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Iterativity in morpho-phonologically induced tonal lowering: Voicing, Nasality and Low tone in Element Theory

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Outline

1. Voicing, Tone and Nasality
   1.1 Element Theory
   1.2 Element geometries

2. Some depressing facts
   2.1 Voicing
   2.2 Breathiness
   2.3 Aspiration
   2.4 Asymmetry
   2.5 New Geometry

3. Nasals and lowering
   3.1 West Grassfields Bantu morphological patterns
   3.2 Iterative |L|
   3.3 Further support

4. Conclusions

1. Voicing, Tone, & Nasality
1.1 Element Theory |A I U H L ʔ|

|N⁺|: consonant or vowel nasality
|L⁻|: slack vocal cord, consonant voicing or tone

(Kaye et al. 1990; Harris 1990)

|L̲|: Head – voicing
|L|: Non-head – nasality

(Nasukawa 1997, Ploch 1999, Kula 1999, 2002, Botma 2004)

Backley, P. (2011) *Element Theory*. Edinburgh: Edinburgh University Press.
Scheer, T. & N.C. Kula (2018) Government Phonology and Element Theory. In SJ Hannahs and Anna Bosch (eds.) *Routledge Handbook of Phonological Theory*. London: Taylor and Francis Group.

oicing - Nasality

ect interactions between voicing and nasality are observed in

) Postnasal voicing: e.g. Zoque: mi**n**-**b**a

) Prenasalised stops: e.g. Tokyo-Northern Tohoku b v. ^{m}b variation

) Voicing-nasal alternations: e.g. Tukuya complementary distribution:
bipi v. **m**ĩpĩ

th represented by |L|

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ne - Voicing

trinsic connection between voicing and tone

- Tonogenesis cases – Vietnamese (Haudricourt 1954): Tone correlated with voiced initial obstruents

- Correlation between the development of contrastive tones and the loss of voicing in obstruents

oth represented by |L|

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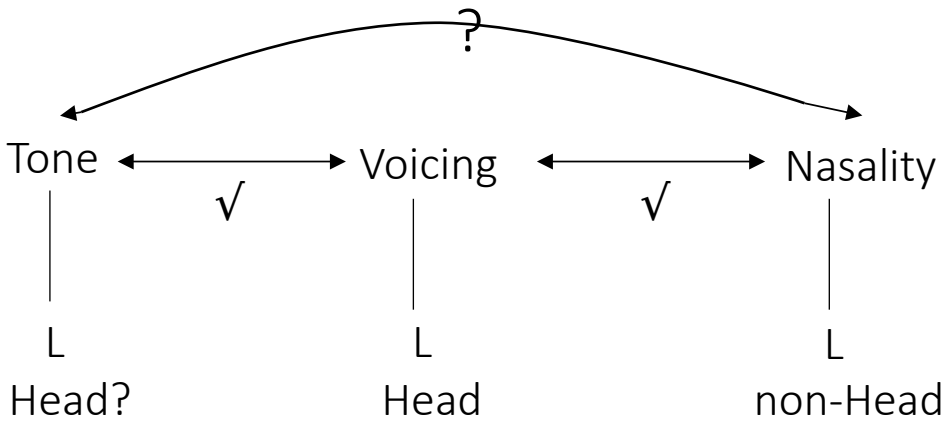
oicing - Tone - Nasality – interaction



Voicing - Nasality – segment-segment interaction

Voicing - Tone – tone-segment interaction

Nasality - Tone – blocked?

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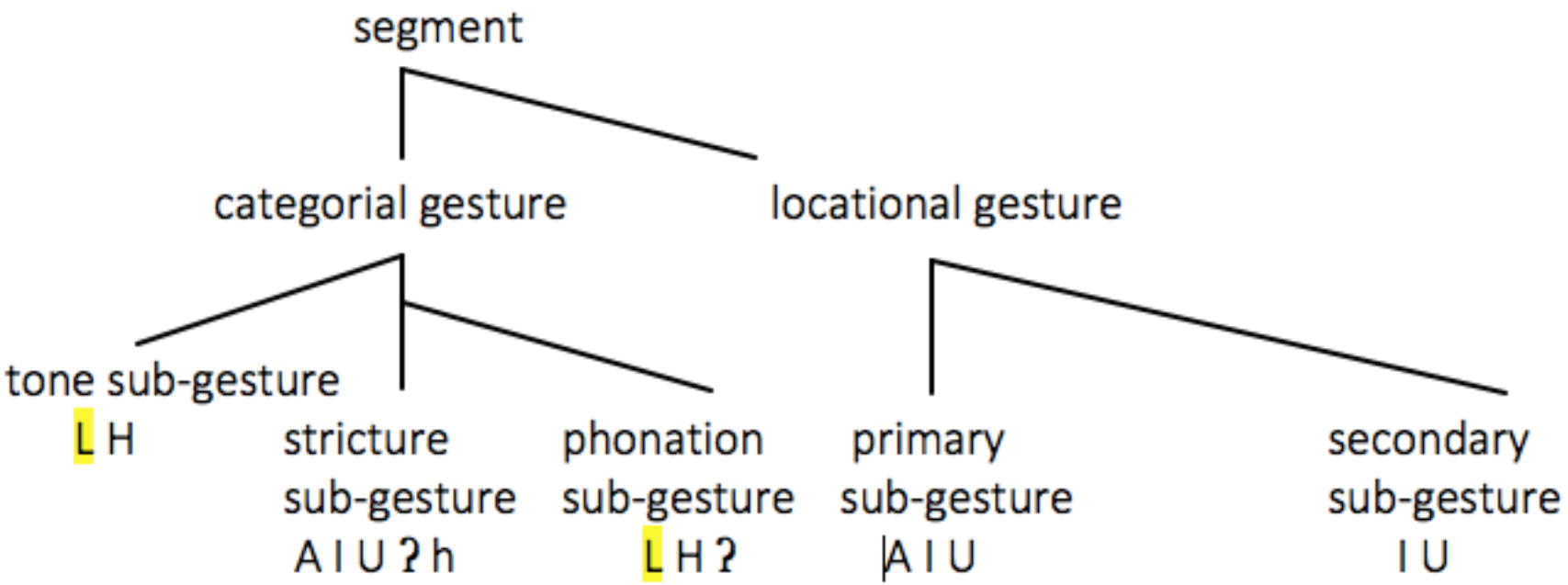
2.2 Element Geometries



Kula 2002, van der Hulst 1989, 2015: Head- dependency relations
(Clements 1985, Clements and Hume 1995 – Feature Geometry)

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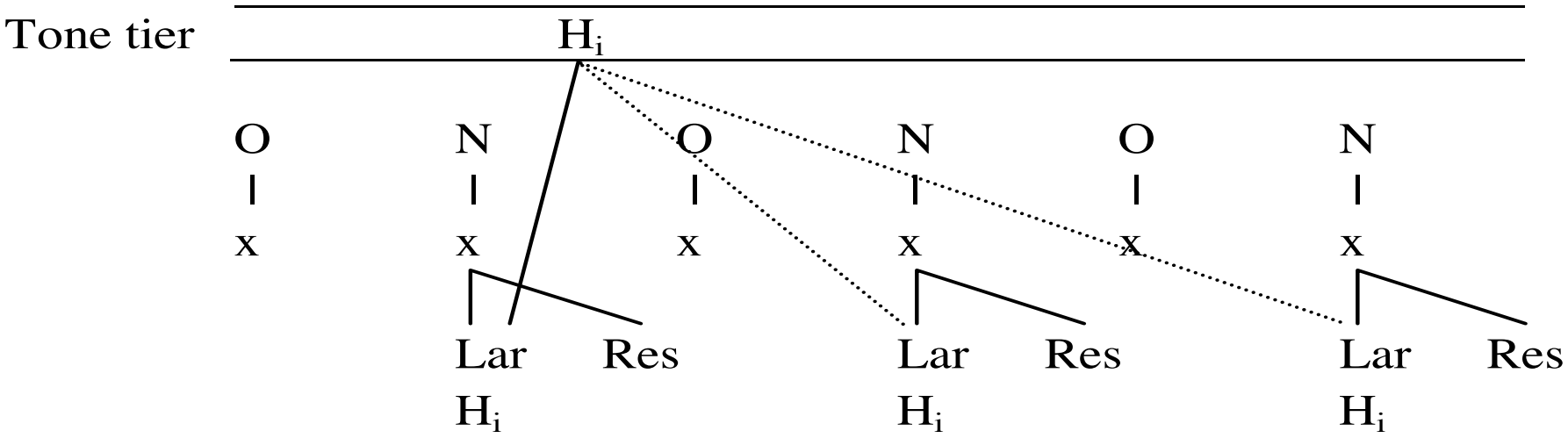
Tone-voicing interaction



N.C. (2012). On the representation of tone in Element Theory. In Eugeniusz Cyran, Henryk Kardela gdan Szymanek (eds) *Sound Structure and Sense*. Studies in memory of Edmund Gussmann. Lublin: wnictwo KUL, 353–370.

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Depressing facts

uthern Bantu languages

Zulu depressor consonants HHHL -> HLHL

ísíkhwámà	‘bag’	
ízìkhwámà	‘bags’	
ísíhlálò	‘seat’	
ízìhlálò	‘seats’	
ísífúndò	‘lesson’	
ízìfúndò	‘lessons’	
ísíkòlè	‘school’	
ízìkòlè	‘schools’	

A., Khumalo, J.S.M. and P. Fridjhon. 1987. Depressing facts about Zulu. *African Studies* 46: 2

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Southern Bantu Languages & Grassfields Bantu

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2.1 Depression in Bantu languages – voicing and nasality

- Voiced consonants are depressors in languages such as Ikalanga, Xhosa, Siswati, and Tsonga
- Nasals are never depressors in the these languages
- Prenasalised consonants are depressors in Xhosa, but non-depressors in Ikalanga and Tsonga

	Ikalanga	Xhosa	Siswati	Tsonga
DEP (= depressor)	Voiced obstr.	voiced obstr. & clicks Prenasalised obstr. & click	Voiced obstr. & clicks ŋ (historically ŋg)	Voiced stops
nonDEP (= non-depressor)	nasal Prenasalised obstr.	nasal	nasal	nasal Prenasalised obstr.

Mathanwange (1996) for Ikalanga; McLaren (1936) and Lanham (1958) for isiXhosa; Rycroft (1976) and Lanham (1960) for SiSwati; Doke (1926), Lanham (1960), Rycroft & Ngcobo (1979) and Khumalo (1981) for isiZulu; and Baumbach (1987) and Lee (2009) for Xitsonga.

.2 Depression in Bantu languages – breathy aspirates

- Non-depressors (e.g. nasals, liquids and glides) become depressors whenever they are breathy.
- Therefore we have…

	Ikalanga	Xhosa	**Tsonga**
nonDEP (= non-depressor)	p^h, t^h, ts, tʃ, h^w, kw, w	ŋ|, ŋǁ, ŋ!	$^{(m)}$b, $^{(n)}$d, $^{(ŋ)}$g, m, n, ɲ, ŋ, l, r, w, j
DEP (= depressor)	$p^ɦ$, $t^ɦ$, $ts^ɦ$, $tʃ^ɦ$, ɦ, $kw^ɦ$, $w^ɦ$	$ŋ^ɦ$|, $ŋ^ɦ$ǁ, $ŋ^ɦ$!	$^{(m)}$b̤, $^{(n)}$d̤, $^{(ŋ)}$g̈, m̤, n̤, ɲ̈, ŋ̈, bv̤, dz̤, dʒ̈, l̤, r̤, w̤, j̈

2.3 Depression in Bantu/Khoisan – voiceless aspirates

- Voiceless aspirates are traditionally associated with high frequencies and are non-depressors, e.g. Ikalanga and Xhosa – But are depressors in e.g. Tsonga and Tsua.

- There are controversies in phonology and phonetics as to whether the orthographical [b, d, g] are voiced depressors (Bradshaw 1999; 2003) or voiceless depressors (Schachter 1976; Traill, Khumalo, & Fridjhon 1987; Downing & Gick 2005) or breathy depressors (Rycroft 1980, 1981) in Siswati and Zulu.

Voiceless aspirates		
nonDEP	**DEP**	**In question**
Ikalanga	Tsonga	Siswati
Xhosa	Tsua	Zulu
	Ikalanga[1]	

Representational issues

How can voiceless aspirates as depressors be explained in element theory?

What is the element representation for breathiness?

How do we explain the asymmetry between nasality and voicing in relation to low tone? (Is there one?!)

|L| - Nasality or Voicing (or Low tone)

|H| - Aspiration or Voiceless (or H tone)

Depressor data summary

Depressors / Languages	Unmarked		Marked		Nasals	
	voiced	any breathy	voiceless aspirates	voiceless unaspirates	nasals	prenasals
Ikalanga	+	NA	+	-	-	-
Tsonga	+	+	+	-	-	-
Zulu	+	+	-	+	-	-
Xhosa	+	+	-	+	-	-
Swati	+	NA	-	+	-	-
Tsua	+	NA	+	-	-	NA
Shanghainese	+	NA	-	+	-	NA

iu & Kula (2018) A comparative study of depression in Bantu, Khoisan and Chinese Wu – aryngeal settings and feature specifications. *Stellenbosch Papers in Linguistics* 54: 17-43.

Mathes, T., K. 2015. Consonant-tone interaction in the Khoisan language Tsua. PhD. dissertation, New York University.

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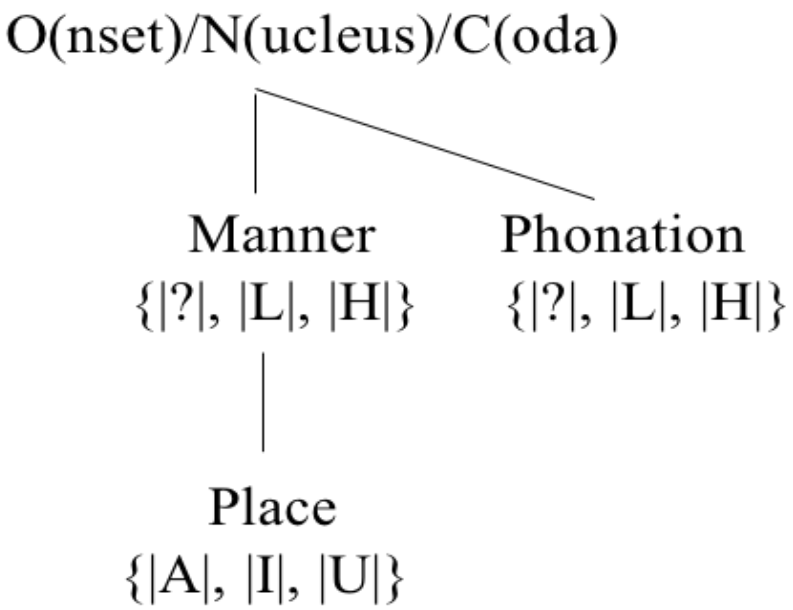
Head-dependency relations



H – breathiness, aspiration, voiceless

L – voicing, nasalisation

ʔ – glottalization, ejection, implosive, creaky voice

Botma (2004), Anderson and Ewen (1987), van der Hulst (1989, 2015)

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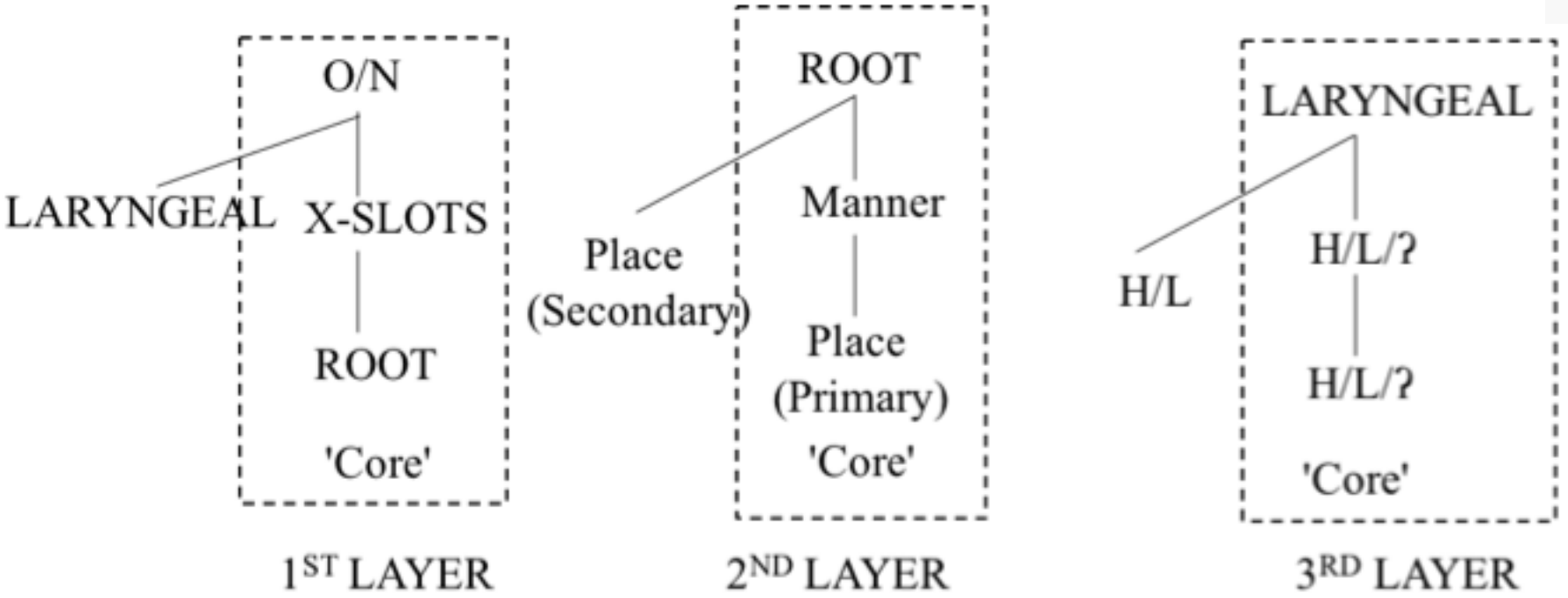
Head-dependency at 3 levels



. (2020) An Element Geometry Approach To Depressors In Bantu & Chinese. PhD thesis, University of Essex

Kula (2020) Recursive representations for depressor effects. In Kuniya Nasukawa (ed.) *Morpheme-internal Recursion tures in Phonology*. Berlin/NY: Mouton de Gruyter, 143-180.

& Liu (2016) An Element-geometry account of depressor effects in Bantu languages and Chinese Wu.

WOP-5 University of the Free State, Bloemfontein

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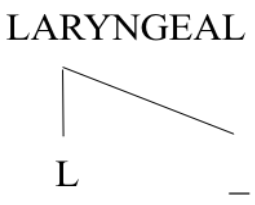
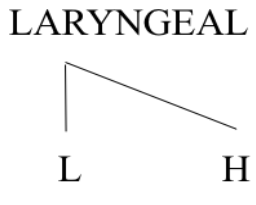
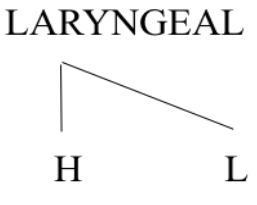
Laryngeal node: dependency relations



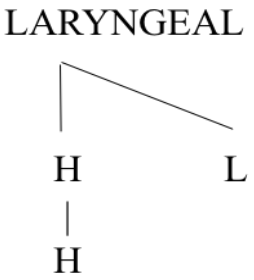
a. Voicing |L|



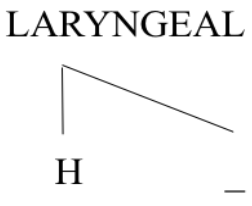
b. Breathiness |L^{H}|



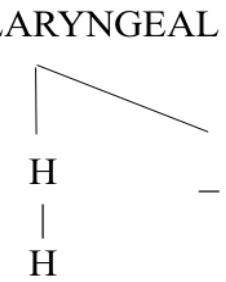
c. Voicelessness |H^{L}|



d. Aspiration |HH^{L}|



e. Voicelessness |H|



f. Aspiration |HH|

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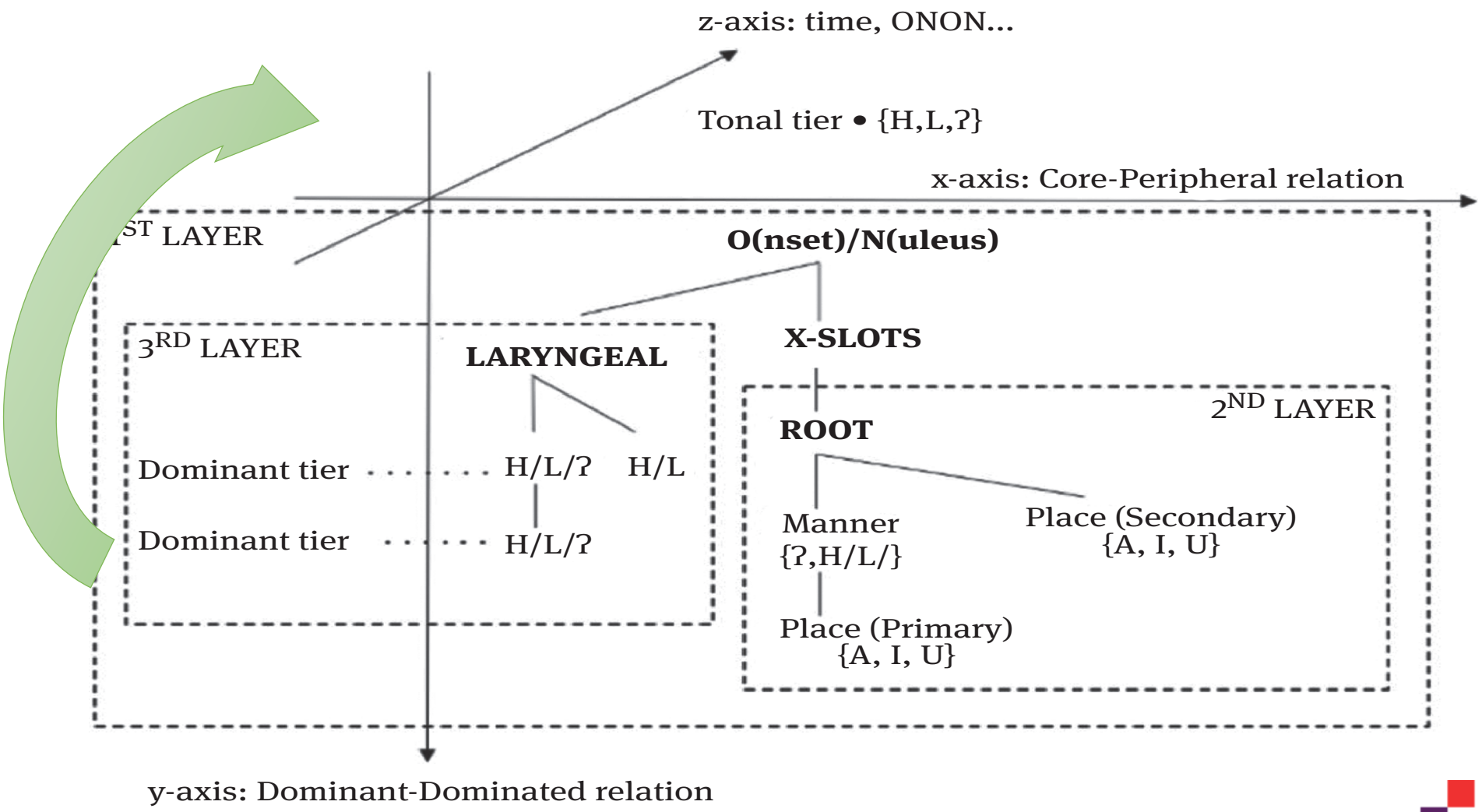
Recursive head-dependency (Liu & Kula 2020, Liu 2020, Kula & Liu 2016, 1



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xplanations

- Two structures for voiceless aspirates one has dependent branching L (with H head)
- Breathy sounds have head L and H dependent
- L on the outermost layer of the Laryngeal node interacts with the tonal tier
- More embedded L for nasality in Manner does not – hence nasals are never depressors

Chen (2015) shows that depressor aspirates in Shanghainese have a breathy period, realised as F0 lowering. She adopts the feature [+slack] for Shanghainese depressors (voiced obstruents ad voiceless aspirates).

Chen, Z.M. (2015). Breathy voice and low tone. *Journal of Chinese Linguistics* 43 (1A): 90–117.

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3. Nasality and tone – enter morphology

4 morpho-phonological alternations between nasality and low tone

Grassfields Bantu languages are a sister branch of (Narrow) Bantu languages - both are branches of Benue Congo

Both Grassfields and Narrow Bantu have Noun Classes

Grasssfields Bantu is divided into WGB and EGB

Data - WGB

(i) Prefix distribution - missing nasal prefixes

(ii) Tone between prefixes and stems

(iii) Tone in nominal associative structures

(iv) Tone of prefix-less nouns

Data sources: Series of papers by Hyman and colleagues on WGB. Hyman 1979, 1980, 2005 Akumbu & Hyman 2016, Akumbu 2008,

(i) Grassfields Bantu nasal prefixes

- Noun class prefixes are (and reconstructed as) low toned in Narrow Bantu and classes 1, 3, 4, 6(a), 9, and 10 have nasals (Meeussen 1967)

- A dichotomy is found in Grassfields Bantu: EGB resembles Narrow Bantu

- But sub-groups of Western Grassfields have High tone prefixes and lack nasals except sporadically (Akumbu & Hyman 2016) - so a correlation between H toned prefixes and the absence of nasals

Akumbu & Hyman (2016) Nasals and Low Tone in Grassfields Noun Class Prefixes. UC Berkeley *Phonetics and Phonology Lab Report (2016)*.

class	Proto-Bantu		Proto-Benue-Congo	
1 (sg.)	*mʊ̀-	*jʊ̀-	*ù-, *ò-	*gwu-, *à-
3 (sg.)	*mʊ̀-	*gʊ́-	*ú-	*gu-, *u-
4 (pl.)	*mì-	*gí-	*í-	*zí- (?), í-
6 (pl.)	*mà-	*gá-	*à	*ga-, *a-
9 (sg.)	*N` -	*jì-	*è-, *ì-	*zì-
10 (pl.)	*N` -	*jí-	*í-	*zí- (?), í-
6a (-)	*mà-	*gá-	*mà-, *nà-	*ma-, *na-
6b (pl)	*mʊ̀-	*mʊ̀-	(?*mʊ-)	
7 (sg.)	*kì-	*kí-	*ki-, *ke-	*ki-

eeussen, A.E. 1967 Bantu Lexical Reconstructions.

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- The nasal consonants that are reconstructed for PB are typically missing in the prefixes of WGB in nasal classes 1, 3, 4, 6, 9, and 10 (Meeussen 1967; Hyman 1980)

Class	*Proto-Bantu*	*Proto-EGB*	*Proto-WGB*
1 (sg.)	*mʊ̀-	*Ǹ-	*ʊ̀(N)-
3 (sg.)	*mʊ̀-	*Ǹ-	*ʊ́-
4 (pl.)	*mì-	---	*í-
6 (pl.)	*mà-	*mə̀-	*á-
9 (sg.)	*Ǹ-	*Ǹ-	* ì(N)-
10 (pl.)	*Ǹ-	*Ǹ-	*í(N)-
6a (-)	*mà-	*mə̀-	*mə́-

Hyman, L.M. (1980) Reflections on the nasal classes in Bantu. *Noun classes in the Grassfields Bantu borderland*. SCOPiL 8: 179-210.

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(ii) Tone between WGB prefixes and stems

- All noun classes have a H-tone prefix, apart from Classes 1, 6a, and 9 which have nasals and are L-tone.

Aghem		Isu	
é-bóʔ	‘bundle’	á-sáŋ	‘corn’
kɨ́-ghɔ́	‘bone’	fə́-nyí	‘matchet’
tɨ́-dzɨ́m	‘backs’	í-bí	‘kolanut’

- Hyman (1979b: 168) reconstructs most noun class prefixes in Babanki (WGB) as *H in an earlier stage and are now L but surface as LM in (a)

a.	kə̀kə̄s ká tsə̂ŋ	‘slave of thief’	/kákòs ká tsòŋ/
	kə̀bvə̄ ká ndə̀ŋ	‘skin of potato’	/kábvə̀ ká ndòŋ/
	kə̀kyē lá kə̀mùʔ	‘just one basket’	/kákyè lá kə̀mùʔ/
b.	kə̀ndə̀ŋ ká tsə̂ŋ	‘neck of thief’	/kə̀ndòŋ ká tsòŋ/
	kə̀mbò ká wìʔ	‘bag of person’	/kə̀mbò ká wìʔ/
	kə̀mfə̀ŋ ká wìʔ	‘foolish person’	/kə̀mfòŋ ká wìʔ/

- Prefixes with nasals are reconstructed as *L but/and surface as as LL in (b) - note they involve NCs

- Could the nasal be part of the prefix in Babanki?

- i.e. Babanki kə-ndɔŋ ‘neck’ be analyzed as:

  kə-ndɔŋ, kən-dɔŋ, or kə-n-dɔŋ

Probably not: Hombert 1976; Hyman 1980a; Möller 2012

Babanki	Kom	Mmen	Gloss
mbɔ̀ʔ/mbɔ̀ʔ-sə́	mbàʔ/mbàʔ-sí	mbàʔ/sé-mbàʔ	‘cloud/clouds’
mbví/mbví-sə́	ŋgvɨ̄/ŋgvɨ̄-sɨ̄	mbvə̄/sé-mbvə̄	‘chicken/chicke

N can have a prefix before it:

Babanki	Kom	Mmen	Gloss
à-ŋgɔ̀m	ī-ŋ̀gɔ̀m	ē-ŋgɔ̀m	‘plantain’
c5-plantain	c5-plantain	c5-plantain	
kà-mpfɨŋ	ā-ŋgêynɨ̀	ā-ŋgyɛ̄yn	‘owl’
c7-owl	c7-owl	c7-owl	

Moller (2012) – prefix replacement in Mmen

à-kú	‘forest’	fà-kú-tà	‘small forest’
à-lyàŋ	‘bamboo’	fà-lyàŋ-tà	‘small bamboo’
kà-shí	‘place’	fà-shí-nà	‘small place’
kà-vú	‘hand’	fà-vú-nà	‘small hand’
ŋgàŋ	‘house’	fà-ŋgàŋ-tà	‘small house’
mbvɨ́	‘chicken’	fà-mbvɨ́-tà	‘small chicken’

Blocked H spreading before NC – Kom (WGB)

a.	fēghâm	‘mat’	/fé-ghàm/
	fēkáìn	‘monkey’	/fé-kàìn/
	āfɔ́ìn	‘chief’	/á-fɔ̀ìn/
	ānyám	‘animal’	/á-nyám/
b.	īŋ̀gɔ̀m	‘plantain’	/í-ŋ̀gɔ̀m/
	āǹtɔ̀in	‘pot’	/á-ǹtɔ̀in/
	āǹjàm	‘axe’	/á-ǹjàm/
	āŋ̀gɔ̀ʔ	‘stone’	/á-ŋ̀gɔ̀ʔ/

) Nominal associate structures

Babanki H spread blocked by NCs in N-associative-N2 structures (NC preser

.	kàshí ká ká$^{\downarrow}$kɨ́m	‘place of crabs’	/kà-shí ká kà-kɨ́m/
	kàshí ká fə́nyìn˚	‘place of bird’	/kà-shí ká fà-nyìn´/
	kàshí ká tə́sɔ̀ʔ	‘place of hats’	/kà-shí ká tà-sɔ̀ʔ/
.	kàshí ká kə̀mbɔ̀^{o}	‘place of bag’	/kà-shí ká kà-mbɔ̀´/
	kàshí ká fə̀nyì	‘place of knife’	/kà-shí ká fà-nyì/
	kàshí ká tə̀ŋgɔ̀m	‘place of plantains’	/kà-shí ká tà-ŋgɔ̀m/

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) Downstep applies when there's no prefix in N2 for NC initial stems only

a.	kàshí ká byí	'place of goat'	/byí/
	kàshí ká bʉ́	'place of dog'	/bʉ́/
b.	kàshí ká m↓bví	'place of chicken'	/mbví/
	kàshí ká n↓dzɔ́ŋ	'place of thorn'	/ndzɔ́ŋ/
	kàshí ká m↓pfĩ	'place of mother'	/mpfĩ/

The nasal in class 6a mə̀- also blocks HTS from a preceding associative marker in Babanki:

a.	kə̀shí ká fə́nyìn	'place of bird'	/kə̀-shí ká fə̀-nyín´/
	kə̀shí ká fə́dzɨ̀ŋ	'place of star'	/kə̀-shí ká fə̀-dzɨ̀ŋ/
b.	kə̀shí ká mə̀nyìn	'place of birds'	/kə̀-shí ká mə̀-nyín´/
	kə̀shí ká mə̀dzɨ̀ŋ	'place of stars'	/kə̀-shí ká mə̀-dzɨ̀ŋ/

(iv) Prefix-less nouns marked by H are L with NC (Class 10 pl)

3)	a.	zhù	zhúsə́	‘snake(s)’
		shɨ̀	shɨ́sə́	‘hoe(s)’
	b.	ndzàm	ndzàmsə́	‘axe(s)
		mbàŋ	mbàŋsə́	‘sticks’

- Nasals and L prefix correlation

Asongwed and Hyman (1976: 32) illustrate that prefixal tone is predictable in Ngamambo, a Momo language (WGB):

- CV prefixes – H tone
- V prefixes – M tone
- Nasal prefixes – L tone

Kom - the prefix is usually M, but becomes ML with nasals (NCs)

ākú	'forest'	vs.	āŋ̀kɛ́m	'crab'
āvə́f	'bone'		āǹfə́f	'poverty'

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Suffixation in Class 10 – Possibly problematic data

) Babanki Class 10 nouns with simplex nasal

bàm	'stiff hill'	bám↓sə́	'stiff hills'
jɔ̀m	'dream'	jɔ́m↓sə́	'dreams'
dzàŋ	'palm nut'	dzáŋ↓sə́	'palm nuts'
jɨ̀ŋ	'hunger'	jɨ́ŋ↓sə́	'hunger'
dzɛ̀m	'back'	dzɛ́m↓sə́	'backs'

) H-toned roots have a downstep regardless

chɨ́	'fire place'	chɨ́↓sə́	'fire places'
byí	'goat'	byí↓sə́	'goats'
bʉ́	'dog'	bʉ́↓sə́	'dogs'
gyégyé	'beard'	gyégyé↓sə́	'beards'

Data summary

- Low tone nasal interaction in prefixation involves NC- initial stems in WGB
- Tonal lowering effects seen with NC- initial stems are absent with simplex C and simplex nasal
- The derived NC at the suffix juncture, is not subject to the same constraints
- One proposal from Hyman is to consider these NCs as having a floating L tone

Theoretical implications in ET

- The fact that nasal – tone interaction is restricted to NC clusters allows for nasals to have a terminal |L| (since place is shared with the following C)

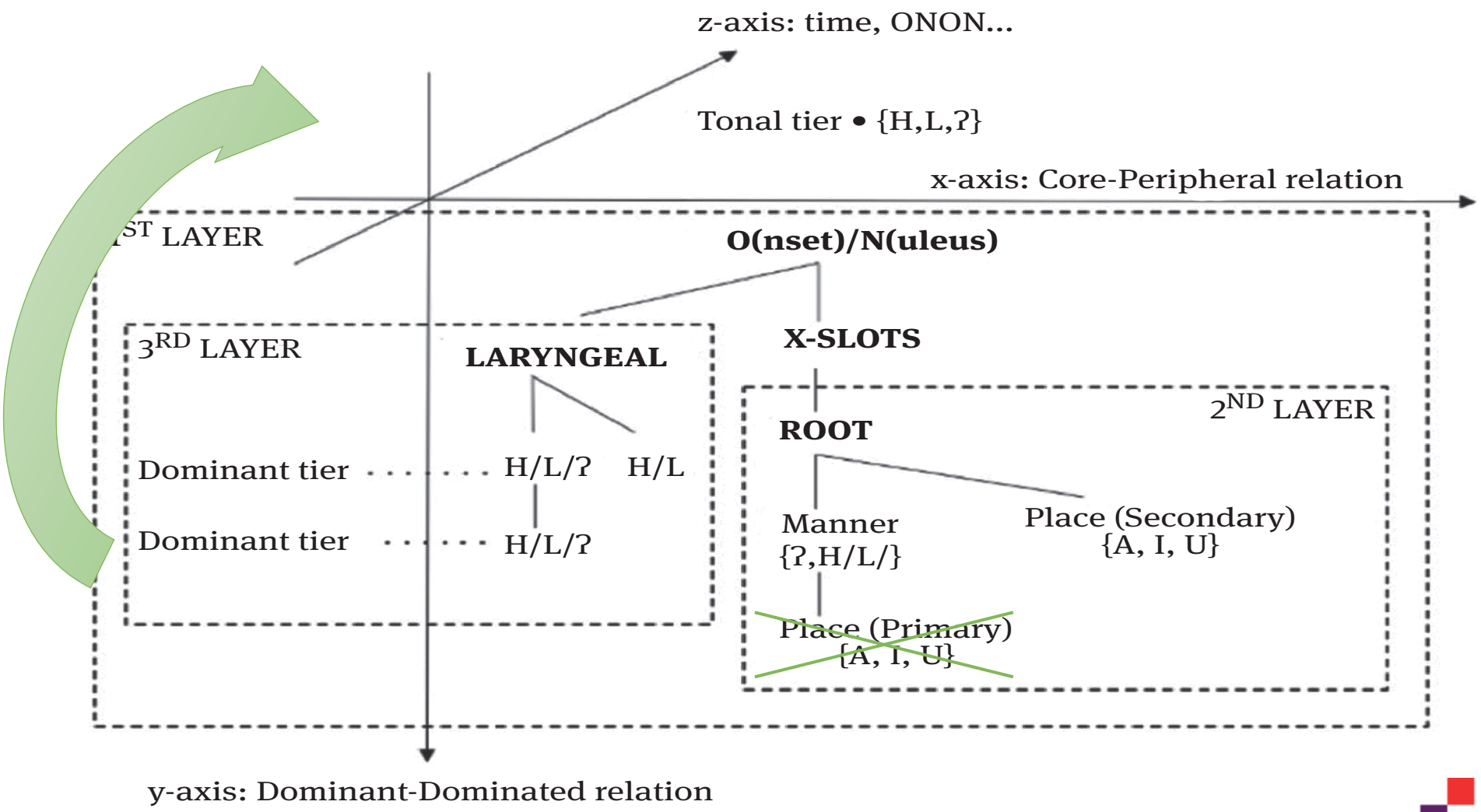
- We can then model an indirect/recursive interaction between nasality and tone via the laryngeal node

- The model thus captures that it is only in NC contexts that nasal lowering effects apply

- The suffixal context data suggest that a morpheme boundary entails a different representation of lexical simplex N and a following C (a derived environment)

- This overall opens up the possibility for parametric variation in the structure of nasals

Recursive head-dependency – iterative |L| interaction



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Supporting arguments for Element geometries

Liu (2020: 174ff) Chinese Wu dialects:

- Plain voiceless and voiceless aspirated initial Cs go with High register
- Voiced and breathy voiced initial Cs go with Low register

Shanghainese bisyllabic tone Sandhi:

[$t^{h}i^{52\text{-}h}$] 'sky' [**d**a$\eta^{14\text{-}l}$] 'hall' → [$t^{h}i^{55\text{-}h}$ **d**a$\underline{\eta}^{22\text{-}h}$] 'heaven'

[p$\text{ɔ}^{34\text{-}h}$] 'report' [**d**$\text{ɔ}^{14\text{-}l}$] 'passage' → [p$\text{ɔ}^{33\text{-}h}$ **d**$\text{ɔ}^{44\text{-}h}$] 'report'

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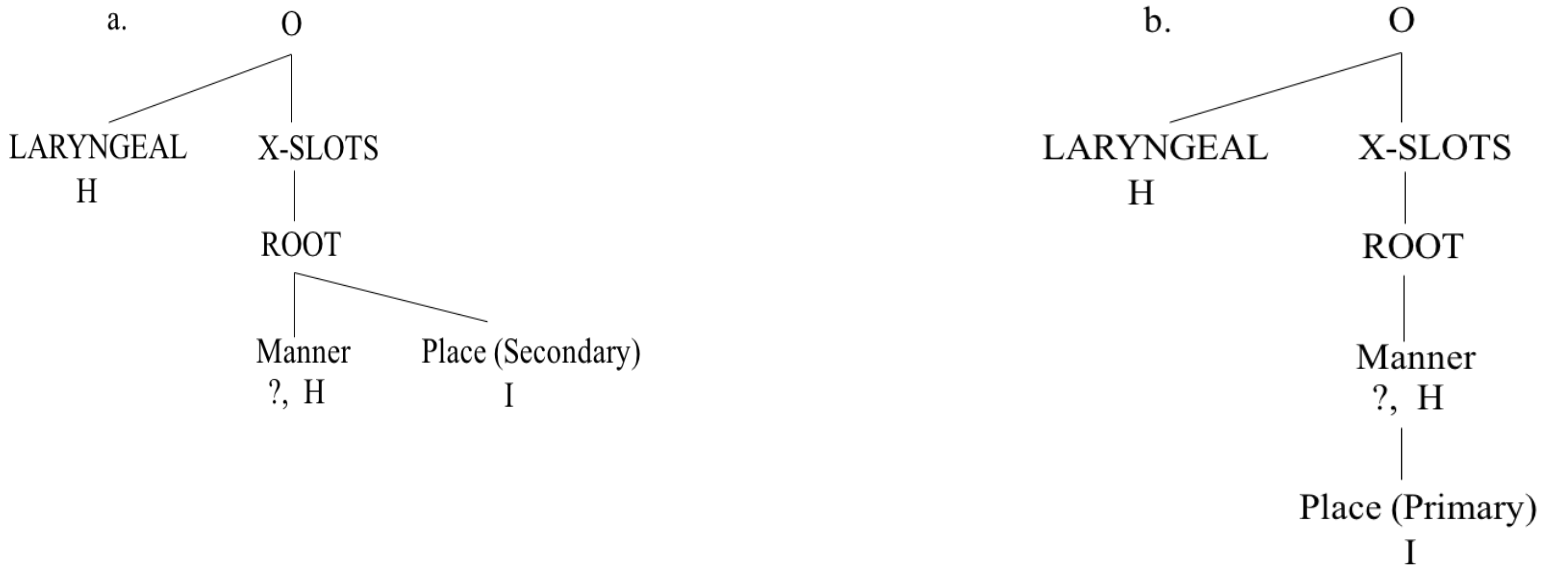
Derived Environment effects and contrastive structures utilizing different dependency positions: Polish palatalization (Lubowicz 2002), nasals in Puyo-Pongo Quechua (Botma 2004), Kinyamwezi depalatalization (Kula 2008)

) Two contrasting palatal structures



Kula (2008) Derived Environment Effects: A representational approach. *Lingua* 118(9): 1328-43.

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Conclusions

- There is a three-way contrast for |L|
- Enriched element geometries allow Depressor effects to be accounted for – particularly the surprising depressor voiceless aspirates
- Consonant-Tone interactions are captured in branching dependency of the Laryngeal node
- Morphological data showing Tone-Nasality interaction are restricted to NCs modeled as involving interative/recursive application via the Laryngeal node
- Nasals only interact with the tonal tier if |L| is terminal in their node

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onsonant-induced tonogenesis

The most commonly accepted theory of tonogenesis is a consonant-induced view.
Haudricourt 1954: Haoni Vietnamese tone development (Matisoff 1973, 1998 later formalised tonogenesis as a conso
one compensatory mechanism)

age I: atonal, beginning of C.E

a	pas>pah	pax>paʔ
a	bas>bah	bax>baʔ

- Atonal; three types of word endings: i). Open vowel or nasals ii). Voice spirants, reduced to h in pre-Vietnamese iii). Some (undefined) kind of "x", reduced to a glottal stop in pre-Vietnamese time

age II: three tones, 6th century

id	Falling	Rising
a	pà	pá
a	bà	bá

- The disappearance of final consonants triggers compensatory falling and rising tones.

age III: six tones, 12th century

gher	pa	pa̰	pá
ower	pà	pã	paʔ

- The merger of voiced and voiceless syllable initial consonants triggers compensatory high vs. low register.

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States of the glottis of depressors

Events (Glottis state)	**Authors**	**Descriptions**	**Language(s)**
voiced (occlusion + release)	Beach 1924	voicing	Xhosa
	Lanham 1958	voicing	Xhosa
	Ladefoged 1971	ordinary voicing, but recognised the diff vib configurations for voiced and breathy voiced stops	Southern Bantu in general
	Rycroft 1976	low voiced	Siswati
	Doke 1923	fully voiced	Zulu
	Luo 1956	voiced	Wu
voiced (occlusion) + aspiration (release)	Colenso 1871	"slight aspiration" heard after "b, d, g" (similar to Ladefoged 1971)	Zulu
	Karlgren 1940	voiced occlusion + extremely weak [ɦ] at release	Wu
	Cope 1966	"voiced fortis", "heavy voice", voice+fortisness, conceived maybe [breathiness]?	Zulu
voiceless + voiced (occlusion)	Luo & Wang 1981, Yuan 1960; Wang 1956; Qian 1992, Cao, Z.Y 2002	voiceless in the first half, voiced in the second half	Wu

voiceless (occlusion) + aspiration (release)	Doke 1926	voiceless not fully voiced; “voiced aspiration”	Zulu
	Doke 1963	devoiced during the stops unless preceded by the homorganic nasals	Zulu
	Lanham 1960	voiceless quality to the breaking of occlusion+immediate fortis release & strong voicing; diff from “voiced aspiration (murmur)”	Xhosa, Zulu, Siswati, Ndebele
	Lanham 1969	both onset and release voiceless, voicing started ±10 msec after the release	Zulu
breathiness (i. over the onset or whole syllable ii. the onset offset and the vowel onset)	Tucker 1949	first one that used “breathy” for voiced “b, d, g”	Sotho-Nguni in general
	Rycroft 1980	a prosodic depression feature with a breathy component on the vowel onset; voiceless with murmur release on the vowel onset	Nguni in genereal
	Rycroft 1981	clarified his 1980’s proposal - voiceless during occlusion with abreathy release on the vowel onset	Swati

	Maddieson 2003	breathiness, but not invariantly present for depression	Swati
	Liu F. 1913	voiceless with voiced aspiration	Wu
	Chao 1928, 1936	introduced 清音浊流“ for “voiceless with voiced aspiration”, environment-conditioned (≈Rycroft 1980’s “breathy voice release“)	Wu
	Ramsey 1987	“voiced aspirates”, breathiness across the whole syllable	Shanghainese
	Cao 1982; Cao 1987a&b; Cao & Maddieson 1992; Ren 1988; Chen 2015 Chen 2015	breathiness on the following vowel onset	Shanghainese Changyinsha, Wenzhou Ningbo
slack voice	Ladefoged & Maddieson 1996	a slightly increase glottal aperture + a moderate increase in flow (not breathy, which has a considerable glottal aperture+increase in flow) But agree with Cao & Maddieson: voiceless + voiced breathiness following (phonation different at release), slack offset	Shanghainese
	Jessen & Roux 2002	larynx lowering causes slack voice	Xhosa
	Chen & Downing 2011	[slack voice], but Zulu and Shanghainese have different phonetic implementations	Zulu, Shanghainese

[slack voice] **[slack vocal.cords]**	Khumalo 1982	for all DEPs that are breathy voiced	Zulu
	Ladefoged and Maddieson 1996	a slightly increase glottal aperture + a moderate increase in flow	Shanghainese
	Jessen & Roux 2003	the same definition as in Ladefoged & Maddieson 1996, triggered by larynx lowering, breathy optional	Zulu, Shanghainese
	Chen & Downing 2011	[slack voice], but Zulu and Shanghainese have different phonetic implementations, due to their different tonal phonologies	Zulu Shanghainese
[breathiness]	Cao & Maddieson 1992	breathiness on vowels	Chaoyinsha, Shanghai, Wenzhou etc.
	Chen 2015	breathiness on vowels	Shanghainese
feature sets	Strazny 2003	depressors: [lax. v.f] anti-depressors: [tense. v.f]	Zulu vs.Musey
[+slack]	Mathes 2015	aspirated depressors	Tsua

Features for depressors for Bantu and Chinese Wu

vents (Feature pecifications)	Authors	Descriptions	Language(s)
lassical ryngeal feature pecification general)	Jakobson 1968	"b, d": [voice, uncheck, 0tense] "g": [voiced, unchecked, lax]	Zulu
	Halle & Stevens 1971	breathy = [+slack, -stiff, +s.g, -c.g]	in general
n inherent [low one] on epressors	Lanham 1960	DEP = voiced consonants + inherent low tone	Nguni
	Khumalo 1987	DEP = [depression] + low tone	Zulu
ow voicing]	Rycroft 1976	relaxed glottal tension, greater breath-flow, and relatively lower pitch	Siswati
lepression]	Rycroft 1980	a prosodic feature comprised of "breathy" voice quality on the following vowel onset (or the whole vowel); a feature realisable over the syllable rather than a single segment	Nguni in general (incl. Zulu, Swati, Xhosa)
	Traill, Khumalo & Fridjhon 1987	Chen & Downing treat [depression]=[slack voice]	Zulu
	Khumalo 1987	in line with TKF, [depression]	Zulu
	Maddieson 2003	in line with TKF, [depression], breathiness but not a consistent concomitant for depression	Swati

[slack voice] **[slack vocal.cords]**	Khumalo 1982	for all DEPs that are breathy voiced	Zulu
	Ladefoged and Maddieson 1996	a slightly increase glottal aperture + a moderate increase in flow	Shanghainese
	Jessen & Roux 2003	the same definition as in Ladefoged & Maddieson 1996, triggered by larynx lowering, breathy optional	Zulu, Shanghainese
	Chen & Downing 2011	[slack voice], but Zulu and Shanghainese have different phonetic implementations, due to their different tonal phonologies	Zulu Shanghainese
[breathiness]	Cao & Maddieson 1992	breathiness on vowels	Chaoyinsha, Shanghai, Wenzhou etc.
	Chen 2015	breathiness on vowels	Shanghainese
feature sets	Strazny 2003	depressors: [lax. v.f] anti-depressors: [tense. v.f]	Zulu vs.Musey
[+slack]	Mathes 2015	aspirated depressors	Tsua