider the resulting representation, illustrated in (43). Spreading of CPlace to a vocalic syllable nucleus derives a consonantal nucleus. The precise nature of the consonant derived is unclear: first, if the feature [cont] spreads as well, following Padgett (1991a) (see §5.3), then the syllable nucleus and margin are of identical oral stricture; second, the nucleus may or may not remain [+sonorant]. However, some possible outcomes are indicated, organized according to the identity of C. We ignore the fate of the VPlace features, which are now secondary, if present:

(43) Vowel acquires CPlace ([+consonantal]) feature ('Art' = articulator)

```
   C         i       →   ???   pp̩,pb̩,bb̩,pf̩,pm̩...
   |         |                 tt̩,td̩,dd̩,ts̩,tn̩,tl̩,tr̩...
 Place     Place               mm̩...
   | _ - - - |                 nn̩,nl̩,nr̩...
  Art      VPlace              ll̩,lr̩...
(-cont)     /  \               ss̩,sz̩,sl̩,sr̩...
        [-bk]  [+hi]
```

Even the most likely-seeming sequences, like *tl̩*, *tn̩*, *pm̩* (e.g. English *bottle*, *button*, etc) are nevertheless quite restricted in occurrence, in terms of both languages of occurrence and distribution within languages. Viewed in terms of these outcomes, then, spreading of CPlace to vowels is at best a highly marked possibility. In fact, we know of no process conforming to (43). It may well be that there are other considerations at play here; thus, Bell (1978) (who notes that syllabic consonants originate mainly from reduced vowels) concludes from his survey that syllables containing consonantal nuclei disfavor margins. Therefore spreading as in (43), if C is a marginal consonant, is plausibly even further disfavored. In any case, note that this issue is about stricture, and not about place interactions per se: consonants do not spread only their [-continuant] values to a syllable nucleus either. Thus this particular issue transcends inherent VPlace theory.

Putting aside this last concern, our conclusion is that C-V interaction is confined to VPlace tiers. Let us therefore return to the fundamental prediction that inherent VPlace theory makes about C-V interaction: though consonants and vowels can interact via VPlace, vowels cannot interact with the CPlace of a consonant, since they have no CPlace features themselves. Here, and in the remaining subsections, we explore this prediction in some detail.

We have seen Type I assimilations from vowel to consonant (Japanese) and from consonant to vowel (Abaza). We have also seen Type II assimilations, by definition from consonant to vowel. However, our contention is that there are no assimilations from vowel to consonant, displacing the consonantal articulator, as depicted below, ignoring structural considerations. For the sake of the argument, we assume for the moment a set of place features that is unified for consonants and vowels, anticipating discussion in §5. Thus roughly the following equivalences hold (e.g. Clements to appear, Selkirk 1991a): Labial = [round], Coronal = [-back, (+high)], Dorsal = [+back, (+high)], Pharyngeal = [+low, (+back)].

(44) Vowel-to-Consonant Spreading

```
f         i         ⇒  si
ǂ- - - - -|
Labial   Coronal
```

Other outcomes besides *si* are imaginable, for example *ši*; we abstract away from this issue, since it does not affect our basic point.

There are no genuine processes involving such vowel to consonant spreading, we hold; there are no *su* → *fu*, *fi* → *si*, and in fact none of the processes imagined below, alternations we might expect to find if vowels could cause a gross shift in the place of a consonant:

(45) Consonant Major Place Displace by Vowel

a. Labial displaced:	fi → si,	fɯ → xɯ,	fa → ħa
b. Coronal:	su → fu,	sɯ → xɯ,	sa → ħa
c. Dorsal:	xu → fu,	xi → si,	xa → ħa
d. Pharyngeal:	ħu → fu,	ħi → si,	ħɯ → xɯ

In each of the hypothetical cases shown, the consonant acquires the major place of the vowel, becoming coronal preceding a coronal vowel, labial preceding a labial vowel, etc. In fact, such alternations are strikingly underattested.

Inherent VPlace succeeds not only in accounting for Type II interactions; just as important, it correctly rules out processes like *su* → *fu*, *fi* → *si* and *sa* → *ha*, processes we claim should have no status within the theory. Vowels cannot cause a shift in major place in a consonant, simply because they have no features with which to do so - no CPlace features. This prediction of inherent VPlace theory intersects in an interesting way with various empirical and theoretical domains, including the treatment of certain well-known facts of Bantu, and the representation of palatalization in feature theory. Before addressing these areas, we briefly discuss the status of seemingly relevant historical data.

4.2.3 Historical Changes

It is not difficult to find instances of historical change in the place of articulation of a consonant, due to an adjacent vowel. Thus, for example, in various unrelated languages labial consonants followed by a palatal glide emerge at some later time as coronals, a change discussed by e.g. Ohala (1978). Consider the Latin words given below, in comparison with their modern French descendents (data from Ohala):

(46)

Latin	French		
sapius	sage	[saʒ]	'wise'
rubeus	rouge	[ʁuʒ]	'red'
rabies	rage	[ʁaʒ]	'rabid'
cavea	cage	[kaʒ]	'cave'

In the languages Ohala discusses, the triggering element is a glide and not a vowel (in the case here examined, this would be true of a period later than that of Classical Latin). Glides are of course in some sense more consonantal than vowels, and their precise representation in feature theory is not clear (a well-known point we touch on in the conclusion). However, for the purposes of this discussion we assume that *y* is identical to *i* in melodic respects. Therefore changes noted by Ohala like *py* → *t/ts/tš/s/š* seem to involve a vowel displacing the major place of a consonant. In inherent VPlace theory there is no way vowels can cause such a change directly, since they have no CPlace features:

(47)

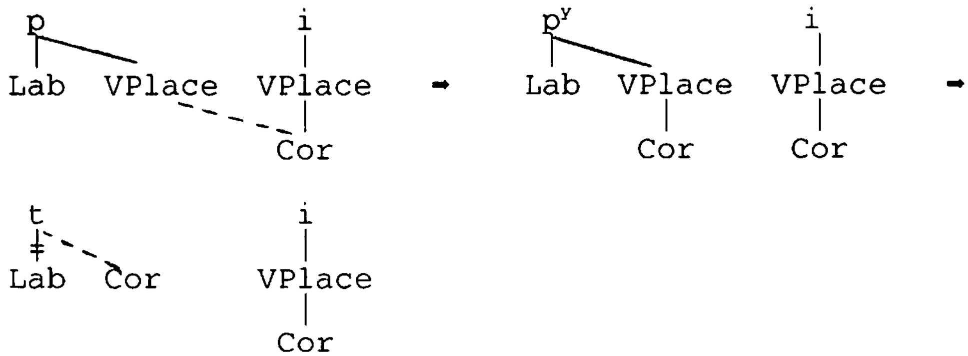
```
 p           y
 |    ??     |
Lab        VPlace
           /    \
       [-bk]  [+hi]
```

One can find similar historical changes involving other places of articulation (see Clements to appear, Calabrese 1992, among others).

In fact, the extension of feature geometry theory to account for such historical data seems inappropriate. Though fairly common, they notably fail to lead to synchronic alternations; thus, there is no *p* ~ *ʒ* alternation in French. This consideration argues against a conflation of historical and synchronic theory, since the synchronic gap is otherwise completely mysterious.

As a further consideration, changes like *pi* → *tsi/si* etc. may involve a sequence of intermediate stages, involving e.g. aspiration, affrication, and/or multiple articulation (see for example the posited Bantu sequence in (50) below). Even if we were to give feature geometric accounts for the historical facts, then, they are likely to require a somewhat indirect characterization, unlike the single node spreading synchronic rules we have seen so far. On this note, Clements (to appear:fn 5), assuming a theory of unified place features, suggests deriving similar historical changes as follows:

(48) VPlace spread + 'promotion'



That is, simple palatalization is followed (or accompanied) by a 'mitosis' of Coronal, and 'promotion' of the VPlace Coronal node of the consonant to CPlace status. (The delinking of Labial can be seen as an automatic consequence of this last step, if multiple CPlace specifications are not allowed). Whether such a formulation should be possible, and whether it is an appropriate characterization of either synchronic or historical data, is a question we leave open.

With these issues in mind, the best strategy, in our view, is to restrict attention to synchronic data for the time being, and to leave the relation between synchronic and historical theory to later research, conducted from a more secure perspective.

4.2.4 Bantu

Bantu languages provide interesting proving ground for inherent VPlace theory, because they widely evince synchronic alternations like those in (49), appearing to contradict the claim that vowels do not displace the CPlace features of consonants. As we will see, however, Bantu in fact yields surprising support for the theory: the 'vowels' in question are actually consonants. For discussion of these cases we rely on Ohala (1978), Hyman (1976, 1991), Zoll (1993), and references therein.

The mutations shown below reflect a pattern typical across Bantu languages (Zoll 1993, Hinnebusch and Nurse 1981):

(49) Characteristic consonantal mutations in Bantu

		Before *i*	Before *u*
p/b	→	f/v	f/v
t/d	→	s/z	f/v
k/g	→	s/z	f/v

Before the high vowels *i* and *u*, stop consonants typically spirantize, and acquire the place of articulation of the vowel. According to Zoll (who relies on Guthrie 1967/71 and Bastin 1986), labials most typically resist the change in place (hence the simple spirantization indicated), though there are examples of labial to coronal as well. Further, (49) is somewhat schematic, since there are less typical outputs found among the wide range of languages. For example, before *i*, *p* becomes *f*, *pf*, *v*, *s*, *š*, *θ*, *ps*, p^h, *h*, *sw*, and *tswh*, among other possibilities. In any case, for all stop consonants we find cases involving a shift in major place before the vowel.

Hyman (1976) suggests a chain of minimal steps that could have led to the overall historical shift; the posited steps are supported by languages with forms at the relevant stage today. Again for *p*:

(50)

$$\begin{tikzcd} \mathrm{pi} \arrow[r] & \mathrm{p^hi} \arrow[r] \arrow[d] & \mathrm{p^si} \arrow[r] & \mathrm{t^si} \arrow[r] & \mathrm{si} \\ & {} \arrow[r] & \mathrm{p^fi} \arrow[r] & \mathrm{fi} & \end{tikzcd}$$

Synchronically, throughout Bantu, the (telescoped) results *pi* → *si*, *ku* → *fu*, etc. survive only under a few morphological conditions, including before reflexes of a causative suffix, as seen in the Cibemba data exemplified below. (Hyman 1991:4; *s* will palatalize to *š* by a separate rule):

(51) Cibemba consonant mutations before causative *-i-*

-leep-	→	-leef-i-	'lengthen'
-lub-	→	-luf-i-	'lose'
-fiit-	→	-fiis-i-	'darken'
-ónd-	→	-óns-i-	'make slim'
-lil-	→	-lis-i-	'make cry'
-buuk-	→	-buus-i-	'get [s.o.] up'
-lúng-	→	-lúns-i-	'make hunt'

In some cases, the phonological conditioning has become so opaque, or the rule so 'quirky' in other respects that the process would seem to defy a phonological (as opposed to morpho-lexical) account, as when labials 'palatalize' to palato-alveolars before the passive suffix *-wa* in Zulu, shown in (52) (Ohala 1978, Beckman to appear and references therein). Observe that the (highlighted) target segment can even be distant from the triggering suffix (though not root-initial), as in (52)b.[13]

(52) Zulu consonant mutations before passive *-wa*

a.	ɓop^{h}a	'tie!'	→	iyaɓošwa	'it is being tied'
	guba	'dig!'	→	ayagujwa	'it is being dug'
	luma	'bite!'	→	uwiyalunwa	'he is being bitten'
b.	ɓop^{h}a	'tie'	→	uyaɓošiswa	'he is being made to tie'

Clements (1985) discusses other highly morphologized and complex data from Chi-Mwi:ni Swahili, another case of Bantu consonant mutation, and concludes that such data should not inform our fundamental conceptions of feature geometry. Still, on the whole the Bantu mutations are quite pervasive and systematic; and on the surface, they appear to challenge inherent VPlace theory.

Further consideration leads to the opposite conclusion, and Bantu instead provides another argument for inherent VPlace. Observe, first, that consonantal mutations occur before only some instances of *i/u*; there are no mutations before the applicative *-il-*, for example. Hyman (1991) gives the following additional Cibemba forms:

(53) No mutation before Cibemba applicative *-il-*

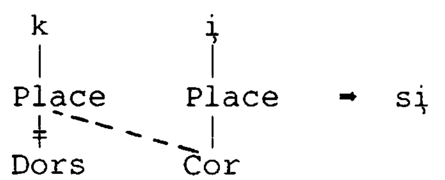
-sit-	→	-sit-il-	'buy for/at'
-fúl-	→	-fúl-il-	'forge for/at'
-kak-	→	-kak-il-	'tie for/at'

Underlying the difference between this suffix and the causative suffix is an important fact about Proto-Bantu: this language distinguished the high vowels *i/u* from so-called 'super-closed' vowels *į/ų*. The latter, according to Hyman (1976:412), "are supposed to have been noisy or strident[.]" Mutations in Cibemba are triggered only by reflexes of the super-closed vowels; that is, consonant place was displaced only by those 'vowels' that were themselves consonantal in stricture. Further, the surveys of Guthrie (1967) and Zoll (1993) demonstrate that this correlation holds across all of Bantu.

[13]Beckman (to appear) however succeeds in giving an interesting phonological account of Zulu that relies not on any notion of palatalization or assimilation, but on a posited dissimilation between the stem labial and the suffix *w*.

Since the mutations were derived, the distinction between high and super-closed vowels has been neutralized in favor of normal high vowels across Bantu. However, a phonological account of the synchronic facts must still distinguish triggering vowels from the non-triggering somehow. Former super-closed vowels differ not only in conditioning mutation; they also typically fail to undergo a height harmony that affects the other high vowels. Hyman (1991) pursues an account for Cibemba in which the former super-closed vowels are specified underlyingly as [+high], while other high vowels are unspecified. Zoll (1993) advocates a different approach, one that appeals more directly to strictural concerns: triggering vowels, unlike other high vowels, have the stricture of continuant consonants underlyingly (a distinction neutralized later). Under this latter interpretation, the representation of mutations becomes straightforward: all interactions are within CPlace tiers; that is, superclosed *į/ų* are syllabic consonants, and we actually have consonant-consonant interaction (note that *į* is given a CPlace representation):

(54) Bantu mutations as consonant-consonant interaction



Zoll further draws attention to the fricativization typically seen under mutation, noting that mutations in place entail the change in stricture as well, and explains this fact assuming the articulator group of Padgett (1991a, to appear), which groups oral stricture and articulator features together (see §5.3 below).

Consider the significance of these facts: inherent VPlace theory entails that vowels cannot target the CPlace feature of a consonant. Bantu mutations stand out in the empirical domain for appearing to contradict this claim in a robust way (i.e. across the language family). In our view it is no coincidence, then, that the triggering 'vowels' are not in fact vowels, but consonants: the mutations take place entirely within CPlace tiers. Thus, Bantu represents a further argument for inherent VPlace theory.

If some apparent counterexamples to inherent VPlace theory reduce to cases of interaction within CPlace, we might speculate about the possible existence of a complementary phenomenon: apparent counterexamples that should be treated as interaction within VPlace. Consider the Cantonese forms given below, analyzed by Yip (1993).

(55) Onset filling in Cantonese

a.	i	→	yi	'two'
	un	→	wun	'bowl'
	ü	→	yü	'fish'
	ɪŋ	→	yɪŋ	'eagle'

b. ɔ	→	ŋɔ	'I/me'
ak saw	→	ŋak saw	'shake hands'
ow	→	ŋow	'shake'

Underlyingly onsetless syllables surface with an onset, the nature of which is determined by the following vowel. This conditioning is transparent in (55)a, where spreading has occurred to satisfy onset position. Yip argues that the (at first mysteriously different) forms in (55)b can be seen as phonologically the same: these latter forms also have glides (in this case low and back) as onsets phonologically. The nasality is simply a result of phonetic implementation, which enforces near closure during implementation, as required for an onset. While for high vowels, near closure is achieved by accentuating tongue raising, for low vowels the soft palate is lowered towards the tongue body, rather than the reverse occurring; nasality is then a side-effect of this means of constriction. (The reverse is said to occur in Mandarin, i.e. tongue backing/raising toward the soft palate, deriving a glide of roughly uvular or pharyngeal place, according to Yip, who cites Pulleyblank 1992). For completeness we note that mid front vowels, when underlyingly onsetless (a rare occurrence), surface with a glottal stop onset.[14]

The point of this discussion is the following: if the nasal onsets were viewed as phonologically epenthetic consonants receiving place (velarity) from the following vowel, we would have a rule such as in (56)a (backness is treated as dorsality for the sake of discussion). Such a rule contradicts our assertion that vowels do not manipulate CPlace features. Instead, if Yip is correct, linking is simply as in (56)b, within VPlace. *ŋ* then denotes a nasalized implementation of the glide.[15]

[14]John McCarthy (p.c.) points out a possible reinterpretation of the Cantonese phenomenon: low back glides/margins are not in fact on a par phonologically with high glides; witness the facts of Berber, in which *a* is the only segment that cannot be a margin (Dell and Elmedlaoui 1985, 1988, Prince and Smolensky 1993), or Axininca Campa, in which the glide equivalent of *a* is uniquely unstable (Black 1991, McCarthy and Prince 1993, references therein). The nasal realization of the derived low back glide could be viewed as the result of a substantive constraint (i.e. marking condition) in the phonology against such segments, and not simply a matter of implementation.

[15]The actual resulting degree of closure is unclear. Though consonantal *ŋ* is transcribed, this segment is notoriously difficult to distinguish from a nasalized low/back glide, both phonetically (Ohala 1975) and in its phonological behaviour (Trigo 1988).

```
(56)  a.  ŋ          a             b.  ʕ          a

      Place     Place              Place      Place
         `----.  |                   |          |
                Dors               VPlace     VPlace
                                       \       /
                                       [+back]
```

Indeed, under Yip's account the linking might conceivably occur as high as the segment (Root) level (though *ŋ* is transcribed regardless of which back vowel follows). In any case, despite the transcription, there are no CPlace features involved.[16]

4.2.5 Palatalization

No exploration of the nature of C-V interaction can omit discussion of palatalization across languages. This area has received a great deal of attention in recent work, and has formed the basis of many competing proposals in feature theory. These proposals have largely attempted to establish a basis for palatalization facts, such as a claimed 'coronal bias', in terms of properties of the geometry. Such an approach is not only inconsistent with inherent VPlace theory, and therefore with the facts that motivate this theory, but should be disfavored on independent grounds. The latter involve the failure of strictly formal (structure-based) theories to capture some familiar lexical-phonological correlations characterizing palatalization. In contrast to the formal view, then, we advocate a substantive (constraint-based) one, treating facts of palatalization by means of feature cooccurrence (marking) conditions.

Let us begin by recalling the facts of Japanese noted in §3, repeated here:

(57)	a. hakob-u	'carry' (pres.)	b.	hakob^y-i
	tatak-u	'hit'		tatak^y-i
	kat-e	'win' (imper.)		kač-i

[16]Dell (to appear) reports a type of assimilation in another Chinese dialect (Fujian), in which syllabic nasals assimilate in place to a following vowel (otherwise the preceding vowel, if there is no following one), giving *n* before front vowels and *ŋ* before back vowels. We might similarly view the syllabic nasals as essentially vocalic. However, they assimilate in place to consonants as well. According to what we have said (and to the articulator group of Padgett 1991a, to appear), linking must be entirely vocalic in the former cases and consonantal in the latter. This is just the behavior attributed to the 'mora nasal' of Japanese (Vance 1987); see Trigo (1988) and Padgett (1991a) for similar cases. If this is right for Fujian, the nasal might be viewed as basically placeless underlyingly (when there is no conditioning segment, the nasal surfaces as *n*), receiving place and stricture from a neighboring segment.

The palatalization seen in (57)b involves the superimposition of a vocalic secondary articulation on the consonant, due to spreading from the following vowel. Such palatalizations are common in languages (see e.g. Bhat 1978, Maddieson 1984). We represent the derived segments in Japanese as follows (on the realization of t^y as $\check{c}$ see below):

(58) Palatalization as secondary VPlace articulation

```
     pʸ              tʸ=č             kʸ
     |                |               |
   Place            Place           Place
   /   \            /   \           /   \
 Lab VPlace       Cor VPlace      Dor VPlace
      /   \            /   \           /   \
    -bk   +hi        -bk   +hi       -bk   +hi
```

This view, which directly captures the assimilatory nature of palatalization, is in the spirit of much work since the advent of feature theory.

However, there are questions regarding the properties of palatalization across languages that (58) does not address. First, why are coronals and dorsals more susceptible to palatalization in languages than are labials (see e.g. Bhat 1978).[17] That is, why are there languages in which coronals and/or dorsals palatalize but labials do not (for example Cibemba, Hyman 1991)? Second, why do palatalized consonants sometimes undergo a change in place of articulation, e.g. $t^y, k^y \rightarrow \check{c}$ (e.g. Russian, Lightner 1972, and see again Bhat 1978)? This second point is the most pressing for us, since it is another apparent instance of consonant major place displacement by a vowel, something ruled out by inherent VPlace theory. As we will see, a familiar notion of substantive constraints on feature cooccurrence can shed light on both issues.

Consider the susceptibility of dorsals and coronals to palatalization: such facts have been taken to argue alternatively for a view of palatalization as either 'coronalization' or 'dorsalization'. For example, if palatalization involves the imposition of a Dorsal node, with e.g. dependent [-back, +high] (Sagey 1986, Halle 1986), then palatalized dorsals are simpler than other palatalized segments - the latter have both a primary and a Dorsal component, compare (59)a and b. On the other hand, if palatalization is the imposition of Coronal (Mester and Itô 1989, Clements to appear, Lahiri and Evers 1991, Broselow and Niyondagara 1991 and references therein), and perhaps dependent [-ant], then palatalized coronals are simplest, compare (59)c and d. The claim implicit in both approaches is that the susceptibility of a segment to palatalization is determined by the simplicity of the outcome. In inherent VPlace theory, on the other hand, palatalization of any segment involves the spreading of VPlace; hence, no conclusions based on simplicity of structure can be drawn.

[17]If this is even true. Compare the synchronic count of Maddieson (1984:38), by which labials are palatalized as often as coronals. Bhat's survey includes many historical changes.

(59) Comparative simplicity of palatalized segments

```
     'Dorsalization'               'Coronalization'

a.    kʸ      b.     tʸ        c.    tʸ      d.     kʸ
      |             / \              |             / \
     Dor         Cor   Dor          Cor         Dor   Cor
```

However, there is little reason to view coronals as crucially more susceptible than dorsals, or vice versa, given the facts known. (On this see Calabrese 1992, and the surveys in Bhat 1978 and Maddieson 1984). Therefore we might reasonably doubt this sort of justification for either the 'coronalization' or 'dorsalization' view - the two of which are of course themselves in competition.[18] If this is correct, then the tendency of the features [+high, -back] to target coronals and dorsals must be attributed to notions extrinsic to the geometry.

The obvious place to look is towards conditions on feature cooccurrence (Kiparsky 1985, Archangeli and Pulleyblank 1986, inter alia), conditions that no doubt have some substantive basis in notions of phonetic naturalness. Archangeli and Pulleyblank (in press) develop an articulated theory of such 'grounded' constraints and their relation to facts of markedness, elucidating, for example, the tendency for [+ATR] to favor high vowels over mid and (especially) low. In fact, serious consideration of the issue leaves little doubt: any theory must adjudicate between formal and substantive conditions - there is scant hope in confining explanations to the former. Feature cooccurrences tendencies and preferences are rife in language: to cite just one unrelated example, ejectives are more likely to be velar than labial (Maddieson 1984); if current theories are correct in representing the features [+constricted glottis] and Dorsal independently, such a fact must clearly be given a substantive account.

Now consider the second point: changes in place induced by palatalization, like $t^y, k^y \rightarrow \check{c}$ or (more drastically) $k^y \rightarrow ts/s$, etc. Various researchers have noted the typical triggers of palatalization - front vowels and glides - and the frequent coronal outcome, and concluded that coronals and front vowels must share the feature Coronal, in order to more fully express the assimilatory nature of the rule (Clements 1976, and the references on 'coronalization cited above). Such approaches can account for place shift under palatalization in a direct way:

[18]Some hybrid solutions are then imaginable, as when palatalization is seen to crucially involve **both** Coronal and Dorsal in some sense (Szpyra 1991, Zec 1992), or employing a node 'Tongue' that dominates just these features (Browman and Goldstein 1989, cf. Zoll 1993). Such proposals still do not address the major concerns outlined in this section.

(60) Palatalization as coronalization

```
  k          i
  ╪‾ ‾ ‾ ‾ ‾ |        →  či
 Dors       Cor
```

However, inherent VPlace theory disallows such direct interaction of VPlace and CPlace features, which are not consistent with the general C-V interaction facts, as we have seen. The clear alternative once again is to appeal to substantive conditions. Suppose we let palatalization simply derive the representations seen in (58) for Japanese - a Type I effect - with further changes leading to coronal place, when they occur, due to constraints on feature cooccurrence. That is, we have in mind something like the following:

(61) Palatalization Output required by other constraints

```
  k         i
Place     Place
  | ‾ ‾ ‾ ‾ |       = kʸ        → → č/ts/s
Dors      VPlace
```

The general idea is of course not new; it receives extensive treatment in the linking rules of Chomsky and Halle (1968:420-32), and under more recent interpretations is advocated by Sagey (1986), Hayes (1991), Calabrese (1992) and (for $t^y \rightarrow č$) Itô and Mester (1993b). The import of the 'other constraints', in the words of Chomsky and Halle (p.423), is that "...when velar obstruents are fronted, it is simpler for them also to become strident palato-alveolars with delayed release."[19] A translation into our framework of the 'restructuring' found in Sagey is given below. We assume here that vocalic features are retained, though outputs only sometimes retain the raised/fronted tongue body articulation of palatalized segments; see Chomsky and Halle 1968 on Russian:

(62) Restructuring of palatalized dorsals (after Sagey 1986)

```
     kʸ                    č
   Place                 Place
   /   \        →        /    \
Dors VPlace           Cor    VPlace
       |               |       |
    [-back]         [-ant]  [-back]
```

[19]We assume that conditions might entail even more drastic place shifts directly, like $g^y \rightarrow$ *dz/z*, etc. John McCarthy (p.c.) informs us of certain Bedouin Arabic dialects in which such changes occurred, leaving synchronic alternations as a reflex; previously existing palatal *ǰ* was not affected, indicating that palatalization did not involve this intermediate stage.

Palatalized coronals would involve a similar, though less severe, restructuring (see Itô and Mester 1993b). From the perspective of formalism, this leap from derived k^y to output $\check{c}$ seems completely arbitrary. This is of course the argument against restructuring implicit in the literature on 'coronalization'. However, the formal approach is at best equally arbitrary: given the facts seen in the preceding sections, palatalizations like $k^y \rightarrow \check{c}$ now stand alone as the only apparent cases involving a vowel displacing CPlace in synchronic alternations; compare e.g. $k^w \rightarrow f$. It has been the burden of preceding sections to argue that the facts expected if such rules could occur are not convincingly attested. We emphasize this point with the following chart (from the unified feature perspective):[20]

(63) V displaces major place of C:

		CPlace			
		Lab	Cor	Dors	Phar
VPlace	Lab	X	-	-	-
	Cor	-	X	✓	-
	Dors	-	-	X	-
	Phar	-	-	-	X

The point is that palatalizations, in having this property, in fact **are** special. From this perspective, **any** account, formal or substantive, must single them out somehow.

From the perspective of the substantive approach, the arbitrariness of the change $k^y \rightarrow \check{c}$ is surely due to the arbitrariness of the vocal tract itself: other feature cooccurrence constraints like *[+high, +low], *[+son, +spread glottis], *[+nas, Dorsal] are all formally completely arbitrary. Yet they (at least implicitly) have a basis in phonetic fact. Few would seriously question that changes that follow from palatalization of velars and coronals - changes in place, affrication, etc. - have some phonetic basis. The latter change, affrication, is typically assumed to follow in this way even by advocates of the 'coronalization' view. A substantive approach to this issue, then, is one which current theories of phonology already condone in all respects.

Finally, in favor of the substantive approach, consider the following independent support. While velar palatalizations resulting in k^y seem most common, and those yielding $\check{c}$ relatively common, those resulting in [+ant] place (*ts*, *s*, etc.) are least so. At the same time, the former simple 'surface' palatalization often displays the syndromes of a postlexical rule in the sense of Kiparsky (1985) inter alia: application across words, lack of exceptions,

[20]We might add here that Maddieson and Precoda (1992), in a survey of a few languages in search of restrictions on cooccurrence between consonants and vowels, find a restriction only on the cooccurrence of velar consonants and *i* - this combination often surfaces as *či*.

automatic and non-structure preserving application. Palatalizations leading to coronal place, however, behave differently. Palatalizations to [+ant] place, like the English Velar Softening seen in *electri[k] ~ electri[s]ity* (see for example Chomsky and Halle 1968), are apparently universally morphologically governed, as well as restricted to within words; and they are at least typically structure preserving. Palatalization to palato-alveolar place may occupy some intermediate position in these respects; at least it clearly shows some of these latter, 'lexical' properties as well. Russian, and other Slavic languages, have **all** these types of palatalization at work, showing just these different correlations of properties within one grammar (see for example Lightner 1972, Szpyra 1991, inter alia).[21]

Theories of Lexical Phonology attribute such correlations in part to the properties of feature cooccurrence conditions: according to the Strong Domain Hypothesis of Kiparsky (1984), Myers (1991), conditions on rule output are enforced underlyingly, and may turn off - but not on - in the course of the derivation. Hence languages 'loosen up' during the derivation, allowing segments and structures later that are disallowed earlier. In the Slavic languages, we may say that conditions requiring that palatalized velars be coronals apply early in the derivation - but not later, when surface (non-structure preserving) k^y, g^y, x^y are derived.

'Coronalization' theories are at a disadvantage in this regard. Virtually all work on feature geometry assumes that properties of the geometry do not change during the course of the derivation. Therefore, such theories cannot obviously explain why palatalizations like $k^y \rightarrow s$ (and $k^y \rightarrow \check{c}$?) never obtain postlexically.[22]

5. Alternatives Approaches to Type II Effects

To account for Type II effects like Turkish $pV \rightarrow pu$ and Arabic $V\Sigma \rightarrow a\Sigma$, we posit the activity of inherent VPlace features in plain consonants. We have considered in general terms an alternative approach to such effects, one that assumes i) a unified set of place features, an assumption we have argued neither for nor against, and ii) the direct linking (in the case of spreading rules) of a CPlace feature to a vowel, disallowed in inherent VPlace theory. We now discuss the alternative approach in more detail, evaluating it from the perspective of

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[21]Of course, given some cases of e.g. $k^y \rightarrow ts$ that are phonologically opaque and morphologically restricted, some have concluded that they deserve no phonological account at all, but rather must be treated morpholexically (for example Spencer 1985 for Polish). If true, then the whole issue of place shift for these cases is irrelevant, at least for synchronic descriptions.

[22]It is possible that purely within-coronal shifts like $t^y \rightarrow \check{c}$ do occur postlexically (though evidence from English seems negative: cases such as *gotcha*, from 'got you', are clear lexicalizations, while assimilations in phrases like 'kiss you' display gradient behavior indicative of phonetic processes, as Zsiga (1993) demonstrates). In any case, a difference between constraints motivating $t^y \rightarrow \check{c}$ versus $k^y \rightarrow$ č, in terms of domain of application, would not be surprising; see Archangeli and Pulleyblank (to appear) and Padgett (to appear) on the presumably 'grounded' notion of constraint 'strength'.

three concerns: the C-V asymmetries explored earlier, some issues underlying interaction or non-interaction, and place-stricture entailments. On the basis of these considerations, we argue that inherent VPlace theory should be preferred.

Proposals for unified consonant and vowel features range over various frameworks, and include e.g. Schane (1984, 1987), Hulst (1986), Anderson and Ewen (1987), Kaye, Lowenstamm and Vergnaud (1985), Selkirk (1988, 1991a), Clements (to appear). For concreteness, we consider a unified feature approach along the lines of the last two references cited, within the theory of feature geometry:[23]

(64) **Unified Feature Hypothesis**

> Consonants and vowels share one set of place features, e.g. [Labial], [Coronal], [Dorsal], [Pharyngeal].

As a means of confronting Type II interactions like Turkish Labial Attraction, unified feature theories can advocate the direct linking of a CPlace feature to a vowel. Two such 'direct interaction' theories, differing in geometrical respects, are explored here. That of Clements (to appear) on the one hand (subsequently pursued by Herzallah 1990 and Hume 1992), assumes a separation of CPlace and VPlace features, as does this work. For convenience, we call this the 'VPlace approach'. Given separate VPlace, a direct interaction account of Type II effects entails the spreading of a CPlace feature to a VPlace node, as illustrated in (65)a, for Turkish Labial Attraction.[24] Selkirk (1988, 1991a, 1993), on the other, posits no such geometrical separation, allowing the more pared-down representation in (65)b. A similarly direct interaction in a non-unified feature framework is found in Sagey's (1986) analysis of Tulu.[25]

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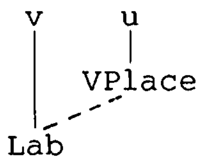
[23]The latter class of proposals includes the 'coronalization' approaches to palatalization discussed in the previous section.

[24]To be precise, Clements (to appear) suggests that such spreading might be ill-formed. However, subsequent work by Hume (1992) and Clements and Hume (1992) instead argues for it.

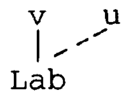
[25]There are further differences between the theories of Clements and Selkirk that do not affect the argumentation here. First, they interpret the place features in (64) somewhat differently. Second, Selkirk (1988, 1991a) does not employ class nodes to capture feature classes. For our purposes, the detail shown in (65) is sufficient.

(65) Type II effects as direct interaction: Turkish *yavru*

a. VPlace approach



b. No VPlace



In the next three sections, we explore the implications of direct interaction, and instead argue for the inherent VPlace theory alternative.

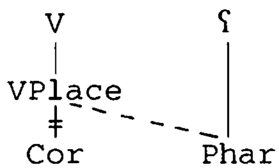
5.1 The Asymmetry in C-V Interaction

Recall the facts of C-V interaction from §4.2: a major argument for inherent VPlace theory concerns the absence of rules in which a vowel displaces the CPlace feature of a consonant; there are no rules *su* → *ʃu*, *vi* → *zi*, and so on. This is because vowels have no CPlace features with which to affect consonants. In fact, we were led to the conclusion that all C-V interaction occurs within VPlace tiers. An argument against direct interaction is that it fails to explain this gap.

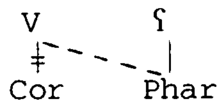
Consider the following comparison. Rules like that of Arabic seen in §3 above, lowering and backing *i* to *a* before a guttural consonant, are not hard to find among languages that have gutturals. The direct interaction formulation of this rule is given in (66)a and b, where the Pharyngeal node of the consonant displaces the Coronal node of the vowel.

(66) Consonant affects vowel in direct interaction:
Arabic Vʕ → aʕ

a. VPlace approach



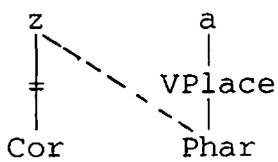
b. No VPlace



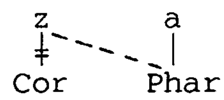
On the other hand, a rule like *za* → *ʕa* seems unheard of. Yet in the direct interaction approach it is equally simple, involving again the spreading of Pharyngeal to a coronal segment, displacing the Coronal node of the latter, as shown in (67). Thus the rules are in the relevant respects identical, differing only in the 'direction' of spreading (from consonant to vowel or the reverse). Yet the difference in plausibility seems undeniable.

(67) Vowel affects consonant in direct interaction:
za → ʕa ???

a. VPlace approach



b. No VPlace



The direct interaction approach to Type II effects, then, leads to great overgeneration.

5.2 Bases of Interaction

The conclusion that C-V interaction is always within VPlace was reached in the following way: i) CPlace and VPlace features are separate and do not interact; ii) vowels have no CPlace features by definition; points i) and ii) entail that interaction involves only VPlace features.

A question worth dwelling on involves the prohibition on the direct interaction of CPlace and VPlace features: though the point has been motivated, why should it be so? Allowing for the possibility of a unified set of features, for example, there is no obvious problem with direct interaction from the purely formal viewpoint, and researchers have naturally explored the possibility. Though the arguments against direct interaction are strong, one might still wonder what motivates this CPlace/VPlace divide.

Though the answer is not clear, it is likely that it must relate these facts to other facts regarding stricture in segments. In particular, various researchers (Greenberg 1960, McCarthy 1988, Selkirk 1988, 1993, Yip 1989, Padgett 1991a,b, Pierrehumbert 1993, inter alia) have noted an important systematic qualification on Obligatory Contour Principle effects over consonants: often, if not usually, consonants of the same place, but differing in some stricture value, may cooccur in spite of the OCP. Thus, in Classical Arabic, there are no roots like **dt*, **fm*. Yet roots such as *drz* 'sew' and *slt* 'extract' occur. In the latter instances, differences in either [continuant] or [sonorant] values entail a failure of interaction. Thus, closeness in stricture is a prerequisite to interaction - at least in regard to OCP effects. This issue has yet to be fully understood and accounted for.

Given that differences in stricture can mean a failure of interaction among consonants, it should come as little surprise that consonants and vowels - as disjoint in stricture as can be - also fail to interact. In VPlace theories, consonantal articulators (CPlace features) are directly dependent on Place, while vocalic ones (VPlace features) are dependent on VPlace. Lack of direct interaction in such a theory must mean that features dependent on one cannot interact with those dependent on another.

Thus in an important sense, direct interaction VPlace theories are not fully consistent with an ideal of C-V separation they embody. Consider the hypothetical rules in (68), both possible in direct interaction VPlace theories (see Clements and Hume 1992). (68)a is a vowel-to-vowel rounding harmony, to which the intervening labial consonant is transparent, a common occurrence, e.g. Turkish *köprü* (see §4.1.2). Thus CPlace and VPlace Labial features fail to interact, as expected. (68)b is instead a Type II effect, in which a vowel (or perhaps a rounded consonant, as in the Berber case discussed above in §4.1.1) dissimilates in rounding after a plain labial consonant. It is the account of Type II effects, involving the direct interaction between CPlace and VPlace Labial, that is inconsistent with the understanding of the theory outlined just above.[26]

(68) Direct interaction or not: VPlace approach

a. No interaction

```
Place    Place    Place
 \         |         \
 VPlace    |    _ _ _VPlace
 |_ _ _ _ _+_ _ _
Lab       Lab
```

b. Interaction

```
Place    Place
  |        |
  |      VPlace
  |        ‡
 Lab      Lab
```

In this view, then, the question of whether interaction obtains or not does not hinge on the seemingly basic issue of stricture. As a further point, it does not seem to hinge on anything else in the theory, i.e. formal or substantive prerequisites, but is rather somewhat arbitrary. Inherent VPlace theory instead adheres to a more restricted view: on the one hand, CPlace features and VPlace features do not interact; on the other, within these tiers, any features present must necessarily be visible to each other. The same rules in our terms both involve only VPlace features, as shown below - the transparency of the intervening labial consonant in (69)a implies the **absence** of inherent [round] when spreading applies:

(69) Interaction or not: inherent VPlace

a. No interaction

```
Place    Place    Place
  |        |        |
VPlace    Lab  _ _VPlace
  |_ _ _ _ _ _ _
[round]
```

b. Interaction

```
      Place     Place
     /  |         |
Lab  VPlace     VPlace
        |         ‡
    [round]    [round]
```

That is, we place much of the burden of explanation on the theory of redundant feature specification, and the question of why Type II interaction only sometimes obtains reduces to

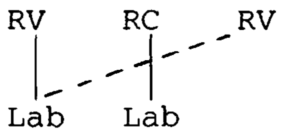
[26]There is no line crossing issue in (68)a: this formulation does not violate the Line Crossing Prohibition of Goldsmith (1979), because the lines do not cross in the same **plane**, as proposed by Hume (1992) and Clements and Hume (1992): one plane is defined by the tiers Place and Labial; the other by VPlace and Labial (Place and VPlace define a third plane). The two planes intersect on the Labial tier.

the question of why redundant features are only sometimes active. There are surely questions remaining in this area of the theory. However, in tying the explanation to issues of feature specification, we relate Type II facts to many others in a way that is quite familiar; further, we capitalize on the explanatory power that theories of redundant feature behavior have, making some interesting predictions, as seen in §4.1.2.

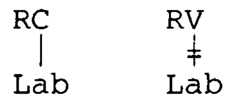
In the direct interaction approach with no VPlace (Selkirk 1988, 1993), the same rules are represented as follows (*RC* and *RV* denote the root nodes of a consonant and vowel, respectively).

(70) Direct interaction or not: No VPlace

a. No interaction



b. Interaction



Line crossing in (70)a is not a problem in Selkirk's terms, given her notion of 'tier-adjacency': the target of spreading is adjacent, because the feature Labial is dependent on identical heads - in this case vocalic stricture features, which Selkirk assumes to define the Root - and no other *RV* intervenes. More generally, in order to interact, place features must have heads with identical stricture content. Thus Selkirk also encodes a separation of consonant and vowel features into the theory.[27]

As with direct interaction VPlace theories, this ideal is not always maintained; thus the features interacting in (70)b do not have identical heads. However, Selkirk notes an interesting fact about such anomalies: the segments involved in Type II effects like this are always 'Root-adjacent', not simply 'tier-adjacent' as in (70)a. This insight into Type II effects finds a partial explanation in Itô, Mester and Padgett (1993), where it is argued to be a property of not only Type II effects, but of redundant feature behavior in general.[28]

---

[27]Pursuing the observations and work of Anderson (1981) and Mester (1986), Selkirk advocates a separate notion of place feature 'rank', independent of strictural concerns, and motivated by asymmetries in place feature behavior like the alternation of some *w*'s in Fula with *b* and other (phonetically identical) ones with *g*, where in Selkirk's view the Labial component of *w* is *primary* in the former instances and *secondary* to Dorsal in the latter. Unlike Selkirk, we do not see accounts of legitimate 'rank' phenomena, which do not seem directly relevant to the major concerns of this paper, as competition for accounts of C-V separation (or related facts involving stricture and interaction).

[28]It is not quite correct that Type II effects require strict Root-adjacency, a point Hume (1992) notes. E.g. Turkish Labial Attraction in *yavru* involves the spreading of [round] across intervening *r*. This behavior is expected, assuming inherent (redundant) VPlace feature spreading (see Itô, Mester and Padgett). On the other hand, the similar adjacency requirement

5.3 Other Place-Stricture Entailments

The notion that closeness in stricture is a prerequisite to interaction is clearly relevant to OCP effects; it is less clear that it is a factor in the case of all assimilation processes (though it seems true of C-V interactions). However, a different entailment here forms another argument against direct interaction: place feature spreading entails oral stricture agreement. Padgett (1991a,b, to appear) argues that articulator features and oral stricture features like [continuant] and [consonantal] form a close grouping in feature geometry. Specifically, these features are bound up together in an *articulator group*, similar to the articulatory *gesture* of Browman and Goldstein (1986, 1990):[29]

(71) The articulator group

```
  Root
   |
  Place
   |
 [Cor   ]        E.g. /t/
 [+cons ]
 [-cont ]
   |
 [+ant]
```

The articulator group has implications for the treatment of place assimilation, complex segments, OCP effects, underspecification and the phonology-phonetics relation, and finds support in such areas. This work, and the work of Selkirk (1991b, c), demonstrates a pervasive interaction of place and stricture features, an interaction that is mysterious given the standard view that stricture features are independent of place.

The articulator group hypothesis makes strong claims about possible C-V interactions. If stricture is bound up with the articulator, then a direct interaction VPlace analysis of Type II interactions like Turkish *pV → pu* becomes a problem, since the vowel acquires [-continuant] as well:

seen on OCP effects involving plain consonants and vowels, and other C-V interactions, e.g. palatalizations, requires further thought.

[29]We ignore irrelevant issues here, such as the question of whether [continuant] is an autosegmental feature. Padgett (1991a) treats it autosegmentally, dependent on the articulator.

(72) Direct interaction and the articulator group

```
       p          i
       |          |
       |        VPlace     --->  ??
       | - - - -
    [Lab    ]
    [+cons  ]
       |
    [-cont]
```

It is of course conceivable that assimilation goes through, but that the representation is then repaired, presumably a 'mitosis' into two articulators with the appropriate stricture values now possible. However, there is no reason to believe any repair is at work, other than the need to undo the damage done by our assumptions (compare the repairs motivated for nasal place assimilation facts in Padgett to appear). Rather, the articulator group hypothesis, if adopted, provides another compelling reason to seek an alternative to direct interaction. In terms of inherent VPlace theory, since all C-V interaction is via VPlace features, the problem disappears: [continuant] and [consonantal] values are the same in all cases.

In the theory of Selkirk (1991b,c), linked place likewise entails identical stricture: though **place** features are dependent on **stricture** features, a proposed *Multiple Linking Constraint* requires that a linked place feature have identical heads. Type II effects are thus similarly an apparent concern for this direct interaction theory (see (70)b, for example, with interaction but non-identical heads); the concern might similarly disappear if the idea of inherent VPlace were extended to this theory.

6. Further Implications

In this section we briefly discuss two further consequences of inherent VPlace theory. Though in each case the discussion is tentative, the issues are important enough to merit attention here. We first raise the question of unified features in inherent VPlace theory; in spite of our claim that there is never direct interaction between CPlace and VPlace features, there may yet be a role for unified features. Second, we consider some interesting possible implications of the theory for the understanding of consonant harmonies.

6.1 A Unified Feature Theory?

If all C-V interaction occurs within VPlace tiers, there would appear to be no reason to posit a unified set of place features. However, there is one class of rules that might yet argue for such a theory: rules of strengthening and weakening, where a vocoid becomes consonantal or a consonant becomes vocalic while retaining the same basic articulator. Examples are discussed in Clements (to appear), Hume (1992) and elsewhere. We illustrate with the weakening process of Glide Formation in Irish (Ní Chiosáin 1991).

(73) Lenition and Glide Formation in Irish

a.	ban'	'take'
	van' / wan'	'took' (lenited)
b.	g'ɑ:r	'cut'
	ɣ'ɑ:r / jɑ:r	'cut' (past, lenited)

In the examples in (73), lenition of the initial stop (see §2.2) results in a fricative which may then undergo a rule of Glide Formation. In VPlace theories, processes like Glide Formation might involve the 'demotion' of place features as illustrated in (74) below, where CPlace Labial demotes to VPlace resulting in a labio-dorsal glide *w*. Since 'plain' consonants in Irish are actually velarized, we represent them with secondary dorsality.

(74) Weakening as 'demotion' of a CPlace feature

```
  v                            w
  |‾‾‾‾‾‾‾‾‾‾‾‾‾‾     →        |
Labial   VPlace             VPlace
           |                /    \
         Dorsal          Labial  Dorsal
```

It should be emphasized that 'demotion' and the reverse case of 'promotion' (involving e.g. glide strengthening) are not examples of direct interaction between CPlace and VPlace features in any sense; rather, they involve a segment-internal change in stricture status (with concomitant structural characterization).

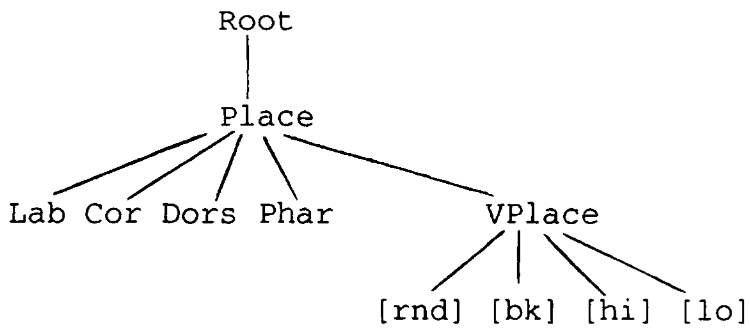
The unified feature view clearly offers a rather direct account for the connection between consonantal and vocalic articulations of the same place, for example *v/w*; the alternative, presumably, is to define 'translations' from Labial to [round], etc. Though this consideration perhaps favors the unified view, there is still significant disagreement in the literature over the exact content of proposed unified features, and questions remain about their role in phonological processes; we do not mean to advocate either theory here.[30]

[30]An independent challenge to unified feature theories is the apparent equipollent nature of some VPlace features, in particular the evidence for equipollent [back] discussed in various works, e.g. Farkas and Beddor (1987), Steriade (1987b), Kiparsky (1991) and Ní Chiosáin (1992). This challenge could perhaps be accomodated by grouping Coronal and Dorsal together (assuming Coronal and Dorsal to correspond to [-back] and [+back], respectively) under a 'Color' node, independent of height. (Where the term 'color' means non-height VPlace features; as a geometrical grouping, it corresponds to Clements' (to appear) *VPlace* and Odden's (1991) *[back]/[round]*). What have been argued to be rules spreading [back] would then be characterized as the spreading of Color (cf. Odden 1991, Selkirk 1991a and Clements and Hume 1992).

6.2 Consonant Harmonies

The geometry we have adopted posits no CPlace feature grouping alongside the VPlace grouping; in this we have followed Clements (to appear):

(75) VPlace, but no CPlace grouping



Clements points out a consequence of this geometry: while total vowel assimilation through consonants can occur, total consonantal place assimilation through vowels cannot - vowels block such spreading, since they have Place nodes as well. This result is a desirable one, since just this asymmetry in place spreading holds in languages, as noted by Clements (1985) (who cites Morris Halle).

However, this geometrical explanation fails in an important respect: it is arguably no less true that **single** articulators do not spread across vowels as we would expect. Thus, though single articulator spreading is somewhat uncommon even under strict adjacency (for reasons unclear to us; but see the Irish example in §2.2), it is simply unobserved across vowels - with the apparent exception of coronal consonant harmonies. Putting the latter aside for the moment, we note that the geometry has no explanation for the non-existence of (76), since vowels bear no CPlace features and cannot be blockers.

(76) Single articulator spreading across vowels?

Shaw's (1991) survey of consonant harmony systems concludes that they are found only for coronals.[31] Thus, systems of 'sibilant' harmony (e.g. Chumash, Poser 1982), and

[31] As McCarthy and Taub (1992) observe, this is not quite correct. Ponapean labials within a morpheme must agree in [back] (Rehg and Sohl 1981, Mester 1986), and various Arabic dialects display harmony in pharyngealization. Our claims here concern only (primary) CPlace feature spreading; on secondary pharyngealization as VPlace, see McCarthy (1991), Herzallah (1990).

harmonies involving other coronal distinctions (e.g. Tahltan, Shaw 1991, or Sanskrit, Steriade 1986), are rather common. Suppose we make the following assumption:

(77) Spreading of CPlace articulator features is strictly local

Now all of these facts arguably follow. First, CPlace features cannot spread across vowels: if such spreading is local, it must spread **onto** the vowel in order to iterate further. However, the vowel is then rendered consonantal, typically a massive violation of syllable structure conditions, as noted in §4.2.2.[32] Second, coronal consonant systems are an exception, because only the Coronal articulator has dependent features like [anterior] and [distributed], features we must assume can spread past vowels.

However, though most cases of coronal consonant harmony can be treated as involving one of these minor place features, a few require both, for example Tahltan (Shaw 1991), and possibly Sanskrit (Steriade 1986). Steriade, Shaw and others have taken the latter cases to be an argument for the spreading of the articulator Coronal itself, given the fundamental tenet of feature geometry that rules target single nodes and not two or more separate features. However, as McCarthy and Taub (1992) point out, we now have an odd coincidence: CPlace harmonies always involve Coronal, and only Coronal has dependent minor place features.

Instead, suppose we maintain (77). If coronal harmony involves only minor place features, then the facts of Tahltan and Sanskrit argue for a grouping of these features **below** coronal, as suggested by Padgett (1991a):

(78) Structure below the Coronal node

```
         Place
           |
         Coronal
         /     \
    [cont]    Site
               /  \
          [ant] [dist]
```

Though there are unresolved questions about this account (e.g. why (77) should be true, why minor place features should be different), this general approach to consonant harmony systems seems promising.[33]

[32]We are grateful to Bruce Hayes, who pointed out this argument to us.

[33]Shaw (1991) also presents an account of these consonant harmony asymmetries. The argument crucially assumes that C- and VPlace articulators - except Coronal - are arrayed on the same tiers, an assumption incompatible with VPlace theories. See McCarthy and Taub (1992) for independent arguments against this account.

7. Conclusion

The notion that consonants have inherent VPlace features, which can be active in the phonology, has far-reaching consequences. The major arguments for this view are i) inherent VPlace maintains a strict segregation of CPlace and VPlace features, required on independent grounds, e.g. geometrical independence (§2), internal consistency and place-stricture entailments (§5); ii) inherent VPlace explains the existence of Type II effects like *pV* → *pu*, and the nonexistence of *fi* → *si*, *sa* → *ha*, etc; iii), in doing this, inherent VPlace theory invokes notions central to the theory of feature redundancy and specification.

Open questions nevertheless remain. Consider the following fact: in the Korean syllable, the glide *y* does not occur with a coronal consonant; nor does it occur with a front vowel. However, coronal consonants occur freely with front vowels. Similarly, *w* does not occur with either labial consonants or round vowels, though the latter freely cooccur (see Martin 1951, Clements to appear for a fuller discussion of these facts). The conventional notion of tierhood is incapable of capturing such facts: if *a* and *b* are on a tier, and *b* and *c* are on a tier, then *a* and *c* should be on a tier. What we have instead is a sort of distance metric, where *a* and *c* fail to interact because they are not similar enough in stricture or sonority. Thus glides take an intermediate position between consonants and vowels in Korean. If such considerations are to be accommodated by the theory, either we must somehow refine our understanding of 'tier' as a formal entity, or else (or equivalently) pursue an approach in which interaction depends in some more direct fashion on stricture content, extending for example ideas of Selkirk (1988, 1991c, 1993).

The 'intermediate' status of glides across languages in other regards is well-known. The existence of interactions between glides and consonants in some languages (see e.g. Selkirk 1993:51 and references therein), rather than the frequent and perhaps more expected vowel-glide interactions, might entail that glides are sometimes [+consonantal] (and thus CPlace), as many have suggested (e.g. Guerssel 1986, Cohn 1989, inter alia). In light of facts like those of Korean, however, we might instead pursue the notion of stricture/sonority distance. Rather than viewing C-V separation as a categorical requirement, we might interpret it as a type of gradient and violable constraint, or constraint hierarchy, with greater differences in stricture under interaction entailing correspondingly greater violation, pursuing ideas of Prince and Smolensky (1993). We leave these issues for future research.

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