Towards a typology of prosody-segment interaction: The case of tone-driven epenthesis

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1 INTRODUCTION

(1) This talk presents on an oft-neglected topic in phonological typology: the **interaction between segments and prosody** (e.g. pitch/tone/intonation/etc.)

(2) One such interaction is '**intonation-driven epenthesis**'
- The phonological insertion of a vowel in order to host an intonational tune

(3) **Take-away point for this talk**:
- A parallel and overlooked process of '**tone-driven epenthesis'** also exists in certain African tonal languages
- Defined as the phonological insertion of a vowel in order to host a tone

(4) **Tone-intonation parallelism** is predicted under a model where:
- Both types of prosodic systems make use of the same **phonological substance** (i.e. H/L tonemes) and **architecture** (e.g. **autosegmental representations**)
- Both have the same functional pressures to **cultivate segmental environments** best suited for **realizing pitch targets**

(5) Roadmap of today's talk
- **§2** Our starting point: Prosodic typology
- **§3** Case study: Tone-driven epenthesis in Ghomala'
- **§4** Zooming out: Why is tone-driven epenthesis so rare?
- **§5** Summary

2 STARTING POINT: PROSODIC TYPOLOGY

2.1 *Tone-segment interactions*

(6) Although the empirical landscape of **tone-segment interactions** is not firmly established, there are some things we know

(7) Known to be common: **Depressor effects**
- Tone lowering with depressor consonants
- "Broadly, it has been found that voiced segments lower F0, while voiceless segments raise it" (Cibelli 2015; see therein for extensive references)
- Reflected in tonogenesis, tone distributions and alignment, and sometimes in intonation (e.g. Jun 1998 on Seoul Korean)

(8) Known to be rare: **Tone height dependent on vowel height** (Jiang-King 1999, Yip 2002:31, Kingston 2007, Becker & Jurgec 2017, Arnold 2020)
- This, despite "connection between vowel height and fundamental frequency: the higher the vowel, the higher the pitch" (Fox 2002:232, references therein)

(9) **Segments affecting tone** much more common than **tones affecting segments**
- "There is … little evidence of reciprocation and very little evidence of tone affecting segments" (Wee 2019:208)
- To date, most common pattern of tones affecting segments involves depression, i.e. **low tone inducing consonant voicing** (Poser 1981, Hansson 2004, Pearce 2007, Sossoukpe 2017, *inter alia*)

2.2 *Even rarer – Prosody-driven vowel epenthesis*

(10) 'Text-tune' relationships in **intonation**
- When **mismatch** between the **segmental structure** (the '**text**') and the **intonational melody** (the '**tune**'), usually **melody accommodates**
- E.g. via compression, simplification, truncation of tune

(11) However, growing literature shows opposite pattern: manipulating the segments to **accommodate intonation** (Roettger 2017, Grice et al. 2018, Roettger & Grice 2019)

(12) Tunisian Arabic [aeb] intonation (Hellmuth 2022)
- Yes-no questions realized with rise-fall complex (i.e. L*+H H-L%) at the right edge of an intonational phrase
- This intonational complex typically co-occurs with an **epenthetic** vowel [**ə**]:

				L*H H-L%
nkemmil	tˤu:l	→	[nkemmil	**tˤu:lə:**]
I-continue	straight.ahead		'Should I go straight ahead?'	

- Epenthesis **never** appears when there is only a **simple** rise or **simple** fall, even in the context of a yes/no question

(13) Such prosody-driven epenthesis is a prediction of autosegmental representation

Table 1: Autosegmental representational possibilities

a. Pre-specified	b. Toneless V	c. Floating T	d. Combinations…
H		H	H
|			
á	a		a

Table 2: Schema of logically possible repairs to deficient representations

	Spreading		Epenthesis	
a. Toneless V	H | á t **=a**	→ H | á t **á**	H | á t **=a**	→ H L | á t **à**
b. Floating T	H **=L** | á t	→ H **L** | â t	H **=L** | á t	→ H **L** | á t **ə**

(14) If intonation-driven vowel epenthesis is possible, then what a counterpart **tone-driven epenthesis** in tone languages – is this possible?

- Question remains **unaddressed in major tone surveys** (Pike 1948, Fromkin 1978, Yip 2002, Hyman 2011b, 2018, Wee 2019, *inter alia*)
- **Unaddressed across major works of epenthesis** (Broselow 1982, Ito 1989, Piggott 1995, de Lacy 2006, Hall 2006, 2011, Baković 2007, Moore-Cantwell 2016, *inter alia*)
- Works which do address it: tone-driven epenthesis is **impossible/unattested** (e.g. Blumenfeld 2006, Gleim 2019)

3 CASE STUDY: TONE-DRIVEN EPENTHESIS IN GHOMALA'

3.1 *Ghomala' language*

(15) Ghomala' [IPA: **ɣɔ̀málâʔ** – ISO 639-3: bbj]

- Grassfields Bantoid language of western Cameroon (closely related to Bantu)
- Data largely from previous description (Nissim 1972, 1981; Piron 1997; Eichholzer 2010)
- Supplemented with recordings on YouTube and from 1970s (Hyman p.c., from Nissim)

Table 3: Segmental inventory of Ghomala'[1]

LAB.	DENT.	PAL.	VEL.	GLOT.	FRONT	CENTRAL	BACK
p b	t d		**k** g	**ʔ**	i	ʉ̶	u
pf bv	ts dz	c j			e	ə	o
f v	s	š ž	ɣ	h	ɛ	ɑ	ɔ
m	n		**ŋ**			a	
	l	y	ʉ̶̂				
		ẅ	ŵ				

(16) Possible codas are in bold (will become important later): **p k ʔ m ŋ**

3.2 *Tone-driven epenthesis*

(17) **The tone system**

- Basic **H vs. L** tonal distinction, at an abstract level
- On surface, lexical **six-way contrast** on roots

[1] More marginal phones include **z**, aspirated stops (e.g. **tʰ** <th>), pre-nasalized stops, as well as various consonant + glide sequences.

Table 4: Six-way tone contrast on open syllables (Nissim 1981:150,153)

a.	*High*	H	fǘ	**[fǘ]**	˥	[ǒ ˈyɔ́	**fǘ]**	˥	‘you saw the **parent**’
b.	*Downstep*	ˈH	ˈdhə́	**[dhə́]**	˥	[ǒ ˈyɔ́	**ˈdhə́]**	ꜜ˥	‘you saw the **spouse**’
c.	*Level-low*	L°	tsə̀°	**[tsə̀°]**	ꜜ	[ǒ ˈyɔ́	**tsə̀°]**	ꜜ	‘you saw the **cola nut**’
d.	*Low*	L	tà	**[tà]**	˩	[ǒ ˈyɔ́	**tà]**	˩	‘you saw the **pot**’
e.	*Falling*	HL	bʉ̂	**[bʉ̂]**	˥˩	[ǒ ˈyɔ́	**bʉ̂]**	˥˩	‘you saw the **madman**’
f.	*Rising*	LH	bvʉ̌	**[bvʉ̌]**	˩˥	[ǒ ˈyɔ́	**ˈbvʉ́]**	ꜛ˥	‘you saw the **dog**’

(18) For our purposes we shall leave aside the lexical downstep (row b. from Table 4)

Table 5: Same set of tone contrasts with syllables closed with a sonorant (i.e. **m ŋ**)

a.	H	kɔ́m	**[kɔ́m]**	‘crab’	(Nissim 1981: 216)
b.	L°	làm°	**[làm°]**	‘condiment’	(Nissim 1981: 72)
c.	L	làm	**[làm]**	‘dry season’	(Nissim 1981: 72)
d.	HL	fâm	**[fâm]**	‘plantation’	(Eichholzer 2010: 16; from English *farm*)
e.	LH	bǎm	**[bǎm]**	‘destiny’	(Nissim 1981: 74)

(19) The star of the show today: **Tone-driven epenthesis**
- Seen with obstruent codas when they co-occur with a rising tone
- A /**cv̌k**/ sequence variably becomes [**cv̀kv́**], with a final epenthetic vowel

Table 6: Tone-driven vowel epenthesis with syllables closed by an obstruent

	a.	H	/káp/	**[káp]**	‘pipe’	(Eichholzer 2010: 23)
	b.	L°	/bàp°/	**[bàp°]**	‘animal’	(Eichholzer 2010: 3)
	c.	L	/pàp/	**[pàp]**	‘wing’	(Nissim 1981: 218)
	d.	HL	/lâp/	**[lâp]**	‘elegance’	(Eichholzer 2010: 31)
→	e.	LH	/lǎp/	**[lǎp ~ làpə́]**	‘pool of water’	(Eichholzer 2010: 31)

(20) This variation is found consistently across Ghomala’ literature/recordings
- Same word, different transcription: **vɔ̀pə́** ‘dust’ (Nissim 1981:198) vs. **vɔ̌p** (Moguo 2021:141) – **No contrast** between such forms

(21) Tone-driven epenthesis happens with all coda obstruents (i.e. **p k ʔ**)

Table 7: Tone-driven epenthesis with all coda obstruents (Nissim 1981)

a.	p	/gɔ̌p/	**[gɔ̀pə́]**	‘hen’	(p. 63)	
		/ŋkǎp/	**[ŋkàpə́]**	‘money’	(p. 300)	[AUDIO]
b.	k	/mɔ̌k/	**[mɔ̀kə́]**	‘fire’	(p. 48)	[AUDIO]
		/sǎk/	**[sàkə́]**	‘wall’	(p. 65)	
c.	ʔ	/gwɔ̌ʔ/	**[gwɔ̀ʔə́]**	‘termite’	(p. 146)	
		/lǎʔ/	**[làʔá]**	‘village’	(p. 74)	
		/pǔʔ/	**[pùʔú]**	‘package’	(p. 146)	
		/gʉ̌ʔ/	**[gʉ̀ʔʉ́]**	‘strength’	(p. 90)	

(22) Nissim is explicit in treating this final vowel as epenthesis, stating that its only function is to support a tone (Nissim 1981:65,90)

(23) No epenthesis with other tonal contrasts (i.e. rows a-d from Table 6)
- bàp° ‘animal’ → only [**bàp°**] Cf. *[**bàpə°**] [AUDIO]
- lâp ‘elegance’ → only [**lâp**] Cf. *[**lápə**]
- lòʔ° ‘yam’ → only [**lòʔ°**] Cf. *[**lòʔə°**] [AUDIO]

(24) Demonstrates epenthesis not due purely to markedness of obstruent codas

(25) Against a deletion alternative – I.e. */**cvcv**/ → [**cvc**]
- The analytic indeterminacy of epenthesis is notoriously difficult (Morley 2015)

(26) Evidence from **root phonotactics**
- Vast majority of roots in language are monosyllabic (e.g. **CV/CVC shapes**)
- Major exception to this generalization are exactly these [**cv̀cə́**] forms

(27) Evidence from **closed syllable restrictions** – Applies to [**cv̀cə́**] too
- Recall the vowel inventory /**i e ɛ ʉ ə ɑ a u o ɔ**/ (where **ɑ** is IPA [**ɐ**])
- Before coda **p** and **k** only the low vowels **ɔ** and **a** are allowed
- If this were underlying /**cvcə**/, we would expect full range of vowels, I.e. expect non-existent roots */**bùpə́**/ or */**gɛ̀kə́**/
- In other words, **cv̌k** patterns as a closed syllable underlyingly

3.3 *Morpho-phonological alternations*

(28) Further evidence comes from **morpho-phonological alternations**
- Reveal **complete co-variation** between rising **tones** and epenthetic **vowels**

(29) **Deverbal nominalization** mirrors the distribution of the monomorphemic lexicon
- Lexical tone of root overwritten with LH tone
- If this involves a coda obstruent, an epenthetic vowel must be added

(30) **Deverbal nominalization** (Nissim 1981: 288-289)
- tʉ̀ ‘be strong’ → tʉ̌ ‘iron’
  sú ‘(to) weed’ → sǔ ‘hoe’
- tùŋ ‘dig inside’ → ntǔŋ ‘throat’
  tɔ́m ‘push’ → tɔ̌m ‘fruit’
- tsʉ̀ʔ ‘twist’ → **dzʉ̀ʔʉ́** ‘liana (vine)’
  fɔ́k ‘blow (cold)’ → **fɔ̂kə́** ‘cold’

(31) Morpho-phonological alternation in **[N of N] constructions**
- Used for possession, compounds, and other meanings of association

(32) Like most Bantoid/Bantu languages, Ghomala’ has a **noun class system**, albeit relatively reduced with only 6 classes (SG-PL pairings 1-2, 3-4, and 5-6)
- Evidence for these classes comes from **distinct concord patterns**
- Class 2 plural msǎŋ ‘birds’ msǎŋ **pə́**-pʉ́ə́ ‘two birds’
- Class 4 plural mkwə̀° ‘feet’ mkwə̀ **mə́**-bʉ́ə́ ‘two feet’
- Class 6 plural dzə́ ‘goats’ dzə́ **tsə́**-pʉ́ə́ ‘two goats’

(33) Class 1 nouns such as **mú** ‘child’ versus Class 3 nouns such as **thə́** ‘head’
- Different concord patterns in [N of N] constructions
- mú **L** bvə̌ → [mû **bvə̌**]
  child[CL1] **of.CL1** dog ‘the child of the dog’ (Nissim 1981: 264)
- thə́ **H** bvə̌ → [thə́ **ˈbvə́**]
  head[CL3] **of.CL3** dog ‘the head of the dog’ (Nissim 1981: 153)

(34) [N of N] constructions and tone-segment co-variation (Nissim 1981: 157-158, 250-252)
- mú **L** gɔ̌p → [mû **gɔ̀pə́**] ‘the child of the hen’
  kòʔ° **L** gɔ̌p → [kôʔ **gɔ̀pə́**] ‘the rooster of the hen’
  gì **L** gɔ̌p → [gì **gɔ̀pə́**] ‘the voice of the hen’ [AUDIO]
  dyə̌ **L** gɔ̌p → [dyə̂ **gɔ̀pə́**] ‘the house of the hen’
- thə́ **H** gɔ̌p → [thə́ **ˈgɔ́p**] ‘the head of the hen’
  mkòʔ° **H** gɔ̌p → [mkòʔ **gɔ́p**] ‘the roosters of the hen’
  kwə̀ **H** gɔ̌p → [kwə̀ **gɔ́p**] ‘the foot of the hen’ [AUDIO]
  tăŋ **H** gɔ̌p → [tăŋ **ˈgɔ́p**] ‘the ear of the hen’

(35) **Complete tone/segment co-variation**
- If you add rising tone to [**cvk**], then you **feed** epenthesis (i.e. [**cvkə**])
- If you eliminate rising tone from [**cvk**], then you **bleed** epenthesis (i.e. [**cvk**])

4 ZOOMING OUT: WHY IS TONE-DRIVEN EPENTHESIS SO RARE?

4.1 *A common constraint*

(36) Let us refer to this constraint in Ghomala’ as ‘**the *[cv̌k] constraint**’
- Sonorous segments such as vowels and sonorants possess richer harmonic structures than obstruents → make for better tone-bearing units
- It is well-known that rising pitch takes longer to execute than a falling pitch and consequently has greater duration on average (e.g. Sundberg 1973, *etc.*)
- Taking together, [**cvk**] structures may not provide enough sonorous material to adequately realize the rising tone within its allotted duration

(37) **Two common repair families**:
- Reduce the contour tone (effect the ‘tune’)
- Expand the vowel duration (effect the ‘text’)

(38) **Reduce** the ‘contourness’ of tone – Compression, simplification, or flattening
- May result in complete neutralization
- In Xhosa [xho], HL contours are merged with H tones when a vowel is shortened in unstressed (i.e. pre-penultimate) environment (Lanham 1958, Zhang 2013)

(39) **Expand** the vowel duration
- Non-neutralizing lengthening in Mitla Zapotec [zaw] for syllables with rising but not falling contours (Briggs 1961, cited in Zhang 2013)

4.2 *Epenthesis as a rare repair*

(40) A common constraint but a rare repair:
- The motivation is very common, i.e. avoiding rising tone on suboptimal host
- However, tone-driven epenthesis as a repair is extremely rare
- E.g. no such repair in aforementioned typological surveys (Gordon 2001, Zhang 2013)

(41) In fact, works which posit a maximally restrictive theory of epenthesis assume tone-driven epenthesis to be **impossible/unattested** (Blumenfeld 2006; Gleim 2019)
- "Tone conditions cannot affect string structure" and therefore tone "cannot force epenthesis/syncope" (Blumenfeld 2006:41)
- Epenthesis is "used exclusively as a response to pressures of syllable structure, sonority sequencing, syllable contact, and word minimality" (Blumenfeld 2006:5)

(42) Outside of Ghomala', tone-driven epenthesis entertained only in:
- Wamey [cou] Tenda, Niger-Congo: Senegal (Santos 1996)
- Kejom [bbk] Grassfields, N.-Congo: Cameroon (Akumbu et al. 2020)
- Kifuliiru [flr] Bantu, N.-Congo: DRC (van Otterloo 2011)
- Hdi [xed] Chadic: Nigeria/Cameroon (Frajzyngier 2002, Gleim 2019)
- Barain [bva] Chadic: Chad (Lovestrand 2012)
- Arapaho [arp] Algonquian: USA (Cowell & Moss 2008, Gleim 2019)

(43) Only in **Wamey** is there good evidence for *bona fide* epenthesis (Rolle & Merrill *to appear*)
- Out soon in *Phonology* – Draft: https://ling.auf.net/lingbuzz/006624
- Arguments parallel to those developed for Ghomala' showing that **rising tones on closed syllables trigger epenthesis**

Table 8: Wamey – Complementary distribution of cvc and cvcə roots based on tone

	Tone	CVC shape		CVCə shape	
a.	H	-cǽw̃	'urinating'	***cvcə́**	
b.	L	-cæ̀w̃	'hiding'	***cvcə̀**	
c.	HL	-cæ̂w̃	'domestic animal'	***cvcə̀**	
d.	LH	***cv̌c**		-nkæ̀w̃ə́	'dance' (n.)

4.3 *Why so rare? – The functional load of tone*

(44) Despite its occurrence in Wamey and Ghomala', it is incredibly rare – **But why?**
- Towards an explanation: **the relatively low functional load of tone**

(45) **Functional load** (Hockett 1955, 1966; Wedel et al. 2013; *inter alia*)
- "Functional load (FL) quantifies the contributions by phonological contrasts to distinctions made across the lexicon" (Round et al. 2022)
- English contrast **t** vs. **d** has a high functional load (e.g. many minimal pairs – *tie*/*die*, *tall*/*doll*, *tune*/*dune*, *sat*/*sad*, etc.)
- Cf. **θ** vs. **ð** with much **lower** functional load (e.g. *ether*/*either*) (Hall et al. 2019)

(46) The number of tonal minimal pairs is often very low in tonal languages

(47) **Hausa** [hau] (Chadic: Nigeria)
- "Although tone does not have a functional load comparable to that of many West African languages like Igbo or Yoruba, it does serve to distinguish a number of lexical items" (Newman 2000:599)
- ràìná: LH 'look after a baby'
  ráínà: HL 'despise, have contempt for'

(48) **Relative functional load (FL) and entropy measures**
- How much information is lost if you merge all values of a category?
  No vowel contrasts: rV̀V̀nV́: vs. rV́V́nV̀:
  No tone contrasts: raina: vs. raina:
- Chinese tonal languages Mandarin and Cantonese – FL of vowels is largely equivalent to that of tone, demonstrating equal lexical importance (Surendran & Niyogi 2003, 2006; Surendran & Levow 2004; Oh et al. 2015)
- In contrast in Hausa, FL of vowels is 3.5 times as important as tone (Rolle 2020)
- What is more typical? Cross-linguistic quantitative study still required

(49) **If functional load is low, little reason to excessively maintain tone contrast**
- In tonal languages, most morphemes bearing tone are expressed jointly by tonal and segmental material together, and more rarely by tone alone
- If there is enough segmental material to differentiate the morpheme from other paradigmatically-related morphemes (e.g. all nominal roots, or all TAM suffixes), then **adding more segmental material** via epenthesis may be **costlier** than being **faithful to the underlying tone** pattern

(50) In short, in most tonal languages if the H portion of a [**cv́k**] sequence were simply deleted, little information would be lost to correctly identify the intended meaning

5 SUMMARY[2]

(51) **To summarize**:
- We demonstrated one rare process termed '**tone-driven epenthesis',** defined as the phonological insertion of a vowel to host a tone
- We provided evidence for this process from the Cameroonian language Ghomala', with evidence from **root phonotactics** and **morpho-phonological alternations** (both derivation and inflection)
- Finally, we hypothesized that the reason tone-driven epenthesis is so rare is due to the **low functional load of tone** in many tone languages

(52) These findings support **tone-intonation parallelism**:
- Both types of prosodic systems make use of the same **phonological substance** (i.e. H/L tonemes) and representation (e.g. **autosegmental architecture**)
- Both have the same functional pressures to **cultivate segmental environments** best suited for **realizing pitch targets**

[2] For references: [rtf] [bib] (or see my website)