

## Testing the Laryngeal Complexity Hypothesis: Evidence from Santiago Laxopa Zapotec

**Introduction:** Most descriptions about the interaction between tone and phonation are based on South East and East Asian languages (e.g., Masica 1976, Thurgood 2002, Michaud 2012, Brunelle & Kirby 2016, Kuang 2017). These descriptions have led to widespread claims about what is possible in languages with tone and phonation, specifically that tone and phonation are co-dependent. This means that certain tones will bear specific phonations or that certain phonation types only appear with certain tones. For example, Mandarin's tone 3 is associated with creaky voice (Hockett 1947) and Vietnamese's low falling tone is associated with breathy voice (Thurgood 2002). This, however, is not the true for Oto-Manguean languages where tone and phonation are independent from one another (Silverman 1997).

**The Laryngeal Complexity Hypothesis:** Despite being independent from one another, tone and phonation need to interact in a way that is perceptually salient. This need for perceptual saliency led to the proposing of the LARYNGEAL COMPLEXITY HYPOTHESIS (LCH; Silverman 1997, Blankenship 1997, 2002). The LCH's basic premise is that for tone and phonation to be best perceived there needs to be an ordering or phasing between the gestures for tone and phonation. If there was no strict ordering of the gestures for tone and phonation then the cues for tone and/or phonation will have interference, see Figure 1 for a graphical illustration. DiCanio's (2012) study exploring the LCH in Itunyoso Trique found exactly this interference. DiCanio showed that when there is a large overlap between the gestures for tone and phonation that the  $f_0$  signal is perturbed by the glottal gestures for phonation.

This paper investigates the LCH's role in Santiago Laxopa Zapotec (SLZ), an understudied Oto-Manguean language spoken by approximately 1000 people in the municipality of Santiago Laxopa in the Sierra Norte of Oaxaca, Mexico.

**Description of SLZ tone and phonation:** SLZ, like other Oto-Manguean languages, contains a robust systems of both tone and phonation which are independent from each other. SLZ has five surface tonal patterns on syllables: three level tones H(igh), M(id), L(ow) and two contour tones HL and MH. Vowels in SLZ, additionally have four phonations types: Modal, Breathly, Checked, and Laryngealized. These different tones and voice qualities are allowed to appear essentially independent from one other in the nominal domain with the only exceptions being H with breathy phonation and MH with checked tone.

**Methodology:** Data was collected from 18 native SLZ consultants living in Santa Cruz, CA in person and in Santiago Laxopa, Ixtlán, Oaxaca, Mexico (11 female). Consultants were recorded repeating three times the phrase *shnia' WORD chone las*. 'I say WORD three times' with each of the 77 target words. Vowels were extracted from the resulting audio files and spectral-tilt measurements were generated for each third of the vowel using VoiceSauce (Shue, Keating & Vicens 2009) following Garellek & Keating (2011). The results were then analyzed in R (R Core Team 2021) using a mixed-effects linear regression with  $f_0$  as fixed variable and speaker and word being random variables to determine to what extent  $f_0$  is affected by phonation similar to DiCanio (2012).

**Results:** The spectral-tilt analysis shows that for both of the male and female speakers from California that H1-A3 is the best measurement for breathy phonation contrary to Esposito's (2010) observations that female speakers of Zapotec are best characterized by H1-H2. It is true that H1-H2 best characterized the checked and laryngealized vowels, both associated with creakiness, in the female. The male's phonation types were best represented by H1-A3 confirming Esposito's (2010)'s observation that male Zapotec speakers are best characterized by this spectral-tilt measurement. Box graphs showing the spectral-tilt measurement for the final third of the vowel for FSR (female) and RD (male) are presented in Figure 2 for H1-H2 and Figure 3 for H1-A3.

Preliminary results of the mixed-effects linear regression drawn from the two speakers living in California show that there was no effect of phonation on  $f_0$  in any portion of the vowel. However, further data is being collected in Santiago Laxopa to verify the results.

**Upshot:** This paper has provided a brief introduction to the tonal and phonation systems of Santiago Laxopa Zapotec, an understudied variety of Sierra Norte Zapotec. This system is important for studying the interaction of tone and phonation because of the complex interactions between tone and phonation that are found in this language. Because any phonation type can co-occur with any tone this presented a unique opportunity to see how the language compensates for using larynx for both tone and phonation. This paper has shown, by using language data elicitation data from SLZ, that the LCH (Silverman 1997, Blankenship 1997, 2002) appears to be the best model of accounting for how tone and phonation interact.

## Figures and Tables

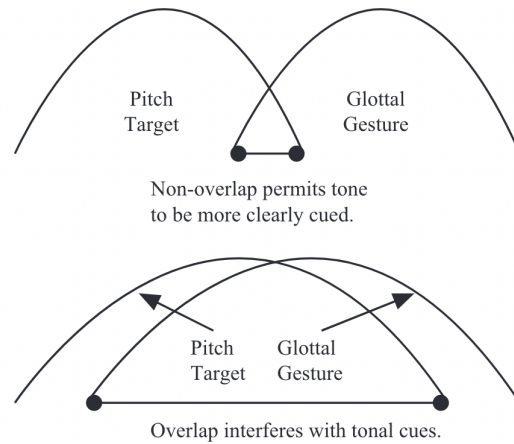
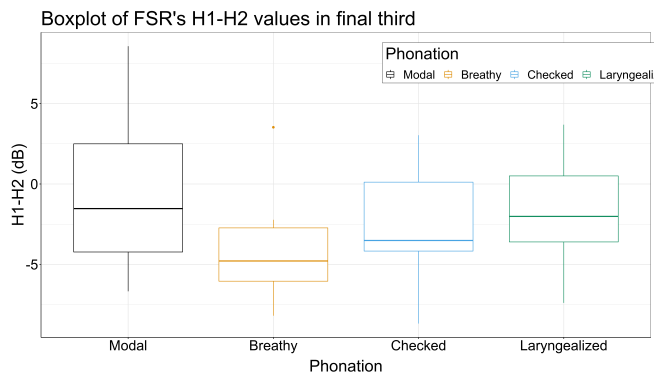
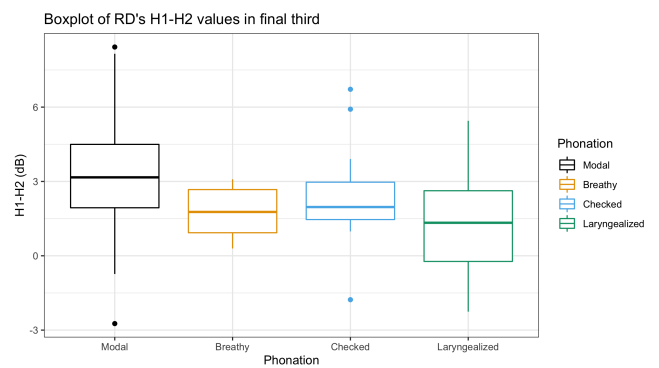


Figure 1: Representation taken from DiCanio (2012).

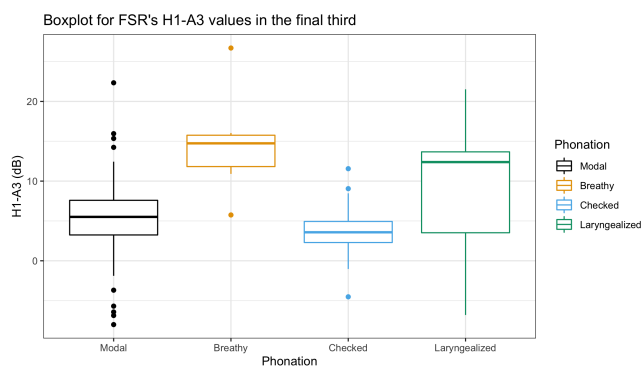


(a) FSR's H1-H2 values.

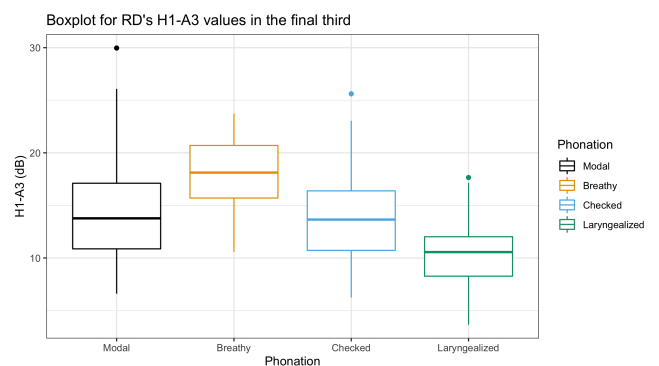


(b) RD's H1-H2 values.

Figure 2: Mean H1-H2 values for the final third of the vowel according to each phonation type.



(a) FSR's H1-A3 values.



(b) RD's H1-A3 values.

Figure 3: H1-A3 values for FSR (a) and RD (b) for the final third of the vowel.

### **COVID Impact**

Due to COVID, the pueblo of Santiago Laxopa closed itself to the outside world until a few months ago. Fortunately, I was able to elicit preliminary data from two SLZ speakers that were living in California. However, this was insufficient data to adequately assess the interaction between tone and phonation, but provided me with some preliminary results, which were presented in this abstract. I am currently, at the time of submitting this abstract, in Santiago Laxopa finishing eliciting data from additional SLZ speakers (6 male; 10 female) to verify the validity of the results of the two SLZ speakers from California.