A Moraic Analysis of Tone and Glottalization in Yucatec Maya

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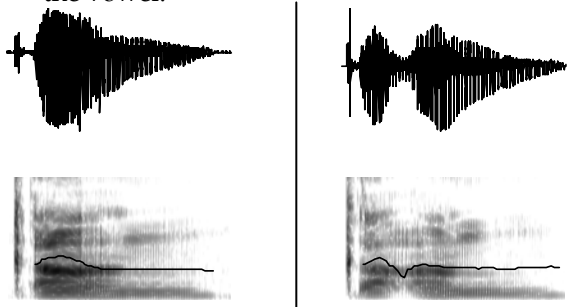
1. Introduction

(1) in Yucatec Maya (Mayan language of Mexico, spoken by about 700,000 in Yucatán, Campeche, and Quintana Roo; Gordon 2005), vowels contrast on the basis of length, pitch, and glottalization:

short	[v]
low tone	[v̀v]
high tone	[v́v]
glottalized	[v́v̰]

- I refer to each contrasting combination of suprasegmental features as a *vowel shape*
- of interest in this paper are the high tone and glottalized vowel shapes

(2) acoustic analysis of words spoken in isolation (Frazier to appear):
a. high tone vowels: modal voice and a falling pitch contour
b. glottalized vowels: falling pitch contour and creaky voice (or, rarely, a full glottal stop), usually during the middle portion of the vowel:



[k′ á a n]
k′áan ‘hammock’

[k′ á a̰ n]
k′a′an ‘strong’

(3) differences in the production of both pitch and creaky voice occur as a result of intonational context (Gussenhoven and Teeuw 2008 (G&T); new results presented in §2)
a. high tone vowels
   - rising pitch contour in non-phrase-final position
b. glottalized vowels
   - always produced with a falling pitch contour
   - creaky voice occurs less often in non-phrase-final position

(4) Why is the pitch contour of high tone vowels variable but the pitch contour of glottalized vowels is always falling?
a. the mora bears glottalization features in addition to tonal features; in Yucatec Maya, tone cannot be moved to a mora that already bears glottalization features (*contra* G&T who claim that the tonal marker of glottalized vowels is attached to the mora but the tonal marker of high tone vowels is attached to the syllable)
b. this analysis accounts for the different effects of intonational context on the pitch contours of high tone and glottalized vowels as well as the grammatical use of creaky voice in Yucatec Maya
c. the goal of this paper is to account for how the pitch contours of these two vowel shapes are constrained by the grammar, but I will not account for the intonational factors that condition the different contours

(5) residual problem: downstep
a. G&T claim the H-tone of both vowel shapes (high tone and glottalized) triggers and is affected by downstep
b. results of current study (§2) show that only the high tone vowel shape participates in downstep
c. Why does downstep occur with high tone vowels but not with glottalized vowels?
d. proposal: tonal marker on first mora of glottalized vowel is conditioned by glottalization marker on second mora

(6) outline of talk
a. experimental methods and results
b. previous analysis (Gussenhoven and Teeuw 2008)
c. proposed analysis: moras bear both tone and glottalization
d. downstep
e. discussion and conclusions

2. Experimental Methods and Results

(7) participants

a. 17 native speakers recorded in Yucatán, México
   - 3 from Mérida
     3 males (ages 20, 25, 48)
   - 14 from Santa Elena
     4 males (ages 23, 44, 64, 69)
     10 females (ages 21, 21, 21, 23, 26, 31, 34, 38, 60, 65)
   - 9 other participants were recorded from the eastern part of Yucatán (Sisbicchen, Xocen, Yax Che), but results from these speakers are not included here due to known dialectal differences in the production of pitch (Frazier to appear)
   - an additional male from Santa Elena participated in the study but did not produce the sentences that were requested, and so all data from this participant was rejected

b. all participants are fluent in Spanish, and three are also fluent in English

c. participants from Santa Elena were all born there and most had only lived in that town, while participants from Mérida were originally from smaller villages in the western part of Yucatán

(8) procedure

a. participants were recorded while they read 144 sentences

b.

4 frame sentences (each includes example target word):	position of target word within phrase	position of target syllable within prosodic word
A Tu ya'alaj <u>chak</u>. *S/he said <u>red</u>.*	final	final
B Yaan u ya'alik <u>chak</u> bejla'e'. *S/he has to say <u>red</u> today.*	non-final	final
C <u>Chak</u>e' tu ya'alaj. *<u>Red</u> (is what) s/he said.*	non-final	non-final
D Táant u ya'alik <u>chak</u>e'. *S/he just said <u>red</u>.*	final	non-final

c. 36 target words of form C_1VC_2 used with each frame sentence
   - C = voiceless obstruent, ejective, or voiced sonorant
   - V = short, low tone, high tone, or glottalized
   - each possible combination of C_1, V, and C_2 = 36 words

d. all frame sentences for a single target word were read together

e. four different random orders were used, such that the order of target words was randomized and the order of frame sentences for each target word was randomized

f. example stimuli:

púuts' *aguja*	**t'uut'** *loro*
Táant u ya'alik <u>púuts</u>e'.	Táant u ya'alik <u>t'uut'</u>e'.
<u>Púuts'</u>e' ku ya'alik.	Yaan u ya'alik <u>t'uut'</u> bejla'e'.
Yaan u ya'alik <u>púuts'</u> bejla'e'.	Tu ya'alaj <u>t'uut'</u>.
Tu ya'alaj <u>púuts'</u>.	<u>T'uut'</u>e' ku ya'alik.

(9) measurements

a. pitch values in Hertz were extracted every 10 ms for the duration of the vowel in each target word using PRAAT (Boersma and Weenink 2006)

b. Hertz was converted to *semitones relative to a context-dependent speaker-specific baseline*

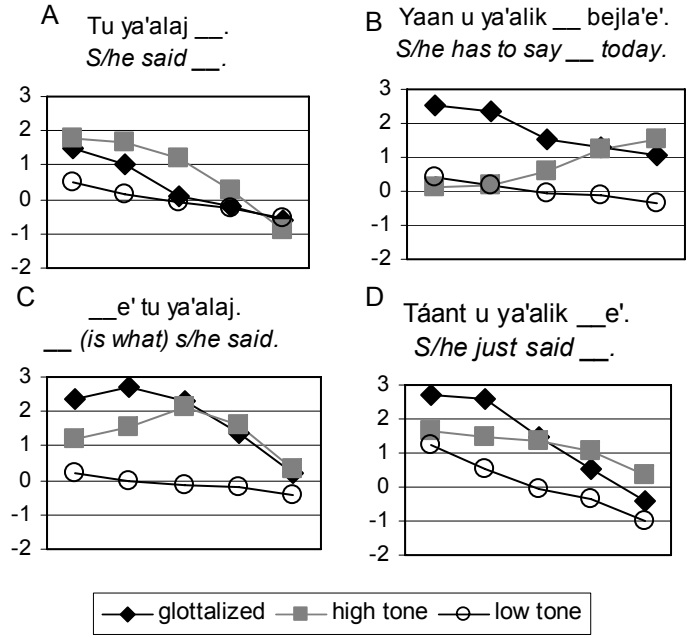
c. equation: $12*\log_2(\text{Hz}/\text{baseline Hz})$
   - the baseline is the average value produced by a given speaker for the middle point of low tone vowels in a given frame sentence
   - example: for all target words produced in frame sentence A by participant 01, the baseline used in the above equation is 127.77 Hz, which is the average pitch value produced by this speaker for the middle point of low tone vowels in frame sentence A

d. semitone measurements of pitch spans provide the most reliable cross-speaker measurement (Nolan 2003)

e. by using a context-dependent baseline, effects of declination are minimized

f. average pitch contours are obtained by averaging pitch (measured in semitones over baseline) at five points during vowel production (initial, 25% of vowel length, medial, 75% of vowel length, final)

(10) average pitch contours for long vowels:



(11) percent of vowels produced with glottalization (creaky voice or glottal stop):

	Tu ya'alaj __.	Yaan u ya'alik _ bejla'e'.	_e' tu ya'alaj.	Táant u ya'alik _e'.
	A	B	C	D
high tone	4%	2%	1%	2%
glottalized	38%	22%	12%	33%

- though production of glottalization differs by context, glottalization is always more likely to be produced with glottalized vowels

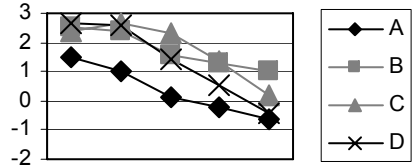
(12) average vowel length (ms):

	A	B	C	D
high tone	186	168	177	175
glottalized	188	173	171	174

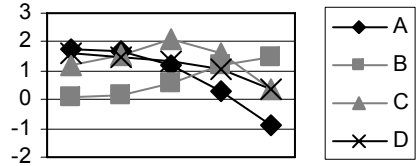
- though vowel lengths differ by context, there are no statistically significant differences in length between high tone and glottalized vowels

(13) discussion

a. glottalized vowels have initial high pitch and a falling contour in each context:



b. high tone vowels have initial high pitch in context A, final high pitch in context B, medial high pitch in context C and somewhat steady mid pitch in context D:



c. I propose that the lack of variability in pitch contours of glottalized vowels can be explained if we allow moras to bear other laryngeal features (i.e. [constricted glottis]) in addition to tone

3. Previous Analysis

(14) Gussenhoven and Teeuw (2008) present similar evidence for positional variation in the production of pitch and glottalization with the high tone and glottalized vowels

a. in phrase-final position, both vowel shapes have a falling contour, and glottalization (creaky voice) is produced with the glottalized vowel
b. in non-phrase-final position, the high tone vowel has a rising contour, while the glottalized vowel has a falling contour and less glottalization

(15) given that pitch contours of glottalized and high tone vowels behave differently in certain prosodic contexts, G&T propose that the difference between the two vowel shapes is related to the unit that bears the tonal marker

a. in glottalized vowels, high tone is pre-linked to the mora

b. in high tone vowels, the lexical representation includes the high tone marker, but it is not linked to the mora; the tone marker becomes linked to the syllable in the output of the phonology:

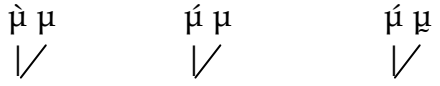
high tone glottalized

(16) theoretical problems with G&T's analysis
a. uses language-specific restrictions on underlying representations, which contradicts Richness of the Base in OT
b. use of syllable node as TBU contradicts the "prosodic anchor hypothesis" (Jiang-King 1996), which says that the mora is the only TBU

(17) these problems can be remedied and the positional variations of pitch contours can be accounted for if the mora bears glottalization in addition to tone

4. Moraic Analysis: Moras Bear Tone and Glottalization

(18) proposed phonological representations of long vowel shapes in Yucatec Maya as spoken in isolation (assumed to be identical to underlying representations):

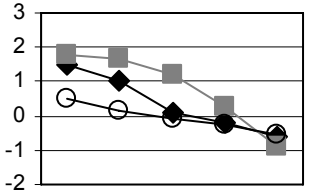


low tone high tone glottalized

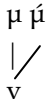
a. the mora bears both tonal features and glottalization features
b. the glottalized vowel is dominated by a mora that is marked for glottalization; both high tone and glottalized vowels are dominated by a mora that is marked for high tone
c. Stenzel (2007) also associates a [constricted glottis] feature with moras in the analysis of Wanano (an Eastern Tukanoan language)
d. high-ranking cross-linguistically viable markedness constraints would ensure that any UR would be mapped onto one of these SRs (*MidTone, AlignL(V,Tone), AlignL(Tone,V), AlignR(Glot,V), HighToneBeforeGlot)

(19) phonological output of high tone and glottalized vowels by context
a. frame sentence A – same as in (18):

A Tu ya'alaj __.
S/he said __.

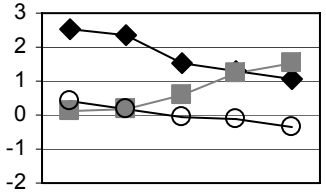


b. frame sentences B and C – tonal marker of high tone vowels is shifted to the second mora:

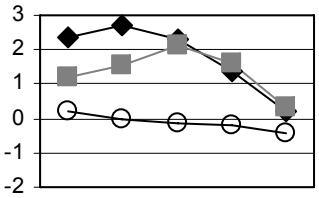


c. tonal marker of glottalized vowels cannot be shifted to second mora because that mora is already marked for glottalization:

B Yaan u ya'alik __ bejla'e'.
S/he has to say __ today.



C __e' tu ya'alaj.
__ (is what) s/he said.

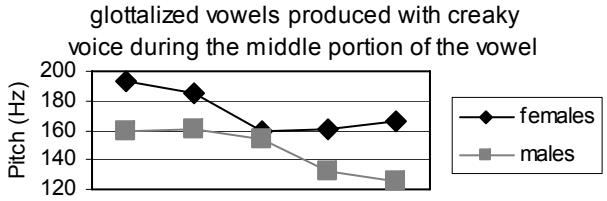


(20) because tone and creaky voice can co-occur in other languages (see Kirk et al. (1993) for an example of creaky voice occurring with three different tone types in Jalapa Mazatec), the fact that creaky voice blocks the appearance of high tone must be a language-specific property of Yucatec Maya
a. in OT, there is a constraint that penalizes the co-occurrence of creaky voice and tone on the same mora
b. in Yucatec Maya, this constraint is highly ranked; in Jalapa Mazatec this constraint is crucially dominated

(21) creaky voice is not tone
a. creaky voice is produced with widely (and often irregularly)

spaced glottal pulses, and, as a result, pitch measurements extracted from creaky voice are of very low values

b. creaky voice could be analyzed as super-low tone
c. it is well know that pitch associated with different tones is a function of a speaker's natural pitch range, e.g. both 'high tone' and 'low tone' as produced by females will be higher (in Hz) then these two tones as produced by males
d. creaky voice results in similar pitch values for both males and females:



e. the pitch values associated with creaky voice are not a function of a speaker's natural pitch range and hence creaky voice should not be analyzed as one end of the tonal spectrum

(22) cross-linguistic evidence for the use of the mora as an anchor for laryngeal features
a. diachronic: the Danish *stød*, which correlates with tone in Swedish and Norwegian, is produced as creaky voice (Fischer-Jørgensen 1989)
b. synchronic: Stenzel (2007), who also claims moras bear other laryngeal features, cites evidence from Eastern Tukanoan languages, including reassociation in Tukano

(23) evidence from morphosyntactic use of vowel shape in Yucatec Maya
a. the passive voice is marked with glottalization:
kin manik *I buy it.*
ku ma'anal *It was bought.*
b. other grammatical functions are marked with tone:
- high tone marks the antipassive of a verb, while low tone marks the middle voice (Bricker et al. 1998: 333)
- possession can trigger a switch from high tone to low tone: *k'áan* 'hammock', *in k'àan* 'my hammock' (Lehmann 1998)

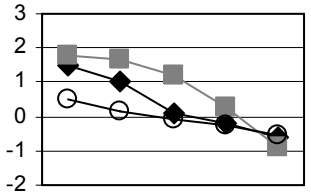
(24) summary
a. glottalization behaves like tone and is best analyzed as suprasegmental
b. by associating all suprasegmental properties with the mora, we can succinctly account for the interaction of tone, glottalization, and intonation in Yucatec Maya

5. Downstep

(25) G&T claim that both high tone and glottalized vowels have lower pitch when produced after another vowel with high tone
a. their proposal: though the vowel shapes differ in terms of TBU (tone bearing unit), they are both associated with an H-tone and hence both trigger and are affected by downstep
b. problem with G&T's evidence: they only look at contours where both high tone and glottalized vowel shapes are averaged together and not at each vowel shape separately

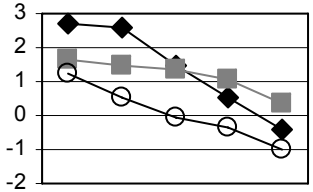
(26) according to my data, the glottalized vowel does not trigger nor is affected by downstep
a. in sentence A, the target word follows a glottalized vowel, and both high tone and glottalized vowels have initial high pitch:

A Tu ya'alaj __.
S/he said __.



b. in sentence D, the target word follows a high tone vowel, and both high tone and low tone vowels start with the same pitch:

Táant u ya'alik __e'.
D *S/he just said __.*



c. only a preceding high tone vowel triggers downstep in only another high tone vowel

(27) downstep only affects high tone vowels because the high tone marker of glottalized vowels is correlated with the creaky voice feature of the second mora
   a. a variety of languages show a correlation between creaky voice and preceding high pitch
      - in Coatlán-Loxicha Zapotec, vowels before glottalized sonorants are produced with high pitch (Plauché et al. 1998)
      - the Danish *stød* begins with high pitch and ends with creaky voice (Fischer-Jørgensen 1989)
      - Acoma has a 'glottal accent', which is marked by a falling pitch contour and creaky voice (Miller 1965)
      - coda glottal stop is believed to condition a rising pitch contour cross-linguistically (Hombert 1978)
   b. high-ranking constraint in Yucatec Maya: HIGHTONEBEFOREGLOT "a mora marked for creaky voice is preceded by a mora marked for high tone"

(28) the fact that the high tone of the glottalized vowel is conditioned by glottalization could also explain why the glottalized vowel does not trigger downstep

6. Discussion and Conclusions

(29) Are other laryngeal features associated with moras?
   a. breathy voice and pitch often interact, e.g. in San Martín Itunyoso Trique post-vocalic /h/ conditions breathiness and sometimes lower pitch on preceding vowels (DiCanio 2008)
   b. but I have not yet found the same types of evidence for breathy voice being a moraic feature

(30) conclusion: glottalization is often considered suprasegmental; I join Stenzel (2007) in specifically claiming that moras bear both glottalization and tonal features
   a. explains why tone is movable in high tone vowels (where neither mora is marked for creaky voice) but not in glottalized vowels (where the second mora is marked for creaky voice)
   b. provides succinct analysis of diachronic development of glottalization from tone (in various languages, e.g. Danish) and of synchronic use of glottalization and tone to mark different grammatical functions (in Yucatec Maya)

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