Rate-sensitive differences between modal and non-modal vowels in San Martín Peras Mixtec

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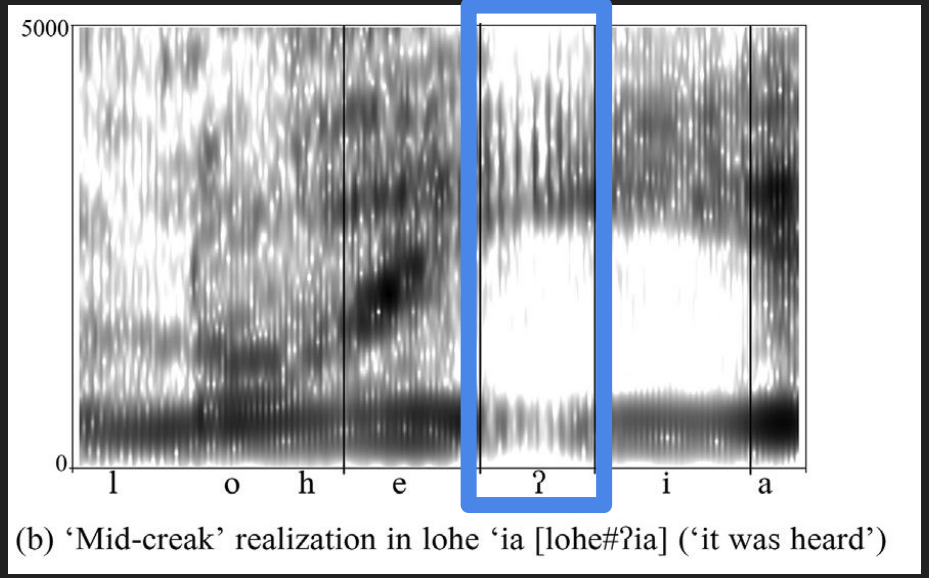
Slides: tinyurl.com/ICPhS2023Mixtec

Acknowledgements

Many thanks to the members of the community of San Martín Peras, both in Mexico and in California, who have shared their language with me. Thanks especially to Natalia Gracida Cruz, Roselia Durán Cruz, and Juan Gracida Ortiz. I'm also grateful to Ryan Bennett and Amanda Rysling for feedback on this work.

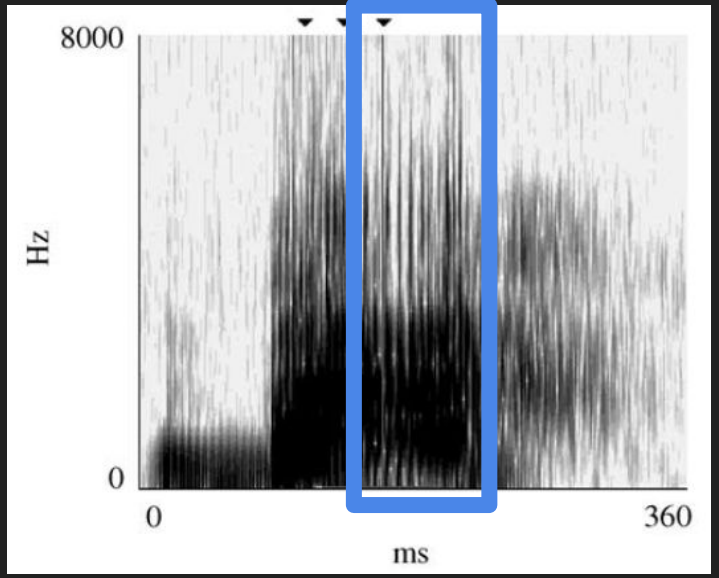
Introduction

The difference between glottal consonants and non-modal vowels is often not obvious from acoustics (Garellek et al. 2021).



(b) ‘Mid-creak’ realization in lohe ‘ia [lohe#ʔia] (‘it was heard’)

Glottal stop in **Hawaiian** (Davidson, 2021:6)

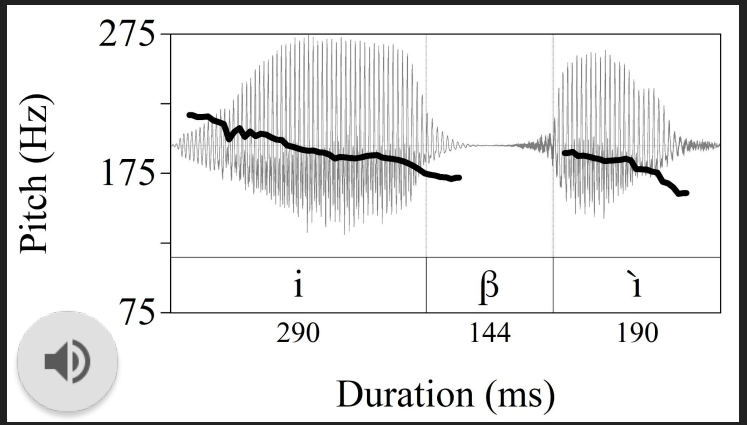


Creaky vowel in **Mazatec** (Blankenship, 2002:164)

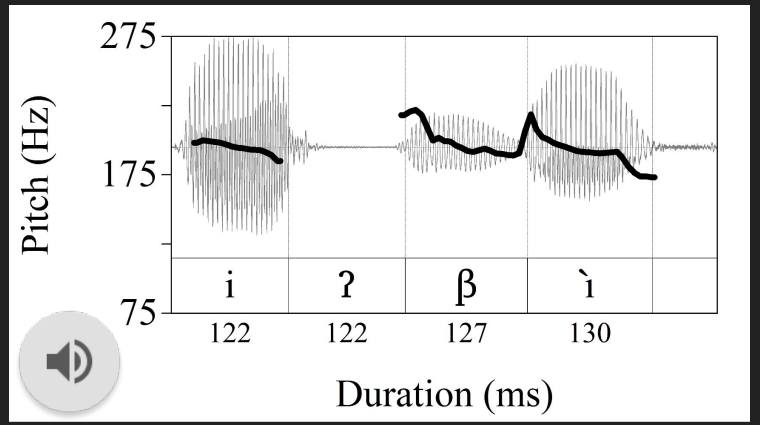
Introduction

In San Martín Peras Mixtec (Otomanguean), the first vowel in a root is sometimes followed by a glottal stop.

1. iβì
   ‘two’



2. iʔβì
   ‘pain’



Background

[V?] sequence could be analyzed in two ways:

- [?] is a consonant, just like [t], [k], etc.
- [V?] sequences are non-modal vowels, phased as modal-then-glottalized

Phonological evidence suggests that [V?] sequences are non-modal vowels (Eischens, 2022).

- But is there any phonetic evidence?

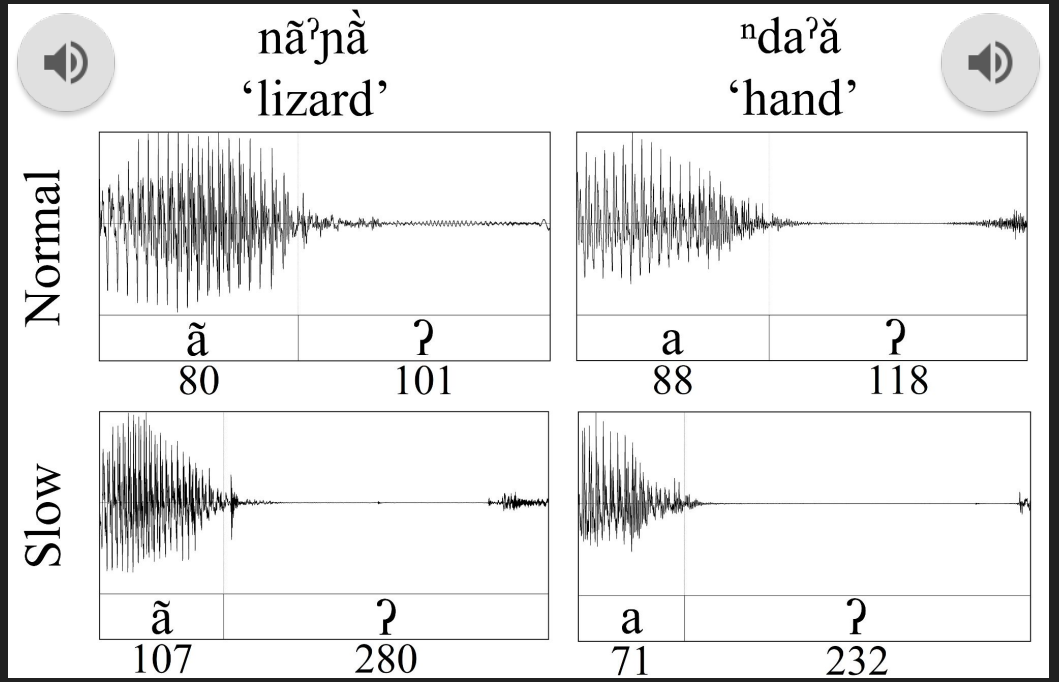
Introduction

This talk:

- Potential novel method for acoustically probing distinction between laryngeal consonants and non-modal vowels
- Modal vowels [V] and glottalized vowels [Vʔ] in San Martín Peras Mixtec respond differently to changes in speech rate
    - Effects of rate on [Vʔ] sequence incompatible with analysis of [ʔ] as consonant

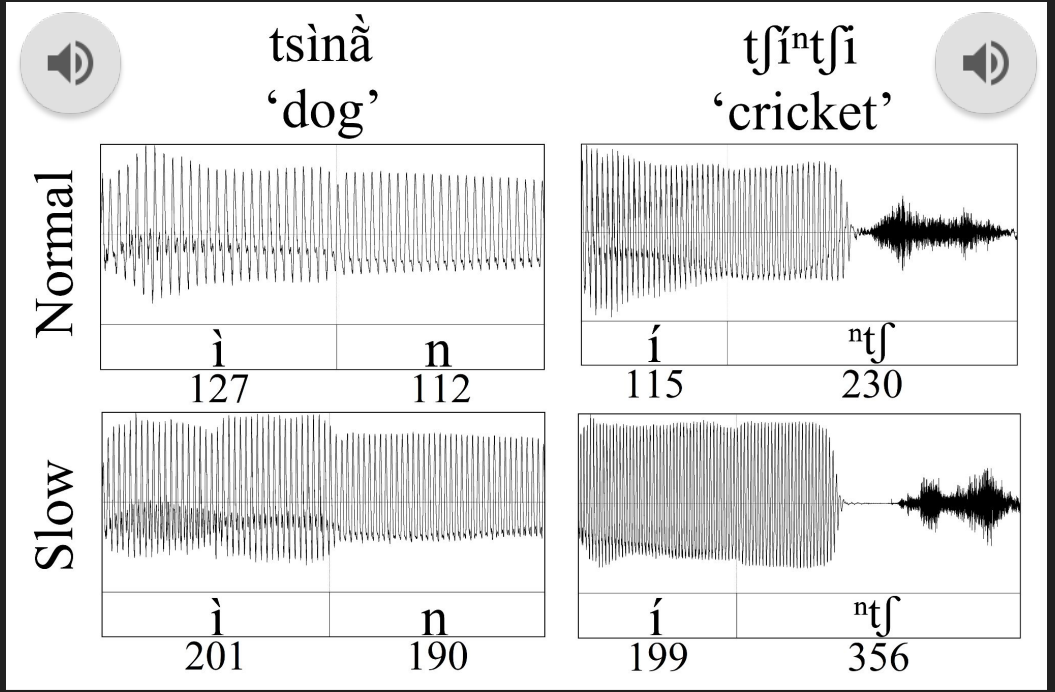
Speech rate

In slow speech, the [ʔ] in [Vʔ] sequences appears to lengthen disproportionately compared to the modal vowel.



Speech rate

Plain modal vowels lengthen proportionately to what follows them in slow speech.

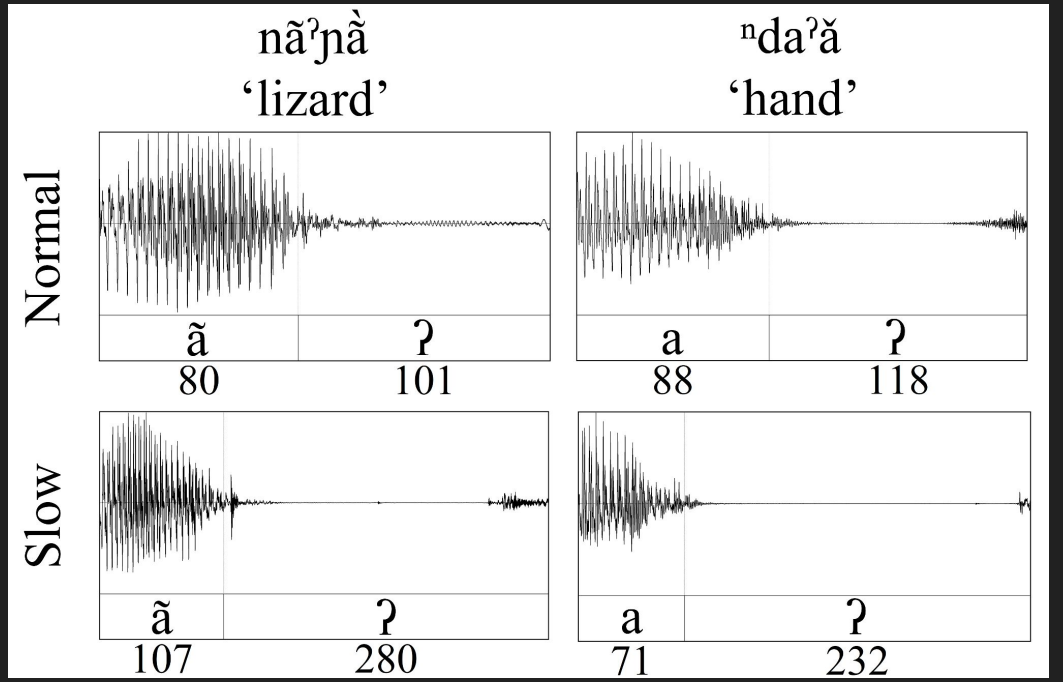


Speech rate

Why is this important?

If [V?] is a glottalized vowel…

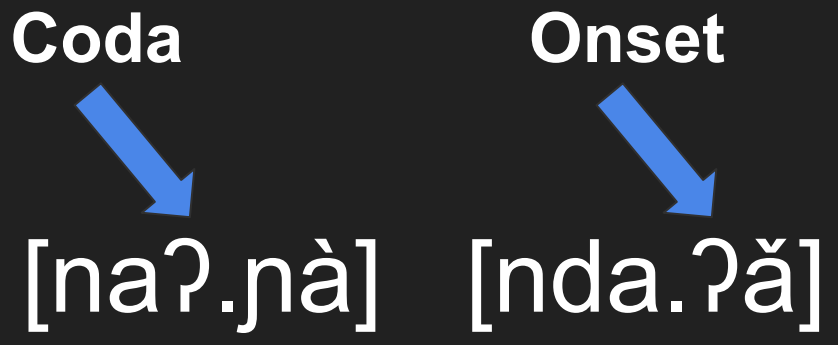
- Glottalized portion of non-modal vowels lengthens disproportionately to the modal portion



Speech rate

If [V?] is a sequence of a vowel and a consonant…

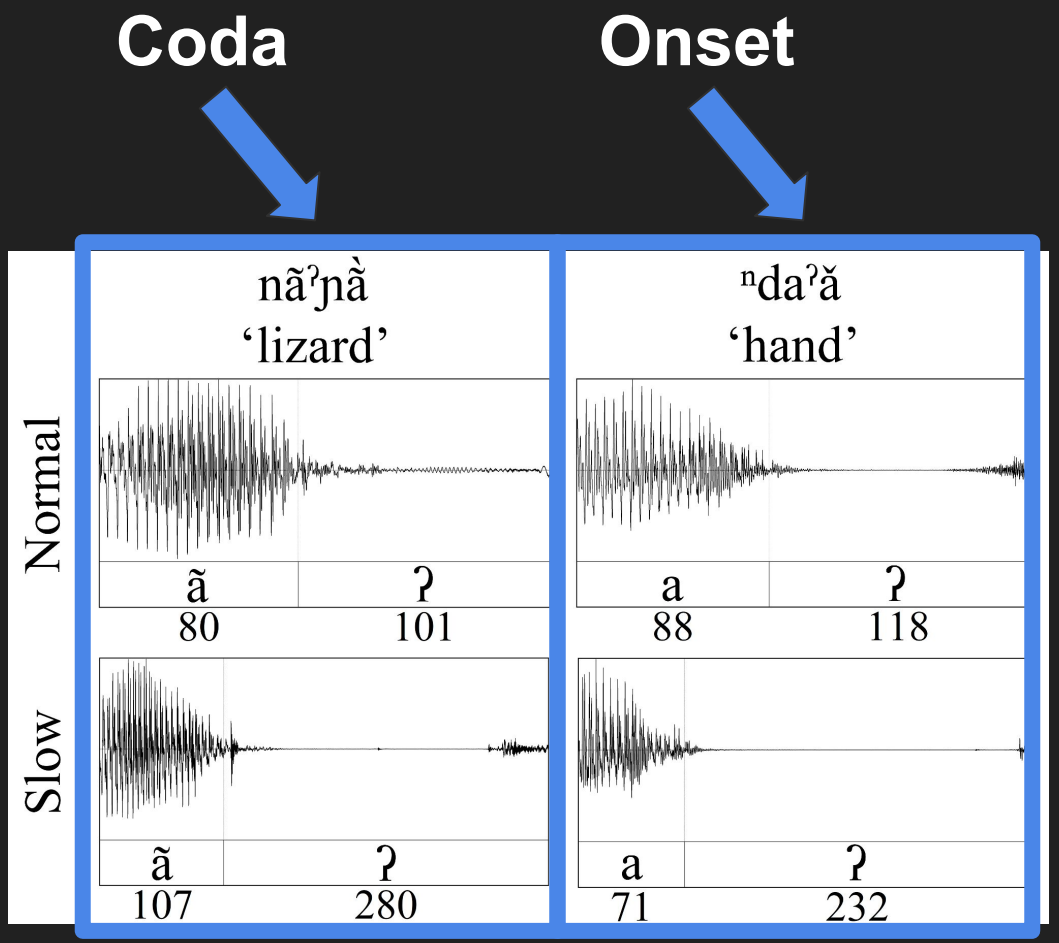
- Expect differences based on syllabification



Speech rate

Expect different lengthening strategies…

- **Coda [ʔ]**
  - Lengthening of [ʔ] = lengthening of rime via lengthening of coda
- **Onset [ʔ]**
  - No longer part of rime
  - Nucleus should lengthen more, but doesn't



If [Vʔ] sequences lengthen uniformly regardless of whether or not there is a following consonant, [Vʔ] is best analyzed as a glottalized vowel.

Pilot study

Goals:

- Quantitatively verify pattern of [Vʔ] lengthening

Preview:

- Results support analysis of [Vʔ] as glottalized vowels

Not discussed:

- Extend study to contrastive and non-contrastive [h]

Pilot study: Participants

- Two middle-aged female speakers of SMP Mixtec
- Live and work in Central Coast region of California
- Grew up in municipality of San Martín Peras, Oaxaca
- Task administered in Spanish

Pilot study: Procedure

Participants prompted to produce target words in a carrier phrase three times

- First at normal rate, then slower, then very slowly
- ~450 productions per participant

1. kã=ɪ̀ ___ βiʰtsĩ
   POT.say=1SG ___ now
   “I will say ___ now”

Pilot study: Materials

Target words varied by…

- What follows first vowel
  - [V?], [Vh], [VⁿC], [VC]
- Presence/absence of medial consonant
  - CV?CV vs CV?V

				V1+P-V1		
				V1	P-V1	
Glottal	C2	nã?ñà̀ ‘lizard’	n	ã	ʔ	ñà̀
	No C2	ⁿda?ă ‘hand’	ⁿd	a	ʔ	ă
Breathy	C2	nṵ̀ni ‘corn’	n	ṵ̀	h	nĭ
	No C2	nì̤hĭ ‘blood’	n	ì̤	h	ĭ
Preasp		tʃúʰtu ‘cat’	tʃ	ú	h	tu
Prenas		tʃíⁿtʃi ‘cricket’	tʃ	í	n	tʃi
Modal		tsìnà̰ ‘dog’	ts	ì	n	à̰

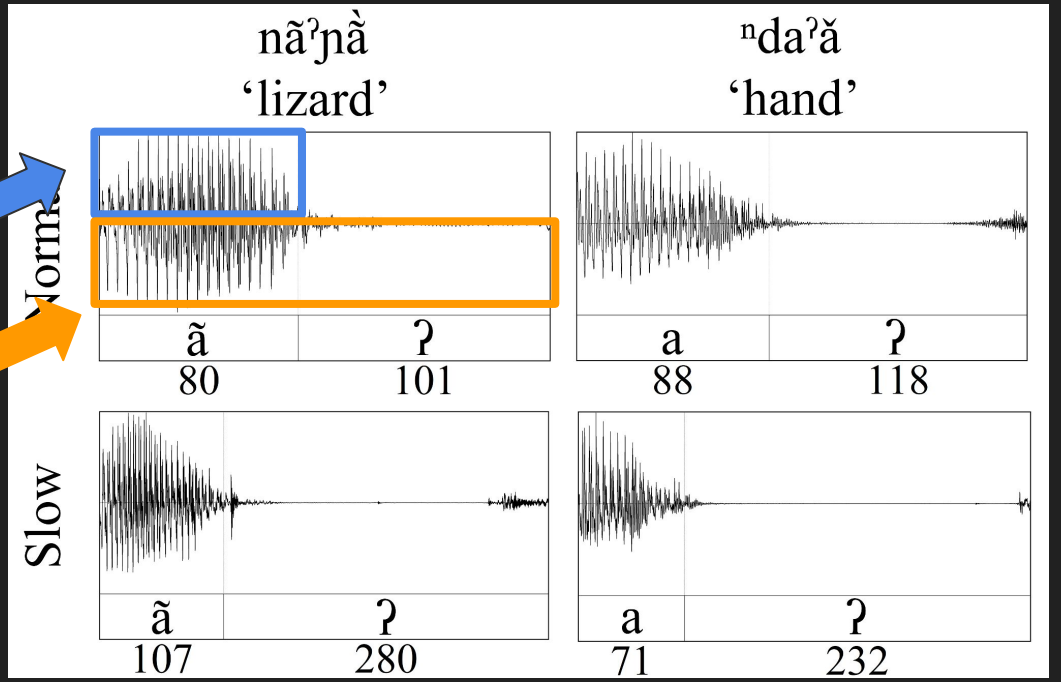
Pilot study: Analysis

Linear mixed effects model

- Dependent variable:

$$\frac{\text{Duration (modal)}}{\text{Duration (modal + post-modal)}}$$

80 / 181 = **0.44**



Pilot study: Analysis

Linear mixed effects model

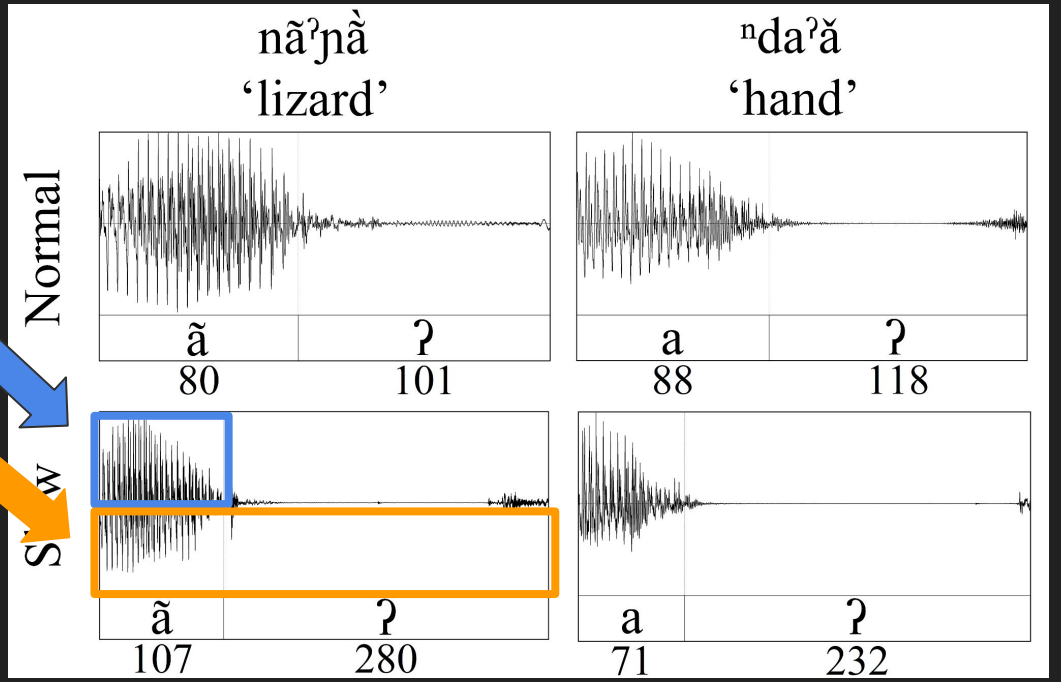
- Dependent variable:

$$\frac{\text{Duration (modal)}}{\text{Duration (modal + post-modal)}}$$

80 / 181 = **0.44**

107 / 387 = **0.28**

Lower in slow speech



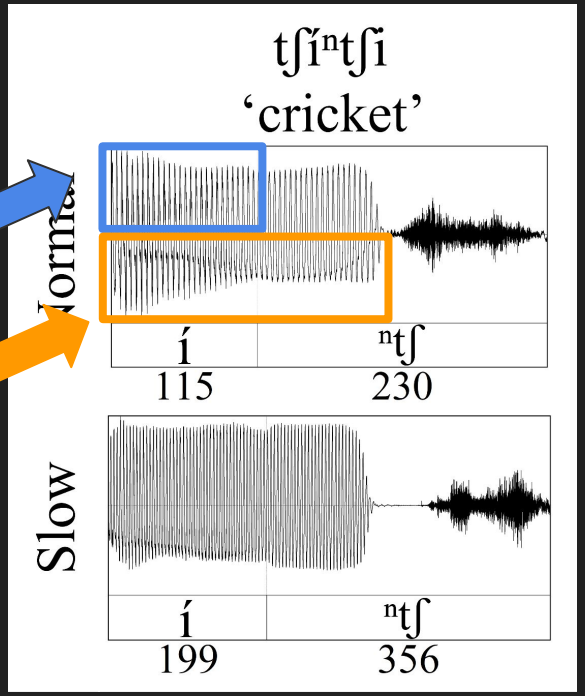
Pilot study: Analysis

Linear mixed effects model

- Baseline: Prenasalized

$$\frac{\text{Duration (modal)}}{\text{Duration (modal + post-modal)}}$$

115 / 214 = **0.54**



Pilot study: Analysis

Linear mixed effects model

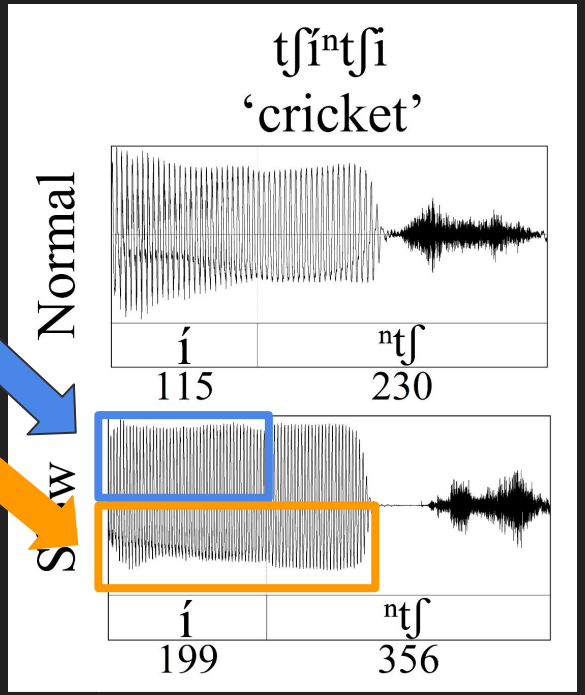
- Baseline: Prenasalized

$$\frac{\text{Duration (modal)}}{\text{Duration (modal + post-modal)}}$$

115 / 214 = **0.54**

199 / 331 = **0.60**

Roughly the same in slow speech (No significant correlation)



Pilot study: Analysis

Independent variables:

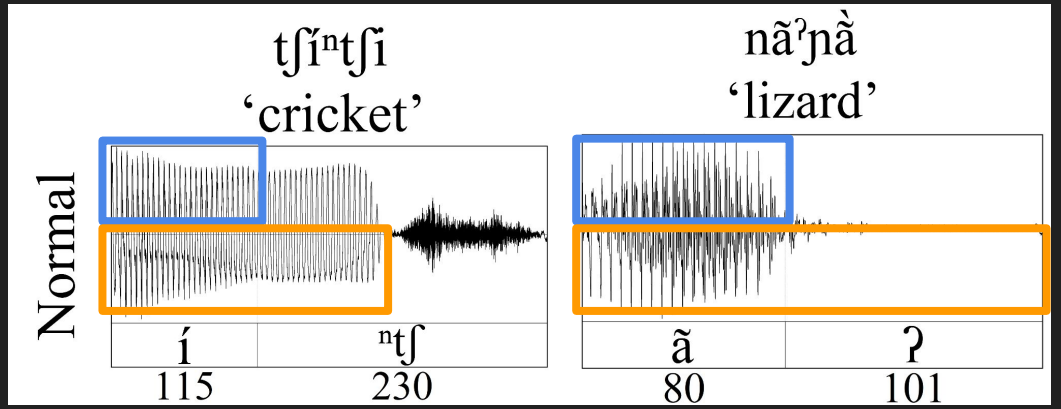
- Speech rate (moras per second)
- Phonation type (glottalized, breathy, preaspirated, modal)
  - Medial C, no medial C
- Speech rate x phonation type interaction

Random effect of item

Pilot study: Results

Negative main effect of glottalized phonation type

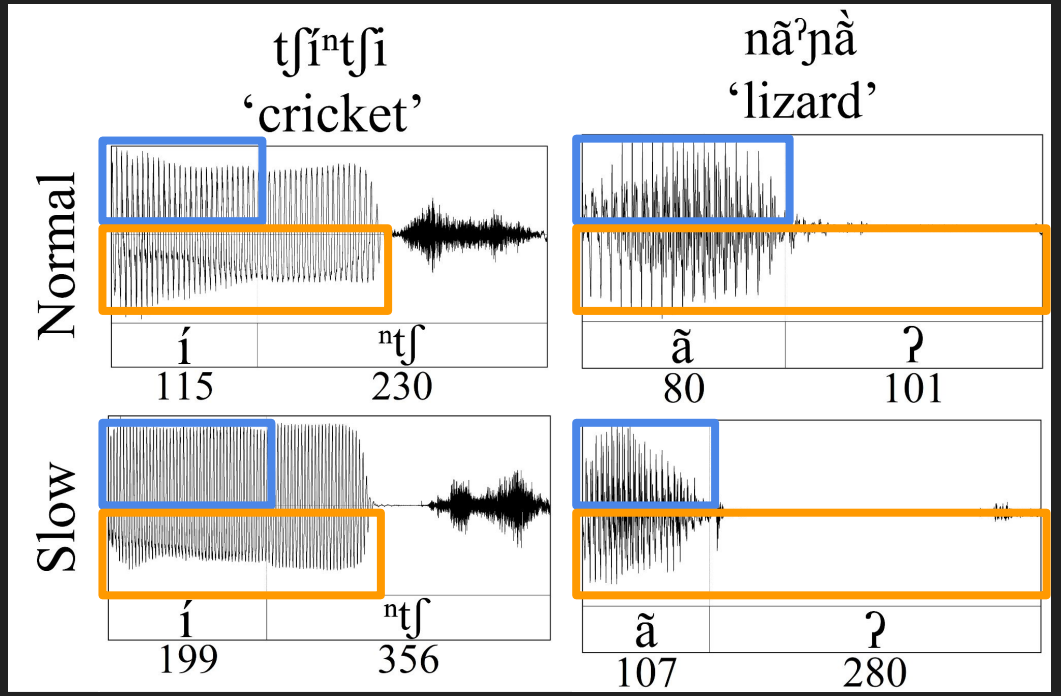
- Ratio of modal vowel to modal vowel + what follows is smaller for [V?] than for [Vⁿ]
- Holds for CV?CV and CV?V



Pilot study: Results

Positive interaction between speech rate and glottalized phonation type

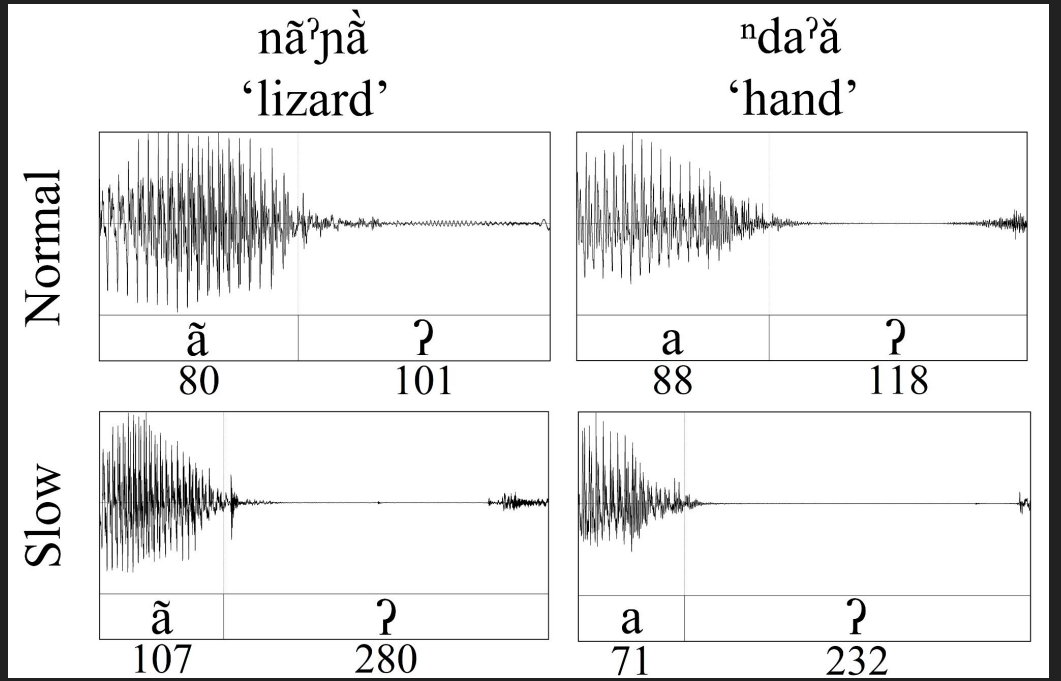
- Ratio of modal voicing to entire [V?] span is smaller in slower speech, larger in faster speech
- Holds for CV?CV and CV?V



Discussion

For both participants, modal vowels…

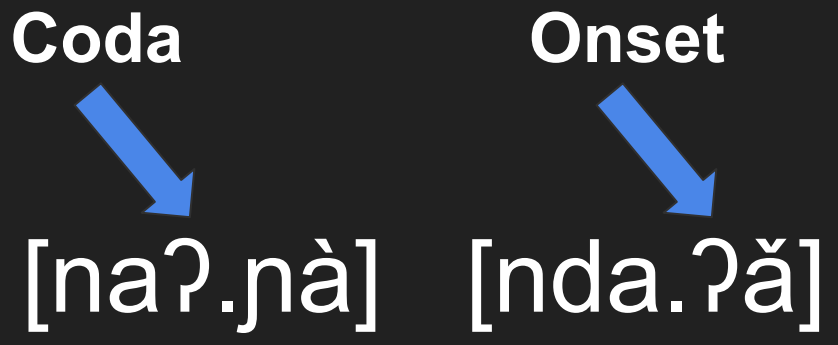
- Are shorter before [ʔ] than in baseline
- Have a smaller proportion relative to [ʔ] as rate slows down
- Same pattern for CVʔCV and CVʔV



Speech rate

If [V?] is a sequence of a vowel and a consonant…

- Expect differences based on syllabification

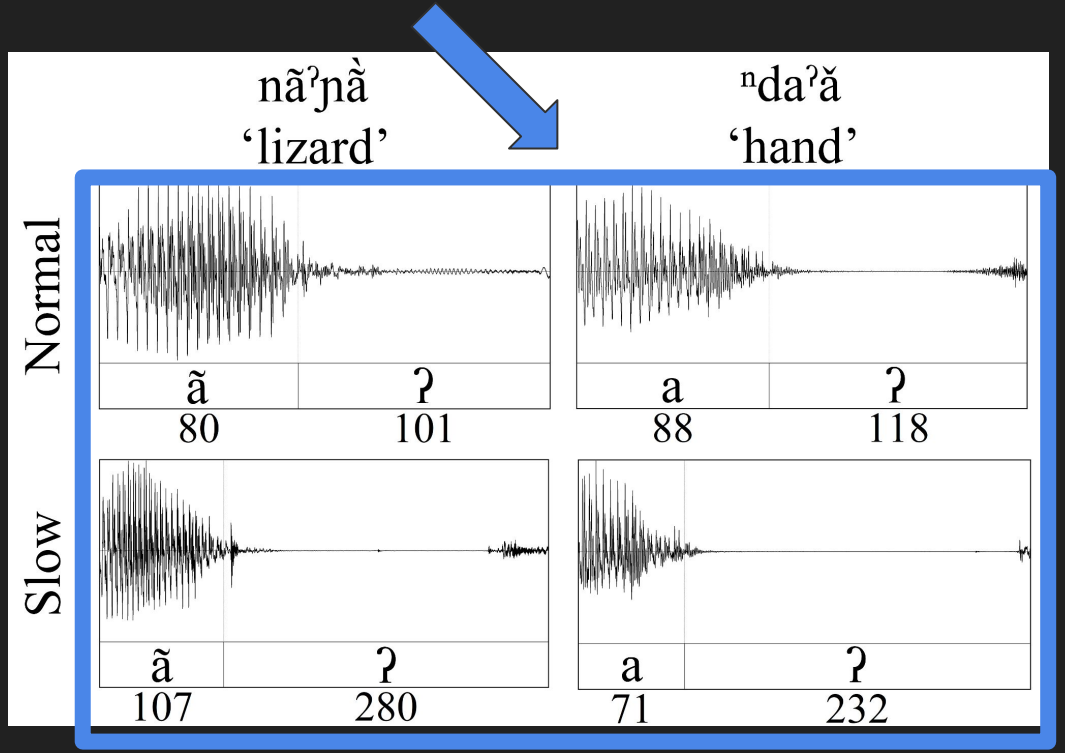


Discussion

If [V?] is a glottalized vowel…

- Glottalized portion of non-modal vowels lengthens disproportionately to the modal portion

Glottalized vowel in all cases



Discussion

Because [V?] sequences lengthen uniformly regardless of whether or not there is a following consonant, [V?] is best analyzed as a glottalized vowel.

Consistent with other Mixtec languages, where [V?] is analyzed as glottalized vowel (Macaulay and Salmons 1995, Gerfen 2013, McKendry 2013, Becerra Roldán 2015, Mendoza Ruiz 2016, León Vázquez 2017, Penner 2019, i.a.)

Conclusion

A novel phonetic method to differentiate glottal consonants from non-modal phonation.

- Most likely relevant in laryngeally-complex languages (Silverman, 1997)
- Results must be verified with more participants (ongoing)

Open question: Why is the glottalized portion of the vowel lengthened more than the modal portion?

- The modal portion hosts a 5-way tone contrast

Tasha’vindó!

Thank you!

References

Becerra Roldán, Braulio. "Un estudio fonológico del mixteco de Santo Domingo Huendio, Oaxaca." (2015).

Blankenship, Barbara. "The timing of nonmodal phonation in vowels." *Journal of phonetics* 30, no. 2 (2002): 163-191.

Davidson, Lisa. "Effects of word position and flanking vowel on the implementation of glottal stop: Evidence from Hawaiian." *Journal of Phonetics* 88 (2021): 101075.

Eischens, Benjamin J. *Tone, Phonation, and the Phonology-Phonetics Interface in San Martín Peras Mixtec*. University of California, Santa Cruz, 2022.

Garellek, Marc, Yuan Chai, Yaqian Huang, and Maxine Van Doren. "Voicing of glottal consonants and non-modal vowels." *Journal of the International Phonetic Association* (2021): 1-28.

Gerfen, Henry. *Phonology and phonetics in Coatzospan Mixtec*. Vol. 48. Springer Science & Business Media, 2013.

León Vázquez, Octavio. "Sandhi tonal en el mixteco de Yucuquimi de Ocampo, Oaxaca." México: Centro de Investigaciones y Estudios Superiores en Antropología Social, 2017.

Macaulay, Monica, and Joseph C. Salmons. "The phonology of glottalization in Mixtec." *International Journal of American Linguistics* 61, no. 1 (1995): 38-61.

McKendry, Inga. "Tonal association, prominence and prosodic structure in South-eastern Nochixtlán Mixtec." (2013).

Mendoza Ruiz, Juana. "Fonología segmental y patrones tonales del Tu'un Savi de Alcozauca de Guerrero." Ciudad de México: Centro de Investigaciones y Estudios Superiores en Antropología, 2016.

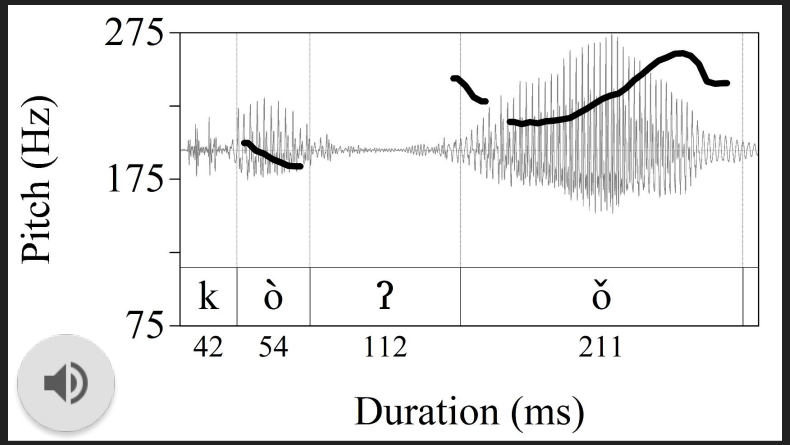
Penner, Kevin. "Prosodic structure in Ixtayutla Mixtec: Evidence for the foot." University of Alberta, 2019.

Silverman, Daniel. "Laryngeal complexity in Otomanguean vowels." *Phonology* 14, no. 2 (1997): 235-261.

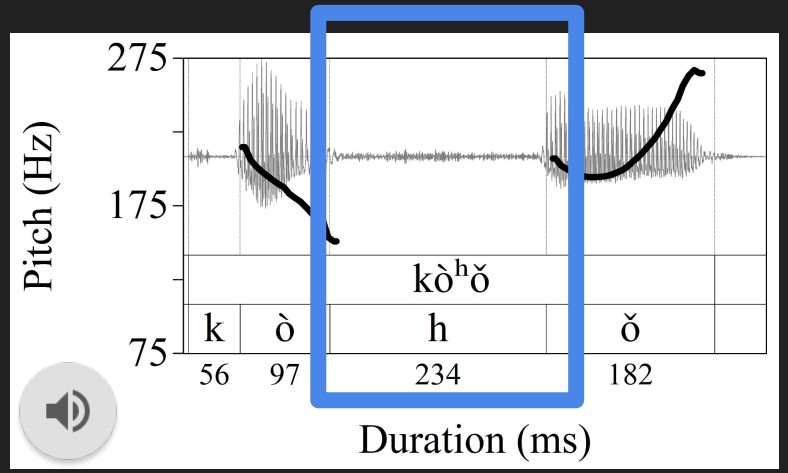
Appendix A: Breathiness?

SMP Mixtec has contrastive [h], which has nearly the same phonotactic distribution as [ʔ].

1. kòʔǒ
   ‘plate’



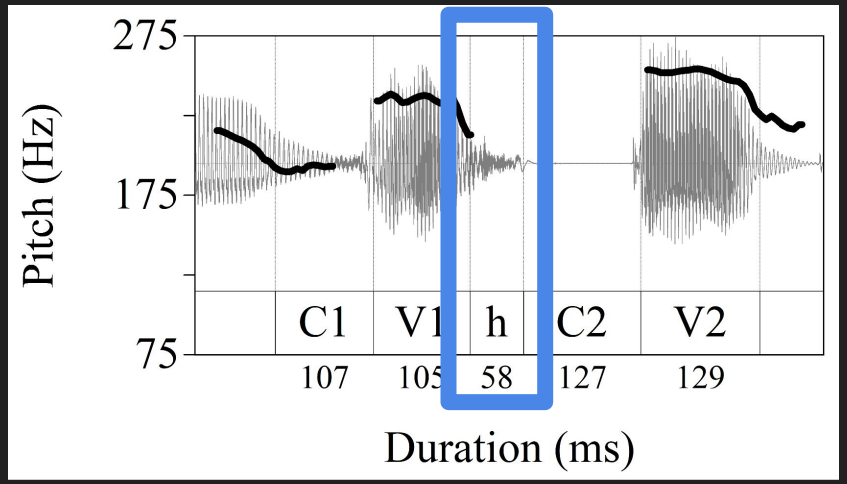
2. kòʰǒ
   ‘snake’



Appendix A: Breathiness?

SMP Mixtec also has non-contrastive [h], which predictably occurs before root-medial, voiceless consonants.

1. ja^{h}tá
   ‘old’



Appendix A: Breathiness?

Question: Do these [h]s show the same lengthening pattern as [ʔ]?

- Potential evidence for segmental or supra-segmental analysis

Results: [h] shows same lengthening pattern as [ʔ] for one participant, but not for the other.

- Participant 1: [h] lengthens disportionately in CVhV and CVhCV words
- Participant 2: [h] lengthens disportionately in CVhCV words, but not in CVhV words
  - Consistent with the consonantal hypothesis!
  - Unclear if variation is patterned or not; one piece of follow-up study