True voiced aspirates in Yemba

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Overview. Hardly any instrumental phonetic work has been carried out on Yemba (Grassfields Bantu, Cameroon), and none at all on its unusual voiced aspirated consonants. A number of voiceless obstruents may also occur with aspiration, but we focus on the voiced aspirated stops [bʰ, dʰ, gʰ], fricatives [vʰ, zʰ, ɣʰ], and sonorants [mʰ, wʰ, lʰ] (Bird 1999), which contrast with non-aspirated equivalents. We demonstrate that voiced aspirated consonants in Yemba differ greatly from voiced aspirates in other languages, which are typically described with breathy voicing through the consonant closure and/or following vowel (Seyfarth and Garellek 2018, Berkson 2019). We instead characterize Yemba voiced aspirates as having a substantial period of *voiceless* aspiration, preceded by breathiness during the consonant, i.e. [C̤ʰV].

Methods; selection of material. Time-aligned audio and electroglottograph (EGG) signals were recorded for four speakers, two recorded in the UCLA Phonetics Lab (1M, 1F) and two drawn from the supplementary corpus in Bird (2003) (2M; no EGG data for one speaker), who read stimuli containing voiced aspirated segments or their unaspirated equivalents. Here we report on an analysis of 391 tokens from the two newly recorded speakers. Visual inspection of the EGG signal reveals a systematic absence of voicing during aspiration (Fig. 1). Slight carryover voicing from the consonant closure may occur, but a long period of voiceless phonation after consonant release is consistently present (mean VOT 127 ms, SD 29 ms; Fig. 2). We thus cannot reliably report voice quality measures for aspiration itself.

Analysis. Voice quality measures were collected (Tehrani 2010, Shue et al. 2011) as the average for each voiced consonant before, and vowel following, aspiration: contact quotient (CQ) from the EGG signal along with cepstral peak prominence (CPP), and H1-A3* from the acoustic signal (see e.g. Berkson 2019, Keating & Esposito 2007). Relatively breathy voicing, which we expect to occur during voiced aspirates, has lower CQ (less vocal fold contact), lower CPP (weaker harmonic structure, calculated for stops and sonorants), higher H1-A3* (increased spectral tilt, calculated for sonorants only). Voice quality measures were submitted to Bayesian mixed-effects linear regression (Bürkner et al. 2018), predicting each measure as a function of nearby phonation (aspirated *vs.* unaspirated), with uninformative priors and random intercepts for speaker and segment type.

Results. The voiced consonants which precede aspiration exhibit breathy phonation, having significantly lower average lower average CQ (Fig. 3; $\beta = 0.3$, CI = [0.01,0.05]). Acoustic measurements confirm this as well, with pre-aspiration voiced consonant exhibiting lower CPP ($\beta = 0.91$, CI = [0.09, 1.75]) and higher H1-A3* ($\beta = -1.73$, CI = [-3.95, 0.00]). These findings suggest that Yemba has "true" voiced aspirates, which are said to be unattested (Ladefoged 1971 et seq): they are phonated in spite of being followed by consistently voiceless aspiration, though phonation during consonant closure is impacted by aspiration after release. This anticipatory breathiness also suggests close articulatory coupling of aspiration with the onset consonant, complicating the account in Bird (1999) in which aspiration is placed in the syllable rhyme on distributional grounds.

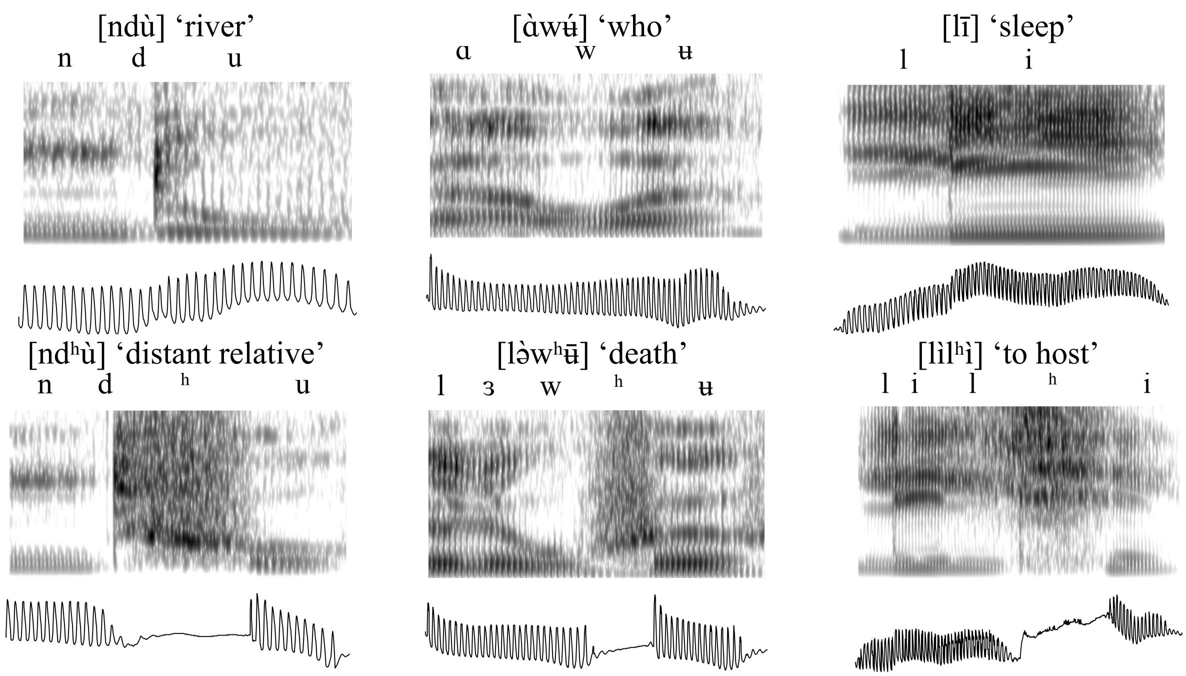

Fig. 1: Spectrogram (0-5 kHz) and EGG signal for representative tokens of voiced *unaspirated* consonants (top) and voiced *aspirated* counterparts (bottom). Note voiceless aspiration interval.

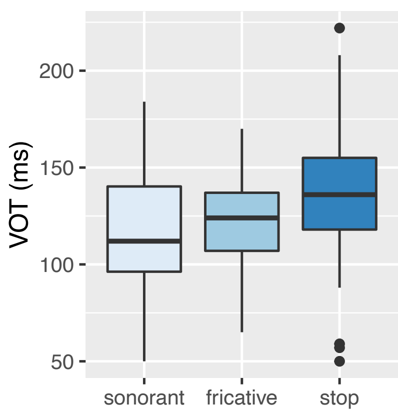

Fig. 2: VOT (voiceless post-release phonation, from EGG signal) by segment type.

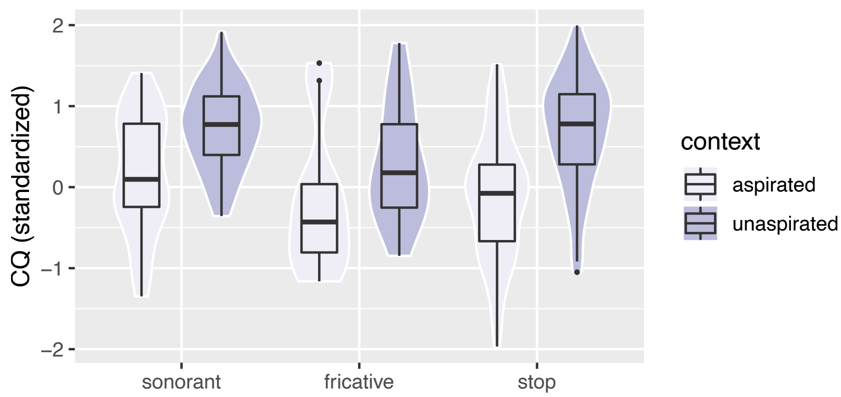

Fig. 3: CQ of voiced sonorants [m^h][l^h][w^h], fricatives [v^h][z^h][ɣ^h], and stops [b^h][d^h] [g^h], pooled by speaker. Aspirated contexts show raised CQ: $\beta = 0.3$, CI = [0.01,0.05].

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