Phonetics of voiced aspirates in Yemba (Dschang)

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- **Harold Torrence** and members of the UCLA graduate field methods course on Yemba, Winter–Spring 2019
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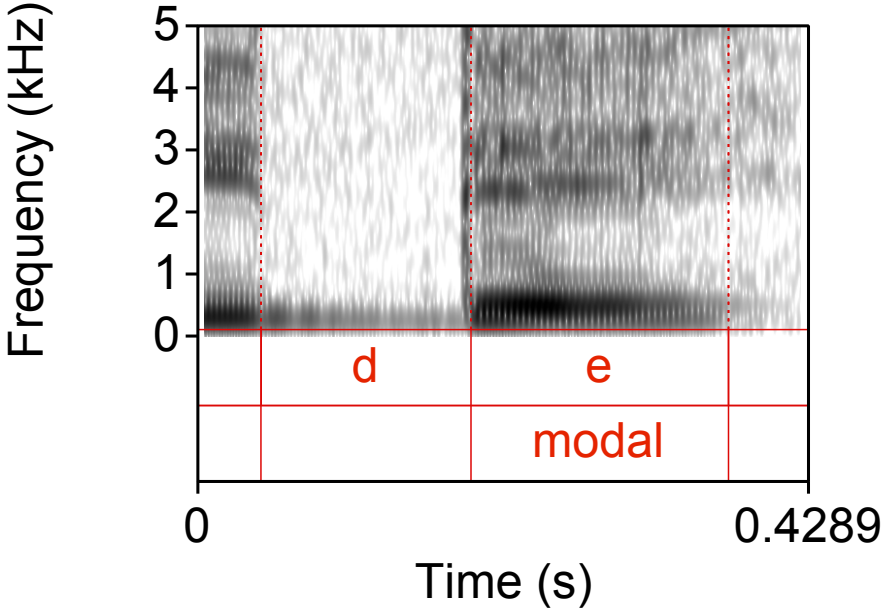
“Voiced aspirated” consonants

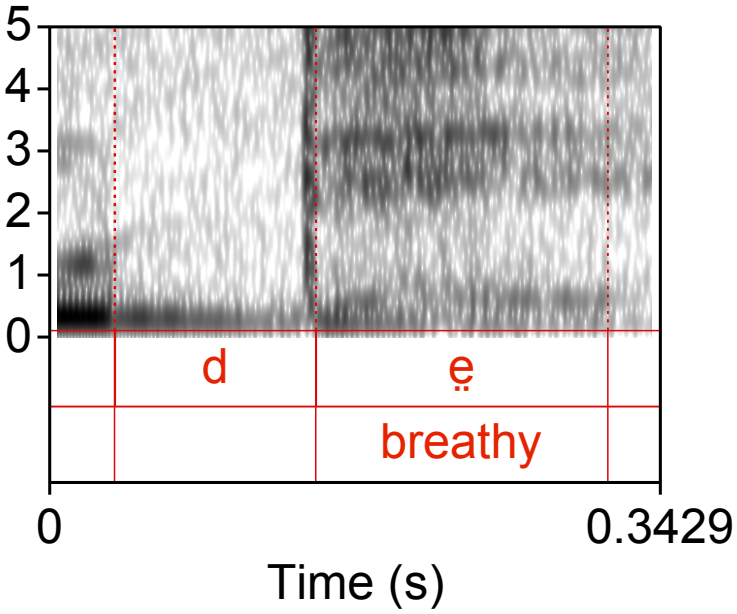
Not actually voiced, then (voicelessly) aspirated: **breathy** phonation present during/after release[1]

» For example, Owerri Igbo[2]

/d/ [īdè] ‘write’



/d^{h}/ [údẹ̈] ‘boom’



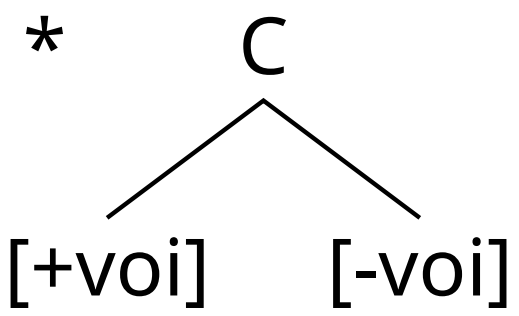
[1] Berkson, 2019; Keating and Esposito, 2007; Seyfarth and Garellek, 2018.

[2] rec. Ladefoged and Keating 1984, UCLA Phonetics Archive

A claim about consonant voicing

No truly **voiced, then voiceless aspirated** consonants

» "[A] sound in which the vocal cords are vibrating during the articulation and then come apart into the voiceless position during the release of the stricture … has not yet been observed in any language" (Ladefoged)[3]



» Some purported examples, but closer examination disproves them[4]

[3] Ladefoged, 1971.

[4] Blust, 2016; Brown, 2020.

This talk: counterevidence

Our claim:

» Voiced aspirates in **Yemba** have precisely this sort of laryngeal timing: **voicing during closure** and **voiceless aspiration** post-release

Outline

» Yemba description
  » Consonant inventory
  » Qualitative description of C^h

» EGG/audio study
  » Presence of voicing
  » Quality of voicing

» Discussion

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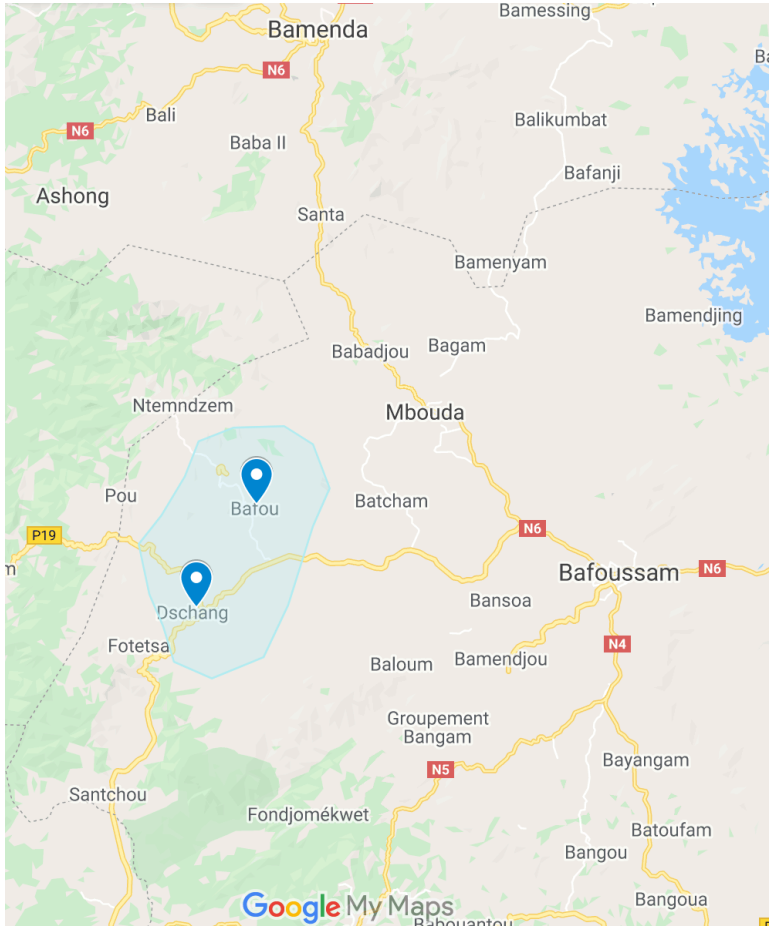
About Yemba

About Yemba AKA Dschang

» Bamileke (Grassfields Bantu) language spoken in West region of Cameroon by 300,000-400,000 people[5]



[5] Eberhard, Simons, and Fennig, 2021.

Yemba consonant inventory

Most consonants have aspirated and unaspirated counterparts, including voiced fricatives, nasals, and approximants[6]

	Labial	Alveolar	Palatal	Velar	Glottal
Stop	p p^h	t t^h		k k^h	ʔ
Affricate	pf pf^h	ts ts^h	tʃ $tʃ^h$		
Fricative	f f^h v v^h	s s^h z z^h	ʃ $ʃ^h$ ʒ $ʒ^h$		(h)
Nasal	m m^h	n n^h		ŋ	
Approx.	w w^h	l l^h	j	ɰ $ɰ^h$	

[6] Bird, 1999.

Yemba consonant inventory

Derived voiced prenasalized stops also occur:

» Unaspirated [^{n}b, ^{n}d, ^{n}g, ^{n}gw] from nasal + /p, l, ɰ, w/

n- ‘CL6’	+	**-p**i	‘liver’	→	**^{n}b**i
n- ‘INF’	+	**-l**ʉ	‘rain (v.)’	→	**^{n}d**ʉ
n- ‘CL1’	+	**-ɰ**ʉə	‘stranger’	→	**^{n}g**ʉə
n- ‘INF’	+	**-w**ɛ	‘have; get’	→	**^{n}g**wɛ

» Aspirated [^{n}b^{h}, ^{n}d^{h}, ^{n}g^{h}, ^{n}g^{h}w] from /p^{h}, l^{h}, ɰ^{h}, w^{h}/

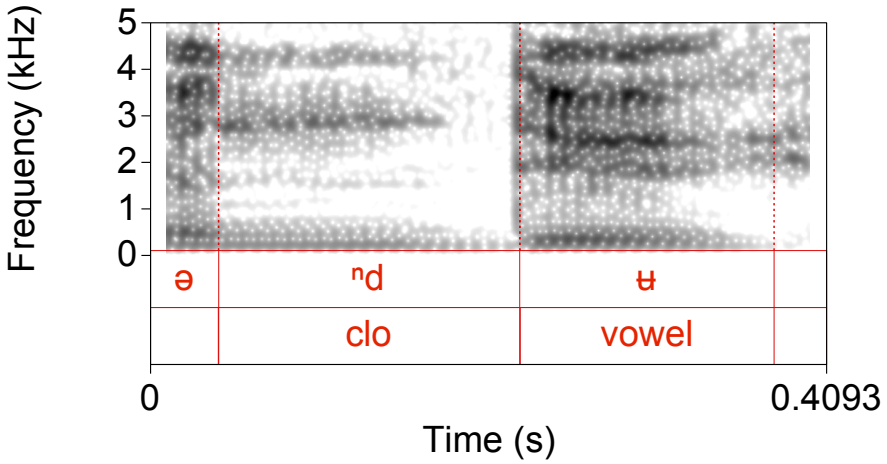
n- ‘INF’	+	**-p^{h}**i	‘sow’	→	**^{n}b^{h}**i
n- ‘INF’	+	**-l^{h}**ʉ	‘wrestle’	→	**^{n}d^{h}**ʉ
n- ‘INF’	+	**-ɰ^{h}**ʉ	‘do’	→	**^{n}g^{h}**ʉ
n- ‘CL9’	+	**-w^{h}**i	‘deer’	→	**^{n}g^{h}**wi

Implementation

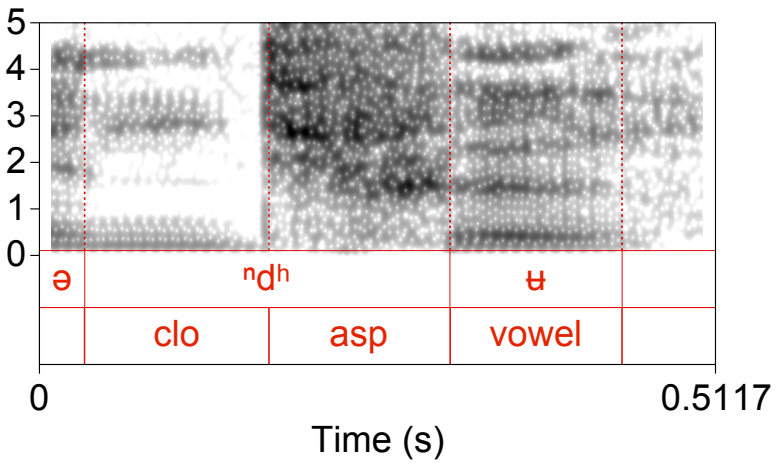
Aspiration appears **voiceless**, even after voiced consonant constrictions

» Prenasalized voiced stops

ⁿdʉ ‘string’



ⁿdʰʉ ‘boundary’

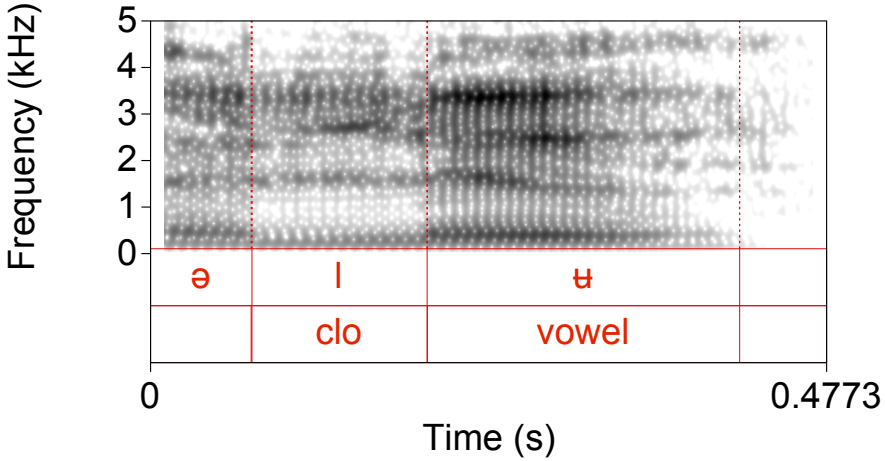


Implementation

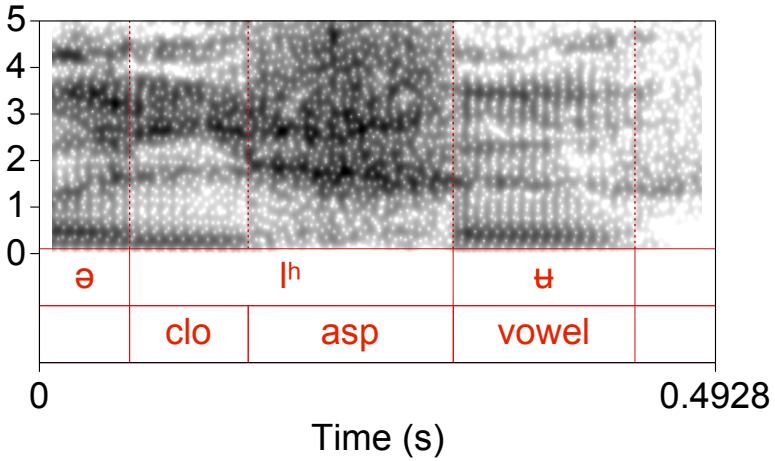
Aspiration appears **voiceless**, even after voiced consonant constrictions

» Voiced approximants

lʉ ‘horse’



məl^hʉ ‘soldier ants’



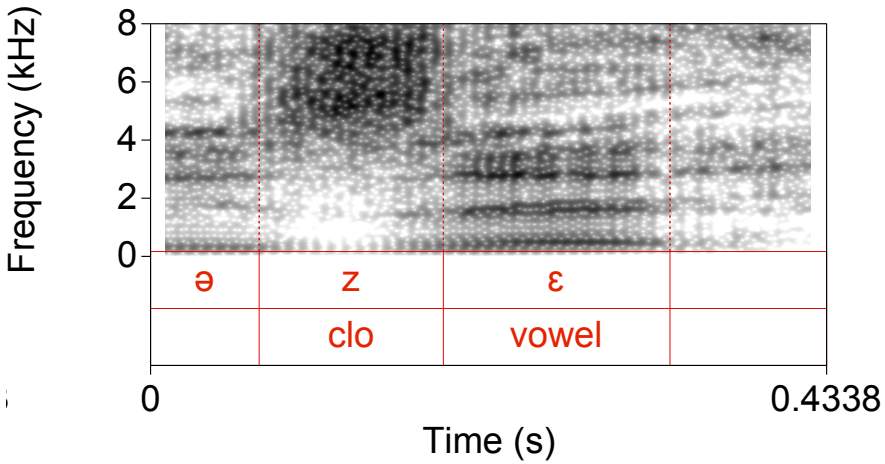
Different implementation strategies

Aspiration appears **voiceless**, even after voiced consonant constrictions

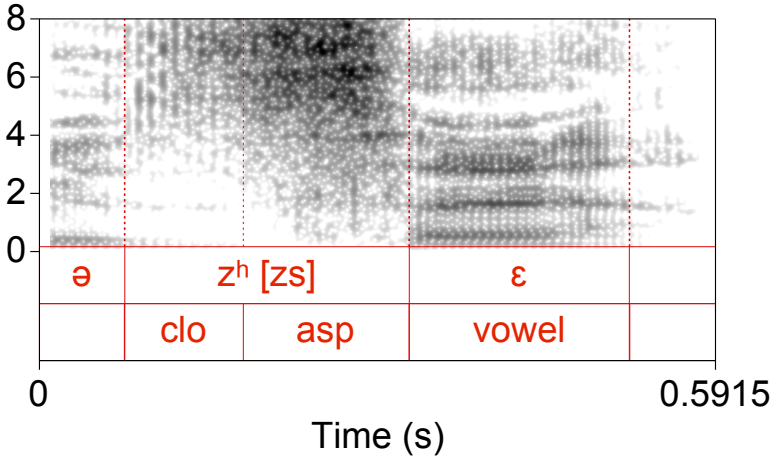
» Voiced fricatives (may also be prenasalized; not shown)

» Often a voiceless extension of the onset fricative, e.g. /z^h/ as [zs]; as reported for Ngyembɔɔn[7]

ləzɛ ‘grass’



ləz^{h}ɛ ‘know’

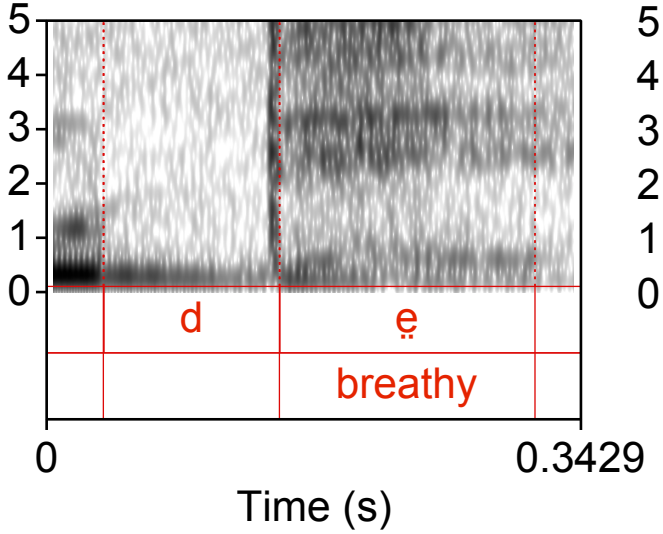


[7] Anderson, 1982.

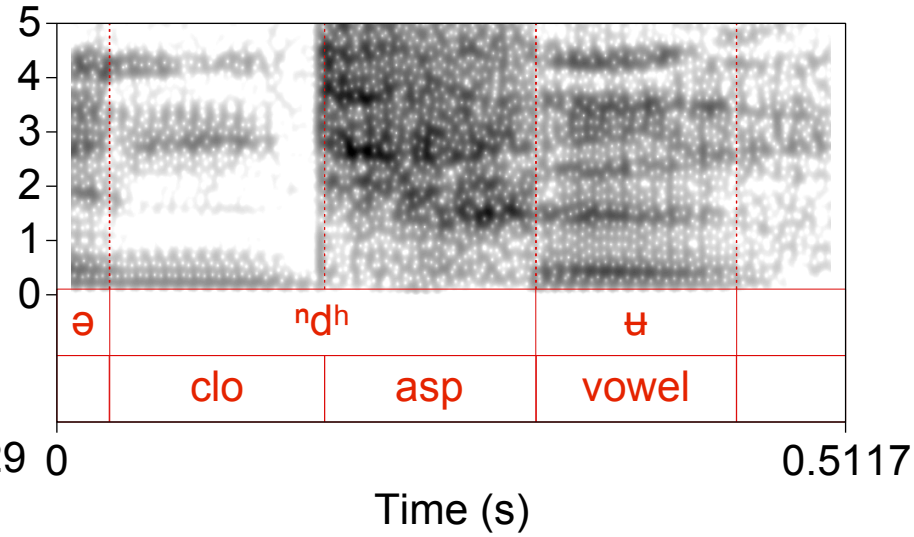
Comparison with breathy Cs

Contrast [$^{n}d^{h}$] with Owerri Igbo /d^{h}/

údẹ̤ ‘boom’



$^{n}d^{h}$ʉ ‘boundary’



» Igbo implements voiced aspirated consonants as **breathy**

» Yemba appears to implement **distinct** period of **voicelessness**

Phonetic study

Recap: study goals

We propose that voiced aspirates in Yemba are voiced during closure with voiceless aspiration at and after release

Goals:

- Characterize voicing in **each subsegment** of voiced aspirates using audio and EGG
  - Strength of voice source
  - Phonation type, where present
  - During closure, after release
- Characterize voice quality of vowels following aspiration

Speakers and **materials**

- Four native speakers (1F, 3M)
  - 1M, 1F lab-recorded (UCLA, late 2019)
  - 2M from pre-existing audio lexicon[8]
- **Materials** collected contained voiced {aspirated, unaspirated} consonants
  - **Prenasalized stops**: [ⁿb ⁿd ⁿg] vs. [ⁿbʰ ⁿdʰ ⁿgʰ]
  - **Fricatives**: [v z ʒ] vs. [vʰ zʰ ʒʰ]; all may also be **prenasalized**
  - **Approximants**: [w l ɰ] vs. [wʰ lʰ ɰʰ]
- Total *n* = 2,022 (sub)segments
  - Lab speakers: 391, balanced list and frame sentence
  - Corpus speakers: 1,631, opportunistic search through lexicon

[8] Bird, 2003.

Methods and **measurements**

- Simultaneous **audio** and **EGG** collected (for three of four speakers)
  - EGG for both lab speakers and one lexicon speaker
- Manual segmentation into **C**, **^{h}**, **V** according to audio
- Voice quality measures calculated in Voicesauce
  - **Strength of excitation** (**SoE**): measure of voice source strength[9]
  - Measures of breathiness: **contact quotient** (**CQ**) from EGG signal; **cepstral peak prominence** (**CPP**) and **H1*-A3*** from acoustics[10]
- CPP, H1*-A3* not calculated for fricatives
- No VQ measures calculated for aspiration

[9] Mittal, Yegnanarayana, and Bhaskararao, 2014; Murty and Yegnanarayana, 2008.

[10] Berkson, 2019; Keating and Esposito, 2007.

Analysis

SoE: duration-normalized **time series** submitted to AR1 generalized additive mixed models (GAMMs)

» Convey typical voice source dynamics in C^hV sequences

» SOE $\sim$ MANNER * ASPIRATION, random smooths by speaker

VQ measures: z-scored; **mean** of time series submitted to Bayesian mixed-effects regression

» Simpler measure of degree of breathiness in flanking Cs and Vs

» Separate models for each of CQ, H1*-A3*, CPP

» Weak uninformative prior

» Structure: MEASURE $\sim$ MANNER * ASPIRATION, random intercepts by speaker

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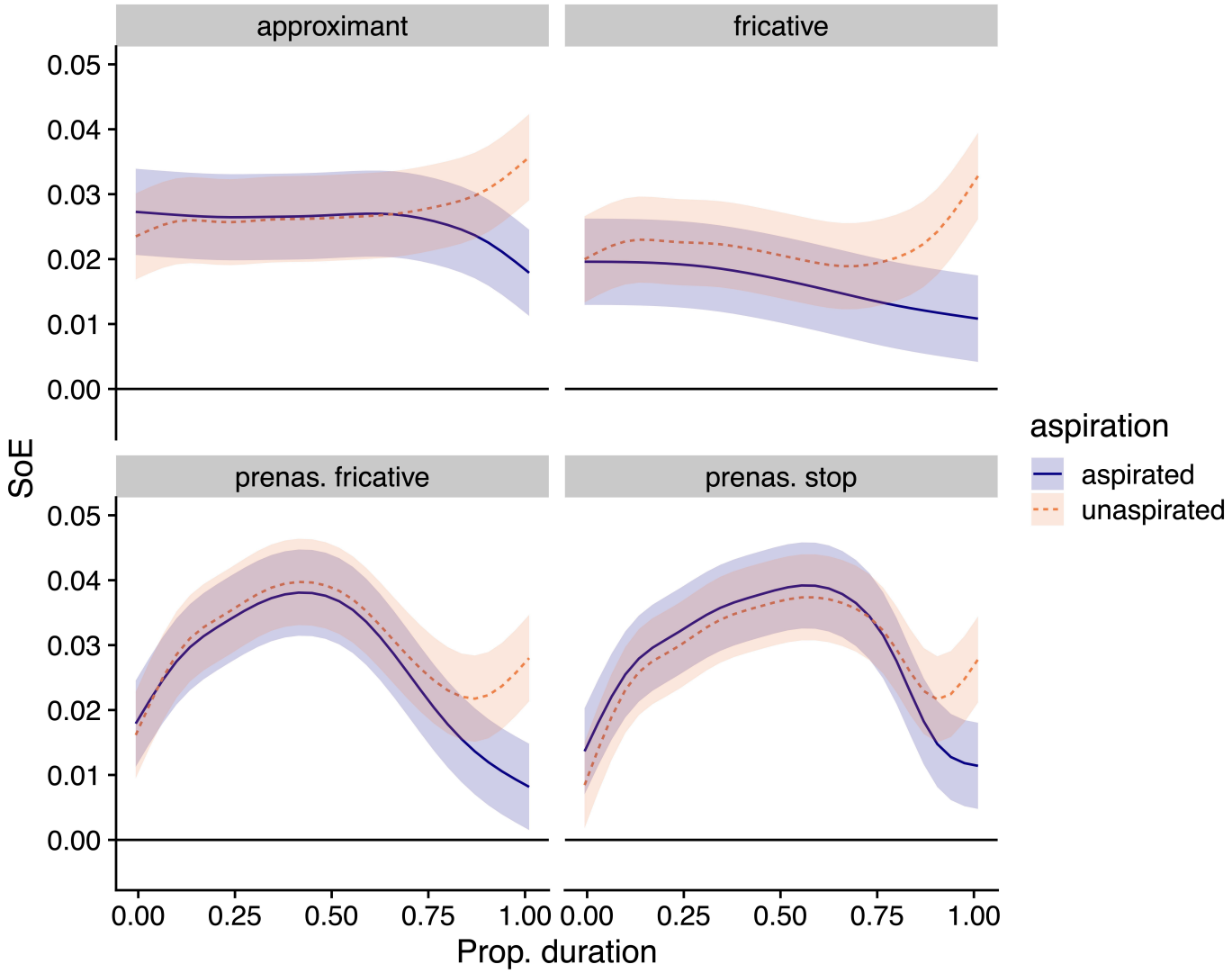
Results: SoE

(strength of voice source: C, ^{h}, V)

Consonant SoE by manner

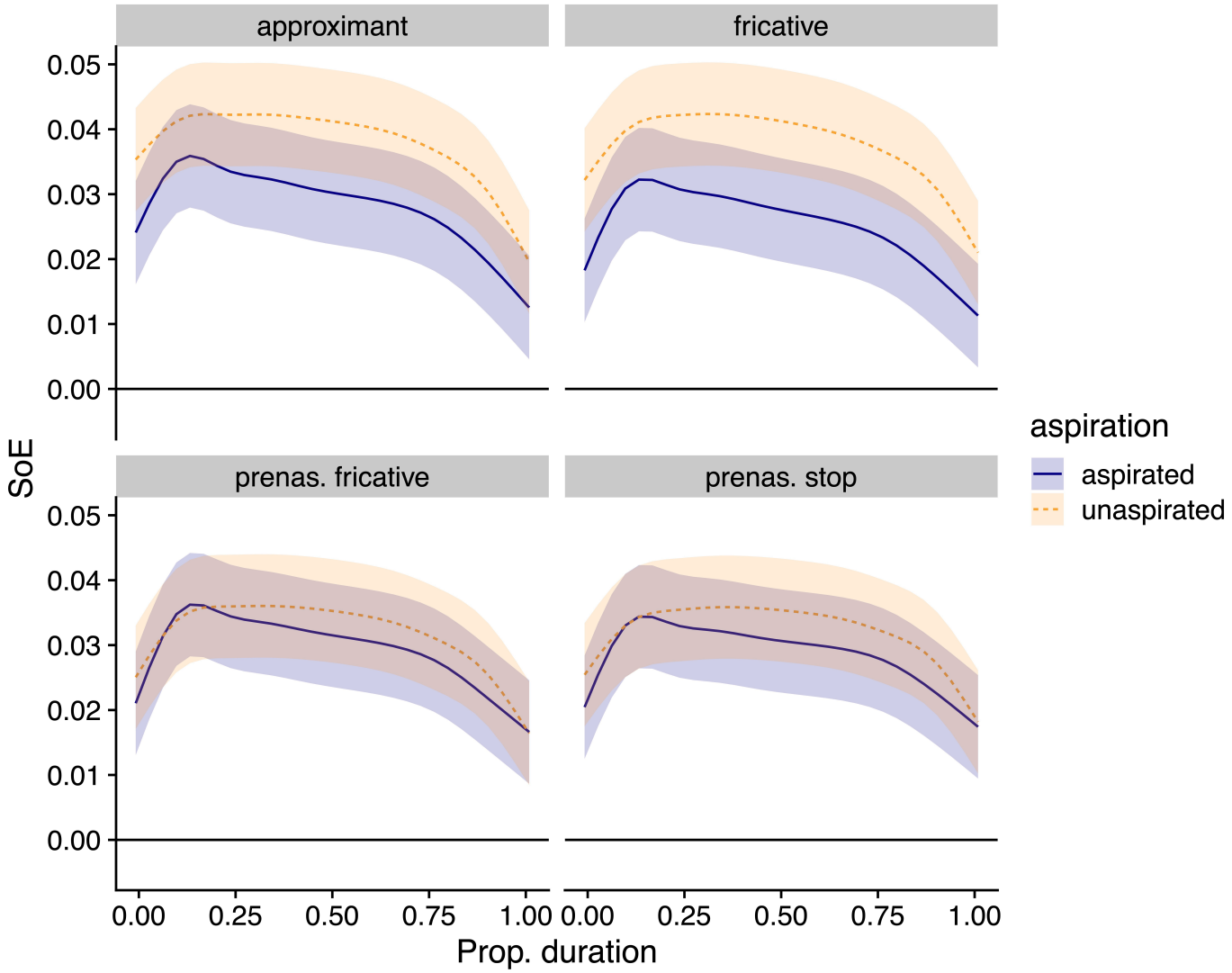
C^hV

» Voice source (modulo manner effects on SoE) is present



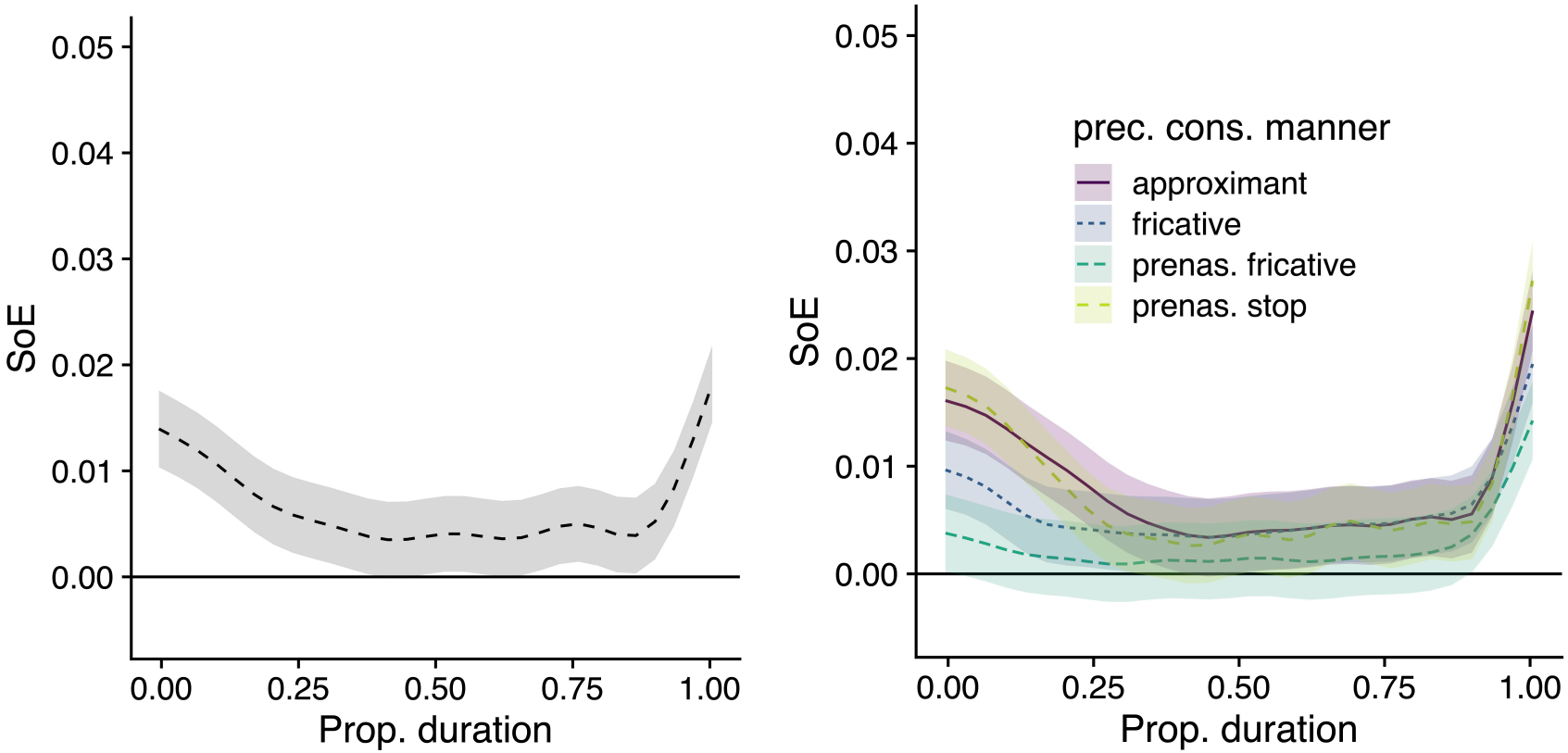
Vowel SoE by preceding C manner C^hV

» Longer-range effect on voice source visible in V



Aspiration SoE, by preceding C manner C^hV

» Very weak or no voice source in post-release aspiration



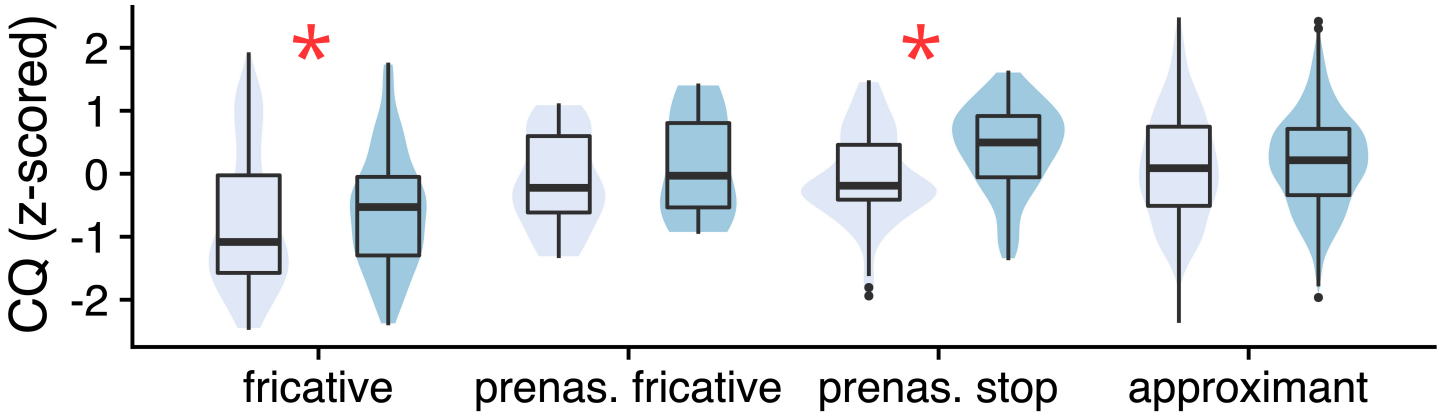
Results: VQ measures

(breathiness: C, V)

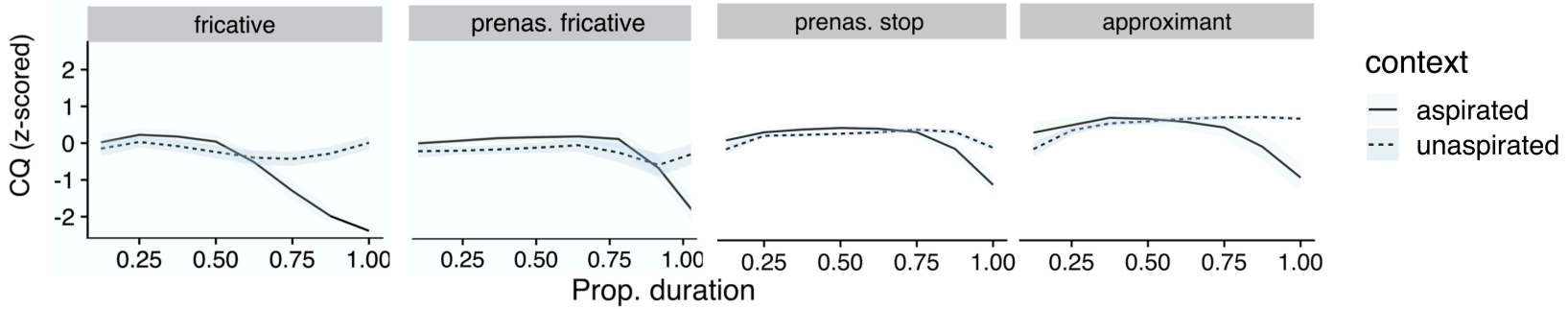
Consonant CQ, by manner C^hV

» **Credible main effect** of aspiration (and interactions *)

» **Lower CQ** preceding aspiration: less vocal fold contact

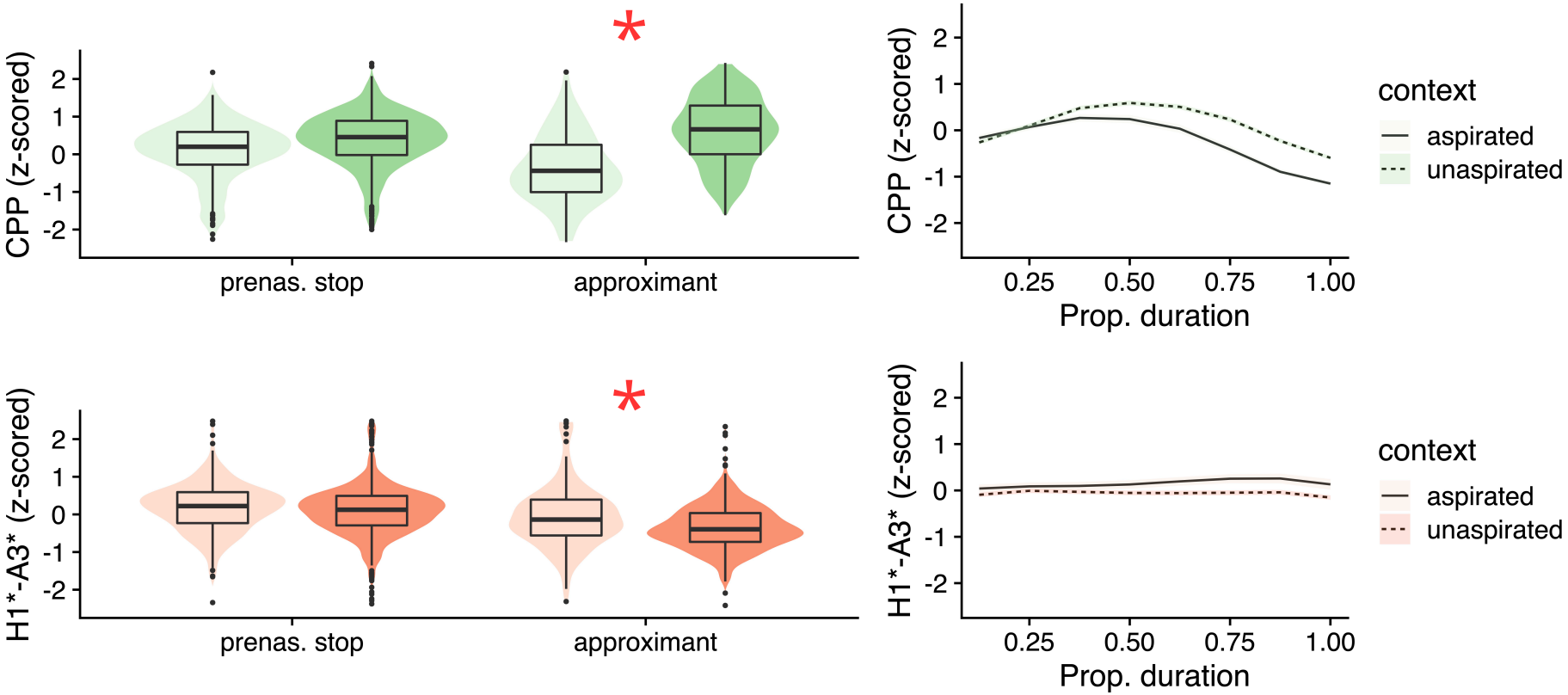


» Time series suggest: mainly *immediately* preceding aspiration, except for oral fricatives



Consonant CPP and H1*-A3*, by manner C^hV

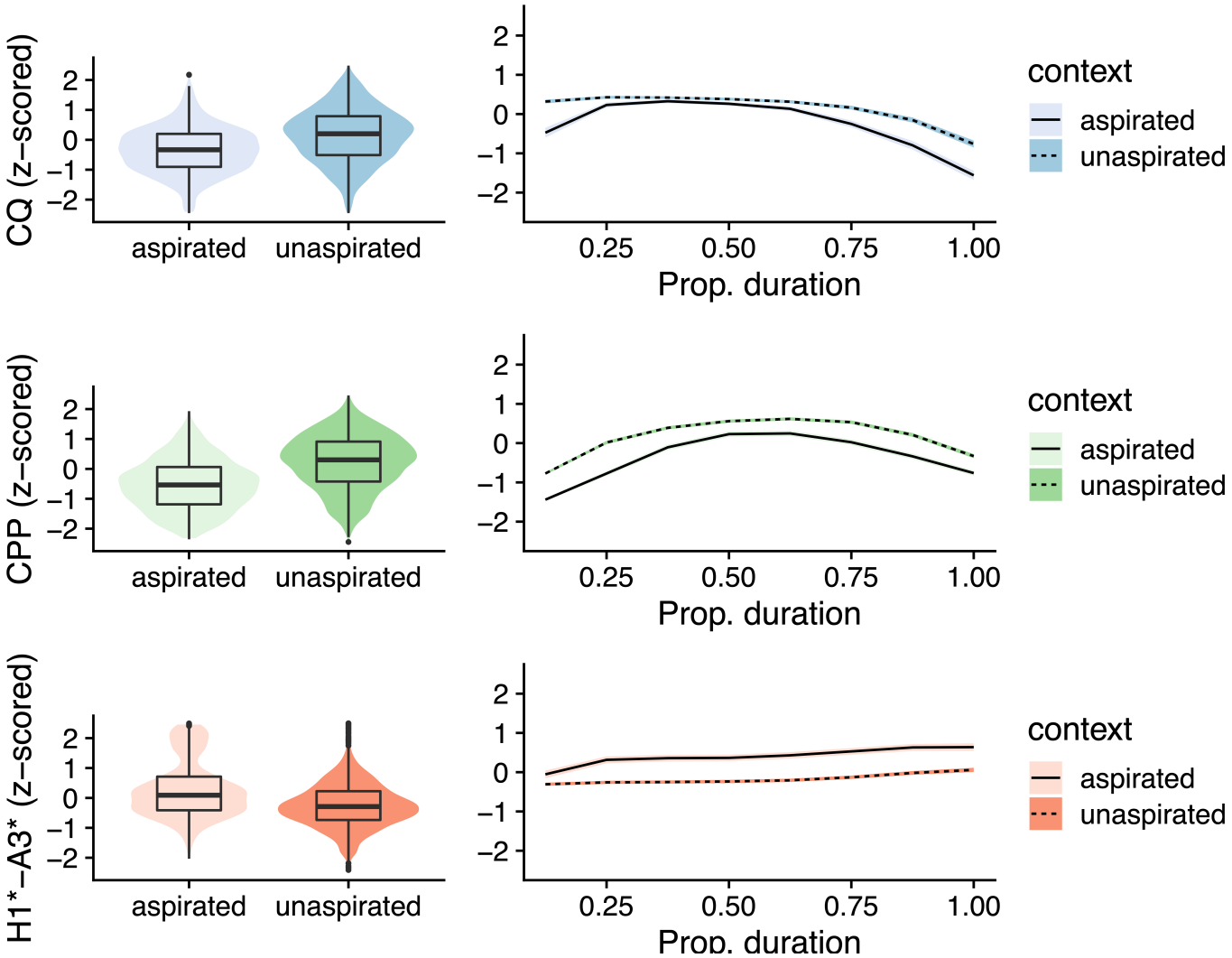
- **Credible main effects** of aspiration for both (and interactions *)
- **CPP lowered** before aspiration: noisier harmonic structure
- **H1*-A3* raised** before aspiration: greater spectral tilt



Vowel VQ measures

C^hV

- » **Credible effect** of aspiration for all measures
- » Time series suggest breathiness over entire following vowel



Discussion

Summary

Yemba voiced aspirates exhibit **mostly modal voicing** in C constriction, followed by **voiceless, spread-glottis target** for aspiration

SoE timecourses suggest:

» Little to no voicing energy present in aspiration

» Near aspiration, *local* anticipation of spread-glottis in C constriction; *longer-distance* spread glottis through V

Voice quality measures suggest:

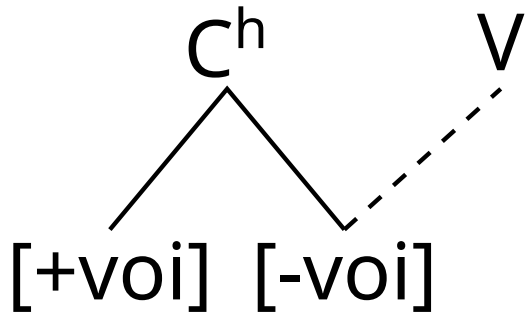
» Vs following aspiration are breathy

» Preceding C constrictions are less affected

Architectural implications

Reinforces the need for ordered sub-segmental representations to reflect production[11]

V'ed aspirate, e.g. /z^h/



Re-evaluate complex segments with mixed voicing or "phonation contour", particularly in African languages

» Ju voiced-voiceless stops, affricates[12]

» Tuu voiced + glottalized ([dts'] etc.)[13]

» Igbo and Sereer voiceless implosives[14]

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[11] Inkelas and Shih, 2016.

[12] Gerlach, 2016.

[13] Miller et al., 2009; Nakagawa, 2010.

[14] Ikekeonwu, 1985; Ladefoged, Williamson, Elugbe, and Uwulaka, 1976; McLaughlin, 2005.

Functional implications

The **other Bamileke languages** have similar aspiration[15]

- » "Aspiration" often develops into fricative release matching C's place (as Yemba fricatives have)
- » Aspiration/affrication is *always voiceless* release, even after [+voi] C
  - » Ghomálá' /tʰ/ in [t͡θə́] 'head'
  - » Ngyembɔɔn /ⁿgʰ/ in [ⁿg͡x̂we] 'dogs'

Why is [+voi][-voi] **stable** once it develops?

- » Voiceless implementation involves large, effortful modulation of voice quality; may be more consistently recoverable[16]
- » Breathy-modal voice contrasts in Cs tend to merge[17]

[15] Anderson, 1982; Hyman, 1972; Nissim, 1981.

[16] Ohala and Kawasaki-Fukumori, 1997.

[17] Berkson, 2019.

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