Approches phonétiques des langues sous-dotées

(avec un accent particulier sur les langues tibéto-birmanes)

Phonetic Approaches to Under-Documented Languages
(With a Special Emphasis on Tibeto-Burman Languages)

LIVRET DES RÉSUMÉS

BOOKLET OF ABSTRACTS

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TABLE DES MATIÈRES
TABLE OF CONTENTS

CONFÉRENCIERS INVITÉS

KEYNOTE SPEAKERS

What Polynesian, Iroquoian, Semitic/Cushitic, Nilotic, West African (ATR), Tibeto-Burman and Germanic languages share in laryngeal articulation

John ESLING
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Many phonetic and phonological labels have been attributed to the sounds that emanate from postures of the laryngeal articulator mechanism. All of the parameters that represent constriction of the mechanism are expressions of the folding (vs. unfolding) of the laryngeal mechanism and of the constriction (vs. expansion) of the epilaryngeal tube. The various reflexes (or potentialities) of the laryngeal constrictor mechanism are the basis for binary oppositions – minimal contrasts – as well as coarticulatory synergies in the phonologies of many different languages. Examples are [h] vs. [ʔ] in Polynesian or Iroquoian languages; "pharyngeal" consonant/vowel oppositions (also interacting with larynx height) in Semitic/Cushitic languages; phonation, constriction and larynx-height contrasts in Nilotic languages; [+ATR] vs. [–ATR] (open vs. raised-larynx quality, also interacting with vowel quality) in West African languages; "lax/tense" register (open vs. raised-larynx/pharyngealized quality, often interacting with phonation type and tone) in Tibeto-Burman languages; and the prosodic incidence of stød (certain syllable rhymes with long sonority) in Danish. Even where constriction reflexes are not phonological, they can occur paralinguistically, e.g. in Germanic languages. These oppositions are examples of an unconstricted (or less constricted) state of the larynx contrasting with a greater factor of constriction (often with accompanying synergies) of the laryngeal constrictor mechanism.

Acoustic Analysis of Phonation Type: Best Practices for Language Description and a Case Study of Highland Totonac

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Phonetic studies of phonation type have increased greatly in the last twenty years, with the vast majority of these making use of acoustic data. In the first part of this talk, I review some best practices in the acoustic analysis of phonation type, and I also draw attention to gaps in our current understanding. To highlight the strengths of the acoustic approach to phonation analysis, I then turn to my recent work on describing the modal vs. glottalized vocalic contrast in Highland Totonac (Totonacan; Mexico). Several varieties of Highland Totonac, including the variety spoken in the municipality of Zongozotla, have been impressionistically described as having lost the contrast. A detailed acoustic analysis finds that the contrast is present in Zongozotla and in four other varieties. However, the contrast is acoustically weak. Thus, the acoustic analysis succeeds in both differentiating the two phonation types of Highland Totonac, as well as capturing their weak phonetic separability. And by comparing the placement of Totonac within an acoustic phonation space derived from other languages (Keating et al. 2023), I show that the contrast is smaller than that found for the "tense-lax" phonation types in three Tibeto-Burman languages. Therefore, the small differentiation between phonation types in Highland Totonac – both internal to the language and when compared to other languages – suggests that the language is likely undergoing phonation loss.

References

Keating, Patricia, Jianjing Kuang, Marc Garellek, Christina M. Esposito & Sameer Ud Dowla Khan. 2023. A cross-language acoustic space for vocalic phonation distinctions. *Language* 99.2: 351–389.

SESSION A

Voyelles laryngées
dans les langues qianguiques du Sichuan occidental

Laryngealized Vowels
in Qiangic Languages of Western Sichuan

A Tentative Survey of Pharyngealized Vowels in Two Minyag Varieties

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Pharyngealized vowels are defined by the retraction of the tongue roots (RTR) rather than their forward movement during articulation. This gesture manifests in a variety of forms, giving rise to vowels characterized by considerable narrowing in the pharynx near the tip of the epiglottis. These vowels are typified by tongue movement, such as retraction, backing and bunching, as observed acoustically (Laver 1994: 326-327; Ladefoged & Maddieson 1996: 306-307; Ladefoged & Disner 2012: 185; Chiu & Sun 2020: 2928).

The acoustic characteristics of a variety of vowels suggest that there is a greater degree of pharyngeal narrowing in both the two varieties of Minyag (cf. Gao 2015: 36-47). The Minyag language (木雅语) (Qiangic, Tibeto-Burman; ISO 639-3: mvm) is a severely endangered language that is spoken by a small group of Tibetan people in the Kangding and Ya'an (雅安) counties in the Western Sichuan Province of China (Huang, 1985; Huang 2023: 12-15). This language can be classified into two dialectal branches: Eastern Minyag and Western Minyag. The eastern dialect is distributed across numerous villages in Shimian County (石棉县), while the western dialect is mainly found in some villages situated along the Gangs dkar (贡嘎; ཀོང་དཀར།) mountain in Kangding.

In Western Minyag, each of the six vowels—e, æ, ə, ɐ, ø, u—has a pharyngealized counterpart, where vowels with even more retraction of the tongue root occur in some senses in conjunction with creaky voice (cf. Huang 1985: 63; Gao 2015: 37; Huang 2023: 36). As illustrated in Table 1, the pharyngealized counterparts in Sabde Minyag are as follows:

Table 1. Examples of plan and pharyngealized vowels in Western Sabde Minyag

Plain		Pharyngealized	
ɣeɣe	good	*ɣeˤɣeˤ*	fragant
læ	Bodhisattva	*læˤ*	bride
mə	fire	*məˤmə̂ˤ*	wind
(nɐ)dɐdɐ	tremble	*dɐˤdɐˤ*	flat
kø	know	*qø̗ˤ*	flour bran
xu	evening	*xuˤ*	go!

Despite the specific phonetic characteristics of pharyngealized vowels discussed thus far, the most notable feature is evident in the acoustic structure. Pharyngealized vowels exhibit a reduced and lower frequency of the third format, the first format is somewhat higher in some Caucasian and Khoisan languages (cf. Catford 1983). Additionally, pharyngealized vowels generally features lower F2 values and higher F1 and F3 values in some rGyalrongic languages (Chiu & Sun 2020).

This paper discusses the auditory and acoustic effects of pharyngealization in Minyag, drawing from an analysis of first-hand data available in both Minyag varieties. This finding indicates that pharyngealized vowels exhibit distinctive spectrograms that differ from those of their unmodified counterparts. A summary of the changing feature of F2 in Western Minyag is illustrated as follows:

Table 2. The decreasing format of F2 from plan vowels to pharyngealized vowels (measured from the midpoint of the whole range of experiment)

		Plan vowels	Pharyngealized vowels	
F2	[ɐ]	1904 (20)	[ɐˤ]	972 (40)
	[u]	2166 (59)	[uˤ]	2061 (43)
	[a]	2866 (41)	[aˤ]	2231 (38)
	[ə]	2830 (19)	[əˤ]	2050 (42)
	[e]	3239 (30)	[eˤ]	2760 (37)
	[ø]	2443 (68)	[øˤ]	2039 (35)

The acoustic results significantly indicate that higher F1 and F3 values are observed for the pharyngealized vowel, whereas F2 shows a lower falling value in comparison to the rising value for F1 and F3. Furthermore, the articulatory examples display that when pronouncing pharyngealized vowels, the whole front part of the tongue is bunched up, with a pronounced hollowing of the part of the tongue below the uvular. It is postulated that the emergence of pharyngealized vowels in Minyag may be conditionally resulted from the co-articulation with velar, uvular and glottal consonants.

The present study examined the vowel quality in Eastern and Western Minyag. It is revealed in the results that the vowel quality contrast between the plain vowels and pharyngealized vowels in Minyag is predominantly influenced by the actual vocal tract of independent vowels. It is also argued in this paper that the feature of pharyngealized vowels is undergoing a progressive decline in a wide range of young Minyag groups due to the improvement of their bilingual and multilingual capacities.

References

Catford, John. C. 1983. Pharyngeal and laryngeal sounds in Caucasian Languages. In D. M. Bless & J. H. Abbs (eds.), *Vocal Fold Physiology: Contemporary Research and Clinical Issues*, 344-350. San Diego: College Hill Press.

Chiu, Chenhao & Jackson T.-S. Sun. 2020. On pharyngealized vowels in Northern Horpa: An acoustic and ultrasound study. *The Journal of the Acoustical Society of America* 147.4: 2928-2946.

Gao, Yang. 2015. *Description de la Langue Menya: Phonologie et syntaxe*. Phd. thesis submitted to the École des Hautes Études en Sciences Sociales, Paris, France.

Huang, Bufan. 1985. Muyayu gaikuang (An introduction to Minyag). *Minzu Yuwen* 3: 62-77.

Huang, Yang. 2023. *Shade Muyayu Cankao Yufa* (A Reference Grammar of Sabde Minyag). Beijing: China Social Sciences Press.

Ladefoged, Peter & Ian Maddieson. 1996. *The Sounds of the World's Languages*. Oxford: Blackwell.

Ladefoged, Peter & Sandra Ferrari Disner. 2012. *Vowels and Consonants (3rd edition)*. Oxford: Blackwell.

Laver, John. 1994. *Principles of Phonetics*. Cambridge: Cambridge University Press.

Uvularized Vowels in Rongpa Choyul: Acoustic and Phonological Analysis

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In articulatory phonetic terms, “uvularization” refers to the articulation involving the retraction of the tongue dorsum toward the uvula, primarily caused by the constriction of the styloglossus and other muscles (Evans et al. 2016). While the term “uvularization” was traditionally analyzed as a consonantal feature in world languages (e.g., Al-Tamimi & Heselwood 2011), vocalic uvularization has more recently been attested in several Tibeto-Burman languages such as Qiang (Sun & Evans 2013; Evans et al. 2016), Nyagrong Minyag (Van Way 2018) and Choyul (Zheng 2023; Guan 2024). The present paper is to discuss the phonemic and phonetic characteristics of vocalic uvularization in Choyul.

Choyul (ISO 639: qvy, in Chinese Quèyù 却域) is an under-documented Sino-Tibetan language spoken primarily in Lithang (理塘), Nyagrong（新龙), and Nyagchu (雅江) Counties within the Dkarmdzes (甘孜) Tibetan Autonomous Prefecture of Sichuan Province, China (Lu 1985).

Rongpa Choyul exhibits an elaborate vocalic system, comprising 8 plain vowels, 5 of which have uvularized counterparts (Zheng 2023), as shown in Table 1:

Plain	*i*	*e*	*ɛ*	*ɘ*	*ɜ*	*ə*	*o*	*u*
Uvularized		*eʶ*	*aʶ*		*ɜʶ*	*əʶ*	*oʶ*	

Table 1. Plain and uvularized vowels of Rongpa Choyul

The identification of vowel pairs in terms of uvularization is undertaken on the basis of parallel vowel alternation patterns in verbal agreement paradigms, as illustrated in Table 2:

Citation form	**1SG**	**1PL**	**2SG**	**2PL**	**3**	**Gloss**
tʰé	*tʰó*	*tʰɛ́*	*tʰó*	*tʰé*	*ptʰé*	*‘to drink’*
ɣdeʶ	*ɣdoʶ*	*ɣdiʶ~ɣdəʶ*	*ɣdeʶ*	*ɣdeʶ*	*ɣdeʶ*	*‘to shear’*

Table 2. Vowel alternation patterns in *tʰé* ‘to drink’ and *ɣdeʶ* ‘to shear’

Uvularization also participates in vowel harmony processes. For instance, the nucleus of the negative prefix mɛ- harmonizes with the uvularized vowel [oʶ] in the verb stem, resulting in the prefix vowel surfacing as [aʶ], which is thus considered the uvularized counterpart of [ɛ]:

mɛ-tʰó→[mɛ́-tʰɔ̀] ‘NEG.NPST-drink.1SG’
mɛ-roʶ→[màʶ-róʶ] ‘NEG.NPST-laugh.1SG’

Based on the phonemic analysis in Zheng (2023), the present study provides additional instrumental evidence for the analysis of uvularization. Acoustic analysis indicates that uvularized vowels have significantly higher F1 values, lower F2 values, and larger F3–F2 differences than their plain counterparts. As summarized in Table 3, all pairwise t-tests revealed statistically significant differences for F1, F2, and F3-F2 across all vowel pairs. These acoustic patterns point to the articulatory underpinnings of uvularization—specifically, lowering of the tongue body (reflected in higher F1) and retraction of the tongue root (reflected in lower F2).

	/oʶ-o/	**/əʶ-ə/**	**/eʶ-e/**	**/ɜʶ-ɜ/**	**/aʶ-ɛ/**
F1	44.66 t(14)=8.007 p<0.001	60.44 t(14)=6.240 p<0.001	156.21 t(14)=15.273 p<0.001	28.93 t(14)=2.568 p=0.022	142.85 t(14)=7.836 p<0.001
F2	-75.07 t(14)=- 4.384 p=0.001	-446.20 t(14)=- 14.344 p<0.001	-904.87 t(14)=- 28.305 p<0.001	-479.63 t(14)=- 25.770 p<0.001	-579.75 t(14)=- 22.577 p<0.001
F3-F2	264.57 t(14)=4.340 p=0.001	447.00 t(14)=5.310 p<0.001	980.66 t(14)=12.650 p<0.001	582.17 t(14)=12.547 p<0.001	677.83 t(14)=8.278 p<0.001

Table 3. Pairwise t-test results for mean shifts (in Hz) in individual formants and uvularized–plain vowel pairs.

Auditorily, members of uvularized–plain vowel pairs can be can be either perceptually close or perceptually distant, as illustrated in Figure 1. For instance, the plain vowel /e/ is phonetically realized as [ɪ], whereas its uvularized counterpart /eʶ/ is perceptually closer to the central vowel [ə]. In contrast, both /o/ and /oʶ/ are perceptually similar. Furthermore, the realization of each uvularized vowel can be influenced by the place of articulation of the preceding consonant, though the variation is often subtle and may require more attention to discern.

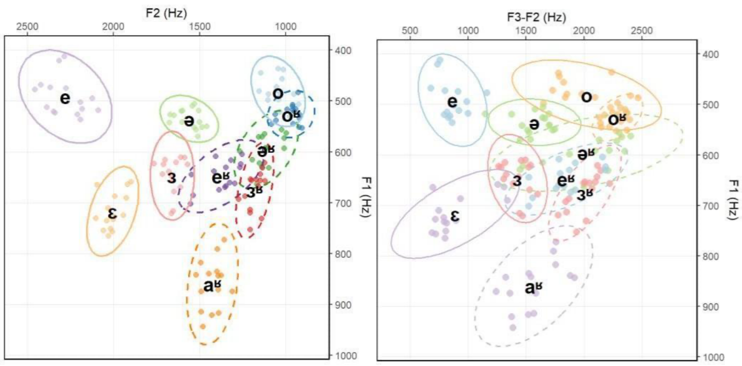

Figure 1. F1×F2 and F1×(F3-F2) vowel space of Rongpa Choyul.

Phonologically, the phonotactic distribution and phonological processes associated with uvularized vowels support the decision to analyze uvularization as a vocalic feature. First, the evidence comes from the distribution of plain and uvularized vowels. Both sets of vowels are compatible with almost all the consonants in terms of the place of articulation (i.e. LABIAL, CORONAL and DORSAL), as shown in Table 3. This pattern differs from the partially contrastive patterns (e.g. plain vs emphatic coronal consonants in Jordan Arabic, see Al-Tamimi & Heselwood (2011)), or from non-contrastive secondary articulations (e.g. velarized lateral [ɫ] in English, Ladefoged & Maddieson (1996: 360-316)). This suggests that it is more economical to treat uvularization as a property of vowels rather than consonants, since otherwise the consonant inventory would be nearly doubled in size.

In terms of phonetic realization of DORSAL consonants, however, two vowel sets exhibits phonotactic constrains: plain vowels do not co-occur with uvular initials, while uvularized vowels are absent with velar initials. This suggests that uvular consonants may in fact be allophonic variants of velars conditioned by the following uvularized vowel.

Preceding consonant		Plain	Uvularized
LABIAL		√	√
CORONAL	alveolar	√	√
	post-alveolar	√	√
	retroflex	√	√
DORSAL	velar	√	-
	uvular	–	√

Table 4. Distribution of plain and uvularized vowels in Rongpa

Second, vowel harmony processes provide additional evidence. Uvularized vowels harmonize leftward, spreading uvularization from stem to its prefixes. Specifically, if a verb stem has a uvularized vowel as its nuclei, orientation prefixes attached to it can be fully uvularized as well; while plain vowels do not trigger this process. Compare the following examples:

kə-tɜ́→[kə́-tɜ̀] 'PFV-pour.1SG'
kə-xt^{h}ɜ́^{ʁ}→[qə́^{ʁ}-χt^{h}ɜ̀^{ʁ}] 'PFV-ask.1SG'

This observation suggests that vowels can be divided into two natural classes— those that trigger vowel harmony on preceding syllables, and those that do not.

Another observation concerns the directionality and valency of uvularization. On the one hand, uvularization does not spread rightward; on the other hand, non-uvularized vowels do not trigger de-uvularization. These facts indicate that uvularization functions as a monovalent (unary) feature, as illustrated by following numeral–classifier combinations:

s^{h}ó^{ʁ} 'three' + *kɛ́* 'CLS. piece'→*[s^{h}ó^{ʁ}-kɛ́]* 'three pieces (of land)'
xnɜ́^{ʁ} 'seven' + *ɣó* 'CLS. bundle' →*[xnɜ́^{ʁ}-ɣó]* 'seven bundles (of firewood)'

Regarding the phonological domain of uvulairzation, first, it appears that within a single syllable, uvularization can affect both vowels and consonants. For instance, the first element of a cluster x-, ɣ- assimilates to uvular fricative [χ-, ʁ-] when the nucleus of the syllable is a uvularized vowel, e.g. xpó^{ʁ}→[χpó^{ʁ}] 'ice'; ɣzɜ́^{ʁ}→[ʁzɜ́^{ʁ}] 'cow'. Second, as noted above, uvularization can also across morpheme boundaries from the verb stem to its prefixes. Specifically, if a verb stem has a uvularized vowel as its nucleus, negative prefixes and orientation prefixes attached to it can become fully uvularized:

mɛ-xkʰɜ́ʶ→[máʶ-χqʰɜʶ] ‘NEG.NPST-fasten.1SG’
kə-xkʰɜ́ʶ→[qə́ʶ-χqʰɜʶ] ‘PFV-fasten.1SG’
kə-mə-xkʰɜ́ʶ→[qə́ʶ-mə́ʶ-χqʰɜʶ] ‘PFV-NEG.PST-fasten.1SG’

This pattern suggests that uvularization may be a property of the entire syllable or even the whole phonological word. However, in one respect, uvularization from enclitics, such as =xaʶ ‘LOC’, does not spread across the clitic boundary to its host; In another respect, uvularization do not spread rightward from the root to the suffixes. Taken together, these observations indicate that while uvularization can affect multiple segments within a syllable or phonological word, its domain is constrained by multiple factors. Therefore, it remains an open question whether uvularization should be analyzed as a suprasegmental feature.

Varieties of Choyul exhibit uvularized vowels (Zheng 2023; Guan 2024, 2025; Suzuki and Sonam Wangmo 2019 who term this phenomenon “velarization”), although this feature was not documented in earlier works. The Rongpa pattern observed in this study closely resembles that of Pubarong variety (see Guan (2025) for a detailed description). Beyond Choyul, the pattern reported here is most closely aligned with Mawo and Yunlinsi Qiang (Evans et al. 2016). From an areal perspective, the related secondary articulation phenomena are also attested in neighboring languages, including “velarization” (Sun 2000; 2004; Lin et al. 2012; Gong 2018), “pharyngealization” (Evans 2006; Chiu & Sun 2020), “Retracted Tontue Root (RTR)” (Gao 2015) or “tense/lax” distinctions (Huang B. 1991; Huang Y. 2023). However, it remains unclear whether these labels reflect truly distinct articulatory mechanisms. To clarify these distinctions, further articulatory investigation using experimental tools such as ultrasound imaging is necessary. While phonetic realizations are informative, phonological statues should rest on the systematic behavior of vowels in morphophonological processes. A detailed analysis of the vowel systems can contribute to understanding the origin and evolution of such systems in the broader Tibeto-Burman context.

Keywords: Rongpa, Choyul, uvularization, phonetics, vowel harmony, Tibeto-Burman

References

Al-Tamimi, F., & Heselwood, B. 2011. “Nasoendoscopic, videofluoroscopic and acoustic study of plain and emphatic coronals in Jordanian Arabic”. In: Hassan, Zeki M. & Heselwood, Barry (eds.), *Instrumental studies in Arabic Phonetics*, 165-191. John Benjamins.

Chiu, Chenhao, and Jackson T.-S. Sun. 2020. “On pharyngealized vowels in Northern Horpa: An acoustic and ultrasound study”. *The Journal of the Acoustical Society of America* 147: 2928-2946.

Evans, Jonathan P. 2006. “Vowel quality in Hongyan Qiang”. *Language and linguistics* 7(4): 731-754.

Evans, Jonathan P., Jackson T.-S. Sun, Chenhao Chiu, and Michelle Liou. 2016. “Uvular approximation as an articulatory vowel feature”. *Journal of the International Phonetic Association* 46(1): 1-31.

Gao, Yang. 2015. *Description d’une langue qianguique: le muya*. Ph.D. diss.: EHESS. Gong, Xun. 2018. *Le rgyalrong zbu, une langue tibéto-birmane de chine du Sud-ouest: une étude descriptive, typologique et comparative*. Ph.D. diss.: Institut national des langues et des civilisations orientales.

Guan, Xuan. 2024. *Phonology and morphosyntax of Pubarong Queyu*. Ph.D. diss., University of Oregon.

Guan, Xuan. 2025. “Uvularization in Queyu phonology”. In: Kuznetsova, Natalia; Anderson, Cormac & Easterday, Shelece (eds.), *Rarities in phonetics and phonology: Structural, typological, evolutionary, and social dimensions*, 437–473. Berlin: Language Science Press.

Huang, Bufan. 1991. “木雅语” [The Minyag Language]. In: Dai, Qingxia, Huang, Bufan, Fu, Ailan, Renzeng Wangmu, and Liu, Juhuang (eds.), 藏缅语十五种 [Fifteen Tibeto-Burman Languages]: 98-131. Beijing: Beijing Yanshan Press.

Huang, Yang. 2023. 沙德木雅语参考语法 [A reference grammar of Sabde Minyag]. 北京: 中国社会科学出版社。

Ladefoged, Peter & Maddieson, Ian. 1996. *The sounds of the world’s languages*. Blackwell.

Lin, You-Jing, Jackson T.-S. Sun, and Zhengxian Chen. 2012. 蒲西霍尔语软腭化的语音对立 [Non-consonantal velarization in Puxi Horpa]. 语言学论丛 [Linguistic Studies] 45, 187-195. Beijing: The Commercial Press.

Lu, Shaozun. 1985. 扎巴语概况 [An introduction to the Zhaba language]. 民族语文 2: 67-76.

Sun. Jackson T.-S. 2000. “Parallelisms in the verb morphology of Sidaba rGyalrong and Lavrung in rGyalrongic”. *Language and Linguistics* 1(1): 161-190.

Sun. Jackson T.-S. 2004. “Verb-Stem variations in Showu rGyalrong”. *Studies on Sino- Tibetan Languages*, 269-296.

Sun, Jackson T.-S. and Jonathan P. Evans. 2013. “麻窝羌语元音音系再探 [The vocalic system of Mawo Qiang revisited]”. In: Shi, Feng and Peng, Gang (eds.), *Eastward flows the great river – Festschrift in honor of Professor William S-Y. Wang on his 80th birthday*, 135–151. Kowloon: City University of Hong Kong Press.

Suzuki, Hiroyuki & Sonam Wangmo. 2019. “An outline of the sound structure of Lhagang Choyu: A newly recognized highly endangered language in Khams Minyag”, *Revue d’Etudes Tibétaines* 48, 99-151.

Van Way, John R. 2018. *The Phonetics and Phonology of Nyagrong Minyag, an Endangered Language of Western China*. Ph.D. diss., University of Hawai’i.

Zheng, Jingyao. 2023. “A Phonological Study of Rongpa Choyul”. *Languages* 8: 133.

Acoustic Correlates of Uvularization in Mawo Qiang: Toward a More Comprehensive Phonetic Account of the Plain–Uvularized Vowel Contrast

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A recent finding in the study of Tibeto-Burman languages in Sichuan, China, is the presence of paired vowel sets, where one vowel is plain and the other exhibits secondary articulatory features such as velarization, uvularization, or pharyngealization. This rare phenomenon provides valuable insights into phonological typology and lower vocal tract phonetics. However, despite its theoretical importance, the contrast remains underexplored due to limited data and a lack of instrumental studies. Among the documented cases, the Mawo variety of Qiang, which contrasts plain and uvularized vowels, offers the clearest example, based on experimental research with two male speakers (Evans et al. 2016). This study builds on that work by examining a larger speaker sample and incorporating additional acoustic parameters to further clarify the vowel contrast.

Data and methodology

The dataset comprises 1,472 tokens from simultaneous audio and electroglottographic (EGG) recordings of 24 minimal pairs contrasting plain and uvularized vowels (/i ~ iʁ/, /ə ~ əʁ/, /u ~ uʁ/, /a ~ aʁ/), produced as isolated CV sequences with alveolar onsets (/t d s n l/) by four male and five female Mawo speakers. The data were manually segmented and annotated in Praat with EGG boundaries marked by the initial and final oscillations.

Acoustic measures

The analysis integrates formant-based measures (F1 to F4), fundamental frequency (F0), and voice quality metrics, specifically the open quotient (OQ), to examine the acoustic and phonatory properties of the vowel sets. Formant values were extracted from the acoustic signal, while both F0 and OQ were derived from the EGG signal, which provides more stable F0 tracking. OQ was calculated from the derivative of the EGG waveform (dEGG) using Praatdet (Kirby 2017), after high-pass filtering at 75 Hz to remove low-frequency noise and enhance glottal pulse detection. Peaks that can be interpreted as the glottal opening and closing phases were identified in the dEGG signal using Howard's (1995) method, with a 3/7 amplitude threshold. Formants were extracted at the vowel midpoint (in Hz), while F0 and OQ were measured throughout the entire vowel duration, which was divided into ten equal intervals (0–10%, …, 90–100%) using custom MATLAB scripts.

Results

The corpus reveals substantial inter-speaker variation in the realization of plain versus uvularized vowels, particularly in vowel quality, phonation, and pitch. Averaging across speakers often obscures these contrasts, underscoring the need for speaker-specific analysis. To capture this variation, we examined three dimensions systematically.

In the formant analysis, we tested whether the contrast reflects uvularization as a secondary articulation, defined as dorsum raising and backing toward the uvula. Two methods were applied: (1) articulatory modeling of F1 and F2 (Maeda 1982) to simulate tongue positions, and (2) analysis of the F4-F3 distance as an acoustic correlate of uvular constriction (Fant 1960/1970). Modeling of /i, ə, u, a/ and their uvularized counterparts revealed speaker-specific strategies, with little evidence for uvularization except in /u/, where retraction is better explained by fronting of plain /u/, phonetically [ʉ]. Overall, F2 lowering emerged as the primary acoustic cue, with minimal contribution from other formants.

The second method showed consistent narrowing of F4-F3 for uvularized vowels in most speakers, with gender effects. For example, female speakers' mean F4-F3 distance was 593 Hz for /uʶ/ versus 1060 Hz for /u/, while male speakers showed narrower differences (1000 Hz vs. 1200 Hz). However, exceptions occur, particularly with /iʁ/, where some speakers showed no narrowing.

Finally, analysis of OQ and F0 indicated that two-thirds of speakers, regardless of gender, used distinct phonation types across the contrastive vowel sets, ranging from statistically significant differences to strong tendencies. These phonatory patterns were also correlated with pitch differences. Figure 1 shows the pattern in OQ and F0 values: OQ ≈ 0.5 indicates modal phonation, < 0.5 suggests "tense" voice, and > 0.5 indicates lax voice. The "tense" quality is most likely the result of laryngeal constriction.

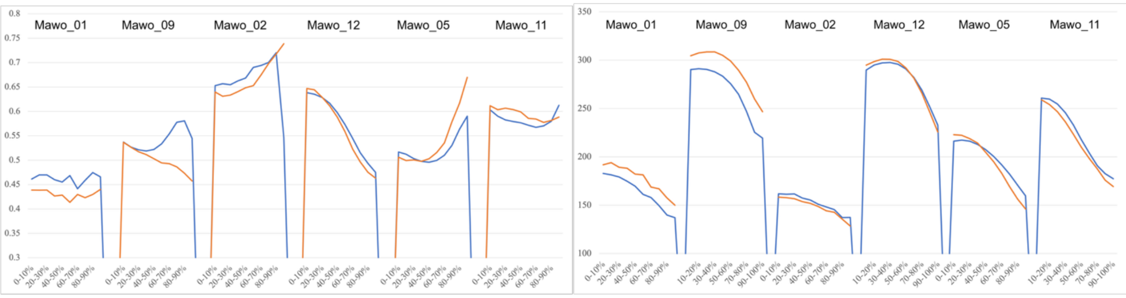

Figure 1. OQ (left) and F0 (right) values for three male and three female Mawo speakers, with plain vowels in blue and uvularized vowels in orange.

The consistent relationship observed between phonation type and pitch—higher pitch associated with tenser phonation and lower pitch with breathier phonation—indicates a potential difference in OQ as a distinguishing characteristic between the two vowel sets across these speakers. This difference may be linked to variations in laryngeal height.

Discussion

Our findings refine Evans et al.'s (2016) definition and characterization of the contrastive vowel sets in Mawo. The contrast is not restricted to vowel quality but is multidimensional, involving several covarying cues—vowel quality, phonation, and pitch—together with coarticulatory effects on the preceding consonant (McKeever 2025). On this basis, we propose that the contrast is more appropriately analyzed at the syllable level rather than as a purely segmental vowel contrast, as previously suggested. Speakers display some flexibility in the cues they prioritize, provided that the overall contrast is preserved.

Given the multidimensional nature of the contrast and the considerable inter-speaker variation it entails, further research is needed—particularly on potential adjustments in larynx height. Such work should ideally draw on a larger speaker sample, more extensive corpora, and complementary articulatory evidence, for example from ultrasound imaging.

References

Fant, G. 1960/1970. *Acoustic Theory of Speech Production With Calculations based on X-Ray Studies of Russian Articulations*. The Hague & Paris: Mouton.

Evans, J., J. T.-S. Sun, C. Chiu, & M. Liou. 2016. Uvular approximation as an articulatory vowel feature. *Journal of the International Phonetic Association* 46.1: 1–31.

Kirby, J. 2017 Praatdet: Praat-based tools for EGG analysis (v0.1.1). https://doi.org/10.5281/zenodo.1117189.

Maeda, S. 1982. A digital simulation method of the vocal-tract system. *Speech Communication*, 1. 3-4: 199-229.

McKeever, L. 2025. Use of Locus Equations to Quantify Anticipatory Coarticulation of Uvularized Vowel Contrasts in the Mawo Variety of Northern Qiang. Presentation at Phon-UDL, September 18, 2025.

SESSION B

Quantification des schémas articulatoires dans les sons complexes

Quantifying Articulatory Patterns in Complex Sounds

Use of Locus Equations to Quantify Anticipatory Coarticulation of Uvularized Vowel Contrasts in the Mawo Variety of Northern Qiang

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This study evaluates the measurement of anticipatory coarticulation through the use of locus equations. Focusing on Mawo, a dialect of Northern Qiang spoken in Heishui County, Sichuan Province, China, this study investigates how variation in coarticulatory strength— captured by differences in the slope of F2 transitions—can signal the presence of a contrast between plain and uvularized vowels (Evans et al. 2016). Coarticulation captures how adjacent segments influence each other, and in the case of uvularization, these effects often manifest in both anticipatory and carryover patterns in formant transitions—most notably in the lowering of F2 and the raising of F1 and F3-F2 (Evans et al., 2016).

The locus equation method, as described by Embarki et al. (2006) relates the onset of the second formant frequency (F2 onset) to its steady-state (F2 midpoint), with the slope of the regression lines providing a numerical index of vowel-induced coarticulation. This aligns with earlier work by Sussman et al. (1999), who used locus equations to reveal how coarticulatory strength varies across consonantal places of articulation. Locus equations, which track the linear relationship between F2 onset and F2 midpoint, are particularly sensitive to changes in coarticulatory dynamics—steeper slopes indicating more vowel influence on consonant articulation.

This paper's analysis employs linear regression models to determine the strength of anticipatory coarticulation, evaluating regression slopes (β) as indices of coarticulatory magnitude. The speech corpus consists of recordings from nine native speakers (4 male, 5 female; mean age = 64 years, range = 58–68 years) of Mawo, drawn from a corpus collected as part of the ANR PhoTon project (https://anrphoton.cnrs.fr/). All participants contributed minimal pairs contrasting plain and uvularized syllables, enabling a controlled investigation of coarticulatory effects. Examples include /ti/ 'black bear' vs. /tiʁ/ 'pair (classifier)', /də/ 'beans' vs. /dəʁ/ 'poison'. Each pair exemplifies the contrastive nature of uvularization in the vowel system. F2 onset and midpoint values were extracted from each token and used to compute locus equations.

Results reveal that uvularized contexts consistently exhibit significantly higher anticipatory coarticulatory slopes across multiple phonetic environments, demonstrating that locus equation analysis is an effective method for identifying uvularization as a contrastive phonetic feature. This pattern is evident across both vowel and consonant analysis contexts, suggesting a widespread articulatory influence of uvularization (Table 1). Among vowels, the mid-central vowel /ə/ showed the most pronounced effect for female speakers, with a steep increase in slope from $\beta = 0.268$ in plain contexts to $\beta = 0.927$ in uvularized contexts ($p < .001$) (Figure 1). This supports findings from Evans et al. (2016), which describe a rearward tongue gesture for uvularized vowels. The high back vowel

/u/ exhibited significant coarticulatory enhancement under uvularization for female speakers (β = 0.025 plain vs. β = 0.633 uvularized, $p < .001$) (Figure 2).

Coarticulatory effects were also robust in consonantal environments. The lateral /l/ showed significantly increased slopes in uvularized contexts for both male (β = 0.739 vs. 0.473, $p < .001$) (Figure 3) and female speakers (β = 0.724 vs. 0.334, $p < .001$) (Figure 4), paralleling ultrasound imaging results in Evans et al. (2016), which demonstrated uvularization effects manifesting during lateral articulation. These findings confirm that uvularization can influence consonantal articulation in ways detectable through acoustic slope measures. The nasal /n/ showed a particularly striking contrast among male speakers, where coarticulatory strength more than doubled in uvularized contexts (β = 1.106 vs. 0.542, $p < .001$) (Figure 5), reinforcing the conclusion that uvularization operates as a pervasive articulatory feature that modifies both vocalic and lingual consonantal segments.

This research represents the first systematic application of locus equation analysis to a corpus of uvularized vowels in a Tibeto-Burman language and offers new evidence that anticipatory coarticulation can serve as an effective phonetic cue for uvularization.

Table 1: Significant Coarticulatory Slope Differences Between Plain and Uvularized Contexts

Segment	β Plain	SE Plain	β Uvularized	SE Uvularized	Z-Score	P-Value
All Vowels - All	0.5013	0.0285	0.6465	0.0273	-3.6844	p < .001
All Vowels - Female	0.3249	0.0387	0.6665	0.0381	-6.2947	p < .001
/ə/ - All	0.3955	0.0651	0.8054	0.0631	-4.5209	p < .001
/ə/ - Female	0.2678	0.0836	0.9271	0.0801	-5.6936	p < .001
/u/ - Female	0.0246	0.1008	0.6334	0.0553	-5.2967	p < .001
/l/ Male	0.4729	0.0633	0.7393	0.0451	-3.4275	p < .001
/l/ Female	0.3338	0.0882	0.7238	0.0585	-3.6828	p < .001
/s/ Female	0.4617	0.0737	0.7463	0.0717	-2.7670	p = .006
/z/ All Speakers	0.4623	0.0598	0.7502	0.0783	-2.9228	p = .003
/z/ Female	0.3248	0.0871	0.9027	0.1097	-4.1263	p < .001
/n/ All Speakers	0.2529	0.0890	0.5490	0.0917	-2.3170	p = .021
/n/ Male	0.5422	0.1229	1.1056	0.1081	-3.4424	p < .001
/n/ Female	0.0264	0.1123	0.4189	0.1181	-2.4085	p = .016

Figure 1: Coarticulatory Slopes for /ə/ in Female Speakers

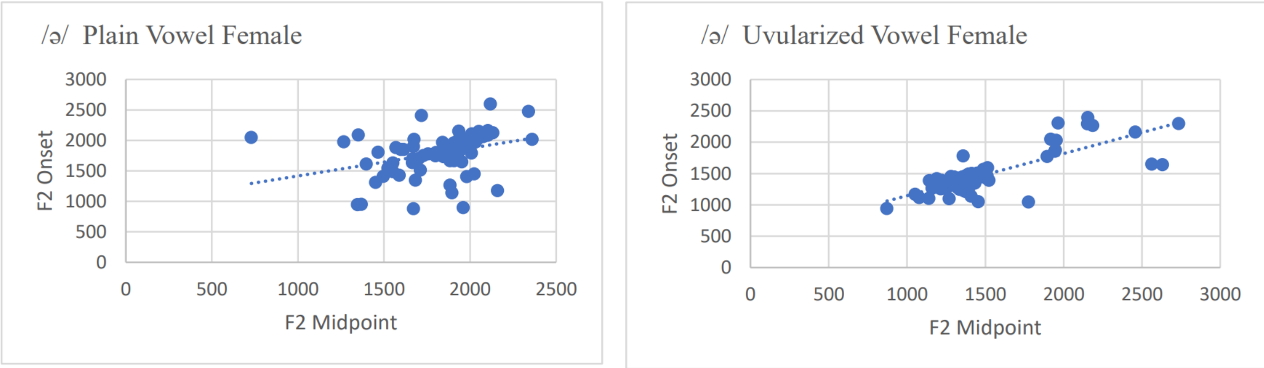


Figure 2: Coarticulatory Slopes for /u/ in Female Speakers

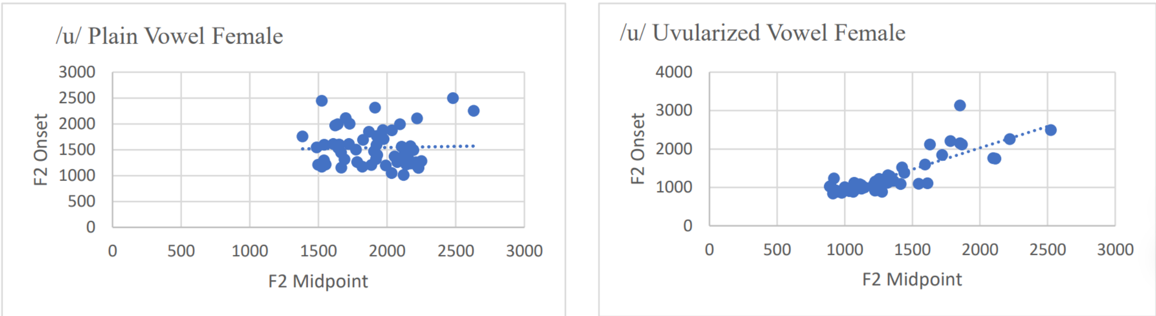


Figure 3: Coarticulatory Slopes for /l/ in Male Speakers

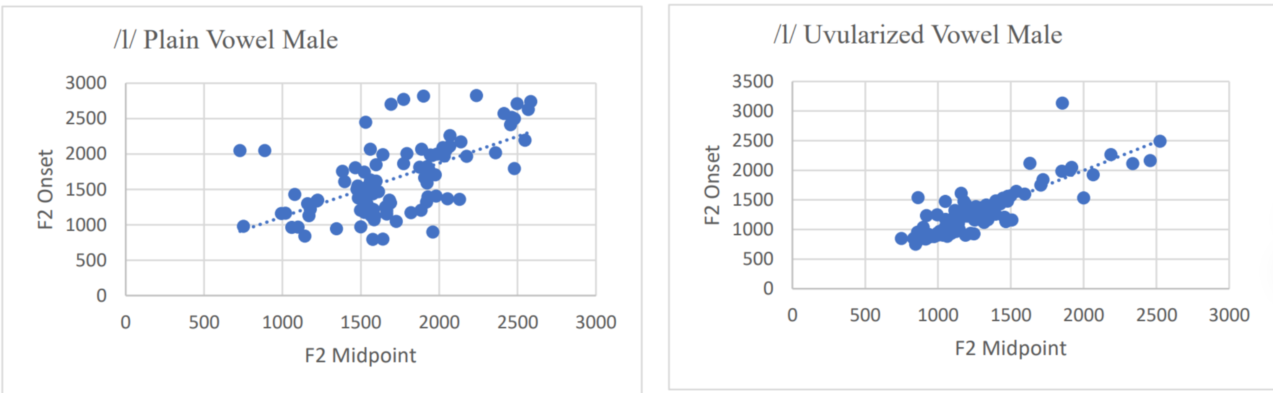


Figure 4: Coarticulatory Slopes for /l/ in Female Speakers

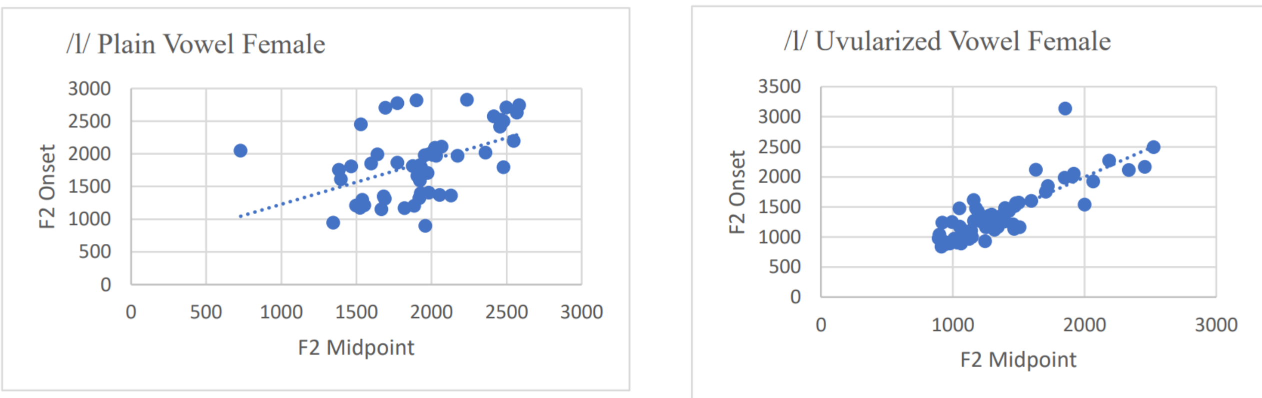
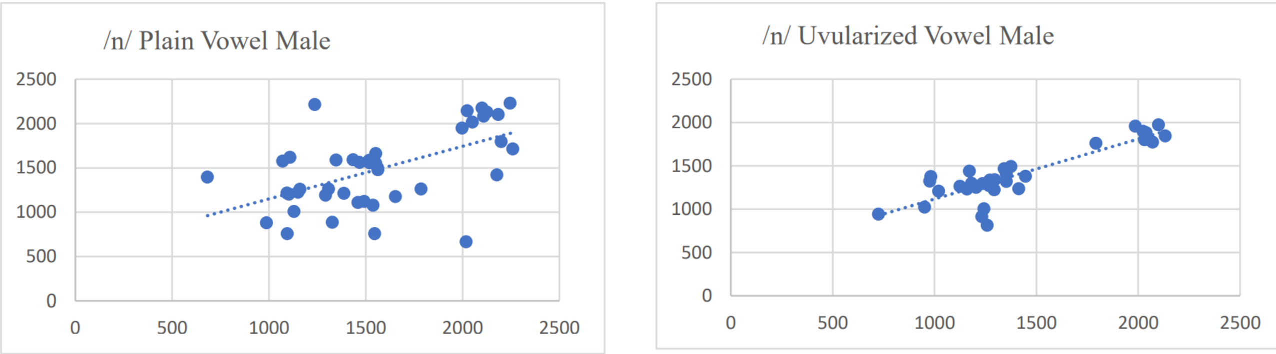


Figure 5: Coarticulatory Slopes for /n/ in Male Speakers



References :

Embarki, M., Guilleminot, C., & Yeou, M. (2006). Équation de locus comme indice de distinction consonantique pharyngalisé vs non pharyngalisé en arabe. In *Actes des XXVIèmes Journées d'Études sur la Parole* (pp. 343–346).

Evans, J. P., Sun, J. T.-S., Chiu, C., & Liou, M. (2016). Uvular approximation as an articulatory vowel feature. *Journal of the International Phonetic Association, 46*(1), 1–31.

Sussman, H. M., Duder, C., Dalston, R. M., & Cacciatore, A. (1999). An acoustic analysis of the development of CV coarticulation: A case study. *Journal of Speech, Language, and Hearing Research, 42*(5), 1080–1096.

Velar ~ Uvular Contrast in Languages With and Without Epilaryngeals: The case of Alutor and Chukchi

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Université Paris Cité, CNRS, LLF UMR

Background: This study aims to document the phonetic implementation of the velar vs uvular phonemic contrasts in two endangered languages: Alutor (Glottocode: alut1245) and Chukchi (chuk1273). Alutor and Chukchi belong to the Chukotko-Kamchatkan language family, and are spoken at the Far East region in Russia. Chukchi was spoken widely in the Chukchi Peninsula and Eastern Siberia (Dunn, 1999); Alutor was spoken in the northern part of the Kamchatkan peninsula (Kibrik et al., 2004). Both languages have an endangered language status, with the number of speakers decreasing drastically from the last Russian census in 2010: Chukchi with 2607; Alutor with 25 speakers, decreasing significantly since the last reports in Nagayama (2003).

While these languages are typologically related and have approximately similar phonemic inventories, velar and uvular contrasts are likely to be implemented differently. Following the Laryngeal Articulator Model (LAM) (Esling, 2005; Esling et al., 2019), and according to Sylak-Glassman (2014), if a language presents epilaryngeal[1] phonemes, the whole post-velar natural class will show similarities in the implementation of the phonemic contrasts. In Alutor post-velars are represented by uvular, epiglottal, and glottal stops, while in Chukchi epiglottal stop is not present. Hence, we predict that the two languages would show differences in how the velar vs uvular stops are implemented, with patterning in the latter with other post-velar consonants.

Method: Data from 8 speakers (5 females for Chukchi; 2 females and 1 male for Alutor), were used. Speakers produced a list of stimuli which included words with /k/ and /q/ across various vowel contexts in word-initial, -medial, -final positions. The corpus used here was composed of 837 velar and 270 uvular tokens for Alutor; 910 velars and 432 uvulars for Chukchi. The recordings were annotated in Praat (Boersma & Weenink, 2024). For target stops, subsegmentat parts were obtained (pre-frication, closure, burst, and post-burst lag), which were analysed via spectral measures, to account for the place of articulation, durational and lenition metrics (following Ennever et al., 2017) to account for the manner of articulation. For the surrounding vowels, we document both static and dynamic measures, including rate of change, to evaluate the differences in coarticulatory patterns. We used Random Forests (RF), which was previously used in the post-velar natural class (Al-Tamimi, 2023; Arkhipov et al, 2023) to evaluate the robustness of the acoustic measures to differentiating between the velar and uvular consonants (according to the position within a word).

Results: The RF results show overall similar patterns for both languages, with small differences emerging primarily through the coarticulatory patterns. In general, the velar and uvular stops seem to

[1] We use the term *epilaryngeals*, which combines both pharyngeals and epiglottals following Shepel et al (2024). This is motivated by the predictions of the LAM (Esling, 2005), which suggests that pharyngeals and epiglottals belong to the same place of articulation.

pattern similarly. Changes within the surrounding vowels are the primary predictors to signal the contrast in both languages. Uvulars show various degrees of vowel retraction impacting the degree of vowel openness and backness. A key difference between the two languages is related to the type of vowel impacted: in Chukchi, the vowels following the uvular experience more changes, while both vowels are equally affected in Alutor. The manner of articulation is a secondary cue: the properties of pre-frication differentiate between velars and uvulars, with longer pre-frication, and pre-glottalisation in velars than on uvulars in Alutor in comparison with Chukchi. The duration of release in both languages is longer in velars than uvulars. Finally, the place of articulation in both Alutor and Chukchi shows variability across vowel contexts: velars and uvulars are produced as fronted in the front vowel environment.

The results show, contra to our predictions, that both languages show similar trends in how the contrast between velars and uvulars is implemented within the targeted consonants and surrounding vowels. It is possible that, due to the two languages being typologically related, common patterns emerge between the two, with small differences in the amount and direction of the influence of the post-velar natural class. This study highlights that the uvular stop shows minute differences in Alutor when compared with Chukchi, with respect to vowel centralisation and duration of the pre-frication; cues possibly informative in the context of the full post-velar natural class. A point we explore in a future study.

References

Al-Tamimi, J. (2023). *On the contribution of "fine phonetic detail" (FPD) to gradience in phonology: Acoustic, articulatory, perceptual and automatic methods*. (HDR in phonetics and phonology). Université Paris Cité.

Arkhipov, A., Daniel, M., Shiryaev, A., & Shepel, E. (2023). Evaluating formant estimations and discrete cosine transform to differentiate between pharyngeal fricatives in Mehweb. In: R. Skarnitzl, J. Volín (eds.), *Proceedings of the 20th ICPhS*. Guarant International (pp. 3407–3411).

Boersma, P., & Weenink, D. 2024. *Praat: doing phonetics by computer*. Computer program. Version 6.4.07, retrieved 17 March 2024.

Dunn, M. J. (1999). *A grammar of Chukchi*. The Australian National University.

Ennever, T., Meakins, F., & Round, E. R. 2017. A replicable acoustic measure of leni- tion and the nature of variability in Gurindji stops. Laboratory Phonology: *Journal of the Association for Laboratory Phonology 8* (1): 20, pp. 1–32.

Esling, J. H. (2005). There are no back vowels: The Laryngeal Articulator Model. *Canadian Journal of Linguistics/Revue canadienne de linguistique, 50* (1-4), 13–44.

Esling, J., Moisik, S., Benner, A., & Crevier-Buchman, L. (2019). *Voice Quality: The Laryngeal Articulator Model (1st ed.)*. Cambridge University Press. https://doi.org/10.1017/9781108696555

Kibrik, A. E., Kodzasov, S. V., & Muravyova, I. A. (2004). *Language and folklore of the Alutor people* (Vol. A2-042). Osaka: ELPR. (Translation of the 2000 Russian edition)

Nagayama, Y. (2003). Ocherk grammatiki aljutorskogo jazyka (Grammatical outline of Alutor). *Endangered Languages of the Pacific Rim* A2-038. Osaka: ELPR.

Shepel, E., Arkhipov, A., Daniel, M., & Shiryaev, A. (2024). Aryepiglottic trilling in Mehweb: acoustics and variability. In 13th International Seminar on Speech Production (ISSP2024). Autrans, France (pp. 53–54).

Sylak-Glassman, J. C. (2014). *Deriving natural classes: The phonology and typology of post-velar consonants*. University of California, Berkeley.

Optical Distance Sensors to Measure the Articulation of Complex Sounds

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Introduction

EPG the most widely used palate-based measurement technique have electrodes distributed over their surface, measuring the presence or absence of contact with the tongue. These contact sensors do not provide information about the position of the tongue at places without contact and about the lingual pressure at the points of contact. This information is provided by OPG (Birkholz et al. (2023). OPG uses optical distance sensors to measure the distance from different locations on the palate to the tongue surface. Optical sensors are both usually larger than EPG electrodes, which limits the number of sensors per palate. Each distance sensor consists of a light source and a photodetector at a close distance from each other, mounted on the lingual side of the artificial palate. To measure the distance to the tongue, the light source emits a beam of light on the tongue, and the photodetector registers the light reflected from the tongue surface. The recorded light intensity is approximately proportional to the inverse square of the distance, Chuang and Wang (1978). The light source is typically a light-emitting diode (LED) or a laser diode, and the photodetector is a photodiode or a phototransistor. Several palate models have been developed at the TU Dresden between 2011 and 2022. This presentation focuses on model 6.

The presentation shows data acquired on Maasai a Nilotic language spoken in Tanzania, a language which is described with a complete set of implosive consonants at the bilabial, alveolar, palatal and velar places of articulation. The paper describes the place of articulation and dynamic of articulatory gestures involved in the production of the alveolar, palatal and velar implosives.

Material and method

Maasai data were recorded with 9 speakers (5male and 4 female) . All speakers wrote a consent form before the recordings. Recoding and processing of the data was made with the *ArticulatoryDataRecorder* software, acoustic data with *winpitch*.

A list of 22 words containing all implosives consonants, presented in random order, and containing all implosives consonants were recorded. Each word was pronounced in isolation and repeated three times.

As the OPG is a new tool to evaluate the dynamics of tongue movements and to evaluate the distance between the tongue and the hard palate, a short following methodological note is necessary. OPG shows the distance between the hard palate and the tongue with a frame every 10ms. OPG allows to observe differences in speed of closure and release of constrictions. Data are recorded in synchrony with an acoustic recording of good quality allowing to match OPG frames with a spectrographic analysis. The reading of OPG data is made from a color system presented at Figure 1. Two palates are presented: one showing a palate with red colors and the other with blue colors. Between both is presented a scale going from red (close or in contact with the palate) to blue (far from or maximally distant from the palate).

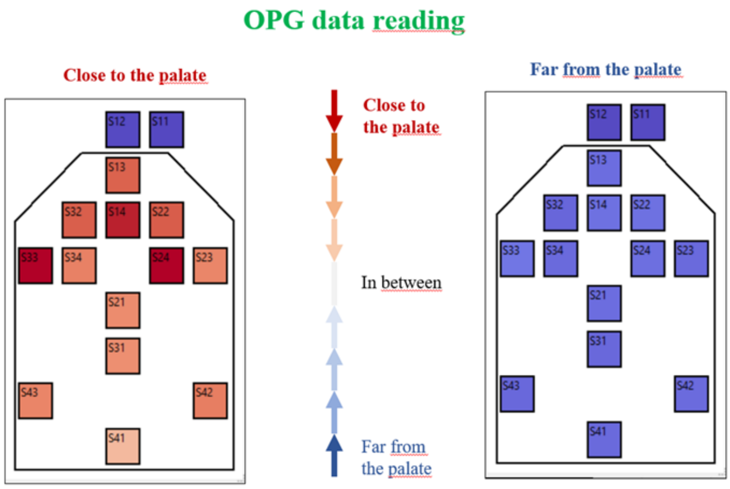

Figure 1. OPG data reading from color grades.

Figure 2. Maasai speaker with the OPG.

Results

Data show that for both Female and male speakers, what is traditionally described as alveolar implosives must described with an alveolar place of articulation. Figure 2a & b show an example in the production of the word auɗu containing a post-alveolar implosive consonant.

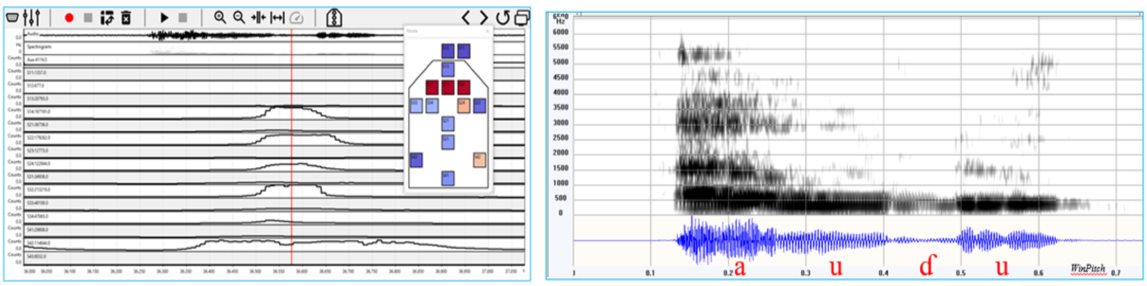

Figure 2a & b. a left. Pattern of electrodes activity and place of articulation a post-alveolar implosive consonant in the word auɗu. b right, wide band spectrogram.

Palatal implosives display a large contact covering an area extending from the post-alveolar region to the end of the hard palate both for female and male speakers. The dynamics of the articulatory gesture shows that the constriction contact is made faster than the release.

Velar implosives are sensitive to coarticulation with the following vowel. Data recorded show that the closure is visible on the OPG when the velar implosive precedes a front vowel.

Conclusion

The new OPG which is in its first use to describe the dynamics of tongue gestures and constrictions shows to be a precious tool to describe with greater precision place of articulation and the dynamics of closing and opening gestures in the production of implosive consonants in Maasai.

References

Peter Birkholz, Simon Stone, Christoph Wagner, Steffen Kürbis, Alexander Wilbrandt, Mats Bosshammer. 2023. A review of palatographic measurement devices developed at the TU Dresden from 2011 to 2022. *ICPHS,* Prague.

C.-K. Chuang and W. S. Wang, 1978. Use of optical distance sensing to track tongue motion. *Journal of Speech and Hearing Research*, vol. 21, 482– 496.

Payne, D. 2012. Phonological variations in Maa varieties, with some implication for grammar. In Occasional papers in Linguistics 4. LOT publications. 35-65.

Yigezu, M. (2001). A comparative study of the phonetics and phonology of Surmic languages. Thèse de doctorat, Université Libre de Bruxelles.

SESSION C

Contrastes de registre en austroasiatique et ailleurs

Register Contrasts in Austroasiatic and Beyond

Covarying Properties of Register Contrast in Mon

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Introduction. Register is a type of contrast typically marked by multiple phonetic properties, including voice quality, pitch, and vowel quality. Register systems usually contrast a high or "head" register, characterized by some combination of higher pitch, lower vowel quality, and modal voice quality, with a low or "chest" register, usually signaled by some combination of lower pitch, higher vowel quality, and breathy voice quality. Register contrasts are common in the Austroasiatic and Austronesian languages of Mainland Southeast Asia. However, the manifestation and relative weighting of the phonetic cues to register vary across languages. Some are reported to rely on F0 as the primary cue [1], while others rely on vowel quality [2]. Interestingly, despite early descriptions highlighting the role of voice quality, recent phonetic studies have rarely identified it as the primary correlate of register.

Mon, an Austroasiatic language spoken in Myanmar and Thailand, has been described as a prototypical register language, with voice quality often cited as the primary—if not sole—feature [3]. On this view, F0 differences across registers are treated as secondary consequences of the laryngeal settings used to produce distinct voice qualities [3]. This raises a broader question: are the phonetic cues to register produced independently, or do they covary in systematic ways?

Previous studies on Mon and other register languages often assume a hierarchy of "primary" and "secondary" cues. They typically evaluate this hierarchy by comparing the effect sizes of each phonetic property, identifying the feature with the largest effect size as the primary cue to register and treating others as secondary. While we also examine how register is realized in Mon, we focus instead on the interrelationships among the potential phonetic correlates. Here, we illustrate a method for estimating the contribution of acoustic cues that takes correlation between cues into account, thereby allowing for covariation among multiple phonetic dimensions.

Our findings show that the acoustic properties of register—particularly F0 and voice quality—do not operate independently. Thus, rather than characterizing register systems in terms of "primary" and "secondary" cues, our results suggest that register in Mon is better understood as the outcome of a unified laryngeal configuration, rather than as a set of individually targeted acoustic properties.

Methods. We collected simultaneous acoustic and electroglottographic (EGG) recordings from 17 native Mon speakers (6F, 11M), using attested monosyllabic and polysyllabic words with target syllables in final position. All words have voiceless unaspirated stop onsets and were balanced for head and chest registers. From the vowel intervals of target syllables, we extracted register-related acoustic measures: F0, F1, F2, H1*-A3*, and cepstral peak prominence (CPP), along with open quotient (OQ) from EGG as a voice quality measure.

After z-score normalization by speaker, we analyzed acoustic and OQ trajectories using functional principal components analysis (FPCA) [4]. F0 were modeled as a single dimension representing pitch; F1 and F2 as multidimensional vowel quality trajectories; and H1*-A3*, CPP, and OQ as three dimensions of voice quality. Principal component (PC) scores capturing variation in these trajectories were analyzed using separate linear mixed-effects models. Register (head vs. chest) was the fixed effect in models of pitch and voice quality; vowel and its interaction with register were included for vowel quality. Subject was included as a random intercept with a random slope for register. To assess whether the phonetic cues to register are covary or vary independently, we applied multidimensional FPCA to cues that differed significantly across registers.

Results. The findings indicate that only F0 and voice quality show systematic differences across register in Mon. Specifically, chest register is characterized by lower F0 and breathier voice quality compared to head register. This is reflected in the significant register-based differences in the first principal component scores (s1) for F0 (Figure 1) and for voice quality measures—H1*-A3*, CPP, and OQ (Figure 2). In contrast, vowel quality showed only limited register-related differences.

Multidimensional FPCA of F0 and voice quality revealed strong covariation between these cues. As shown in Figure 3, higher s1 values correspond to lower F0 and CPP, and higher H1*-A3* and OQ; lower s1 values show the reverse pattern. These directional patterns align with established register contrasts: head register exhibits higher F0 and CPP, and lower H1*-A3* and OQ, while the chest register shows the opposite pattern.

Conclusion. Overall, the findings suggest that Mon speakers do not independently control voice quality and F0, nor do they treat one as a primary property and the other as a secondary by-product. Instead, evidence from multidimensional FPCA points to a unified production strategy: speakers appear to target a general laryngeal setting—such as a lax configuration—that simultaneously gives rise to both F0 and voice quality correlates. In this sense, Mon may reflect a system governed by a single underlying mechanism. Applying this methodology to other register languages may offer further insights into how register is produced and whether similar covariation patterns hold across languages.

References

Abramson, Arthur S., Theraphan L.Thongkum & Patrick W. Nye. 2004. Voice register in Suai (Kuai): An analysis of perceptual and acoustic data. *Phonetica* 61(2–3). 147–171.

Brunelle, Marc, Tạ Thành Tấn, James Kirby & Đinh Lư Giang. 2020. Transphonologization of voicing in Chru: Studies in production and perception. *Laboratory Phonology* 11(1). 1–33.

Abramson, Arthur S., Mark K. Tiede & Theraphan Luangthongkum. 2015. Voice Register in Mon: Acoustics and Electroglottography. *Phonetica* 72(4). 237–256.

Ramsay, James O. & Bernard W. Silverman. 2005. *Functional Data Analysis*. Springer.

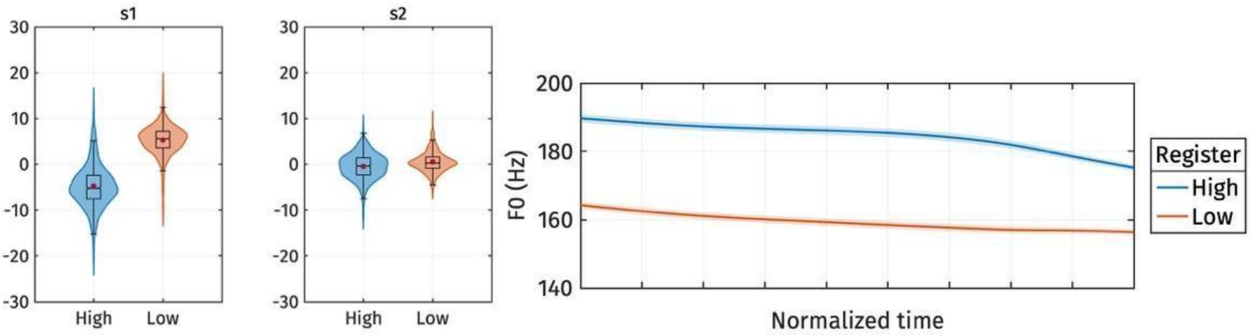

Figure 1. Violin plots (left) of s1 and s2 F0 PC scores by register, with red dots indicating category means. Reconstructed normalized F0 trajectories (right) based on estimated marginal means of s1 for each register.

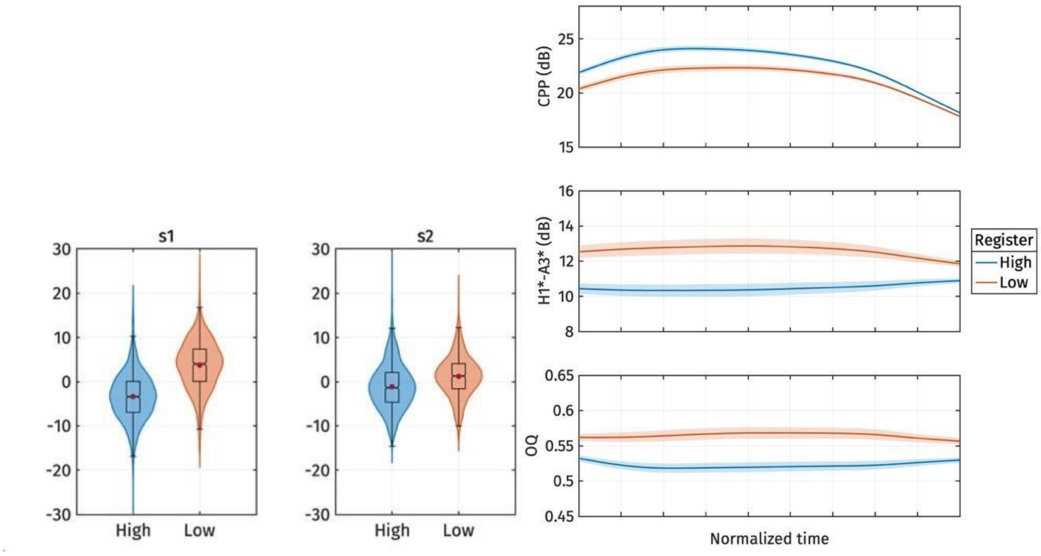

Figure 2. Violin plots (left) of s1 and s2 PC scores for voice quality measures by register, with red dots indicating category means. Reconstructed normalized trajectories (right) based on s1 estimates: CPP (top), H1*-A3* (middle), and OQ (bottom).

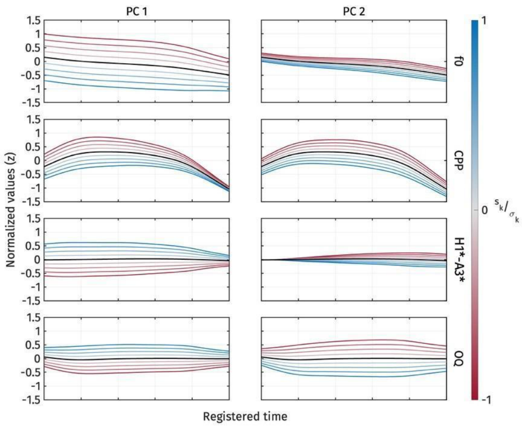

Figure 3. First two PCs of normalized F0, CPP, H1*-A3*, and OQ during the target vowel interval, pooled across speakers.

Glottal Coda F0 Perturbations are Modulated by Register Contrasts and Individual Differences: Acoustic and Electroglottographic Evidence from Mon

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Institute for Phonetics and Speech Processing, LMU Munich

This study investigates whether glottal codas in Mon induce f0 perturbations on the preceding vowel consistent with phonetically motivated models of tonogenesis, such as Haudricourt's (1954) proposal for Vietnamese. Based on acoustic and electroglottographic (EGG) data, we show that this is the case; however, the magnitude and direction of the effects are modulated by the register contrast and show talker- specific effects.

Introduction. It is well-documented that laryngeal contrasts in onset consonants have contributed to tone development across languages. This tonogenetic process frequently involves f0 perturbations: voiceless onsets raise f0 on the following vowel, while voiced onsets can lower it (Kingston 2011, Kirby 2018, Hombert et al. 1979).

Beyond onset voicing, glottal codas—[ʔ] and [h]— also induce f0 perturbations that may function as phonetic precursors to tone. Haudricourt (1954) hypothesized that Vietnamese glottal stops, produced with increased vocal fold tension, raised f0 (*paʔ > *pá), whereas glottal fricatives, produced with slack vocal folds, lowered it (*pah > *pà). Over time, further tone splits developed following the loss of onset voicing.

Similar glottal coda effects have been suggested in other Southeast Asian and North American languages (Kingston 2011), but empirical investigation remains limited—likely due to the rarity of languages contrasting [ʔ] and [h] in final position (but cf. Hombert et al. 1979).

Mon, an Austro-Asiatic language spoken in Myanmar and Thailand, contrasts both glottal stops and fricatives word-finally, making it an ideal case study. Additionally, Mon features a modal vs. breathy register contrast, a remnant of earlier onset voicing distinctions, allowing us to explore possible interactions between glottal codas and register-induced laryngeal settings.

Methods. Acoustic and EGG data were collected from 17 Mon speakers (6 female, 11 male) in Samut Sakhon, Thailand. The dataset included 8 monosyllabic words with voiceless stop onsets and either [ʔ] or [h] codas, balanced across modal and breathy registers. Each token was repeated 3 times, yielding 408 tokens for analysis.

Given the well-known variability of laryngeal articulation —especially for glottal stops (Esling et al. 2019)— we focused on by-speaker analysis rather than population averages.

We conducted two analyses. First, 95% confidence intervals (CI) of f0 contours over vowels were examined per speaker, per register, per coda. Second, we correlated f0 values in the final vowel quarter with the closed quotient (CQ)—an EGG-derived measure indicating glottal contact.

Results. Starting with the analysis of f0 contours, glottal stop codas [ʔ], induce a raising pattern onto the preceding vowel for about half of the participants (8/17, 7M) in the breathy register, broadly in line with Haudricourt's predictions. This is illustrated in Figure 1, which shows the patterns of SP1 and SP16 (orange dotted 95% CIs). Note the overall rising pattern before the cessation of vocal fold vibration towards end of the vowel. Other participants have either flat contours (6/17) or very slight falls (3/17).

In contrast, only one participant showed a rise with [ʔ] in the modal register. The vast majority (16/17) exhibited f0 falls, again visible in SP1 and SP16's solid orange contours.

Glottal fricatives [h] in the breathy register also triggered falls for slightly over half the participants (9/17), as expected. However, the magnitude of these falls was smaller than

the [ʔ]-induced rises. The remaining participants showed either flat contours (5/17) or slight rises (3/17). In the modal register, [h] induced f0 falls for 16/17 speakers, as shown by the blue solid lines in Figure 1.

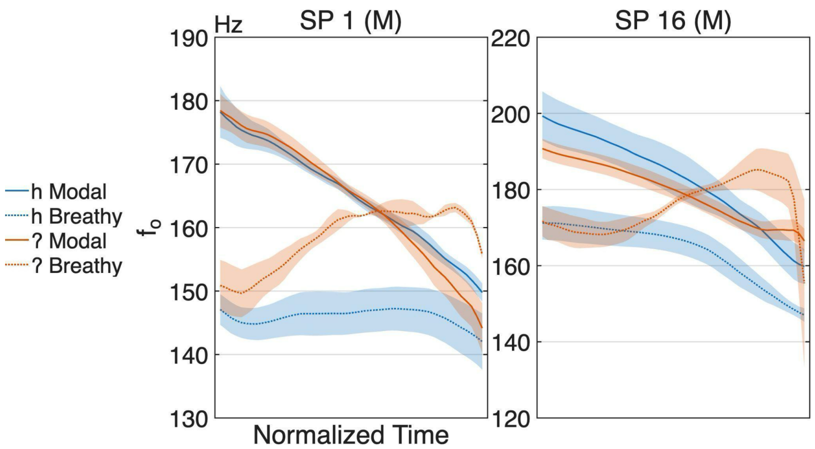

Figure 1 Means and 95% CIs for f0 trajectories over target word vowels, color codes coda and line type codes register.

We further hypothesized that closed quotient (CQ) would positively correlate with f0, as higher CQ correlates with greater vocal fold contact and laryngeal tension. This pattern emerged in five male participants during the final quarter of vowels.

In tokens with glottal fricative codas, these speakers showed lower CQ and f0, reflecting breathy phonation beginning into the vowel. Conversely, tokens with glottal stop codas exhibited higher CQ and f0, indicating increased laryngeal tension in the preceding vowel. Figure 2 (top panels, SP6 and SP14) illustrates these positive CQ-f0 correlations.

The remaining participants showed no significant CQ-f0 correlation. This was particularly true for female speakers, whose closed quotient values did not clearly distinguish glottal fricatives from stops, suggesting that glottal stops may involve greater glottal aperture than expected (Figure 2, bottom panel).

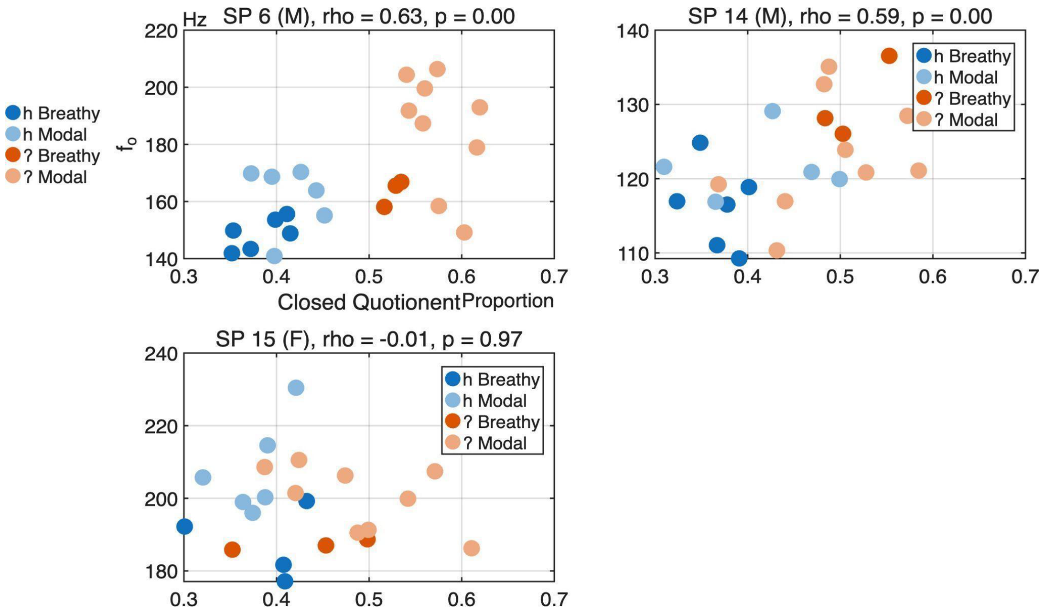

Figure 2. Closed Quotient (x) – f0 (y) correlation in the last quarter of target word vowels. Each dot represent a token, color-coded by glottal coda and register types. Titles contain correlation and p values.

Discussion. Acoustic evidence demonstrates that glottal codas induce f0 perturbations on preceding vowels, consistent with phonetically-based tonogenetic models. EGG data partially confirms the phonetic basis of these effects. This is a welcome result because posited diachronic patterns reflect majority trends in a study with a relatively sizable number of speakers.

However, two key sources of variation have emerged. First, [ʔ] raises f0 only in the breathy register, making this effect register-specific and potentially limited to lower f0 ranges. In higher f0 regions, glottal stops induce f0 falls, mirroring [h] behavior. Second, substantial variation exists in [ʔ] laryngeal articulation. Female speakers in particular produce some [ʔ] without full glottal adduction or ventricular involvement, maintaining vocal fold vibration. These tokens resemble [h] both auditorily and spectrographically.This articulatory variation in glottal stop production may partially explain the complex relationship between f0 patterns and glottal articulation.

References

Esling, J. H., Moisik, S. R., Benner, A., & Crevier-Buchman, L. (2019). Voice quality: The laryngeal articulator model (Vol. 162). Cambridge University Press.

Haudricourt, André-G. (1954). De l'origine des tons en vietnamien. Journal Asiatique 242. 69-82.

Hombert, J. M., Ohala, J. J., & Ewan, W. G. (1979). Phonetic explanations for the development of tones. Language, 37-58

Kingston, J. (2011). Chapter 97. Tonogenesis.

Kirby, J. (2018). Onset pitch perturbations and the cross-linguistic implementation of voicing: Evidence from tonal and non-tonal languages. Journal of Phonetics, 71, 326-354.

Tone and Phonation in Baima (Tibeto-Burman): Evidence for Register-Tone in the Tibetosphere

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This study advances the quantitative analysis of suprasegmental features in Baima, a Tibetic (Tibeto-Burman) language spoken by approximately 10,000 people in northern Sichuan, China. Despite its typological interest, Baima remains understudied, with conflicting descriptions of its tonal system. Chirkova et al. (2023) suggest that Baima lexical tones are distinguished not only by fundamental frequency (f0) contours but also by differences in phonation type. According to their analysis, the high falling tone (â) is produced with "tense" phonation, the mid-level tone (ā) with modal phonation, and the low rising tone (à) with breathy or lax phonation. The "tense" quality is most likely the result of laryngeal constriction. This register-tone system—previously unattested in Tibetic languages and more commonly found in Southeast Asia—carries important implications for tonal typology within the Tibetic branch. Building on findings originally based on a single male speaker, the present study offers a more detailed and empirically robust account of phonation in Baima's tonal system.

Data and Procedure

Data were collected in 2024 from nine native Baima speakers (4 female, 5 male; age 45–85) in Sichuan. All participants were fluent in Southwestern Mandarin and reported daily use of Baima. The corpus includes a word list targeting tonal contrasts, featuring seven (near-)minimal triplets and nine (near-)minimal pairs. Participants translated each word from a Mandarin prompt and repeated it three times in isolation. Recordings used simultaneous acoustic and electroglottographic (EGG) methods. Each token was manually segmented into consonant and vowel portions in Praat, yielding 1,368 annotated vowel tokens. EGG data were similarly annotated, with word boundaries defined by the initial and final visible EGG oscillations.

Acoustic Measures

This study investigates tonal and phonatory contrasts in Baima using two key acoustic parameters: (1) f0, to characterize pitch contours, and (2) open quotient (OQ), to capture phonation type as a direct measure of glottal opening. Both were extracted from the EGG signal, which provides more stable f0 tracking than the acoustic signal. OQ was calculated from the derivative of the EGG waveform (dEGG) using the Praatdet toolset (Kirby 2017), following high-pass filtering at 75 Hz to remove low-frequency noise and enhance glottal pulse detection.

Glottal closing and opening peaks were identified from the dEGG signal, with the latter detected using Howard's (1995) method as implemented in Praatdet, applying a threshold of 3/7 waveform amplitude. F0 and OQ were measured across the vowel, segmented into ten equal intervals (0–10%, …, 90–100%), using custom Matlab scripts.

Results

The data confirm a consistent three-way lexical tone contrast across all speakers, aligning with the system proposed by Chirkova et al. (2023). In Figures 1–3, the high falling tone (tense) is shown in blue, the mid-level tone (modal) in grey, and the low rising tone (lax) in orange.

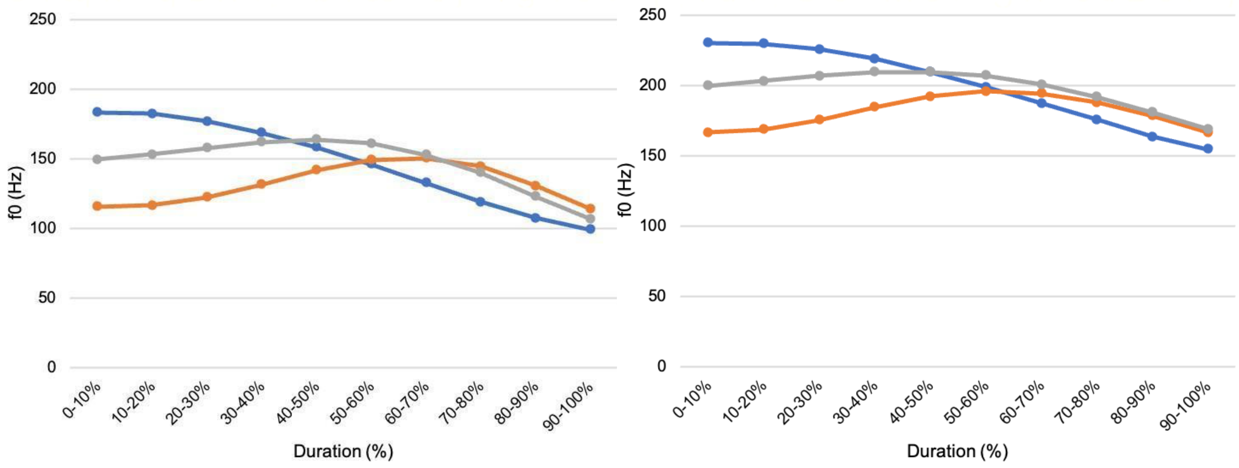
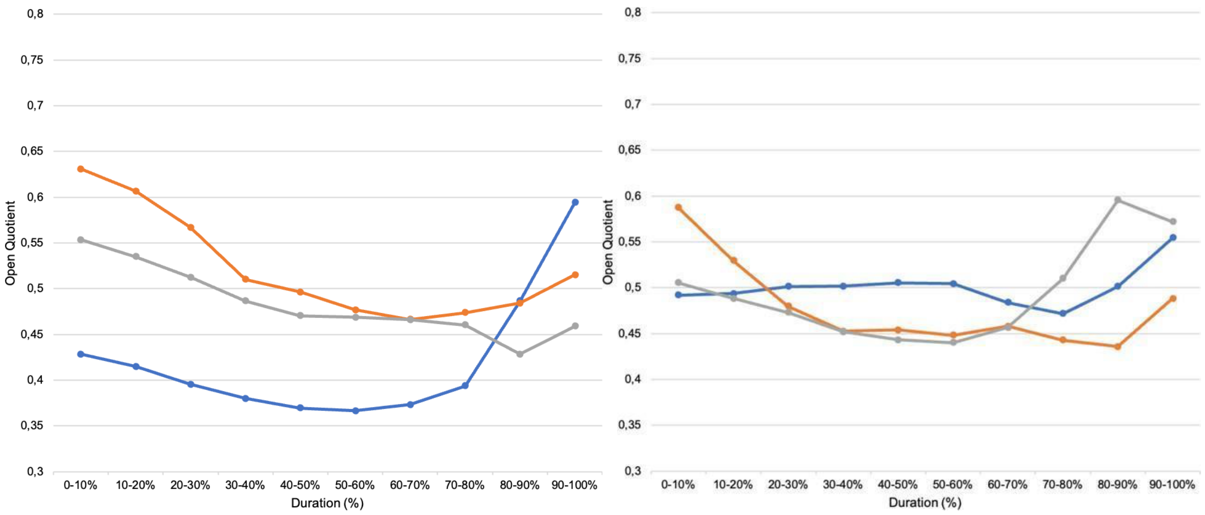


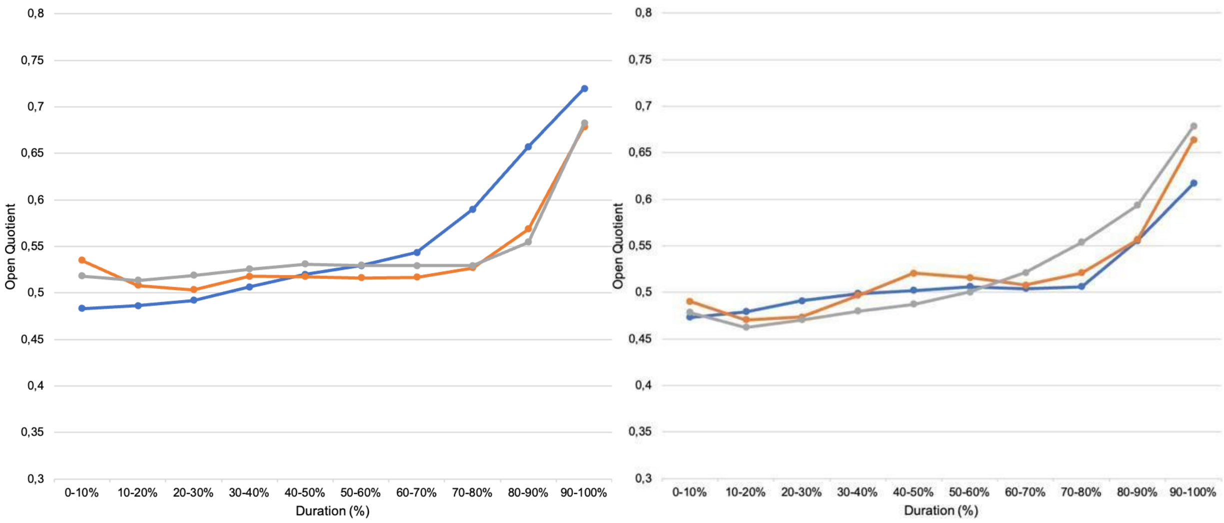
Figure 1. Averaged f0 trajectories for male (left) and female (right) speakers across the entire corpus.

As shown in Figure 1, f0 distinctions are most prominent in the first half of the vowel, with clear separation among tones. In the second half, however, the contours converge toward a similar mid-falling trajectory. This apparent neutralization is likely attributable to the elicitation context: since words were produced in isolation and in phrase-final position, a boundary tone— possibly a default mid-falling contour—may have overridden lexical distinctions.

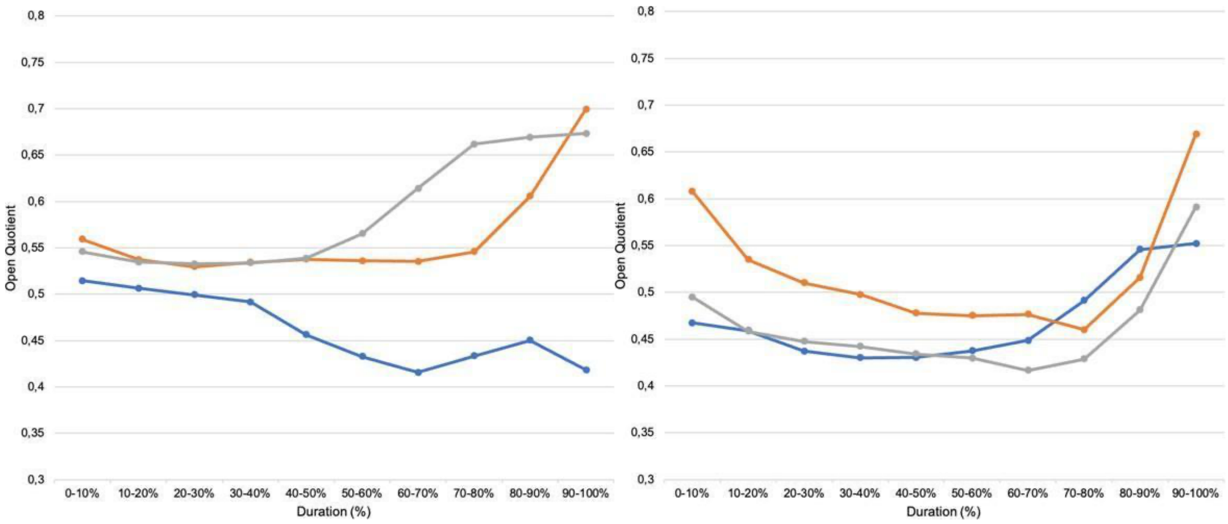
The data generally support a link between lexical tone and phonation type, in line with previous findings, though notable variation occurs both within and across speakers. Figure 2 illustrates this variability using data from two male (Baima_01, _03) and two female (Baima_05, _09) speakers, based on two (near-)minimal triplets. In Figures 2–3, OQ values around 0.5 indicate modal phonation, values below 0.5 reflect tense phonation, and values above 0.5 suggest lax voice quality.



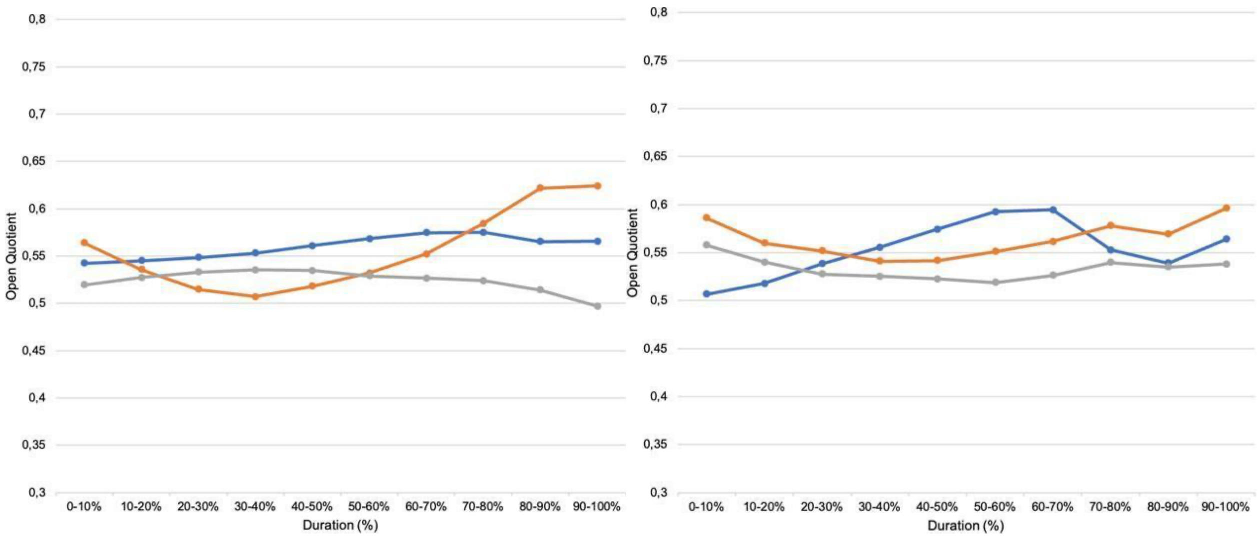
Baima_01



Baima_03



Baima_05



Baima_09

Figure 2. Inter- and intra-speaker variation in OQ values for two male (Baima_01, _03) and two female (Baima_05, _09) speakers, based on two (near-)minimal triplets: /nô/ 'inside' – /nō/ 'sky' – /nò/ 'exist' (left); and /mâ̱/ 'scar' – /mɑ̄/ 'butter' – /mɑ̀/ 'son-in-law' (right).

As shown in Figure 2, unlike f0, OQ-based phonation contrasts are distributed more evenly across the syllable, with distinctions arising at different points—e.g. early in Baima_01 and later in Baima_05. Overall, the tone–phonation association is more consistent among male speakers (Figure 3), indicating potential gender-based differences in phonetic realization strategies.

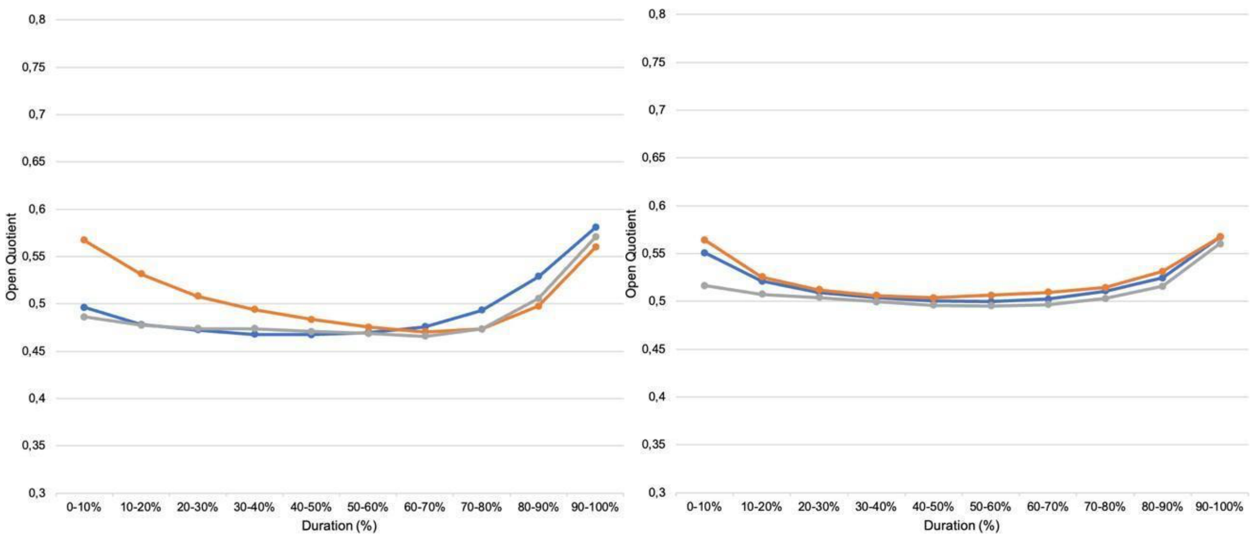


Figure 3. Averaged OQ trajectories across the corpus for male (left) and female (right) speakers.

Figure 3 shows that the low tone—marked by breathy-like phonation—is distinct from the high falling and mid-level tones, which group as non-breathy. This pattern is supported by linear mixed-effects models in R (lme4, lmerTest) with post-hoc pairwise comparisons (emmeans), run separately for male and female speakers.

For male speakers, results showed significant main effects of tone group (low vs. others), syllable interval, and their interaction (all $p < .001$). OQ values were significantly higher for the low tone in the first half of the syllable, peaking at 0–10% (estimate = 0.079, $p < .0001$), then reversing in the final interval (80–100%), where non-low tones had slightly higher values ($p < .01$), indicating dynamic glottal adjustment over time.

For female speakers, the same model showed significant effects of tone group and interval (both $p < .001$), with a weaker interaction ($p = .0056$). The low tone exhibited slightly higher OQ values across intervals (max estimate = 0.030, $p < .001$), with no reversal, suggesting a more stable glottal configuration across the syllable.

Discussion

This study broadly supports Chirkova et al.'s (2023) analysis of Baima's tonal system while refining it by revealing variation in contrastive phonation. To advance understanding, methodological improvements are suggested, including increasing the number of tokens and speakers, expanding prosodic contexts—especially phrase-medial—and incorporating more natural speech. Future research should also explore additional acoustic measures, notably combining spectral balance (H1*–H2*) with periodicity metrics such as CPP and HNR.

References

Chirkova, K., T. Kocjančič Antolík, & A. Amelot. 2023. Baima. JIPA, 53.2: 547–576.

Kirby, J. 2017 Praatdet: Praat-based tools for EGG analysis (v0.1.1). https://doi.org/10.5281/zenodo.1117189.

SESSION D

Études expérimentales de la phonation et du voisement dans les langues tibéto-birmanes

Experimental Approaches to Phonation and Voicing in Tibeto-Burman Languages

A Case Study of Phonation and Consonant-F0 Relationship in Amdo Tibetan of Hainan

Jiexiong ZHENG and Kun SHEN

Peking University

This study investigates the influence of different types of stops and fricatives on the following fundamental frequency(F0), as well as the presence of special phonation types, in the Amdo Tibetan dialect of the Hainan (Pastoral Area), Qinghai Province, utilizing acoustic parameters – including F0, Harmonic-to-Noise Ratio (HNR), Cepstral Peak Prominence (CPP), and the amplitude difference between the first and second harmonics (H1-H2) – and electroglottographic (EGG) parameters – including Open Quotient (OQ) and Speed Quotient (SQ)

Amdo Tibetan in Hainan exhibits a non-strict voicing contrast: In Tibetan script, voiceless consonants with a prefix or superscript are realized as "h + voiceless consonant" in Hainan Tibetan, voiced consonants with a prefix or superscript are realized as "ɦ + voiced consonant", and voiced consonants with a nasal prefix or superscript in Tibetan script are realized as homorganic-prenasalized voiced stops.

Additionally, Hainan Tibetan contrasts aspirated and unaspirated fricatives: In the absence of a prefix or superscript, voiceless fricatives in Tibetan script are pronounced as aspirated voiceless fricatives in Hainan Tibetan, and voiced fricatives in Tibetan script are unaspirated voiceless fricatives.

And this research finds:

(1) The "h" in "h + voiceless stop" onsets is an extremely brief and weak glottal aspiration before the stop, often barely visible on spectrograms and perceptually resembling laryngeal tension. This "h + voiceless stop" onset has negligible effects on F0 at the onset of the following vowel (onset F0), showing no significant difference compared to the bare voiceless stops.

(2)The "ɦ" in "ɦ + voiced stop/fricative" onsets functions as a voiced glottal fricative with weak friction or even vowel-like qualities. Both "ɦ + voiced stop" and prenasalized voiced stop onsets significantly depress the onset F0. The initial F0 after these onsets is approximately 10 Hz lower than after voiceless stops or "h + voiceless stop" onsets, with this depressing effect lasting about 30 ms. Voiced fricative onsets significantly depress the onset F0. The onset F0 after voiced fricatives is approximately 20 Hz lower than those after unaspirated or aspirated voiceless fricatives, with this effect lasting 40–50 ms.

(3)Previous research suggested that the initial portion of vowels following aspirated fricatives in Amdo Tibetan often exhibits characteristics of breathy voice (Wang & Chen 2010).While the influence of aspirated versus unaspirated fricatives on the following F0 observed in this study was not significant, acoustic parameters showed that for some speakers, the HNR and CPP values in the initial vowel portion following aspirated fricatives were lower than those following unaspirated fricatives. EGG parameters revealed that the SQ for the initial vowel portion following aspirated fricatives was lower compared to those following unaspirated fricatives, while OQ showed no significant difference. These observations may provide supporting evidence for the presence of breathy voice characteristics in the initial vowel portion following aspirated fricatives in Amdo Tibetan. Nevertheless, inter-speaker variation exists in the acoustic properties between aspirated and unaspirated fricatives.

(4)Vowel segments following voiceless versus voiced stops and fricatives in Amdo Tibetan showed no significant differences in acoustic and EGG parameters. But for some speakers, the voiced segment /ɦ/ before voiced stops and fricatives (marked as “pre-voiced”) was found to exhibit some characteristics similar to breathy voice in some acoustic and EGG parameters. Regarding the acoustic parameters, the CPP values of the /ɦ/ segment are relatively low for some speakers, while the HNR values of the /ɦ/ segment tend to be higher. In terms of EGG parameters, the OQ of the /ɦ/ segment is higher, whereas the SQ is lower.

Amdo Tibetan has not yet developed lexical tones. Comparing its consonant-induced F0 perturbations with the "high after voiceless, low after voiced" pattern in tonal Lhasa Tibetan may provide insights into the tonegenesis and tone splitting of Tibetan. Phonation type holds significant linguistic importance, yet traditional field methods have limitations in identifying and documenting it. This study also demonstrates that acoustic instruments like the electroglottograph (EGG) can play a crucial role in fieldwork of Tibeto-Burman languages, especially in those resource-scarce and under-documented ones, for determining the presence of special phonation types, exploring segmental-suprasegmental relationships, investigating language evolution and so on.

Keywords: Amdo Tibetan; Phonation; Consonant-F0 Interaction; Electroglottography (EGG); Aspirated Fricative

Primary References：

Chen, X. et al. (2010). Jiyu EGG Xinhao de Anduo Zangyu Yuanyin Sangyintezheng Yanjiu [A study on the features of vowels in Amdo Tibetan based on EGG Signals]. Xibeiminzudaxue Xuebao (Zirankexue Ban) [Journal of Northwest University for Nationalities (Natural Science)], 77, 20-23; 78.

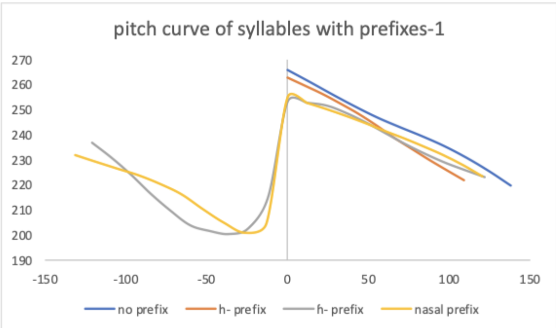
Dougecairang et al. (2008). Zangyu Biaozhunyin Zhuoshengmu de Shiyan Yanjiu [An Experimental Study on the Voiced Consonants in Standard Tibetan]. Dibajie Zhongguo Yuyinxue Xueshu Huiyi [Proceedings of the 8th Chinese Phonetics Conference]. Zhongguo Shehuikexueyuan Yuyan Yanjiusuo [Institute of Linguistics, Chinese Academy of Social Sciences]

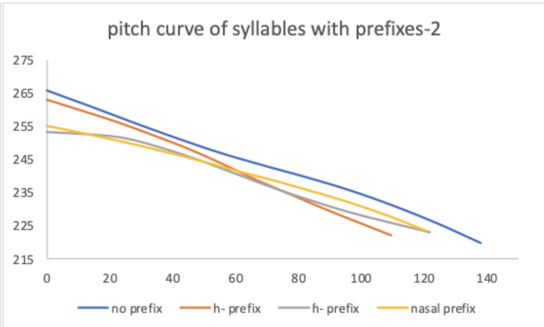
Huang, B. (1994). Zangyu Fangyan Shengdiao de Chansheng he Fenhua Tiaojian [Tonogenesis in Tibetan dialects and conditions for tone-differentiation]. Minzu Yuwen [Minority Languages of China], 3, 1-9.

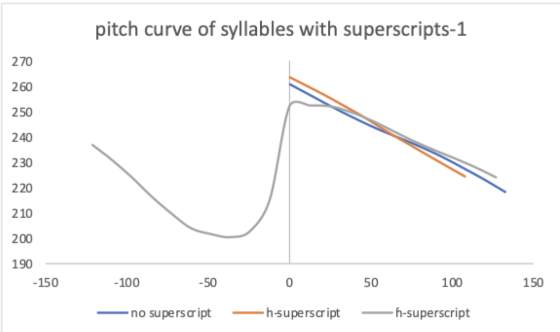
Kirby, J. (2018). Onset pitch perturbations and the cross-linguistic implementation of voicing: Evidence from tonal and non-tonal languages. Journal of Phonetics, 71, 325-354.

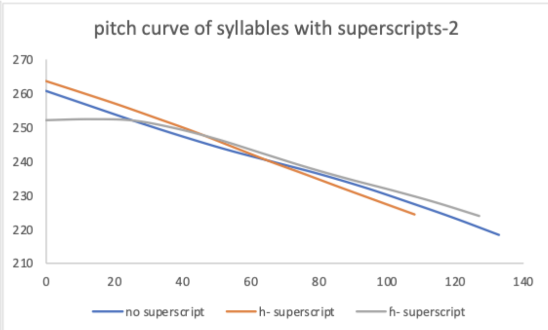
Sun, J. T. (2003). Variegated tonal developments in Tibetan. In Randy LaPolla et al. (eds.), Language variation: Papers on variation and change in the Sinosphere and in the Indosphere in honour of James A. Matisoff, 35–51. Canberra: Pacific Linguistics.

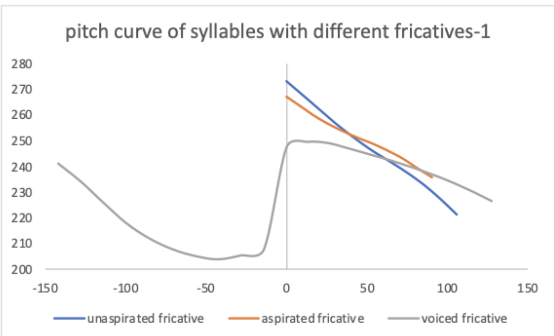
Suzuki, H. (2015). New Perspectives on the Suprasegmentals in mBrugchu Tibetan: An Introduction to the Tonogenesis Triggered by Breathy Voice. Bulletin of Chinese Linguistics, 8, 117-139.
Tournadre, Nicolas & Suzuki, Hiroyuki (2023) The Tibetic Languages: An Introduction to the Family of Languages Derived from Old Tibetan, Villejuif, France: Lacito Publications.
Wang, S., & Chen, Z. (2010). Anduo Zangyu Songqicayin de Shiyan Yanjiu.[An experimental study on the aspirated fricatives in Amdo Tibetan]. Minzu Yuwen[Minority Languages of China], (02), 7-15.
Wang, S. (2011). Maduo Zangyu de Shengdiao [Tones in Maduo Tibetan], Minzu Yuwen [Minority Languages of China], 3, 26-32.
Wang, S. (2012). Anduo Zangyu Yuyin Yanjiu [A phonetic study on the Amdo Dialect of Tibetan], Shanghai: Zhongxi Book Company.

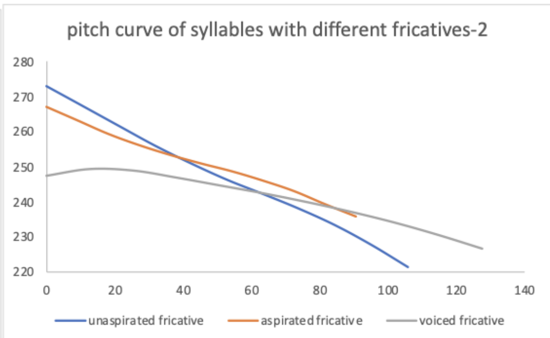













F1-fricative: CPP
Value
Sample Point
type Aspirated Prevoiced Unaspirated Voiced
F1-fricative: H1H2c
Value
Sample Point
type Aspirated Prevoiced Unaspirated Voiced
F1-fricative: HNR05
Value
Sample Point
type Aspirated Prevoiced Unaspirated Voiced
F1-fricative: HNR15
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Sample Point
type Aspirated Prevoiced Unaspirated Voiced
F1-fricative: HNR25
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Sample Point
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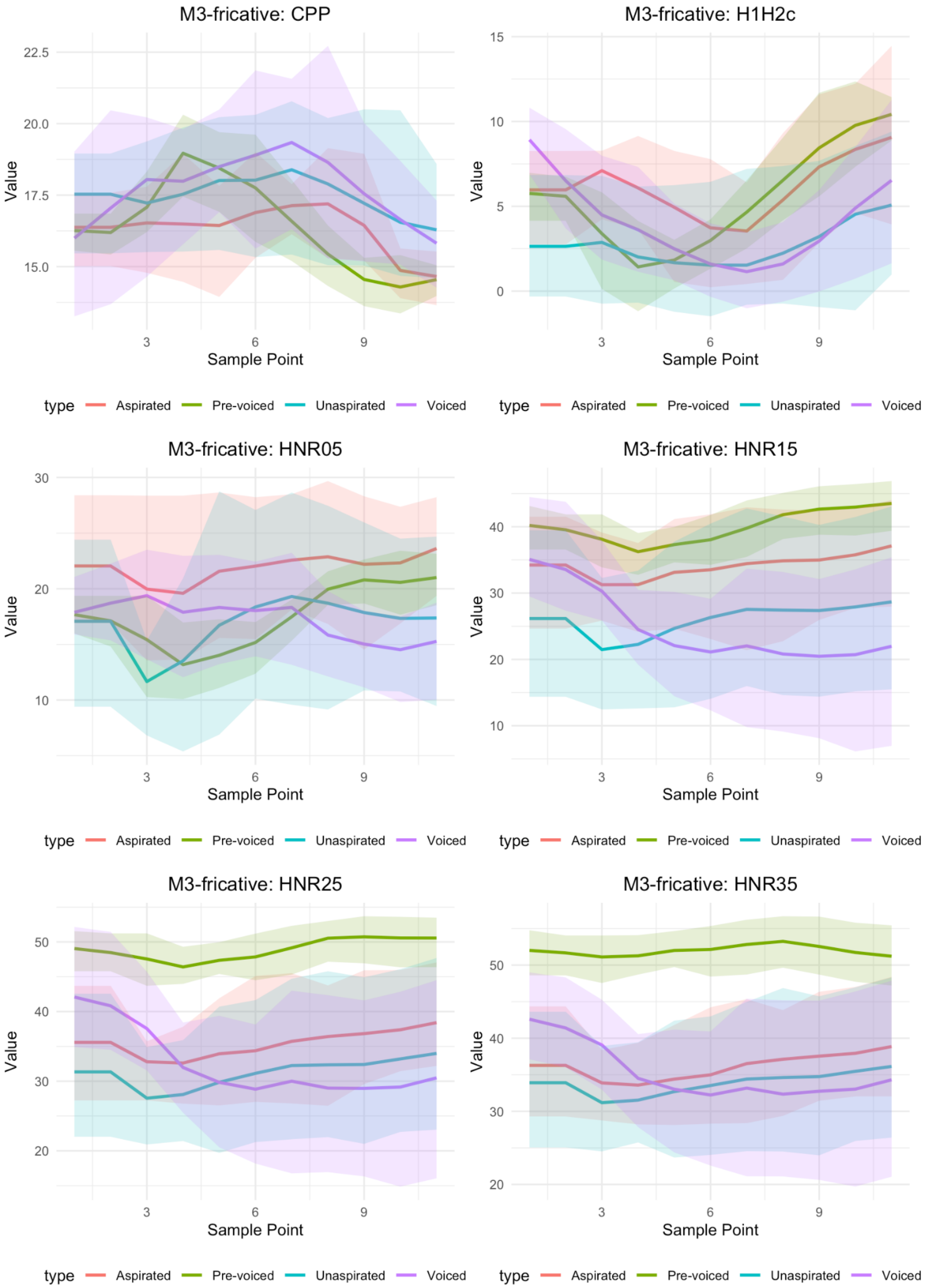
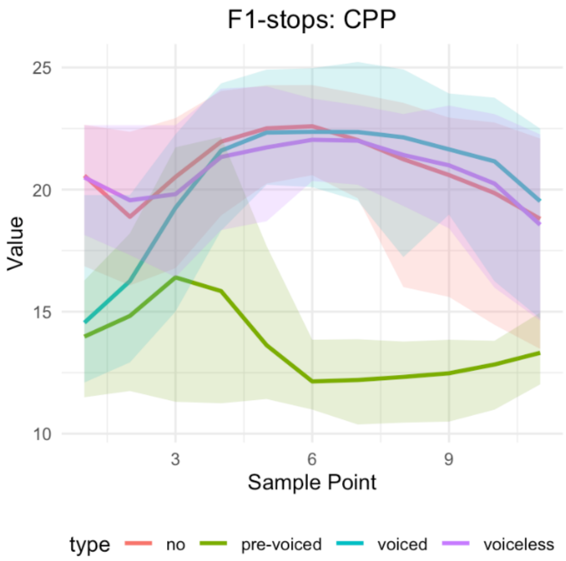

M3-fricative: CPP
M3-fricative: H1H2c
M3-fricative: HNR05
M3-fricative: HNR15
M3-fricative: HNR25
M3-fricative: HNR35
Value
Sample Point
type Aspirated Pre-voiced Unaspirated Voiced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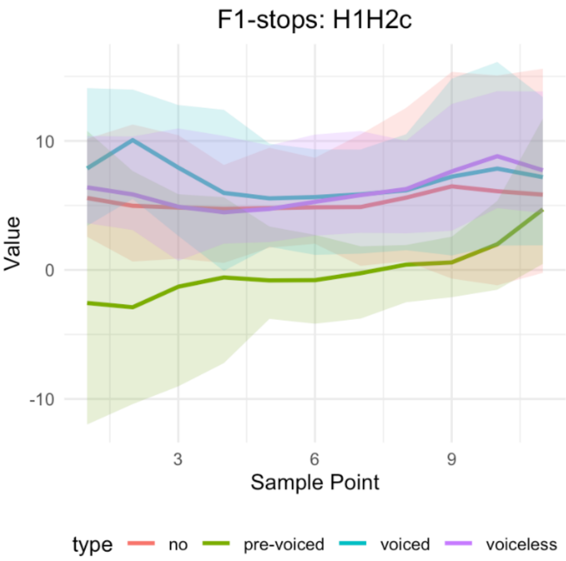
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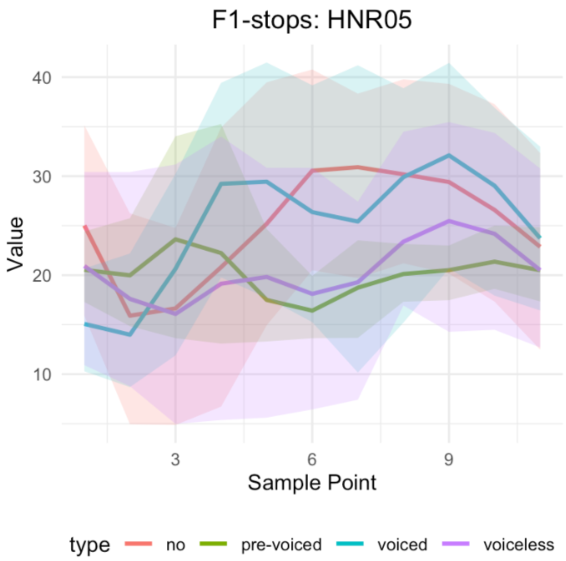
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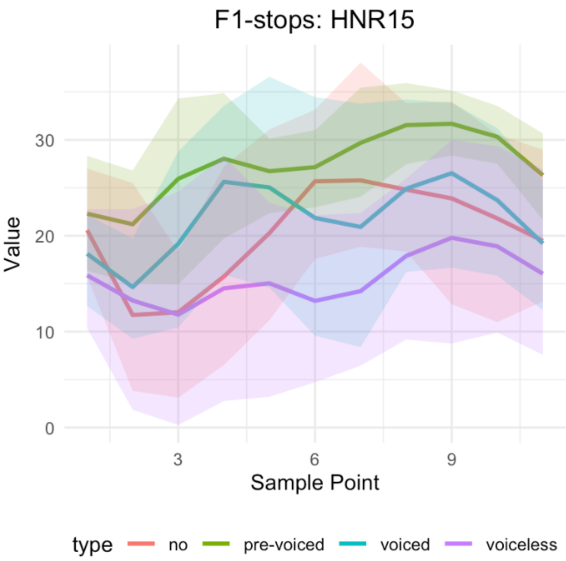
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voiced
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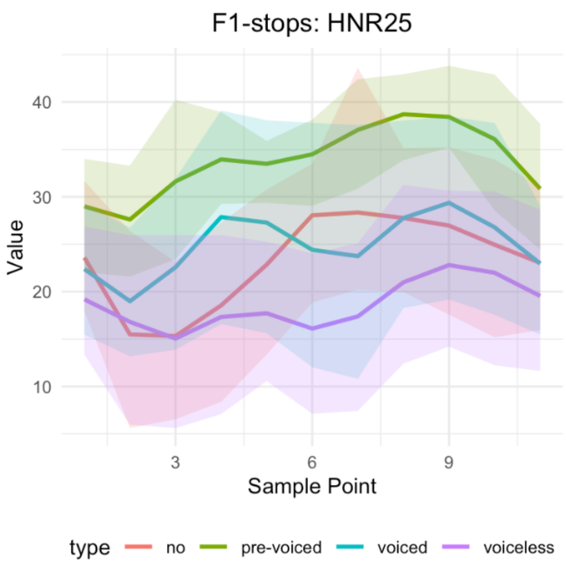
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voiced
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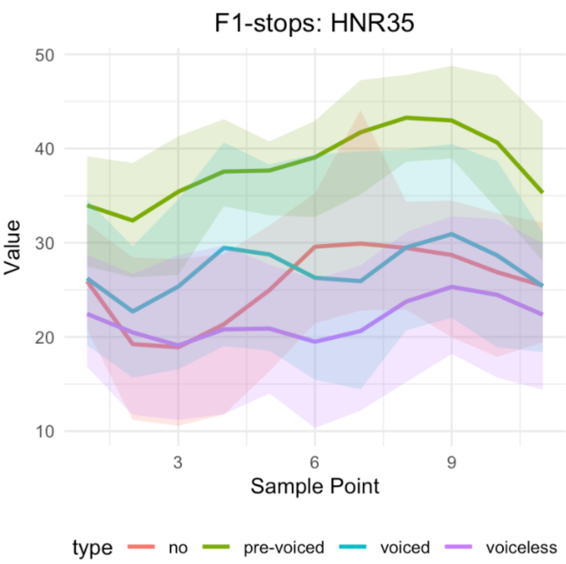
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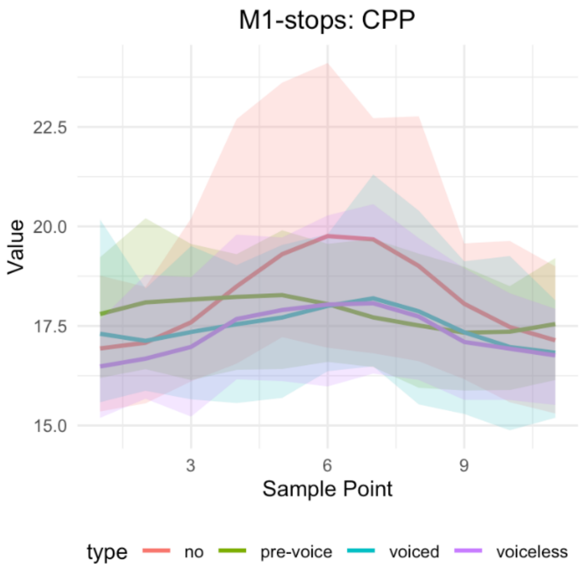
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6
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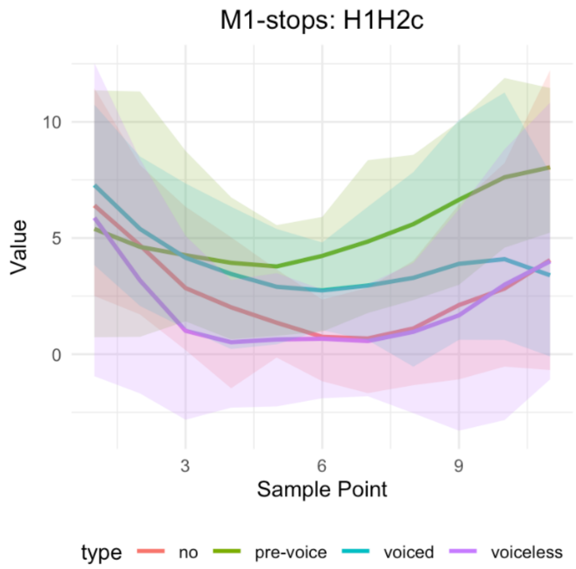
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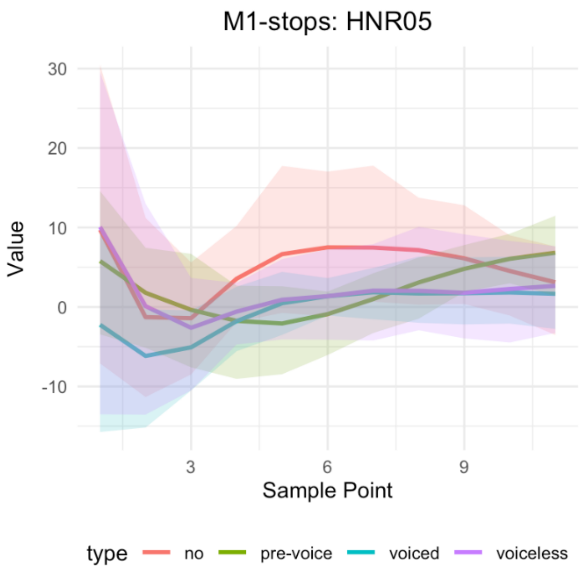
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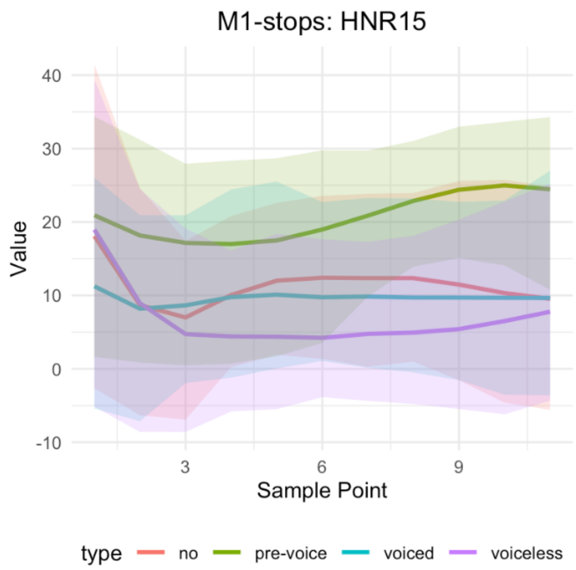
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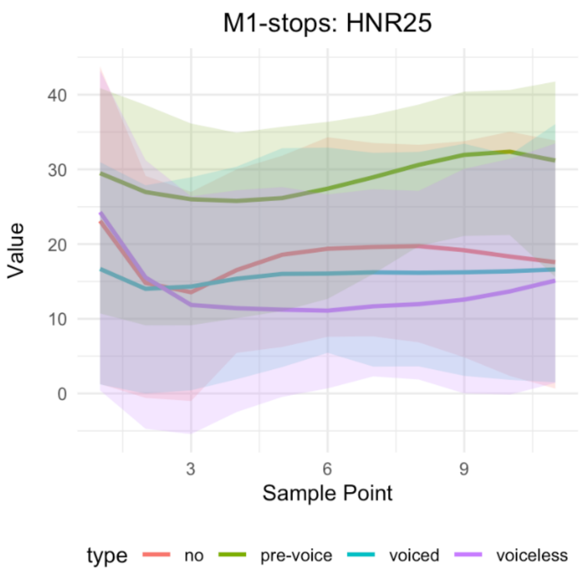
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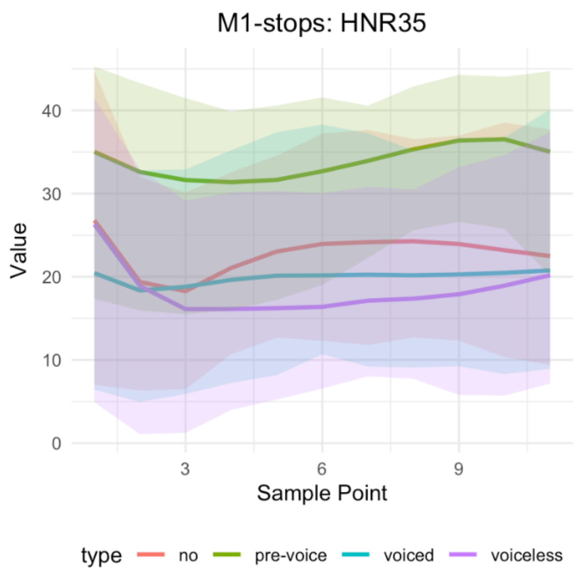
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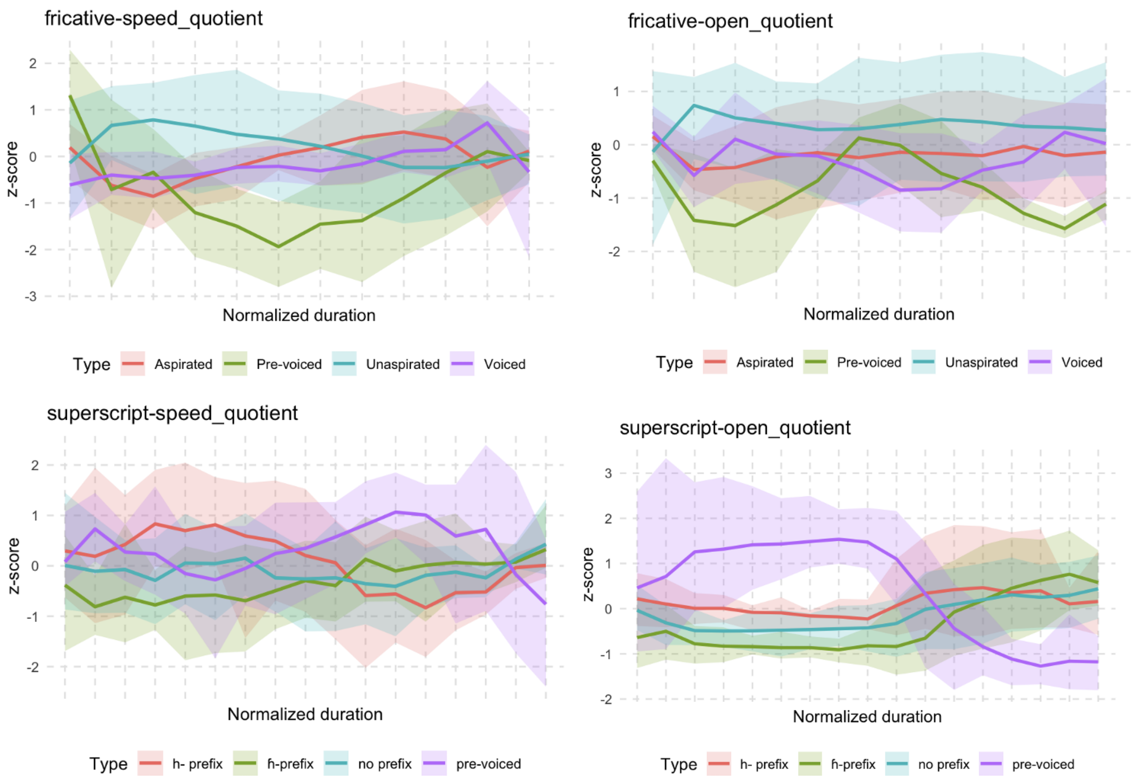
voiced
voiceless


fricative-speed_quotient
z-score
Normalized duration
Type
Aspirated
Pre-voiced
Unaspirated
Voiced
fricative-open_quotient
z-score
Normalized duration
Type
Aspirated
Pre-voiced
Unaspirated
Voiced
superscript-speed_quotient
z-score
Normalized duration
Type
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ɦ-prefix
no prefix
pre-voiced
superscript-open_quotient
z-score
Normalized duration
Type
h- prefix
ɦ-prefix
no prefix
pre-voiced

Vowel Glottalization as a Realization of the Velar Stop Coda: An EGG Study for Bokar

Ao QIU

Peking University

Bokar is a Tani language (Sun, 1993) spoken at the southern margin of the Tibetan Plateau. Scarcely any description of Bokar is available apart from the works of Megu (1990) and Ōuyáng (1985), both of which are short of detailed descriptions of phonological alternations. With the help of acoustic phonetic examination, this paper aims to demonstrate a phonological alternation of glottal replacement in Bokar with first-hand data collected in Mǐlín, China: the /k/ coda, when followed by a voiced non-velar consonant, loses its oral place of articulation; the preceding vowel is in turn lengthened and glottalized vowel-medially.

Preliminary inspection of formant transitions reveals that /k/ can lose its place of articulation. As shown in Figure 1(a), when /o/ is followed by a bilabial /p/ (in fact it is a sequence of a coda /p/ plus the initial of the next syllable /d/), the second formant (F2) of /o/ falls precipitously into a bilabial closure. However, as shown in Figure 1(b), when the coda is /k/ and followed by a /d/, the vowel /o/ does not show any transition for the closure of /k/. Instead, the duration of the vowel increases, and towards the end F2 rises for the alveolar closure of the /d/.

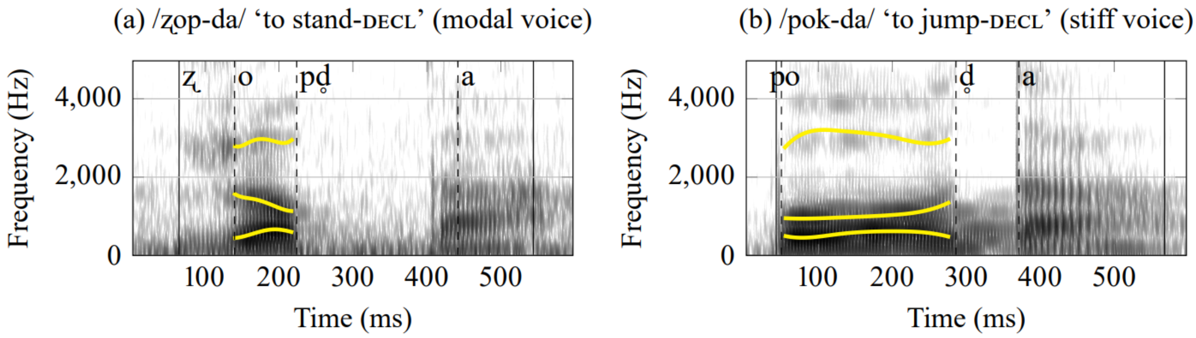

Figure 1: Wideband spectrograms with tracks of the first 3 formants

As mentioned earlier, in the target alternation, the vowel is not only lengthened but also glottalized. Glottalization is here defined as non-modal phonation with a more constricted glottis, including creaky voice and stiff voice on Ladefoged's (1973, p. 76) continuum. In most of the tokens collected, vowel glottalization is realized as stiff voice; only few tokens show creakiness. Creakiness occurs vowel-medially and can be observed in spectrograms (Figure 2). Stiff voice, however, is not amenable to spectrographic analysis; we therefore turn to electroglottograph (EGG) signals.

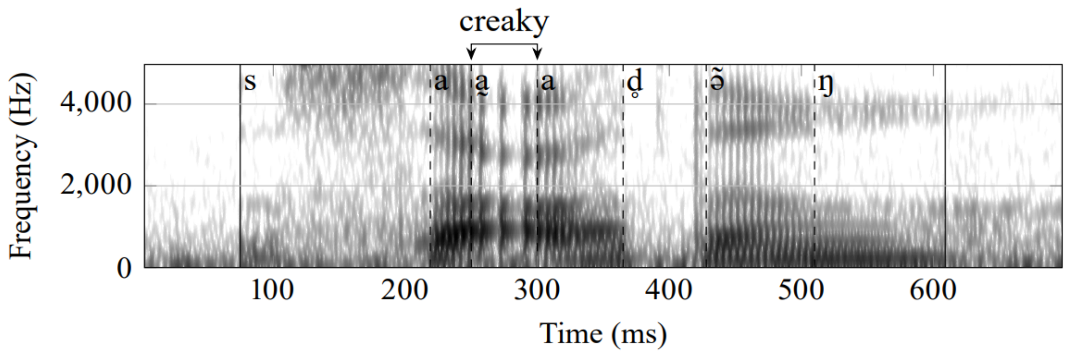

Figure 2: Wideband spectrogram of /sak-dəŋ/ 'to pant' (with creaky phonation)

Three parameters from the EGG signals, namely fundamental frequency (F0), contact quotient (CQ), and speed quotient (SQ), are used. It has been observed that glottalization is often accompanied by lower F0 (Hollien, 1974, p. 126), and more recent studies have found it to be in positive correlation with CQ and SQ, with CQ considered as the most reliable measure (see Kuang & Keating, 2014, Section II.D).

EGG signals of three groups (i) /CVk-da/ 'Verb-DECL', (ii) /CVk-to/ 'Verb-IMP', and (iii) /CV:da/ 'Verb-DECL' are collected. In group (i) glottal replacement is triggered; the vowel (V) is lengthened and glottalized. Groups (ii) and (iii) are control groups. 5 minimal pairs of /CVk/ and /CV:/ of different vowels are chosen (C = /p/ or /t/), and for each minimal pair, 5 tokens are recorded for each group, all pronounced by one female speaker (N = 5 × 5 × 3 = 75). None of the tokens shows creaky phonation.

F0, CQ, and SQ values at the duration of the vowel (V) are extracted using the hybrid method (Howard et al., 1990, p. 207). The results are fitted individually for each group with Generalized Additive Mixed Models (GAMMs) (Wood, 2017), with duration included as a fixed effect. The results are shown in Figures 3 and 4.

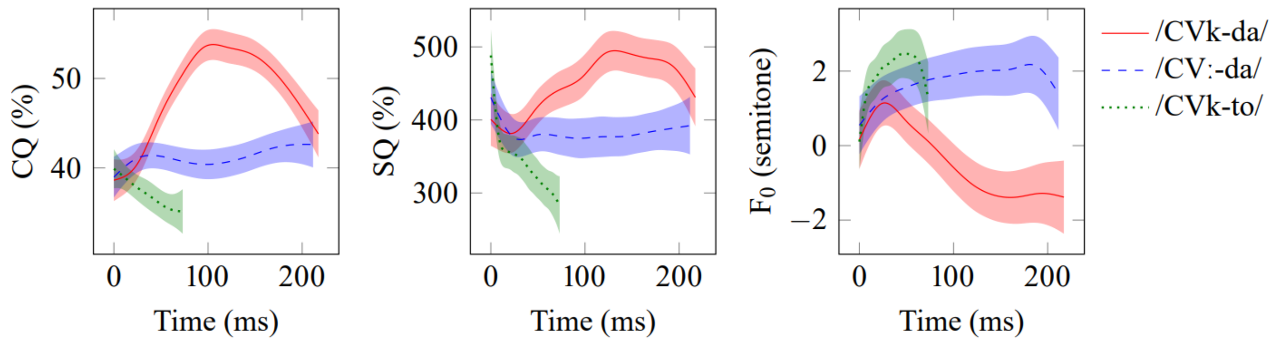

Figure 3: CQ, SQ, and F0 (reference at 220 Hz = A3) predicted by the models at mean duration for each group (95 % CI)

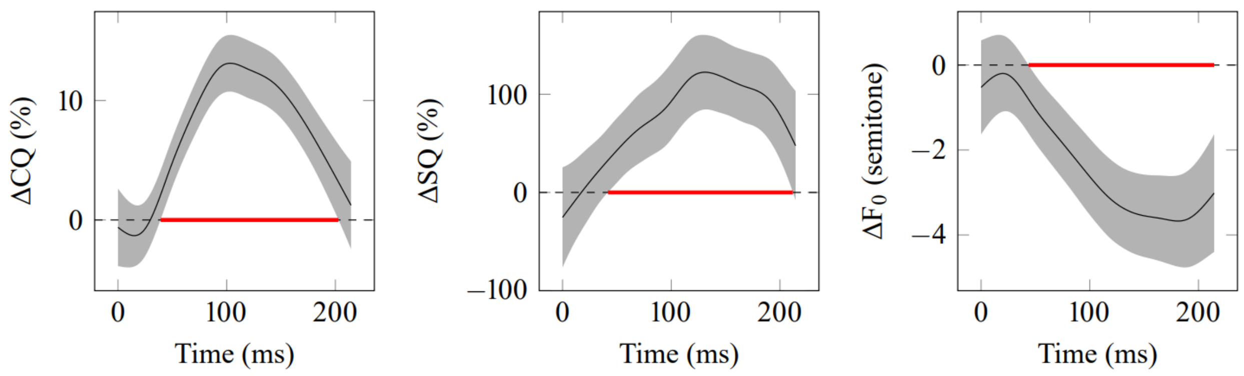

Figure 4: CQ, SQ, and F0 differences at mean duration between /CVk-da/ and /CVː-da/ (95 % CI)

The results show that the /V/ in /CVk-da/ is indeed glottalized, as both CQ and SQ are significantly higher, and F0 significantly lower for /CVk-da/ than /CVː-da/ for the most part of the vowel. What is worth noticing is that the point of the most constricted glottis occurs near the midpoint of the vowel's duration, instead of the very end of the vowel. The glottalization is hence vowel-medial, which goes in line with the observation made on the few tokens that exhibit creaky phonation.

The Bokar data demonstrate that the loss of a consonantal place feature is not a random diachronic accident but a phonetically conditioned process. Spectrograms map vowel lengthening and the vanishing formant transitions, and EGG traces the compensatory glottal constriction. Experimental phonetics helps to verify the precise acoustic conditions that license lenition and provides a more detailed account of its realization, shedding light on the prediction of segment erosion across languages.

References

Hollien, H. (1974). On vocal registers. *Journal of Phonetics*, *2*(2), 125–143. https://doi.org/10.1016/S0095-4470(19)31188-X

Howard, D. M., Lindsey, G. A., & Allen, B. (1990). Toward the quantification of vocal efficiency. *Journal of Voice*, *4*(3), 205–212. https://doi.org/10.1016/S0892-1997(05)80015-3

Kuang, J., & Keating, P. (2014). Vocal fold vibratory patterns in tense versus lax phonation contrasts. *The Journal of the Acoustical Society of America*, *136*(5), 2784–2797. https://doi.org/10.1121/1.4896462

Ladefoged, P. (1973). The features of the larynx. *Journal of Phonetics*, *1*(1), 73–83. https://doi.org/10.1016/S0095-4470(19)31376-2 Megu, A. (1990). *Bokar language guide*. Dr. P. C. Dutta.

Ōuyáng, J. (1985). *Luòbāzú yǔyán jiǎnzhì (Bēngní-Bógá'ěryǔ)* [A brief description of the languages of the Luoba ethnic group (Bengni-Bokar)]. Mínzú Chūbǎnshè.

Sun, T. J. (1993). *A historical-comparative study of the Tani (Mirish) branch in Tibeto-Burman* (Publication No. 9408131) [Doctoral dissertation]. ProQuest Dissertations and Theses Global. Wood, S. N. (2017). *Generalized additive models: An introduction with R* (2nd ed.). CRC Press, Taylor & Francis Group. https://doi.org/10.1201/9781315370279

Perceptual Differences in Voicing Contrast Between Early and Late Bilinguals: A Case Study of Jiuhe Naxi

Zihe LI

Peking University

Cross-linguistic research suggests that both VOT (Voice Onset Time) and F0 (fundamental frequency) may serve as perceptual cues in distinguishing voicing contrasts. In contexts of language contact, might the perceptual patterns of voicing contrasts undergo changes? This study investigates this question using Jiuhe Naxi, a variety of western Naxi spoken in Jiuhe Township, Lijiang, Yunnan Province.

In Jiuhe Township, approximately 40% of the population are Naxi, while 50% are Bai. In the southern mixed-residence areas, most Naxi individuals over the age of 40 can speak some Bai language. Naxi-Bai bilinguals who either have one Bai parent or began learning Bai before school age are defines as early bilinguals, while late bilinguals are those who started learning Bai after entering school. Naxi is a true-voicing language with a three-way voicing contrast (voiced vs. voiceless unaspirated vs. voiceless aspirated) and three lexical tones, whereas Bai has a two-way contrast (voiceless unaspirated vs. voiceless aspirated) and six tones.

In production test, 26 monosyllabic words with voiceless unaspirated stops or voiced stops were selected. 25 participants were recruited and asked to read these words. The recordings were measured to get their VOTs. The results show that for Tone 55 words with voiced initials, the absolute VOTs produced by both early and late bilinguals were greater than those for Tone 33 words with voiced initials. For Tone 21 words with voiced initials, early bilinguals produced smaller absolute VOTs compared to Tone 33 words with voiced initials (Fig. 1).

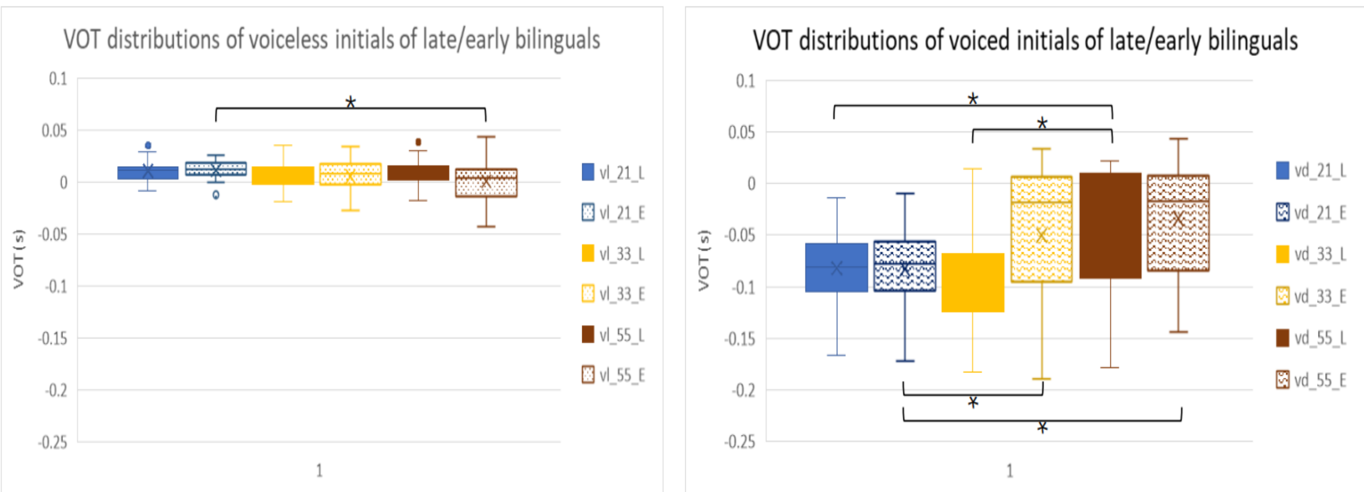

Figure 1 VOT distributions

For perception analysis, four voicing continua (p21-b21, p33-b33, t33-d33, t55-d55) were constructed by manipulating VOT from maximally negative to maximally positive values for perceptual experiments. The same 25 participants were required to listen to one stimulus at a time and then choose the word they heard from a voicing / voiceless unaspirated minimal pair. The findings reveal that: (1) The voicing boundary for Tone 33 syllables was located closer to the more negative VOT end than that for Tone 21 syllables, while the boundary for Tone 55 syllables was shifted even further toward the negative VOT end compared to Tone 33. (2) The overall percentage of "voiced" responses followed the order: Tone 21 continuum > Tone 33 continuum > Tone 55 continuum (Fig.2).

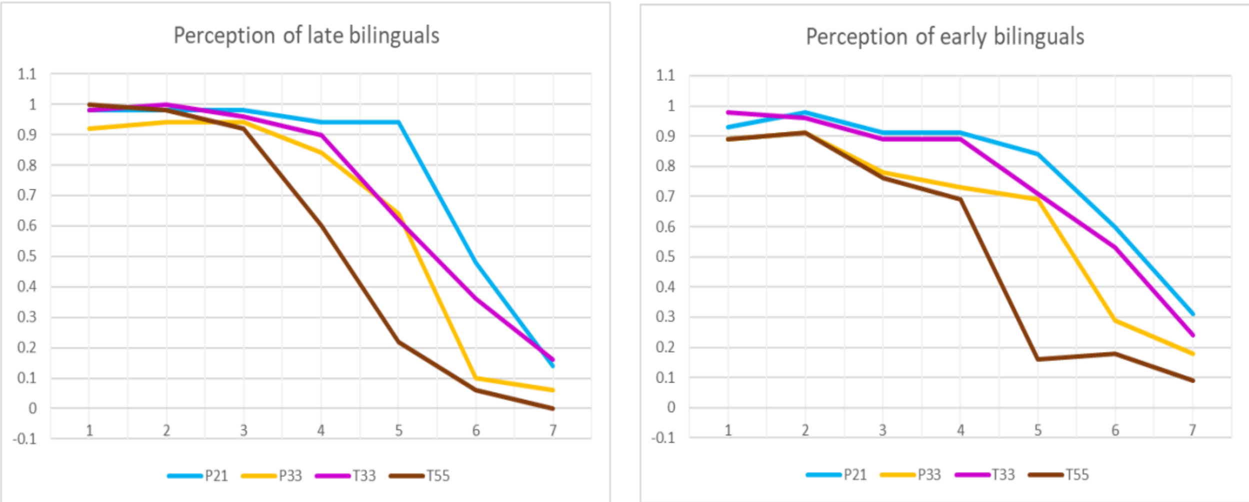

Figure 2 Perception curves

A GLMM were built to measure the effects of steps of continua, tones, and early/late bilingual. The result show that all these factors as well as their interactions have significant effects on voicing perception. Early bilinguals showed a stronger influence of F0 on voicing perception than late bilinguals (Table 1).

Table 1 GLMM estimation results

	Estimate	Std.Error	z-value	Pr(>|z|)	
(Intercept)	-0.32175	0.28737	-1.12	0.26287	
step2	0.27572	0.30347	0.909	0.36358	
step3	1.81006	0.34683	5.219	1.80E-07	***
step4	3.00294	0.47506	6.321	2.60E-10	***
step5	2.43998	0.40038	6.094	1.10E-09	***
step6	3.73559	0.62523	5.975	2.31E-09	***
step7	3.19928	0.50942	6.28	3.38E-10	***
tone33	-0.83188	0.27776	-2.995	0.00274	**
tone55	-2.04506	0.4299	-4.757	1.96E-06	***
bailate	-1.02987	0.41093	-2.506	0.0122	*
step5:tone55	1.56905	0.61563	2.549	0.01081	*
step7:tone55	1.68239	0.74377	2.262	0.0237	*
step3:bailate	1.40508	0.50283	2.794	0.0052	**

step5:bailate	1.66106	0.59903	2.773	0.00556	**

A possible explanation is that F0 plays a more critical role in Bai's perceptual structure than in Naxi's, leading to differences in how early and late bilinguals establish voicing categories. Additionally, from a typological perspective, using F0 as a cue for voicing contrasts is highly common, suggesting that Naxi (L1)-Bai (L2) bilinguals may be shifting toward a less marked perceptual pattern.

SESSION E

Approches phonétiques instrumentales des langues peu documentées

Instrumental Phonetic Approaches to Under-Documented Languages

Hadza Phonetics: Articulatory, Aerodynamic and Acoustic Aspects

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[3] University of Bayreuth Faculty of Languages and Literatures

1. Introduction

Hadza an isolate language spoken in Tanzania has non-pulmonic consonants, clicks and ejectives, in its phonetic / phonological inventory. Sands, Maddieson & Ladefoged (1996), Sands (2013) and (2020) describe Hadza with 9 clicks while Miller (2008) suggests that there are 12. Recent data show that the language has 13 : [ʘ̰, ǀˀ, ǀʰ, ᵑǀ, ᵑǀˀ, !ˀ, !ʰ, ᵑ!, ᵑ!ˀ, ǁ, ǁʰ, ᵑǁʰ, ᵑǁˀ]. Thus there are 4 types of clicks with various accompaniments [k, g, q, ʰ, ˀ, ʱ, ŋ, ŋ̊] that can sometimes be combined.

The aim of this presentation is to describe the aerodynamic, articulatory and acoustic features of Hadza clicks. The goal is also to evaluate the gestures involved in clicks with a measure of time and establish their distinctive features from acoustic and aerodynamic data. A precise articulatory and acoustic understanding of the mechanisms involved in their production and perception is necessary to characterize and formalize these consonants in terms of distinctive features. Another issue that will addressed is: are there aspirated clicks in Hadza?

2. Material and method

Words including all Hadza consonants were recorded. Each word was repeated 3 times by 5 male and 4 female native speakers. For the present study (that only analyzes data from 2 females & 2 males) the following set of data has been used to compare the production of all the speakers. 1) [ʘ] Bilabial click [mʘ̰ʷa] 'Thank God'; 2) [ǀ] Dental click (glottal, aspirated, nasal, glottal nasal) : [ǀˀu] 'To end on an errand', [ǀalʰa] 'Threshing rock', [ᴺǀ̰ata] 'Tongue', [tuᴺǀ̰ˀe] 'To pluck feathers'; 3) [!] Alveolar click (simple, nasal, aspirated, glottal): [la!o] 'To trip', [kuᴺ!̰ana] 'Kudu', [!ʰaku] 'To jump', [!ˀoje] 'Beeswax', [!ˀakx'itɬa] 'The hard palate'; 4) [ǁ] Lateral click (simple, aspirated, glottal nasal, nasal): [ǁupʰi] 'To sleep', [ǁʰa] 'To throw', [beᴺǁ̰ˀe] 'To shine', [ᴺǁ̰a:] 'For the whole camp to visit another one'. As the bilabial click has very limited occurrences, the main focus is set on the dental, alveolar and palatal clicks.

Aerodynamic and acoustic data were recorded with an EVA2 Workstation [5] allowing simultaneous recordings of several aerodynamic parameters: intraoral pressure (Po) measured in hecto-Pascal (1hPa = 1.02cm H_2O), oral airflow and if necessary nasal airflow in dm^3/s. Audio recordings, synchronized with the aerodynamic data, are recorded with a microphone integrated to the EVA2 transducers. Oral Airflow (Oaf) was collected using a flexible silicone mask set on the subjects' mouth. Intraoral pressure (Po) was recorded by inserting a small tube into the pharynx through the nasal cavity. EGG was also systematically recorded in synchronization with the other parameters.

3. Results

The timing of front and back closures releases in clicks is shown from aerodynamic data combining Po and Oaf. They allow to describe with precision the sequence between the front and the back release in clicks. Figure 1. shows an example of three consecutive dentals clicks [ǀ], in the word [ǀaǀaǀʰaɦa] the third being aspirated. Po in red, Oaf in green and the audio waveform in blue show the sequence of gestures. It can be seen that the release of the front closure corresponds to a burst visible both on the audio waveform and on the spectrogram. At this moment Oaf becomes negative showing an incoming airflow. This is the consequence of the volume increase created between the two sealed closures (in the dental and velar/uvular area) to produce the clicks. It can also be observed that Po falls slightly after the first burst. This corresponds to the release of the back closure. The aspirated character of the third dental click is shown by a much greater airflow following the release of the second click closure.

The role of the posterior cavity is also important to consider in click releases. The short rising resonances - the partials - [between 1 and 2 kHz] following the posterior release, results from the lowering and retraction of the tongue dorsum reducing the volume of the pharyngeal cavity. These short resonances are visible after the 1st transient of the aspirated click in Figure 1. Although this has been observed with all accompaniments, but the bilabial, this occurs more frequently with the glottal and aspirate clicks.

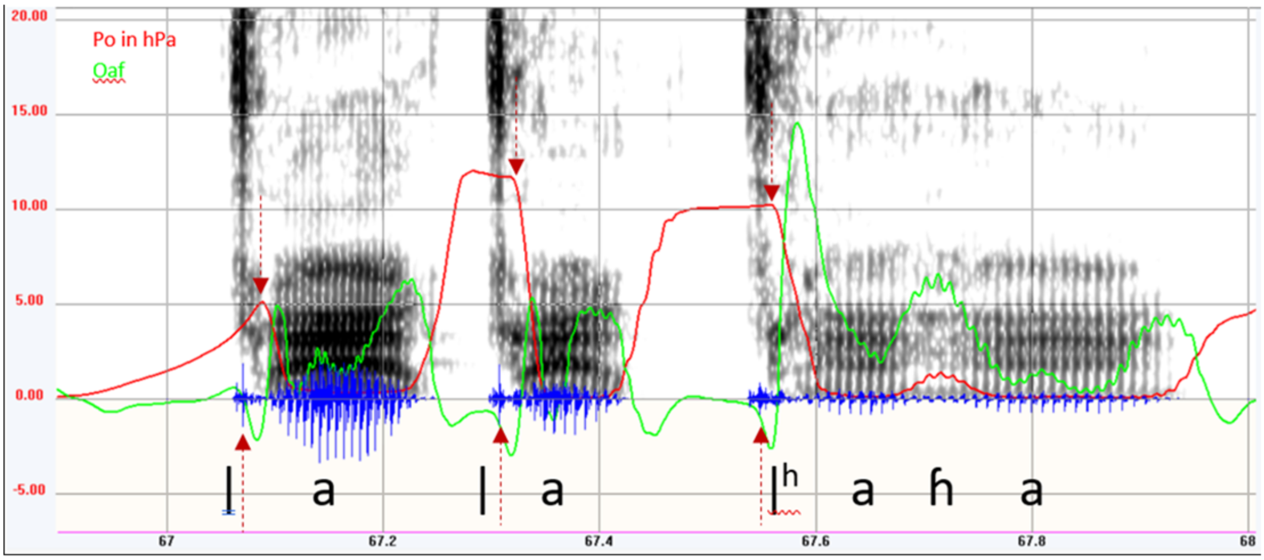

Figure 1. Audio waveform (blue), Po (red), Oaf (green) and wideband spectrogram of the word [ǀaǀaǀʰaɦa] in Hadza. Vertical arrows show the releases of the front closure and downward arrows the moment of the back releases.

Discussion

This presentation aims at describing the timing of articulatory gestures involved in clicks and to demonstrate the presence of aspirated clicks in Hadza. A detailed account of the nine speaker variations between of these phenomena will be presented.

References

Sands, B, Maddieson, I. & Ladefoged, P. 1996. The phonetic structures of Hadza. *Studies in African linguistics* (25), 2: 171-204.

Sands, B. 2013. Phonetics and phonology of Hadza. In R. Vossen (ed). *The Khoesan languages*. London, Routledge: 38-42.

Sands, B. 2020. Click consonants an introduction. In B. Sands (ed.) *Click consonants*. Leiden, Brill: 1-73.

Miller, K. 2009. *Highlights of Hadza Fieldwork*. Ms. San Francisco.

Ghio, A. and B. Teston, "Evaluation of the acoustic and aerodynamic constraints of a pneumotachograph for speech and voice studies," in *International Conference on Voice Physiology and Biomechanics,* 2004: 55–58.

Traill, A. 1997. Linguistic phonetic features for clicks: Articulatory, acoustic and perceptual evidence. In R.K. Herbert (ed.) *African Linguistics at the Crossroads: Papers from Kwalusemi*. Köln, Rudiger Köppe: 97-117.

An Acoustic Exploration of Aspirated Fricatives in Gyersgang Tibetan

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Aspirated fricatives are typologically uncommon sounds, primarily concentrated in Asia, the Americas, and parts of Africa. Among these, the Sino-Tibetan language family exhibits high prevalence of aspirated fricatives (Jacques, 2011). Jacques (2011) highlights that aspirated fricatives are notoriously unstable sounds, with languages like Burmese showing ongoing mergers of aspirated and unaspirated fricatives (Wheatley, 2003).

According to Rabha et al. (2019), similar to aspirated stops and affricates, aspirated fricatives exhibit a period of aperiodic aspiration between the consonant release and vowel onset, with a significant decrease in amplitude compared to fricative segments. Previous research indicates that aspirated fricatives can be generally divided into two types: one where the fricative noise and aspiration noise are distinct, and another where these components are acoustically inseparable.

In languages like Korean, the aspirated fricative has a noticeable energy change between the fricative noise and aspiration noise, and a line can be drawn to separate these two noises. Conversely, in languages such as Cone Tibetan, Rabha, and Angami, the aspiration and frication components are difficult to distinguish, as both manifest aperiodic noise generated by turbulent airflow (Rabha et al. 2019).

The target language of this study, Gyersgang Tibetan, is an endangered Eastern Tibetic language spoken in Thebo County, Gansu Province, China. It features a contrast between aspirated and unaspirated fricatives in three distinct articulatory positions: alveolar (/s^h/-/s/), alveolo-palatal (/$ɕ^h$/-/ɕ/), and uvular (/$χ^h$/-/χ/). In Gyersgang Tibetan, aspirated fricatives exhibit a mixture of two types, but their occurrence follows a consistent pattern: while most aspirated fricatives show discernible aspiration noise, significant aspiration noise is rarely observed before the vowel /i/ or in the non-sibilant aspirated fricative /$χ^h$/. To investigate aspirated fricative in Gyersgang Tibetan, this study examines the three fricative pairs (/s^h/-/s/, /$ɕ^h$/-/ɕ/, /$χ^h$/-/χ/) across different vowels (/i/, /e/, /a/) produced by 10 speakers (5 females, 5 males; aged between 24-47 years old). Duration, spectral moment, and onset f0 were used as acoustic parameters for analysis. Spectral moments were measured using the methods proposed by Spinu & Lilley (2016), by which each fricative segment was subdivided into three equal-length regions for more detailed acoustic analysis.

For the duration, aspirated fricatives consistently demonstrate longer consonant segment duration than their unaspirated counterparts. However, this durational difference is only significant in fricatives preceding the vowel /i/, where it holds across all three fricative pairs: the alveolar /s^hi/ (241.53 ms) exceeds /si/ (206.15 ms; $p < .001$), the alveolo-palatal /$ɕ^h$i/ (265.11 ms) surpasses /ɕi/ (211.58 ms; $p < .001$), and the uvular / $χ^h$i/ (209.08 ms) exceeds /χi/ (193.40 ms; $p < .005$). This pattern indicates that although aspiration noise proves difficult to observe before the high vowel /i/, duration serves as an additional cue to distinguish between aspirated and non-aspirated fricatives.

Among the spectral moments, center of gravity (CoG) and standard deviation (sdev) demonstrate the most consistent statistically significant distinctions between aspirated and unaspirated fricatives. While these parameters show no significant distinction within the first two regions, marked divergence emerges in Region 3 (including the potentially aspirated segment) with statistically significant differences observed in both CoG and sdev.

As shown in Figures 1 and 2, for both sibilant pairs /s^h/-/s/ and /$ɕ^h$/-/ɕ/, significant differences in CoG and sdev were observed across all vowel contexts. Aspirated fricatives exhibited lower CoG but higher sdev compared to their unaspirated counterparts, suggesting a wider constriction gap during articulation. Conversely, for the non-sibilant pair /$χ^h$/-/χ/, neither CoG nor sdev showed significant differences across all vowel combinations.

Figure 1: CoG values of /s/-/s^h/, /ɕ/-/$ɕ^h$/, and /χ/-/$χ^h$/ in three vowel contexts.

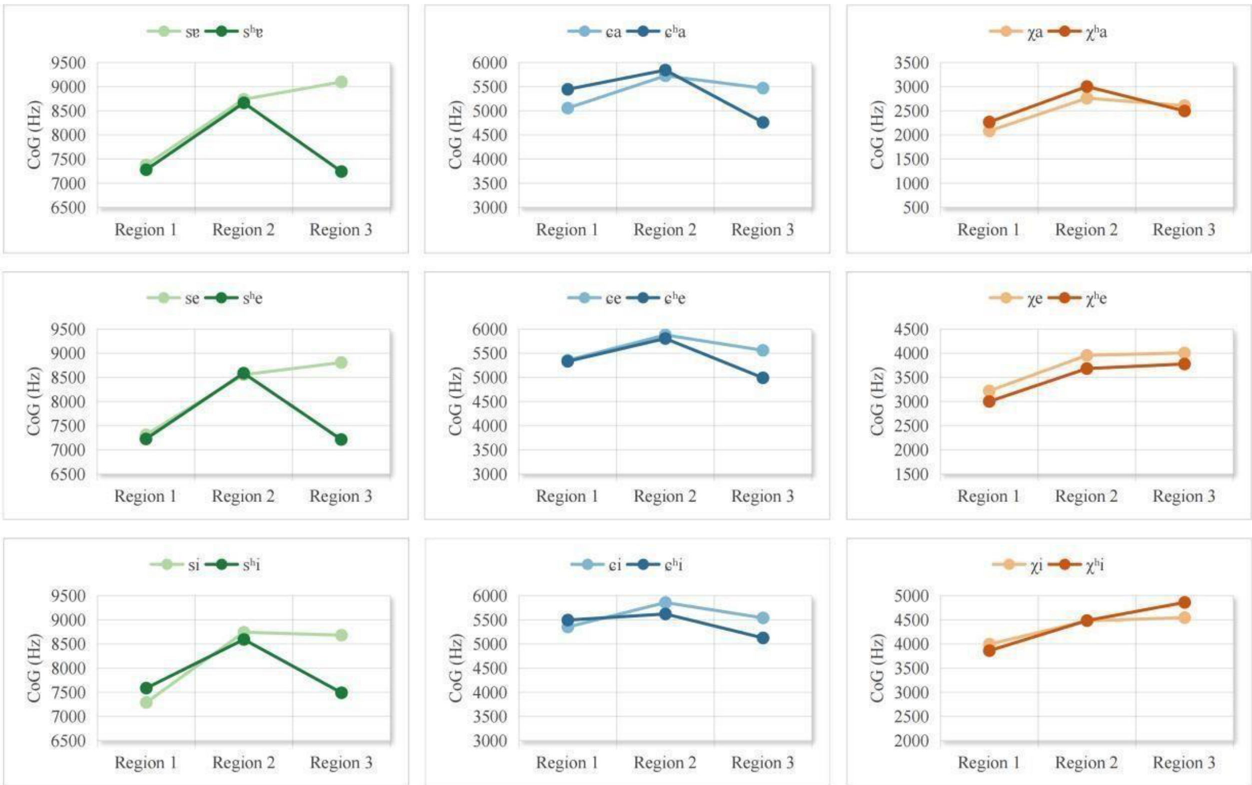
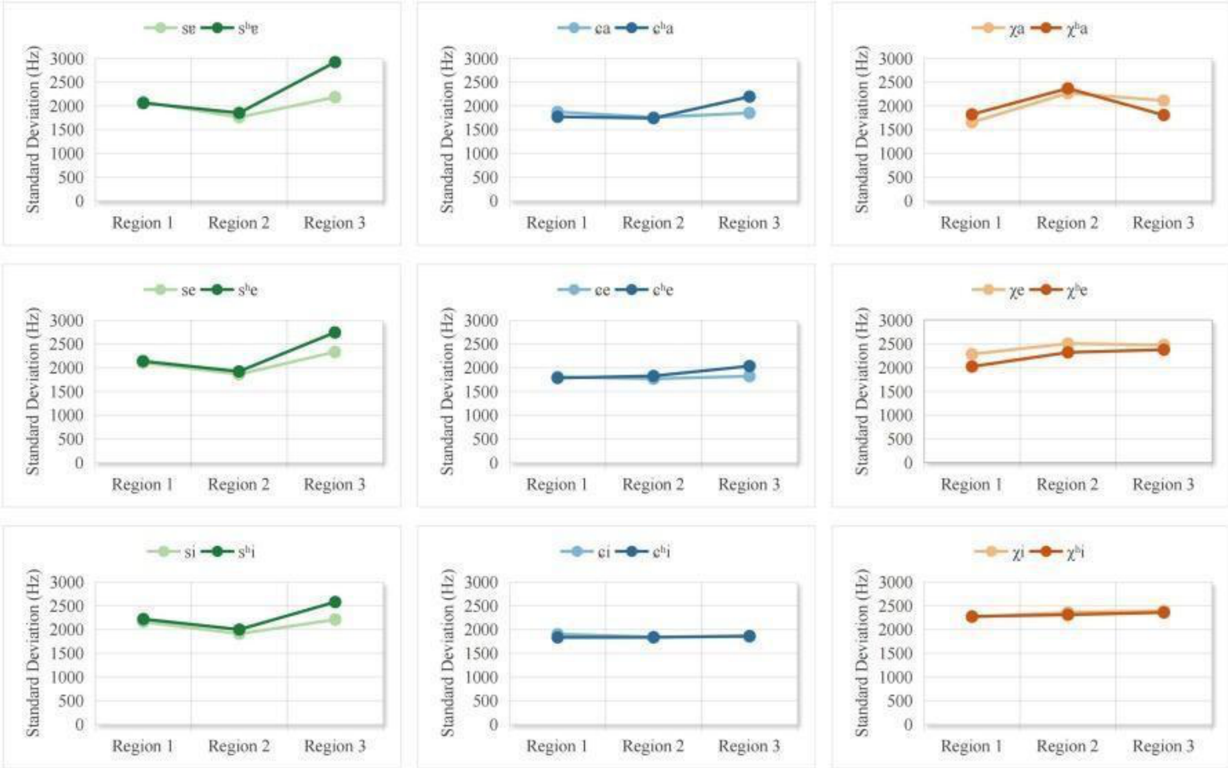
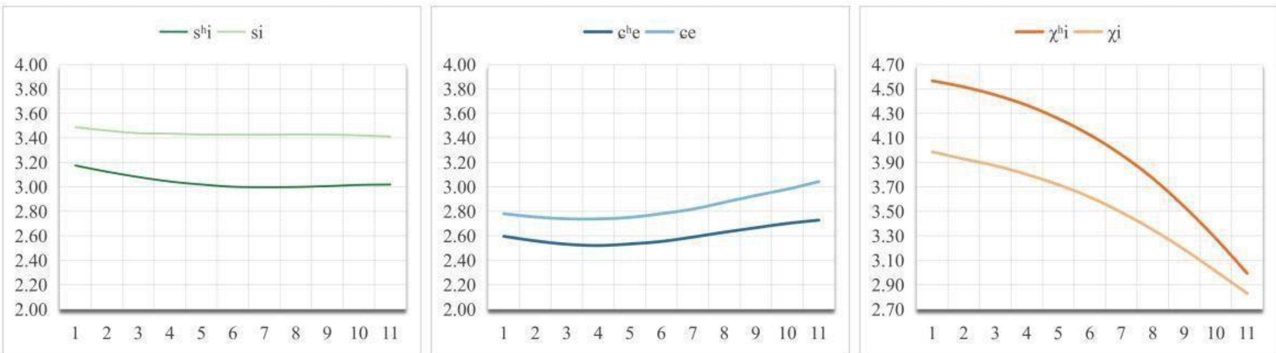


Figure 2: Sdev values of /s/-/s^h/, /ɕ/-/$ɕ^h$/, and /χ/-/$χ^h$/ in three vowel contexts.



However, onset f0 measurements of three minimal pairs representing different articulation sites showed significant differences across all groups. As shown in Figure 3, the two sibilant pairs (/sʰ/-/s/, /ɕʰ/-/ɕ/) exhibited lower onset f0 in aspirated fricatives compared to unaspirated counterparts, whereas the non-sibilant pair /χʰ/-/χ/ displayed higher onset f0 in aspirated productions. Crucially, the largest f0 difference occurred in the non-sibilant pair /χʰ/-/χ/: at the onset position, /χʰi51/ significantly exceeded /χi51/ by 4.57 to 3.99[2] ($p<.001$). Based on the non-significance of CoG and sdev for /χʰ/-/χ/, the significant difference of f0 data suggests that the merge between /χʰ/ and /χ/ may have already occurred in the Gyersgang Tibetan, with the loss of this distinction shifting toward tonal differentiation. The findings align with expectations of phonological reorganization in unstable categories, suggesting a dynamic linguistic evolution.

Figure 3: Onset f0 values of /se55/-/sʰe55/, /ɕi13/-/ɕʰi13/, and /χi51/-/χʰi51/.



References

[2] The onset f0 values are converted to a five-point scale using T-transform.

Du, S.R. (2024). Diebuxian zangyu huayuanhua yinxi tanjiu [A phonetic and phonological profile of Gyersgang Tibetan in Thebo]. Capital Normal University

B.A. Dissertation.

Jacques, G. (2011). A panchronic study of aspirated fricatives, with new evidence from Pumi. Lingua, 121(9), 1518-1538.

Rabha, S., Sarmah, P., & Prasanna, S. R. (2019). Aspiration in fricative and nasal consonants: Properties and detection. The Journal of the Acoustical Society of America, 146(1), 614-625.

Spinu, L., & Lilley, J. (2016). A comparison of cepstral coefficients and spectral moments in the classification of Romanian fricatives. Journal of Phonetics, 57, 40-58.

Yoon, K. C. (2002). A production and perception experiment of Korean alveolar fricatives. Speech sciences, 9(3), 169-184.

Zhang, W. J. & Lan, C. (2020). Ganzixian zangyu songqi cayin zhi yuyinxue benzhi [The phonetic essence of "aspirated fricative" in Garze-Dzong Tibetan]. The 2020 Annual Research Forum of the Linguistic Society of Hong Kong (LSHK-ARF-2020), Hong Kong, China.

Étude acoustique et articulatoire exploratoire des plosives coronales non voisées du baniwa de l'Içana

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1 Introduction

Le baniwa de l'Içana est une langue arawak du nord parlée par environ 7 000 locuteurs (1). Cette étude pilote porte sur le dialecte central du baniwa, parlé dans la région médiane du fleuve Içana, au Brésil. D'après (2), cette langue distingue deux occlusives coronales orales: une apico-alvéolaire /t/ et une lamino-dentale /t̪/. Cette opposition est particulièrement rare dans les langues du monde (3), ce qui motive notre objectif de caractériser leur production à travers des analyses articulatoires (palatographie et linguo graphie) et acoustiques (transitions de F2 et durée du VOT). Cette étude constitue la première phase d'un projet de recherche plus large, qui inclura d'autres mesures articulatoires et acoustiques telles que les loci, les transitions de F1, des données paléographiques et échographiques, ainsi que des tests acoustico-perceptifs.

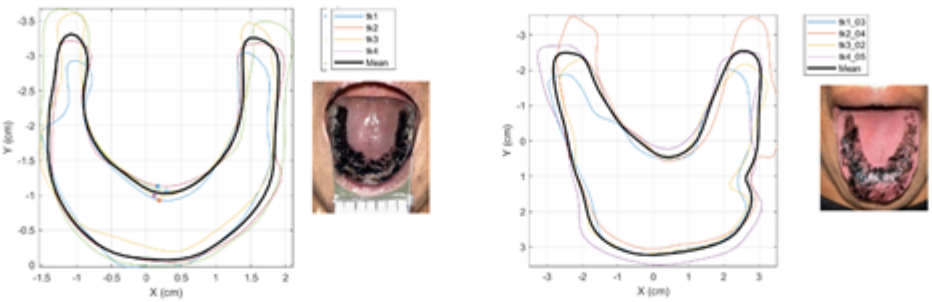
2 Méthode

Ce travail a été mené avec une locutrice native de 25 ans, originaire de Tunui Cachoeira (région de l'Içana, Brésil), parlant également le portugais brésilien comme langue seconde. Les données paléographiques et linguographiques ont été recueillies à partir de 16 mots cibles contenant /t/ et /t̪/ en syllabe accentuée, dans des contextes #CV et VCV, en couvrant l'ensemble des voyelles /i e a o̞/ (1). Afin d'éviter le chevauchement des traces articulatoires avec celles du segment cible, les autres syllabes ont été construites avec des consonnes extra buccales. Le mélange palatographie utilise du charbon actif, de l'huile d'olive et du chocolat, appliqué respectivement sur la langue et le palais supérieur. Chaque mot a été répété quatre fois. Les images ont été capturées à l'aide d'un smartphone haute résolution, d'un miroir et d'une règle millimétrée.

Pour l'analyse acoustique, les mots cibles ont été insérés dans une phrase porteuse, enregistrée quatre fois. Le logiciel Praat (4) a été utilisé pour segmenter l'occlusive cible et la voyelle qui la suit, et pour mesurer F2 toutes les 5 ms, de 10 ms avant la frontière consonne- voyelle à 20 ms après le début de la voyelle. Sept points de mesure de F2 ont ainsi été extraits pour chaque séquence cible. La durée du VOT a été segmentée en trois phases: Transitoire (T), Friction (F) et Aspiration (A), selon (5). L'ensemble de l'analyse a été menée conformément à (6).

3 Résultats et discussion

Les analyses palatographiques et linguographiques représentent deux articulations distinctes. Pour /t/, les données palatographiques (Figures 1 et 2) montrent une articulation apico- lamino-dentale, dans laquelle la lame et la pointe de la langue semblent se situer à une hauteur similaire lors de l'occlusion, produisant une trace plus large. En revanche, /t̪/ est réalisé avec une articulation lamino-pré-alvéolaire, la pointe étant plus basse que la lame, ce qui produit une trace plus étroite. Ces configurations sont constantes quel que soit le contexte vocalique (#CV ou VCV), /t/ présentant une occlusion plus étendue que /t̪/. Ces résultats diffèrent des descriptions proposées dans (2).



• *Figure 1. Palatographie (à gauche) et linguographie (à droite) de la consonne /t/ dans le mot /taapa/ « tombée de la nuit ». Les tracés de quatre répétitions ont été calculés de manière semi-automatique à l'aide d'un script MATLAB interne.*

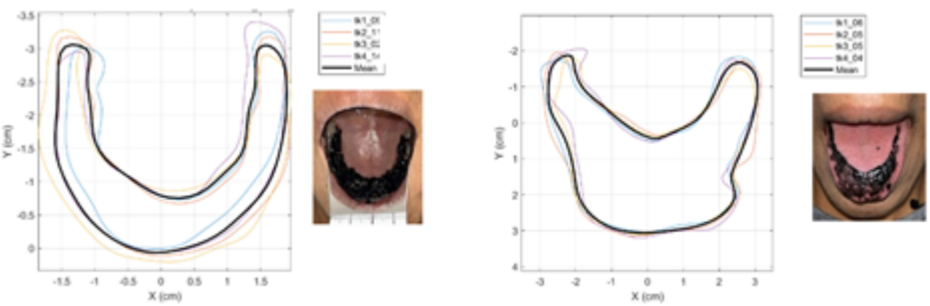


Figure 2. Palatographie (à gauche) et linguographie (à droite) de /t̪/ dans le mot /t̪amome/ « lumière ». Les tracés de 4 répétitions ont été calculés de manière semi-automatique à l'aide d'un script MATLAB

Les analyses acoustiques indiquent que, dans les positions #CV et VCV, la fréquence moyenne de F2 au début du voisement est de 1,6 kHz pour /t/ et de 1,8 kHz pour /t̪/ (Figure 3). La constriction plus restreinte observée pour /t̪/ suggère une cavité antérieure plus large que pour /t/, ce qui se traduit par une F2 plus basse. L'analyse du VOT montre des différences significatives uniquement en contexte VCV, ou les phases d'Aspiration (A) et de Friction (F) sont plus longues pour /t̪/.

Par ailleurs, les différences observées entre /t/ et /t̪/, tant sur le plan articulatoire qu'acoustique, pourraient être interprétées à travers l'échelle de coarticulation/invariance proposée par (7). Cette approche s'appuie sur la théorie de l'information et utilise l'information mutuelle comme mesure quantitative de la résistance à la coarticulation, de la synergie motrice et de l'invariance articulatoire. L'application de cette méthode à nos données futures permettrait de situer ces occlusives coronales rares sur un continuum de coarticulation, et ainsi de mieux comprendre leur stabilité gestuelle au sein du système phonétique du baniwa.

Cette étude pilote constitue la première étape d'un projet de recherche plus vaste, qui prévoit une analyse articulatoire et acoustico-perceptive approfondie de cette locutrice, avant l'élargissement du corpus à d'autres locuteurs, hommes et femmes.

Bibliographie

D. M. Eberhard, G. F. Simons, and C. D. Fennig, *Ethnologue: Languages of the World*, 26th ed. Dallas, TX: SIL International, 2023.

H. Ramirez, Uma gramática do Baniwa do I¸cana. São Paulo, Brazil: Universidade de São Paulo, 2001.

P. Ladefoged, ”The relationship between phonetics and phonology,” in Phonological Theory: An Introduction, 1st ed., J. A. Goldsmith, Ed. Oxford: Blackwell, 1996, pp. 105– 115.

P. Boersma, ”Praat, a system for doing phonetics by computer,” Glot International, vol. 5, no. 9/10, pp. 341-345, 2001.

K. N. Stevens, Acoustic Phonetics. Cambridge, MA: MIT Press, 2000.

R Core Team, ”R: A language and environment for statistical computing,” R Foun- dation for Statistical Computing, Vienna, Austria, 2021.

K. Iskarous, C. Mooshammer, P. Hoole, D. Recasens, C. H. Shadle, E. Saltzman, and D. H. Whalen, ”The coarticulation/invariance scale: Mutual information as a measure of coarticulation resistance, motor synergy, and articulatory invariance,” J. Acoust. Soc. Am., vol. 134, no. 2, pp. 1271–1282, Aug. 2013, doi: 10.1121/1.4812855.

SESSION F

Descriptions phonologiques et changements phonétiques dans les langues tibéto-birmanes

Phonological Descriptions and Sound Change in Tibeto-Burman Languages

Phonological and Sub-Lexical Features of Lepcha Rong Language

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/rɔŋ a.riŋ/ Lepcha is an endangered Tibeto-Burman l anguage primarily spoken by the indigenous Lepcha community residing predominantly in Sikkim and its neighboring regions including the Gorkhaland Territorial Area, the Terai areas of North Bengal, India, parts of Bhutan (Samtse), and eastern Nepalillam district. Despite its endangered status, Lepcha maintains official recognition in Sikkim, where it actively functions in education, media, administration, and cultural expressions, supported by its distinct script known as **/rɔŋ a.miŋ/.** Nevertheless, comprehensive linguistic documentation, particularly at the sublexical phonological level, remains comparatively limited.

This paper basically is a descriptive analysis seeks to address the gap through an extensive phonological investigation based on fieldwork conducted across multiple Lepchaspeaking localities in Sikkim. Specifically, the study focuses into detailed analyses of segmental phonemes, suprasegmental attributes, syllable structure, syllable weight, and phonotactic constraints.

Segmentally,Lepcha demonstrates an intricate consonantal and vocalic system comprising 31 consonants including retroflex like ([ʈ, ʈʰ, ɖ]) and 9 vowels. The consonantal inventory uniquely contrasts labio-dental phones with bilabial plosives. Likewise, palatal plosives and affricates contrast phonemically, underscoring the phonological richness of the language. A notable phonemic feature includes the absence of voiced aspirated plosives, typically prevalent in neighboring languages. Additionally, Lepcha's vowel system highlights an unusual and significant phonemic contrast between a back unrounded vowel [ɯ] and the rounded vowel [u], a feature contributing to its typological distinctiveness.

Suprasegmentally, Lepcha exhibits clear phonemic distinctions concerning vowel length, aspiration, and tone. The tonal system particularly distinguishes between high í and low tones i, profoundly influencing lexical meaning and syntactic interpretation. The significance of these suprasegmental features extends beyond simple phonetic detail, playing a critical role in morphophonological processes and lexical differentiation within Lepcha.

Phonotactic constraints in Lepcha display notable typological interest. Unlike typical Tibeto-Burman phonotactics, Lepcha permits specific consonants, particularly voiceless obstruents ([p, t, k]) and sonorant consonants ([m, n, ŋ, l, r]), can appear in all positions word initial, medial and word-final. Additionally, the language allows complex onset consonant clusters, including patterns such as [kl-], [pl-], [plj-], and [krj-], providing evidence of moderately flexible yet well-defined phonotactic parameters. These features suggest a unique phonological adaptation, potentially influenced by historical contact and internal linguistic developments.

The syllable structure analysis reinforces Lepcha's phonological complexity, predominantly conforming to a canonical syllabic pattern of $C0^3VC0^1$. This syllable structure permits variations ranging from simple consonant-vowel combinations to moderately complex consonant clusters in onsets. Furthermore, Lepcha rhyme reveals both light [short vowel] and heavy [[long vowel] or [short/long vowel with coda]] moraic structures, emphasizing nuanced phonological weight distinctions.

As part of my ongoing linguistic documentation and analysis, this research significantly contributes to preserving Lepcha language and culture. It also enhances theoretical discussions on phonological diversity and typology within the Tibeto-Burman language family, providing empirical foundations necessary for comparative linguistic studies and language preservation strategies. The findings underscore the importance of detailed phonological documentation in understanding typological variability and addressing linguistic endangerment challenges facing languages of the eastern Himalayan region.

Keywords:
Lepcha language, Tibeto-Burman languages, phonological typology, segmental inventory, suprasegmental features, phonotactics, syllable structure, linguistic documentation, endangered languages.

References

Barfungmu, Saldung. 2018. *The Introduction of Linguistic and Phonetics in Lepcha language.* Vol-II. Gangtok: DELDs & Corporation.

Foning, A.R. 1987. (reprint 2003). *Lepcha My Vanishing Tribe*.Kalimpong: ChyuPandi Farm. Gorer, Geoffrey. 1938. *Himalayan Village an account of the Lepcha of Sikkim*. 2nd edn. New Delhi: Pilgrims Publishing.

Mainwaring, G.B. 1876 (reprint 2018). *A Grammar of the Rong (Lepcha) Language, as its exists in the Dorjeling and Sikim Hills*. Kalimpong: MLLDB.

Plaisier, Heleen. 2006. *A Grammar of Lepcha*. Leiden: Brill Academic Publication.

Plaisier, Heleen. 2015. Unraveling Lepcha Manuscrips. Maja Kominko (ed.), *From Dust to Digital. Ten years of the endangered Archives Programme*. 67-88. Cambridge, UK: Open book publications.

Shipmoo, Ugen. 2017. *Lepcha English Dictionary*. Siliguri: Ugen Shipmoo.

Stocks, C. De Beauvior. 1975. *Sikkim Customs and Folklore*. New Delhi: Cosmo Publications.

Tamsang, K. P. 1981. [illegible]. Kalimpong: Lyangsong Tamsang.

Tamsang, K. P. 1980. *The Lepcha-English Encyclopedic Dictionary*. Kalimpong: Mayal Clymit Lepcha.

Tamsang, K. P.1983. *The Unknown and Untold Reality about the Lepchas*. Hong Kong: Lyangsong Tamsang.

Tamsang, Norbu Tshering. 2012. [illegible]. Gangtok: Lepcha Language Development Organization.

Targain, Tar Tshering and Tom Tshering Lucksom. 2012. [illegible]. Gangtok: RMRK.

The Phonological Sketch of the Mojiang Biyo

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The Biyo language [ISO 639-3:byo] is classified as belonging to the Southern Loloish subgroup of the Tibeto-Burman branch of the Sino-Tibetan language family. It is spoken by the Biyo people who mainly reside in the counties of Mojiang, Jiangcheng, Zhengyuan and Xinping of Yunnan Province in China.

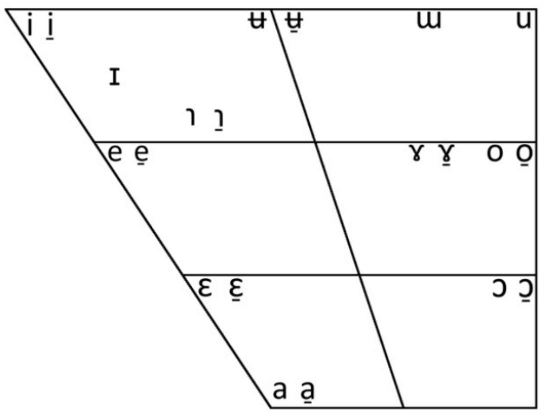
The data presented in this paper was collected by the principal researcher during September and October 2023 while staying at the main consultant's home. Basic lexicon (ca. 3200 words derived from the lexical list of the Chinese Academy of Social Sciences) from 3 speakers each, as well as 1 fable (the North Wind and the Sun) from the main consultant have been collected. The main language consultant is HDW (M, born in 1970) whose data has been crosschecked with the other two consultants HF (M, born in 1941) and BLP (F, born in 1970) .

Based on the analysis of the phonological data which has been transcribed and analyzed on Praat, the following features of Mojiang Biyo are identified:

[Consonants]

	Bilabial	Labiodental	Alveolar	Retroflex	Alveolo-palatal	Palatal	Velar
Plosive	p p^h p^j		t t^h				k k^h
Affricate			ts ts^h	tʂ tʂ^h	tɕ tɕ^h		
Nasal	m m^j		n n^j			ɲ	ŋ
Fricative		f v	s	ʂ ʐ	ɕ		x
Approximant						j	
Lateral			l l^j				

[Vowels] Biyo has 12 phonemic vowels, among which 9 also occur in their tensed counterparts.



[Tones]

Using the five-scale pitch system developed by Chao (1930), citation monosyllabic words exhibit five contrastive tones: 55, 51, 33, 31, 24.

Tonal patterns on disyllabic words and phrases are: 31-31, 31-55, 31-33, 55-33, 33-31, 55-55, 33-33, 33-31, 33-55 and 31-51.

Two key phenomena involving tone 24 have been identified. First, tone 24 occurs in SW Mandarin loanwords. Second, it emerges in a tone sandhi process, where certain monosyllabic words with tone 31 shift to tone 24.

The above features will be elaborated with examples and contrasted with previous studies on Biyo. Research on the phonological system of Biyo is extremely limited. Hansson's (1989) study is based on data collected from a single speaker—a 29-year-old male from Mojiang— during her time at the Yunnan Institute of Nationalities in Kunming (now known as Yunnan Minzu University) in 1982. Her dataset comprises 581 words. In contrast, Jing (2015) examines the phonological features of Biyo based on the speech of three elderly speakers, offering a broader but still limited perspective on the language's sound system.

The present research seeks to address the gaps in existing knowledge by providing new data and a detailed analysis of the phonological system of the Biyo language. The analysis, while not exhaustive, offers significant insights into the phonological features of Biyo, including its consonant and vowel inventories and tonal patterns. These findings contribute to the documentation of an understudied language and highlight its distinct linguistic features.

Selected references

Bradley, David. 1979. *Proto-Loloish*. Scandinavian Institute of Asian Studies Monograph 39. London: Curzon Press.

Bradley, David. 1997. Tibeto-Burman languages and classification. In David Bradley (ed.), *Papers in Southeast Asian linguistics* 14, *Tibeto-Burman languages of the Himalayas*, 1–72. Canberra: Pacific Linguistics.

Chao, Yuen Ren. 1930. ə sɪstəm əv "toun-lɛtəz" (A system of "tone letters"). *Le Maître Phonétique* 30, 24–27. Cambridge: Cambridge University Press.

Chirkova, Katia. 2015. A phonological sketch of Duoxu. *Cahiers de Linguistique: Asie Orientale* 44 (2), 97–121. Leiden: Brill.

Dai, Qingxia 戴庆厦, Duan Kuangle 段贶乐, Luo Shuwen 罗书文 & Li Piran 李批然. 2001. *Han Hani cidian* 《汉哈尼词典 》[The Chinese-Hani Dictionary]. Kunming 昆明: Yunnan minzu chubanshe 云南民族出版社.

Hansson, Inga-lill. 1989. A comparison of Akha, Hani, Khàtú and Pîjɔ̀. *Linguistics of the Tibeto-Burman Area* 12, 6–91.

Jing, Dian 经典. 2015. *Mojiang Biyo Haniyu cankao yufa* 《墨江碧约哈尼语参考语法》 [A reference grammar of Mojiang Biyo Hani]. Beijing 北京: Zhongguo shehui kexue chubanshe 中国社会科学出版社.

Maddieson, Ian & Peter Ladefoged. 1985. "Tense" and "lax" in four minority languages of China. *Journal of Phonetics* 13, 433–454.

Ramsey, S. Robert. 1987. *The Languages of China*. New Jersey: Princeton University Press.

Sagart, Laurent & Xu Shixuan. 2001. History through loanwords: the loan correspondences between Hani and Chinese. *Cahiers de Linguistique Asie* 30 (1), 3–54.

Zangmianyu Yuyin he Cihui Bianxiezu 《藏缅语语音和词汇》编写组. 1991. *Zangmianyu yuyin he cihui* 《藏缅语语音和词汇》 [Tibeto-Burman phonology and lexicon]. Beijing 北京: Zhongguo shehui kexue chubanshe 中国社会科学出版社.

Rethinking the /u/-/o/ Merger in Honi Varieties: Phonetic Evidence from Tuha Haoni

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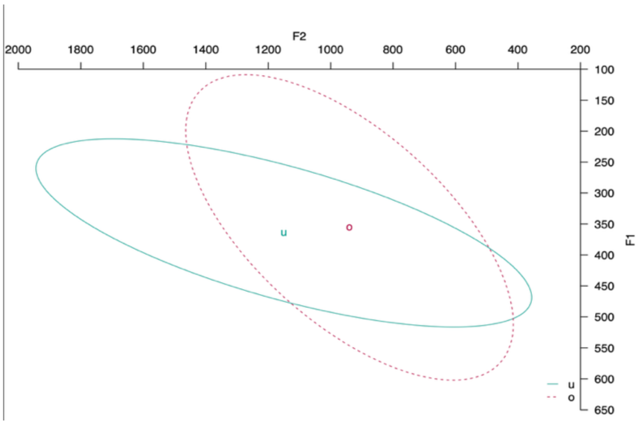
The vowel merger of /u/ and /o/ in several Honi (Lolo-Burmese, ISO 639: how) dialects has been previously documented. Yang (2021) argues that in the Woni dialect, the overlap between /u/ and /o/ results from a pull chain shift: /v/ < /u/ < /o/. This study aims to test this hypothesis by examining the same phenomenon in Haoni, another Honi dialect.

First-hand data were collected through fieldwork in Tuha, a mountainous village in Yuanjiang County, Yuxi City, Yunnan Province, China. The dataset includes recordings from four speakers: two male (aged approximately 50 and 30) and two female (also aged 50 and 30). The F1 and F2 of /u/ and /o/ were extracted using autocorrelation in Praat and analyzed in various phonological contexts. In addition to the acoustic analysis, the study considers potential sociolinguistic factors, such as gender-related variation, that may influence the dynamics of the merger.

The results confirm the presence of a vowel merger in Haoni (Figure 1). However, a revised interpretation of the pull chain hypothesis is proposed: /ʉ/ < /u/ < /o/, with /u/ showing fronting after coronal consonants. This pattern is not only observed in another Southern Loloish language, Akha (cf. Labov 1994), but is also supported by experimental data from unrelated languages (Harrington et al. 2008). The presentation focuses on the experimental phonetic analysis of this merger and its interaction with broader phonological patterns in Haoni.

This study contributes to the typological understanding of vowel mergers in the Southern Loloish branch by grounding competing theoretical proposals in empirical phonetic data.

Keywords: Honi dialects; Vowel merger; Experimental phonetics; Historical phonology; Lolo-Burmese.



References:

Harrington, J., Kleber, F., & Reubold, U. (2008). "Compensation for coarticulation, /u/-fronting, and sound change in standard southern British: An acoustic and perceptual study". *The Journal of the Acoustical Society of America*, 123(5), 2825–2835. https://doi.org/10.1121/1.2897042

Labov, W. (1994). *Principles of linguistic change, volume 1: Internal factors*. Malden, MA: Wiley-Blackwell.

Yang, Y. 杨艳. (2021). *Hāníyǔ Wōníhuà Yánjiū* 哈尼语窝尼话研究 *(A Study of Woni)*. Beijing: China Social Sciences Press 社会科学出版社.