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) Such 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 representation (e.g. autosegmental architecture)
   • Both have the same functional pressures to cultivate segmental environments best suited for realizing pitch targets

(5) Roadmap of today’s talk
   • §2 Prosodic typology and prosody-segment interactions
   • §3 Major case study: Tone-driven epenthesis in Ghomala’
   • §4 Tone-driven epenthesis in a wider perspective
   • §5 Why so rare? The functional load of tone
   • §6 Summary and zooming out

2 PROSODIC TYPOLOGY

(6) Our starting point for examining prosodic typology generally
   • What do we know about tone within this typology?
Despite small literature, certain tone-related **phonological generalizations** are clear at this point

- Three to four pitch heights are common (e.g. low, mid, and high), but five are rare and six virtually unattested (Yip 2002: 20; Odden 2020)
- Operations like downstepping are quite common while ‘upstep’ is attested but much rarer (Snider 1990)
- A large number of asymmetries with regard to anticipatory vs. regressive tone assimilation (Hyman 2007 for extensive survey)

### 2.1 Tone-segment interactions

- **Tone-segment interactions – Its empirical landscape** not firmly established

- **Depressors** – 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)

  - This, despite “connection between vowel height and fundamental frequency: the higher the vowel, the higher the pitch” (Fox 2002:232, references therein)

- **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*).

- **Plural allomorphy in Kera language** [ker] (East Chadic: Chad – Pearce 2007:15)
  - /KV-àzrä/ → g-ázraw ‘gazelles’ (PL)
  - /KV-ágày/ → k-ágày ‘hoses’ (PL)

### 2.2 Even rarer – Prosody-driven vowel epenthesis

- ‘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

- However, growing literature shows opposite pattern: manipulating the segments to **accommodate intonation** (Roettger 2017, Grice et al. 2018, Roettger & Grice 2019)
(15) 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]:

\[
\text{nkmml} \quad \text{tˤu:l} \quad \rightarrow \quad [\text{nkmml} \quad \text{tˤu:lo}] \\
\text{I-continue} \quad \text{straight-ahead} \quad \text{‘Should I go straight ahead?’}
\]

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

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

<table>
<thead>
<tr>
<th>a. Pre-specified</th>
<th>b. Toneless V</th>
<th>c. Floating T</th>
<th>d. Combinations…</th>
</tr>
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<tbody>
<tr>
<td>H</td>
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Table 2: Logically possible repairs to deficient representations

<table>
<thead>
<tr>
<th>a. Toneless V</th>
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<td>[\text{á} \quad \text{t} = \text{a} \quad \text{á} \quad \text{t} \quad \text{á} ]</td>
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<table>
<thead>
<tr>
<th>b. Floating T</th>
<th>H</th>
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<td>[\text{á} \quad \text{t} \quad \text{á} \quad \text{t} \quad \text{á} ]</td>
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(17) If intonation-driven vowel epenthesis is possible, then what a counterpart tone-driven epenthesis in tone languages – is this possible?
- Works which do address it: tone-driven epenthesis is impossible/unattested (e.g. Blumenfeld 2006, Gleim 2019)

3 MAJOR CASE STUDY: TONE-DRIVEN EPENTHESIS IN GHOMALA’

3.1 Ghomala’ – Language profile

(18) Ghomala’ [IPA: yɔmáłá mortgages 639-3: bbj]
- Grassfields Bantoid language of western Cameroon (closely related to Bantu)
- Data largely from previous description (Nissim 1972, 1981; Piron 1977; Eichholzer 2010)
- Supplemented with recordings on YouTube and from 1970s (Hyman p.c., from Nissim)
Table 3: Segmental inventory of Ghomala’

<table>
<thead>
<tr>
<th>LAB.</th>
<th>DENT.</th>
<th>PAL.</th>
<th>VEL.</th>
<th>GLOT.</th>
<th>FRONT</th>
<th>CENTRAL</th>
<th>BACK</th>
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<tbody>
<tr>
<td>p</td>
<td>b</td>
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</tr>
</tbody>
</table>

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

(20) Only codas (will become important later): p k ? m ŋ

3.2 Tone-driven epenthesis

(21) Basic H vs. L tonal distinction, but a lexical six-way contrast on roots

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

<table>
<thead>
<tr>
<th>a. High</th>
<th>b. Downstep</th>
<th>c. Level-low</th>
<th>d. Low</th>
<th>e. Falling</th>
<th>f. Rising</th>
</tr>
</thead>
</table>

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

<table>
<thead>
<tr>
<th>a. H /kóm/</th>
<th>b. L⁰ /lém⁰/</th>
<th>c. L /lém/</th>
<th>d. HL /fám/</th>
<th>e. LH /bóm/</th>
</tr>
</thead>
</table>

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

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

<table>
<thead>
<tr>
<th>a. H /káp/</th>
<th>b. L⁰ /báp⁰/</th>
<th>c. L /páp/</th>
<th>d. HL /láp/</th>
<th>e. LH /láp/</th>
</tr>
</thead>
</table>

(23) Tone-driven epenthesis
- Seen with obstructed codas when they co-occur with a rising tone
- A /cỳk/ sequence variably becomes [cỳk], with a final epenthetic vowel
(24) This variation is found consistently across Ghomala’ literature/recordings
   - Same word, different transcription:
     \( \text{v} \text{ðp} \text{á} \) ‘dust’ (Nissim 1981:198) \( \text{VS.} \) \( \text{v} \text{ðp} \) (Moguo 2021:141)
   - No contrast between such forms

(25) Tone-driven epenthesis happens with all coda obstruents (i.e. \( \text{p k ?} \))

<table>
<thead>
<tr>
<th>Table 7: Tone-driven epenthesis with all coda obstruents (Nissim 1981)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ( \text{p} ) ( \text{/g} \text{ðp}/ ) ( \text{[g} \text{ðp} \text{á}]/ ) ‘hen’ (p. 63)</td>
</tr>
<tr>
<td>( \text{/ŋk}/ ) ( \text{[ŋk} \text{á}]/ ) ‘money’ (p. 300)</td>
</tr>
<tr>
<td>( \text{/p} \text{ù}/ ) ( \text{[p} \text{ù} \text{á}]/ ) ‘package’ (p. 146)</td>
</tr>
</tbody>
</table>

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

(27) No epenthesis with other tonal contrasts (i.e. rows a-d from Table 6)
   - \( \text{b} \text{áp}^\circ \) ‘animal’ \( \rightarrow \) only \( \text{[b} \text{áp}^\circ]/ \) Cf. *\( \text{[b} \text{áp}^\circ] \) [AUDIO]
   - \( \text{l} \text{áp} \) ‘elegance’ \( \rightarrow \) only \( \text{[l} \text{áp]/} \) Cf. *\( \text{[l} \text{áp]/} \)
   - \( \text{l} \text{ò}^\circ \) ‘yam’ \( \rightarrow \) only \( \text{[l} \text{ò}^\circ]/ \) Cf. *\( \text{[l} \text{ò}^\circ]/ \) [AUDIO]

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

(29) Against a deletion alternative – I.e. */c\text{vcv}/ → [c\text{vc}]
   - The analytic indeterminacy of epenthesis is notoriously difficult (Morley 2015)

(30) 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 [c\text{vcá}] forms

(31) Evidence from closed syllable restrictions – Applies to [c\text{vcá}] too
   - Recall the vowel inventory /\( \text{i e e u ä a u o ɔ} \) (where \( \text{α} \) is IPA [\( \text{ɐ} \)])
   - Before coda \( \text{p} \) and \( \text{k} \) only the low vowels \( \text{ɔ} \) and \( \text{a} \) are allowed
   - If this were underlying /c\text{vcã}/, we would expect full range of vowels, I.e. expect non-existent roots *\( \text{b} \text{úp}^\circ/ \) or *\( \text{g} \text{ěk}^\circ/ \)
   - In other words, c\text{vk} patterns as a closed syllable underlyingly

3.3 Morpho-phonological alternations

(32) Further evidence comes from morpho-phonological alternations
   - Reveal complete co-variation between rising tones and epenthetic vowels
(33) **Deverbal nominalization**
- Lexical tone of root overwritten with LH tone
- If this involves a coda obstruent, an epenthetic vowel must be added
- Mirrors the distribution of the monomorphemic lexicon

(34) **Deverbal nominalization** *(Nissim 1981: 288-289)*
- tǔ́ ‘be strong’ → tǔ́ ‘iron’
- sú́ ‘(to) weed’ → sú́ ‘hoe’
- tǔ́ ‘dig inside’ → n̪tǔ́ ‘throat’
- tóm ‘push’ → tóm ‘fruit’
- tsì́ ‘twist’ → dzuʔú́ ‘liana (vine)’
- fók ‘blow (cold)’ → fókó ‘cold’

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

(36) 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)

(37) Evidence for these classes comes from **distinct concord patterns**
- Class 2 plural m̪s̪àŋ ‘birds’ m̪s̪àŋ pá-pú́ ‘two birds’
- Class 4 plural mkwə̀ ‘feet’ mkwə̀ má-bú́ ‘two feet’
- Class 6 plural dzó ‘goats’ dzó tsá-pú́ ‘two goats’

(38) Class 1 nouns such as mú́ ‘child’ versus Class 3 nouns such as thó́ ‘head’
- Different concord patterns in [N of N] constructions

(39) **Concord with different grammatical tones in [N of N] constructions**
- mú L bva → [mú bů́]
  child[CL1] of.CL1 dog ‘the child of the dog’ *(Nissim 1981: 264)*
- thó H bva → [thó bů́]
  head[CL3] of.CL3 dog ‘the head of the dog’ *(Nissim 1981: 153)*

(40) **[N of N] constructions and tone-segment co-variation** *(Nissim 1981: 157-158, 250-252)*
- mú L ḡōp → [mú gōpá] ‘the child of the hen’
- kóʔ̂ L ḡōp → [kóʔ̂ gōpá] ‘the rooster of the hen’
- gi L ḡōp → [gi gōpá] ‘the voice of the hen’ [AUDIO]
- dyǎ L ḡōp → [dyǎ gōpá] ‘the house of the hen’
- thó H ḡōp → [thó gōp] ‘the head of the hen’
- mkóʔ̂ H ḡōp → [mkóʔ̂ gōp] ‘the roosters of the hen’ [AUDIO]
- kwá H ḡōp → [kwá gōp] ‘the foot of the hen’ [AUDIO]
- tǎŋ H ḡōp → [tǎŋ gōp] ‘the ear of the hen’

(41) **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 TONE-DRIVEN EPENTHESIS IN A WIDER PERSPECTIVE

4.1 A common constraint

(42) Let us refer to this constraint in Ghomala’ as ‘the \([cvk]\) constraint’

(43) General cross-linguistic tendency to avoid rising contours on inadequate hosts
   - The phonetic underpinnings of the \([cvk]\) constraint are well-known
   - Sonorous segments such as vowels and sonorants possess richer harmonic structures than obstruents
   - Thus, they make for better tone-bearing units as the pitch targets are better perceived on them

(44) Moreover, 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

(45) Contour restrictions
   - Implicational tendencies with contours – “if a language allows contour tones on CV, it also tolerates them on CVO, CVR, and CVV” (Gordon 2001:428)
   - Contour tone survey (Zhang 2013) – languages with only allow surface falling tones \((n=37)\) > languages that only allow surface rising tones \((n=3)\)

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

(47) Reduction of contour tone – Compression, simplification, or flattening
   - May result in complete neutralization, e.g. in Xhosa \([xho]\), HL contours are merged with H tones when a vowel is shortened in an unstressed (i.e. pre-penultimate) environment (Lanham 1958, Zhang 2013)

(48) 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)
   - In the Africanist context, this is often framed as mora insertion if there is neutralization with long vowels

(49) Gokana \([gkn]\): /\(t\bar{o}/\) plus floating low \(\rightarrow [t\bar{o}n\bar{e}n]\) ‘house of person’ (Hyman 2011a:74)

4.2 Epenthesis as a rare repair

(50) 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)
In fact, works which posit a maximally restrictive theory of epenthesis assume tone-driven epenthesis to be impossible/unattested (Blumenfeld 2006; Gleim 2019)
- Epenthesis is “used exclusively as a response to pressures of syllable structure, sonority sequencing, syllable contact, and word minimality” (Blumenfeld 2006:5)
- “Tone conditions cannot affect string structure” and therefore tone “cannot force epenthesis/syncope” (Blumenfeld 2006:41)

Outside of Ghomala’, tone-driven epenthesis posited/entertained only in:
- Kifuliiru [flr] Bantu, N.-Congo: DRC (van Otterloo 2011)
- Barain [bva] Chadic: Chad (Loverstrand 2012)

On Wamey (also called Konyagi/Coniagui)
- Number of arguments parallel to those developed for Ghomala’ showing that rising tones on closed syllables trigger epenthesis (Santos 1996, Rolle & Merrill to appear)
- E.g. restrictions on the shape of roots based on tone

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

<table>
<thead>
<tr>
<th>Tone</th>
<th>CVC shape</th>
<th>CVCə shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. H</td>
<td>-cæw  ‘urinating’</td>
<td>*cvćə</td>
</tr>
<tr>
<td>b. L</td>
<td>-cæw  ‘hiding’</td>
<td>*cvćə</td>
</tr>
<tr>
<td>c. HL</td>
<td>-cæw  ‘domestic animal’</td>
<td>*cvćə</td>
</tr>
<tr>
<td>d. LH</td>
<td>*cvć</td>
<td>-nkæwə ‘dance’ (n.)</td>
</tr>
</tbody>
</table>

Comparable morpho-phonological alternations also exist – See paper for details
- Out soon in *Phonology* – Draft: [https://ling.auf.net/lingbuzz/006624](https://ling.auf.net/lingbuzz/006624)

Despite its occurrence in Wamey and Ghomala’, it is incredibly rare – **But why?**

## 5 Why so rare? – The functional load of tone

Two findings of prosody-segment typology make the rarity of tone-driven epenthesis particularly puzzling
- First, comparable epenthesis operation is frequently cited in the intonation literature (e.g. Roettger 2017, etc.; Tunisian Arabic example in (15))
- Second, a similar process of ‘tone-driven retention’ is quite common

**Tone-driven retention:**
- Vowels that are otherwise expected to delete and/or reduce according to the regular phonology are retained if and only if they bear tone
- Examples from Cheyenne [chy], Acoma [kjq], Konso [kxe], Shanghainese [wuu], Japanese [jpn], among others (Roettger & Grice 2019: 279-280)
Towards an explanation for its rarity: **the relatively low functional load of tone in tone systems**

**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)

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

**Hausa** [haú] (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)
- *ràìnáː*: LH ‘look after a baby’
- *ràínàː*: HL ‘despise, have contempt for’

**Relative functional load (and entropy measures)**
- How much information is lost if you merge all values of a category?
  - No vowel contrasts: *r̥Vn̥ː* vs. *r̥VVn̥ː*
  - No tone contrasts: *rainaː* vs. *rainaː*
- Chinese tonal languages Mandarin and Cantonese – Functional load 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, functional load of vowels is 3.5 times as important as tone (Rolle 2020)
- Situation in Hausa is quite typical of tone languages generally → Quantitative study still required

**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

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

Predicts that the functional load of tone in Ghomala’ (and Wamey) for lexical tone contrasts should be higher than other tonal languages (on average)
Comparison to intonation
- Characterized in these terms, the functional load of tone in tonal languages is lower than the functional load in intonational systems
- The ‘intonemes’ of intonational systems normally do not occur with segmental co-exponents
- Losing cues for the intonational melody is more costly since there would be no additional segmental cues
- To avoid this, post-lexical epenthesis appears as one of several strategies

To summarize:
- We began with the big picture: The state of prosodic typology and in particular tone-segment interactions
- 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

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

Zooming-out: Towards a typology of prosody-segment interactions
- Common constraints are phonetically grounded – Such as the *[c̍v̌k]* constraint, due to inherent properties of obstruents and rising tone duration

Major prediction:
- Repairs for these constraints emerge based on the phonological system
- Contrast loss to accommodate this constraint is more likely when this contrast has a low functional load – and equally, less likely when high

REFERENCES
See Output on my website [rtf] [bib]