Coronal features and retroflexion in Dhivehi and other Indo-Aryan languages

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Hamann (2003) identifies several articulatory properties of retroflexion, three of which correspond to distinctive features commonly employed in the literature: posteriority ([–anterior]), apicality ([–distributed]) and retraction ([+back]). I use phonological activity as a diagnostic to determine which of these features are phonologically distinctive for retroflex segments in Dhivehi and other Indo-Aryan languages. The evidence suggests that retroflex segments in these languages are distinctively apical ([–distributed]), and potentially retracted ([+back]) at a post-lexical level. There is no evidence for [–anterior] at any level of representation. In light of similar findings reported in Dravidian and Australian languages with maximal coronal place inventories, I argue that this is not a case of contrastive (under) specification. Rather, I suggest that posteriority ([–anterior]) may be a universally redundant and non-essential property of retroflexion that is derived from the combination of apicality ([–distributed]) and retraction ([+back]). Some implications for models of coronal place features are briefly discussed.

1. Introduction

In the phonological literature, three phonological features are commonly used to account for retroflex segments and other coronal places of articulation: [±anterior], [±distributed] and [±back]. In this paper, I use phonological activity as a diagnostic to determine which of these three features are phonologically distinctive for retroflex segments in Dhivehi and other Indo-Aryan languages. I argue that the phonological behaviour of retroflexes in these languages can be explained if they are distinctively [–distributed], and if they are potentially [+back] at a post-lexical level. However, the feature [–anterior] cannot account for the behaviour of retroflexes at any level of representation. In light of broader cross-linguistic evidence, I suggest that the absence of

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[–anterior] on retroflexes in these languages is not a simple case of contrastive (under) specification. Rather, the tendency for retroflexes to be post-alveolar (i.e., [–anterior]) may be a universally redundant effect derived from the combination of [–distributed] and [+back].

The paper is organized as follows. Section 2 introduces the phonological features commonly employed for retroflexes and other coronal places of articulation, along with the diagnostic of phonological activity. Data from Dhivehi is presented in section 3, and analyzed in section 4. In section 5, the analysis of Dhivehi is corroborated and further refined in light of evidence from other Indo-Aryan languages. Broader cross-linguistic evidence is considered in section 6, and the implications of the proposed analysis for models of coronal place features are briefly discussed. Finally, a summary is provided in section 7.

2. Theoretical background

Phonological inventories can distinguish up to four coronal places of articulation. Maximal four-way coronal inventories typically include dental, alveolar, palato-alveolar and retroflex articulations. Such inventories are found in South Dravidian and Australian languages (e.g., Asher & Kumari 1997, Christdas 1988, Diffloth 1975, Dixon 1980, 2002, Evans 1995, Hamilton 1993). Standard approaches to feature theory have accounted for the four coronal places by means of two binary features, [±anterior] and [±distributed], as shown in Table 1 (e.g., Chomsky & Halle 1968, Sagey 1986, Lahiri & Evers 1991, Clements & Hume 1995, and many others).

Table 1: Standard coronal place features

<table>
<thead>
<tr>
<th></th>
<th>Dental</th>
<th>Alveolar</th>
<th>Palato-Alv</th>
<th>Retroflex</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORONAL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>[anterior]</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[distributed]</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

The feature [±anterior] divides the oral cavity in two at the alveolar ridge. Those coronal consonants articulated on or in front of the alveolar ridge are [+anterior] (i.e.,dentals and alveolars) while those articulated behind the alveolar ridge are [–anterior].

1 Throughout this paper I use the term palato-alveolar as a cover term for any laminal post-alveolar coronal. Within this class a distinction is sometimes made between palato-alveolar (closer to alveolar) and alveolo-palatal (closer to palatal) (Pullum & Ladusaw 1996: 33, 204). However, these distinctions are not phonologically relevant because no language is known to contrast more than one laminal articulation in this range (Hall 1997: 67). In the literature, these coronals are often described loosely as ‘palatal’. However, they must be distinguished from true palatals, which I take to be dorsal (cf., Ladefoged & Maddieson 1996: 32–33, Hall 1997). In Indo-Aryan languages (and many others), laminal post-alveolar stops are typically pronounced with an affricated release. Hence I represent them throughout the paper as /tʃ/. Other common transcription conventions include /c/ and /ʃ/.

2 Small capitol letters represent privative features (e.g., CORONAL) while lower case letters represent binary features (e.g., [anterior]). A check mark indicates the application of a privative feature.
The feature \([\pm \text{distributed}]\) corresponds to the phonetic distinction between laminal (i.e., tongue blade) and apical (i.e., tongue tip) articulations. Laminal articulations are \([+\text{distributed}]\) (i.e., dentals and palato-alveolars) while apical articulations are \([-\text{distributed}]\) (i.e., alveolars and retroflexes).^{3}

Coronal consonants are known to interact with vowels in many languages. In particular, rules of palatalization like that in (1) are very common cross-linguistically (e.g., Bhat 1978, Hall 1997: 66). In these alternations denti-alveolar consonants become palato-alveolar in the context of front vowels and glides.

\[(1) \quad \text{t} \rightarrow \text{tf} / \text{i, e} \]

These alternations are generally assumed to be assimilatory in nature (e.g., Lahiri & Evers 1991). If this is so, then palato-alveolar consonants and front vowels/glides must share certain articulatory features and form a natural class. However, there is no consensus on the feature or features that define this class. At least two solutions to this problem have been proposed in the literature. One approach makes use of the standard coronal place features outlined in Table 1. In this approach, front vowels are represented with the same features as palato-alveolar consonants, namely \([+\text{coronal}], [-\text{anterior}]\) and \([+\text{distributed}]\). Back vowels are represented with the DORSAL articulator feature, which corresponds to the tongue body. Palatalization is achieved by spreading \([-\text{anterior}]\) from a front vowel to a \([+\text{anterior}]\) denti-alveolar consonant (e.g., Lahiri & Evers 1991, Clements & Hume 1995).

A second approach is to attribute tongue body features such as \([-\text{back}]\) and/or \([+\text{high}]\) to both front vowels and palato-alveolar consonants (e.g., Chomsky & Halle 1968). One variation of this general approach is Hall (1997), who argues that: (i) palato-alveolars are inherently palatalized by means of a feature that they share with front vowels, (ii) this feature is \([-\text{back}]\) (which represents a fronted tongue body position), and (iii) \([-\text{back}]\) can be a CORONAL or DORSAL feature. Thus, Hall supplements the standard coronal place features with \([-\text{back}]\), as shown in Table 2.

<table>
<thead>
<tr>
<th></th>
<th>Dental (\text{f})</th>
<th>Alveolar (\text{t})</th>
<th>Palato-Alv (\text{tf})</th>
<th>Retroflex (\text{t})</th>
</tr>
</thead>
<tbody>
<tr>
<td>([\text{anterior}])</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>([\text{distributed}])</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>([\text{back}])</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hamann (2003: 32ff.) identifies four articulatory properties of retroflexion: apicality, posteriority, sublingual cavity, and retraction, listed in (2).

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^{3} Cross-linguistically, there tends to be a correlation between dental place and laminality on the one hand, and alveolar place and apicality on the other (e.g., Keating 1991: 42, Ladefoged & Maddieson 1996: 20–21, Hall 1997: 42). I assume that the laminal/apical distinction is the relevant distinction, as implied by the feature \([\pm \text{distributed}]\), and that the specific place of contact (dental vs. alveolar) may vary.
Articulatory properties of retroflexion (based on Hamann 2003)

a. apicality: articulated with the tip or underside of the tongue
b. posteriority: articulated behind the alveolar ridge
c. sublingual cavity: a cavity beneath the tongue blade
d. retraction: displacement of the tongue back towards the pharynx or velum

Three of these properties correspond to articulatory features employed in the literature. Apicality and posteriority correspond to [–distributed] and [–anterior], respectively. The property of tongue retraction corresponds to the tongue body feature [+back] (Hamann 2003: 36). Various people have proposed [+back] for retroflexes because they pattern with back vowels in many languages (e.g., Lin 1989, Gnanadesikan 1994, Hamann 2002, 2003, Boersma & Hamann 2005). Parallel to patterns of palatalization like that in (1), we find patterns of retroflexion like that in (3), where a denti-alveolar becomes retroflex in the context of back vowels (see Hamann 2003: 90ff. for examples, and the discussion of retroflex variation in section 5.1 of this paper). If these alternations are assimilatory in nature, then they imply that retroflexes and back vowels share an articulatory feature such as [+back].

(3)  t → ṫ / u, o, a

In summary, we find that the standard coronal features [±anterior] and [±distributed] are often supplemented by the tongue body feature [±back] in order to account for the phonetic properties and phonological behaviour of palato-alveolars and retroflexes. A more complete list of potential coronal features includes [±back], as shown in Table 3.

Table 3: Summary of potential coronal place features

<table>
<thead>
<tr>
<th></th>
<th>Dental</th>
<th>Alveolar</th>
<th>Palato-Alv</th>
<th>Retroflex</th>
</tr>
</thead>
<tbody>
<tr>
<td>[anterior]</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>[distributed]</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>[back]</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
</tbody>
</table>

Strictly speaking, however, no more than two coronal features (not counting CORONAL itself) are necessary to represent retroflexes, or any other coronal place of articulation. For instance, theories of underspecification suggest that languages might employ features only if they are contrastive, and they might only make use of marked feature values in establishing contrast. Thus, features might be redundant and underspecified if they are non-contrastive and/or unmarked (e.g., Dresher et. al. 1994). Assuming a contrastive approach to feature specification, it is doubtful that any language would ever require three binary features to distinguish among coronal places of articulation.
articulation. This is because two binary features are sufficient to account for a maximal four-way coronal contrast, as illustrated by the use of [±anterior] and [±distributed] within the standard model in Table 1.

There is another reason why two features should be sufficient to represent retroflexes. Hamann (2003: 39) points out that the four articulatory properties of retroflexion are interrelated. Certain pairs of features automatically entail the remaining two. She identifies the entailments in (4a-b). To these we could add (4c) because an apical gesture (in which the tip is turned up and tongue shape is concave) combined with a retracted tongue body is likely to yield a posterior contact and sublingual cavity.\(^4\)

\[
\begin{align*}
\text{(4) } & \text{a. apicality & posteriority} \quad \rightarrow \quad \text{retraction, sublingual cavity} \\
& \text{b. posteriority & retraction} \quad \rightarrow \quad \text{apicality, sublingual cavity} \\
& \text{c. apicality & retraction} \quad \rightarrow \quad \text{posteriority, sublingual cavity}
\end{align*}
\]

These entailments suggest that the phonological use of any two of the coronal features in Table 3 should be sufficient to account for the full range of phonetic properties associated with retroflex consonants. Thus, it is possible that some features are phonologically relevant while others are derived and redundant. The question is, which of the features associated with retroflexion are phonologically relevant?

Within models of contrastive specification, phonological activity is often taken as a diagnostic for the status of phonological features. According to the Contrastivist Hypothesis, only contrastive features are active in the lexical phonology, while non-contrastive features are phonologically inert (e.g., Dresher 2008). Borrowing this diagnostic, the question becomes: Which of the features associated with retroflexion are phonologically active? In other words, which features account for the phonological behaviour of retroflexes? In the following sections I apply the diagnostic of phonological activity to Dhivehi. I argue that the phonological behaviour of retroflexes in this language can be attributed to the features [±distributed] and/or [±back], but not [±anterior].

3. Dhivehi: Palatalization & gemination

Dhivehi is a lesser-known Indo-Aryan language spoken in the Maldivian islands. Like most Indo-Aryan languages, it maintains a three-way coronal system that includes dental, retroflex, and palato-alveolar consonants. Cain & Gair (2000) document a phonological pattern involving palatalization and gemination in Dhivehi. When noun stems ending in /i/ are followed by a vowel-initial suffix, two interdependent

\(^4\) According to Hamann (2003: 43) apicality and retraction yield a velarized apico-alveolar without posteriority. However, she also argues that all retroflexes are necessarily velarized, but not necessarily posterior. This suggests that a velarized apico-alveolar and a (non-posterior) retroflex might be distinguished only by sub-lingual cavity. Given the entailments between articulatory features (p. 39) it is not clear to me how sub-lingual cavity could be manipulated independently (i.e., without some concomitant difference in apicality, retraction, or posteriority). This raises the question as to whether there is any phonological difference between a velarized apico-alveolar and a retroflex, or whether these are merely different phonetic implementations of the same phonological reality. This question deserves further exploration, but cannot be pursued here. I maintain that apicality and retraction can yield posteriority (at least potentially, if not necessarily). This is supported by the evidence from retroflex variation in Indo-Aryan languages discussed in section 5.1.
phonological alternations are triggered. First, the final /i/ is retracted into the stem where it causes palatalization of a preceding segment. Secondly, the final consonant of the stem geminates. The palatalization of the stem is realized in more than one way, depending on the nature of the final consonant. Labial and velar consonants (i.e., non-coronals) are transparent to palatalization. When /i/ is retracted into the stem, it passes through labials and velars to the nucleus of the preceding syllable where it forms a diphthong with the existing vowel. This is illustrated by the examples in (5). Note that the geminate counterpart of a pre-nasalized stop is a full homorganic nasal-stop sequence (NC → NC), and the geminate counterpart of /l/ is [pp].

(5) Diphthongization with gemination (VCi+V → VjCC+V)

<table>
<thead>
<tr>
<th>Noun</th>
<th>Noun-INDEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labial</td>
<td></td>
</tr>
<tr>
<td>loobi</td>
<td>loojbb-ek</td>
</tr>
<tr>
<td>a&quot;bi</td>
<td>ajmb-ek</td>
</tr>
<tr>
<td>nijami</td>
<td>nijajmm-ek</td>
</tr>
<tr>
<td>kurafi</td>
<td>kurajpp-ek</td>
</tr>
<tr>
<td>avi</td>
<td>ajvv-ek</td>
</tr>
<tr>
<td>Velar</td>
<td></td>
</tr>
<tr>
<td>boki</td>
<td>bojkk-ek</td>
</tr>
<tr>
<td>buraki</td>
<td>burajkk-ek</td>
</tr>
<tr>
<td>vaagi</td>
<td>vaajgq-ek</td>
</tr>
<tr>
<td>fuja9gi</td>
<td>fulajng-ek</td>
</tr>
</tbody>
</table>

Coronals are not transparent to palatalization. When /i/ is retracted into the stem it causes palatalization of a preceding dental consonant, as illustrated in (6).

(6) Palatalization of dentals with gemination (ti+V → tfj+V)

<table>
<thead>
<tr>
<th>Noun</th>
<th>Noun-INDEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental</td>
<td></td>
</tr>
<tr>
<td>eti</td>
<td>e tfj-ek</td>
</tr>
<tr>
<td>rodi</td>
<td>rod fj-ek</td>
</tr>
<tr>
<td>doodi</td>
<td>dooddj-ek</td>
</tr>
<tr>
<td>ha&quot;di</td>
<td>hannj-ek</td>
</tr>
<tr>
<td>fani</td>
<td>fañnj-ek</td>
</tr>
<tr>
<td>duni</td>
<td>düñnj-ek</td>
</tr>
<tr>
<td>duuni</td>
<td>duuñnj-ek</td>
</tr>
<tr>
<td>fali</td>
<td>fajj-ek</td>
</tr>
</tbody>
</table>

Palatalization and gemination are interdependent. If one is blocked, then both fail to apply. For example, when the final consonant of the stem is already geminate, and therefore incapable of further gemination, then both gemination and palatalization are blocked, as illustrated in (7). Under these conditions, the final /i/ of the stem is retained and an epenthetic /j/ glide is formed to resolve the vowel hiatus.

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5 tfj and ddj represent geminate palato-alveolars, not sequences of dental + palato-alveolar.
(7) No palatalization or gemination after geminate consonants

<table>
<thead>
<tr>
<th>Noun</th>
<th>Noun- INDEF</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Labial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nappi</td>
<td>nappi-j-ek</td>
<td>*najpp-ek</td>
<td>‘bad food’</td>
</tr>
<tr>
<td>bimbi</td>
<td>bimbi-j-ek</td>
<td>*bijnmb-ek</td>
<td>‘millet’</td>
</tr>
<tr>
<td>Dental</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>batti</td>
<td>batti-j-ek</td>
<td>*batť-ek</td>
<td>‘light’</td>
</tr>
<tr>
<td>buddi</td>
<td>buddi-j-ek</td>
<td>*budđ-ek</td>
<td>‘mind’</td>
</tr>
<tr>
<td>bonti</td>
<td>bonti-j-ek</td>
<td>*bontj-ek</td>
<td>‘unopened frond’</td>
</tr>
<tr>
<td>đinni</td>
<td>đinni-j-ek</td>
<td>*đijnj-ek</td>
<td>‘genie’</td>
</tr>
<tr>
<td>Velar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fañgi</td>
<td>fañgi-j-ek</td>
<td>*fañgj-ek</td>
<td>‘frond’</td>
</tr>
</tbody>
</table>

Significantly, palatalization and gemination are also blocked when the final consonant of the stem is retroflex, as in (8). As coronals, the retroflexes are not transparent to palatalization; they do not allow /i/ to pass through them to the nucleus of the preceding syllable.\(^6\) However, unlike dentals, the retroflexes are incapable of being palatalized. As a result, they block palatalization and, with it, gemination.\(^7\) Once again, the final /i/ of the stem is retained and an epenthetic /j/ glide is formed to resolve the vowel hiatus.

(8) No palatalization or gemination after retroflex consonants

<table>
<thead>
<tr>
<th>Noun</th>
<th>Noun- INDEF</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retroflex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bañi</td>
<td>bañi-j-ek</td>
<td>*bañiže-ek</td>
<td>*bañiž-ek</td>
</tr>
<tr>
<td>fari</td>
<td>fari-j-ek</td>
<td>*fariže-ek</td>
<td>*fariž-ek</td>
</tr>
<tr>
<td>buri</td>
<td>buri-j-ek</td>
<td>*burr-ek</td>
<td>*burr-ek</td>
</tr>
</tbody>
</table>

Cain (2000) argues that gemination in Dhivehi can be seen as a case of compensatory lengthening that is crucially linked to the loss of stem final /i/. The stem final /i/ is deleted only if it can preserve a trace of itself via feature spreading (i.e., diphthongization or palatalization). For example, in the case of rodi + ek ‘a thread’, the stem final /i/ is able to leave a trace of itself via palatalization of the preceding dental stop. As a result, it is freely deleted and the palatalized dental undergoes compensatory lengthening (i.e., gemination). This is sketched in (9), where the palatalized dental takes over the mora vacated by /i/ in addition to forming the onset of the following syllable.

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\(^6\) Dhivehi has no noun stems ending in /fi/ (Bruce Cain, personal communication). As a result, there are no examples of palatalization and gemination involving underlying palato-alveolar stops in the stem. Even so, I assume (along with Cain 2000) that /i/ interacts with the coronal class as a whole. This analysis predicts that if noun stems ending in /fi/ were introduced they would behave like dentals (i.e., they would host the features of /i/ and would not block gemination) with the exception that they might not show any significant change in palatalization since they are already inherently palatalized.

\(^7\) The behaviour of retroflexes with respect to palatalization and gemination cannot be attributed to a general ban on geminate retroflexes. Dhivehi has geminate retroflexes in monomorphemic words (e.g., /veţun/ ‘falling’, /aţđun/ ‘open side up’, /sëlį/ ‘flea’, /sirru/ ‘secret’) and in derived contexts (e.g., [avatţeri] < /avas + teri/ ‘neighbour’, [aţđîha] < /aş + diha/ ‘eighty’) (Cain & Gair 2000: 12).
If a trace of the vowel cannot be preserved via feature spreading, then it is retained and compensatory lengthening of the preceding consonant does not occur. This is seen in examples like \textit{badji-je}k ‘a gun’ where the consonant preceding /i/ is retroflex. The retroflex blocks diphthongization and palatalization so that /i/ is not able to spread its features. As a result, the vowel is preserved and the retroflex cannot geminate. Instead, glide formation applies to form an onset with the following syllable (10).

What features are required to account for the phonological behaviour of retroflexes in Dhivehi? In the following section, I examine the predictions that follow from each of the potential features in Table 3.

4. Phonological activity in Dhivehi

In the pattern of palatalization and gemination, labials and velars are transparent with respect to /i/, but coronals are not. Cain (2000) observes that this asymmetry can be explained if front vowels are coronal. He adopts the model of Lahiri & Evers (1991) in which front vowels are defined as CORONAL, [–anterior] and [+distributed]. In this view, labials and velars fail to host or inhibit the features of /i/ because they are non-coronal. Any features spread from /i/ pass through them to the preceding syllable where they induce diphthongization, as in (5). Dentals and retroflexes are not transparent to /i/ because they are CORONAL. They must either host the features of /i/ or repel them.

Following Lahiri & Evers (1991), Cain suggests that the palatalization of dentals is accomplished by spreading [–anterior] from /i/ to the dental, with concomitant delinking of [+anterior]. He argues that retroflexes block palatalization because they are already [–anterior] and, therefore, incapable of hosting a second [–anterior] from the vowel.\footnote{Cain (2000) rejects the possibility that [–anterior] might spread to the retroflex with vacuous effects. If features of the vowel were preserved via spreading, then we would expect vowel deletion with compensatory lengthening of the retroflex. Thus, it is crucial that the features of the vowel are repelled by the retroflex and not simply merged with it.} However, while Lahiri & Evers’ (1991) model makes desirable predictions about the interaction of /i/ with coronals, the feature [–anterior] is problematic. I argue that this feature predicts very different results than those suggested by Cain. The positive and negative values of binary features represent mutually exclusive and antagonistic articulatory gestures. For this reason it is often assumed that a given segment cannot be
specified for both values of the same feature (e.g., Chomsky & Halle 1968), or if it is (as in the case of contour segments, e.g., Sagey 1986), that the two values must be implemented sequentially, not simultaneously. If this is so, then we can expect opposing values of a feature to repel one another, and identical values to be compatible. Thus, if dentals are specified as [+anterior] we should expect them to repel the spread of [–anterior], as shown in (11a). Similarly, if retroflexes are [–anterior] then we should expect them to be fully compatible with palatalization. In other words, there is no reason why they should not absorb the feature [–anterior] from the vowel (i.e., via merger with their own [–anterior]). This would satisfy the condition of feature spreading, allowing /i/ to delete and the retroflex to geminate, as shown in (11b).

(11)  a. \[t \quad i \rightarrow \ ^\ast \!t \quad i\]
      \[
      \begin{array}{ccc}
      & \chi & \\
      \text{COR} & \text{COR} & \text{COR} \\
      (+\text{ant}) & (+\text{ant}) & (+\text{ant}) \\
      \end{array}
      \]

      b. \[t \quad i \rightarrow \ ^\ast \!\ell\]
      \[
      \begin{array}{ccc}
      & \ell & \\
      \text{COR} & \text{COR} & \text{COR} \\
      (+\text{dist}) & (+\text{dist}) & (+\text{dist}) \\
      \text{[P]} & \text{[P]} \\
      \end{array}
      \]

The feature [+distributed] makes much better predictions about the behaviour of retroflexes in this language because it predicts a natural class that includes dentals, palato-alveolars and front vowels, but excludes retroflexes. The feature [+distributed] can spread from a front vowel to a dental because dentals are either (i) specified for the same feature, or (ii) unmarked and underspecified for [+distributed], as in (12a).\(^9\) Retroflexes repel [+]distributed because they are distinctively [–distributed], as in (12b). Notice, however, that the spreading of [+distributed] alone is not sufficient to account for the palatalization of dentals because dentals are already [+distributed] (either distinctively or redundantly). Thus, if [+distributed] is responsible for the behaviour of retroflexes, then palatalization must involve the spreading of [+distributed] along with some other feature(s). This is tentatively represented by [P] (for ‘palatalization’) in (12).

(12) a. \[t \quad i \rightarrow \ ^t\!\ell\]
      \[
      \begin{array}{ccc}
      & \ell & \\
      \text{COR} & \text{COR} & \text{COR} \\
      (+\text{dist}) & (+\text{dist}) & (+\text{dist}) \\
      \text{[P]} & \text{[P]} \\
      \end{array}
      \]

\(^9\) There is some evidence that [+distributed] might be unmarked in relation to [–distributed], and underspecified on dentals in Indo-Aryan languages. Many Indo-Aryan languages exhibit patterns of coronal assimilation in which dentals are always the targets of assimilation, never the triggers (e.g., Sanskrit: Whitney 1967 [1889], Panjabi: Malik 1995). This kind of asymmetry is often attributed to unmarked features and/or underspecification (Rice 2007). Either way, [+distributed] makes the right predictions here.
The palatalization feature, represented by [P] in (12), could be [–anterior], [–back] or some other feature. Unfortunately, the choice among these options cannot be determined from the Dhivehi data alone and can only be made in light of broader cross-linguistic evidence. I return to this issue in section 6.

The feature [±back] is also capable of explaining the behaviour of retroflexes. If (i) [–back] is the palatalization feature (e.g., Hall 1997), and (ii) retroflexes are [+back] (e.g., Lin 1989, Hamann 2003, etc.), and (iii) these features can be CORONAL or DORSAL dependents (e.g., Gnanadesikan 1994, Hall 1997), then the vowel /i/ might attempt to spread [–back] to other coronals. In this analysis, dentals are susceptible to palatalization because they have no inherent tongue body features. The addition of [–back] to a dental yields a palato-alveolar, as illustrated in (13a). Retroflexes repel [–back] because they are [+back], as depicted in (13b).

(13) a. \[
\begin{array}{c}
\text{COR} \\
\text{COR} \\
\hline
\text{[–back]} \\
\end{array}
\]  \[\rightarrow\]  \[
\begin{array}{c}
\text{COR} \\
\text{COR}
\end{array}
\]

b. \[
\begin{array}{c}
\text{COR} \\
\text{COR} \\
\hline
\text{[+back]} \\
\text{[–back]}
\end{array}
\]  \[\rightarrow\]  \[
\begin{array}{c}
\text{COR} \\
\text{COR} \\
\hline
\text{[+back]} \\
\text{[–back]}
\end{array}
\]

In summary, the phonological behaviour of retroflexes in Dhivehi might be attributed to the feature [±distributed] and/or [±back], but not [±anterior]. Minimally, this suggests that [–anterior] is not a distinctive feature of retroflexes in this language. Since the behaviour of retroflexes is consistent with either [–distributed] and/or [±back], it is difficult to determine on the basis of internal evidence alone whether one or both of these features are active in the language. In the following section I present evidence from other Indo-Aryan languages supporting the conclusion that retroflexes in these languages are distinctively [–distributed], but also [+back] at a post-lexical level.

5. Retroflexion in other Indo-Aryan languages

5.1 Allophonic variation

Evidence from other Indo-Aryan languages supports the conclusion that retroflexes are sensitive to the features [–distributed] and [+back] but not [–anterior]. One source of evidence is the allophonic variation of retroflexes. Although retroflexes are typically described as post-alveolar, palatographic studies of Indo-Aryan languages have revealed that there is significant intra-speaker variation and that this variation is
conditioned by vocalic context. For example, a study by Khatiwada (2007) revealed that the retroflex stops of Nepali are apical alveolar in the context of front vowels, and post-alveolar (and apical or sub-apical) only in the context of back vowels (14).

(14) Variation of retroflex /t/ in Nepali

mi[t]i (nonsense word)
mu[t]u ‘heart’
ba[t]a ‘vessel’

Similar patterns of variation have been reported in other Indo-Aryan languages, suggesting that the pattern may be a widespread family trait. For instance, Dixit & Flege (1991) found that the retroflex stops of Hindi range from post-alveolar to dental, and that the degree of retroflexion decreases systematically from the context of /a/ to /u/ to /i/. Hindi dental stops, by comparison, show little or no variation based on vocalic context (Dixit 1990). Significantly, the same pattern of variation has been reported in Sinhala, which is the closest relative of Dhivehi within the Indo-Aryan family. Gair & Paolillo (1997: 11) report that the retroflex consonants of Sinhala are “pronounced as retroflex when preceded or followed by back vowels, and as alveolar in most other environments.”

It is reasonable to expect that a phonologically distinctive feature (i.e., one that is critical to the identification of a segment within a language) should be subject to less variation than one that is non-distinctive. The studies cited above reveal that the retroflex consonants of Indo-Aryan languages vary from apical to sub-apical in terms of lingual contact, and from dental to post-alveolar in terms of place. Both apical and sub-apical articulations fall within Hamann’s (2003) definition of apicality (see (2a)). Thus, the variation of lingual contact falls within a range that can be identified as consistently apical and [–distributed]. Retroflexes are never laminal and [+distributed]. However, when it comes to the place of contact, the range of variation is not consistent with definitions of [–anterior]. It spans the area covered by both [–anterior] and [+anterior]. This suggests that Indo-Aryan retroflexes are distinctively apical (i.e., [–distributed]), but not distinctively posterior (i.e., [–anterior]). If retroflexes were distinctively [–anterior] then we would not expect them to be articulated so regularly in the [+anterior] region. However, if they are distinctively [–distributed], then some variation in their place of articulation might be expected and phonologically irrelevant.

The allophonic variation of retroflexes also suggests that they may be [+back] at a post-lexical level. From a phonetic point of view, the retroflex phonemes are maximally retroflex and posterior only in the context of back vowels. The pattern can be explained in one of two ways. First, retroflex phonemes might become [+back] by means of post-lexical phonetic enhancement. If this enhancement is blocked/inhibited in the context of [–back] vowels, then they might emerge as apical alveolars in that context. Alternatively, retroflexes might simply be apical phonemes that assimilate [+back] in the context of back vowels to yield retroflexion, but remain apical alveolar elsewhere. This option is noted by Gair & Paolillo (1997: 11) who suggest “the retroflex series of Sinhala might

10 Although the phonological sequence /miṭi/ does not occur as an independent word in Nepali, it does occur as part of the colloquial word /dʒiṭimiṭi/ ‘all belongings’ (Khatiwada, personal communication).
equally be considered alveolar”. In either analysis they are distinctively [–distributed], but not [–anterior], and they take on the feature [+back] post-lexically.

It is important to note that the allophonic variation of retroflexes cannot be attributed to [±anterior]. A shift from retroflex to alveolar would require a change from [–anterior] to [+anterior] in the context of front vowels. If front vowels are [–anterior] then there is no reason why they should induce a shift toward the [+anterior] region. Alternatively, a shift from alveolar to retroflex would require a change from [+anterior] to [–anterior] in the context of back vowels. However, by most accounts, coronal features such as [±anterior] apply only to front vowels, while back vowels are DORSAL. Thus, it is not clear why back vowels would have any affect on the feature [±anterior] at all.

5.2 Loanword adaptation

Another source of evidence that bears on the phonological representation of retroflexes comes from the domain of loanword adaptation. All Indo-Aryan languages that maintain a contrast between dental and retroflex articulations exhibit a consistent pattern in their adaptation of English loanwords: the apical alveolar stops of English are always adapted as retroflex, not as dental. This is illustrated in (15) with representative examples from Hindi (e.g., Koshal 1978, Ohala 1978).

(15)

<table>
<thead>
<tr>
<th>English</th>
<th>Hindi</th>
</tr>
</thead>
<tbody>
<tr>
<td>taxi</td>
<td>/təksə/</td>
</tr>
<tr>
<td>hotel</td>
<td>/hoɾəl/</td>
</tr>
<tr>
<td>coat</td>
<td>/koɾ/</td>
</tr>
<tr>
<td>doctor</td>
<td>/dəkəɾəɾ/</td>
</tr>
<tr>
<td>soda</td>
<td>/sɔdə/</td>
</tr>
<tr>
<td>pad</td>
<td>/pəɾd/</td>
</tr>
</tbody>
</table>

It is often argued that segmental adaptations like these are determined to a large extent by the phonological system of the borrowing language, and in particular by the contrastive features of that language (e.g., Herd 2005, Rose & Demuth 2006, Dresher 2008). If this is so, then the treatment of English alveolars provides a useful diagnostic for determining the contrastive features of Indo-Aryan coronals. Apico-alveolars have exactly one feature in common with both dentals and retroflexes. They share [+anterior] with dentals, and [–distributed] with retroflexes (see Table 3). If the distinction between dentals and retroflexes were established by [±anterior] then we would expect alveolars to be adapted as dental, since both dentals and alveolars are [+anterior]. The fact that alveolars are adapted as retroflex suggests that [±distributed] is the relevant feature at work. If retroflex consonants in Indo-Aryan languages are distinctively apical and [–distributed], then we can expect the speakers of these languages to perceive this property in English alveolars and relate it to their own retroflex series.

In summary, the evidence from allophonic variation and loanword adaptation supports the conclusion that retroflex segments in Indo-Aryan languages are distinctively [–distributed]. The evidence from allophonic variation suggests further that they can be [+back], at least at a post-lexical level, and that the combination of [–distributed] and
[+back] may yield posteriority. However, there is nothing to suggest that the feature [+anterior] is phonologically relevant at any level of representation.

6. Discussion

In light of the evidence from other Indo-Aryan languages, it is best to attribute the behaviour of retroflexes in Dhivehi to the feature [+distributed]. If palatalization involves the spreading of [+distributed], then retroflexes block palatalization because they are distinctively −distributed (see (12b)). However, [+distributed] alone is not sufficient to distinguish palato-alveolars from dentals. Thus, palatalization must involve the spreading of [+distributed] along with some other feature (see (12a)). Stated differently, palato-alveolars and front vowels must share some ‘palatalization’ feature not shared by dentals. As noted earlier, the precise nature of this feature is underdetermined by the Dhivehi data, and might be [−anterior] or [−back]. I argue that [−back] is the better candidate because there is positive evidence indicating that [+back] is active in the post-lexical phonology of Indo-Aryan languages, but there is nothing to suggest that [+anterior] is active at any level of representation. Thus, I suggest that Dhivehi coronals are distinguished by the features in Table 4. Features in parentheses might be unmarked or non-contrastive.

Table 4: Proposed coronal place features for Dhivehi

<table>
<thead>
<tr>
<th></th>
<th>Dental</th>
<th>Retroflex</th>
<th>Palato-Alveolar</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORONAL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>[distributed]</td>
<td>(+)</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>[back]</td>
<td>(+)</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

The phonological behaviour of retroflex consonants in Dhivehi and other Indo-Aryan languages is not consistent with the feature [−anterior]. On the basis of Indo-Aryan alone, we might assume that this is a case of underspecification. There is no contrast between retroflexes and apico-alveolars in these languages, so the retroflexes could easily remain underspecified for [−anterior]. However, if this were the case, then we should expect [−anterior] to be a distinctive feature of retroflexes in languages with maximal coronal inventories, where a contrast between alveolar and retroflex segments is maintained. Recall that maximal four-way coronal inventories are found in some South Dravidian and Australian languages. Significantly, these languages also fail to show evidence for the feature [+anterior] and the natural classes it predicts. For example, Diffloth (1975) argues that the feature [+anterior] is “useless” for defining natural classes in the South Dravidian language, Irula. Hamilton (1993) argues the same point with

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11 Hall (1997: 45–46) has argued that Sanskrit and Gujarati (both Indo-Aryan) provide phonological evidence for [−anterior]. Elsewhere I have demonstrated that the Sanskrit problem requires the complete assimilation of all coronal features. Thus, it is consistent with any set of coronal features, and does not require [+anterior]. The Gujarati case can be accounted for with the feature [+distributed] (see Arsenault 2007, cf., the rule of Distributed Merger in Hall 1996: 18). Thus, I maintain that there is no evidence for [+anterior] in Indo-Aryan languages.
respect to Australian languages, and Gnanadesikan (1994) with respect to both Australian and Dravidian. These same authors demonstrate that the laminal and apical classes predicted by [±distributed] are highly relevant in these languages. Moreover, palato-alveolars are often conditioned by front vowels in much the same way that they are in Dhivehi, while retroflex consonants often pattern with back vowels like they do in Indo-Aryan languages (e.g., Gnanadesikan 1994, Dixon 1980, 2002). Thus, while there is a conspicuous lack of evidence for [±anterior] in Dravidian and Australian languages, there is evidence that [±distributed] and [±back] are phonologically active.

In light of these broader cross-linguistic considerations, it is doubtful that the absence of [–anterior] on retroflexes in Dhivehi and other Indo-Aryan languages is the product of underspecification. The evidence suggests that it might not be a distinctive feature in any sense at all. I suggest that posteriority (i.e., [–anterior]) might be a universally redundant property of retroflexion that is derived via articulatory entailments from the combination of apicality (i.e., [–distributed]) and retraction (i.e., [+back]). Stated differently, retroflexes may tend to have a posterior contact because they are apical and retracted, but this property is not phonologically significant or even required. This is consistent with Hamann’s observation that “a segment is still retroflex if it has all criteria except posteriority satisfied” (2003: 43).

This hypothesis opens up new avenues for research into the representation and phonological behaviour of coronal consonants. For instance, we might explore the possibility that coronal places of articulation are distinguished solely by the features [±distributed] and [±back], as shown in Table 5. Within such a model, we would have to assume that the feature [±back] achieves a ternary contrast so that the absence of this feature on dentals and alveolars is distinct from both [+back] and [–back]. In other words, dentals and alveolars are simple laminal and apical coronals, while retroflexes and palato-alveolars are coronals with inherent secondary articulations represented by [±back].

Table 5: Coronal place features without [±anterior]

<table>
<thead>
<tr>
<th></th>
<th>Dental</th>
<th>Alveolar</th>
<th>Palato-Alv</th>
<th>Retroflex</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORONAL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>[distributed]</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>[back]</td>
<td>–</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This hypothesis raises new questions about the relationship between coronal places of articulation and secondary articulations. For instance, if retroflex and palato-alveolar consonants have inherent secondary articulations, then we predict that languages should not be able to contrast velarized and non-velarized retroflexes (/ɻ/ vs. /ɬ/), or palatalized and non-palatalized palato-alveolars (/ɾ/ vs. /ɾ/). A cursory glance at the data suggests that this is the case. I know of no languages (Indo-Aryan or otherwise) with a contrast between velarized and non-velarized retroflexes, and Indo-Aryan languages with
distinctive secondary palatalization systematically fail to palatalize the palato-alveolar series (e.g., Konkani: Miranda 2003, Kashmiri: Bhat 1987). However, some languages have contrasts such as /t\ vs. /tʃ/ and /s\ vs. /ʃ/ (e.g., Konkani: Miranda 2003, Kashmiri: Bhat 1987). From a phonetic point of view, the distinction between palatalized denti-alveolars such as [t\] and palato-alveolars such as [ʃ] lies more in the relative timing of articulatory gestures than in the nature of the gestures themselves. In the case of [t\], the palatal gesture is implemented somewhat sequentially following the primary coronal closure, whereas in the case of [ʃ] it is implemented more or less simultaneously with the closure. Thus, it is possible that the distinction between the two does not lie in articulatory features, which represent articulatory gestures, but in some other aspect of phonological representation that is responsible for the implementation and timing of those gestures. For instance, they may be distinguished by differences in segmental structure (e.g., simple vs. complex segments, as in Sagey 1986, Clements & Hume 1995, etc.), prosodic structure, or some combination of these (cf., unary vs. cluster analyses of nasal-obstruent sequences in Riehl 2008). These possibilities deserve consideration, but cannot be explored here.

7. Conclusion

The phonological behaviour of retroflex segments in Dhivehi and other Indo-Aryan languages suggests that they are distinctively [–distributed], and that they may also be [+back], at least at a post-lexical level. However, there is nothing to indicate that the feature [–anterior] is relevant for retroflexes at any level of representation. South Dravidian and Australian languages with more than one apical ([–distributed]) series also lack evidence for the feature [±anterior] and the natural classes it predicts. In light of these cross-linguistic considerations, I argue that the absence of [–anterior] on Indo-Aryan retroflexes is not the result of contrastive (under) specification. Rather, I suggest that posteriority (i.e., [–anterior]) may be a universally redundant and non-essential property of retroflexion that is derived from the combination of apicality (i.e., [–distributed]) and retraction (i.e., [–back]). This hypothesis raises new questions about the relationship between coronal places of articulation and secondary articulations.

References


12 Some Slavic languages, such as Russian, are said to have a contrast between palatalized and non-palatalized palato-alveolar fricatives (/ʃ/ vs. /ʃ/). However, phonetic studies reveal that the later phoneme is apical. Thus, the distinction is more accurately described as palato-alveolar vs. retroflex (/ʃ/ vs. /ʃ/) (e.g., Hamann 2003: 40–47, 2004, cf., Keating 1991: 35–36, Hall 1997: 63). As a result, these cases do not constitute exceptions to the generalization made here. See also Hall 1997: 71ff.
CORONAL FEATURES AND RETROFLEXION IN DHIVEHI AND OTHER INDO-ARYAN LANGUAGES


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