

# Interactions of Tone and Phonation in Santiago Laxopa Zapotec

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## Questions

- How does phonology interact with phonetics?
- How does tone and phonation interact at the phonetics-phonology interface?
- How does tone and phonation interact in Santiago Laxopa Zapotec?

## 1 Introduction

- This paper investigates how tone and phonation interact with each other and with the phonetics-phonology interface.
- This investigation uses Santiago Laxopa Zapotec to answer these questions.
- Santiago Laxopa Zapotec (SLZ) is a variety of Sierra Norte Zapotec, an Oto-Manguean language (Adler et al. 2018, Sichel & Toosarvandani 2020).
- SLZ is spoken by ~1200 people in the municipality of Santiago Laxopa, Oaxaca, Mexico with a small number of speakers in Oaxaca City, Mexico and Santa Cruz, CA.
- Similar to other Oto-Manguean languages, SLZ has both tone and phonation (Campbell, Kaufman & Smith-Stark 1986, Stolz & Stolz 2001, E. Campbell 2017, E. W. Campbell 2017).
- Data is drawn from elicitations conducted 2020-2021 with two native speakers of SLZ that live in the Santa Cruz, CA area.

## 2 Phonetics-Phonology Interface

- Kingston (2007) explains that there are three ways in which phonetics can interface with the phonology.
  1. Phonetics *defines* distinctive features
  2. Phonetics *explains* many phonological patterns
  3. Phonetics *implements* phonological representations.
- Using these three ways in which the phonetics interacts with the phonology, we can account for the ways that tone and phonation interact.
- We can *define* what the tones and phonation types are in SLZ.
  - This can be accomplished through frameworks such as Articulatory Phonology (Browman & Goldstein 1992) and Auditorism (Kingston & Randy L. Diehl 1994, 1995).

- We can *explain* what the tones and phonation types are in SLZ.
  - This can be done through discussing the physical, physiological, and/or psychological properties of speaking and listening.
  - For tones, this means discussing the f0 measures and perceived pitch
  - For phonation, this means discussing relevant acoustic measurements like spectral tilt and CPP (Garellek 2019).
- We can *implement* the phonological representations of tone and phonation types in SLZ.
  - This would be accomplished by discussing what the abstract phonological categories are and what factors control how those categories are actually implemented within the phonetics.
- This paper will tackle the way *explaining* what the tones and phonation types are and how those phonological representations are *implemented*.

### 3 Phonemic Inventory

#### 3.1 Vowels

- SLZ exhibits a basic five vowel inventory.

	Table 1: SLZ Vowels		
	front	central	back
high	i		u
mid	e		o
low		a	

- Like other Oto-Manguean languages, SLZ exhibits classes of laryngeally-complex vowels (Silverman 1997).
- In addition to Modal phonation, all five vowels in SLZ can also appear with:
  - Breathy: [ ǁ ] *ah*
  - Checked: [ a̰ ] *a'*
  - Laryngealized: [ a̰a ] *a'a*
- These phonation types are contrastive as seen in (1)

(1) Near-minimal triple

- a. *yah* [ jǁa̰ ] ‘iron; rifle’

- b. *yu'* [ ɕu<sup>ʔ3</sup> ] ‘earth’
- c. *yu'u* [ ju'u<sup>13</sup> ] ‘house’

- Additional evidence from the closely related Yalálag Zapotec shows that there is variable pronunciation of the laryngealized vowels (Avelino Becerra 2004, Avelino 2010).
- Similar variability is observed between speakers in SLZ.

Table 2: Layngealized Vowels in Yalálag Zapotec

/V <sup>ʔ</sup> V/	[V <sup>ʔ</sup> V]
	[V̥V̥]
	[V̥V̥ː]
	[V̥V̥]

- I am currently working on extracting tokens from elicitations to run statistical analyses.
  - Answer questions about the acoustic measurements for the different phonation types.
    - \* Data from Adler & Morimoto (2016) and preliminary data from myself shows that H1-H2 and CPP are both measures that correspond to the phonation types.
  - Answer questions regarding the moraic status of the different phonations.
  - Answer questions about the interaction of tone and phonation.

### 3.2 Tone

- Tonal analysis was done following Pike (1948) and K. L. Snider (2018)
- SLZ exhibits five different tonal patterns as shown in Table 3
  - Three level tones: H, M, and L (represented using Pike’s numbers)
  - Two contours: MH and HL

Table 3: SLZ tones

high	a <sup>1</sup>	<i>xha</i>	[ ɬa <sup>1</sup> ]	‘clothing.poss’
mid	a <sup>2</sup>	<i>nu'ulhe</i>	[ riɜ <sup>2</sup> ]	‘house.poss’
low	a <sup>3</sup>	<i>yu'</i>	[ ɕu <sup>ʔ3</sup> ]	‘earth’
rising	a <sup>21</sup>	<i>yu'u</i>	[ ju'u <sup>21</sup> ]	‘quicklime (sp. cal)’
falling	a <sup>13</sup>	<i>yu'u</i>	[ ju'u <sup>13</sup> ]	‘house’

- We believe that the mora is the tone bearing unit in SLZ.

- This also in keeping with other analyses of tone in Zapotecan languages (e.g., Chávez-Peón 2010).
- With the mora being the TBU in SLZ and only one tone per mora the contour tones must be born on syllables containing two morae or split across the multiple syllables.
- However, if fortis consonants are moraic in nature then the question arises as to how tone interacts with these moraic consonants.
- It is a well established fact that tone can appear on sonorant consonants but less likely on obstruents (e.g., Yip 2002, Hyman 2014, K. Snider 2014, K. L. Snider 2018).
- This has been well-established for other Zapotec varieties but with one exception. Only vowels and fortis sonorants are able to bear tone in Quiavini Zapotec (Chávez-Peón 2010: Ch. 5).

## 4 Interaction of Tone and phonation

- The interaction of tone and phonation is a well-established fact and has been heavily studied in Asian tonal languages (see references in Yip 2002, Michaud 2012, Brunelle & Kirby 2016).
- In these languages it is common for certain phonation types to co-occur with certain tones.
- The interaction between tone and phonation in the languages of the America's has been studied but to a lesser extent than Asian languages (Adler & Morimoto 2016, Chávez-Peón 2010, DiCanio 2012).
- Chávez-Peón (2010) showed that the similar restrictions in tone and phonation co-occurrence appear in Quiavini Zapotec but are at the same time much more free, see Table 4.

Table 4: SLQZ tone and phonation

	High	Low	Falling	Rising
Modal	✓	✓	✓	✓
Breathy	X	✓	✓	X
Creaky	✓	✓	✓	X
Interrupted	✓	✓	✓	X

- One previous study attempted to explore this question in SLZ, but was ultimately flawed (Morimoto 2017).
- I am currently trying to determine to what extent tone and phonation interact in SLZ.

## 5 Methodology

- Two native speakers of SLZ (1 male and 1 female) were asked to perform two tasks:
  1. Word lists elicitation
  2. A narrative elicitation
- Word list elicitation consisted of approximately 200 words repeated three times each in a carrier sentence.
- Consultants were recorded using a Zoom H4n audio recorder (44.1kHz and 16bit) and Zencast, a professional podcasting service that records in high quality audio.

### (2) Carrier Sentence

sh-ni=a<sup>'13</sup>                      \_\_\_\_\_ cho<sup>2</sup>ne<sup>2</sup> las<sup>2</sup>  
 CONT-speak=1SG                      three      times  
 'I say \_\_\_\_\_ three times'

- Because carrier sentence elicitation is rather artificial an additional task was chosen to produce a more natural context.
- This was done in order to test the claims made by Garellek & Esposito (2021) that in narrative contexts the only acoustic measure that indicates different phonation types is CPP.
- This was done by having consultants tell the story presented in a picture book called "Where are you, Frog?"

## 6 Next Steps

- Finish extracting tokens from word list elicitation
- Process audio for "Where are you, Frog?" from speaker f1
- Continue reading Esling et al. (2019) on Voice Quality
- Due readings on the phonetic-phonology interface (Keating 1996, Kingston 2007, Zsiga 2020)

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## Appendix

### Consonants

- SLZ has approximately 27 consonants as shown in Table 5
- Like other Zapotecan languages consonants are divided between fortis and lenis (Nellis & Hollenbach 1980, Jaeger & Van Valin 1982, Uchihara & Pérez Báez 2016).
- Following Jaeger & Van Valin (1982) there are four reasons that we distinguish fortis/lenis instead of voiceless/voiced in Zapotecan languages.
  1. Fortis obstruents are always voiceless, while lenis can be voiced, partially devoiced, or voiceless.
  2. Fortis stops and affricates always retain their stop closure, whereas lenis stops and affricates are often realized as fricatives.
  3. Fortis obstruents are usually of longer duration than lenis obstruents
  4. Fortis and lenis sonorants are primarily distinguished by length, with fortis having a longer duration than lenis.

- The behavior that Jaeger & Van Valin (1982) described is illustrated in Table 6.
- This same behavior has been observed to some extent in SLZ and in other Sierra Norte varieties (Sonnenschein 2005).
  - It is quite common that lenis stops become their voiceless fricative counterpart word final, e.g. *yag* [jax<sup>3</sup>] ‘wood; tree’

Table 5: SLZ Consonants

		bilabial	alveolar	retroflex	alveo-palatal	palatal	velar	labio-velar	uvular
nasal	lenis		n						
	fortis	m:	n:						
stop	lenis	b	d				g	g <sup>w</sup>	
	fortis	p	t				k	k <sup>w</sup>	
fricative	lenis		z	ʒ~ɮ	ʒ	ç			ʁ~χ
	fortis		s	ʂ	ʃ				
affricate	lenis		dz						
	fortis		ts		tʃ				
lateral	lenis		l~r						
	fortis		l:						
trill			r						
approximate						j		w	

Table 6: Allophones of some fortis and lenis obstruents in Yateé Zapotec

Fortis				Lenis			
/t/	→	ṭ	initially	/d/	→	d, ɖ, ɗ, ɗ̥	initially
		ṭ:	medially			d, ɗ	medially
		t <sup>h</sup>	finally			ɗ̥, θ	finally
/tʃ/	→	ṭʃ	initially	/dʒ/	→	ɖ̣, ɖ̣̣, ʒ, ʒ̣	initially
		ṭʃ:	medially			ɖ̣̣, ʒ̣	medially
		ṭʃ <sup>h</sup>	finally			ɖ̣̣̣, ʒ̣̣, ʃ	finally

- One explanation for this behavior has to do with morae.
- According to many authors the reason for this difference in behavior is because fortis consonants are inherently moraic (e.g., Chávez-Peón 2010, Uchihara & Pérez Báez 2016 ).



- Additional evidence for this comes from the behavior of vowels before fortis and lenis consonants (Arellanes 2009, Chávez-Peón 2010, Uchihara & Pérez Báez 2016).

- Before fortis consonants vowels are short.
- Before lenis consonants vowels are long.

(3) Lenis and fortis codas in Quiaviní Zapotec

Lenis		Fortis	
lá:d	‘side’	lát:	‘tin can’
tá:n	‘Cayetana’	tas:	‘cup’