

# Phonetic and phonological patterning of glottalized sonorants in Lobi

---

Amber Galvano, Sansan Claude Hien, Hannah Sande | UC Berkeley  
LSA Annual Meeting 2025

# Language background

Lobi is a Gur language (also called Mabilia) spoken in Burkina Faso and Côte d'Ivoire

- There are several previous descriptions of aspects of Lobi
  - Labouret (1958), Lamothe (1964, 1966), Vaillant (1967), Becuwe (1982), Maimouna (2007), Sib (2016, 2018, 2020)
- None of these include phonetic evidence
- There are several points on which the descriptions conflict. We attempt to address some of these issues here.

**In this talk:** We examine the phonotactic distribution, acoustics, and articulation of the implosive /ɓ/ and the typologically uncommon set of glottalized sonorants /ʔj, ʔl, ʔw/ in Lobi

# The data presented here

- Work with our co-author Sansan Claude Hien between 2022-2024
- Additional data checks with a handful of Lobi speakers in Côte d'Ivoire during field trips in 2022 and 2024
- All data is available in the California Language Archive

# Phonological background

---

# Consonant inventory

	Bilabial	Labio-dental	Alveolar	alatal	Velar	Labial-velar	Labialized velar	Glottal
Plosive	p b p <sup>h</sup>		t d t <sup>h</sup>	c ɟ	k g k <sup>h</sup>	k <sup>ɸ</sup> g <sup>ɸ</sup>	k <sup>w</sup>	
Implosive	ɓ							
Glottalized			ʔ	ʔj		ʔ <sup>w</sup>		
Nasal	m		n	ɲ				
Fricative		f v	s					h
Approximant			l	j		w		
Trill			r					

# Glottalized sonorants and implosives

Glottalized sonorants like /ʔj, ʔl, ʔw/ are rare in the world's languages

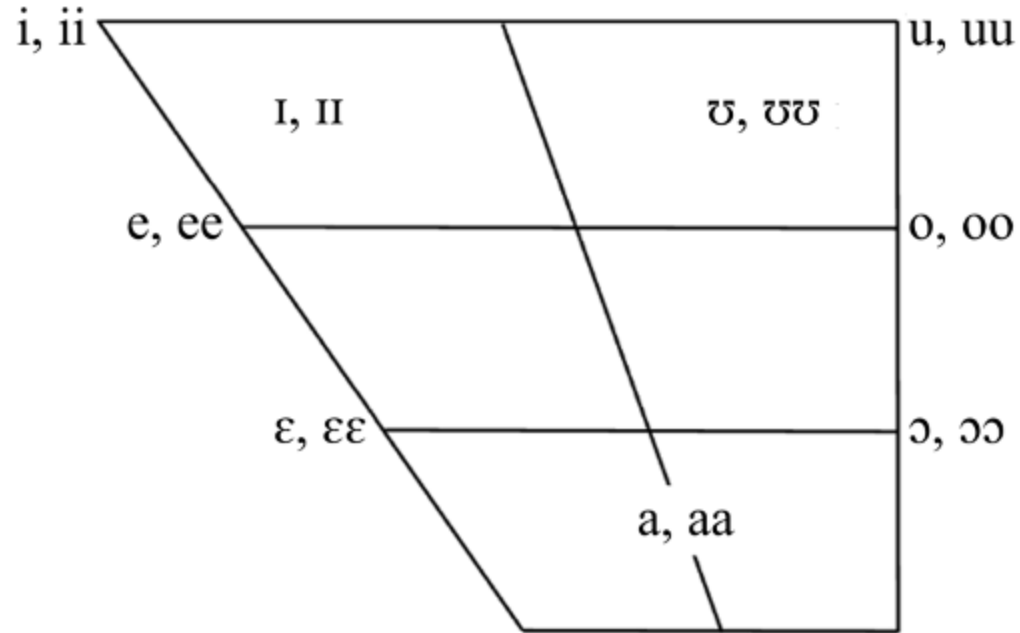
- Only 27 of 3,183 (0.8\%) languages in the Phoible database are listed as having glottalized sonorants
- Only 16 of 629 (2.5\%) in PBase are listed as having contrastive glottalized sonorants

Implosives pattern phonologically with obstruents in some languages and with sonorants in others (Sande & Oakley, 2023).

**We investigate** the phonotactic distribution and phonetic properties of /b,ʔj, ʔl, ʔw/ in Lobi:

- Do they all pattern as a coherent class in Lobi?
- What are the phonetic and phonological properties of the typologically rare glottalized sonorants?
- Do implosives pattern phonologically and phonetically with sonorants or obstruents in Lobi?

# Vowel inventory



# Tone and syllable structure

- Tone
  - Two contrastive heights: H and L (here, H is marked and L is unmarked)
  - Contour tones HL and LH are possible on long vowels and CVL syllables
  - Downstep of a H suffix or clitic after a stem containing a H
  - Tone of toneless affixes is determined by the tone of the stem they attach to
  - Grammatical tone is present in possessive, progressive, and future contexts, among others
- Syllable structure
  - Syllables in Lobi are minimally **CV** ([na] `cow`)
  - Underlying V-initial syllables (V, VC) are produced with initial glottal stops ([ʔoŋólo] `cat`)
  - Other possible syllable shapes include **CVV, CVC, CCV, and CVVC**
  - CCV syllables are arguably derived from /CVCV/
  - VV sequences can consist of a long vowel or diphthong ([síí] `snake`, [biɛl] `one`)



# Phonotactics and segmental alternations

- Vowels are systematically nasalized before nasal codas (the nasal codas themselves are only optionally produced)
- Nasals place assimilation to following consonant
- ATR and nasal harmony (suffixes undergo root-controlled harmony)
- Vowel hiatus is resolved via gliding or vowel deletion
- All consonants can appear in onset position except [r]
- **Only /j, w, l, r, n, m/ and the implosive /ɓ/ can surface in coda position**
- **Sonorants assimilate to a preceding sonorant across a morpheme boundary**

# Phonological behavior of /b/

In Lobi, there is limited evidence as to whether /b/ patterns with obstruents versus sonorants, because there are few alternations and phonotactic restrictions involving /b/.

- **Codas:** /b/ patterns with sonorants in that it can surface in coda position: /khu**b**/ ‘bone’, /sɪʔjɛ**b**/ ‘turtle’
- **Assimilation of following sonorants:** Root-final sonorants cause assimilation of a following sonorant-initial morpheme such as the definite /-rá/: [ɟʊr=rá] ‘the fufu’, [bɪɛl=lá] ‘the one’, [mín=ná] ‘the flour’.
  - However, the implosive does not trigger assimilation of a following sonorant: [khu**b**-rá]
  - Word-initially, obstruent+sonorant clusters are common, [bló] ‘white’
  - This seems to be a way in which implosives pattern more like obstruents than sonorants, or at least unlike sonorants: they fail to trigger assimilation of a following sonorant

**To investigate:** the production of /b/ in different positions within a word in order to determine whether anything about its phonetic profile helps to explain its phonotactic behavior

# Summarizing phonotactic distributions by segment type

The phonotactic distribution of obstruents, implosives, sonorants, and glottalized sonorants in Lobi

	Obstruents	/b/	Sonorants	Glottalized Sonorants
#_V (Word-initial)	X	X	X	X
V_V	X	X	X	X
V_# (Word-final)		X	X	
C_V (C2 in cluster)			X	
_CV (C1 in cluster)	X	X		

# Phonetics of glottalized sonorants

---

# Data collection methods

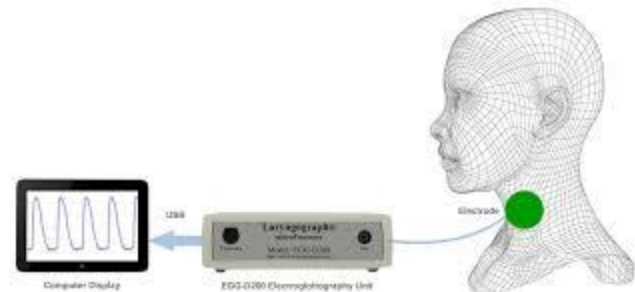
- 2 sessions, one in spring 2023 and one in fall
- Randomized PowerPoint slides contained a single stimulus or minimal pair, read at least twice
  - First dataset: isolated stimuli
  - Second dataset: carrier sentence *mɪ sór \_\_\_ dii*, 'I said \_\_\_ yesterday'
- Stimuli: vocabulary items containing /b, b, ʔj, ʔl, ʔw, j, l, w/
  - 8,711 token and 133 distinct words/phrases
- Electroglottograph and audio signals recorded using the EGG-D800 system, audio doubled with Zoom H4n

# Phonetic uncertainties

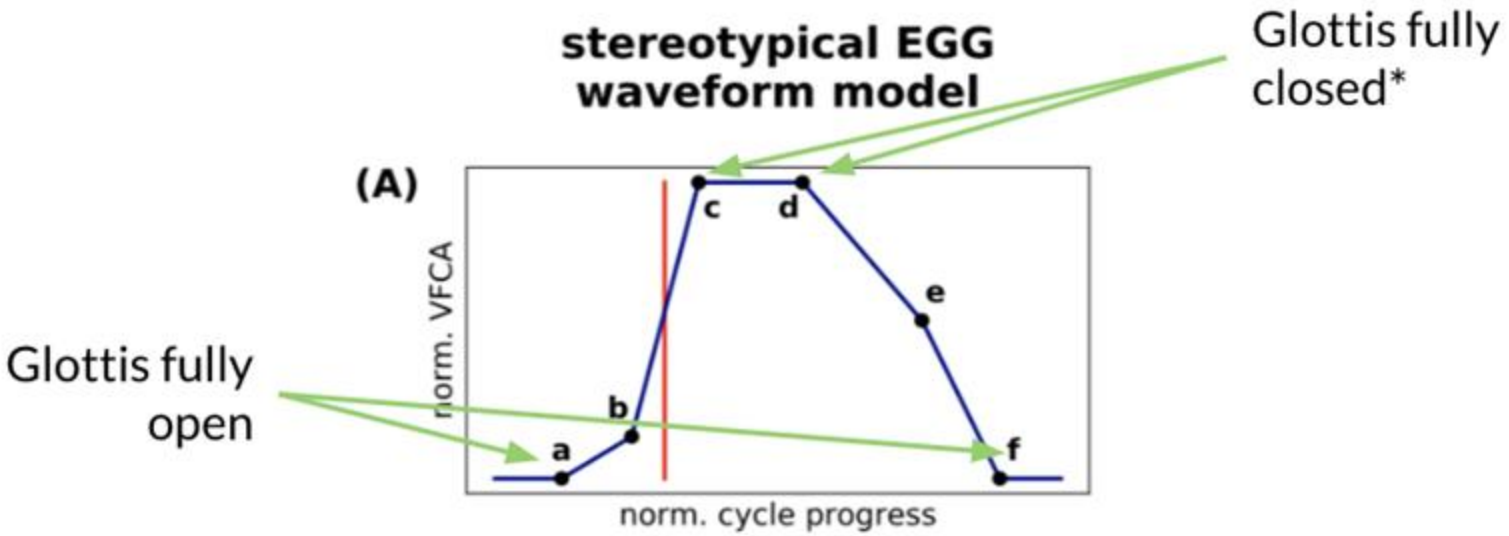
- Difficult to know if segments previously transcribed as implosive/glottalized are due to:
  - “Laryngealization” (perceivable constriction of the laryngeal apparatus, or ‘tensing’)
  - Presence of glottal stop
  - An implosive airstream mechanism (these do not obligatorily co-occur)
- Other possible articulatory cues to implosive percept:
  - **Larynx lowering** (oral cavity expansion – also seen in plain voiced stops) } EGG sheds light
  - **Increased degree of vocal fold contact**
  - Velarization (raising of the tongue back)
  - Lowering of the hyoid bone
- Possible acoustic cues:
  - Earlier and more gradually sloped onset of voicing and a more drastic shift in formants into following vowels.
- Does different phonological patterning of these sounds correspond to different phonetic cues?
  - Which sounds (glottalized sonorants,  $\text{b}$ , labiovelars) tend to share phonetic realizations?

# Electroglottography

- Electroglottography (EGG), introduced by Fabre (1957), has been useful for understanding the behavior of a range of laryngeal phenomena
  - Voice quality, properties of tone, breathiness, ATR, voicing contrasts, linguistic prominence and laryngeal activity, comparison of phonetic and phonological similarities, differences between stop types
- Relevant observations
  - Mielke 2012: Voiced obstruents showing greater larynx lowering than sonorants and suggested larynx height may be most useful as a metric for glottalized sounds
  - Abberton (1972):
    - All Korean stops, including voiceless, showed **supra-laryngeal activity** in the EGG signal
    - The term 'glottalized' can have multiple purposes, such as **true glottal closure** or the **percept of a glottal stop**



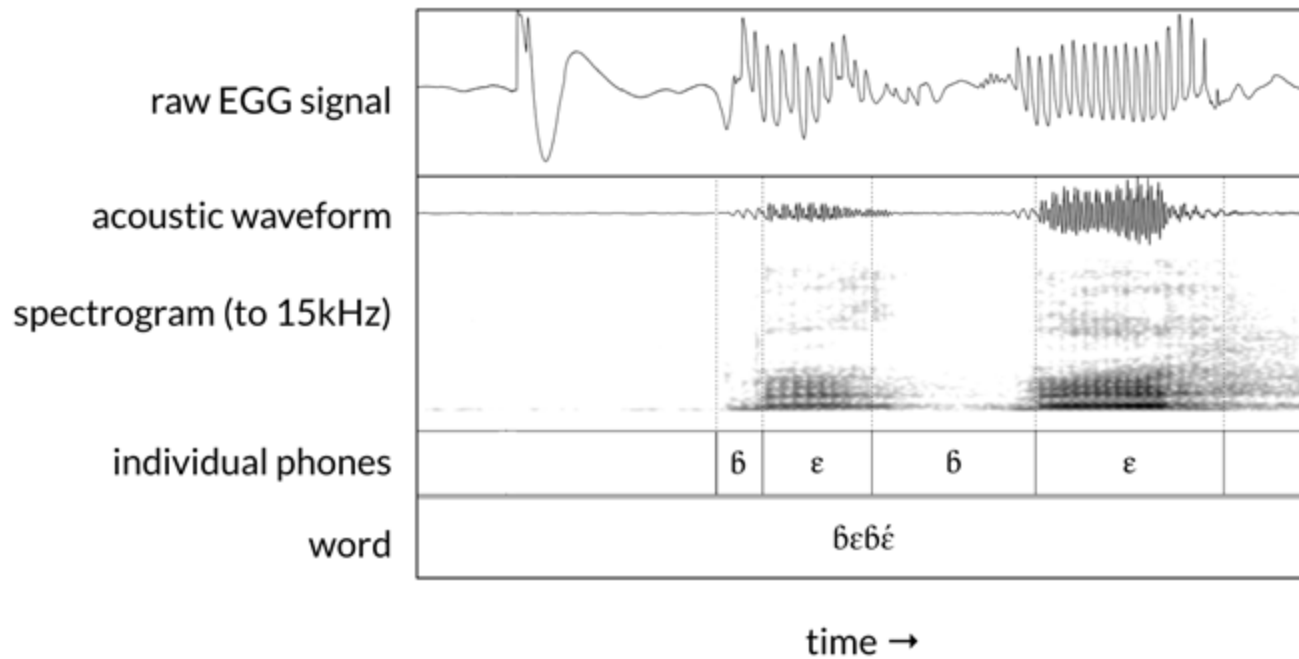
# Electroglottography





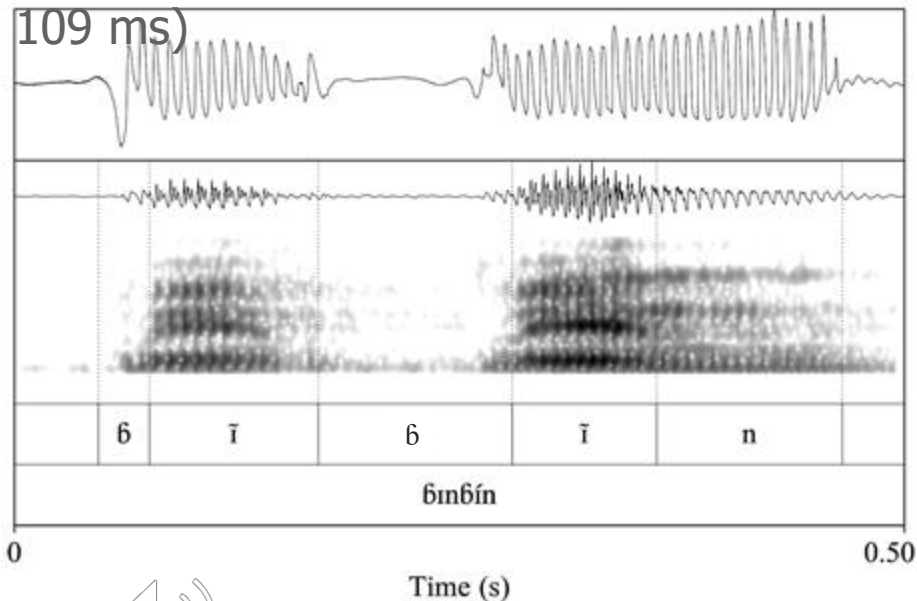
# Qualitative results

# Results

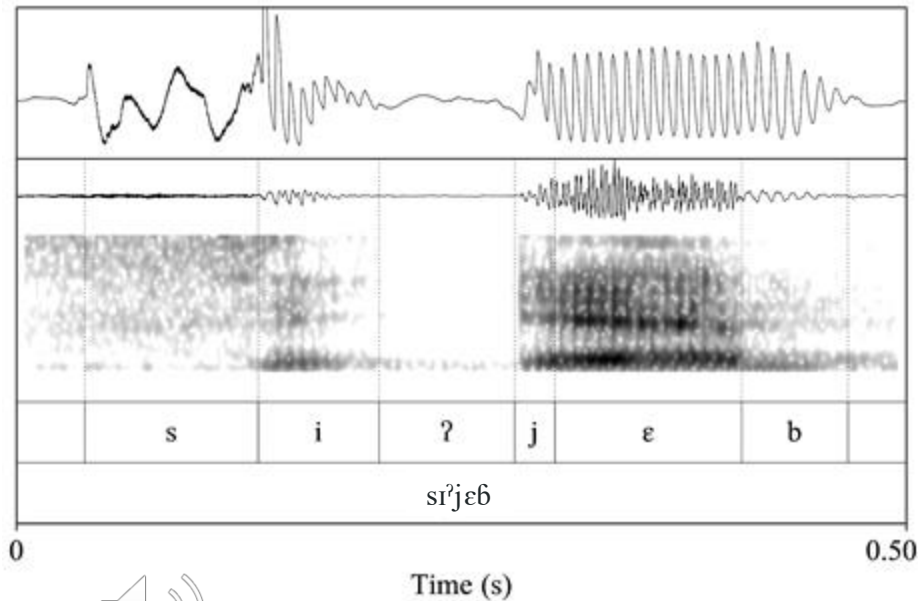


# Results: word-initial vs. word-medial vs. word-final /b/

"4th daughter" ([b]1 = 29 ms, [b]2 = 109 ms)



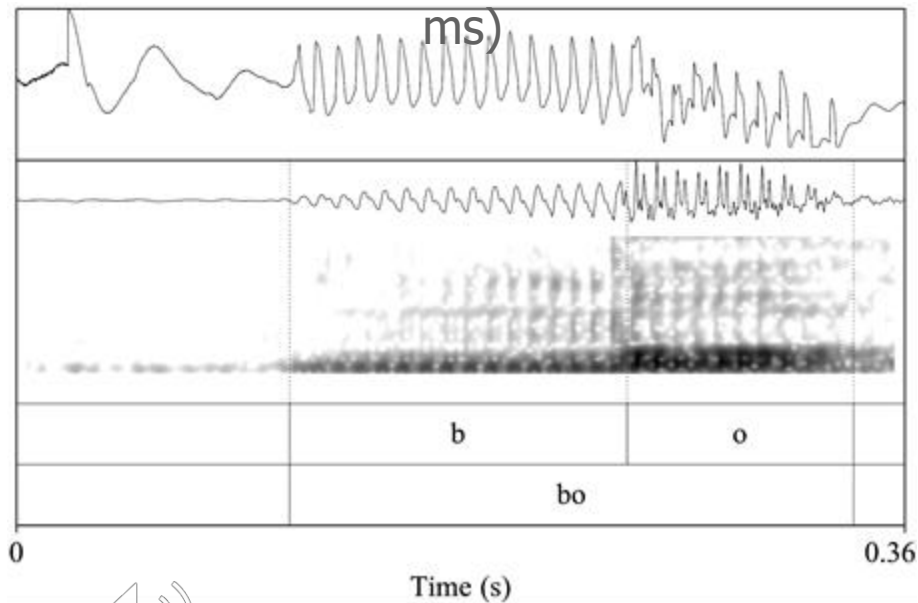
"Turtle" ([b] = 65 ms)



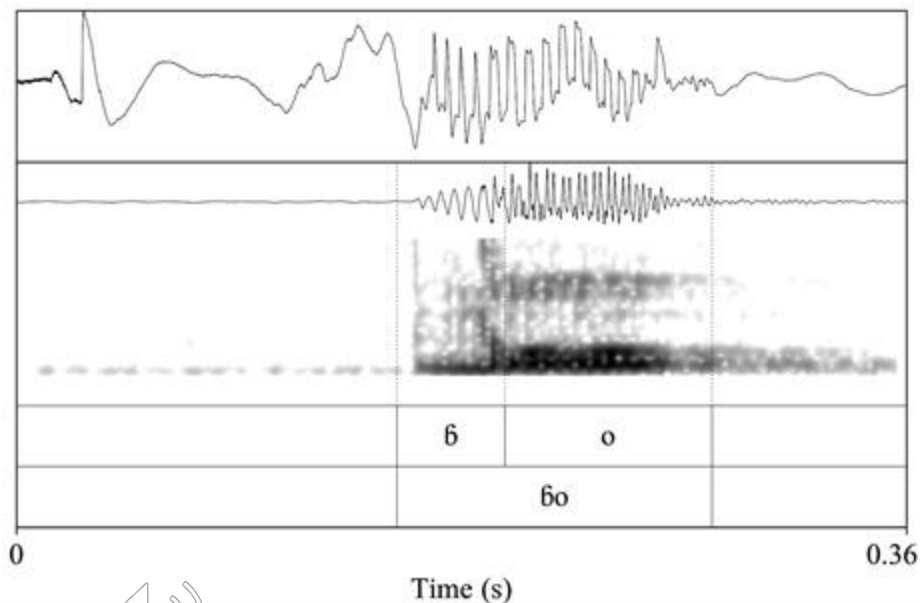
# Results: /b/ vs. /b/

"consult" ([b] = 135

ms)

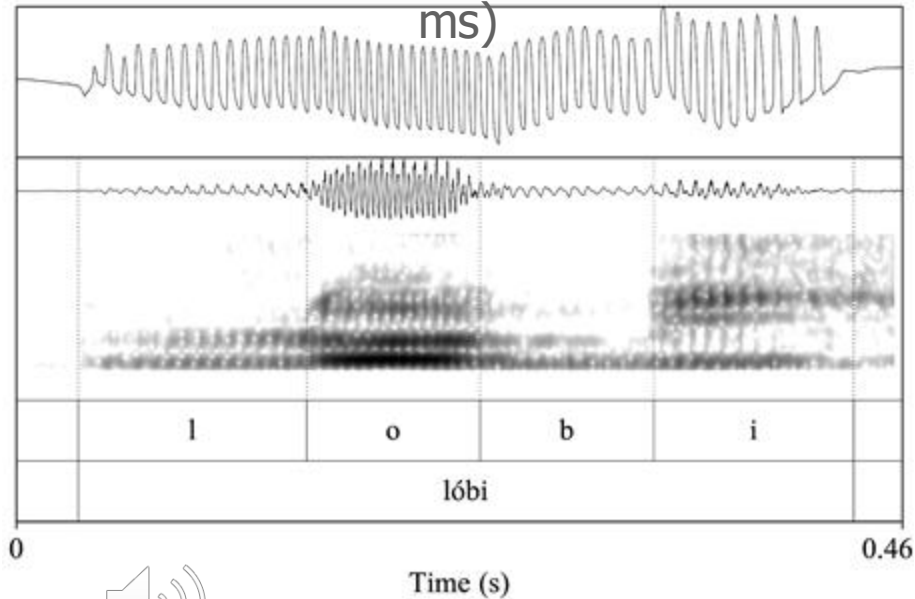


"first" ([b] = 27 ms)

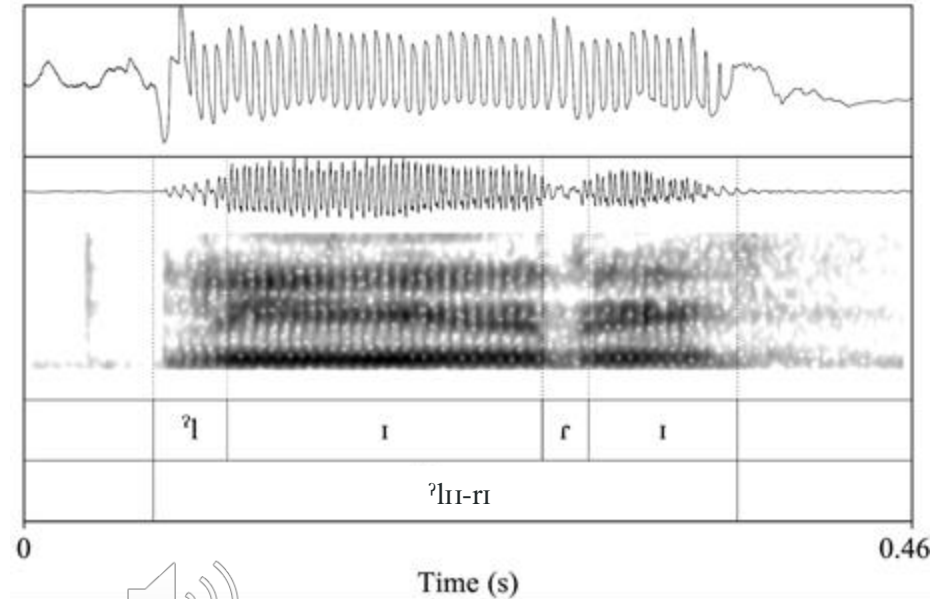


# Results: /ʔl/ vs. /l/

“Lobi” ([l] = 126 ms)

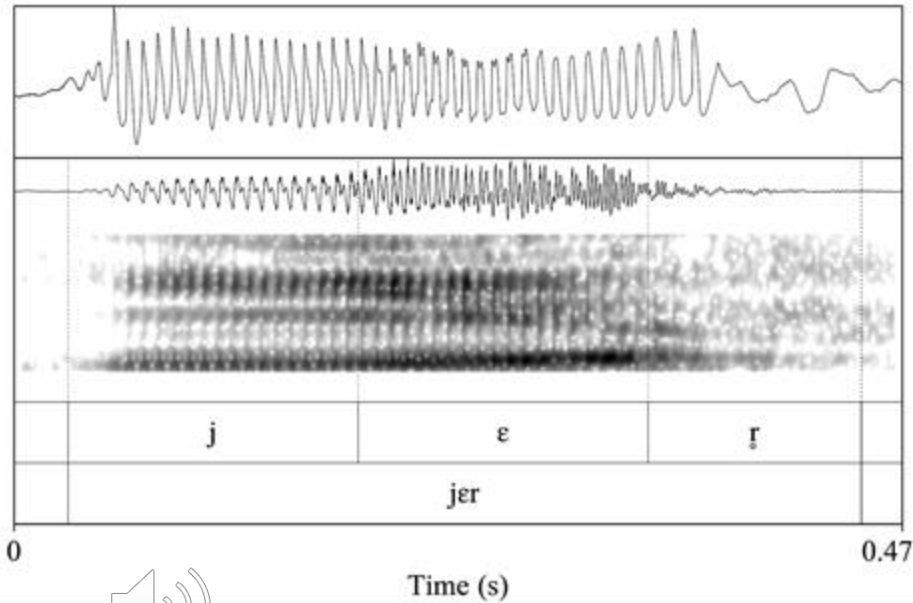


“demand one’s money” ([ʔl] = 39 ms)

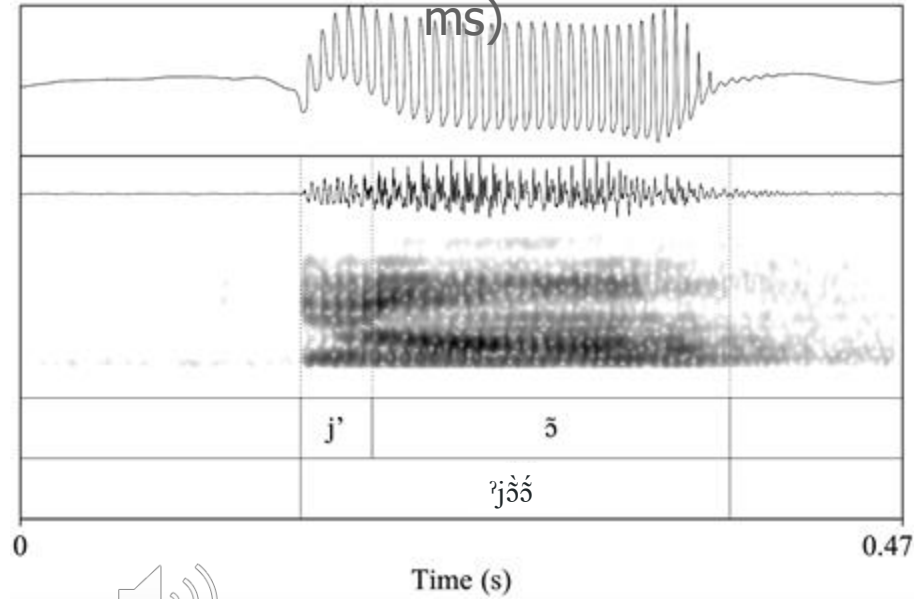


# Results: /ʔj/ vs. /j/

“year” ([j] = 154 ms)

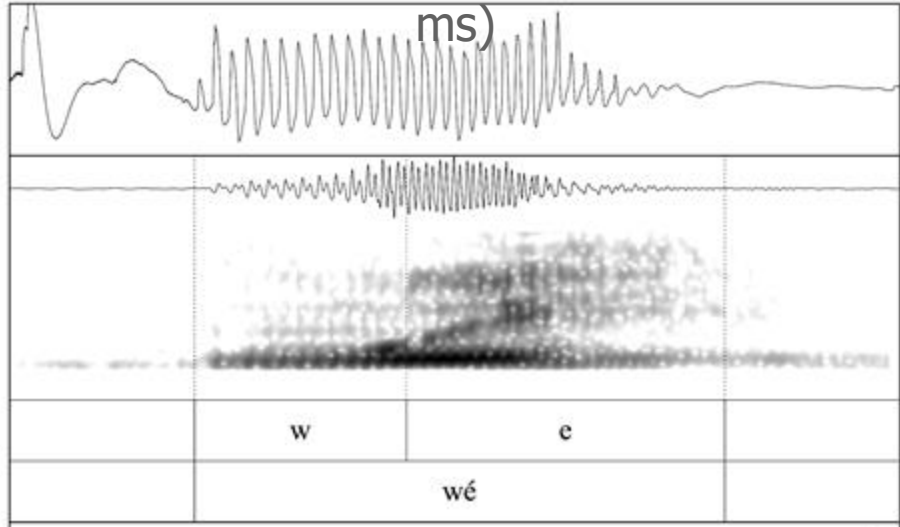


“thin soup” ([ʔj] = 39 ms)



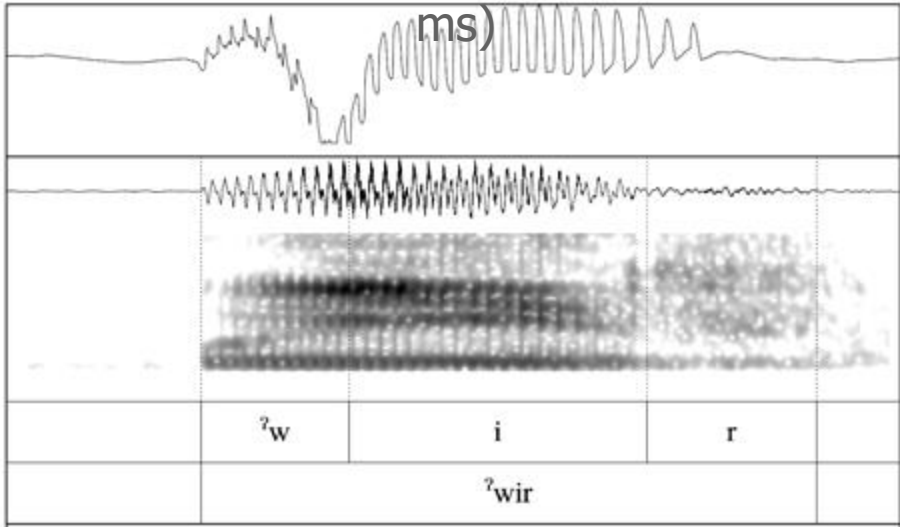
# Results: /ʔw/ vs. /w/

"call" ([w] = 91



Time (s)

"cold (n.)" ([ʔw] = 81



Time (s)

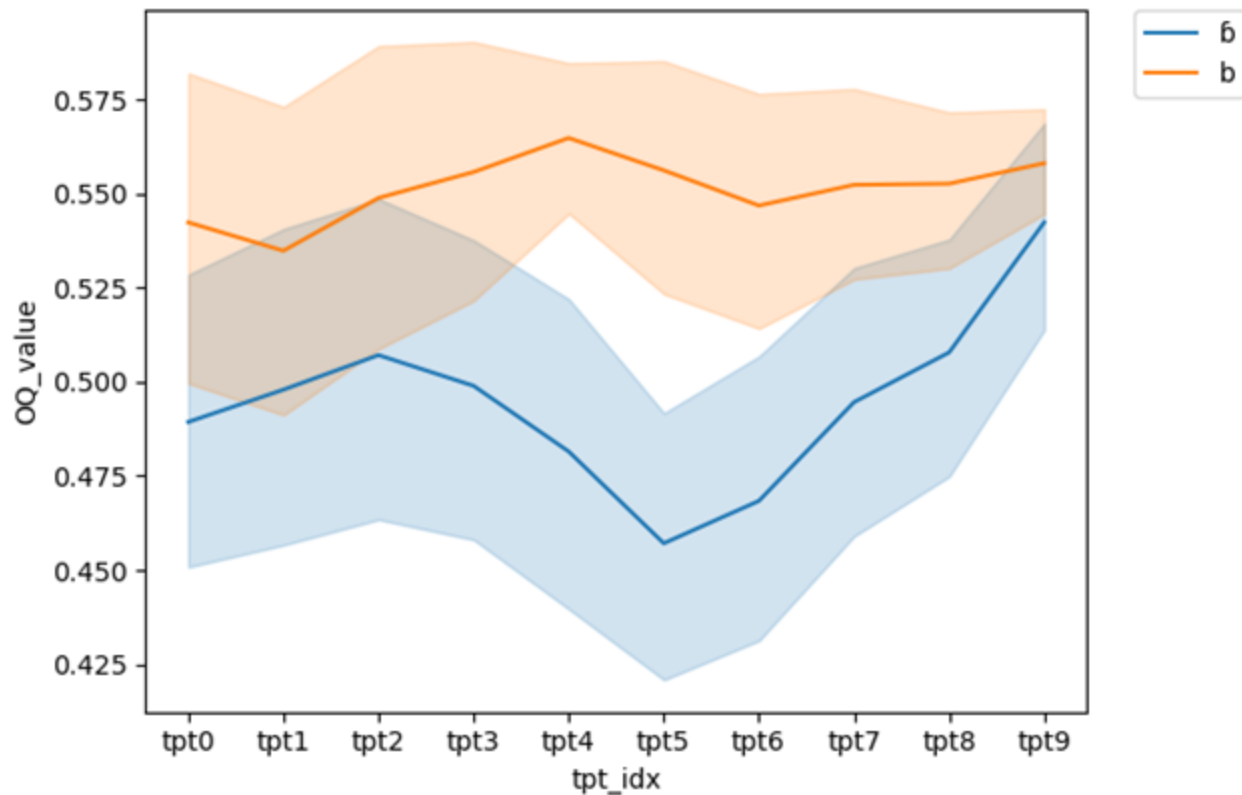
# Quantitative results



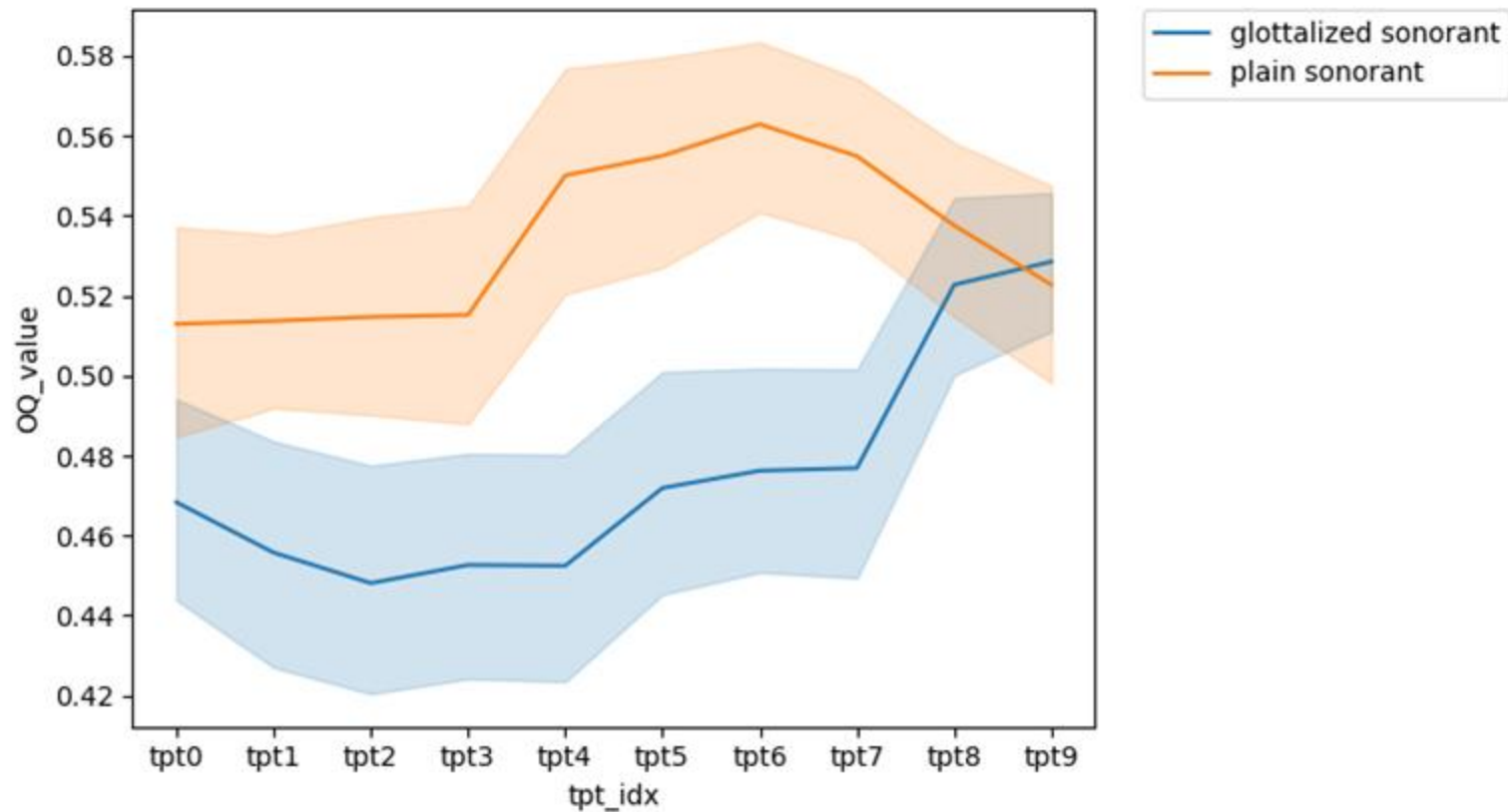
# Open quotient (Oq)

- OQ: the ratio of the duration between two consecutive glottal closing instants, (or fundamental period) and the duration between the glottal opening instant and the consecutive glottal closing instant (open time)
  - Period of glottal cycle / glottal opening
- **Greater value = *more* glottal contact**
  - **Taken at 10 equally-spaced time points per token**
- Implosives and glottalized sounds differ in their degree of vocal fold contact and their onset of contact
  - Contact itself is used as a proxy for “laryngealization”
- **Lindsay (1992): Hausa /y'/ is (variably) produced with a lower Oq than /b, d/**
- Whether Lobi /ʔl ʔj ʔw/ and /b/ are laryngealized to a similar degree will help to determine whether they make use of the same articulatory pathways
  - If not, brings into question whether they are part of the same class of sounds

# Oq results: /b/ vs. /b/



# Oq results: plain vs. glottalized sonorants



# Oq results: plain vs. glottalized sonorants by place



# Statistical results

Intercept: tpt0, plain stop, alveolar

<b>effect group</b>	<b>term</b>	<b>estimate</b>	<b>std.error</b>	<b>statistic</b>	<b>df</b>	<b>p.value</b>
1 fixed	(Intercept)	0.543	0.015	36.092	571.058	0
2 fixed	tpt_idxtpt8	0.032	0.009	3.4	4376.944	0.001
3 fixed	tpt_idxtpt9	0.038	0.009	4.081	4376.944	0
4 fixed	typeimplosive	-0.032	0.017	-1.875	653.45	0.061
5 fixed	typeplain sonorant	-0.023	0.013	-1.729	1474.306	0.084
6 fixed	typeglottalized sonorant	-0.096	0.018	-5.197	386.86	0
7 fixed	placepalatal	0.034	0.014	2.377	324.291	0.018

`lmer(OQ_value ~ tpt_idx + type + place + (1 | word))`

# Discussion

---

# Recap

4. Implosive /ɓ/'s Oq trajectory aligns more closely with /l j w/ than /b/ (shared “sonorant” property)
5. Plosive /b/'s Oq trajectory aligns more closely with /ʔl ʔj ʔw/ (shared “obstruent” property)

Observation	Sounds which demonstrate
prevoicing	/ɓ, b, gb, kp/
EGG drop before low V	/ɓ, l', j', w', gb, kp/
EGG drop before high V	/ɓ, l', j', w'/
EGG drop before front V	/ɓ, l', j', w', gb/
EGG drop before back V	/ɓ, j'/
positional allophony	/ɓ/

# Acknowledgements

- Sansan Claude Hien and the other Lobi speakers who worked with us (Dah Frank, Dah Doudou, Hien Kambire Bebe)
- Katherine Russell for helping to collect Lobi data in Côte d'Ivoire
- The members of the Lobi Field Methods courses
- Keith Johnson and Ronald Sprouse for helping us learn how to use EGG and work with Oq data





# Takeaways

## Do implosives and glottalized sonorants form a natural class?

- Phonologically, it doesn't seem like it (different distributions within a word/syllable)
- Phonetically, all glottal sounds have glottal periods, but that glottalization can be realized in different ways

## Do implosives pattern with sonorants or obstruents?

- Phonotactically, Lobi /b/ shows mixed patterning with the sonorants (coda) and obstruents (no sonorant assimilation)
- Phonetically, implosives share some phonetic properties with sonorants (Oq) and some with obstruents (word-final production)

## Other take-aways

- Usefulness of EGG and Oq data for describing and differentiating sounds reliant on cues of the larynx

# References

Becuwe, J. (1982). Éléments de phonologie et de grammaire du Lobiri. [Doctoral Dissertation, Université de la Sorbonne Nouvelle Paris III].

Eberhard, David M., Gary F. Simons, and Charles D. Fennig (eds.). 2024. Ethnologue: Languages of the World. Twenty-seventh edition. Dallas, Texas: SIL International. Online version: <http://www.ethnologue.com>.

Labouret, H. (1958). Notes grammaticales sur le lobi. In Nouvelles notes sur les tribus du rameau lobi: leurs migrations, leur évolution, leurs parlers et ceux de leurs voisins (Vol. 54), pp. 100-275. Institut Français de l'Afrique Noire.

Lamothe, Charles. 1964. Esquisse du système verbal lobi. No. 2. Université de Dakar.

Lamothe, Charles P. B. 1966. Esquisse du système grammatical Lobi. (Recherches Voltaïques, 4.) Paris: C. N. R. S.

Maimouna Le Men, F. (2007). Parlons Lobiri: Langue et culture des Lobis Burkina Faso. L'Harmattan.

Moran, Steven & McCloy, Daniel (eds.) 2019. PHOIBLE 2.0. Jena: Max Planck Institute for the Science of Human History. (Available online at <http://phoible.org>, Accessed on 2024-12-09.)

Sib, Sié Justin. 2016. Réduplication verbale en lobiri de Bouna: cas d'un procédé répétitif. In Aimée-Danielle Lezou Koffi and Kallet Abréam Vahoua and Kouakou Appoh Enoc Kra (eds.) Cheminements linguistiques: Mélanges en hommage à N'Guessan Jérémie Kouadio. Editions universitaires Européennes.

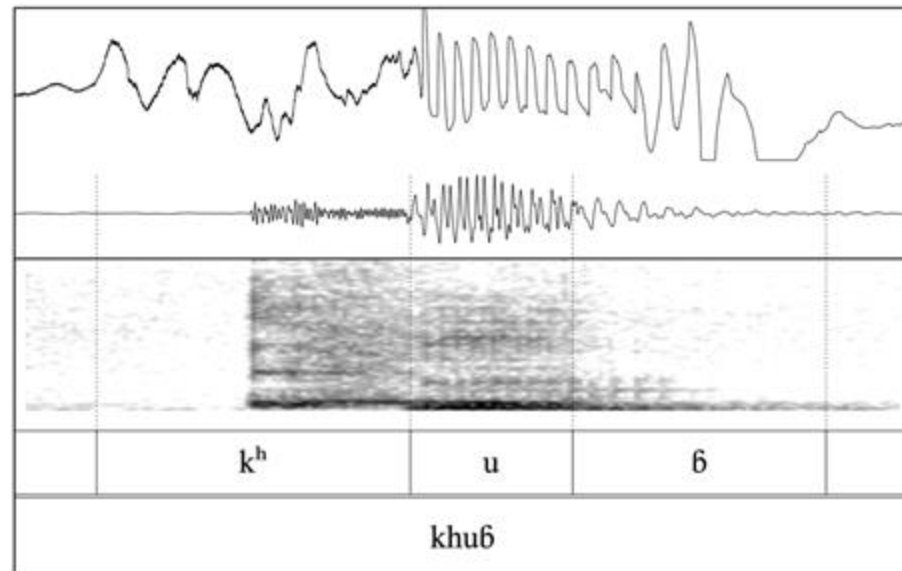
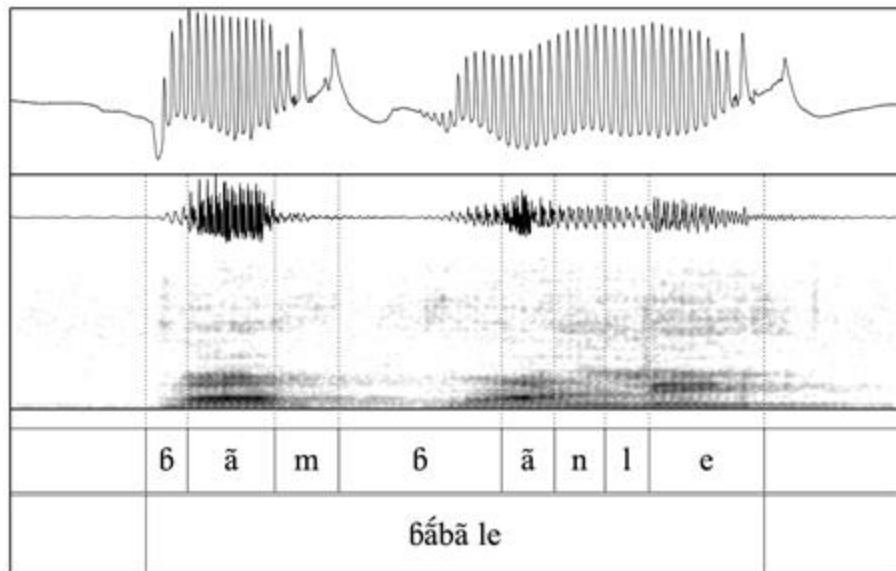
Sib, Sié Justin. 2018. Etude typologique et syntactico-sémantique des verbes en lobiri. Studii de gramatica contrastiva 29: 66-77.

Sib, Sié Justin. 2020. Etude des ideophones en lobiri. Revue Djiboul.

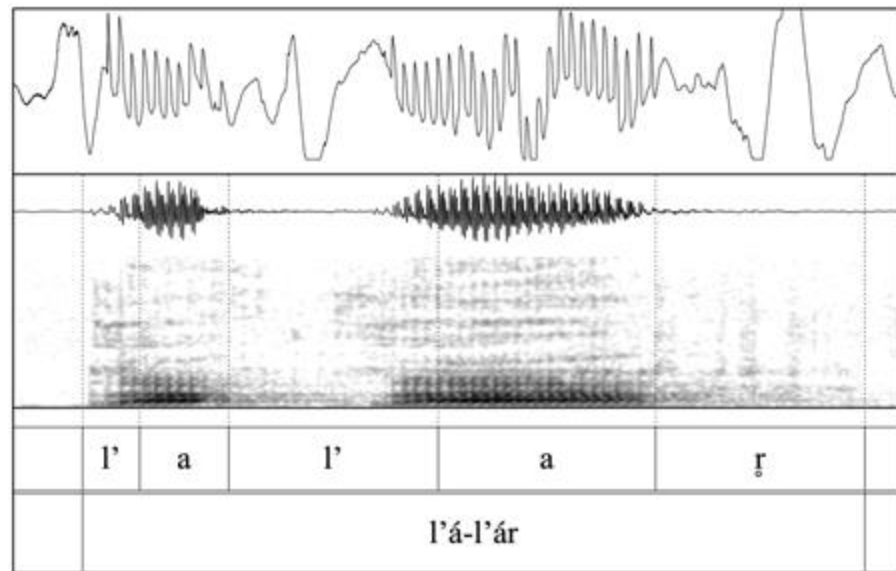
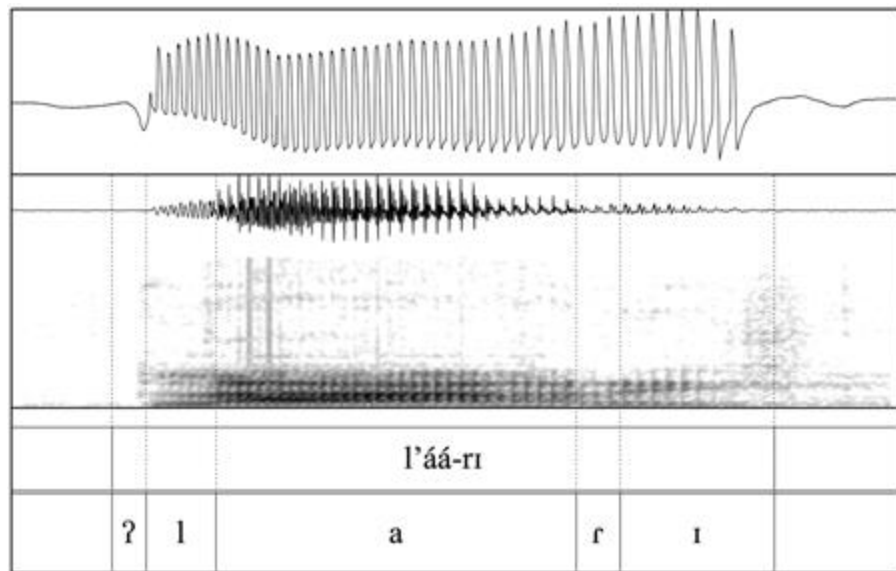
Vaillant, M. (1970). Esquisse grammaticale du lobiri. [Doctoral Dissertation, Université de Dakar].

# Appendix

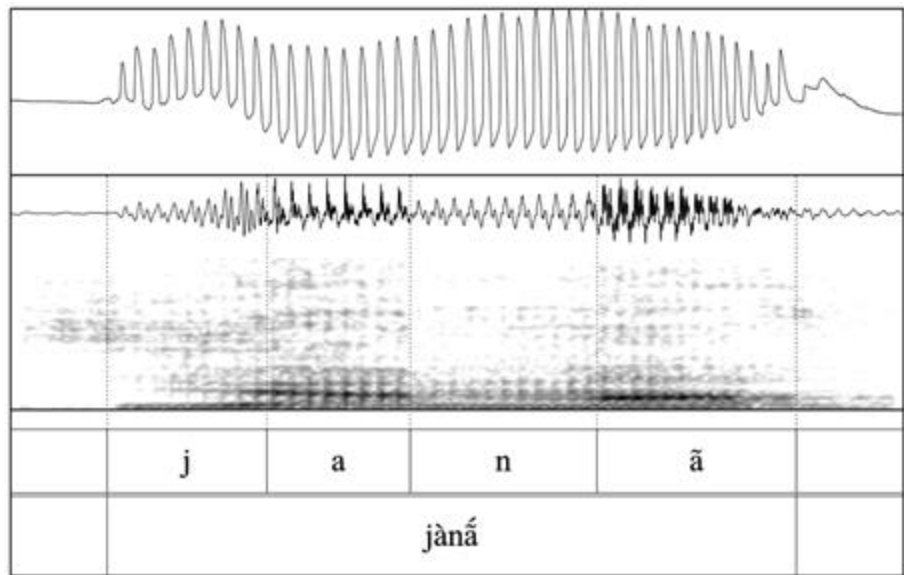
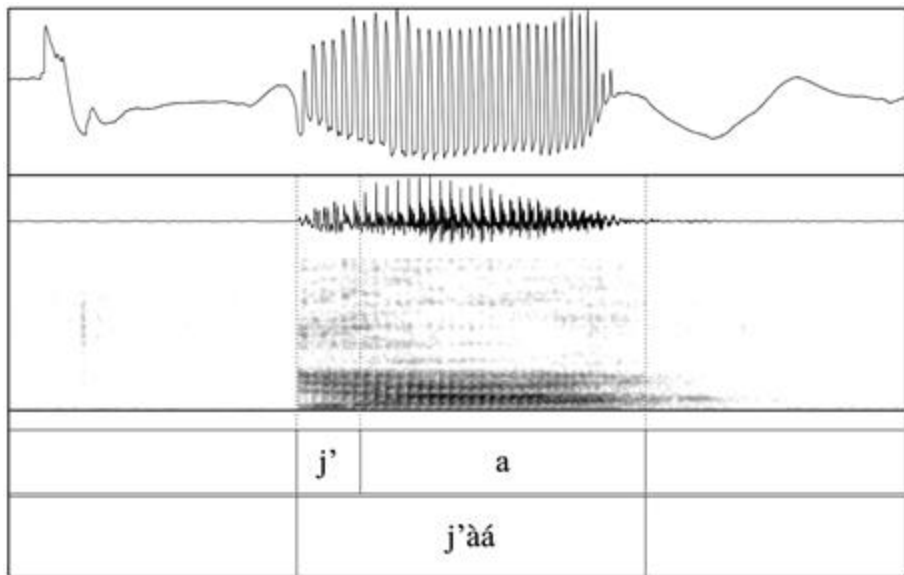
# Results: /b/



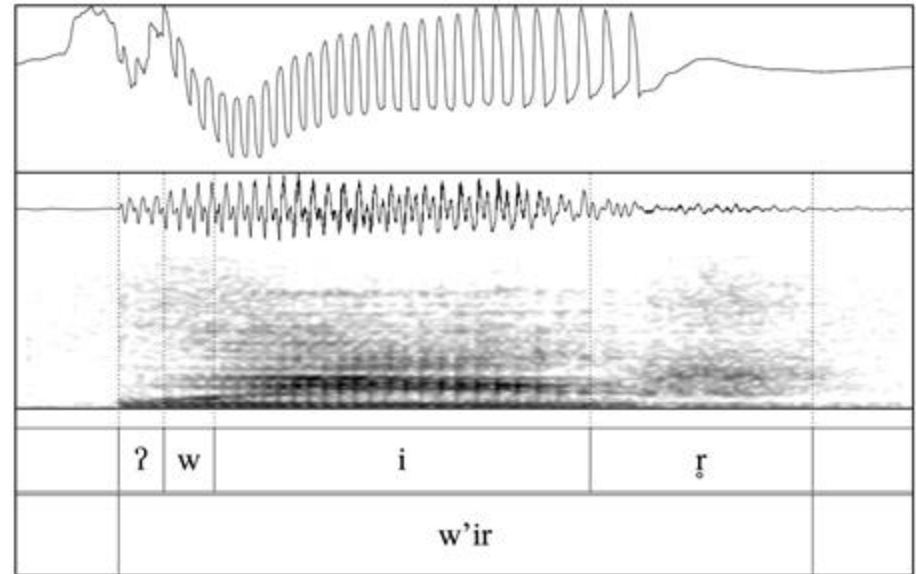
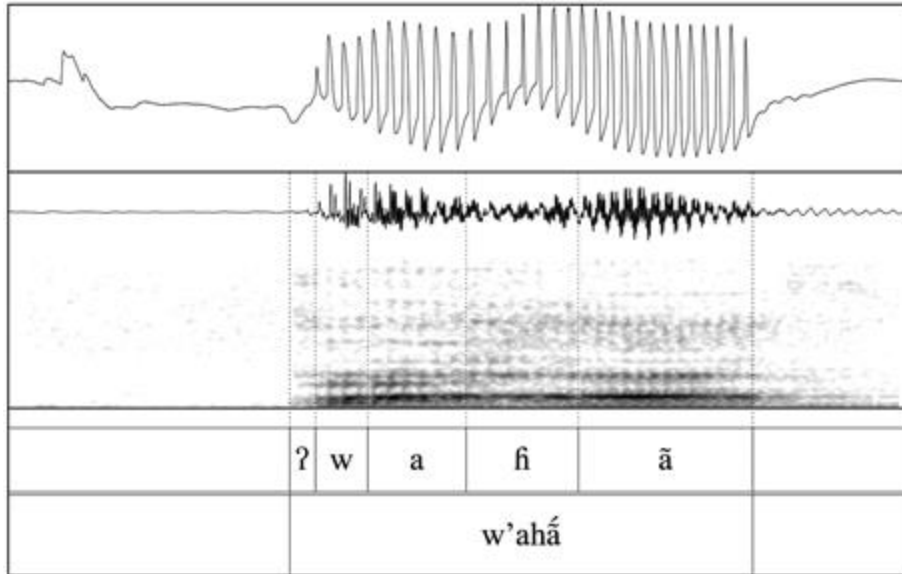
# Results: /l'/



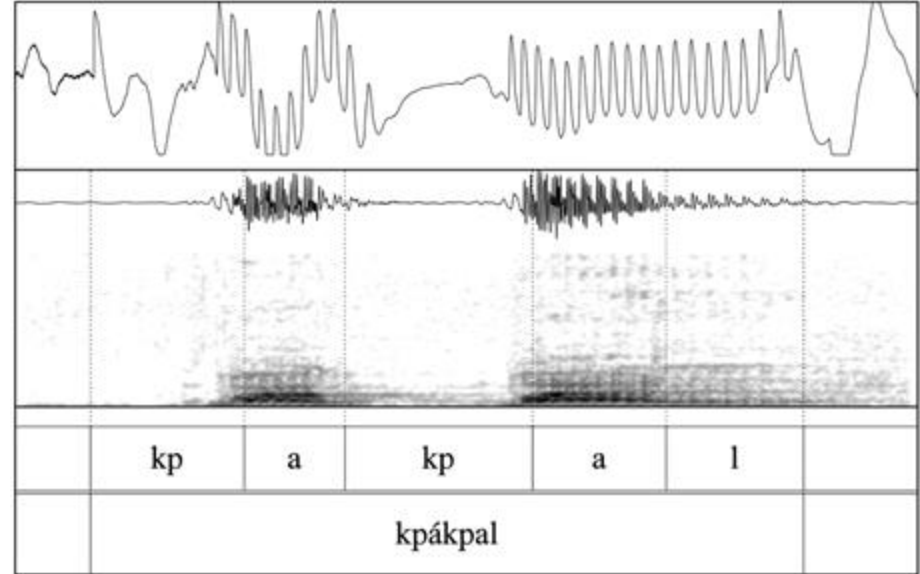
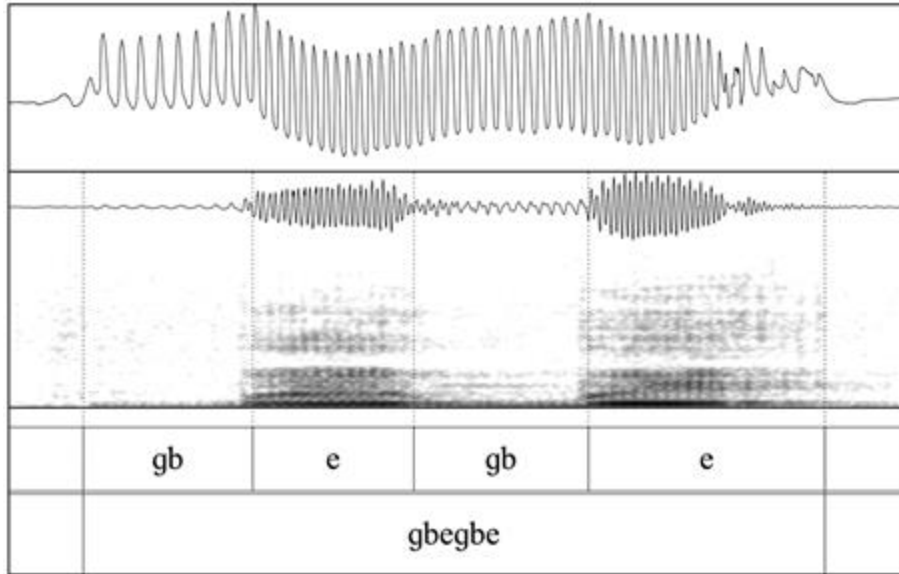
# Results: /j'/



# Results: /w'/ vs. /w/

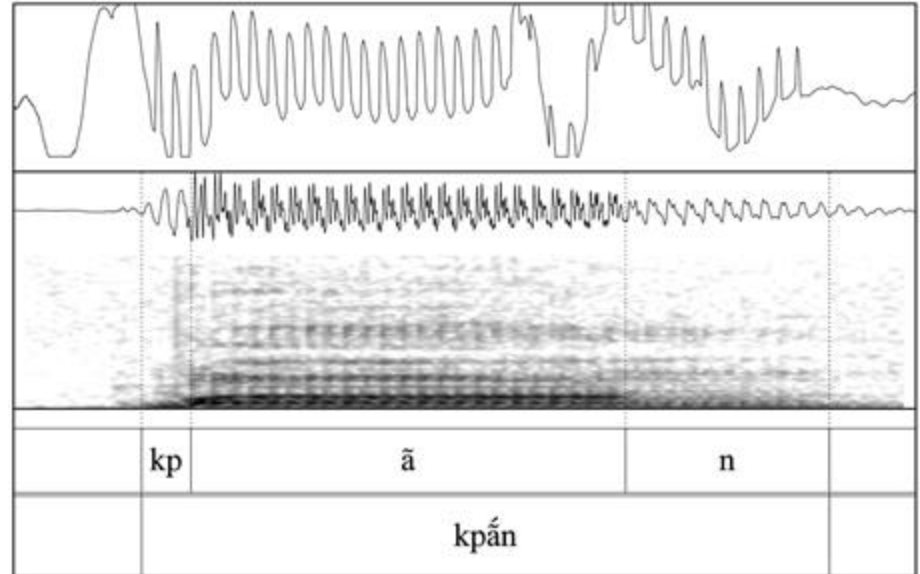
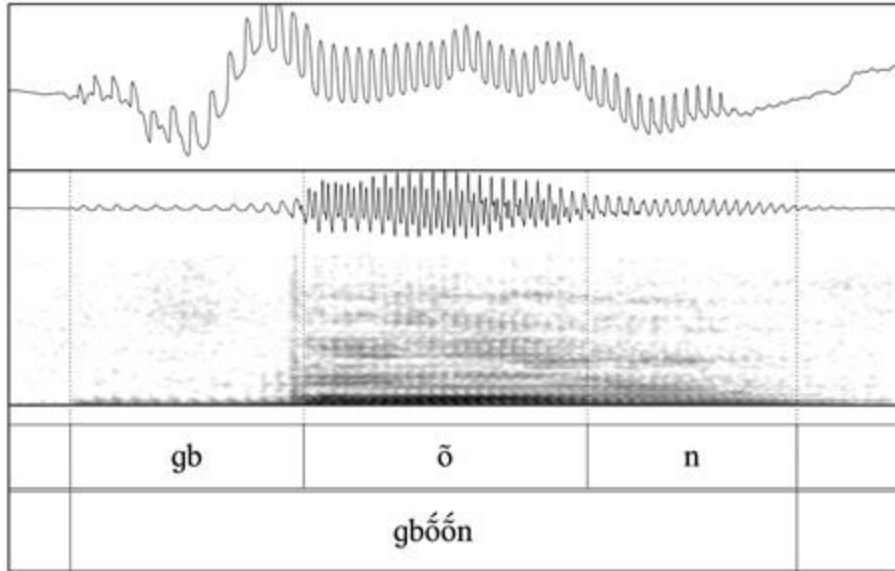


# Results: /gb/ vs. /kp/

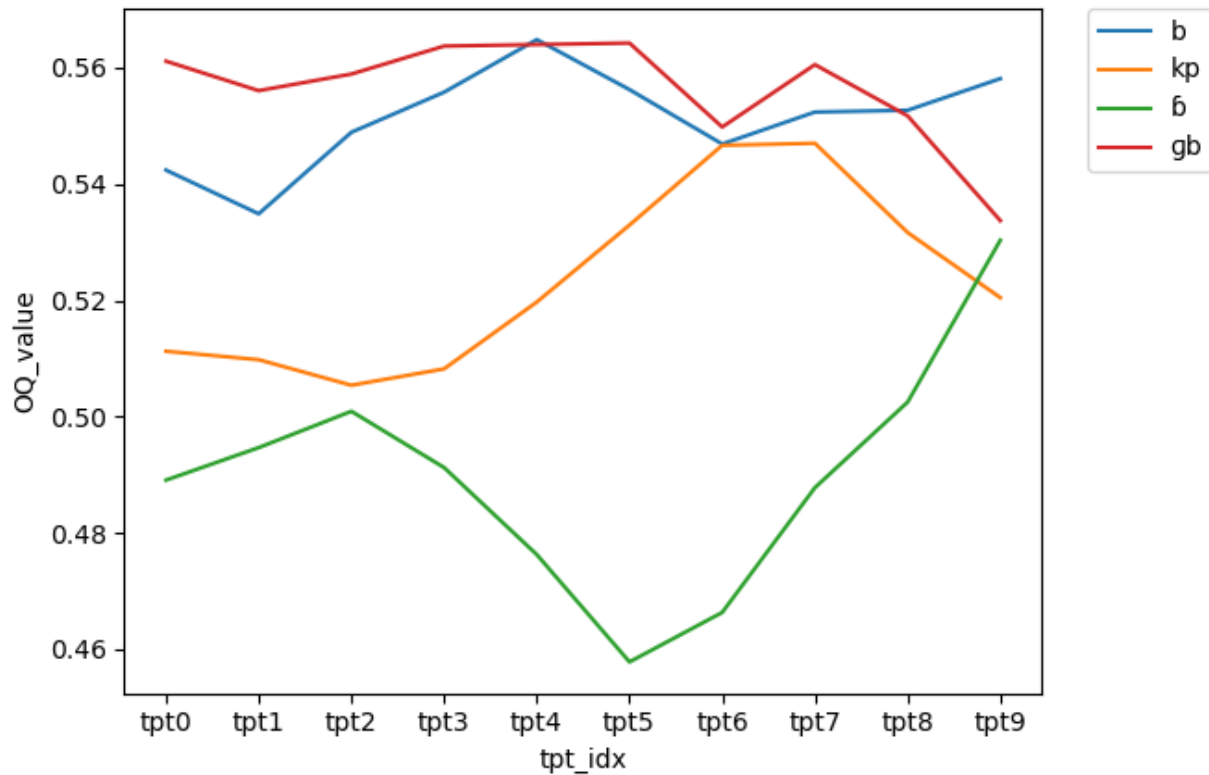




# Results: /gb/ vs. /kp/



# Oq results: all phones w/ labial features



## Discussion: Oq results

- /b ʔl ʔj ʔw/ tend to show an **increase in Oq over the course of the segment**, suggesting initial tenseness that gives way to modal or slightly breathy voicing
  - Plain sonorants and /b/ show greater fluctuation and may decrease in the second half
- All sounds also tend to show **stronger cues of any kind in word-initial position** than when intervocalic or pre-consonantal
  - Sounds in word-initial and syllable onset positions are more prominent and changes to sounds in these positions tend to be highlight penalized (Beckman 1998)
- In the comparison of /b/ and /b̥/, we saw opposing trends, especially in the second half of the segments
  - Plain sonorants did not pattern as cohesively

# Future work

## Future work

- Whole-sentence and spontaneous speech data
- Airflow data
- Parallel study on the tongue root behavior in Lobi's ATR vowel contrasts
- Work with additional speakers