

## The Phonetics and Phonology of Tongue Body Position in Coronals

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### 1. Introduction

- Place of articulation is usually specified purely in terms of the position of the primary constriction, unless there is a contrastive secondary articulation (but see Chomsky and Halle 1968:307).
- In non-dorsal consonants, tongue body position is typically redundant, and does not figure in descriptive phonetic characterizations.

Main claims:

- Tongue body backness must be specified during coronals in order to account for interactions between coronal consonants and adjacent vowels.
- The relationship between coronal place and backness is shaped by ease of articulation constraints, formulated as cooccurrence constraints in OT.

### 2. Some coronals condition vowel fronting

- It is well established that coronals can condition fronting of vowels (Clements 1991, Hume 1992), e.g. Cantonese (Cheng 1991). Other examples are discussed by Flemming (1995, 2002) and Hume (1992).

- (1) i y u  
 e ø o  
 a.ai

- (2) k<sup>h</sup>yt 'decide'      k<sup>h</sup>ut 'bracket'  
 hø 'boots'      ho 'river'  
 t<sup>h</sup>yt 'to take off'      \*t<sup>h</sup>ut t<sup>h</sup>uk 'bald head'  
 t<sup>h</sup>øn 'a shield'      \*t<sup>h</sup>øn t<sup>h</sup>ok 'to carry (on shoulders)'

### 3. Other coronals condition vowel retraction

- Not all kinds of coronals can condition vowel fronting – retroflexes condition vowel retraction (Gnanadesikan 1994)
- e.g. Kodagu (Emeneau 1970, Burrow and Emeneau 1984): front vowels do not appear before retroflexes (except when a palato-alveolar precedes).

- (3) i tu u plus vowel length contrasts  
 e ɣ o  
 a

- (4) uŋi 'the whole'      uŋu- 'to put on (sari)'      \*iŋ  
 kuŋlu 'lower, below'      kuŋlu 'cooked rice'      \*iŋ  
 ɣŋe 'double'      oŋak- 'to dry'      \*eŋ  
 kɜ:ŋu 'ruin, rottenness'      koŋɜ 'monkey'      \*eŋ

### 4. Outline of the proposal

- The effect of coronals on adjacent vowels involve assimilation to the tongue body position of the coronal.
- Coronal place influences tongue body position because the tongue tip is attached to the tongue body
- The constraints required for the analysis of vowel fronting/retraction also derive a wide range of other coronal-vowel interactions.

### 5. The articulatory basis of coronal-backness interactions

Placement of the tongue tip and blade to form a coronal constriction is easiest if the tongue body moves cooperatively.

- Anterior coronals (dentals and alveolars) require the tongue tip/blade to be near the teeth, most easily achieved if the tongue body is fronted (Öhman 1966:167, Stevens 1999:355).

- Non-anterior laminals (palato-alveolars) – it is difficult to form a laminal constriction behind the alveolar ridge without the front of the tongue body being close to the hard palate, i.e. fronted.

- Non-anterior apicals (retroflexes) it is easiest to curl the tongue tip back towards the palate if the tongue body is back, allowing the front of the tongue to be lowered.

NB There is wide variation in terms used to describe coronals

### 6. The analysis

- Constraints on tongue body position during coronals:

- (5) ANTERIOR □ FRONT: [+anterior] □ [-back]  
 PALATO-ALVEOLAR □ FRONT: [-anterior, laminal] □ [-back]  
 RETROFLEX □ BACK: [-anterior, apical] □ [+back]

- [laminal]/[apical] are mutually exclusive (cf. [+/- distributed])
- [anterior], [apical]/[laminal] only apply to coronals
- coronals are sounds with a constriction formed by the tongue tip or blade – not palatals [j, ç, ʝ, ç, etc], not front vowels.
- a [-back] consonant is not necessarily a palatalized consonant (see below).

- Main assimilation constraint (cf. Lombardi (1999)):

(6) AGREE(back): A consonant must have the same value of [back] as an adjacent vowel.

### 6.1 Fronting of vowels adjacent to anterior coronals and palato-alveolars

- Fronting by anterior coronals ([tʰ] front tongue body, [tʰ] back tongue body):

(7) /tʰ/	ANTERIOR FRONT	AGREE (back)	IDENT (back) <sub>v</sub>
a. tʰ <sub>u</sub>	*!		
b. tʰ <sub>u</sub>		*!	
c. tʰ <sub>y</sub>			*

- Fronting by palato-alveolars:

(8) PA □ FRONT, AGREE (back) >> IDENT(back)<sub>v</sub>

- PA □ FRONT >> ANT □ FRONT may be universal: if anterior coronals condition fronting, so do palato-alveolars.

### 6.2 Retraction of vowels before retroflexes

(9) /i/	RETROFLEX □ BACK	AGREE (back)	IDENT (back) <sub>v</sub>
a. i <sub>l</sub>	*!		
b. i <sub>u</sub>		*!	
c. i <sub>u</sub>			*

### 6.3 Properties of the coronal-backness constraints

- refer to tongue body position in coronals
- violable, ranked
- bi-directional. E.g. a retroflex can condition retraction of vowels (i<sub>l</sub> → i<sub>u</sub>) a front vowel can condition loss of retroflexion (i<sub>l</sub> → i)

### 7. Tongue body positions are not inherent to coronal types

- Constraints on relationship between types of coronals and tongue body position represent a preference for effort minimization, which may be out-ranked by other constraints.
- E.g. contrastive velarization and uvularization (a.k.a. pharyngealization):

(10) IDENT(back)<sub>c</sub> >> ANTERIOR □ FRONT

- Arabic uvularization involves a back tongue body position (Card 1983, Ladefoged and Maddieson 1996, McCarthy 1994), e.g. [atb] 'he was sorry', [tʰarb] 'he recovered',
- Marshallese (Bender 1968), e.g. [tʰo] 'ignite', [tʰo] 'sugar cane'.

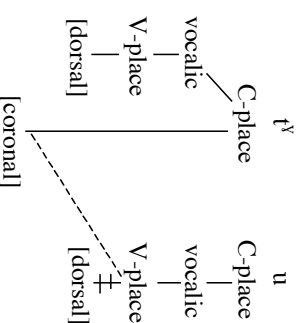
- As expected, velarized coronals condition retraction of adjacent vowels, i.e. fronting/backing depends directly on tongue body position, and only indirectly on coronal place.

- Tongue body position during coronals has to be represented because it is not predictable from coronal place.

- It is also apparent from phonetic evidence that coronal-backness constraints can be violated to satisfy assimilation constraints.

Velarized and uvularized coronals are problematic for the proposal that front vowels are specified [coronal] (Clements 1991, Hume 1992).

- predicts that velarized coronals should be able to condition fronting by spreading their [coronal] specification.



### 8. Interactions between vowels and coronals go in both directions

- E.g. RETROFLEX □ BACK and AGREE(back) create a conflict in sequences like [it<sub>l</sub>].
- Both can be satisfied by violating IDENT(back) – retracting the vowel (9).
- They can also be satisfied by advancing the coronal to alveolar (i<sub>l</sub> → i<sub>l</sub>), violating IDENT(anterior).

Generally:

- AGREE(back) can create conflicts between vowel backness and the backness preference of an adjacent coronal.
- These conflicts can be resolved by modifying the vowel or the coronal.
- Coronal can be modified by a change in [anterior] or [apical]/[laminar]

(11) Predicted typology of processes:

ANTERIOR □ FRONT		tu → ty	example:
vowel fronting		ut̪ → ut̪	Cantonese
coronal retraction			Walmatjari
RETROFLEX □ BACK		it̪ → ut̪	Kodagu
vowel retraction		it̪ → it̪	Walmatjari
coronal advancement		si → ji	Acoma
laminarization			
PA □ FRONT		ju → jy	Lahu
vowel fronting		ju → su	Molinos Mixteco
apicalization		tu → tu	Wargamay
coronal advancement <sup>1</sup>			

- The preferred resolution depends primarily on the ranking of faithfulness constraints, e.g. a more complete analysis of vowel fronting by anterior coronals requires

IDENT(ant) >> IDENT(back) v:

(12)

/tu/	ANTERIOR □ FRONT	AGREE (back)	IDENT (ant)	IDENT (back) v
a. t <sup>h</sup> u	*!			
b. t̪u		*!		
c. t̪̥				*
d. t <sup>h</sup> u			*!	

### 9. Vowels affect coronal place

- Coronal consonants can affect backness of adjacent vowels, and backness of adjacent vowels can affect place of coronal consonants.

#### 9.1 Retraction and advancement of apical coronals: Wargamay and Walmatjari

- Australian languages with contrasts between apical alveolars and retroflexes usually neutralize this contrast word-initially (Dixon 1980, Steriade 1995). Neutralized apicals often vary between alveolar and retroflex. Adjacent back vowels condition a preference for retroflex realizations, e.g. Walmatjari (Hudson and Richards 1969).

(13) *Walmatjari*:

jingji landa	'poke'	pari nuɲuɲɛri	'boy, bleeding'
janu landa	'wound it'	manja farpara	'hold the girl!'

<sup>1</sup>Palato-alveolar stops are transcribed with a subscript line- [l̪], following Ladefoged and Maddieson (1996:15).

(14)

/ut̪/	AGREE (back)	RETRO □ BACK	ANT □ FRONT	IDENT (back) v	IDENT (ant)
a. ut̪	*!				
b. u <sup>h</sup> t̪			*!		
c. u <sup>h</sup> t̪̥					*
y <sup>h</sup> t̪				*!	

(15)

/it̪/	AGREE (back)	RETRO □ BACK	ANT □ FRONT	IDENT (back) v	IDENT (ant)
a. it̪					*
b. it̪̥		*!			
c. i <sup>h</sup> t̪̥	*!				
u <sup>h</sup> t̪̥				*!	

-Wargamay (Dixon 1981)

- Contrasts apical and laminal coronals.

- apicals are usually alveolar but optionally retroflex following back [u]:

(16) it̪ \*it̪̥ ut̪ ~ ut̪̥

- Similar patterns in other Queensland/NSW Australian languages that lack apical alveolar/retroflex contrast (Dixon 1980:155).

#### 9.2 Apicalization of palato-alveolars, laminarization of retroflexes.

- Molinos Mixteco (Hunter and Pike 1969): palato-alveolar [ʃ, ʒ] are in allophonic variation with retroflex [ʃs, ʒz]: ʃ, ʒ / \_[-back] ʃs, ʒz / \_[+back]

(17) ʃt̪i 'side' ʃsãã 'very'  
 ʒeʒe 'outside' zoʒo 'rope'

(18)

/ʃi/	PA □ FRONT	AGREE (back)	RETRO □ BACK	IDENT (laminal)
a. ʃi			*!	
b. ʃi̥				*

(19)

/ʃu/	PA □ FRONT	AGREE (back)	RETRO □ BACK	IDENT (laminal)
a. ʃ <sup>h</sup> u			*	*
b. ʃu		*!		
c. ʃ <sup>h</sup> u	*!			

- Additional rankings: IDENT(back) v, IDENT(ant) >> IDENT(laminal)

- Acoma (Miller 1965): retroflexes become palato-alveolar before front vowels (retroflexes and palato-alveolars contrast elsewhere).

(20) ʔaʃáʔni 'a step'      ʔaʃáʔni 'wheat'

(21) /s i- dʰa ʔa tʰs- a tʰa/      s i dʰa ʔa tʰs a tʰa 'We (dual) are holding him'  
 /s i- dʰa ʔa tʰs- i/      s i dʰa ʔa tʰs i 'We (pl.) are holding him'

/s- a ʔa kʷ/      s a ʔa kʷ 'you bit him'  
 /s- i z a a tʰ i ʔ w a/      ʃ i z a a tʰ i ʔ w a 'you work up'

### 9.3 Advancement of palato-alveolars by back vowels: Wargamay laminals

- Wargamay contrasts apical and laminal coronals (cf. 5.1).

- laminals are usually palato-alveolar, optionally realized as dental before [a, u], but not before [i].

(22)      tʰi \*tʰi      tʰu ~ tʰu

#### Analysis:

- Apical-laminal contrast is enhanced by realizing laminals as palato-alveolars (should be a distinctiveness constraint – Flemming 2001):

(23) LAMINAL □ PALATO-ALVEOLAR: contrastively [laminal] coronals must be [-anterior]

- Enhancement conflicts with effort minimization (PA □ FRONT) before non-front vowels.

- These constraints are unranked resulting in variation.

(24)

/tʰ/	AGREE (back)	PA □ FRONT	LAMINAL □ PA	ANT □ FRONT	IDENT (ant)
a. tʰi			*!		
b. tʰi					*

(25)

/tʰu/	AGREE (back)	PA □ FRONT	LAMINAL □ PA	ANT □ FRONT	IDENT (ant)
a. tʰu			*	*	*
b. tʰu		*			
c. tʰu	*!				

- Additional rankings: IDENT(backness)<sub>v</sub>, IDENT(laminal) >> IDENT(anterior)

#### Evidence that [-anterior] enhances [laminal] contrasts:

- Anderson (1997) perception study on Arremite coronals

- Arremite contrasts apical alveolar, laminal dental, retroflex, palato-alveolar.

- dental nasals are misperceived as apical ~22%
- palato-alveolar nasals are misidentified as apical ~5%
- but palato-alveolar and dental stops are both correctly identified ~100%

- There are languages with an apical-laminal contrast where laminals are always palato-alveolars (rather than cross-linguistically more common dentals) – e.g. Dyirbal (Dixon 2002:559), Wergaia (Hercus 1986:73, 106).

#### Significance:

- Back vowels can condition the appearance of dentals, while dentals can condition vowel fronting.
- Dentals can condition vowel fronting because of ANT □ FRONT.
- but a back dental is less marked than a back palato-alveolar (PA □ FRONT >> ANT □ FRONT), and is faithful to [laminal].
- relative ranking of the coronal-back constraints is crucial.

### 10. Comparison with alternatives

#### 10.1 Attempts to identify inherent features shared by coronals and vowels

- Clements (1991), Hume (1992): [-back] = [coronal] associated to Vplace.

- Problem: can't account for behaviour of retroflexes (§3) or velarized and pharyngealized coronals (§7).

- Solution: - Front vowels are not coronal, some coronals are front.
- TB position is not inherent to coronal places, it is governed by violable constraints.

- Generalizing the 'inherent features' approach is problematic:

- Front vowels condition [+anterior] in apical coronals (tʰ □ tʰi, §9.1), but are associated with [-anterior] laminals (tʰ □ tʰi, §9.3, also sʰ □ ʃi in Japanese etc). Cannot derive both patterns by attributing an [anterior] value to front vowels.
- Back vowels can condition [+anterior] in laminals (tʰ □ tʰu, §9.3), but [-anterior] in retroflexes (tʰ □ tʰi, §9.1). Cannot derive both patterns by attributing an [anterior] value to back vowels.
- Solution: interactions between coronal place and vowel backness are indirect, mediated by tongue body position during the coronal, and the coronal-backness constraints.

## 10.2 Default rules

- The coronal-backness constraints resemble redundancy rules for filling in default values of [back] depending on coronal place, but they are quite different. They are co-occurrence constraints, and consequently bidirectional – they allow tongue body position to affect coronal place as well as vice versa.
  - E.g. redundancy rule [+ant] □ [-back] does not account for it □ utt, it □ it.
- The co-occurrence constraints must also be ranked with respect to each other (e.g. Wargamay laminal, §9.3), and other constraints (e.g. velarized dentals, §7) – OT co-occurrence constraints have precisely these properties.

## 10.3 OT constraints without phonetic detail

- Hayes (1999) argues that phonetic detail is relevant to the derivation of constraints, but is not needed in phonological representations.
  - E.g. \*NT: \*[+nasal]-voice, -son] (Pater 1996, Hayes 1999) does not represent the properties that are liable to make voicelessness difficult following a nasal (nasal leak, velar pumping) – Hayes argues that this is a virtue (p.272f.).

-Reference to TB position in coronals cannot be eliminated in this way: a constraint like \*[+ant] [-back] fails to account for ‘exceptional’ anterior coronals such as pharyngealized dentals.

- ‘Compling’ phonetic detail into constraints depends on the phonetic realization of a phonological configuration being predictable – tongue body position during coronals is not in general predictable.
- Underlying mechanisms must be analyzed in any case.

## 11. Finer articulatory distinctions

### 11.1 Fronting vs. palatalization

- There is a difference between plain coronals produced with a fronted tongue body and palatalized coronals.
- Palatalization involves a narrower constriction between the front of the tongue body and the hard palate than is found in plain fronted coronals. This narrower constriction can be represented by the feature [+Hense].

### Anterior coronals vs. palato-alveolars

- Most anterior coronals prefer partial fronting, not palatalization. Palatalization is most consistent with palato-alveolars.
  - To form a narrow constriction against the hard palate, the front of the tongue body must be curved into the vault of the palate, and this curvature naturally turns the tongue tip downwards. This places the tongue blade close to the region behind the alveolar ridge. Forming an anterior constriction without incidental palato-alveolar contact is more difficult.

- Polish: Palatalization of dentals can yield alveolo-palatals (palatalized palato-alveolars). (Keating 1991).
- Japanese: dentals are palatalized to palato-alveolars before [i] (Vance 1987).

### Alveolars vs. dentals

- Alveolars are more compatible with palatalization than dentals:
  - Russian: the palatalized counterpart to a dental stop is a laminal post-alveolar (Keating 1991, 1993).
  - dentals tend to be produced with a less fronted tongue body than alveolars (based on acoustic evidence): Malayalam (Stevens et al 1986, Dart and Nihlani 1999), Tohono O’odham (Dart 1991).
  - Stevens et al (1986): dental constriction is more easily formed if the front of the tongue is flattened, whereas full fronting involves curving the front of the tongue.

- Analysis: \*PALATALIZEDDENTAL >> \*PALATALIZEDALVEOLAR

## 11.2 Parallels between phonetics and phonology

- Many of the patterns described above are paralleled by more subtle ‘phonetic’ effects:
- Partial fronting of back vowels by alveolars in English (and many other languages).
  - Partial retraction of vowels adjacent to retroflexes in Gugada (Platt 1972), and many Dravidian languages (Emeneau 1970).
  - Partial advancement of retroflexes following front vowels in Gujarati (Dave 1977), Manjityara (Marsh 1969)

## 12. Summary

- Front vowels are not coronal, some coronals are front.
- It is necessary to represent tongue body position in coronals, even where highly redundant.
- Each type of coronal has a preferred tongue body position which facilitates production of the coronal articulation.
- Actual tongue body position is determined by interaction with other constraints.
- The dependencies between coronal place and tongue body position are best analyzed in terms of violable constraints on articulatory effort.

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