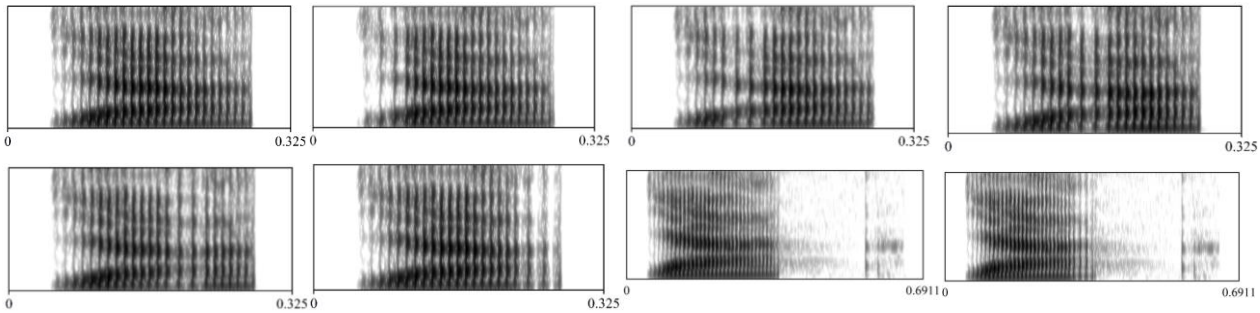
Perception of checked and rearticulated phonations: Effect of duration and glottalization phasing

Introduction. Sierra Norte Zapotec is known for having two contrastive glottalized phonations: rearticulated and checked (e.g. Yalálag: Avelino 2016; Betaza: Crowhurst et al. 2016). Rearticulated vowels have long duration and have vowel-medial glottalization, whereas checked vowels have short duration and vowel-final glottalization. The current study is among the first studies to test the effect of duration and glottalization positioning on the perception of checked and rearticulated phonation, and how they interact with each other. The language we investigate is Yateé Zapotec spoken in the Sierra Norte region of Oaxaca.

Stimuli and participant. The stimuli involves six tone/phonation minimal pairs: ya [jâ] "reed", yaa [jă] "metal", ya'a [jàˀà] "mountain", ya'a [jáˀà] "green", ya'a [jàˀá] "plaza", ya' [jáˀ] "San Andres Yaa (village name)". These six words have the same segmental structure, but differ in phonation and tone. **In terms of duration**, we converted the original stimuli into **three lengths**: 150 ms, 225 ms, and 300 ms using. **In terms of glottalization**, we created **eight conditions**, varying the position of glottalization in the vowel: no glottalization; glottalization at 1/5, 2/5, 3/5, 4/5, and 5/5 portion of the vowel; glottal stop closure release in the end; glottalization at the 5/5 of the vowel + glottal stop closure release in the end. The glottalization is created by jittering the f0 of the glottalized portion of vowel and lowering the intensity of the glottalized portion by adjusting the Intensity Tier in Praat. The spectrograms of the eight glottalization positions on vowels with 300 ms duration are presented in Figure 1. Each participant listened to 48 trials (8 gl * 3 duration * 2 repetitions).

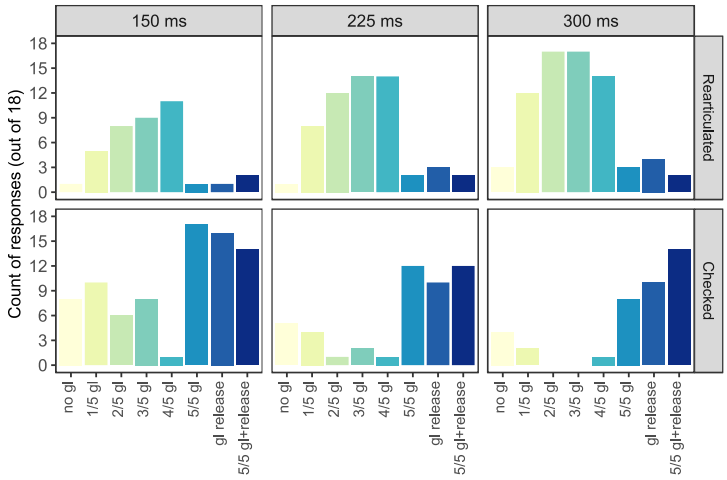
Figure 1. Stimuli spectrograms (from left to right, first row: no gl, 1/5 gl, 2/5 gl, 3/5 gl; second row: 4/5 gl, 5/5 gl, gl release, 5/5 gl + gl release).



Nine participants from San Francisco Yateé participated in an identification study. The participants were presented with six pictures, accompanied by orthographic representation of the word in Yateé Zapotec, and its Spanish translation.

Results. The descriptive statistics of the rearticulated and checked vowel responses by each glottalization position and duration condition are shown in Figure 3. By comparing the upper (rearticulated) and lower (checked) panels in Figure 3, we see that the distribution of the two phonation responses are almost in complementary distribution. The results of logistic regressions confirm that: 1) having **glottalization** in **earlier** positions (at 1/5, 2/5, 3/5, 4/5) in the vowel elicited significantly **more rearticulated** vowel responses, but **less checked** vowel responses, than having glottalization in the vowel **final** position (5/5 and glottal release); 2) having **glottaliztion** in vowel **middle** position (at 2/5, 3/5, 4/5) elicited significantly **more rearticulated** vowel responses, but **less checked** vowel responses than having glottalization at the vowel **initial** position (1/5) or having **no** glottalization; 3) **longer duration** elicited **more rearticulated** vowel responses; **shorter duration** elicited **more checked** vowel responses.

Figure 2. Count of rearticulated (upper) and checked (lower) responses for each condition.



We also observe that duration and glottalization position interact with each other. When the glottalization is at the 4/5 of the vowel, even when the duration is very short (150 ms), checked vowel responses did not increase compared with longer duration conditions. We also see that the positioning of glottalization for eliciting rearticulated vowels is more flexible than for eliciting checked vowels. Having it at 2/5, 3/5, or 4/5 of the vowel are all effective in eliciting rearticulated responses; whereas glottalization need to be at the end of the vowel to elicit checked vowel responses. This is consistent with the higher variability in glottalization positioning for rearticulated vowels we observed in natural production.

Social impact. The social impact of this study lies in the feedback of the participants after participating in the experiment. Several participants reported that they have many difficulties telling apart rearticulated words with different tones (i.e. "mountain" with low tone [jàʔà] vs. "green" with falling tone [jáʔà] vs. "plaza" with rising tone [jàʔá]). This feedback reflects the sound change trend that we observe in the field – in the younger generation, many tonal and phonation contrasts were lost in their natural production. They self-reported to only use the context of conversion to differentiate words with different phonation and tones. Future study could compare the production and perception patterns between younger and older generations to predict the language shift trend.

References

Avelino, Heriberto. 2004. "Topics in Yalálag Zapotec, with particular reference to its phonetic structures." Dissertation, University of California, Los Angeles.

Crowhurst, Megan J., Niamh E. Kelly, and Amador Teodocio Olivares. 2016. "The influence of vowel laryngealisation and duration on the rhythmic grouping preferences of Zapotec speakers." *Journal of Phonetics* 58:48–70