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Amalia E. Gnanadesikan
University of Massachusetts at Amherst

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1. Introduction

Theories of feature geometry strive to represent phonological segments in such a way as to reveal what natural classes the sounds fall into, and which of their features may be affected as a group by the phonological rules. Consider, for example, rules of place assimilation. Assimilation of a segment to *any* adjacent place of articulation (labial, coronal, or velar) is at least as natural as assimilation to only one specific place (i.e., only to labial, only to coronal, or only to velar). This is accounted for by the presence of a place node in the geometry. Assimilations to any adjacent place are then analyzed as spreading of the adjacent place node to the assimilated segment. Such an assimilation is shown in (1). As well as sharing place nodes, the two linked arguments will also share any features dependent on place, represented here as Z. For a further discussion of the theoretical issues of feature geometry, see Clements (1985),Sagey (1986), and McCarthy (1988).

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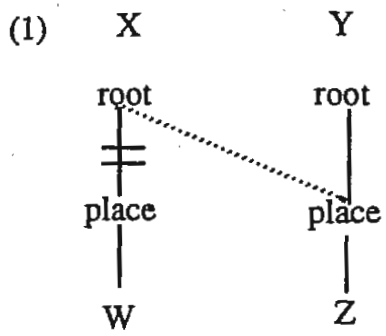
(1)



This paper focuses on one of the dependents of the Place node, Coronal. Coronal sounds are generally defined as being articulated with the blade, or just the tip of the tongue (Chomsky and Halle, 1968 henceforth SPE, Keating, 1991). Many languages contrast two or more places of articulation within the larger class of coronals. The question of which features account for these fine contrasts between coronal places, and how such features are related to the Coronal node will be the topic of this paper.

Since SPE, the features [distributed] and [anterior] have commonly been used to differentiate coronal places. In SPE, sounds with a point of articulation at or forward of the alveolar ridge are described as [+anterior], while those articulated behind the alveolar ridge are [-anterior]. The feature [anterior] thus distinguishes two places within Coronal, but is also used to distinguish among noncoronals. Velars and pharyngeals are [-anterior] while labials are [+anterior]. The SPE-style [anterior] thus predicts that velars and pharyngeals form a natural class with the "backer" coronals, while labials form a natural class with the "fronter" coronals.

The [distributed] feature in SPE is likewise used to distinguish among both coronals and noncoronals. In the SPE framework, [+distributed] is used to characterize sounds which have a long constriction in the direction of the air flow, while [-distributed] sounds have a short constriction. Coronals made with the blade of the tongue ("laminals") are considered [+distributed], whereas coronals made with just the tip of the tongue ("apicals") are considered [-distributed]. [distributed] is also used to differentiate between bilabials and labiodentals, bilabials being [+distributed] and labiodental [-distributed]. This classification predicts that laminals and bilabials form one natural class, and that apicals and labiodentals form another.

The SPE features [anterior] and [distributed] can be used to subdivide coronals into four subplaces. This is shown in (2), where (as throughout this paper) t̪ represents a laminal dental, *t* stands for an apical alveolar, ʈ is a retroflex (apical domal), and ʈʸ[1] is a laminal alveolopalatal. As pointed out in SPE, apical

[1] The ʈʸ symbol is used here for three reasons. First, there is no consistent symbol used in the literature on the Australian languages considered here. Second, being based on the *t*, it is intuitively understood as coronal, unlike symbols such as *c*. Finally, none of the languages discussed here makes a distinction between alveolopalatals and palatoalveolars. The ʈʸ is used as

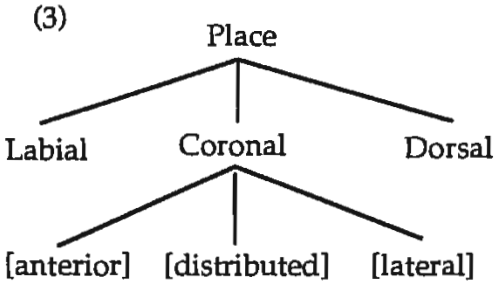
dentals and laminal alveolars also occur (in Temne, for example), but the presence of an apical dental in a language implies that any other "anterior" coronal must be a laminal alveolar, and *vice versa*. In terms of the features [anterior] and [distributed] an apical dental and an apical alveolar are equivalent, as are a laminal dental and a laminal alveolar. In the languages used for the present study the "fronter" laminals are dental, and the apicals alveolar.

(2)

	ɸ	f	t̪	t	ʈ	tʸ	k
cor	-	-	+	+	+	+	-
ant	+	+	+	+	-	-	-
dist	+	-	+	-	-	+	

The SPE definitions of [anterior] and [distributed] have been criticized for predicting that coronals and noncoronals will pattern together as natural classes (Kenstowicz & Kisseberth, 1979; Steriade, 1986; Keating, 1988; but see Cho (1991) for a defense of SPE-style [anterior]). Steriade proposes that [anterior] and [distributed] are features that only make distinctions among coronals. Thus [distributed] is used solely for the apical/laminal contrast and [anterior] is used solely to separate the "fronter" coronals from the "backer" coronals. In feature-geometric terms, Coronal is represented as a node dependent on Place, with its own dependents [anterior] and [distributed], as well as [lateral]. Since a coronal-dependent [anterior] can no longer distinguish between labial and velar places, the nodes Labial and Dorsal are added. This is shown graphically in (3).

(3)



The model shown in (3) will hereafter be called the A/D model in reference to its representation of the [anterior] and [distributed] features. As in SPE the A/D model can subdivide the coronal place into four subplaces, using the [anterior] and [distributed] features. The geometry of the A/D model makes several explicit claims about the phonology of coronals. First, and rather obvious, is the claim that coronals form a natural class. Secondly, it claims that the

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a cover term to mean any laminal post-alveolar stop. The tʸ should not be understood as having a palatal offglide.

features [anterior], [distributed] and [lateral] also describe natural classes, but that these are subclasses of the coronal class. Furthermore, these features, while dependent on Coronal, are independent of each other, defining independent classes of sounds. In feature geometric models, phonological processes spread or delink individual nodes (terminal or non-terminal) in the geometric tree. This model therefore predicts that processes affecting coronals may spread either the Coronal class node, or a dependent feature, but not, say, two out of the three dependent features of Coronal.

In this paper I will test the predictions of the A/D model, specifically the claim that [anterior] and [distributed] define natural classes within the larger class of coronals. Such a test requires examining the phonological patterning of subsets of coronal consonants: if a feature defines a class of sounds which pattern together to the exclusion of other sounds, then we have evidence for the phonological reality of the feature. If, on the other hand, a feature groups together sounds which consistently take part only in different patterns and processes, we have evidence against the feature. Languages of Australia and India, which have multiple coronal places, will be examined for evidence as to the patterning of various coronals. I propose that while [distributed] has phonological reality in the laminal/apical distinction of these languages, [anterior] fails to define a natural class. On the basis of this evidence I claim that the traditionally [-anterior] coronals instead have vowel features as secondary place features. Specifically, alveolopalatals have the feature [-back] in common with the front vowels, while retroflexes share the feature [+back] with back vowels. Since the alveolopalatals and retroflexes have opposite values of [back], they will not form a natural subclass within Coronal. Furthermore, they will pattern with opposite types of vowels—front vowels for alveolopalatals, and back vowels for retroflexes. I propose that [back] is located under the Coronal node when it characterizes phonologically simple coronal segments, and is not dependent on a secondary vowel place node.

The rest of this paper will proceed as follows. Section 2 briefly discusses the languages from which the evidence in further sections is drawn. Section 3 provides evidence that [distributed], defined as the apical/laminal contrast, accurately distinguishes two natural classes. Evidence is drawn from phonotactic constraints, historical developments, allophone alternations, speakers' judgments, and Diyari voicing distinctions. Section 4 provides evidence that [distributed] is dependent on the Coronal node, as in the A/D model. The evidence is drawn from phonotactic constraints, constraint-driven repairs, and coronal assimilations. Section 5 discusses the lack of evidence for [anterior], showing that alveolopalatal and retroflex coronals cannot be characterized by a single value of one feature such as [-anterior]. Instead, alveolopalatals are shown to pattern with one class of vowels (i.e. front) while retroflexes pattern with the opposite class (back). Section 6 outlines the major proposal of this paper, claiming that alveolopalatals are [-back] while retroflexes are [+back]. Section 7 discusses the geometric locus of [back] in coronals.

This paper focuses on the coronal place distinctions traditionally made by [anterior] and [distributed]. "Manner" features associated with coronals, such as [lateral] and [strident], are therefore not discussed.

2. The Data

Data for this study come mainly from Australian and Dravidian languages, which have rich coronal inventories, typically distinguishing three or four coronal places. Additional support is garnered from Sanskrit and Ponapean. In general, only the nasal and oral stops of a given language are considered. This is for two reasons. First, it is in the nasal and oral stops that we find contrasts both among coronals and between coronals and other major places. Secondly, discussion of liquids and fricatives necessitates discussion of [lateral] and [strident], which, as noted above, is outside the scope of this paper.[2]

Charts of the relevant phonemes may be found in the appendix. Four types of Australian phonemic inventories are shown: except for a handful of languages with a palatalized velar series, these are the only types attested.[3] This means that no Australian language has as coronals only two apicals or two laminals. The distinction between dentals and alveolopalatals is not made for languages with only one laminal. Thus all single laminal languages are classified as having a t^y when some actually have only the t̪. In many of these languages, the two alternate allophonically. Percentages show the proportion of Australian languages following a given phonemic pattern (Busby, 1980).

The Dravidian languages and Sanskrit are shown with a *c* in the alveolopalatal series. This is the traditional way of representing the alveolopalatal affricate(s) in these languages. These affricates are included in the same series with the stops, however, on the strength of phonological evidence and native tradition.

3. Evidence for the feature [distributed]

Assuming that the [distributed] feature is defined as the apical/laminal or tongue tip/tongue blade distinction, evidence for this feature must consist of proof that laminals and apicals pattern differently within languages. In other words, we would expect laminal coronals (the dentals and palatals) to exhibit phonological behavior foreign to apicals and noncoronals. Similarly, apicals (alveolars and retroflexes) should exhibit behavior foreign to laminals and noncoronals.[4] Such evidence is easily found, as the following sections should demonstrate.

3.1 Phonotactic Evidence

A large number of languages have phonotactic conditions unique to apicals, as the evidence given below should clearly demonstrate. This shows that

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[2] A further reason for neglecting fricatives is that almost no Australian languages have them, and they are comparative newcomers to Dravidian phonemic inventories. It is therefore difficult to find a good sample of cases where large inventories of coronal stops and fricatives may be compared within the same language.

[3] Voicing is ignored in the typology, most Australian languages having only voiceless stops. It should also be noted that while most Australian languages have a nasal corresponding to every stop place, a few do not. In these languages it is always a laminal (specifically a dental in two-laminal languages) which is missing. (Busby, 1980)

[4] If, on the other hand, one value of [distributed] is left unspecified, we might expect only laminals or only apicals to exhibit the special behavior. The "special" behavior of the other-valued coronals would consist only in being immune to the processes affecting the other. This seems not to be the case, however, as shown below.

apicals form a natural class separate from all other consonants. After each language is listed its language family and the number of distinct apical stop places is given in parentheses.[5]

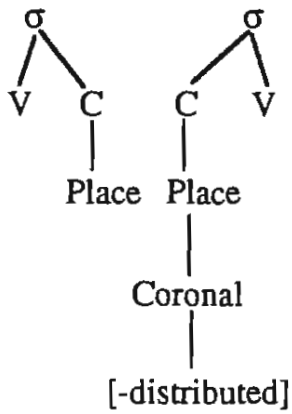
(A) Several languages do not allow apicals to begin words. This is true of Tamil (D, 2[6], Christdas, 1988), proto-Dravidian (D, 2, Zvelebil, 1970), Toda[7] (D, 2, Emeneau, 1984), Ngiyambaa (A, 1, Donaldson, 1980), Thargari (A, 2, Dixon, 1980), and Andiljaugwa (A, 2, Dixon, 1970). Tamil also prohibits apicals suffix-initially. This may be true of the other languages as well, but it is more difficult to find data on this point. Djinang (A, 2, Waters, 1979) is similar to Tamil in not allowing apicals to begin a suffix or grammatical function word, but it does allow a few voiced apical stops and nasals in word-initial position.

(4) shows the general constraint operating in these languages, which shows that apicals are ruled out in word-initial position.

(4) * # [-distributed]

(B) It is also common to find languages which do not allow apicals as the second element of a non-homorganic consonant cluster. This is the case in Toda, Iwaidja (A, 2, Pym, 1979), Djinang, Mantjiltjara (A, 2, Marsh, 1969), Walmatjari (morpheme-internally; A, 2, Hudson & Richards, 1969), Gugada (A, 2, Platt, 1972), and Pintupi (A, 2, Hansen & Hansen, 1969). These languages are characterized by constraint (5) which shows that an apical is ruled out as a syllable onset if the preceding syllable is closed by a consonant which does not share a Place Node with the apical. This refers specifically to a heterorganic consonant, as adjacent homorganic consonants are assumed to share Place nodes. The sharing of a Place Node allows a segment to be licensed in a particular position on the strength of the fact that the segment it is linked to is licensed (Itô, 1986). The placement of [–distributed] under Coronal will be justified in section 4.

(5) *



[5] "A" will represent "Australian", and "D" Dravidian. All data from a given language is from the source listed beside its first mention, unless otherwise noted.

[6] Tamil data in this paper is true of the Kanniyakumari dialect of Christdas (1988). Certain other dialects of Tamil distinguish only one type of apical stop.

[7] There are a few exceptions to this constraint in Toda, involving /n/. It is possible that the Toda /n/ follows the same allophonic pattern as Tamil, which will be discussed below in 4.3.

Constraints (4) and (5) both have the effect of ruling out apicals in positions where they are not preceded by vowels. The two constraints can not be conflated, however, since they do not occur in all the same languages. In languages such as Pintupi, for example, apicals are ruled out completely after nonhomorganic consonants (by constraint (5)), but only alveolars are ruled out word initially (see footnote 10).

(C) Other languages neutralize the apical place contrast after a non-homorganic consonant. A case in point is Mangarayi. Mangarayi (A, 2, Merlan, 1982) neutralizes the apical contrast in three different ways, depending on the environment. Word-initially, only retroflexes occur. Word internally but morpheme-initially, only retroflexes occur after vowels and retroflexes, and only alveolars occur after (non-retroflex) consonants. Morpheme internally, only alveolars occur after (non-retroflex) consonants, while only retroflexes occur after retroflexes. Mangarayi apicals are thus in complementary distribution except when post-vocalic. The Mangarayi apical facts are illustrated in (6), which states rules rather than constraints for the sake of simplicity.

(6) a) [–distributed] —> [+retroflex] / # _____

b) [–distributed] —> [+retroflex] / V + _____

c) [–distributed] —> [+retroflex] / [+retroflex] (+) _____

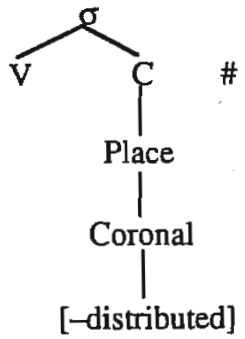
d) [–distributed] —> [–retroflex] / $\left[\begin{matrix}+\text{consonantal}\\-\text{retroflex}\end{matrix}\right]$ (+) _____

Walmatjari is another case of apical neutralization after consonants, with many of the same complications as Mangarayi. As stated above in (B), tautomorphemic non-homorganic consonant clusters in Walmatjari may not contain apicals as second element. Across morpheme and word boundaries apicals may follow a consonant, but the contrast between alveolars and retroflexes is neutralized. After a consonant, only alveolars occur, except after retroflexes, as in Mangarayi. The Mangarayi and Walmatjari apicals will be discussed further in 3.3 below.

(D) The phonotactic constraints considered thus far have been ones that specifically rule out (or neutralize contrasts between) apicals in certain positions. The opposite type of constraint is also attested, namely that in which apicals are the only consonants *not* ruled out. Thus some languages disallow all consonants but apicals in word-final position. This is true of Lardil (A, 2, Hale, 1973) and Ngiyambaa[8]. This is formulated as a positive constraint in (7), which shows that a word-final consonant is allowed if it is apical.

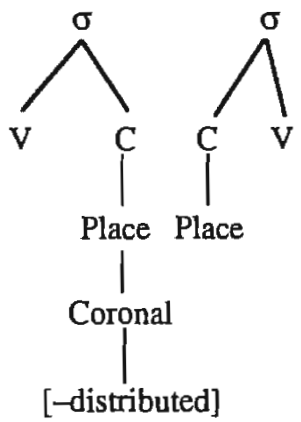
[8] In Ngiyambaa, this is only attested in the nasals, since oral stops are independently ruled out in word-final position. Since Ngiyambaa has only one apical nasal, the alveolar, one might be tempted to ascribe the special behavior of /n/ in this language to place-underspecification of /n/. This is not an adequate solution, however, since, as Donaldson (1980) notes, there is already a word-final place-underspecified nasal in the language, which must delete except when followed by a suffix, in which case it assimilates to the following consonant.

(7)



(E) Some languages allow only apicals to occur as the first element of a non-homorganic consonant cluster. This is the case in Toda, Yidiny (A, 1, Dixon, 1977), Ngiyambaa, Pitta-Pitta (A, Dixon, 1980), Guugu Yimidhirr (with one exception involving a laminal; A, 1, Dixon, 1980) and Warrgamay (A, 1, Dixon, 1980).[9] This is shown as a positive constraint in (8).

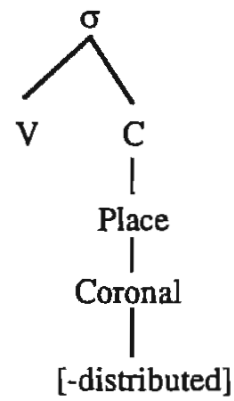
(8)



The constraints in (7) and (8) are very similar, since they both have the effect of allowing only apicals in the codas of syllables. It is possible that they can be conflated, with the effect of ruling out all non-apical codas, word-medially or finally, as in (9).

[9] Tamil marginally falls into this class. In general, Tamil allows no heterorganic nasal-obstruent clusters at all. It is interesting to note, however, that all of the five exceptions to this known to Christdas (1988) are cases where apicals, both retroflex and alveolar, may precede heterorganic consonants. Another suggestive tidbit of data comes from Malayalam (D, 2), where the single exception to obligatory nasal place assimilation known to Mohanan (1991) involves an apical alveolar.

(9)



This would require assuming that the languages listed in (E) and not in (D) differ from Ngiyambaa and Lardil in allowing word-final consonants to be extrametrical. This means that word-final consonants need not be incorporated into syllables at the level where constraint (9) would apply. This would allow nonapicals to evade constraint (9) word-finally in some languages.

A possible difficulty with conflating (7) and (8) is that Lardil, while allowing only apicals in word-final codas, relaxes this condition somewhat word-internally. In word-internal codas alveolopalatal-labial clusters are also allowed (Hale et al., 1981). This could perhaps be handled with an additional positive constraint allowing palatals in this context.

Constraints which allow only a particular type of consonant in the coda of syllables ("coda conditions") have been used as evidence that certain consonants lack a Place Node (Yip, 1991). If a language allows, say, only alveolars in coda positions, this is taken as evidence that the language has a general restriction on Place Nodes in codas, and that alveolars have no Place Node. This is not a possible explanation for the constraints in (7) and (8), however. Several of the languages mentioned as having these constraints contrast two types of apicals: the alveolars and the retroflexes. Both are allowed in codas, while other consonants are excluded. The reasoning presented in Yip (1991) would lead one to conclude that both retroflexes and alveolars have no place node. Retroflexes contrast with alveolars in their place of articulation, however, and a contrast in place implies the presence of a Place Node. The fact that these consonants are both allowed in codas, and that they contrast phonemically in this position, shows that they must be specified for the place distinction between alveolars and retroflexes, and hence must possess a Place Node. The coda conditions in these languages can therefore not be reformulated as a restriction on Place in codas.

As the above examples demonstrate, apical consonants are frequently singled out as a natural class by phonotactic constraints. Putting together the points made above, it can be seen that apicals are dispreferred as onsets either of words[10] or of syllables after closed syllables (as in constraints (4), and (5)). On

[10]Restrictions on word-initial apicals are even more common than the above sections imply. Many languages neutralize their apical contrasts in this position. Retroflexes but not alveolars are allowed in Pintupi, Pitta-Pitta, Mantjiltjara , Lardil (Dixon, 1970, Waluwara (A, 2, Dixon, 1970), Warlbiri (A, 2, Dixon, 1970, Walmatjari (utterance-initially) and Mangarayi. Alveolars but not

the other hand, they are preferred above other consonants in coda positions, either word-finally (constraint 7) or syllable-finally (constraint 8).

The reason for onset position restrictions on apicals—supposedly unmarked segments—is unclear, but the reality of the phenomenon is strengthened by its occurrence in the Dravidian languages as well as in the Australian. This effectively rules out areal or historical explanations which would pin the whole responsibility on the whims of a single parent language.[11] Certain evidence points to a prosodic or stress-related cause. Australian languages in general have initial, trochaic stress. In Djinang, apicals are restricted word-initially, and disallowed as onsets after closed syllables (except after a homorganic consonant, where they are assumed to be doubly-linked, and therefore licensed by the preceding apical). These are both foot-initial, stressed positions. In addition, apicals are disallowed as onsets to *any* stressed syllable, even if the preceding syllable is open. Similarly, in Aranda (A, 2, Strehlow, 1942) the retroflex nasal is specifically confined to unstressed syllables. This suggests that apicals are sensitive to stress or to foot-structure.[12] Trying to account for all the restrictions in all these languages on stress or prosodic grounds may be difficult, however, since in Tamil (which has no stress, only an "accent" which is realized only as phonological—but not phonetic—prominence of the first syllable of a word) the restriction on apicals is also true of suffixes, which need not be underlyingly syllabifiable.

Whatever the prosodic reason for their behavior, the lesson that can be drawn from this is that apicals are dispreferred onsets, whether the domain be the word, syllable, or foot. On the other hand, apicals are preferred above other consonants as codas, word-finally and/or syllable-finally. This evidence firmly points to apicals as a natural class, separate from both laminals and non-coronal consonants.

Phonotactic evidence for a natural class of laminals is weaker, but not non-existent. In general, laminals are preferred above other consonants in onset positions, a situation opposite to that describing apicals. Many languages do not allow laminals to end a word, but when one discards from this list the languages also not allowing non-coronals in this position (thus ruling out interference from constraint (7)), the list shrinks dramatically. Tamil, which allows only sonorants word-finally (underlyingly word-final obstruents are supported by epenthesis), disallows the laminal nasal. This is not a strong point, however, since the laminal nasal is rare anyway. The restriction appears to be historically robust, however, being also true of proto-Dravidian, in which the laminal nasal seems to have appeared somewhat more frequently (Zvelebil, 1970). In Guugu Yimidhirr, the contrast between the dental and alveolopalatal laminals is neutralized word-finally

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retroflexes are permitted in Garawa (A, Dixon, 1970), Kitja (A, Dixon, 1980), and Iwaidja . While such restrictions on only one apical are not in themselves evidence for apicals acting together as a natural class, they add weight to the observation that apicals are dispreferred in onset positions.

[11] Taking this similarity of behavior as evidence for a historical relationship between the Australian and Dravidian language families is not a reasonable option. Even if the languages were related, the time span involved would be so great as to bring up the question in another form: what makes the apical constraints so durable and resistant to change?

[12] It is possible that there are other languages which are like Djinang in not allowing apicals to begin *any* stressed syllable. Most sources catalogue possible consonant clusters but may miss the restriction on apicals beginning every other light syllable that Waters (1979) found.

in favor of the dental. According to Dixon (1980), neutralization of the laminal contrast word-finally is quite common in Australian languages. One language surveyed proved an exception to the dispreference of final laminals, while still supporting laminals as a distinct natural class: in Mantjiltjara, the laminal stop is the only licit word-final stop.

While not as strong as the evidence from apical phonotactics, the phonotactics of laminals support the view that apicals and laminals form distinct natural classes, as predicted by feature [distributed] in the A/D model. Evidence from other areas of phonology strongly supports this conclusion.

3.2 Historical Evidence

Historical work on proto-Australian suggests that the two laminal series originally came from one. In cognates between a two-laminal language and a one-laminal language, both laminals of the first language will map to the one laminal in the other. Dixon (1970) argues that the dental laminals are the original proto-Australian series, with the alveolopalatals occurring allophonically before /i/. In the modern one-laminal languages, the alveolopalatal has often expanded into the major allophone, with the dental playing a minor role. This historical evidence shows laminals corresponding to, and developing into, only laminals , and not apicals or non-coronals.

The historical evidence also suggests that the two apical series in Australian languages came from a single apical series in proto-Australian. The facts here are not quite as clear, however, and may be indicative of an earlier phonemic split than that of the laminals. Cognates show both apicals of a two-apical language corresponding to the single apical in a one-apical language. Dixon (1980) reconstructs a single alveolar series for proto-Australian, with retroflexes occurring allophonically after /u/. As with the laminals, we find apicals here corresponding uniquely to apicals, and not to other consonants.

3.3 Synchronic Allophonic Evidence

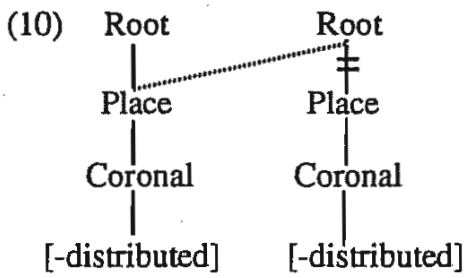
The synchronic facts for the Australian languages that show allophonic alternations in their coronals are much the same as the historical reconstructions. Laminals alternate with laminals, and apicals with apicals. Languages with only one underlying laminal will generally have an alveolopalatal before /i/ (and /e/ if the language contains this vowel). Elsewhere they have a dental, as in Tiwi (Osborne, 1974), Madimadi ("except in the second, accented syllable of words of more than two syllables," Dixon, 1970), and Gugada[13] (Platt, 1972).

Synchronic apical alternations occur in Mangarayi. As shown in 3.1(C) above (see especially rules in (6)), Mangarayi retroflexes become alveolar after non-retroflex consonants, but alveolars become retroflex after retroflexes. This assimilation of alveolars to retroflexes is of special interest, as it implies a relationship between the two apicals that is not shared by other consonants. In fact, I would claim that apicals are similar enough to each other to cause assimilation triggered by the Obligatory Contour Principle in this language. The Obligatory Contour Principle (OCP) prohibits identical adjacent nodes, forcing

[13] Before /a(:)/ and word-finally, the laminal nasal shows a certain amount of free variation between the dental and palatal articulations.

adjacent segments of the same place to share place nodes (Leben, 1973; McCarthy, 1986; Yip, 1988). The fact that alveolars assimilate to retroflexes (but not to other coronals) under the OCP implies that at some level they have identical places not shared by other coronals. This can be explained if these apicals share [-distributed] as well as Coronal. The assimilation is shown in (10), which shows that all apical clusters will be homorganic.

(10)



Walmatjari is another case cited above with apical alternation. Utterance-initially, all Walmatjari apicals are retroflex. After a word or morpheme boundary, apicals all become alveolar, except after retroflex consonants, /a/ and /u/, where they are all retroflex. This alternation will receive a theoretical explanation in section 6 below.

As might be guessed from the historical evidence presented above, retroflexion after a back vowel (usually just /u/) is a common synchronic phenomenon in the single-apical languages of eastern Australia (Dixon, 1980). This argues for a special relationship between retroflexes and back vowels, as discussed in section 6.

3.4 Evidence from Speakers' Judgments

Yet another type of evidence that shows the laminal coronals forming a class separate from the apical coronals is that of speakers' judgments. In many Australian cultures, the death of a person brings about a taboo on that person's name and on similar lexical items. Opposite laminals are considered to make a word similar enough to invoke the taboo. Thus in Yolŋu (Dixon, 1980) the death taboo on the name Bitjiŋu (where "tj" is an alveolopalatal stop) extended to the lexical item *bithiwul* (meaning "no, nothing", and where "th" is a dental stop).

Apicals have also been shown to be considered close in taboo contexts. In Mantjiltjara, the repetition of a person's name is avoided. Thus if a person is required to say a name several times, a consonant or vowel will be changed to make the repeated forms just slightly different. While Marsh (1969) does not give strict rules about which consonants are used to replace which, the example he gives replaces an alveolar with a retroflex. Specifically, the name *Wiljtjin* is shown to alternate with *wiljtjuɳ*. Note that the change to retroflex is accompanied by a change from front to back vowel.

3.5 Evidence from Diyari Voicing

A final piece of evidence for [distributed] as a feature separating the apical and laminals into natural classes is from Diyari (A, Busby, 1980). Most stops in

Diyari do not show a voicing contrast. Voicing is distinctive, however, only in the two apicals.

Putting together all the forms of evidence cited above, we see that apicals consistently pattern with (or alternate with) apicals, to the exclusion of laminals and non-coronals, and laminals pattern and alternate with laminals, to the exclusion of apicals and non-coronals. The only natural conclusion is that laminals and apicals form independent (i.e. non-overlapping) natural classes. This is what is predicted by assigning them to the opposite values of the binary feature [distributed].

An alternative to the binary-valued feature would be to make the feature privative, defining one of these natural classes as unspecified for the feature defining the other. In such a case the feature should perhaps be renamed [apical], since the phonotactic constraints cited, and the Diyari voicing, depend rather heavily on the presence of a feature specifying apicals. Constraints (4) and (5), for instance, rule out apicals in onsets while permitting all other segments. If the apical/laminal contrast were made with a privative [laminal] feature, these constraints would be difficult to formulate. Instead of just ruling out [-distributed] in onset positions, these constraints would have to be formulated so as to rule *in* both noncoronals and [laminal] coronals. This would have the effect of ruling out apicals, but at the cost of complicating the constraints so that they no longer refer to a single natural class. Being able to refer to the class of apicals with a single feature is therefore preferable.

On the other hand, a privative [apical] feature would predict that laminals would frequently assimilate to adjacent apicals by simple feature-filling rules, while the reverse would not tend to occur. This does not appear to be the case.

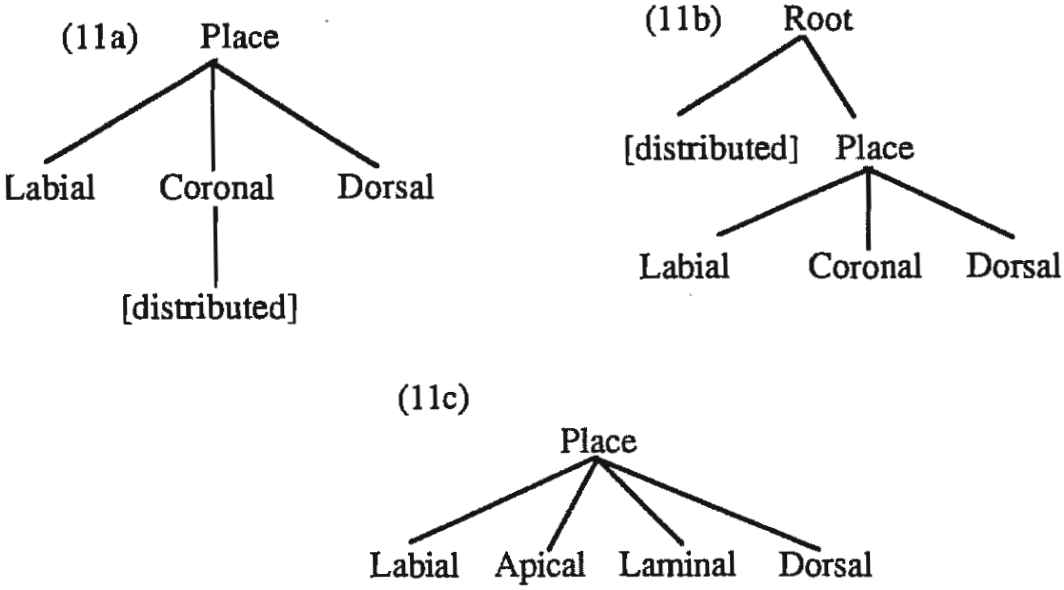
A second alternative to a binary valued [distributed] would be two privative features Apical and Laminal. This would predict that three classes of coronals could contrast: apical, laminal, and neutral coronals. Evidence for such a three-way contrast has not been found. I will not go further into issues of privativity here, however. The important point is that apicals and laminals constitute independent natural classes, and this fact is adequately accounted for with a binary-valued feature [distributed].

4. [Distributed] as Dependent on the Coronal Node

The evidence discussed above clearly demonstrates that an adequate theory of feature geometry must assign apicals and laminals to separate natural classes, and this is satisfactorily done by the feature [distributed]. What is yet to be demonstrated is the feature's locus in the feature geometry. There are logically three possible positions for [distributed] on the geometrical tree: under Coronal, completely separate from Coronal, or replacing Coronal. The first possibility, putting [distributed] under the Coronal node as in the A/D model, would predict that apicals and laminals together form a larger natural class, that of coronals. The second alternative, separating [distributed] from the Coronal node, would in effect be a restating of the SPE definition of [distributed] in a feature-geometric framework. It would predict that apicals and laminals could form their respective natural classes with certain non-coronal consonants, and that the union of [-distributed] and [+distributed] sounds would not form a larger natural class equivalent to the coronal class. This would also predict that segments could share Coronal Nodes without sharing their values for [distributed]. The third option

would do away with the larger class of coronals, and make apicals and laminals independent of each other in much the same way as, say, labials and velars. In this case, consistency would call for splitting the binary feature into the privative features of Apical and Laminal, to match the other major place nodes.

The three geometric possibilities are shown in (11a)-(c). In (11b) the exact locus of the [distributed] node is not important; what matters is that it is not dependent on the Coronal node.



It will be argued here, in keeping with the A/D model, that (11a) is the correct representation. To demonstrate this it is necessary to show that laminals and apicals together form a natural class which can be identified with that traditionally known as the coronal class. Since SPE it has generally been assumed that a major natural class consisting of coronal consonants, and including apicals and laminals as subtypes, does exist. Evidence for the natural class of coronals, as demonstrated for example by assimilations and phonotactic constraints, abounds in the world's languages (Paradis & Prunet, 1991). This evidence has led to models of feature geometry wherein Coronal is a major class node, and [distributed] is one of its dependents, as in Steriade (1986).

Steriade's argument for Coronal as a major class node, with dependent features which distinguish the coronal subplaces, comes mainly from Sanskrit. Sanskrit (Allen, 1951) has an unusual coronal assimilation process, called the *nati*, or n-retroflexion rule. In this case, *n* is retroflexed to *ṇ* if it follows a retroflex continuant, i.e. *ṣ* or any of the syllabic or consonantal rhotics. Unlike many other types of assimilation, this one is not restricted to adjacent consonants. Any number of vowels or consonants may intervene between the trigger and the target, provided that none of the consonants is a coronal.[14] Thus *ārabhya* + *māna* becomes *ārabhyamāṇa*. The coronal consonants form a natural class blocking this rule. Steriade analyzes the n-retroflexion as spreading of the coronal node,

[14] The coronal semivowel, y, is an exception. I assume that this is because y is nonconsonantal and is either not specified as coronal or has its features on a separate vowel-tier.

providing a natural explanation of the blocking behavior of the coronals. This argues in favor of a major class node, Coronal, dominating other features as in (11a). If the Sanskrit dental series is considered [+distributed], then the n-retroflexion also involves the spreading of [distributed], since retroflexes are [-distributed]. Given that Coronal can already be assumed to be spreading, and given that phonological processes are regarded as spreading one node at a time, this would imply that [distributed] is under the Coronal node.[15]

The following subsections will discuss further evidence found in the present language sample for [distributed] as dependent on Coronal. This inevitably also includes further evidence for Coronal as a natural class.

4.1 Evidence from Coronal Phonotactics

(A) While the languages in this study usually have separate phonotactic constraints for the classes of apicals and laminals, it is possible to observe phonotactics unique to the whole class of coronals. Thus in Pintupi, the only consonants permitted to end a word clause-internally (clause-finally no consonants are permitted) are apicals and laminals. Here we see the apicals and laminals together forming a natural class, and this is the class traditionally known as coronal. In other words, the union of the classes defined by [+distributed] and [-distributed] is exactly coextensive with the natural class of consonants permitted word-finally. This suggests that the two values of [distributed] form a larger natural class. In feature geometric terms, this is evidence for Coronal as a major place node dominating [distributed], and defining a natural class that includes both values of the feature, as in (11a).

In Pintupi, as well as in Mantjiltjara and Walmatjari,[16] coronals (both apicals and laminals) are immune to phonotactic restrictions on other classes of sounds. These languages permit consonant clusters to be heterorganic only if they start with a coronal. Thus coronal-noncoronal clusters are permitted, as are homorganic noncoronal-noncoronal clusters, but noncoronal-coronal clusters are ruled out. For example, mb, ŋg, nʸb, nʸg, ɲb, ɲg, nb, and ng are licit clusters in these languages, but *md, *mdʸ, *mɖ, *mg, *ŋd, *ŋdʸ, *ŋɖ,*ŋb are not.

These facts point to the presence of a constraint which allows only coronals in non-place-linked codas, as shown in (12). This constraint is similar to constraint (9), by which certain languages allow only apicals in non-place-linked codas. Here, however, the constraint affects the whole coronal class.

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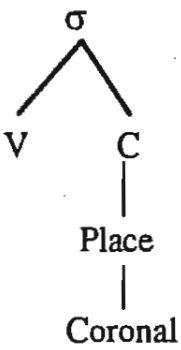
[15] In Section 7 I argue that Sanskrit dentals are not specified for [distributed]. This leaves intact Steriade's argument that Coronal is a major class node with dependent features, but forces us to look elsewhere for evidence regarding the placement of [distributed] specifically.

[16] In Walmatjari, stop-stop clusters are an exception to the description given here, since noncoronal-coronal clusters are allowed in these cases.

(12)



In the case of Walmatjari it must be assumed that word-final consonants are extraprosodic, as most consonants are allowed in this position, in apparent violation of (12). In the case of Mantjiltjara, as in Pintupi, no word-final noncoronals appear. The case is slightly different from Pintupi, however, in that apical stops (but not nasals) are also ruled out word-finally. Presumably this is the result of an independent constraint.

As in the case illustrated by constraint (9), where only apicals are allowed in codas, constraints such as (12) are often reformulated to hold for *any* place node in a coda, under the assumption that the permitted codas are unspecified for place. This is an undesirable result here, since Pintupi, Mangarayi and Walmatjari all distinguish three subplaces within the coronal class. Coronal underspecification could only work in these cases if all distinctions within coronals are made by features not dependent on the Coronal Node (as in (11b), for example). This is not a suitable alternative given the evidence that spreading Coronal entails the spreading of [distributed], shown below in (B).

(B) In some languages coronals in clusters must assimilate to one another, while coronal-noncoronal clusters are permitted. Iwaidja nasal-stop clusters follow such a pattern. Thus *nb, ng, nʸb, nʸg, ɳb* and *ɳg* are all permitted heterorganic clusters, but **ndʸ, *ɳdʸ*. The only permitted coronal-coronal clusters are the homorganic *nd, nʸdʸ,* and *ɳɖ*.[17] Thus coronal clusters share not only their specification of major place, but also the values of the features distinguishing the coronal subplaces, including [distributed]. This is easily explained if we assume that the OCP is sensitive to adjacent instances of Coronal Nodes in Iwaidja coronal nasal-stop clusters. This forces these clusters to share Coronal Nodes. This will also result in the sharing of any nodes dependent on the Coronal node. Since [distributed] is shared, this can be taken as evidence that it is, in fact, under the Coronal node.

The same homorganicity requirement on coronals can be found in Walmatjari liquid-nasal, nasal-nasal, and nasal-stop clusters, with the exception of a few instances of a *ntʸ* cluster. As in Iwaidja, this is evidence for the representation in (11a) rather than that in (11b) or (11c).

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[17] Heterorganic clusters ending in apicals are independently ruled out (see constraint (7)). The coronal cluster facts can not be explained by combining the apical restriction with a phonotactic constraint on laminals, since in liquid-stop clusters laminals are allowed to follow apicals. In any kind of cluster, a first consonant will be coronal if the second one is.

Further evidence may be found in Tamil. In the Level 1 morphology of Tamil, suffix-initial dentals assimilate to stem-final apical stops (the reverse can not happen, as suffix-initial apicals are independently ruled out). Examples are shown in (13) (data from Christdas, 1988).

(13) paṭ + t̪ + aa] —> [paṯ̪aa] "suffer + past tense + pronominal"
ṯoṭ + t̪ + aa] —> [ṯoṯ̪aa] "plant + past tense + pronominal"

keṭ + t̪ + aa] —> [keṯ̪aa] "spoil + past tense + pronominal"
pet + t̪ + aa] —> [pettaa] "bear + past tense + pronominal"

Unfortunately, most Tamil verbs do not form their past tense with the "*t̪*" morpheme, so evidence for the underlying dental character of the suffix here is scarce. Christdas does, however, contrast the forms in (13) with forms that do not end in apical stops. Thus underlying /paarC/ ("to see", where C is an unfilled consonantal position) forms its past tense as *paaṯ̪*, in which the dental suffix spreads to the C position, forming a geminate. The /r/ then deletes. The past tense suffix in this example has not undergone assimilation, and surfaces in its underlying dental form.

Here again we find assimilation to opposite values of [distributed], involving no noncoronal sounds, strengthening the force of the evidence found in Iwaidja and Walmatjari.

4.2 Evidence from Constraint-driven Repairs

As described in 3.3 above, phonological alternations pair apicals with apicals, and laminals with laminals. There are a few cases, however, of apicals becoming laminals, or laminals apicals, in cases where the underlying segment violates the phonotactic constraints of the language.

Tamil, as can be seen by its phoneme chart, has been analyzed by Christdas (1988) as possessing a phonemic alveolar nasal, but not a dental one. The phonotactic constraints of the language do not allow apical nasals to begin words. In this environment, the apical alveolar nasal becomes a laminal dental. Thus Tamil possesses a dental nasal allophonically, but not phonemically. The rule (again, rather non-theoretically, pending more theoretical developments in later sections) is demonstrated in (14).

(14) $\begin{bmatrix}\text{-distributed}\\ \text{"+anterior"}\end{bmatrix}$ —> [+distributed] / #____

The point here is that under the pressure of phonotactic constraints, one type of coronal can become the other type of coronal. This argues against the representation in (11c), where a change from apical to laminal would be only as likely as a change from apical to labial or dorsal.

A similar situation occurs in Lardil. According to the phonotactic constraints of Lardil, words may only end in apicals (or vowels). When a word ending in a *t* receives a vowel-initial suffix, the *t* becomes a *ṯ* before a back vowel (/a/ or /u/), and a *tʸ* before a front vowel (/i/). This is shown in (15).

(15) (data from Hale (1973))

uninflected	nonfuture	future	
yaɽput	yaɽputʸ - in	yaɽput̲ - uɽ	"snake, bird"
ŋampit	ŋampitʸ - in	ŋampit̲ - uɽ	"humpy"
kaltʸit	kaltʸitʸ - in	kaltʸ it̲ - uɽ	"urine"

Hale (1973) uses these facts to formulate the rule in (16).

(16) $t \longrightarrow \begin{bmatrix} +\text{distributed} \\ \alpha\text{anterior} \end{bmatrix} / \_\_ + \begin{bmatrix} V \\ \alpha\text{back} \end{bmatrix}$

Stevens, Keyser, & Kawasaki (1986) pursue the question of why the value of [anterior] appears to depend on [back] in this case. They argue that [back] serves the purpose of enhancing the [anterior] distinctions between [+distributed] coronals, dentals being redundantly [+back], and alveolopalatals being redundantly [-back]. According to the analysis I give in this paper, the Stevens, Keyser, & Kawasaki proposal for the use of [back] with laminals is basically correct, except that I claim that [back] should replace [anterior], instead of being used to enhance it (see sections 5 and 6).

As I see it, the real question here involves the alternation in [distributed], rather than that in anterior.[18] The *t* can be understood as alternating with *t̲*, which then independently alternates with *tʸ*. The alveolopalatal can easily be seen as being derived from the dental in the environment before a front vowel, as in many of the other Australian languages. This interpretation is borne out by other data of the language: a search of Hale et al.'s (1981) dictionary of Lardil shows only 5 instances where a dental stop is followed by /i/[19], as opposed to 120 instances of an alveolopalatal stop followed by /i/. Of these five cases, two are loan words from English. Two contain the same morpheme, which appears elsewhere with an /u/. In these two words and the remaining fifth word, /i/ also appears in the following syllable and may be credited with some influence. It is then not unreasonable to assume that in Lardil dentals become alveolopalatals regularly before front vowels. This is more realistic than assuming that the alveolars directly become alveolopalatals, since alveolar - /i/ clusters do appear in the language (87 are listed in the dictionary).

What needs to be explained is why the apical *t* alternates with the dentals in the first place. I believe the key to the problem is to be found in the phonotactics of the language. Of the coronal stops, *t* is the only one that occurs root-finally in Hale et al.'s dictionary. Although the nasals allow both alveolars and retroflexes in this position, the oral stops do not. As there is thus no contrast among (oral) coronal stops in this position, the one coronal stop that does occur may be considered underlyingly unspecified for [distributed] (and any other

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[18] Stevens, Keyser & Kawasaki also argue, in another section of the paper, that the [distributed] distinction between alveolars and dentals is also enhanced by the feature [back], alveolars being [-back], and dentals being [+back]. This is not in itself enough to cause the alternations between alveolars and laminals: if the alveolar is [-back], why should it become a palatal in the environment of a [-back] vowel?

[19] There is also one case of the dental before the relatively rare front vowel /e/.

dependents of Coronal). If [+distributed] is assumed to be the default value supplied for this coronal, the appearance of laminals in the suffixed forms follows. Word-finally, however, assigning the value [+distributed] would result in a stray segment, as laminals may not end words. In these cases, the coronal must assume the value [-distributed], and will thus surface as an alveolar, which is assumed to be the unmarked apical.

What is crucial here is that the phonotactics of Lardil and Tamil motivate changes in (or different assignments of) the value of the [distributed] feature. In each case the result is another coronal, and non-coronals do not participate in the alternation.[20] This suggests that [distributed] is dependent on coronal, as in (11a).

Putting together the above points, it is reasonable to conclude that (11a) shows the correct position of the [distributed] node in the feature geometry. Not only are apicals and laminals independent natural classes, but together they make up the larger class of coronals. If two segments share Coronal Nodes, then they will also share values of [distributed], implying that [distributed] is a dependent of the Coronal Node. This is as predicted by the A/D model. Thus far evidence for both the existence of the feature [distributed] and its geometrical placement have supported the A/D model. This will not be true of [anterior], as explored in the following sections.

5. Lack of Evidence for the Feature [anterior]

Section 3 listed a wealth of evidence for [distributed]. If [anterior] exists as a sister to [distributed], as in the A/D model, then similar evidence should be available for the existence of two natural classes defined by the two values of [anterior]. Such evidence would consist of instances where alveolars and dentals pattern together against retroflexes and alveolopalatals, or vice versa.

After the abundance of cases calling on the feature [distributed], the lack of evidence for [anterior] is striking. There are a few possible instances of it, however, and these will be mentioned first.

In Guugu Yimidhirr, words may end only in vowels or coronal sonorants. Of the coronal nasals, *n* or *n̪* may occur, but not *nʸ*. This could be claimed as an example of the [+anterior] coronals patterning together, but I believe another explanation is far more likely. As Dixon (1980) points out, Australian languages tend to neutralize the contrast between laminals word-finally. This is how the Guugu Yimidhirr facts were interpreted in 3.1 above. What makes this case open to debate is the absence of a retroflex series in the language. If retroflexes occurred, and were ruled out word-finally, this would be evidence for [anterior], as the two [-anterior] nasals would be acting as a class. If the retroflexes occurred but were not ruled out word-finally, this would be evidence that the absence of *nʸ*

[20] At this point one might wonder why Tamil does not display similar alternations between retroflexes and alveopalatals, since these consonants are also claimed to have opposite values of [distributed]. In the A/D model there is no satisfactory answer to this, but in the model developed below it will be shown that retroflexes and alveopalatals differ in more than this one feature. See section 6.

is simply due to word-final neutralization of the contrast between laminals.[21] Given the lack of a contrastive retroflex series, however, the Guugu Yimidhirr case is far from being clear-cut evidence for [anterior].

Another possible argument for [anterior] involves the Lardil and Tamil dental-alveolar alternations noted in 4.2 above. Here dentals and alveolars alternate, but not alveolopalatals and retroflexes. This could suggest that dentals and alveolars form a natural class separate from alveolopalatals and retroflexes. There is some difficulty with this interpretation, however. The feature being manipulated in these cases is [distributed]. The alternations occur under the pressure of restrictions on certain values of [distributed]. It is thus unclear how the value of [anterior] could be relevant such processes. Why would a phonological rule, which operates to repair violations of phonotactic constraints on [distributed], target only one value of [anterior]? In other words, if [anterior] were really the feature distinguishing alveolars and retroflex, and dentals and alveolopalatals, repairs on [distributed] should operate in the presence of either value of [anterior], causing alveolopalatal-retroflex alternations along with the observed alveolar-dental alternations.

As it turns out, the Lardil and Tamil facts can easily be read otherwise. Further evidence presented in section 6 below will show that alveolopalatals and retroflexes differ in more than just the [distributed] feature, so it would be unlikely to find a single phonological process turning one into the other (except in cases of total coronal assimilation).

Several of the phonotactic constraints listed in 3.1 above show the neutralization of the contrast between the two apical series or between the two laminal series in certain positions. For example, retroflexes might be the only apicals allowed word-initially in certain languages, while in others alveolopalatals might be the only laminals allowed word-finally. According to the A/D model, these two phonotactic rules would be restrictions on [+anterior]. The problem with this interpretation is that while laminals might lose their contrast word-finally, apicals almost never lose theirs in this position, and while apicals often lose their contrast word-initially, laminals do not. Apicals and laminals never lose their respective contrasts in the same positions. That is, constraints affecting "[-anterior]" apicals never affect "[-anterior]" laminals, and vice versa.

A good example of this comes from Lardil (Dixon, 1970; Hale, 1973), which has the full range of four coronal subseries. This gives us two places that are [-distributed], two that are [+distributed], and—according to the A/D model—two that are [+anterior] and two that are [-anterior]. Since there are two in each group, participation in natural classes should be evident. The apical/laminal contrast has already been demonstrated in 3.1(D), on the evidence that only apicals in Lardil can end a word. As mentioned in footnote 10, however, the apical contrast is neutralized word-initially in favor of the retroflex. In terms of the A/D model, the [+anterior] apical is disallowed in word-initial position. The same is not true for the laminal series. Both types of laminals may begin a Lardil word. The two [+anterior] subplaces are not acting together, and we thus have no evidence here for natural classes defined by [anterior].

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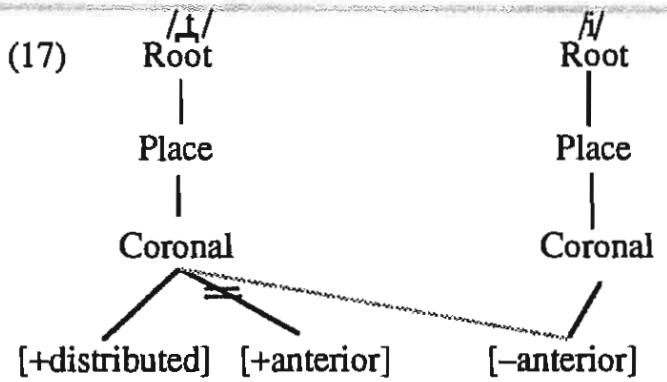
[21] Guugu Yimidhirr also allows as finals both its rhotics (which many languages—e.g. Sanskrit—consider retroflex), as well as its lone lateral (an alveolar) and the semivowel /y/. The presence of the rhotics suggests that the restriction would not extend to retroflexes, but without a contrastive retroflex series this can not be considered solid evidence.

The facts mentioned above show the functioning of "[anterior]" as if it were dependent on the value of [distributed]. It is certainly possible that an independent feature need not always function independently. A particular rule affecting [anterior] *may* specify the value of [distributed] in its target, just as the assimilation of coronal clusters in Iwaidja nasal-stop clusters (see 4.1) is sensitive to the presence of a nasal rather than liquid first element. If all rules affecting the value of [anterior] do this, however, we have good reason to be suspicious, and at this point suspicion regarding the existence of an independent feature [anterior] is justified. Unfortunately, we have here a problem of finding negative evidence. In light of the quantity of positive evidence for the [distributed] feature, though, negative evidence here should be quite telling.

Evidence of a positive sort is forthcoming, however. As discussed in sections 3.2 and 3.3, historical and synchronic processes point to alveolopalatals being derived from dentals before /i/, and retroflexes being derived from alveolars after /u/. Looking first at palatalization, it is only reasonable to assume that this is the result of feature spreading. Other possible phonological processes, such as dissimilation or delinking, seem far less likely. If we furthermore assume the structure of alveolopalatals given in the A/D model, we must conclude that the spread feature is [-anterior], and the target a coronal with a [+distributed] feature., as in (17). This would be another instance of [anterior] failing to behave independently of [distributed].

(17)

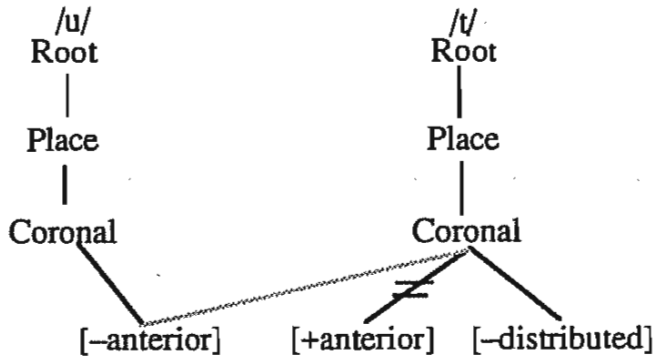


The assumptions of the A/D model lead to the conclusion that /i/ (and presumably other front vowels) is a coronal with the feature [-anterior], as shown in (17). This is because /i/ must possess the feature [-anterior] in order to spread it, and the presence of [anterior] presupposes that of the Coronal node, due to the dependency relation between these two nodes. Analyses of this type have been made before, for example by Mester & Itô (1989), Clements (1991) and Broselow & Niyondagara (1991). For the palatalization of laminals, then, this analysis appears to work. If [anterior] really were an independent feature, however, rules which spread it should not *always* target [+distributed]. One would expect to find similar instances of front vowels conditioning retroflexion of alveolars.[22]

[22] There is one case that I know of which involves retroflexion conditioned by front vowels. This is the *ruki*-rule of Sanskrit, in which /s/ is retroflexed following r, u, k, or i. This is a problematic case for both the A/D model and the new model proposed below. It is interesting to note that the same environment caused /s/ to become ʃ in Avestan, and *x* in Old Church Slavonic (Allen, 1951). This suggests that in proto-Indo-European /ɾ/ could have triggered a retroflex fricative, /u/ and /k/ a velar one, and /i/ an alveopalatal one. The three fricatives later collapsed into one, leaving a rule which is no longer fully assimilatory in nature. Further work is needed to understand this case.

Instead of being triggered by front vowels, however, retroflexion is triggered by back vowels. Again, we can assume that a spreading process is at work here. If we continue to assume the A/D model, which worked for palatalization, we get contradictory results. According to the A/D model, the difference between alveolars and retroflexes is the value of [anterior]. This implies that retroflexes are derived from alveolars by the spreading of the feature [-anterior], which in turn implies that back vowels are [-anterior] and, furthermore, coronal. The spreading is shown in (18).

(18)



The A/D model thus predicts that front and back vowels are both coronals, and both [-anterior]. This is problematic. Since back vowels are not made by raising the blade or tip of the tongue, it is undesirable to call them coronals. Furthermore, if one thus uses consonantal features to describe vowels, surely front and back vowels should have different features, not the same. Appealing to a difference in the feature [distributed] (with front vowels as [+distributed] and back vowels as [-distributed]), doesn't help. It is even less likely articulatorily that back vowels are made with the tip of the tongue than that they are made with the blade. And, of course, we are left with the problem of why [anterior] never behaves independently of [distributed], while [distributed] can behave independently of [anterior].

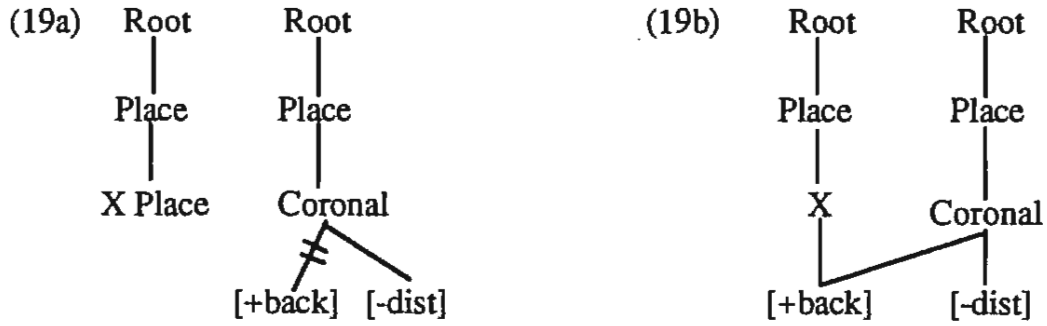
I propose that it is far better to assume that front and back vowels can not both be [-anterior] coronals than to assume, on the grounds of the A/D model, that they both are. If the grounds for considering the back vowels as [-anterior] are questioned, the same questions must be applied to the front vowels, and any reasonable explanation of the palatalization and/or retroflexion processes as described by the [anterior] feature of the A/D model falls apart. I would propose, then, in light of the lack of evidence for [anterior] behaving as an independent feature, and in light of the contradictory evidence of [anterior] being associated with both front and back vowels, that [anterior] does not exist as a true phonological feature. Instead, the contrast between alveolars and retroflexes, and between dentals and alveolopalatals, must be made in some other way, as described in the following section.

6. A New Proposal

The evidence in the preceding section revealed that a single value of one feature dependent on the Coronal node can not account for both the distinction between retroflexes and alveolars and that between alveolopalatals and dentals. The [anterior] feature of the A/D model has thus been discredited, and something

(or somethings) new must take its place. The historical and allophonic evidence cited gives us a clue to what this should be. As we have seen, palatalization is associated with front vowels, and retroflexion with back vowels. I propose, therefore, that the new features associated with these coronals should be those associated with the appropriate vowels. Thus alveolopalatals are characterized as [+distributed] and [-back], while retroflexes are [-distributed] and [+back].[23] This will be called the D/V model, in reference to the fact that [distributed] and vowel features distinguish among coronals.

The D/V model successfully accounts for the coronal alternations examined thus far. A case in point is Walmatjari, whose apical alternations could not receive a natural explanation under the A/D model. As seen in section 3.3, Walmatjari apicals exhibit complex alternations in morpheme-initial positions. Utterance-initially, retroflexes but not alveolars occur. After a word or morpheme boundary, apicals are alveolar except after retroflexes or /a/ and /u/, where they are retroflex. The utterance-initial condition suggests that underlyingly initial apicals are retroflex. They then become alveolar when preceded by a (nonretroflex) consonant or a front vowel. In the D/V model this change from retroflex to alveolar can easily be analyzed. Retroflexes are characterized as [+back]. Coronals with the [+back] feature are ruled out in morpheme-initial (but not utterance-initial) position. This constraint triggers delinking of [+back]. The rule is blocked by the presence of a preceding retroflex or a back vowel. This suggests that a morpheme-initial retroflex can escape the constraint on onset [+back] by becoming doubly linked with the preceding segment. (19a) shows the a retroflex following a nonback segment becoming alveolar through the delinking of [+back], while (19b) shows a retroflex remaining retroflex due to double linking with the preceding segment.[24]



One might ask what an apical would look like that was [-back], or a laminal that was [+back]. These are presumably the opposite-valued apicals and

[23] It may be that [-back] should be replaced by Coronal, and [+back] by Dorsal, as argued, for instance, by Clements (1991). Since much of the evidence for front vowels being coronal has hinged on the assumptions of the A/D model, however, a more conservative stance is adopted here. The crucial point is that retroflexes are characterized by the place feature of back vowels (whatever that may be), and the alveopalatals are characterized by the place feature of front vowels.

[24] This analysis assumes, of course, that adjacent segments in Walmatjari may become doubly-linked even after morpheme concatenation, and that the constraint on initial retroflexes is not enforced until after the linking occurs.

laminals: [-back] apicals are thus apical alveolars, and [+back] laminals are laminal dentals. This would lead one to predict that dentals and retroflexes, or alveolars and alveolopalatals could pattern together.

This prediction appears to be confirmed by some phonotactic facts of Toda (Emeneau, 1984). Toda has constraints on the consonants which may occur after both *ü* and *ü:*. The consonants which may occur after neither the long nor the short high front rounded vowel are the velars, retroflexes, and dentals[25] (and *m*). As predicted, the retroflexes and dentals pattern together. The patterning of velars here with [+back] consonants is not surprising, especially in light of how Ponapean also classes velars as [+back], as discussed below. The facts here do not constitute as strong evidence as one might wish, however, since the high front rounded vowels are rare in Toda, and only three consonants of the language appear after *both* the long and short version of the vowel. Nevertheless, the Toda facts tentatively support the predictions of the D/V model.

Further evidence for dentals as [+back] and alveolars as [-back] comes from Stevens, Keyser & Kawasaki (1986), who studied the acoustic properties of dentals and alveolars in Malayalam. They found that for alveolar stops the frequency of the second formant on either side of the stop closure was markedly higher than for dentals. According to Stevens, et al., such an elevated second formant is evidence of a fronted tongue body position. This leads them to the conclusion that [-back] is a phonetic enhancement feature characterizing alveolars, while [+back] is an enhancement feature characterizing dentals. This is evidence for the present model, except that I claim that [back] is distinctive for coronals, and not relegated to the status of "enhancement" feature.

The features characterizing the various types of coronals in the D/V model are shown in the table in (20), with the values assigned by the A/D model included for comparison. The specific geometry of the D/V model with respect to the placement of the vowel features will be discussed in section 7.

(20)

	D/V Model		A/D Model	
	distributed	back	distributed	anterior
t̪	+	(–)	+	+
t	–	(+)	–	+
ʈ	–	+	–	–
tʸ	+	–	+	–

[25] This is true of the Toda dental stops and the non-strident fricative /θ/. Toda also possesses a strident fricative /s/ and two affricates (voiced and voiceless) which Emeneau describes as "post dental". There is evidence, however, that these stridents are phonologically dental, in which case the feature [strident] would be needed to distinguish /θ/ from /s/. If this is so, the above phonotactic statement grouping retroflexes with dentals would have to be reworded to include only nonstrident dentals. With five contrasting coronal fricatives, Toda is a good candidate for a study of [strident] and coronal fricative places.

The values for [back] are given in parentheses for alveolars and dentals. It appears that for these coronals the value of [back] may be redundant, and thus unspecified, in certain languages. This would allow deretroflexion in Walmatjari to be a simple case of delinking [+back], as proposed above, rather than delinking followed by a default insertion of [-back]. It would also explain why it is only dentals and alveolars that alternate in the Lardil and Tamil phonotactically-driven rules.

In Tamil, word-initial alveolars surface as dentals, in accordance with Tamil's constraint on word-initial apicals. The same alternation not found with the retroflexes (see section 4.2 above). In Lardil, the root-final unspecified coronal surfaces as a dental before a suffix, but as an alveolar word-finally, as required by the phonotactic constraints of Lardil (see 4.2). The dental then becomes palatal before front vowels, by a rule assumed to be already present in the language, given the (near) absence of dental – i clusters in the language. The rule can not be seen to operate the other way (i.e. palatals become dental before back vowels) because both palatals and dentals freely occur before back vowels (Hale, et al., 1981). In both cases, we have alveolars and dentals alternating. If these sounds are assumed to be unspecified for [back], these facts follow naturally. Dentals and alveolars will differ only in the feature [distributed], while retroflexes and alveolopalatals differ in this as well as in [back]. In Tamil the change from alveolar to dental only involves changing the value of one feature, namely [distributed]. A simple change in [distributed] will thus not correct the violation of a phonotactic constraint by a retroflex, and so this repair is not effected. In Lardil, assuming the alveolars and dentals to be underspecified for [back] means that alveolars are less complex apicals than retroflexes and that dentals are less complex laminals than alveolopalatals. This explains why the unspecified coronal defaults to the dental instead of to the alveolopalatal, and why the unspecified coronal appears as an alveolar when it is required to be apical. It may be, however, that other languages choose different coronals to be unspecified for [back]. Further investigation is required on this point.[26]

While the patterning of alveolopalatal coronals with front vowels has often been noted (see, for example, references on this in section 5), the patterning of retroflex consonants with back vowels is less acknowledged. For this reason, further evidence for the feature [+back] as characterizing the retroflex coronals, in support of the D/V model, will be given here.

In Australian languages, we have already seen instances of back vowels triggering retroflexion in diachronic and synchronic processes (sections 3.2 and 3.4). In some Dravidian languages the opposite process has taken place: retroflexes have triggered back vowels. Koḍagu (Zvelebil, 1970) is a case in point. This language has added high and mid back unrounded vowels (*ï* and *ë*) to the general Dravidian five-vowel system of *i*, *e*, *a*, *o*, *u*. These vowels are now phonemic in the language, but were originally derived from the front vowels in the following way. Front vowels were backed before retroflex consonants. If the

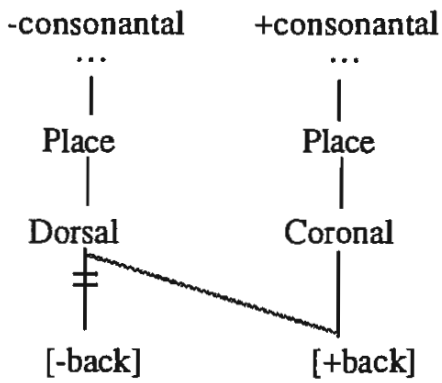
[26] The same result could be obtained by assuming that [-back] is Coronal and [+back] is Dorsal, as in Clements (1991). Alveopalatals could be coronals with an additional secondary Coronal node, while retroflexes could have a secondary Dorsal node. Alveolars and Dentals could simply have no secondary places in most cases (Toda being perhaps an exception). Using a binary feature [back] may here be a disadvantage.

preceding consonant was labial, the resulting back vowel would be rounded; otherwise, it would be unrounded. Examples of this, comparing Koḍagu words to cognates in other Dravidian languages, are shown below, where (21a) shows backing in the absence of a labial, and (21b) shows backing and rounding in the presence of a preceding labial (data from Zvelebil, 1970).

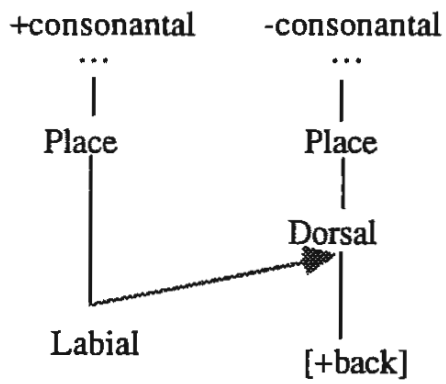
(21)	Koḍagu		Other Dravidian	
(a)	ïḷi		iḷi (Tamil, Malayalam, Kannada)	"to descend"
	ëṇṇ–	"to say, tell"	eṇṇu (Tamil)	"to think, count"
	kë:l	"to hear, ask" ke:l	(Tamil)	"to hear"
(b)	puḍi–		piṭi (Tamil & Malayalam)	"to catch hold"
	poṇṇï		peṇ (Ta, Ma, Ka)	"wife, female"

If the preceding consonant was an alveolopalatal, however, the change did not take place at all. Rules for this are shown in ((22a) and (22b) below . Note that /a/ is considered not to be [+back], since it did not undergo the rounding in (22b)). As the only low vowel in the language, it need not be specified for [back]. (22c) shows the blocking effect of the alveolopalatal. The alveolopalatal is assumed to be linked to the front vowel, blocking delinking of [-back].

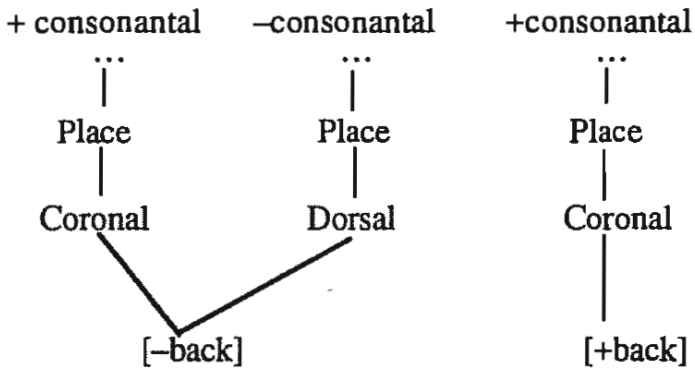
(22a)



(22b)



(22c)



In the modern language, loss of some retroflex consonants has obscured the earlier operation of rule (22a). It is still the case, however, that only back rounded vowels (and /a/) can occur in the environment between labials and retroflexes, and that back unrounded vowels can not occur after alveolopalatals (as in (22c)).

The evidence from Koḍagu strengthens the claim that retroflexes possess the feature [+back], since at one time the assimilation process of (22a) operated productively. These facts also support the association of alveolopalatals with front vowels, since the environment of the alveolopalatal blocked (or perhaps undid) the backing of these vowels.

Iruḷa (Zvelebil, 1970), another Dravidian language, presents similar evidence, although in a more complex form. Iruḷa has added four new vowels to the Dravidian inventory: back unrounded *ï* and *ë*, and front rounded *ü* and *ö*.[27] Proto-Dravidian *i* and *e* became *ï* and *ë* before retroflex consonants, as in (23). These backed vowels were rounded to *u* and *o* if also preceded by a labial, although this was largely erased by a later process (see (24)). In the case of the high vowels, the backing was blocked by a preceding alveolopalatal.

(23) *kiḻi > kïḻi "parrot"
*keṯṯa > këṯṯa "bad"

So far the facts are basically the same as for Koḍagu, supporting the analysis of retroflexes as [+back]. Further changes in Iruḷa also support the present analysis. Between a labial and retroflex, when not also followed by *i* or *ay*, high back vowels (original or derived) were fronted to *ü*. Mid vowels before retroflex sonorants were fronted to *ö*. This is shown in (24).

[27] Zvelebil actually describes these four vowels as central, but I will consider them as [-back] and [+back] phonologically. The description of the historical developments here differs somewhat from Zvelebil's in interpretation.

(24) *viɻu >(*vuɻu) > vüyu "to fall"
*pul > püɭɭu "bird"
*eɻutu > (*ëɻutu) > öɭdu "to write"
*peɳ > *poɳɳu > pöɳɳu "woman, wife"
*ontu > *oɳʈu > öɳɖu "one"

In this case we have fronting before retroflexes, as opposed to the earlier backing. Again retroflexes are conditioning a front/back change, but this time in the opposite direction. I analyze this as a dissimilation process. The presence of dissimilation with regard to the feature [back] is further evidence that this feature is present in the retroflexes. This argues against Stevens, Keyser & Kawasaki's (1986) analysis of [back] being used among coronals simply as a phonetic enhancement feature. If [+back] simply enhanced retroflexes, dissimilation with regard to [back] would be phonetically counterproductive. If [back] is a nonredundant phonological feature of retroflexes, however, dissimilation with respect to this feature is less unlikely.

The Micronesian language Ponapean (Rehg, 1973) provides additional support for the D/V model's claim that retroflexes are [+back]. Ponapean has a consonantal inventory of labials (p, m), labio-velarized labials (p^w, m^w), apical-dentals (t, s, n, l), an apico-alveolar (r), a retroflex affricate (ʈʂ, which patterns as a stop), and velars (k, ŋ). The *r* is presumably phonologically retroflex, as in Sanskrit, since it patterns with the retroflex affricate, as shown below. For a consonantal phoneme chart see the appendix.

The consonants pattern in two groups, as shown in the following chart.

(25)

Front	Back
p	p^w
m	m^w
t	ʈʂ
l	r
n	ŋ
s	—
—	k

Consonants in the "front" column may not co-occur in the same morpheme with their counterparts in the "back" column.[28] Thus sequences such as pVp, m^wVm^w, or tVt are allowed, but *pVp^w, *tVʈʂ, etc. This is presumably an OCP effect. Consonants sharing values of [sonorant] and [continuant] which share major places are obliged to share secondary place features as well.[29] This would

[28] There are five exceptions to this: one including *l* and *r*, and four involving *ŋ* and *n*.
[29] On this assumption the pairing of *n* with *ŋ* is mysterious, but note that it is this case with the most exceptions.

result if the major place nodes of the homorganic consonants were linked, as required by the OCP. Dependent place features would then also be shared.

The division of the consonants into two groups is thus justified, but the labeling of the groups as "front" and "back" has not been. First of all, it is reasonable to assume that the secondary articulation of the labio-velarized labials is derived from the features characterizing back vowels (Goodman, 1991). Further evidence for the labeling of the two columns, however, comes from the interactions between consonants and short vowels. Consonants in the "front" column have a centralizing effect on short *back* vowels. Consonants in the "back" column centralize short *front* vowels. This is shown in (26) (from Rehg).

(26)	Vowels	Front Consonants	Back Consonants
	i	[pil] "also"	[rɨr] "secret"
	e	[mɛm] "sweet"	[ʈʂəŋ] "tight"
	a	[pa^p] "swim"	[kɑ^k] "can"
	u	[lʉs] "jump"	[pʷuŋ] "correct"
	o	[pøs] "explode"	[ʈʂopʷ] "lush"
	ɔ	[pɜs] "hammer"	[rɔŋ] "burned"

When a vowel is flanked by consonants of both types, the quality of the vowel will glide from one to the other. The data cited above show that "back" consonants are incompatible with front vowels, and that "front" consonants are incompatible with back vowels. This justifies the classification of Ponapean consonants into front and back groups. The retroflex *ʈʂ* and *r* pattern as back as opposed to their front counterparts *t* and *l*. This supports the D/V model's claim that retroflexes are [+back]. The "front" consonants may be only redundantly [-back], since these do not possess secondary articulations.

The evidence from Iruḷa, Koḍagu and Ponapean confirms the evidence from the Australian languages that retroflexes are [+back]. Considerable evidence is thus available both for apical retroflexes as [+back], and for the laminal alveolopalatals as [-back].

7. Placement of Features in the D/V Model

So far the identity of the features characterizing coronals have been discussed, but—except for [distributed]—their place in the feature geometry has not. The proposal here is that [back] is directly dominated by the Coronal node when it characterizes coronal consonants.[30] The proposed geometries of the various coronals are shown in (27), with [back] shown linked by a dotted line to the dental and alveolar, indicating that these may be unspecified for the feature.

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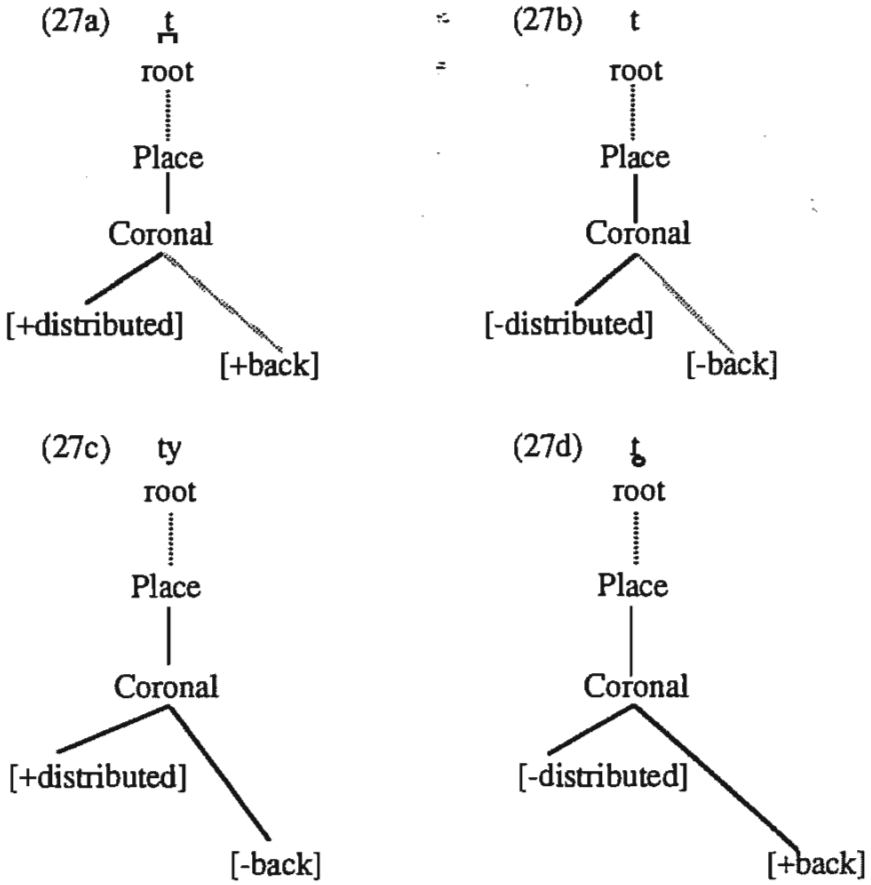
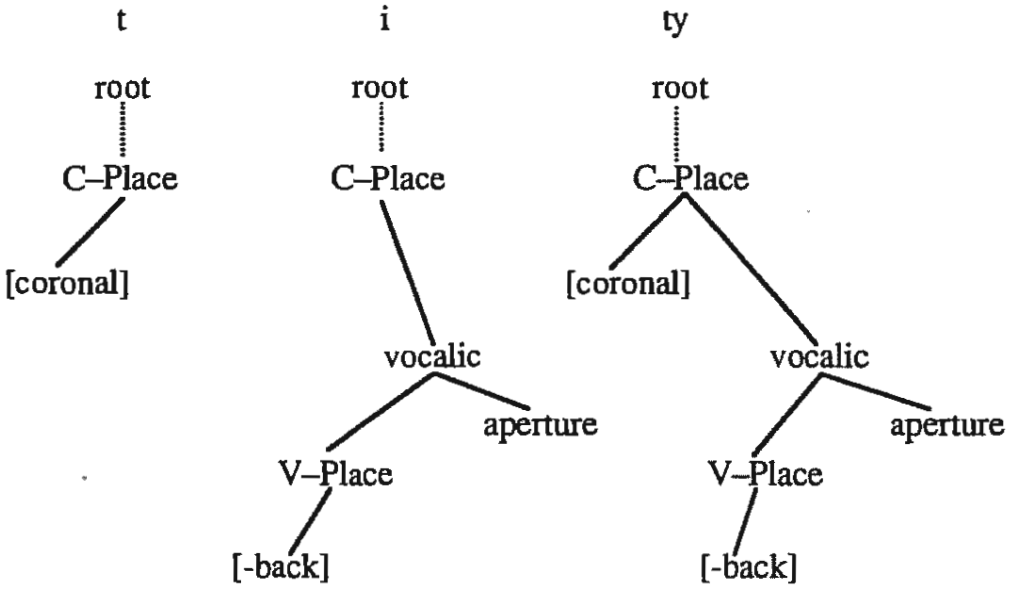
[30] A slightly different proposal would retain [back] under Dorsal, and place a whole Dorsal node under Coronal. This is not done here, since it would lead us to expect more processes sensitive to simply the presence of the Dorsal, regardless of its dependents. This would be much like [anterior], which, as we have seen, does not function in phonological processes. To my knowledge, the *ruki* rule is the only process that might be interpreted as evidence for the intermediate Dorsal (see Selkirk, 1991).



Other possibilities of placement are also available, but are less desirable because they make inaccurate predictions. Consider, for example, Clements' (1991) proposal concerning vowel features and secondary articulations in consonants. (28) shows Clements' view of how an alveolopalatal coronal consists of a plain coronal plus the features of a front vowel (after Clements' Figure 1).[31]

[31] Clements actually uses [coronal] instead of [-back] for front vowels. For the present purposes, this difference is not important.

(28)



The two models make very different predictions regarding the behavior of alveolopalatals and retroflexes.[32] The Clements model puts the relevant features of alveolopalatals on the same tier as they are on in vowels. In light of the evidence that retroflexes also share features with vowels, consistent application of the Clements model requires that [back] must also be on a vowel tier in retroflexes. The presence of vowel-tier features in these coronals makes it impossible to spread vowel features through such coronals without crossing association lines. As Clements notes, this model predicts that vowel harmony with respect to a given feature will always be impossible across consonants which have that feature as a secondary place feature. Thus [back] harmony will be blocked by coronals specified for [back]. Secondly, long-distance assimilations of consonants with secondary articulations are impossible across vowels. This means that spreading [back] from one coronal to another could not occur across any vowels specified for [back]. A third prediction is that adjacent coronals could share their Coronal nodes without sharing their secondary features. Only coronals sharing C–place nodes would share all their relevant place features: spreading Coronal alone would not ensure complete homorganicity.

The D/V model, on the other hand, makes very different predictions. First of all, alveolopalatals and retroflexes need not block vowel harmony, since the relevant features are under the Coronal node in the coronals, and somewhere else (under Dorsal or V-Place) in the vowels. This allows features to spread from vowel to vowel without crossing association lines. The secondary features of the coronals should also be able to spread across vowels without crossing lines. A

[32] This assumes that palatals and retroflexes are the only coronals specified for [back]. The following arguments may be extendible to all coronals in some languages. The details of underspecification with regard to [back] is a topic for further investigation.

positive prediction of the D/V model is that spreading the Coronal node will result in total homorganicity.

Some of the data already considered directly support the D/V model over the Clements' model of secondary place as V–place (hereafter the V-place model). Consider, for instance, the Sanskrit *nati* rule, whereby /n/ is retroflexed following coronal continuants, as described in section 4. Any noncoronal segments may intervene. The blocking effect of the coronals has already been discussed as evidence for the Coronal class. This blocking behavior of the coronals, including the non-targeted non-nasal coronals, is evidence that the node being spread here is the Coronal node (see Steriade, 1986).

Other alternatives for the spreading node are not satisfactory. Consider, for instance, the possibility that [-distributed] is being spread. This could work if [-distributed] were the only Coronal-dependent feature specified for Sanskrit retroflexes ([+back] being redundant), and other Sanskrit coronals were specified as [+distributed]. The spreading of [distributed] would then be blocked only by coronals, since these would be the only segments specified for this feature. I believe there is evidence against this in the facts of Sanskrit sandhi.

In Sanskrit (Whitney, 1889; Coulson, 1976), *t* and *ʈ* are the only coronal stops permitted word-finally. In external sandhi a final *t* will assimilate to either a following retroflex *ʈ* or an alveolopalatal *c*, as in (29) (examples from Whitney).[33] It does not assimilate to noncoronal stops. The retroflex will not assimilate to either the dental or the alveolopalatal.

(29) tat ɲi:ka: —> taʈ ɲi:ka:
tat ʈʰa:lini: —> taʈ ʈʰa:lini:
ut carati —> uc carati
etat cʰattram —> etac cʰattram

These facts suggest that, as the dental assimilates to both the other coronals, it is unspecified for coronal subfeatures. This allows the assimilation to be a simple feature-filling rule. The retroflex, which does possess coronal subfeatures, is not affected. On the other hand, the dental does not assimilate to noncoronals, implying that it *is* specified for Coronal. This analysis leads to the conclusion that the dental is not specified for [distributed], and therefore could not block spreading of [-distributed]. This implies that [distributed] is not the node that is spread in the *nati* rule. As stated above, the most reasonable analysis is that the *nati* rule spreads the Coronal node.

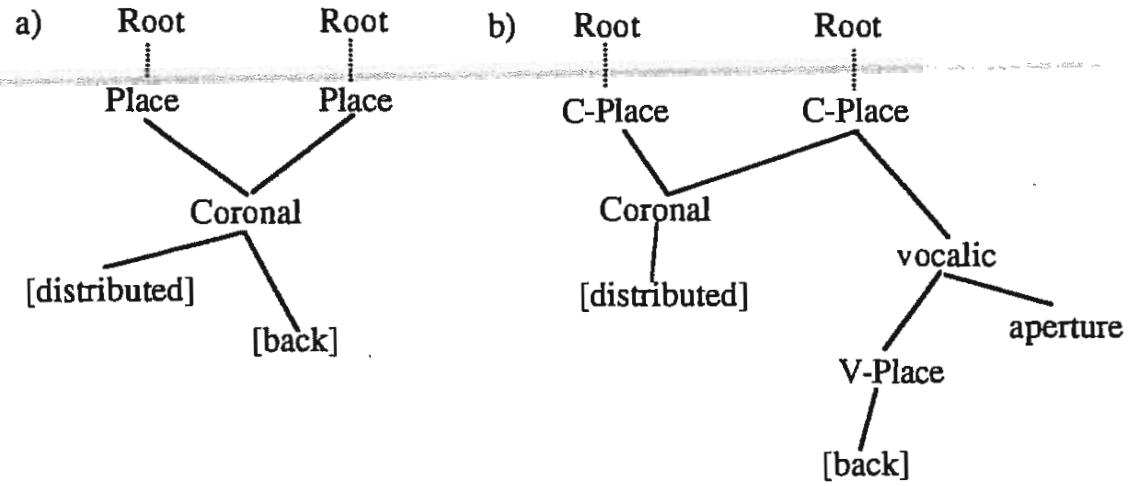
In the V–place model, spreading the Coronal node would not result in retroflexion, since it would not involve spreading the V-place node, where the specification of retroflexion is located. In the D/V model, spreading the Coronal node of a retroflex coronal would automatically result in retroflexion. In the V–place model the spreading would have to be either of the C–Place node, or the V–Place node (or its dependent, [back]). None of these could work. If the C–Place node were spread, any intervening segment would block the spreading, since any intervening segment would have a C–Place node. If the V-Place node were spread, any intervening vowel would block it, since any intervening vowel would

[33] The facts for nasals are similar, but slightly more complicated.

have a V–Place node. If [back] were spread, any vowel specified for [back] would block it. The long-distance effects of the *nati* rule could not be achieved without line crossing in this model. The D/V model correctly predicts that the features of retroflexion will be spread when the Coronal node is spread, and that such spreading need only be blocked by other coronals. This is direct evidence against the second and third claims of the V–Place model.[34]

Further evidence for the D/V model's positioning of its vowel features is from the coronal assimilation facts of Iwaidja and Walmatjari, discussed above in section 4.1. In these languages certain types of coronal clusters must be completely homorganic, while heterorganic coronal-noncoronal clusters are permitted. This was analyzed as an OCP effect that requires these clusters of coronals to share Coronal nodes in these languages. The sharing of Coronal nodes is predicted by the D/V model to result in complete homorganicity (see (30a)). In the V–Place model consonants sharing Coronal nodes need not be completely homorganic—they would only share the value of [distributed], as shown in (30b).

(30)



In the V–place model, the node shared by such completely homorganic coronals would have to be the C–Place node. This is not an impossible interpretation of the data. The analysis that the homorganicity is the result of sharing Coronal nodes appears more natural, however. The fact that coronals are allowed to form clusters with noncoronals suggests that there is an OCP requirement on adjacent Coronal nodes, not a restriction on adjacent consonantal

[34] Further supporting evidence can be found in Tahltan coronal harmony (Shaw, 1991) where coronal affricates share all coronal place features within a word, suggesting that spreading of the coronal features (including [-back]) can occur across vowels and involve the spreading of a single node. Interpreting the data involves making crucial assumptions about underspecification and the position of [lateral], so this will not be further discussed here.

C-Place nodes.[35] This is at least suggests that the third prediction of the V–place model may not be accurate.

The first prediction listed for the V–place model is that [back] or total vowel harmony will always be blocked by alveolopalatals and retroflexes. The presence of [back] under V-Place in these coronals will block any spreading of [back] or V-Place. The corresponding D/V model prediction, on the other hand is less restrictive. Vowel harmony is predicted to be blocked if the spreading rule is sensitive to the presence of the particular feature on any tier. It need not be blocked if the target must be on the same tier as the feature being spread.

The claim that vowel harmony can be sensitive to instances of a feature which is (according to the V–Place model) on another tier is demonstrated by the vowel harmony facts of Warlbiri, which illustrate a process of Labial harmony. The fact that this is Labial harmony makes the example separate from the issue of the representation of coronals, and provides neutral ground from which to demonstrate cross-tier interaction.

Warlbiri (Hale, 1973, Nash, 1980) has a process of vowel harmony, involving many nominal suffixes and all clitics, in which a suffixal or clitic /u/ becomes [i] if that is the value of the adjacent stem vowel. This process is blocked by /a/. The harmony will spread through as many suffixes as may be present, provided /a/ is not encountered. This is shown in (31), where (31d) shows the blocking effect of /a/ within series of suffixes (data from Nash).

(31)a.	kuɖu–kuɭu–ɭu–lku–tʸu–lu	"child-proprietive-ergative-then-me-they"
b.	maliki–kiɭi–ɭi–lki–tʸi–li	"dog-prop-erg-then-me-they"
c.	minitʸa–kuɭu–ɭu–lku–tʸu–lu	"cat-prop-erg-then-me-they"
d.	maliki–kiɭi–kirra–lku–tʸu–lu	"dog-prop-*allative*-then-me-they"

The harmony process in (31) is blocked by labial consonants. This is shown in (32).

(32)a.	miyi–ki–purda	"food–desiderative"
b.	wajirrki–puru	"wet time–during"
c.	milpirri–puru	"cloud–during"

The data in (32) shows that the feature being spread is Labial, since labial block the process. /a/ is presumably immune to the harmony because it has no rounded counterpart.

According to the V–Place model, rounding in vowels is represented as a Labial node under the V–place node.[36] The Labial node for labial consonants is

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[35] Proponents of the V–place theory could argue that sharing Coronal implies sharing C–Place, but this effectively does away with any useful distinction between what is dominated by Coronal, and what is dominated by C–Place.

[36] Clements (1991) makes an exception for Swedish rounded vowels, analyzing /u/ and the "inrounded" vowel /ʉ/ as C-place labials, to distinguish them from the "outrounded" /y/. This is an unusual case, however. Presumably rounding in vowels would not be represented under the C-place node when two types of rounding are not differentiated in a language.

under the C-place node. If spreading Labial from vowel to vowel (i.e. spreading V-place Labial) is blocked by the presence of a labial consonant (with C-place Labial), this is evidence for cross-tier blocking of spreading.

Given that cross-tier blocking can occur, the D/V model predicts that such a cross-tier process would produce blocking effects when [back] is spread in the environment of alveolopalatals or retroflexes. On the other hand, the harmony need not be sensitive to the features on other tiers. For example, total vowel harmony, in which the whole V–place node is spread, would not be expected to be blocked by the presence of [back] in the D/V model, contrary to the predictions of the V–Place model.

A remaining question that can not be fully explored here regards the differing behavior of alveolopalatals and retroflexes with respect to vowel harmony. Alveolopalatals are known to block [back] harmony (see, for example, Clements & Sezer, 1983), while retroflexes are not known to do so. It may well be that not all alveolopalatals have the same phonological representation. The languages in the present study are ones in which the alveolopalatals are all simple segments. In the Australian languages they are all stops. In the Dravidian languages they are phonetically affricated, but they pattern phonologically with the stops. Such simple segments, I argue, have phonological representations as in (27). Alveolopalatals in certain other languages may not have the same structure. Alveolopalatals which give evidence of being complex segments, and are phonologically affricated or have an offglide, may well have features on a V-Place tier, as in (28). Such complex coronals would be expected to obligatorily block [back] harmony. More cross-linguistic work is needed on this point.

As we have seen, the presence of blocking effects in vowel harmony processes is not in itself evidence in support of the V–Place model for simple segments, since it is also in accord with the predictions of the D/V model. I would predict, however, that instances of vowel harmony which treat all coronals as transparent could occur.

In summary, the V–place model makes three important predictions, namely that vowel harmony can not operate across alveolopalatals and retroflexes, that coronal assimilations and harmonies can not operate across vowels, and that sharing Coronal nodes does not ensure complete homorganicity for coronals. The second prediction has been disproved on the basis of the Sanskrit long-distance retroflexion of the *nati* rule. The third prediction has also been questioned in light of the *nati* rule and the Walmatjari and Iwaidja coronal clusters. In contrast, the D/V model predicts the possibility of both vowel harmony through simple alveolopalatals and retroflexes, and long-distance coronal assimilations. Furthermore it predicts that sharing the Coronal node implies total homorganicity of coronals. Although the first prediction has not yet been proved, the remaining two predictions have been borne out, and the structures in (10) are thus justified as correct representations of the coronal consonants.

8. Conclusions

This paper has set out to formulate an adequate feature-geometric model of coronal subplaces, using as a point of comparison the A/D model which puts the features [anterior] and [distributed] under the Coronal node. It has been found that [distributed], defined as the apical/laminal contrast, is phonologically valid, while [anterior] is not. Rather, the traditionally [-anterior] coronals pattern with

opposite valued vowels. This motivated the used of [-back] to characterize alveolopalatals, and [+back] to characterize retroflexes. These features were then argued to be located under the Coronal node, contrary to the claims of a V–place model of secondary place features.

Other issues regarding the features of coronals remain, however. An interesting unresolved question regards the directional preference of assimilation in alveolopalatals and retroflexes. In both the Australian and Dravidian language families, alveolopalatals tended to be associated with *following* front vowels, while retroflexes tended to be associated with *preceding* back vowels. The possible significance of this is not yet understood. Other further topics would include the position of [lateral] and [strident], and issues of coronal underspecification.

Abbreviated Phoneme Charts

Australian Languages:

Type A (35%): Andiljaugwa, Aranda, Diyari (with some voicing), Kitja, Lardil, Pitta-Pitta, Thargari, Waɭuwara,

p	t̪	t	ʈ	tʸ	k
m	n̪	n	ɳ	nʸ	ŋ

Type B (25%): Guugu-Yimidhirr, Ngiyambaa

p	t̪	t	tʸ	k
m	n̪	n	nʸ	ŋ

Type C (22%): Djinang (with voicing), Gugada, Iwaidja, Mangarayi, Mantjiltjara, Madi-madi, Pintupi,Walmatjari,Warlbiri, Garawa (with kʸ)

p	t	ʈ	tʸ	k
m	n	ɳ	nʸ	ŋ

Type D (16%): Tiwi, Warrgamay, Yidiny,

p	t	tʸ	k
m	n	nʸ	ŋ

Other Languages:

Tamil (Kanniyakumari dialect), Proto-Dravidian

p	t̪	t	ʈ	c, (T j)	k
m		n	ɳ	nʸ	

Toda

p, b	t̪, d̪	t, d	ʈ, ɖ		k, g
	tˢ, dᶻ			c, j	
m		n	ɳ		

Sanskrit (based on modern Hindi phonetic values)

p, pʰ,b,bʰ	t̪, t̪ʰ, d̪, d̪ʰ	ʈ,ʈʰ,ɖ,ɖʰ	c, cʰ,j,jʰ	k,kʰ,g,gʰ
m	n	ɳ	nʸ	ŋ

Ponapean

p	pᵂ	t		ʦ	k
		s			
m	mᵂ	n			ŋ
		l	r		

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