Vocalic dorsality in Articulator Theory

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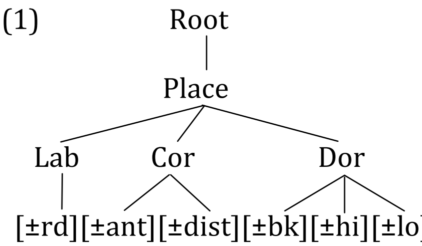
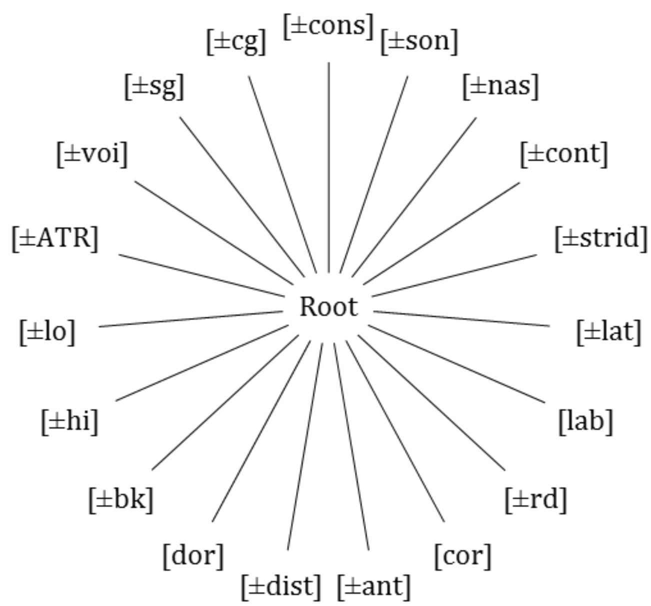
1. Introduction. On the strength of Halle's (1995) demonstration that assimilation processes spread only terminal elements, Halle et al. (2000) propose to revise the Articulator Theory of feature geometry (Sagey 1986 et seq.) by treating designated articulators not as nodes (1) but as features —viz. [coronal], [labial], [dorsal]— since indeed they participate in assimilation (Halle et al. 2000: 421-3, 434-9). Halle (2005) goes on to conclude that all features are terminal (since all may spread) and that we should dispense with subsegmental nodes altogether: "the restrictions noted by Clements and others on the simultaneous spread of more than one feature should not be expressed directly in the feature geometry of the segments, but instead should be captured by special constraints on feature spreading" (p. 30).

(1)



Though he cites no one in this regard, Halle here aligns himself with several optimality theorists —notably Padgett (2002) and Yip (2005)— by restoring Hayes' (1990a) "bottlebrush" view of the segment (2) and abandoning representational explanations of feature class behaviour (John Harris 2007:129).[1]

(2)



Aside from these revisions, Halle (like Padgett and Yip) retains the feature-geometric conception of (local) assimilation as spreading (Clements 1985:231). Revised Articulator Theory also preserves a long tradition[2] in taking the tongue body to be the designated articulator of vowels (Halle 2003; Levi 2008), a view that is anathematic to the now dominant school of feature geometry known as Vowel-Place Theory (Clements 1989 et seq.). Thus current Articulator Theory uniquely generates the strong hypothesis that vowels are specified for an articulator feature [dorsal] which can spread individually because it is terminal in the segment. On the further (also traditional[3]) assumption that phonotactics intensify within syllable rhymes, a more precise prediction can be made: [dorsal] may spread from any vowel to any adjacent segment, and coda consonants are favored targets.

This specific prediction of current Articulator Theory is borne out in a variety of velarization patterns across languages. Revising and extending an original proposal by Paradis and Prunet (1993), I show that vowels can spread [dorsal] to a following tautosyllabic consonant, be it nasal (§2), obstruent (§3.1) or liquid (§3.3). I also argue that extant alternative analyses fail (§2.3, §3.2, §4). My conclusion is that the frequency and range of velarization effects argue strongly in favor of the Articulator Theory view of vowels (Halle 2003; Levi 2008): they are [dorsal], and this is a terminal feature.

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[1] Compare Yip (2005:68): "features can be treated as an unstructured set"; "feature geometrical theories can be achieved by constraints on feature co-occurrence ... [E]ven feature classes can be dispensed with" (p. 86-7).

[2] Sievers (1881:93ff.), Chomsky and Halle (1968:302), Sagey (1986) et seq.

[3] Kuryłowicz (1948), Pike (1967), Fudge (1969), Selkirk (1982), etc. For moraic theory, Hayes (1989:299) remarks that "the notion of "rhyme-internal segment" can be reformulated as "segment dominated by μ." (See also Broselow et al. 1997:64.)

2. Nasal velarization and velar nasal epenthesis.

This first section treats patterns of nasal velarization and velar nasal epenthesis in syllable-final position. These patterns are first described (§2.1), then analyzed in Articulator Theory (§1). An alternative analysis of these patterns in terms of phonetic interpretation is also described and dismissed (§2.3).

2.1. Some examples.

The velarization of nasals in coda position is remarkably common across languages. Examples abound in Romance (e.g., Resnick 1975:29; Lipski 1975; Porto Dapena 1976; Guitart 1981; James Harris 1983; Anderson 1986; Durand 1988b; a; Bullock 1995; Van Deyck 1996), West Germanic (e.g., Kuepper 1992; Hoeksema 1999; van Oostendorp 1999 et seq.), Bantu (e.g., Hyman 1975:168), Niger-Congo (e.g., Creissels 1989:93-6; Olawsky 2002:206-11), Austronesian (e.g., Aronoff et al. 1987; Goldsmith 1990:131; Sneddon 1993; Rau 2000), Papuan (e.g., Wurm 1982), Cariban (e.g., Jackson 1972:47; Peasgood 1972:39; Walter F. Edwards 1978:226; Abbott 1991), Totonacan (e.g., MacKay 1994:380), Sino-Tibetan (e.g., Matthew Chen 1973; Chung-yu Chen 1981; Rutgers 1998), Japanese (e.g., Trigo 1988; Yip 1991), Mongolian (Poppe 1970:55), and elsewhere.[4]

This process targets a specific syllable-final nasal in some instances, for example, the palatal nasal in Canadian French (3). "When /ɲ/ occurs preconsonantally or in word-final position, that is to say at the end of a syllable, a productive process causes it to be realized as the velar [ŋ]" (Douglas C. Walker 1984:115).[5] This change is unconditioned by the height or backness of the preceding vowel.

(3) *Nasal velarization in Canadian French* (Douglas C. Walker 1982:76, my transcriptions)

a. *Onset position*		b. *Word-finally*		c. *Preconsonantally*	
gɑɲe	'won'	gɑŋ	'win!'	gɑŋpɛ̃	'job' (win-bread)
peɲe	'combed'	pɛŋ	'comb!'	pɛŋwaʀ	'peignoir'
liɲe	'lined'	lɪŋ	'line'	ɑ̃lɪŋmɑ̃	'alignment'

All syllable-final nasals are targeted in other languages, such as Ligurian (Romance: Ghini 1995) which distinguishes /m, n, ɲ, ŋ/ (e.g., *ramu* 'branch', *raɲu* 'spider', *pena* 'pen', *peŋa* 'pain'), but which permits only [ŋ] in coda position: word-finally (4a) and even before heterorganic consonants (4b,c). Again, the quality of the vowel preceding the nasal seems immaterial to the change; the resultant nasal is always [ŋ].

(4) *Nasal velarization in Ligurian* (Ghini 1995:58-9)

a. *Word-finally*		b. *Before labials*		c. *Before coronals*	
viŋ	'wine'	puŋpa	'pump'	ʧaŋtaː	'plant (v.)'
noŋ	'not'	riŋbursu	'refund'	veŋde	'sell'
feŋ	'fine'	kaŋpaŋŋa	'bell'	iŋʃaː	'blow up'

Similarly, Sinhala (Indo-Aryan: Fairbanks et al. 1968; Reynolds 1980; Stonham 1995:25) has an exceptionally large inventory of nasal consonants (/m, n, ɳ, ɲ, ŋ, ^{m}b, ^{n}d/) which are all neutralized to [ŋ] word-finally, as seen in the plurals of (5a,b).

(5) *Nasal velarization in Sinhala* (Feinstein 1979:247)

a. *sg. def.*	*plur.*		b. *sg. def.*	*plur.*		cf. *sg. def.*	*plur.*	
bim-ə	biŋ	'ground'	a^{m}b-ə	aŋ	'mango'	mal-ə	mal	'flower'
gam-ə	gaŋ	'village'	li^{n}d-ə	liŋ	'well'	pot-ə	pot	'book'
kan-ə	kaŋ	'ear'	ka^{n}d-ə	kaŋ	'trunk'	gas-ə	gas	'tree'

[4] Nasal velarization is a restricted, emergent pattern in some languages. In Standard Chinese, for instance, coda nasals velarize (variably) only in loanwords (You 2004:32) and in child language (Hua & Dodd 2000:27).

[5] Dakelh/Carrier (Athabaskan: Cook 1985) also velarizes coda /ɲ/.

Apparently related to nasal velarization are cases of velar nasal epenthesis in coda position. For instance, subminimal words are augmented with *ŋ* in Bugis (Austronesian), e.g., [teŋ] 'tea' (*[te]) (Mills 1975:53; Lombardi 2002:235, fn. 12), and *ŋ* is added to nasalized vowels in (adult) Midi French, e.g., [bjẽ] → [bjẽŋ] 'well', [blɑ̃] → [blɑ̃ŋ] 'white' (Durand 1988a:31; Pierret 1994:45). Similarly, some dialects of Portuguese turn nasalized vowels into vowel+velar nasal sequences, e.g., *rw*[ĩ] → *rw*[ɪŋ] 'basis', *b*[õ] → *b*[ɔŋ] 'goed', [ũ] → [uŋ] 'een' (Oostendorp 2001a:120). As with nasal velarization, vowel height and backness appear not to be conditioning factors.

A similar but more complex pattern is found in Kaingáng (Macro-Je: Wiesemann 1972). Light penults are augmented with [ŋ] in plural forms, e.g., kɨpe > kɨŋpe 'taufen'. Noting that stress always falls on the penult in plurals (Wiesemann 1972:205, fn. 7), Yip (1992) suggests that plurals (up to some lexical exceptions) "acquire velar nasal codas because they require their penultimate syllable to be heavy" (p. 31). (Cf. McCarthy & Prince 1990 on plurals in Arabic.)

Insertion of [ŋ] also occurs word-finally in several Australian languages, reflecting a well-known preference for consonant-final (prosodic) words:[6] "Languages from a number of different areas have added /ŋ/ onto a final vowel, to produce a word that ends in a consonant" (Dixon 1980:211). The best known case is Uradhi (Hale 1976; Crowley 1983:321; Trigo 1988:57-9; Paradis & Prunet 1993): it famously avoids vowel-final words by adding [ŋ] notwithstanding that all lexical word-final consonants are exclusively coronal. This perplexes even Dixon (1980:211): "The final dorsal in Uraði carries no meaning contrast and so is not a phonological element —it is an automatic phonetic addition. … [O]ur phonological description provides NO explanation for why *ŋ* (and not *n* or *l*, say) is used to derive consonant-final forms." The following examples are from Yadhaykenu Uradhi, where paragogic [ŋ] is optional (Paradis & Prunet 1993:428).

(6) *ŋ-insertion in Yadhaykenu Uradhi* (Crowley 1983:329)

	UR	*Utt.-internal*	*Utterance-final*	*Glosses*
a.	/ama/	[ama]	[ama] ~ [amaŋ]	'person'
b.	/juku/	[juku]	[juku] ~ [jukuŋ]	'tree'
c.	/ipi/	[ipi]	[ipi] ~ [ipiŋ]	'water'

2.2. Analysis in revised Articulator Theory. In their analysis of *ŋ*-insertion in Uradhi (6), Paradis and Prunet (1993) make the original suggestion that the dorsal articulation of [ŋ] is obtained through autosegmental spreading from a preceding vowel.[7] I favor this proposal but note first that it raises several difficult questions for Paradis and Prunet themselves.

Paradis and Prunet assume a version of Vowel-Place Theory (Clements 1989 et seq.) under which the three vowels of Uradhi /i, u, a/ are expected to be Coronal, Labial and Dorsal, respectively. Since only /a/ is specified Dorsal, why should a velar nasal also be inserted after /i, u/ in Uradhi, e.g., [ipiŋ] 'water' (6c), [jukuŋ] 'tree' (6b)? In answer to this question, they suggest that a redundancy rule assigns a Dorsal node to front and round vowels, a proposition that is problematic in Vowel-Place Theory (see especially Hume 1994, 1996, Clements and Hume 1995, and Rice 1995b, 2002).[8]

Second, even if we accept that front and round vowels are redundantly specified Dorsal in addition to being Coronal and Labial (respectively), why should only Dorsal spread to the coda nasal, and never Labial or Coronal, e.g., *[jukum] 'tree' (6b), *[ipin], *[ipiɲ] 'water' (6c)? The absence of Coronal spread from /i/ is particularly surprising since all lexical word-final consonants in Uradhi are indeed coronal (including [n, ɲ, ɳ]; Crowley 1983). Paradis and Prunet (1993) recognize this

[6] McCarthy and Prince (1990, 1994), Piggott (1991), McCarthy (1993).

[7] Kenstowicz (1994:532) makes the same suggestion in passing.

[8] Bullock (1995) adopts Paradis and Prunet's proposal, including this double assumption (p. 57): Place in vowels is characterized by [coronal], [labial] and [dorsal], as in Vowel-Place Theory, and all vowels are also [dorsal], as in Articulator Theory.

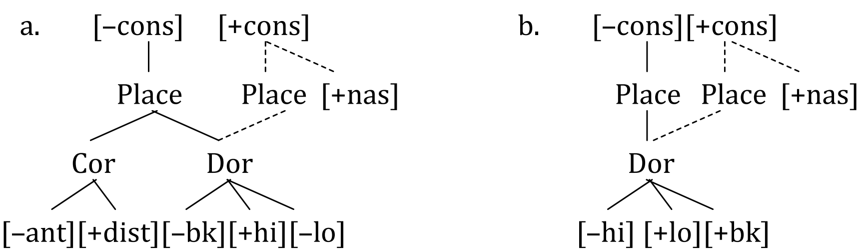
general problem but are unable to address it: “we do not account here for the fact that spreading in Uradhi is limited to Dorsal, as opposed to Coronal or Labial” (p. 433).

Paradis and Prunet’s proposal that all (surface) vowels are specified Dorsal leads to a third difficult issue. The Uradhi vowels /i, u, a/ differ in specification for the Dorsal features [±back], [±high] and [±low], yet these vowels uniformly induce final [ŋ] which is [+back, +high, –low]. As they ask, “why do the Dorsal-dependent vowel features not color the velar nasal …?” (p. 433). They propose the following solution (ibid.):

> [T]he Dorsal articulator spreads with its dependent features but … these may be subsequently severed from the velar consonant either because the information they encode is not contrastive in the small articulatory range occupied by velar nasals or because they create an ill-formed consonant.

How this solution works is unclear, since the proposed spreading results in a doubly-linked Dorsal node, as illustrated in (7) (adapted from Paradis and Prunet’s (5)/(8)). To avoid *[iŋ^j] from /i/ (7a), [+back] must be substituted for [–back] on the nasal, but this cannot happen without also affecting the vowel (*[ɯŋ] ~ *[uŋ]). Likewise, to avoid *[aŋ̣] from /a/ (7b), [–high] and [+low] must be replaced with their opposite values on the nasal, but again this would incorrectly modify the vowel (*[ɯŋ] ~ *[uŋ]).[9]

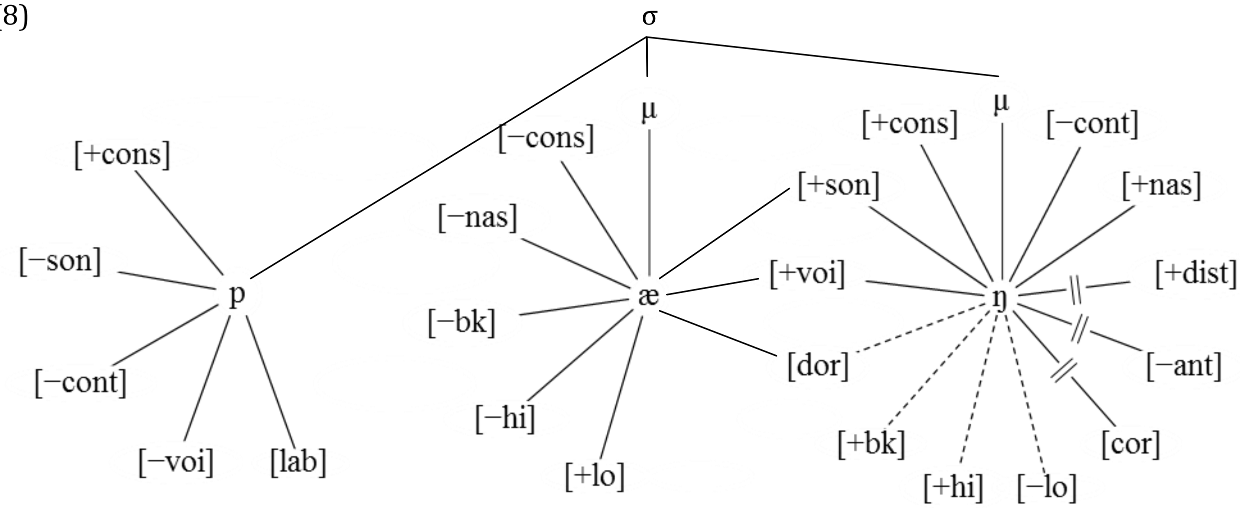
(7)



The problems just outlined disappear if we recast Paradis and Prunet’s original proposal in current Articulator Theory. As described in the introduction, this theory newly postulates that “[d]esignated articulators are indicated by features, rather than nodes in the geometry” (Halle et al., 2000:388; see also Halle, 2003:317-8), and reaffirms that [dorsal] is the designated articulator feature of all vowels (Halle 2005:35; cf. fn. 2 above). To illustrate: in (8) [dorsal] and [coronal] are terminal articulator features in the syllable rhyme of the French word [pæɲ] ‘skirt’:

[9] Bullock (1995:57) contradicts herself in a similar way: “a [dorsal] node dominates the features for height and backness ([high][back]). … when it is spread to the coda … it spreads only its specification for the major articulator structure not its actual content in terms of height or back properties of the vowel.”

(8)



Because the [dorsal] feature is terminal in the vowel tree, it can spread individually to the following nasal (ɲ), causing its tongue blade features to delink, as represented in (8). The other tongue body features for [ŋ] are then filled in. This is arguably what happens in Canadian French where /ɲ/ becomes [ŋ] in coda position, e.g., /kɑ̃pæɲ/ → [kɑ̃pæŋ] 'countryside' (cf. [kɑ̃pæɲɑʀ] 'country person'), /ɛspæɲ/ → [ɛspæŋ] 'Spain' (cf. [ɛspæɲɔl] 'Spanish'). Note that in these particular examples, none of the other tongue body features of the vowel [æ], namely [–high, +low, –back], are spread to [coronal] *ɲ* which nonetheless converts to [dorsal] *ŋ*, which is [+high, –low, +back].[10] In this respect, the Articulator Theory analysis captures the generalization noted earlier: the application of nasal velarization does not (necessarily) depend on the height or backness of the preceding vowel. That is, [dorsal] aside, other Place features of [ŋ] such as [+high] are not necessarily present in a preceding vowel; if absent yet required, such features must be introduced separately into the representation, as in (8).

Alternatively, a language might avoid fully specifying a velarized nasal. This option is instantiated, perhaps, by nasal velarization in Japanese (Yip 1991): its coda nasals must share their place of articulation with the onset of the following syllable, either as homorganic clusters (9a) or as geminates (9b), else they surface as "unreleased, either velar or uvular, and the oral closure may not be complete" (Yip 1991:69; see also McCawley 1968:84) (9c). Variation between [ŋ] and [ɴ] in particular suggests that [high] is either unspecified or variably specified.

(9)	a.	*Preconsonantally*		b.	*Geminated*		c.	*Word-finally*	
		sense:	'teacher'		minna	'every one'		zeŋ ~ zeɴ	'goodness'
		kampai	'cheers'		amma	'masseur'		hoŋ ~ hoɴ	'book'

Turning to velar nasal epenthesis, as in Uradhi, this too can be understood as [dorsal] spreading under revised Articulator Theory, as can, for instance, the (prosodically driven) insertion of [ŋ] in Bugis /te/ → [teŋ] 'tea' (Lombardi 2002: 235, fn. 12).[11] The choice of an epenthetic nasal here is unsurprising given the crosslinguistic preference for nasals in coda position.[12] Crucially, the choice

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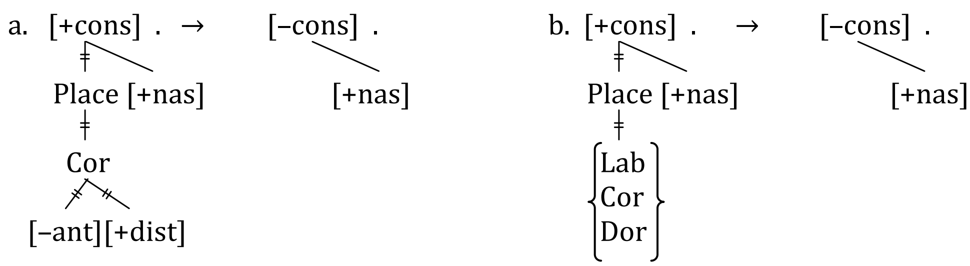
[10] In Canadian French [back] is contrastive at every vowel height level, even [+low]: e.g., [pæt] 'paw' *vs.* [pɑt] 'noodle', [tæʃ] 'stain' *vs.* [tɑʃ] 'task', [mæl] 'case' *vs.* [mɑl] 'male' (Douglas C. Walker 1984:77-8).

[11] Cf. Midi French [bjẽ] → [bjẽŋ] 'well', Kaingáng [tẽ-tẽ-m] → [tẽŋtẽm] 'fliegen flassen (pl.)'.

[12] Indeed nasals are the only consonants permitted syllable-finally in many languages, such as Standard Chinese (Duanmu 2000), Kiribati (Inkelas & Cho 1993:553-4) and Jul'hoansi (Miller-Ockhuizen 2003:128). Broselow (2003:167) gives an optimality theoretic constraint CODA=NAS ("codas must be nasal") for Malayalam.

of [ŋ] in particular can be explained by the spread of [dorsal] from [e]. Other Tongue Body features such as [+high] and [+back] are then assigned to [ŋ] by default, as in (8) above.

2.3. An alternative analysis: [ŋ] as [N]. The sound [ŋ] that results from nasal velarization and velar nasal insertion (§2.1) is widely considered a placeless nasal glide "N" (e.g., Trigo 1988; 1991; Yip 1989:358; 1991:69; Goldsmith 1990:132; McCarthy & Prince 1994:356; 1997:79; Kenstowicz 1994:543; Humbert 1997:224; Piggott 1999; Baković 2001; McCarthy 2001b; Oostendorp 2001a:120; Lombardi 2002:235; Shepherd 2003:72ff.; Goad & Brannen 2003; de Lacy 2006:283ff.; 2009; de Lacy & Kingston in press). On this interpretation, coda velarization of a particular nasal as in Canadian French, or of all nasals as in Sinhala, amounts to the loss of Place, which leads in each case to [N], a nasal glide whose "major articulator is Soft Palate, without further specification" (Halle 2003:318), as represented in (10a,b).[13]

(10)


The conception of [ŋ] as a minimally specified segment, perhaps just [–consonantal, +nasal], helps to explain why the velar nasal should be used for epenthesis, as happens in Midi French, Portuguese dialects, Bugis, Kaingáng and Uradhi (§2.1).

In this approach, the realization of [–consonantal, +nasal] as [ŋ] is considered a matter of phonetic implementation. That is, raising the dorsum in nasal glides is not a phonologically-specified directive, but rather a phonetic necessity, as de Lacy (2006:38) explains:

> [T]he implementation of [glottal] for nasals [see fn. 13 above] effectively calls for the most direct route from the glottis to the nostrils via the pharyngeal and nasal airways. Therefore, the size of oral cavity must be restricted. … [A] constriction in the velar or post-velar region is the best that can be done in this regard... Coincidentally, this happens to be the same as [ŋ]'s phonetic realization.

Similarly, according to Bakovic (2001:7), "the so-called "velar" nasal … is a debuccalized (placeless) nasal … which looks and sounds velar due to the articulatory and perceptually sympathetic relation between velum lowering and linguo-velar contact." Of the "placeless nasal [N]" McCarthy (2008:278, fn. 3) too states: "There is no oral closure during the production of this sound, but because the soft palate is lowered, the point of maximal constriction is in the dorsal region. For this reason, it is often transcribed as [ŋ]." (See also de Lacy 2009; de Lacy & Kingston in press.)

In the case of velar insertion Yip (1996) claims that phonetic interpretation is so flexible that epenthetic [ŋ] is not even [+nasal]:

> [S]ince contact is with the soft palate, which is itself mobile, "rapprochement" can also be achieved by lowering the velum, giving a nasalized back continuant sound, a nasal glide or anusvara, often transcribed as [ŋ] (see Trigo 1988). Crucially, this segment is never pho-

[13] de Lacy (2006:184) claims that nasal glides are further specified [+glottal] (see also de Lacy 2009; de Lacy & Kingston in press), while Bakovic (2001) deems that the nasal remains [+consonantal] even in the absence of a Place node, since "final glides strongly attract final stress in [Spanish] (Harris 1983) and final nasals do not, even in the varieties in question" (p. 7, fn. 11). The latter assumption is also implicit in Trigo (1988:81): "velars are the phonetic realization of place-less [+consonantal] segments."

nologically specified as [+nasal]. The nasality is simply a chance by-product of the attempt to achieve closure in the phonetics. (p. 161)

Paradoxically, a drawback of such phonetic explanations of velarization is their high degree of abstractness (Kiparsky 1968). As de Lacy (2006:506, fn. 267) concedes, "[t]he fact that [N] and [ŋ] have the same phonetic realization makes it difficult to determine cases where they contrast phonologically." To illustrate: recall that Canadian French velarizes /ɲ/ in coda position (see (3) on p. 2). As it happens, this dialect also (optionally) changes voiced stops to their nasal counterparts when they are adjacent to a nasal segment (Douglas C. Walker 1984:113-4). As a comparison between Standard French (SF) and Canadian French (CF) reveals, this nasal assimilation applies after nasalized vowels (11) as well as before nasal consonants (12).

(11)	SF	CF	
a.	gʀɑ̃d	gʀɑ̃n	'tall' (f.)
b.	blɔ̃d	blɔ̃n	'blond' (f.)
c.	ʒɑ̃b	ʒɑ̃m	'leg'
d.	ɔ̃bʀ	ɔ̃m	'shadow'
e.	ʒœ̃gl	ʒœ̃ŋ	'jungle'
f.	lɑ̃g	lɑ̃ŋ	'language'

(12)	SF	CF	
a.	admiʀe	ænmiʀe	'admire'
b.	fʀwadmɑ̃	fʀwænmæ̃	'coldly'
c.	ɑ̃ʒɑ̃bmɑ̃	ɑ̃ʒɑ̃mmæ̃	'enjambement'
d.	djagnɔstik	djæŋnɔstɪk	'diagnostic'
e.	fʀagmɑ̃	fʀæŋmæ̃	'fragment'
f.	lɔ̃gmɑ̃	lɔ̃ŋmæ̃	'lengthily'

Conspicuously, the velar nasal that results from the nasalization of /g/, as in (11e-f) and (12d-f), has the same realization and distribution as the one that results from the velarization of /ɲ/ (see (3) on p. 2). As Walker (1984:116) states, "there is no way to distinguish the [ŋ] in *enseignement*, where the source is /ɲ/, from that in *longuement*, where the [ŋ] results fom the nasalization of /g/." It is possible that speakers assign them different output representations —one [dorsal], the other placeless— but an account without this assumption is preferable.[14]

Next consider the case of nasal place assimilation in Chukchi (Chukotko-Kamchatkan: Bogoras 1922 et seq.[15]). An underlying /ŋ/ converts to [m] before labials and to [n] before coronals (13a).[16] Crucially, the other nasals /n, m/ do not Place-assimilate in this way (13b).

(13) *Chukchi* (Kenstowicz 1980:90-2; 1986:81; also Odden 1987)

a.	[teŋ-əɬʔ-ən]	'good'		
	[tam-peɻa-k]	'look good'	[tam-βaiɻgin]	'good being'
	[tan-ɬəmŋəɬ]	'good story'	[tan-leut]	'good head'

b.	/ge-n-kim-ew-lin/	[ɣenkimewlin]	'impeded' (cf. [nəkiməqin] 'slow')
	/ga-n-pera-w-len/	[ɣanperawlen]	'decorated' (cf. [peran] 'image')
	/n-mk-kin/	[nəmkəkin]	'often' (cf. [mək] 'many')
	/imti-t/	[imtit]	'loads' (cf. [imət] 'load'

Trigo (1988:89) claims that coda [ŋ] is specially susceptible to Place-assimilation in Chukchi because it is placeless.[17] However, Place assimilation is bled by a separate process of nasal dissimilation which turns [ŋ] into [ɣ] (Chukchi lacks [g]) before a nasal, as shown in (14). This alternation

[14] Picard (1993) alleges that English speakers, including Walker, misperceive syllable-final /ɲ/ as [ŋ] because [ɲ] is an allophone of /ŋ/ after front vowels in English. This fails to explain why /ɲ/ is also reported as [ŋ] after back vowels, e.g., (3b,c).

[15] Skorik (1961), Krause (1980), Kenstowicz (1980, 1986), Odden (1987), Spencer (1999), and de Lacy (2006). The following description is confirmed phonetically by Asinovskii (1991).

[16] [a] ~ [e] alternations are due to vowel harmony. Bogoras' and Kenstowicz's *r* is written ɻ, after its description in Spencer (1999:2.1) as "retroflex glide (like Standard British English)." (15b) is from Spencer (1999:9.4.1.12).

[17] Rice (1996) similarly assumes that Chukchi [ŋ] lacks Place features; her approach is discussed below in §3.2.

argues that the coda nasal is not placeless ("N") but rather [dorsal] (de Lacy 2006:196; de Lacy & Kingston in press).

(14) *Chukchi nasal dissimilation* (Krause 1980:20)

[raʧwəŋ-ək]	cf.	[mət-raʧwəɣ-mək]	'we competed'
[taraŋ-ək]	cf.	[nə-taraɣ-more]	'let's build a place to live'
[enawrəŋ-ək]	cf.	[enawrəɣ-nən]	'he presented him'
[petʔiŋ]	cf.	[petʔiɣ-ŋinqej]	'boy with a cold'

Moreover, if [ŋ] were placeless, we might expect it to fully assimilate it to its environment, but this is not the case. The additional forms in (15) illustrate that Place assimilation in Chukchi implicates primarily the designated articulators of source segments. In (15a) *ŋ* agrees with the [dorsal] specification of the uvular *q* but not with its [−high] feature.[18] In (15b) *ŋ* assimilates the [labial] articulation of *w* but not its other Place specifications [+round] and [dorsal].[19] In (15c) *ŋ* assimilates the [coronal] articulation of *ɻ*, *ʧ* and *j* but not their [−anterior] or [+distributed] features.

(15) *Place assimilation in Chukchi* (Bogoras 1922:653-7; Kenstowicz 1980:90-1)

a. [nə-teŋ-qin] 'good' (adj.) b. [tam-waŋeiɻgin] 'good work'

c. [tan-ɻan] 'good house' [tan-ʧotʧot] 'good pillow' [ten-jəɬqetək] 'sleep well'

Such a surgical pattern of assimilation is expected in current Articulator Theory, which postulates terminal articulator features which may spread autonomously. After Halle (1995), Place assimilation involves spreading the set of terminal features under the Place node, with individual features blocked if their spreading would result in ill-formedness. In Chukchi, some Place features spread leftward onto the nasal but structure preservation (Kiparsky 1993) blocks the spreading of others:[20] [−high] in (15a) (*[ɴ]), [dorsal] and [+round] in (15b) (*[ŋ͡m], *[ŋ͡mʷ], *[mʷ]), and [−anterior] and [+distributed] in (15c) (*[ɲ], *[ɳ]). (See fn. 24 on p. 6 for related discussion.)

Another problem for the anusvara-treatment of [ŋ] in coda position is that this sound can alternate with a truly placeless glide, as happens in Aguaruna (Trigo 1988:112-4, 123-5, 129ff.; Payne 1990). As Payne (1990:162) describes, "/ŋ/ is realized as a nasalized laryngeal glide [ɦ̃] in syllable initial position. Thus /suŋkuŋ/ 'influenza' in the nominative case is [suŋkuŋ]. With an accusative suffix adjoined it is /suŋkuŋan/ [suŋkũɦ̃ăn]. Phonetic nasalization from the glide spreads to adjacent vowels." Similarly Trigo (1988:113): "The morpheme /-ŋu/ 'possessive-aspectual' has two realizations: [-ɦ̃ũ] and [-ŋ] which are conditioned by a rule of vowel deletion whose environment is not well understood," e.g., *duha-ŋ-tinu* 'rise-asp-fut' vs. *duha-ɦ̃ũ-t* 'rise-asp-inf'; *kumpa-ŋ* 'friend-poss' vs. *kumpa-ɦ̃ũ* 'friend-poss-vocative'. Crucially, the understanding of Aguaruna [ɦ̃] as "a debuccalized velar nasal" (Trigo 1988:114, fn. 6; also: Payne 1990:162) is unachievable if [ŋ] is already placeless.[21]

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[18] On [high] in velars vs. uvulars, see Chomsky and Halle (1968:304-5), Zetterstrand (1998), Vaux (1999), and Halle et al. (2000:426-7).

[19] There is phonological evidence that Chukchi *w* is all of [labial], [+round] and [dorsal]. On the one hand, *w* variably dissimilates to [dorsal] *ɣ* when adjacent to a [+round] vowel, e.g., *wopqə* ~ *ɣopqə* 'moose' (cf. Korjak *wepqa-n*), *wut-ək* ~ *ɣut-ək* (cf. Korjak *wut-ək*) (Kenstowicz 1980:92-3). On the other hand, [dorsal] *ɣ* converts to *w* preceding [labial] consonants, e.g., *ətləɣ-ən* 'father' vs. *ətləw-pojg-ən* 'father's spear', *ʔiɣ-ən* 'wolf' vs. *ʔiw-pipiq-əlɣ-ən* 'lemming' (wolf+mouse) (ibid.; after Skorik 1961:46).

[20] Structure preservation does not explain all partial spreading. For example, a similar pattern of nasal Place assimilation occurs in Acehnese (Austronesian: Durie 1985; Al-Harbi 2003): only [m] occurs before labials (e.g., *gumpa* 'earthquake'), only [n] occurs before coronals (e.g., *mɨntrɔə* 'vizier'), and only [ŋ] occurs before dorsals (e.g., *naŋgrɔə* 'country'). Crucially, /ɲ/ is a phoneme in Acehnese (Durie 1985:19) yet apico-alveolar [n], not palatal [ɲ], also occurs before palatals (e.g., [hanco], *[haɲco] 'broken'). See also Quechua example in fn. 24 below.

[21] Nasalized laryngeal glides are confirmed phonetically by Cohn (1993) and phonologically by Piggott (2003).

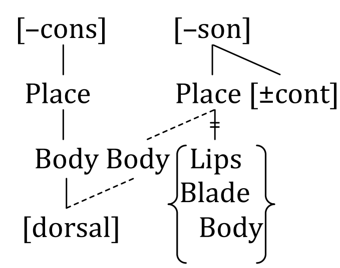
Finally, the view that velarization and velar insertion in coda position (§2.1) involve placeless [N] predicts that these processes are specific to nasals. As de Lacy (2006:39) puts it, "at least *one* language should exist in which stops and/or fricatives neutralize to [k] and [x] while nasals neutralize to 'ŋ'. However, there is no such language." Indeed de Lacy (2006:40) asserts that "[k] and [x] are never epenthetic"; "there is never epenthesis of [k] or [x], and these segments are never the output of neutralization" (2006:42). (See also de Lacy 2009; de Lacy & Kingston in press.) By contrast, the proposed Articulator Theory analysis of these processes predicts that [dorsal] can also spread from a vowel to a non-nasal consonant. The next section verifies this prediction (§3.1), and offers additional arguments against the claim that [ŋ] lacks Place features (§3.2).

3. Non-nasal targets. This section first treats the velarization of obstruents under current Articulator Theory (§3.1). The possibility that such cases involve 'placeless' velars (Rice 1994; 1996 et seq.) is also considered and rejected (§3.2). The Articulator Theory analysis of velarization is then extended to approximants (§3.3).

3.1. Obstruent velarization and velar obstruent insertion. Obstruent velarization and velar obstruent epenthesis are less common across languages than their nasal counterparts but are nonetheless attested. In Cuban Spanish, for instance, "all nasals are realized as velar before other consonants and in word-final position" (Guitart 1976:49). Crucially, Guitart finds that in colloquial Cuban Spanish coda velarization extends to nonfinal obstruents such that, for example, *apto* 'fit' and *acto* 'act' are homophonous as ['akto] (ib., p. 77). Several other examples are given in (16). (The resultant velar obstruents spirantize occasionally (16b,d,f).)

(16) *Obstruent velarization in colloquial Cuban Spanish* (Guitart 1976: 23, 48, 77)

a.	conce[k]to	'concept'	*cf.*	conce[β]ir	'to conceive'
b.	rece[ɣ]tor	'receptor'	*cf.*	reci[β]ir	'to receive'
c.	su[k]desarrollado	'underdeveloped'	*cf.*	su[β]arrendado	'subleased'
d.	ecli[ɣ]sar	'to eclipse'			
e.	é[g]nico	'ethnic'			
f.	a[ɣ]mitir	'to admit'			

(17)


Guitart (1982) reports the same pattern in the Spanish spoken in Maracaibo, Venezuela, e.g., *obsequio* [oksekio] 'gift', *este* [exte] 'this' (see also Trigo 1988; de Lacy 2006:352). If this pattern is synchronic, parallel to nasal velarization in these dialects (see §2 above), it can be understood as assimilation to the [dorsal] articulation of the vowel, as represented in (17) just above (cf. (8) on p. 5). As with nasal velarization, the height and backness of the preceding vowel appear insignificant to this pattern, while syllable structure plays a critical role. Compare *s*[uk.li]*ngual* 'sublingual' vs. *s*[u.βli]*mar* 'to sublimate' (Guitart 1976:48).

The parallel participation of nasals and obstruents in velarization can also be seen in the development of Fuzhou Chinese (Matthew Chen 1973; Norman 1988:228-39), where coda velarization affected not only nasals (18a) but also stops (18b).[22]

[22] Fricatives and other continuants do not occur syllable-finally in Chinese. (Earlier) Fuzhou is thus a counterexample to de Lacy's (2006:283) claim that "there is no language in which 'ŋ' as the result of neutralization parallels [k]: i.e. there is no language … that bans all but [k] and [ŋ] in codas." (See also de Lacy 2009; de Lacy & Kingston in press.) Arekuna Carib (Walter F. Edwards 1978:227) and Bugis (Uhrbach 1987:164), to be discussed shortly, represent two other counterexamples.

(18) *Coda velarization: Middle Chinese (MC) > Fuzhou* (Norman 1988:229ff.)

a.	śjəm	> ts^{h}iŋ	'deep'	b.	diep	> t^{h}ak	'stack up'
	duân	> touŋ	'break off'		ngjwɐt	> ŋuok	'moon'
	dung	> tøiŋ	'copper'		ńźjiuk	> nyk	'meat'

Akin changes have occurred in several Chinese dialects of Hong Kong (Zee 1999:161-2). For instance, the Xiamen words *ts^{h}it* 'seven' and *sin* 'new' are pronounced with final [k, ŋ] in adjacent Chaozhou (cf. Xiamen/Chaozhou: *pak* 'north', *taŋ* 'winter') (Norman 1988:236-7). As Chen (1973:44) remarks: "In the Chaozhou case the nasal and the stop endings have followed parallel and synchronous paths of development."

A similar pattern occurs synchronically in Tlachichilco Tepehua: "the coda can be filled with any consonant with one condition: if the consonant is a noncontinuant (i.e. a stop or a nasal), it must be nonanterior [i.e. dorsal]" (Watters 1988:494). The effect of this constraint is productive velarization, as shown for /t, p, k/ in (19). The forms in (19b) illustrate a small complication: "if [+labial] is present within the delinked place node, it is relinked directly to another position of the root tier, forming a complex consonant." (ib.) (Relatedly, coda /m/ velarizes as [w̃], e.g. *ta*[w̃] 'one'.)

(19) *Stop velarization in Tlachichilco Tepehua (Watters 1988)*

a.	qasmat- → qas'makɬi	'X heard Y'	cf.	qas'mat'a	'X hears Y'
	q'ut → ʔoq-ɬi	'X drank it'	cf.	ʔot'a	'X drinks it'
	ʦq'ut- → 'ʦ'oqɬi	'he wrote it'		'ʦ'ot'a	'X writes Y'
	huq'ak- → ho'ʔakna	'men'		'hoʔati	'man'
	ʧankat- → ʧan'kakna	'sugarcanes'		'ʧankati	'sugarcane'
	ta-liʦukut- → taliːʦu'kukna	'animals'		taliː'ʦukuti	'animal'
	ʃtaq'aːt- → ʃtaʔaːkna	'petate pl'		ʃtaʔaːti	'petate'
b.	nip- → ni^{w}kʃi ~ nikʃi	'squash'		nipʃi	(Huehuetla, Tecomojapa)
	ʃap- → ʃa^{w}kɬi	'X panted'	cf.	ʃap'a	'X pants'
	kap- → 'ka^{w}kɬi	'he forgot it'		'kap'a	'he forgets it'
c.	paːstak- → paːstak-nan	'X thinks'	cf.	paːstak-'a	'X thinks of Y'

The synchronic "rule of 'consonant backing'" (ib.:495) extends to loanwords as shown here:

(20) *Stop velarization in loanwords* (Watters 1980)

a.	*Huayacocotla* (Aztec place name) → wajako'kokla	
	Huehuetla (Aztec place name) → we'wekla	
b.	*capsula* 'capsule' → 'kawksula	*reptil* 'reptile' → 'rektil
	septiembre 'September' → sekti'jembre	*pepsi* 'Pepsi' → 'peksi

A comparable neutralization of obstruents occurred in Ecuador Quichua (Orr 1962). In this language, [k, g] are the only obstruent stops permitted in coda position, e.g., *l^{j}ak.ta* 'village', *pu.sak* 'eight', *ʧig.ni.na* 'to hate', *ug.ʃa* 'grass'; "/p/ and /t/ [and /b, d/] are not found in syllable-final position" (Orr 1962:61). That stop velarization is at least partially responsible for this state of affairs is suggested by loan adaptations, e.g., Spanish *Pedro* 'Peter' is adapted as [pig.ru] in Quichua (ib., p. 65, 73).[23] Orr (p. 61-2) notes that this distribution of obstruents parallels /h, n/, which are realized as velar [x, ŋ], respectively, in coda position.[24]

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[23] To explain the Place restriction on syllable-final stops, de Lacy (2006:254)suggests that /p, b, t, d/ convert to [m, n] in coda position, whereas /k, g/ do not nasalize correspondingly because Quichua lacks [ŋ]. In fact there is no evidence that /p, b, t, d/ nasalize in coda position. Moreover, [ŋ] is very common in this position, due to nasal velarization (Orr 1962:62), e.g., *aŋsa* 'dark', *kaŋwa* 'with you', *riŋri* 'ear', *ʧuŋl^{j}a* 'quietly' (see section §2.1 above).

[24] /n/ remains alveolar before coronal stops, including palatoalveolar ones, e.g. *ɲukanʧi* 'we'. Similarly, in Aya-

Obstruent velarization is also one of several strategies adopted in Dschang (Bamileke) to avoid final coronals in English loans, as Bird (2003:14) describes: "Alveolars are not licensed in the syllable coda. In [mɛta] *mat*, a vowel is inserted, making the *t* into the initial segment of the next syllable. For [dəək] *debt*, the place of articulation of the *t* is changed to velar, making it a legal syllable-final consonant. For [aplɛŋgɛ] *blanket*, the final *t* is deleted."

In Arekuna Carib, too, obstruent velarization is presumably responsible for the fact that [k] is the only obstruent permitted in coda position, e.g., [ek.ma] 'road', [wɨ.rik] 'girl', ['wok.ɽa] 'marudi (bird)'. "All Arekuna consonants can appear syllable-initially and word-initially, but only [k], [ŋ], [m], and [n] are permissible in syllable-final positions. Word-finally only [k] and [ŋ] are possible" (Walter F. Edwards 1978:227). ([m, n] occur syllable-finally only in Place-assimilation to a following consonant, e.g., [i.'pan.ta] 'branch'.)

There is additional evidence of obstruent velarization in Carib (Hoff 1968:59-61, 86-92; 2003:261). Like other members of the Cariban family, this language of Guyana habitually drops stem-final vowels before suffixes (Gildea 1995). When such syncope brings together a stop and an obstruent, the first neutralizes to a velar fricative, as exemplified in (21). (Pre-obstruent spirantization is here considered a separate process.)

(21) *Stop velarization in Carib of Surinam* (Hoff 1968)

enapɨ+taŋʲ → enaxtaŋʲ	'he'll eat'	*cf.*	enapɨ	'to eat' (p. 60)
wɨ:to+sa → wɨxsa	'I go' (p. 66)		wɨ:to	'to go' (p. 168)
s+eka:ritɨ+to → seka:rixto	'I told it then cont.'		eka:ritɨ	'to tell' (p. 172)
wonɨ:kɨ+poro → (w)onɨxporo	'to sleep'		wonɨ:kɨ	(p. 157, fn. 38)

Lacy describes the Carib process, Lacy (2006:135) suggests that the output of this neutralization in Carib "[χ] is not a true uvular, but perhaps glottal [h] with a strident secondary articulation ... Without close phonetic analysis, further speculation about Surinam Carib is unwarranted." (See also de Lacy 2009; de Lacy & Kingston in press.)

Obstruent velarization similarly occurred historically in Blackfoot (Proulx 1989). As the following data illustrate, Proto-Algonquian consonants have shifted to [x] in (non-final) coda position. This velarization and spirantization affected stops (22a,b), fricatives (22c,d), nasals (22e) and even laryngeals (22f-h).[25]

(22) *Historical velarization in Blackfoot* (Proulx 1989, my revised Blackfoot data)

	Proto-Algonquian	*Blackfoot*	
a.	*-tpikaji	(m)oxpikís	'rib'
b.	*-tka:ʧi	(m)oxkát(s)-	'leg'
c.	*-weɬkani	oxkin	'bone'
d.	*ka:ʃkantamwa	ikaxkɛnnima:	'bite it off'/'cut off branch'
e.	*-to:ntani	(m)o:toxtón	'heel'
f.	*nehk-	inixka(t)	'name'

cucho Quechua according to Parker (1969:19), "/n/ is apico-alveolar [n] before vowels and before the consonants /t č d s ř/ [where č is "palatal stop" (p. 18) and ř is a "retroflex spirant" (ib.)], and is dorso-velar [ŋ] elsewhere." Under Articulator Theory, this is understood as follows: [dorsal] regularly spreads from a vowel to coda /n/, which thereby drops its [coronal] articulation. However, this [dorsal] assimilation is blocked if the [coronal] feature of /n/ is shared with a following consonant —apparently an inalterability effect (Hayes 1986). Crucially, only in current Articulator Theory is it assumed that every vowel has a terminal [dorsal] feature which can therefore spread independently, and that [coronal] can be shared between two consonants which otherwise differ in terms of [±anterior] and [±distributed], such as [n] *vs.* [č, ř].

[25] Proulx (1989:50) also documents *x*-epenthesis in Blackfoot: "**s* → *xs* noninitially" [i.e., postvocalically], e.g. PA *-so:wi > Blackfoot (m)oxsojís 'tail of quadruped'.

j.	*-hpani	(m)oxpín	'lung'
h.	*-aʔteː	-ixtsiː-	'be located'

Turning to velar obstruent epenthesis, recall that Uradhi grammar adds [ŋ] to vowel-final stems, a pattern which has been taken as evidence that the added nasal is really placeless "N" (e.g., de Lacy 2006:183). In fact, Hale (1976:44) reports that "this [velar] constriction is oral if the first consonant to the left is also oral … and nasal if the first consonant to the left is nasal." Crowley (1983) confirms that the final velar is variably realized as [k] (except following a nasal) in several dialects, such as Atampaya and Angkamuthi:

(23) *Uradhi (Atampaya, Angkamuthi)* (Paradis & Prunet 1993:428)

/luwu/	[luwuk] ~ [luwuŋ]	'stonebird'
/ipi/	[ipik(ʲ)] ~ [ipiŋ(ʲ)][26]	'water'
/juku/	[jukuk] ~ [jukuŋ]	'tree'
/ama/	[amaŋ] (*[amak])	'person'

Next consider Jacobsen's (1999) description of the "velar increment" in Makah (Nootkan): "The Makah language has undergone a sound change consisting in the insertion of -k- after a short vowel of a word-initial syllable when this is followed by a semivowel -w- or -y- followed in turn by a vowel. Formulaically: Ø → k / #CV__w/yV" (p. 1). While this pattern of *k*-insertion in coda position has no obvious rationale,[27] Jacobsen provides copious evidence for it. Some of his examples are presented in (24), along with cognates from Ditidaht (John Tl'iishal Thomas & Hess 1981) and Nuuchahnulth-Nootka (Powell 1991), for comparison.[28] (Note that *k* undergoes rounding after *u* (24g,h).)

(24) *k-insertion in Makah* (Jacobsen 1999)

Makah	*Ditidaht*	*Nuuchahnulth*	
ʦik.ˈja.puxʷs	ʦi.ˈjaːpxʷs	ˈʦi.ja.pux(ʷ)s	'hat'
ʦ̓ak.ˈwaːk	ʦ̓a.ˈwaːk	ʦ̓a.ˈwaːk	'one'
tak.ˈjaːj	ta.ˈjaaj	ta.ˈjiː	'older brother'
ʔak.ˈwatiːd	ˈʔa.wa.tiːd	ˈʔa.wa.tin	'eagle'
ʔak.ˈja	ˈʔa.ja	ˈʔa.ja	'lots'
qak.ˈwej	qa.ˈwaj	qa.ˈwiː	'salmonberry'
bukʷ.ˈwaʧ	ˈbu.waʧ	mu.waʧ	'deer'
ʔukʷ.jaχ.bis	ˈʔuj.χabs	ʔu.jaqħ.mis	'news' (Jacobsen 1969:136)

Finally consider Coast Tsimshian (Sm'algya<u>x</u>) wherein, according to Dunn (1979:13), "[t]he most common type of plural reduplication consists of copying the first consonant of the word and prefixing it to the word along with a vowel and a kay (k)."

(25) *CVk-reduplication in Coast Tsimshian* (Dunn 1979)

a.	ɬpun	ɬʌk-ɬpun	'whale'	d.	gʲemk	gʲik-gʲemk	'heat, sun, moon'
	ɬaːts	ɬʌk-ɬats	'scraper'		gʲet	gʲik-gʲet	'person'
	luːt	lʌk-luːt	'wedge'		gʲiːk	gʲik-gʲiːk	'fly'

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[26] In Atampaya velars regularly become palatalized after [i], i.e., [–back] spreads from [i] to a following velar. This effect which Paradis and Prunet (1993) dismiss as "a non-discrete phonetic alternation" (p. 433) provides independent support for the Articulator Theory analysis involving spreading from a vowel's Tongue Body features.

[27] McCarthy and Prince (1999) argue for a constraint against intervocalic *w* (*VwV) in Southern Paiute.

[28] There are several classes of exceptions (Jacobsen calls them "inhibition contexts"): k-insertion fails in proper names (e.g., buwaʧ̓atχ 'Moachat') and in contexts derived from suffixation (e.g., ʧ̓i-jak cut-instrument: 'knife') and reduplication (e.g., wi-wikχs 'none on bush').

	małiłk	mʌk-maːłiłk	‘tell’	e.	beːd	bɨk-beːd	‘bed’
	miːlk	mʌk-miːlk	‘dance’		p’iʔiłosk	p’ɨk-p’iʔiłosk	‘dried seaweed’
	naluːłk	nʌk-naluːłk	‘nest’		w̰aːn	wɨk-w̰aːn	‘tooth’
b.	duːs	dik-duːs	‘cat’		w̰ej	wɨk-w̰ej	‘find’
	ʥiːɥ	ʥik-ʥiːɥ	‘dolphin’	f.	ʔalaːjs	ʔak-ʔalaːjs	‘lazy’
	ʦ́al	ʦ́ik-ʦ́al-t	‘face’		ʔanoːl	ʔak-ʔanoːl	‘allow’
	sejp	sik-sejp	‘bone’		haːʔps	hak-haːʔps	‘cover’
	sweda	sik-sweda	‘sweater’		hało	hak-hało	‘cloth’
c.	jeːj	jik-jeːj	‘fat’	g.	ɢaːχ[29]	ɢɑk-ɢɑq	‘black bass’
	juːta	jik-juːta	‘man’		ɢoːm	ɢɑk-ɢoːm	‘ash(es)’

As illustrated in (25), the reduplicative syllable always ends in [k] whereas the quality of its vowel varies greatly according to the initial consonant.[30] For our purposes we can ignore this vocalic variation, which also occurs in reduplication in other Tsimshianic languages such as Nisga’a (Shaw 1987) and Gitksan (Rigsby 1986). Of more relevance is that the reduplicant in Coast Tsimshian is shaped CVk. By contrast other Tsimshianic languages have regular CVC-reduplication (ibid.). Alderete et al. (1999) argue that featural markedness may drive fixed segmentism in reduplication. For instance, Tübatulabal (Uto-Aztecan) may replace stem consonants with glottal stop in reduplication because this segment is unmarked in terms of place features. A coda consonant is also reduplicated in Tübatulabal, but only if it shares its place features with a following (base) consonant, that is, "[o]nly if having a coda does not introduce additional place-markedness violations" (p. 345). In the same vein, perhaps Coast Tsimshian favors CVk-reduplication (rather than CVC-reduplication as in other Tsimshianic languages) because [k] avoids adding place features by sharing its [dorsal] feature with the preceding vowel.

Similarly, the (foot-size) reduplicant ends with [k] in Bugis (Austronesian), as illustrated in (26) (Uhrbach 1987; Urbanczyk 2000 -glosses not provided). Uhrbach and Urbanczyk both argue that [k] is not a fixed segment in this reduplicative pattern but is derived: “only two consonantal phonemes are permitted in morpheme-final position: *k* and *ŋ*. Thus it is *k* which appears in final position in the affix, closing the syllable. ... Thus these are not true cases of segment-changing reduplication per se.” (Uhrbach 1987:164). (Note that [k] is realized as [ʔ] in some dialects.)

(26) *Bugis* (Uhrbach 1987:165)

a.	araweŋ	arak-araweŋ
b.	cabberu	cabbek-cabberu
c.	pattama	pattak-pattama

In sum, obstruent insertion in each of Uradhi, Makah, Sm’algyax̲ and Bugis seems prosodically motivated, but as with *ŋ*-epenthesis (see above), the specific choice of epenthetic *k* can be understood as [dorsal]-spreading from a vowel, with default features filled-in ([−continuant], [−sonorant], etc.).Other cases of obstruent velarization and obstruent velar epenthesis will be introduced below.[31] See also Rice (1996) for several examples from Dakota (Shaw 1978:235-6; 1980), Cayuga (Dyck 1991), and Chukchi (Kenstowicz 1980; Odden 1987:13), among others.[32]

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[29] /q/ regularly spirantizes finally (Dunn 1979:11).

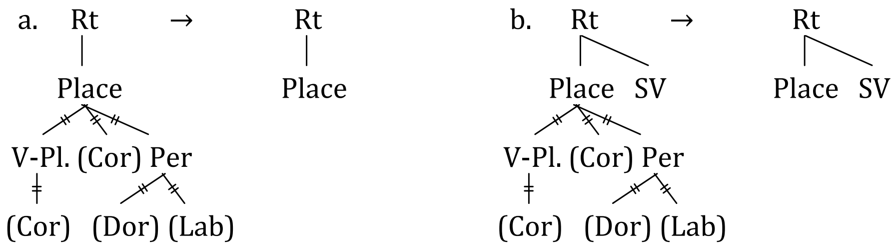
[30] The reduplicant vowel is [ʌ] after laterals and nasals (25a); [i] after nonlateral, nonnasal coronals (25b) including /j/ (25c) as well as after palatalized velars (25d); [ɨ] after (nonnasal) labials (25e); [a] after laryngeals (25f), and [ɑ] after uvulars (25g).

[31] I ignore cases in which labial obstruents become labial-dorsal [w] in coda position, for instance, /v/ in Georgian (Aronson 1990) or Persian (Hayes 1986). Velarization is apparently derivative of lenition in such cases. Indeed, in some languages the change of labial obstruents to [w] is part of a more general process of syllable-final lenition, as in dialectal Inupiaq (Dorais 1990:51) and Hausa (Clements & Hume 1995:276).

[32] Obstruent velarization is triggered by coronal dissimilation in each of Dakota, Cayuga and Chukchi.

3.2. Coda velars as unspecified for Place. Rice (1994; 1996; 2003; Rice & Causley 1998) proposes that velarization processes involve the loss of features only *under* Place (see also Ghini 1995; 2001b; a; Humbert 1997:224-5). This leaves a 'bare' Place node which is seen, by hypothesis, as a possible phonological representation for not just [ŋ] but any velar: "syllable-final "dorsal" consonants [are] without a Place dependent" (Rice 1994:206-7). In this approach, obstruent velarization (as in Cuban Spanish (16) or Surinam Carib (21)) looks like (27a), and nasal velarization (as in Ligurian or Sinhala) looks like (27b) (cf. (10b)).[33]

(27)



There is assumed to exist "a distinct mechanism of phonetic interpretation that interprets a consonant lacking a phonological place of articulation as a velar" (Rice 1996:493).[34] This mechanism is not described by Rice but it must be loose enough to be applicable to both velar nasals and velar obstruents.

As with the 'anusvara' treatment of nasal velarization (§2.3), a challenging aspect of Rice's approach is that velars resulting from syllable-final neutralization are indistinct from velars resulting from other processes that clearly involve [dorsal]. Consider one of Rice's examples: stop velarization in Western Apache (Athabaskan: Hill 1963). In the San Carlos dialect (SC), /t, k/ are distinguished word-finally (/p/ is rare and never final) but in the White Mountain dialect (WM) final coronals have shifted to velars; compare the following cognates:[35]

(28) *Apache stem-final stops: San Carlos vs. White Mountain* (Hill 1963:150-2)

	SC	WM			SC	WM	
a.	-ʧát	-ʧák	'leg'	b.	-ʧʰak	-ʧʰak	'cry'
	-lit	-lik	'burn'		-tak	-tak	'count'
	-zit	-zik	'spit'		-tok	-tok	'be warm'
	-ziːt	-ziːk	'work'		-ʦ́ak	-ʦ́ak	'hear'
	-ʦit	-ʦik	'fear'		-ʦok	-ʦok	'be yellow'

According to Rice (1996:510) final velars are specified [dorsal] in San Carlos Apache, since they contrast with final coronals, whereas these same segments lack Place features in the White Mountain dialect (cf. (27a)). This analysis is admittedly abstract — Rice concedes that final velars are phonetically identical across dialects[36]— yet it is happily falsifiable. In particular, additional data from Hill (1963:150-2) and Greenfeld (1978:152) reveal that

(29) *White Mountain Apache*

-kʰéːt	'ask for it'
-kéːt	'dig'
-kot	'knee'
-ɣot	'strength'
-xot	'be lame'

[33] SV is Sonorant Voice, which has the default interpretation Nasal (Rice 1995; John Peter Avery 1997); V-Place (Coronal) is used for [ɲ] (Rice 1996:507); Per(ipheral) has the interpretation Labial unless it dominates Dorsal (Rice 1994).

[34] In Rice's earlier work (Peter Avery & Rice 1989; Rice & Avery 1993) and elsewhere (e.g., Humbert 1997; Causley 1998), it is assumed that a segment with a bare Place node is interpreted as coronal, not velar.

[35] This change occurred identically in the Southern Min dialect of Chinese (Matthew Chen 1973).

[36] Similarly, Pham (2006) treats velar codas in Hanoi Vietnamese as [dorsal] but the same velar codas in Saigon Vietnamese as placeless.

coronals resist velarization in syllables that contain a velar consonant (29). As Greenfeld (1978:152) remarks: "There also seems to be a tendency among all speakers to want to pronounce stems which begin in a velar with a final alveolar. Thus one can elicit [ʃikok] 'my knee', but most speakers seem to prefer [ʃikot]." The latter effect is clearly dissimilatory in nature and as such, it is unintelligible unless both consonants involved are specified[+consonantal, dorsal], contra Rice (1996).[37]

Assimilation effects cast further doubt on Rice's analysis of velars as unspecified for Place. For instance, Rice (1996:507) suggests that nasal velarization in Carribean Spanish involves the loss of Place features, as diagrammed in (27b) above. However, when a velarized nasal precedes a labial consonant in Cuban Spanish, regressive Place assimilation additionally occurs, resulting in a doubly-articulated nasal, e.g., *u*[ŋ͡m] *boleto* 'a ticket', *u*[ŋ͡m] *francés* 'a Frenchman' (Guitart 1976:23, 76). This interaction is also found in other Spanish dialects, such as Asturian (e.g., *e*[ŋ͡m]*pezó* 'began', *u*[ŋ͡m] *palo* 'a stick'; Cadierno and Prieto 1989) and Chinato (e.g., *pa*[ŋ͡m] *pequeño* 'little bread'; Hualde 1991:68) . This pattern proves that the velar nasal resulting from coda velarization must be [dorsal]; if it lacked Place features, regressive [labial] assimilation would always yield [m], never [dorsal]-[labial] [ŋ͡m].

Recall too that nonfinal coda obstruents become velar in coda position in some Caribbean dialects of Spanish, e.g., *este* [exte] 'this' (Guitart 1976; 1981; Trigo 1988). The Madrid dialect of Spanish shows a different pattern of coda velarization: /s/ assimilates to a following velar, e.g., *asco* [axko] 'nausea', *los campos* [loxkampos] 'the fields' (Quilis 1965:22; Turnham & Lafford 1995:313).[38] This is evidently a case of [dorsal] assimilation since "the velarization of /s/ to [x] occurs only before a velar consonant" (Turnham & Lafford 1995:336, n. 2).[39] But unlike Madrid Spanish [x] which is arguably [dorsal], Caribbean Spanish [x] is alleged to lack Place features. No such abstract claim is needed in the Articulator Theory analysis (§3.1).

A comparable point can be made with Selayar (Makassar: Mithun & Basri 1986): it exhibits word-final nasal neutralization to [ŋ] as well as nasal Place assimilation, as shown clearly in the reduplicated forms in (30). Focusing on (30e-h), it is suspect to treat some [ŋ]'s as [dorsal] (via Place-assimilation to [k] or [g]) and others as lacking Place features (via syllable-final neutralization), since Mithun and Basri (1986) find no difference between them.[40] Yet this is what Rice (1996:501) is forced to argue.[41]

(30) *Homorganic NC clusters in Selayar* (Mithun & Basri 1986)

a.	pekampekaŋ	'hook object'	e.	roŋganroŋgaŋ	'rather loose'
b.	bambambambaŋ	'sort of hot'	f.	keloŋkeloŋ	'sort of sing'
c.	ʤaŋaŋʤaŋaŋ	'bird'	g.	gintaŋgintaŋ	'chili object'
d.	dodondodoŋ	'sort of sick'	h.	huk:uŋhuk:uŋ	'punish lightly'

[37] A similar effect is found in Gullah English (Klein & Harris 2001): /wn/ regularly becomes [wŋ] word-finally, e.g., *down* [dawŋ], *drown* [dɹawŋ], *around* [(ə)ɹawŋ], *sundown* [sʌndawŋ]. Evidently [dorsal] spreads from labio-dorsal /w/ to /n/, giving [ŋ]. This simple analysis is confirmed by Klein and Harris' (2001) observation that the assimilation fails if it would result in tautosyllabic dorsal consonants, e.g., *gown* [gawn], *[gawŋ]; *ground* [gɹawn], *[gɹawŋ]. Again, this dissimilation effect argues that both consonants are specified [+consonantal, dorsal].

[38] Some participants in Turnham and Lafford's (1995) study applied /s/-velarization almost categorically in conversational style (p. 332) but for most subjects the process was variable (p. 334).

[39] Similarly, in South Central Castillian Spanish /s/ loses its coronal articulation syllable-finally: it is realized [x] before dorsals (e.g., *mis̠ cosas* 'my things'), else it surfaces as [h] or Ø (Sánchez Muñoz 2003).

[40] Mithun and Basri use quite narrow transcriptions in their study. For instance, they point out that "[l]ike the other velar consonants, [ŋ] is fronted before front vowels" (p. 222) and they indicate this fronting in all their transcriptions, e.g., ['ŋ^{j}ê:raŋ] 'bring', ['ŋ^{j}ĩ:nũŋ] 'drink' (ib.).

[41] The same point can be made with Canadian French. As Eychenne (2003:56) states, "/ɲ/ tends to be realized [ŋ] in word final position ([kɔ̃paŋ] for *compagne*) or before /w/, the velarity of which it assimilates (*baignoire* is most often pronounced [bɛŋwɒr])."

Finally, in the next section I show that coda velarization extends to approximants. Although Rice does not consider such cases, her approach to velarization implies that velarized approximants, too, lack Place features, and that the phonetics module is somehow able to interpret as velar not only placeless nasals and obstruents but also placeless approximants. Such lax phonetic interpretation of phonological representations is possible, but unnecessary given the Articulator Theory approach.

3.3. Liquid velarization. So far the revised Articulator Theory analysis of coda velarization as [dorsal] assimilation has been applied to nasals and obstruents. I now extend this analysis to rhotics and laterals.

3.3.1. Rhotics The velarization of rhotics is relatively uncommon, but incidences are well known. Notably, apico-alveolar [r] (or [ɾ]) has evolved into uvular [ʀ] (or [ʁ]) in dialects of many familiar languages, including French (Straka 1965), German (Howell 1987) and several Scandinavian languages (Swedish, Danish, Norwegian: Torp 2001).[42] Contrary to the popular view (e.g., Chambers & Trudgill 1998:170-3), rhotic velarization appears to have evolved independently in many cases (Howell 1987; 1991; King & Beach 1998), so it is appropriate to develop a formal account of this process.

The genesis of rhotic velarization is plausibly inferred from present-day dialects in which the change is incomplete, where alveolar and uvular rhotics continue to alternate. Interestingly, in several such dialects [r] is favored in syllable onset position while [ʀ] is favored in coda position. Zhirmunksii (1962) first reported this distribution for some Cologne dialects of German. For instance, he found that syllable-final [ʀ] in, e.g., *Ferkel*, *werfen*, *Sturm* is realized [r] if these words are pronounced with anaptyxis: *fęrəkəl*, *vęrəpə*, *štorəm* (p. 378). The same distribution of alveolar *vs.* uvular rhotics is widely reported as a robust tendency for Canadian French (e.g., Clermont & Cedergren 1979:25 on Montreal French; Alain Thomas 1986:65-6 on Sudbury French; Flikeid 1984; Cichocki 2004 on Acadian French).[43] Old English /r/, too, is widely assumed to have been alveolar in onset position but either uvular (Lass & Anderson 1975) or velar (Lass 1983; 1994:50; Hogg 1992:40, 85) in coda position. Relatedly, in some Northern dialects of Brazilian Portuguese [r] in onset position (e.g., *cores* 'colors' *quatro* 'four' *pára* 'for' *caro* 'dear', etc.) corresponds to [x] in coda position (e.g., *cor* 'color', *guarda* 'guard', *porta* 'door', *carne* 'meat', etc.) (Rossi 1945:303; Earl W. Thomas 1974:9; Messias & Zerling 1996; Giangola 1997:146-7).

To account for the distribution of rhotic variants, Zhirmunskii (1962) suggests that *r*-velarization derives from *r*-vocalization, which is well-known to be coda-conditioned. Specifically, he claims that syllable-final [r] weakens to a vowel-like sound which speakers reinterpret as uvular [ʀ] (p. 377). Howell (1987:340), too, notes the parallel environment for velarization and vocalization: "The crucial fact regarding the distribution of [r] versus [R] in dialects possessing both contextual variants is that the uvular *r* shows a strong tendency to develop in those positions where *r* commonly is vocalized (i.e., before a consonant, word-finally)."

Zhirmunskii's explanation, which is also adopted by King and Beach (1998:283, 287), involves abductive reinterpretation (Vr. → CVV. → CVʀ.; cf. Andersen 1973) and as such, is necessarily

[42] Other examples include Portuguese (Noll 1997), Italian (Ladefoged & Maddieson 1996:225), Spanish (Puerto Rican: Navarro Tomás 1966; Granda 1966), English (Northumbrian and Sierra Leonean: Rydland 1995; Ladefoged & Maddieson 1996:236), Dutch (Gussenhoven 1999), Yiddish (Eastern: King & Beach 1998:284-6), Russian (Ladefoged & Maddieson 1996:225), several Central Sulawesi languages (Lauje, Dampelas and Tolitoli: Himmelmann 1991), and at least two Banda languages, Ngbugu (Cloarec-Heiss 1978) and Langbasi (Olson 1996).

[43] In the French spoken in Havre St-Pierre, Quebec, *r* becomes [k ~ g] preconsonantally, e.g., *merci* [meksi], *garçon* [gaksɔ̃], *perdrix* [pɛgdri] (Santerre 1982:77). Syllable-final rhotics are identically affected in French loanwords in Dschang (Bird 1999) as well as in Vietnamese (Andrea Hoa Pham 2003:35, 52).

opaque. Howell therefore proposes a less abstract account of rhotic velarization, based on articulatory ease: “The uvular or velar pronunciation could alleviate some of the articulatory difficulties which seem to be inherent in the apical trill/flap in the syllable coda. At the same time, its introduction can prevent the total loss of the phoneme /r/ in weak positions” (p. 341-2).

A similar account is given by Straka (1965) to explain the historical development of uvular *r* in French. He suggests that speakers of French began their use of uvular *r* in weak positions because its dorsal gesture was ‘softer’ than the coronal articulation of apico-alveolar *r*, yet the acoustic effect was similar (trill). Indeed it is well documented that French *r* has long undergone coda weakening, as can be inferred from 12th century rhymes such as *sage* : *large*, *force* : *Escoce*, *courges* : *rouges* (Fouché 1961:863-4). Moreover, 13th century rhymes reveal that coda *r* caused lowering in a preceding vowel, e.g., *serge* : *large*, *Robert* : *Lombart*, *gouverne* : *Marne* (Fouché 1958:348), which Fouché (ib.) takes as evidence that apical *r* had by that time already shifted to uvular *r* in coda position.

In sum, the change from coronal to dorso-uvular rhotics seems to be favored syllable-finally, and thus emulates velarization processes that affect nasals (§2) and obstruents (§3.1).[44] Like these, rhotic velarization can be understood as spreading [dorsal] from a tautosyllabic vowel, with other Tongue Body features ([–high], [–low], [+back]) filled in, similar to (8) on p. 5.

I assume that the resulting uvular rhotics are eventually generalized in most dialects. That these rhotics are [dorsal], not ‘placeless’ in Rice’s sense (§3.2), is suggested by their syntagmatic effects. For example, in Child French a coronal stop can assimilate the dorsality of a following uvular rhotic, as shown in (31).[45] In revised Articulator Theory: [dorsal] spreads from the uvular to a preceding coronal, independently of [high]; the target is assigned unmarked [+high], while the source [ʁ] is [–high] (see fn. 18 on p. 6; for related discussion, see also fn. 24 on p. 6).

(31) *Théo* 2;05-4;00 (Rose 2000:237)

dʁol	→ gʁol	‘funny’	tʁ̥o	→ kʁ̥o	‘too much’
dʁɑgɔ̃	→ kʁ̥ɔgɔ̃	‘dragon’	sitʁ̥ʊj	→ kʁœj	‘pumpkin’
tʁ̥ɛ̃	→ kʁ̥ɛ	‘train’	tʁ̥avaje	→ kʁ̥avaje	‘to work’

3.3.2. Laterals Laterals too are susceptible to velarization in coda position, as evidenced by Dutch (Booij 1995:8), Portuguese (Mateus & Pardal 2000), Puerto Rican Spanish (Saciuk 1989) and Sasak (Austronesian: Clynes 1995), among others. Latin is a well-known case in which /l/ was plain [l] in onset but velarized (‘dark’) [ɫ] in the coda (Schein & Steriade 1986:704-8). Evidence comes from the backing and raising effects syllable-final *l* had on preceding vowels: “short *e* and *i* became *o* and *u*, respectively, before a dark *ɫ*; and *o* was raised to *u* in the same context” (Schein & Steriade 1986:705):

(32) *Coda velarization in Latin* (Schein & Steriade 1986)

	Onset position		Coda position	
a.	*vel-im*	‘want-OPT-1s’	*vul-t*	‘want-3s’
b.	*sepel-i-o*	‘bury-1s’	*sepul-chrum*	‘grave’
c.	*facil-is*	‘easy-MASC, FEM’	*facul*	‘easy-NEUT’
			facul-tas	‘ability’
d.	*exsil-ium*	‘banishment’	*exsul*	‘exile’

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[44] A more complex distribution of coronal vs. uvular rhotics occurs in some southern Swedish dialects (Elert 1974). The uvular variant is used word-initially (e.g., *rask* [ʀask] ‘refuse’) and after a short stressed vowel (e.g., *dörr* [dɜʀ] ‘door’, *herre* ['heʀe] ‘gentelman’), while the alveolar variant is used before a consonant (e.g., *varm* [varm] ‘warm’) and after a long vowel (e.g., *hör* [hɜ:r] ‘hear’, *hare* [ha:re] ‘hare’) (ibid., p. 3). I propose (tentatively) that in these dialects the uvular rhotic is basic and —itself being marked— is avoided in marked environments: before a consonant and after a long vowel.

[45] Only coronals are targeted; cf. [bʁɑ] ‘arm’ (2;10.05), [pʁ̥i] ‘occupied’ (2;09.12) (ibid.).

e.	*col-umen*	'summit'	*cul-men*	'summit'
f.	*stol-idus*	'stupid'	*stul-tus*	'stupid'
g.	*adol-eo*	'burn'	*adul-tus*	'burnt'

The backing and raising effects seen in (32) are not specific to dark *ł*. Backing of nonlow vowels is also triggered by labiovelar [w] in coda position (e.g., *brewis* 'short' vs. **brewma* > **browma* > *bruːma* 'winter solstice'), and raising of nonlow vowels is equally triggered by [ŋ] in coda position (e.g., *dek-et* 'it is appropriate' vs. *diŋ-nus* 'suitable') (Schein & Steriade 1986:706). The backing and raising processes can therefore be understood more generally as regressive assimilation of [+back] and [+high], respectively. The participation of syllable-final /l/ in vowel backing and raising[46] begs the question: why is Latin *l* specified both [+back] and [+high] in coda position? Schein and Steriade (1986:707) stipulate an "ɫ-rule" which adds [+back] and [+high] to [+lateral] in the rhyme. Building on the revised Articulator Theory analysis of velarization from the preceding sections, I propose instead that *l* acquires the Tongue Body articulator feature [dorsal] from any preceding tautosyllabic vowel, and it then receives default value specifications for the other Tongue Body features [back], [high], and [low].

The treatment of lateral velarization as [dorsal] assimilation receives independent support from Italian. As Clivio and Danesi (2000:52) describe, Italian /l/ assimilates to a following velar consonant, becoming [ɫ] (33a). (/l/ also assimilates to a following palatal consonant, becoming [ʎ] (33b).)

(33) *Lateral allophony in Italian* (Clivio & Danesi 2000:83)

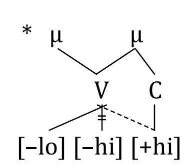
a.	*falco*	[faɫko]	b.	*falce*	[faʎʧe]	c.	*alto*	[alto]
	colgo	[kɔɫgo]		*Belgio*	[bɛʎʤo]		*calmo*	[kalmo]
	volgo	[vɔɫgo]		*calcio*	[kaʎʧo]		*latte*	[latːe]

Finally, it is worth highlighting that laterals do not necessarily forfeit their apico-alveolar gesture in velarization. The resultant dark [ɫ] is thus a complex segment: both [coronal] and [dorsal]. This is likely due to the fact that the loss of the coronal articulation in [ɫ] would result in either a velar lateral [ʟ] or a velar approximant [ɰ], both of which are marked in the extreme (Ladefoged & Maddieson 1996:190, 322).

Not surprisingly, however, many languages substitute the much less marked labial-dorsal [w] for coronal-dorsal [ɫ] in coda position. Examples include Mehri (Semitic: Johnstone 1975; Walsh 1995:541), Serbo-Croatian (Kenstowicz 1994), Old French (Fouché 1961:856), Provençal (Rohlfs 1966:342; Grandgent 1905:69-70), Belear Catalan (Alcover y Sureda & Moll 1968; Walsh 1995:541), and several other Romance languages (see esp. Bullock 1995). For example, in Brazilian Portuguese *mal* 'badly' and *mau* 'bad' are often homophonous as [maw], and *calda* 'syrup' and *cauda* 'tail' are both pronounced [kawda] (Quednau 1994).

To summarize so far: building on Paradis and Prunet (1993) it is proposed that the velarization of a syllable-final consonant, whether nasal (§2.1), obstruent (§3.1) or approximant (§3.3), is [dorsal]-assimilation to a vowel. This simple analysis makes several predictions which are described and confirmed in the following section.

[46] Raising affects only short vowels: "compare *soːl* 'sun', *seːŋnis* 'lazy', whose long vowels fail to raise, with *consul* (early *consol*), *septiŋgenti* (from **septeŋgenti*)" (Schein and Steriade 1986:707); the exemption of long vowels from raising is represented on the right.



4. General discussion and conclusion.

> *Dorsale Articulation: die nothwendigen Engen bez. Verschluesse werden durch Emporheben eines Theiles des Zungenrueckens ... zum Gaumen gebildet.* (Sievers 1881:59)

Though he once famously stated, "if the representations are right, then the rules will follow" (1988:84), McCarthy now finds this premise overly optimistic: "The hope of simplifying the rules by complicating the representations was never fulfilled" (2001a:72). Notwithstanding, in this study I have endeavored to show that a revised and indeed simplified feature geometry can uniquely envisage widespread and complex sound patterns, such as the velarization of nasals, obstruents, and approximants. Of special importance were two traditional postulates which have been restored in Articulator Theory (Halle et al. 2000; Halle 2003; Levi 2008): that "an essential characteristic of vowels is their "dorsal articulation"" (Chomsky & Halle 1968:302), and that phonological features properly characterize designated articulators (ib.:303ff.). The first assumption distinguishes Articulator Theory from virtually every other contemporary theory of segmental phonology —most notably Vowel-Place Theory (Clements & Hume 1995). The second assumption is shared by the latter theory, but Articulator Theory uniquely defines articulator features as strictly terminal.[47]

These distinctive postulates of current Articulator Theory —that all vowels are dorsum-articulated and that designated articulators are terminal features in the tree— not only correctly predict the varied velarization patterns described above, but also point to a possible explanation for why velarization effects should be relatively common in the first place. Halle et al. (2000:395ff.) assume that segments are fully specified in all representations. In principle, this implies that phonological representations may abound in redundant features, that is, in features which are neither contrastive nor marked. It is doubtful, however, that phonologies sway freely to redundancy. In particular, [dorsal] is completely redundant as a terminal feature in a vowel tree, but its redundancy is eliminated if it becomes associated with an adjacent consonant in which it is contrastive or marked. In other words, velarization may well be motivated by the elimination of phonological redundancy.

Indeed, there is some evidence that a phonology may actively avoid redundancy by linking features to segments in which they are either contrastive or marked. Notably, Itô, Mester and Padgett (1995) argue that the feature [+voice] spreads from a nasal to a following obstruent in Japanese, because the resulting configuration optimally satisfies not only a "grounded" constraint that nasals be voiced, but also a "licensing" constraint that [+voice] not be redundant (as it would be if it were associated only with a nasal). Similarly, Howe (2000) argues that [+round] spreads from /u/ to a following obstruent in Oowekyala to avoid being redundant while satisfying the phonetic-realizational requirement that high back vowels be rounded (rounding is redundant in the Oowekyala vowel system /i u a/).

More generally, Place licensing may be related to the fact that velars or velarized segments are sometimes restricted to syllable-final position. In particular, *ŋ* occurs only in coda position in many languages. Examples include Dutch (Booij 1995), Latin (Schein & Steriade 1986:706, fn. 10), Canadian French (Douglas C. Walker 1984), Ulwa (Green 1999), Aguaruna (Payne 1990), Zoque (Wonderly 1965:109), Kobon (Davies 1981), Mongolian (Poppe 1970:51) and Mandarin Chinese (Duanmu 2000). [ŋ] is syllabified in coda position even intervocalically in some languages, e.g., Galician (Porto Dapena 1976; Carballo Calero 1979 20274), English (Hammond 1999) and Korean (Chung 2001 20353).

Similarly, velar obstruents occur only in coda position in some child languages. For instance, many children learning English go through a stage in which velars are allowed to surface in codas (e.g., [jʌk] 'yuck'), but not in onsets (e.g., [tʰaʊ] 'cow') (Stemberger 1996; Bernhardt & Stemberger

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[47] This definition happily obviates the use of *pointers* in Articulator Theory (Sagey 1986; Halle 1988; 1992), thus reducing the normal inventory of primitives to features, nodes and association lines (Halle et al. 2000:390).

1998:216). Like the velar nasal, [k] may be syllabified in coda position even preceding (unstressed) vowels (Stoel-Gammon 1996:205). The velar fricative [x] is also commonly restricted to syllable-final position, as in Luiseño (Kroeber & Grace 1960 21447:12), Blackfoot (Algonquian: Taylor 1969), and some dialects of Brazilian Portuguese (Rossi 1945:303; Earl W. Thomas 1974:9; Messias & Zerling 1996; Giangola 1997:146-7).

For liquids, too, we saw that uvular ʀ (or ʁ) occurs only in coda position in the dialects of some languages such as German and French (see §3.3.1), and that 'dark' ɫ occurs only in coda position in a number of languages including Latin, Portuguese, Sasak, and Dutch (see §3.3.2).

The restriction of velars and velarized segments to syllable-final contexts is problematic, since the segmental inventory in coda position is normally a subset of that in onset position (Trubetzkoy 1939; Hooper 1976; Goldsmith 1990; Blevins 1995; Beckman 1999). The problem is exacerbated by the markedness of velars and velarized segments. Dorsal consonants are more marked than other consonant types; this is true of nasals (Maddieson 1984:69), obstruents (Bernhardt & Stemberger 1998) and liquids (Ladefoged & Maddieson 1996). Why should a language restrict relatively marked segments to coda position?

The proposed Articulator Theory analysis offers a credible answer to this question: in some languages certain types of consonant do not license the feature [dorsal], but in coda position this feature can be shared with a preceding vowel such that the dorsal consonant in question is at least derivable (syntagmatic), if not phonemic (paradigmatic). This solution is proposed independently by Golston and Bills (2001) to account for the fact that some children restrict dorsal consonants in general to coda position. They suggest that at this stage of development, velars are licensed only by a Dorsal-bearing vowel in the same rhyme, as in our Articulator Theory analysis. Inkelas and Rose (2003:39) dismiss this analysis based on "the lack of evidence in adult language for the type of vowel-to-consonant licensing of Dorsal on which Bills and Golston's analysis relies." In fact, such evidence is extant if not ample, as I have shown.

Finally, the Articulator Theory analysis also accounts for languages such as Fuzhou Chinese (Matthew Chen 1973; Norman 1988:228-39), Arekuna Carib (Walter F. Edwards 1978:227), Bugis (Uhrbach 1987:164), Japanese (9) and Selayar (30) which allow velars syllable-finally but otherwise do not license Place features in coda position. Nonfinal syllables in dialectal Inuktitut are another example: "the North and South Baffin dialects now possess only two types of [intervocalic] non-geminate groupings ...: velC (velar/consonant) and uvuC (uvular/consonant)" (Dorais 1990:103). Rice (1996 et seq.) reasons that such velars cannot be [dorsal], since they are not followed by an onset that might license a Place feature (p. 69; see also Rice 1996:495). But that conclusion is unwarranted if the [dorsal] feature in question is sponsored by the preceding tautosyllabic vowel (see, e.g., (8) on p. 5).

That placeless consonants can receive articulator features from adjacent segments, including vowels, is supported by patterns of phonologically-conditioned allomorphy. A good example is the ergative suffix in Yidiɲ (Dixon 1977). As shown in (34) it has the general form -(N)Cu, where N is a nasal and C is a stop, whose place of articulation is determined by the stem-final segment. The nasal is dropped after both nasals[48] (34a) and liquids (34b), and variably after /j/ (34c). Stem-final rhotics and /j/ also variably delete (34b,c). Crucially for our purpose, NC is dorsal after vowel-final stems (34d).[49]

(34) *Ergative allomorphy in Yidiɲ* (Dixon 1977:45, 57, 126-7)

a.	*ɟuɟuːm-bu*	'father's sister'	c.	*ɟaruː(j)-ɲɟu*	'brown bird'
	hubaːn-du	'big butterfly'		*gunduːj-(ɲ)ɟu*	'brown snake'
	ŋubirbiɲ-ɟu	'leech'		*dabuː(j)-ɟu*	'bird'

[48] According to Dixon (1977:126) "no stem ends in *ŋ*."

[49] Due to general apocope (Dixon 1977:44-9) *-ŋgu* reduces to *-ːŋ* if the vowel-final stem is even-syllabled, e.g., *buɲaː-ŋ* 'woman-ERG' (p. 45), cf. *buɲa-nu-ŋgu* 'woman-GEN-ERG' (p. 53).

b.	*baɟigal-du*	‘tortoise’	d.	*mulari-ŋgu*	‘initiated man’
	maŋgumba(r)-du	‘leaf grub’		*waguɟa-ŋgu*	‘man’
	buliji(ɽ)-du	‘chicken hawk’		*gindanu-ŋgu*	‘moon’

Dixon (1977:46) takes -*ŋgu* to be the underlying form of the ergative to explain its use after vowels, but this assumption fails to account for the homorganic behavior of the ergative (34a-c). Place assimilation is not a general property of Yidiɲ phonology. Dixon (1977:35-7) makes it clear that clusters may be heterorganic intramorphemically, e.g., *gangul* ‘grey wallaby’, *balgal* ‘make, build’, as well as intermorphemically, e.g., *bargan-gu* ‘wallaby-PURP’, *muɟa:m-gu* ‘mother-PURP’. Our Articulator Theory analysis affords a new solution: the ergative suffix consonants lack Place; they acquire it from stem-final segments, including vowels, which are [dorsal] (34d).[50]

The Indonesian prefix *məN-* ‘actor’ provides another potential example. Its final nasal is commonly assumed to be underspecified for Place (e.g., Dale F. Walker 1976:6; Humbert 1997:224; Pater 1999; Kager 1999:59) since its realization is generally predictable from adjacent segments: it is [m] before labials (35a), [n] before alveolars (35b), [ɲ] before palatals (35c), and [ŋ] before velars (35d-f). The fact that it is also [ŋ] when the only adjacent place-specified segments are vowels (35g-j) suggests once more that the latter supply [dorsal] to the nasal, as per our Articulator Theory analysis.[51]

(35) *məN- allomorphy in Indonesian*

a.	*bəli*	*məmbəli*	‘buy’	f.	*xianat*	*məŋxianati*	‘betray’
b.	*daki*	*məndaki*	‘mountain-climb’	g.	*hafal*	*məŋhafal*	‘memorize’
c.	*ʤadi*	*məɲʤadi*	‘become’	h.	*iŋat*	*məŋiŋat*	‘remember’
d.	*gigil*	*məŋgigil*	‘shiver’	i.	*eraŋ*	*məŋeraŋ*	‘groan’
e.	*ɣairah*	*məŋɣairahkan*	‘arouse’	j.	*orak*	*məŋorak*	‘unfasten’

Note that in this case, intervocalic [ŋ] is in onset, not coda position. This brings us to our last example: in the Papuan language Awara (Wantoat: Quigley 2003), the 2s genitive suffix is alveolar-initial after labials (36a) and after alveolars (36b), but it is velar-initial after velars (36c) as well as after vowels (36d).[52]

(36) *2s genitive allomorphy in Awara* (Quigley 2003:183)

a.	*mom-da*	‘your aunt’	c.	*miŋ-ga*	‘your mother’
	pajip-da	‘your machete’		*ok-ga*	‘your uncle’
	ap-da	‘your husband’		*kakʌluk-ga*	‘your chicken’
b.	*sadun-da*	‘your axe’	d.	*pʌje-ka*	‘your SS.sib’
	hiput-da	‘your stick’		*kaji-ka*	‘your eye’
	jot-da	‘your home’		*jagʌ-ka*	‘your water’

Quigley (2003:70) suggests that the suffix is /-ga/ underlyingly, and that it becomes [-da] after labials and coronals due a rule rule which converts velars to coronals after [–dorsal] consonants. Quigley calls this rule “coronal assimilation” but is well aware of its awkwardness: “Though the alternation between coronal and dorsal is a natural process in Awara, it is impossible to specify a single rule that defines a voiced consonant as coronal after labials and coronals and dorsal after dorsals. This is problematic for both Distinctive Feature theory and Feature Geometry” (ib., n. 45). Our

[50] Compare Hayes (1990b:90): “[T]he most reasonable account would be to characterize the Yidiɲ ergative not with phonological rules but with rules of allomorphy: …

(a) Insert /ŋgu/ / V__$_{[+\text{Ergative}]}$ (b) Insert /du/ / C__$_{[+\text{Ergative}]}$.”

[51] Cf. Onn (1980:43): “the basic prefixal nasal /ŋ/ only occurs before vowel-initial stems, or velar consonants; in all other cases, the nasal shares the same point of articulation as the stem-initial consonant.”

[52] Stops regularly (if strangely) devoice after vowels in Arawa (Quigley 2003:69).

foregoing Articulator Theory analysis provides a simpler interpretation of this phonologically-conditioned allomorphy: the suffix-initial consonant is coronal by default but becomes velar in assimilation to the [dorsal] feature of a preceding velar consonant or vowel. As in Indonesian (and Yidiɲ, in fact) above, the assumption here is that [dorsal] can also spread from a vowel to an *onset* consonant. This is important, else most cases of velarization reviewed in this article could be "explained" alternatively by a constraint that "codas must be dorsal, as in Carribbean Spanish" (Yip 2004:33).

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