4pSC27. An acoustic study of laringeal contrast in three American Indian Languages

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INTRODUCTION

An orthogonal contrast between two laryngeal features is commonly found in many American Indian languages: *Modal* and *non modal phonation*, on the one hand, and *tone* on the other.

The use of laryngealized voice has been reported in a number of languages from different linguistic families in Mesoamerica, such as Yalálag Zapotec (Otomanguean), Yucatec Maya (Mayan), and Ocotepec Mixe (Mixe-Zoquean).

The three languages contrast modal and laryngealized vowels, but differ in the status of lexical tone. In Zapotec there is a contrast between high, low, and falling tones; Maya has phonemic high and low tones only on long modal vowels, whereas Mixe does not present phonemic tone.

	TONE	PHONATION	
		Modal	Laryngealized
Yalálag Zapotec	High	zé'each'	zé'wall'
	Low	bà'tomb'	bà 'animal'
	Falling	bê'echoe'	bê 'in the morning'
Yucatec Maya	High	tʃáːk 'rain'	tʃaːk 'amaranth'
	Low	tʃàːk 'to cook'	
Ocotepec Mixe	no contrast	taːk 'mother'	taˀk'cornfield'
		heːp 'to crossout'	hɔ̰ts 'brother in law'

DEFINITION OF THE PROBLEM AND HYPOTHESES

This paper investigates the acoustics properties of laryngealized features, tone and phonation in three languages in which the phonemic status of tone differs.

I. We consider the hypothesis that the specific implementation of laryngeal features (i.e. the particular production of phonation and pitch) will be a function of the phonemic status of these features.
In Yalalag Zapotec in which both laryngeal dimensions are contrastive, it is expected that the control of tone and phonation will be maintained and will disfavour neutralization. In Yucatec Maya, where the tone contrast is neutralized in non modal phonation, it is predicted that the acoustic instability introduced by a falling contour could substitute for the production of contrastive laryngealization. In Ocotepec Mixe in which tone is non contrastive pitch could be used as an enhancing feature of the larygenalized phonation.

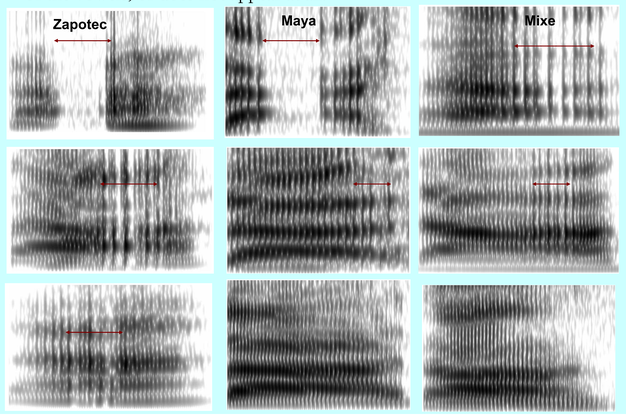
II. The patterns of distribution of phonation and tone throughout the vowel will be also a function of the constrastiveness of laryngeal features. Thus, in Zapotec the synchronization will be more stringent than in Maya, which in turn will be more strict than those in Mixe. The typology of modal/nonmodal phonation in phonation-synchronizing languages thus will be explained as a function of contrastive laryngeal features and might inform processes of tonogenesis.

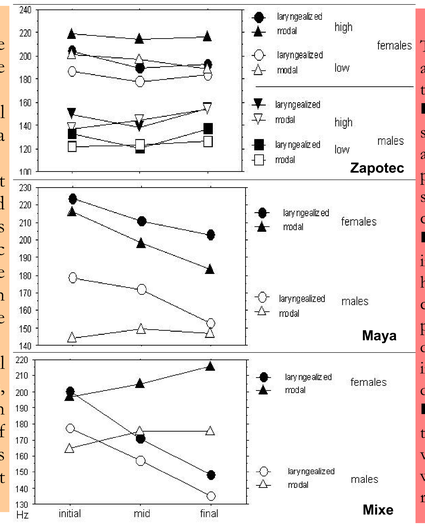
METHODS AND MATERIALS

- Six speakers of Yalálag Zapotec (3 females, 3 males; 35-45); eight speakers of Yucatec Maya (3 females, 5 males); three speakers of Ocotepec Mixe (2 females, 1 male).
- A series of words that contained vowels contrasting modal and laryngealized phonation, and tone (H-L) were recorded in fieldwork.
- Three spectral measures, H1-H2, H1-A1, H1-A3 were taken from a fast fourier transform (FFT) calculated over a 26 ms window at three points within a vowel: 25%, 50% and 75%.
- F0 measurements at the same three points in the vowel.

RESULTS

- There was a wide variation, both across-subjects as well as within subjects in each language. Laryngealized vowels in the three languages were produced in a continuum ranging from a vowel interrupted by a glottal stop vʔv to a vowel with irregular phonation restricted to the middle portion, vv̰v, and vowels with no evidence of irregular phonation.
- In Zapotec laryngealized vowels are produced as a three-section vowel modal-creakiness-modal.
- In Maya and Mixe laryngealization is produced in the middle and end portions of the vowels, or does not appear at all.





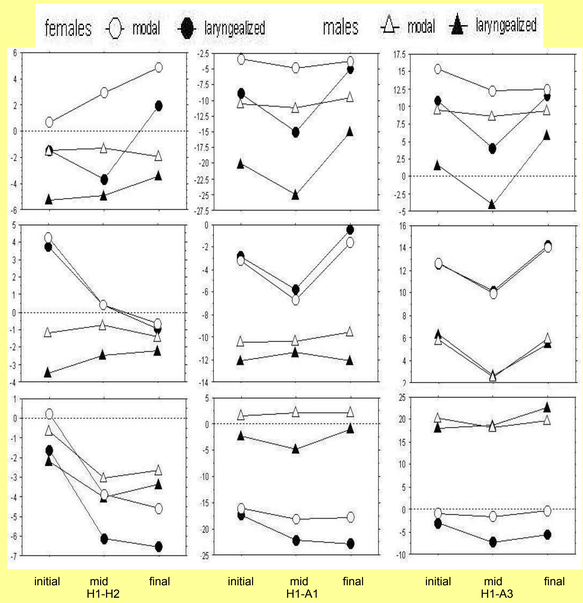
TONE

The F0 contours of laryngealized and modal vowels differed in the three languages.

- Female Zapotec speakers showed a clear separation of high and low tones across both phonation types unlike male speakers who failed to produce consistent tone patterns.
- Overall, laryngealized vowels in Yucatec show a trend to have higher F0 values and a falling contour. Males distinguish both phonation types by pitch cues during the first half of the vowel, in contrast with femeles, who differentiate them in the last half.
- Mixe phonation types showed two F0 patterns: Laryngealized vowels had a falling contour, whereas modal vowels had a rising contour.

PHONATION

- Overall, modal and laryngealized vowels in Zapotec are well differentiated. Laryngealized vowels showed a consistent pattern -across sex groups and measures- of a mid portion of the vowel with increased properties of creakiness, in contrast with the initial and final portions which showed properties similar to those of modal vowels at equivalent points in the vowel. In fact, the greatest difference between modal and laryngealized vowels was observed at the middle point, while there was no significant difference towards the end of the vowel.
- The data indicate that Maya vowels do not show a contrast between modal and laryngealized types. Within each sex group both vowel types show similar values in the three measures. Only males show barely significant differences at the begining of the vowel in the H1-H2 measure (rm-anova, $p<0.05$). There are, however, differentiated patterns for females and males. In general, males showed a tendency to produce more extreme laryngealized vowels than females. This is shown in the first half of the vowel in the H1-H2 , and the final portion of the H1-A1 in male speech (significant at $p<0.01$ and 0.05, respectively).
- Both vowel types in the two groups show a depth in the middle of the vowel in the measure H1-A3, but only females show also a similar pattern in H1-A1. This result was unexpected as there is no indication of a laryngeal adjustment in modal vowels similar to laryngeal vowels.



- Considering the three measures, Mixe laryngealized and modal vowels have more differenciated acoustic properties chiefly towards the end of the vowel, in contrast with the begining which does not show significant differences.
- According to the H1-H2 and H1-A1measures both types of vowels showed increased properties of laryngealization throughout the the last half of vowel in both, females and males. However, the H1-A3 measure does not show any significant difference in the speech of females.
- The two types of vowels in Mixe show a clear differentiation between sex groups.

DISCUSSION AND CONCLUDING REMARKS

- The results obtained in this study have shown that the phonetic implementation of laryngeal features -tone and phonation- differ in languages according to the phonemic status of such a features.
- In **Yalálag Zapotec** the contrast between modal and non modal phonation is consistently preserved across tone patterns. This indicates that there are no neutralizing patterns commonly reported in other languages, but there is a fine control of the actions of the larynx to produce within the same vowel the overt implementation of the two features. Nonetheless, in Zapotec both features do not overlap, but are re-aligned throught the vowel: Laryngealization is produced in the middle of the vowel, and tone is kept at the begining and end portions of the vowel. This arrangement, could be optimal to produce extremely demanding and contradictory laryngeal settings entailed by the some combinations of features (i.e. high-creaky vowels).
- The **Yucatec Maya** data showed that females and males do not distinguish modal and laryngealized vowels by their spectral properties, but by the modulation of tone patterns: Laryngealized vowels show higher F0 values than the corresponding modal ones. This result was unexpected as laryngealized vowels are canonically associated to creakines, which entails a lower vibration of the vocal folds.
- One possible interpretation of the data suggests that Maya speakers implement the laryngealized category with an increased tension of the vocal folds, which in turn, produces the global effect of an increased fundamental frequency.
- **Mixe** vowels were diferentiated mainly in the vowel offset by spectral properties. In addition, the most reliable difference between the two vowels is observed in the F0 patterns. The falling contour found in laryngealized vowels is consistent with a transition of the glottal configuration changing from a modal (neutral tone) setting to a laryngeal (low tone) one.
- Taken together the present study has shown that the pattern and distribution of laryngeal features is a function of the constrastiveness entailed by each feature entailed by each particular feature within the particular language.
- The languages analyzed here may represent three stages in the development of tonogenesis. The particular hypothesis suggested by the present analysis claims that contrastive tone may have been developed from a contrast in phonation, particularly, modal vs laryngealized: i. Mixe represents the initial stage in which tone is an enhancing phonetic feature of the phonemic phonation contrast, ii. Maya represents an intermediate stage in which tone has been phonologized and serves a the main cue to the voice quality contrast, iii. Zapotec represents the last stage in which both features co-exist and are concurrently prduced in the same vowel.

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