

# **Mixed voice in Yemba voiced aspirates**

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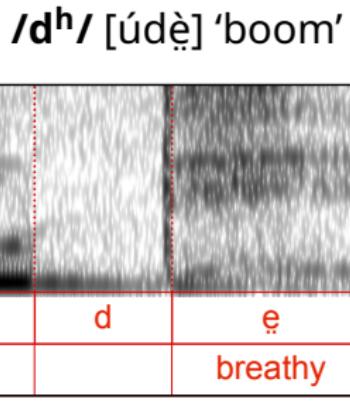
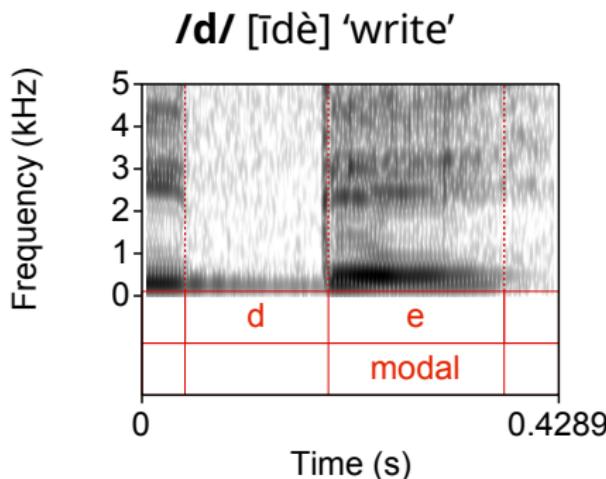
# Acknowledgements

- » **Rolain Tankou**, our primary Yemba consultant
- » **Harold Torrance** and members of the UCLA graduate Field Methods course on Yemba, Winter–Spring 2019
- » **Jae Weller** and **Bryan Gonzalez** for annotation work
- » **Florian Lionnet** for discussion

# "Voiced aspirated" consonants

Not actually voiced, then (voicelessly) aspirated: **breathy** phonation present during/after release<sup>1</sup>

» For example, Owerri Igbo<sup>2</sup>



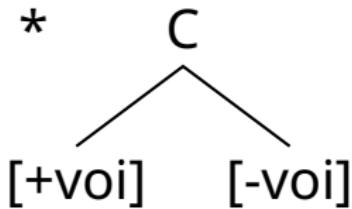
<sup>1</sup> Berkson, 2019; Keating and Esposito, 2007; Seyfarth and Garellek, 2018.

<sup>2</sup> 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)<sup>3</sup>



- » Some purported examples, but closer examination disproves them<sup>4</sup>

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<sup>3</sup>Ladefoged, 1971.

<sup>4</sup>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**

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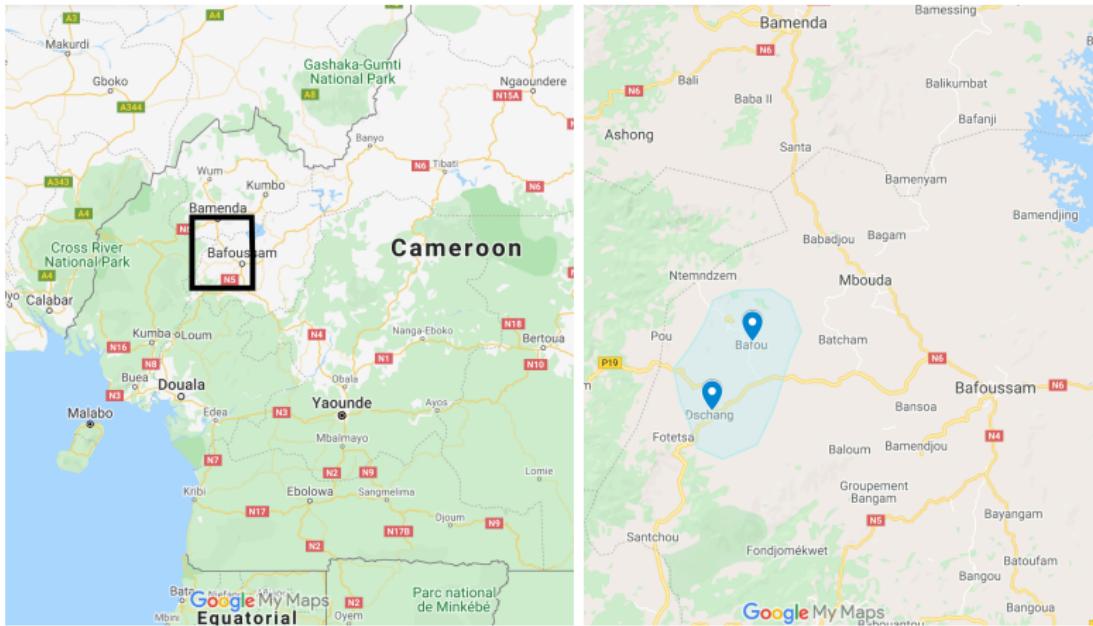
## Outline

- » Yemba description
  - » Consonant inventory
  - » Qualitative description of C<sup>h</sup>
- » EGG/audio study
  - » Presence of voicing
  - » Quality of voicing
- » Discussion

# **About Yemba**

# About Yemba AKA Dschang

- » Bamileke (Grassfields Bantu) language spoken in West region of Cameroon by 300,000-400,000 people<sup>5</sup>



<sup>5</sup>ethnologue

# Yemba consonant inventory

**Most consonants** have aspirated and unaspirated counterparts, including **voiced fricatives, nasals, and approximants**<sup>6</sup>

	Labial	Alveolar	Palatal	Velar	Glottal
Stop	p p <sup>h</sup>	t t <sup>h</sup>		k k <sup>h</sup>	?
Affricate	pf pf <sup>h</sup>	ts ts <sup>h</sup>	tʃ tʃ <sup>h</sup>		
Fricative	f f <sup>h</sup>	v v <sup>h</sup>	s s <sup>h</sup>	z z <sup>h</sup>	ʃ ʒ ʒ <sup>h</sup> (h)
Nasal	m m <sup>h</sup>	n n <sup>h</sup>		ŋ	
Approx.	w w <sup>h</sup>	l l <sup>h</sup>	j	ɥ ɥ <sup>h</sup>	

<sup>6</sup>Bird, 1999.

# Yemba consonant inventory

Voiced prenasalized stops also occur, and are derived:

- » Unaspirated [<sup>n</sup>b, <sup>n</sup>d, <sup>n</sup>g] from nasal + /p, l, ψ/

<b>n-</b> 'CL6'	+	-pi 'liver'	→	<sup>n</sup> bi
<b>n-</b> 'INF'	+	-l <sup>h</sup> u 'rain (v.)'	→	<sup>n</sup> d <sup>h</sup> u
<b>n-</b> 'CL1'	+	-ψ <sup>h</sup> e 'stranger'	→	<sup>n</sup> g <sup>h</sup> e

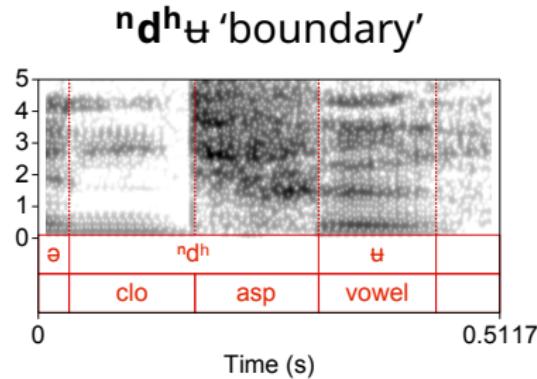
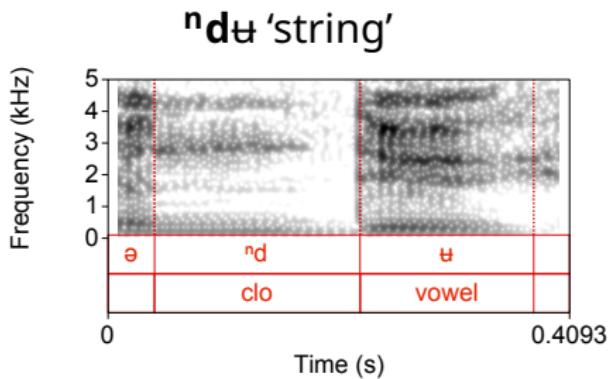
- » Aspirated [<sup>n</sup>b<sup>h</sup>, <sup>n</sup>d<sup>h</sup>, <sup>n</sup>g<sup>h</sup>] from /p<sup>h</sup>, l<sup>h</sup>, ψ<sup>h</sup>/

<b>n-</b> 'INF'	+	-p <sup>h</sup> i 'sow'	→	<sup>n</sup> b <sup>h</sup> i
<b>n-</b> 'INF'	+	-l <sup>h</sup> u 'wrestle'	→	<sup>n</sup> d <sup>h</sup> u
<b>n-</b> 'INF'	+	-ψ <sup>h</sup> u 'do'	→	<sup>n</sup> g <sup>h</sup> u

# Examples

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

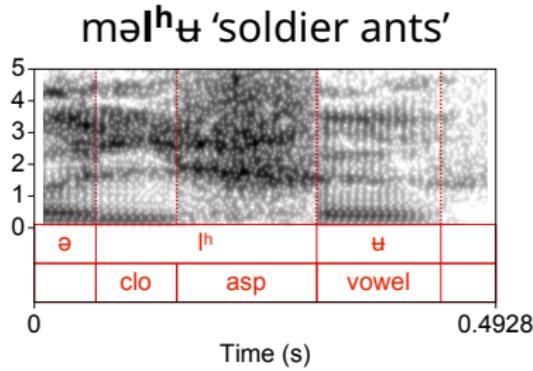
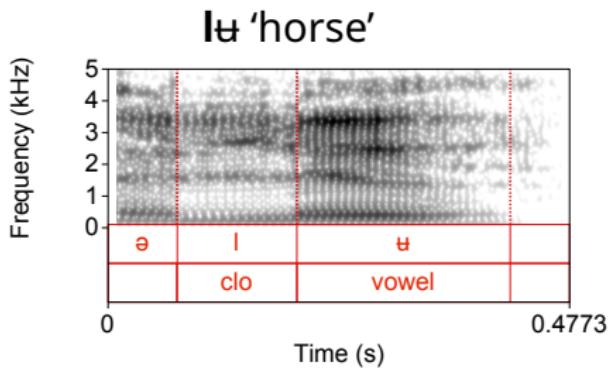
- » Prenasalized voiced stops



# Examples

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

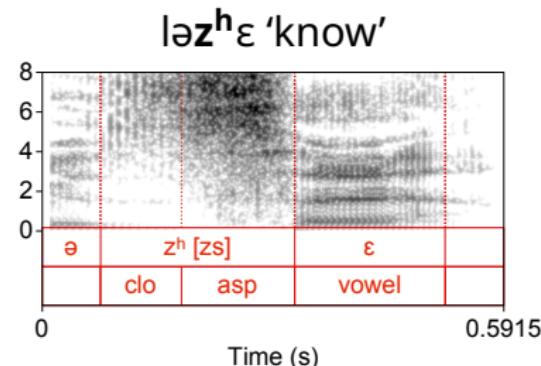
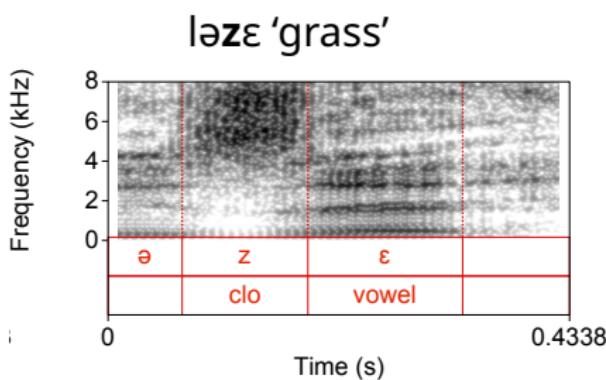
- » Voiced approximants



# Examples

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<sup>h</sup>/ as [zs]



# **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<sup>7</sup>
- » **Materials** collected contained voiced {aspirated, unaspirated} consonants
  - » **Prenasalized stops:** [nb nd ng] vs. [nb<sup>h</sup> nd<sup>h</sup> ng<sup>h</sup>]
  - » **Fricatives:** [v z ʒ] vs. [v<sup>h</sup> z<sup>h</sup> ʒ<sup>h</sup>]; all may also be **prenasalized**
  - » **Approximants:** [w l ɥ] vs. [w<sup>h</sup> l<sup>h</sup> ɥ<sup>h</sup>]
- » Total  $n = 2,022$  (sub)segments
  - » Lab speakers: 391, balanced list and frame sentence
  - » Corpus speakers: 1,631, opportunistic search through lexicon

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<sup>7</sup>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<sup>8</sup>
  - » Measures of breathiness: **contact quotient (CQ)** from EGG signal; **cepstral peak prominence (CPP)** and **H1\*-A3\*** from acoustics<sup>9</sup>
- » CPP, H1\*-A3\* not calculated for fricatives
- » No VQ measures calculated for aspiration

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<sup>8</sup>Mittal, Yegnanarayana, and Bhaskararao, 2014; Murty and Yegnanarayana, 2008.

<sup>9</sup>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<sup>h</sup>V sequences
- » SOE ~ 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 ~ MANNER \* ASPIRATION, random intercepts by speaker

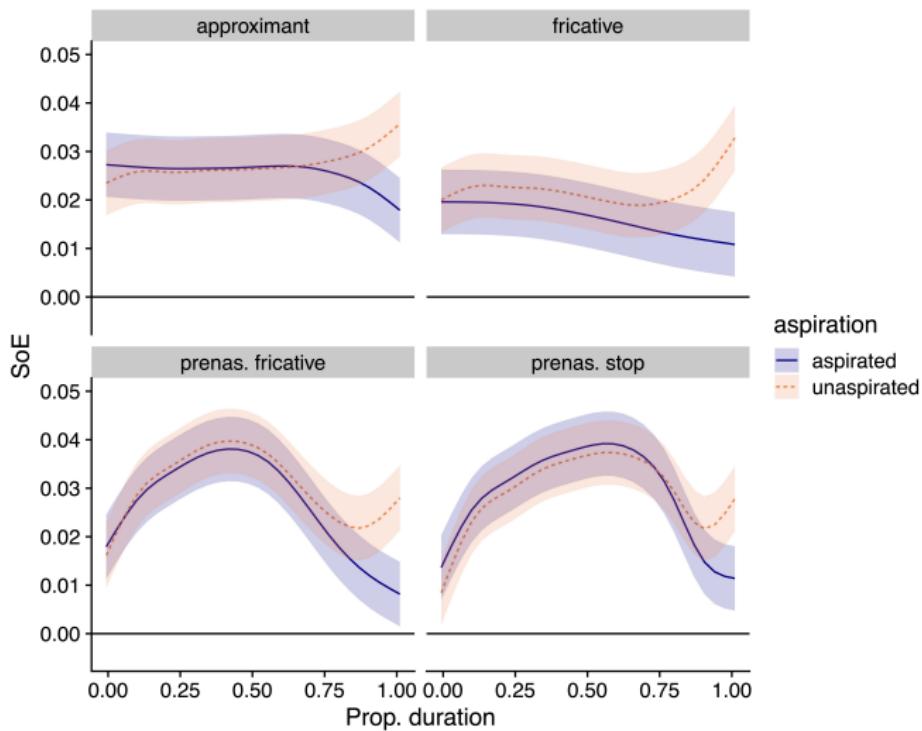
# **Results: SoE**

**(strength of voice source: C, <sup>h</sup>, V)**

# Consonant SoE by manner

C<sup>h</sup>V

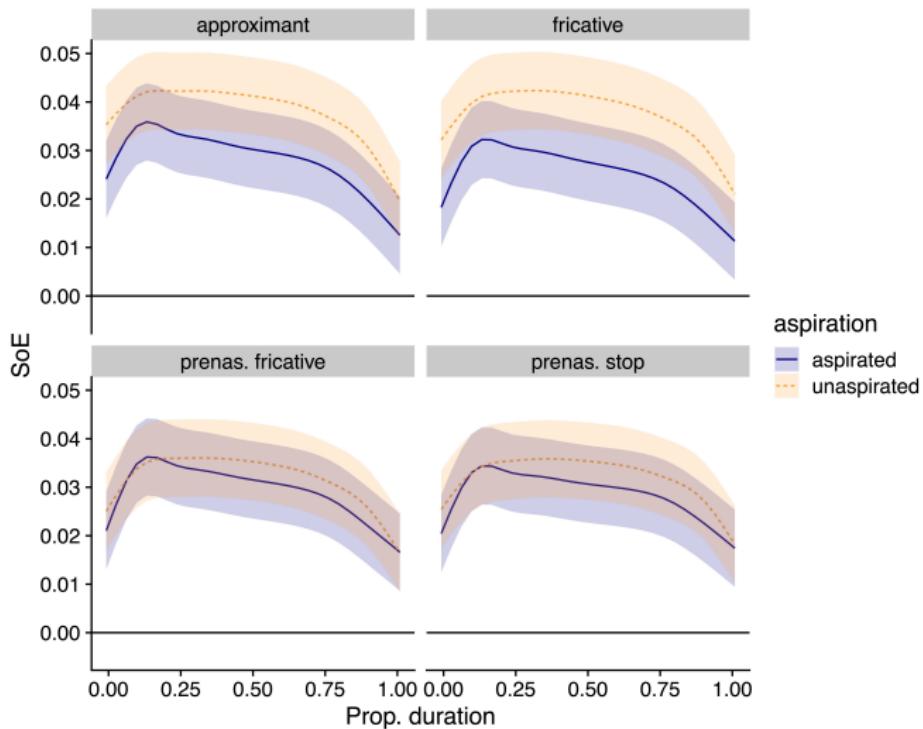
» Voice source (modulo manner effects on SoE) is present



# Vowel SoE by preceding C manner

C<sup>h</sup>V

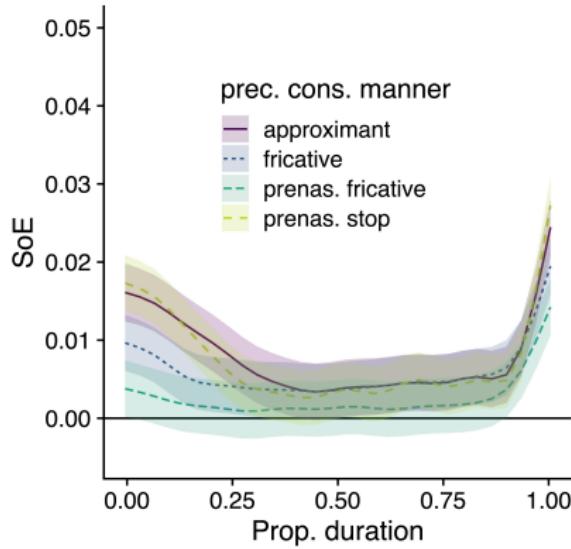
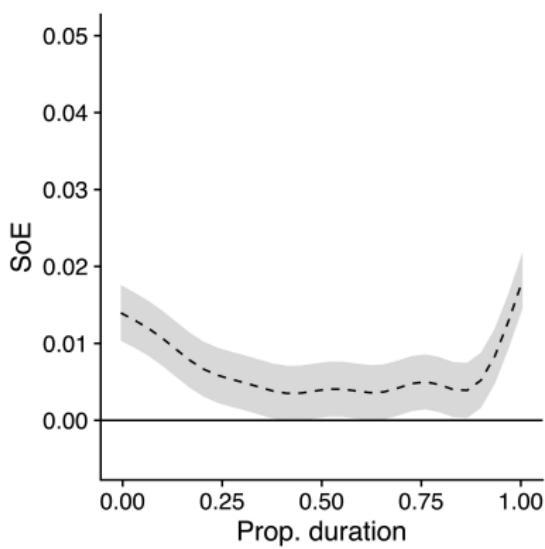
- » Longer-range effect on voice source visible in V



# Aspiration SoE, by preceding C manner

C<sup>h</sup>V

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



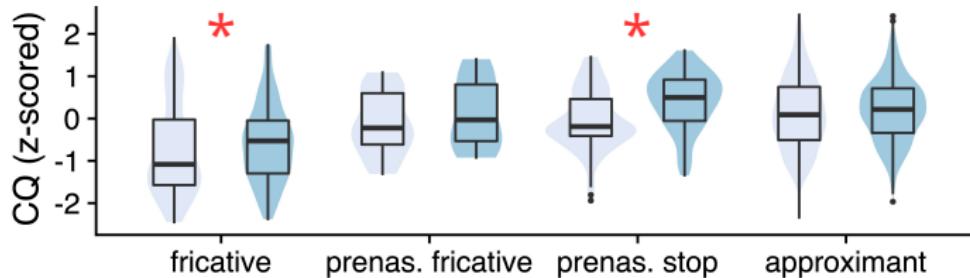
# **Results: VQ measures**

**(breathiness: C, V)**

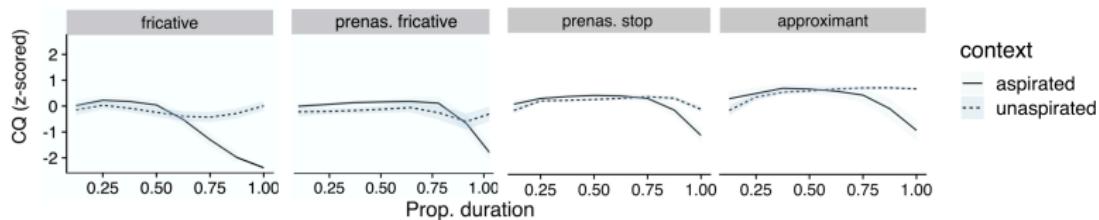
# Consonant CQ, by manner

C<sup>h</sup>V

- » **Credible main effect** of aspiration (and interactions \*)
- » **Lower CQ** preceding aspiration: less vocal fold contact



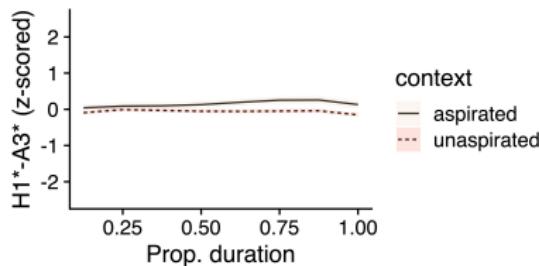
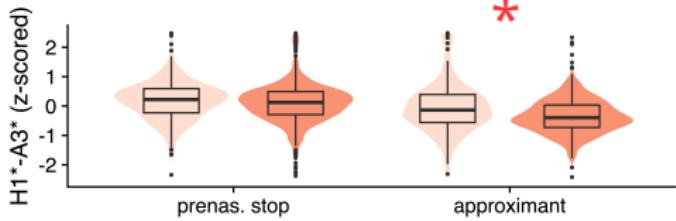
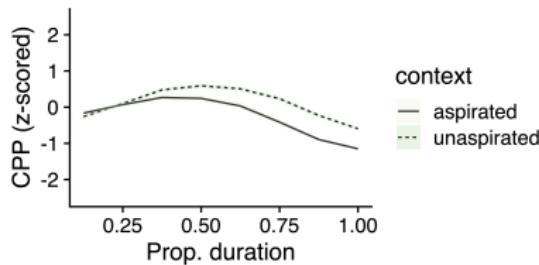
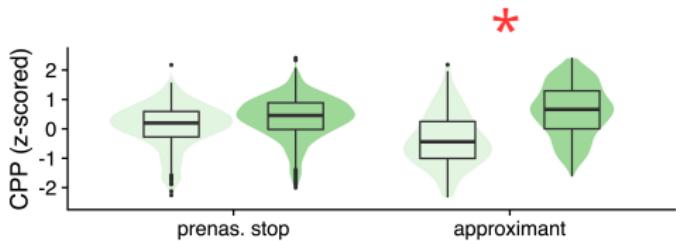
- » Time series suggest: mainly *immediately* preceding aspiration, except for oral fricatives



# Consonant CPP and H1\*-A3\*, by manner

C<sup>h</sup>V

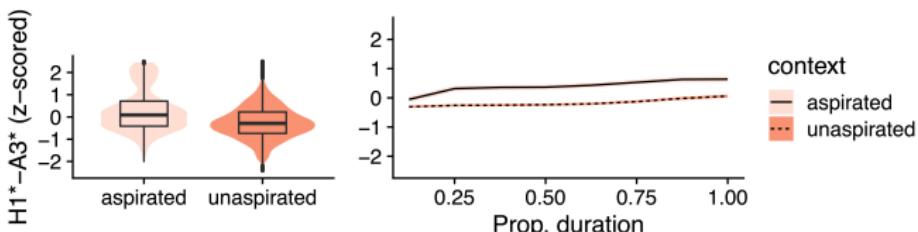
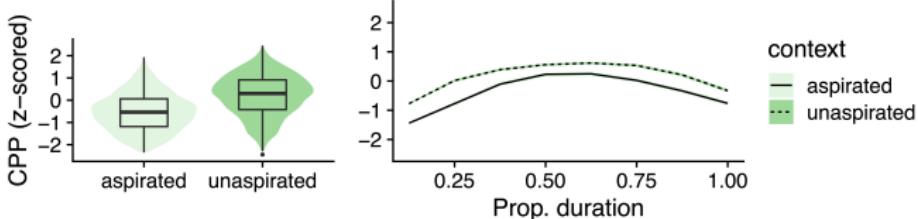
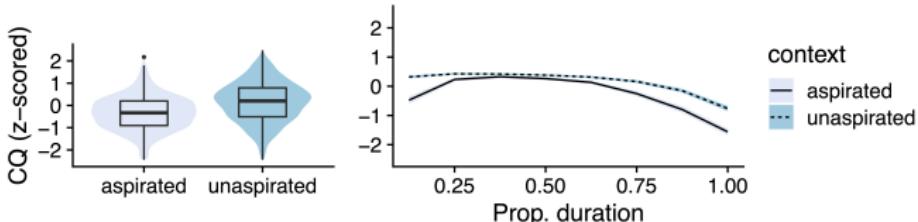
- » **Credible main effects** of aspiration for both (and interactions \*)
- » **CPP lowered** before aspiration: noisier harmonic structure
- » **H1\*-A3\* raised** before aspiration: greater spectral tilt



# Vowel VQ measures

C<sup>h</sup>V

- » **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

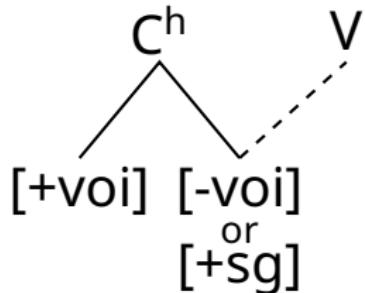
**SoE** timecourses suggest:

- » 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

V'ed aspirate, e.g. /z<sup>h</sup>/



# Architectural implications

Reinforces the need for ordered subsegmental representations<sup>10</sup>

Suggests need for broader evaluation of mixed voicing or “phonation contour”

- » Ju voiced-voiceless stops, affricates<sup>11</sup>
- » Tuu voiced + glottalized<sup>12</sup>

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<sup>10</sup>Inkelas and Shih, 2016.

<sup>11</sup>Gerlach, 2016.

<sup>12</sup>Miller et al., 2009; Nakagawa, 2010.

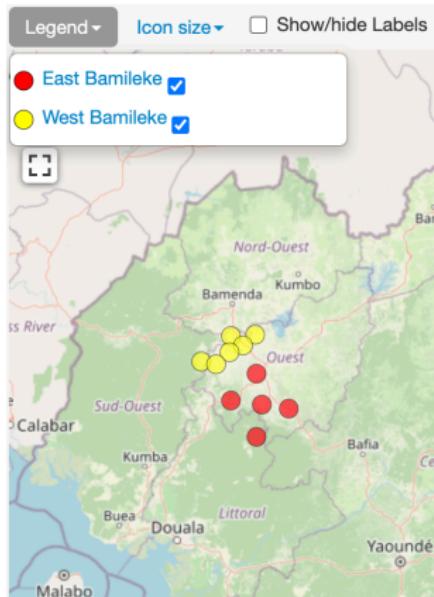
# Functional implications

The **other Bamileke languages**<sup>13</sup> have qualitatively similar aspiration:<sup>14</sup> **why is this pattern stable?**

- » Voiceless implementation may make aspiration more recoverable across manner
- » Berkson (2019): breathy sonorants prone to merger with modally voiced sonorants

**Manner specificity** of aspiration remains to be investigated

- » Many manners, plus nasals (not examined here)



<sup>13</sup>Hammarström, Forkel, Haspelmath, and Bank, 2020.

<sup>14</sup>Nissim, 1981.

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