Vowel-initial words and glottalization: a corpus study of Chichicastenango K'iche'

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Introduction

Word-initial glottal stops or glottalization attested across the Mayan language family, but descriptions vary:
- *All* otherwise vowel-initial words [1, 2]
- *Conditioned* by properties of word or context [3, 4]

Perceptual evidence and generalization; little to no acoustic evidence

This study: distribution of word-initial full closures and glottalization of initial vowels in a corpus of spontaneous narratives from the Chichicastenango variety of K'iche' [QUC, Guatemala]

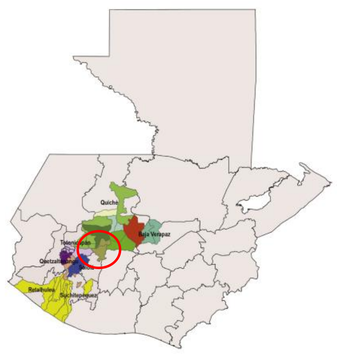

Fig. 1: Map of K'iche' dialects [5], Chichicastenango in red circle

Research questions

1. When are full closures found in word-initial position?
2. When is there evidence of glottalization in the initial vowel?
3. Is the time course of these cues consistent with an initial glottal stop segment?

Methods

The data
- 2 h 40 min spontaneous narratives
- 12 speakers from Chichicastenango
- Archived (if consent given) in the Archive of the Indigenous Languages of Latin America [6]
- 2628 tokens (all words beginning with a vowel or glottal stop in the transcription)

Segmentation
- Primarily based on intensity curve, with formants and antiformants as secondary indicator
- Full closure = at least 20 ms of silence *or* a pulse + following silence adding to at least 20 ms
- Other periods of laryngealization included in vowel

Measurements
Praat [7] script used to measure in each third of each vowel:
- Spectral tilt (H1-H2, H1-A1, H1-A2, H1-A3)
- Periodicity (average HNR, jitter, shimmer)
- Intensity and pitch minimum
- F1 and F2

Hypotheses
More full closures and other cues to glottalization were expected in the beginning of the vowel for words **following a word ending in a vowel or pause** [2, 4], for words that are **initial in the IP** [4], for words that are **monosyllabic** and have **initial stress** [4], for **roots** [3], and for **Spanish borrowings** [3]. Unpredictable variation expected by **morpheme** and **recording**. More cues to glottalization expected for words **following a word ending in a glottal or glottalized** (ejective/implosive) **consonant**.

Statistical analysis
Analyzed in R [8] with linear mixed effects models using package lme4 [9]. Separate model for each acoustic measure in each third of the vowel and another for full closures.

Syllable count, word origin and morpheme type produced (almost) no significant effects and were eliminated.

Results: Acoustic cues

- Tables show coefficients of **significant** effects only ($p < 0.05$); blank indicates no significant effect
- Effect consistent with glottalization shaded in gray
- Results are of three types:

Glottalization in 1st third of the vowel only: preceding glottal(ized) consonant, preceding pause, initial stress

Measure	1st third	2nd third	3rd third
H1-H2			
H1-A1	-8.198		
H1-A2	-5.107		
H1-A3	-3.516		2.783
HNR			
Jitter			
Shimmer			
Intensity min			
Pitch min			

Table 1: Effects of preceding glottal or glottalized consonant

Measure	1st third	2nd third	3rd third
H1-H2		2.427	2.117
H1-A1	-2.557	2.546	2.394
H1-A2		2.656	2.072
H1-A3		3.416	2.445
HNR	-2.875	-2.551	
Jitter	0.029		
Shimmer	0.102	0.069	
Intensity min	-5.423		1.353
Pitch min	-9.715		9.378

Table 2: Effects of preceding pause

Measure	1st third	2nd third	3rd third
H1-H2	-1.622		
H1-A1	-4.045		
H1-A2	-3.409		
H1-A3	-2.783		
HNR	-2.277		2.450
Jitter	0.023		
Shimmer	0.068		
Intensity min	-2.695	1.564	
Pitch min			34.437

Table 3: Effects of initial stress

Glottalization throughout but decreasing in strength: preceding vowel

Measure	1st third	2nd third	3rd third
H1-H2	-2.194	-1.402	
H1-A1	-6.310	-3.748	-1.591
H1-A2	-4.381	-2.234	
H1-A3	-4.657	-3.092	
HNR	1.892	-1.081	-1.001
Jitter		0.013	0.013
Shimmer			
Intensity min	2.160		
Pitch min	-14.678	-12.357	

Table 4: Effects of preceding vowel

Consistent glottalization throughout the vowel: IP-initial position

Measure	1st third	2nd third	3rd third
H1-H2			-2.024
H1-A1	-2.881	-2.854	-1.996
H1-A2			
H1-A3		-1.625	-1.567
HNR	-2.074	-3.040	
Jitter	0.025	0.031	
Shimmer	0.074	0.042	
Intensity min	-1.572	-1.070	
Pitch min		-9.179	

Table 5: Effects of IP-initial position

Results: Full closures

Subset	Percentage
Overall	8.8%
Baseline	1.7%
Preceding vowel	5.0%
Preceding glottal(ized) consonant	6.7%
IP-initial	12.4%
Initial stress	23.6%

Table 6: Percentage of full closures

Statistical model: significant effects of **IP-initial** position and **initial stress** (more full closures), and interaction between them (effects do not stack)

Discussion

Preceding pause, preceding vowel, initial stress:
- Localized effect similar to effect of preceding glottal or glottalized consonant
- Consistent with existence of word-initial glottal stop segment that is usually reduced in production

IP-initial position:
- Persistent effect
- Prosodic marker of beginning of IP
- Contrasts with domain-final spread glottis feature (aspiration of stops, devoicing of sonorants and [h] insertion on vowel final words) [10, 11]

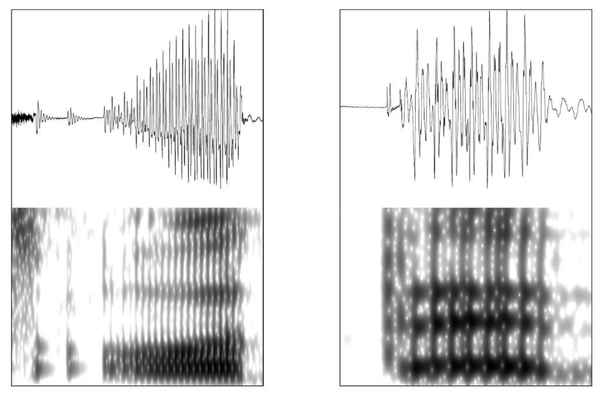

Fig. 2: Initial vowels in /ˈʔʊʧ/ 'good' (left, initial stress) and the focus marker /aˈre/ (right, IP-initial)

Stress, prosody and preceding context affect voice quality in a number of (Indo-)European languages, e.g. [12]. This shows similar patterns in a geographically distant and unrelated language.

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References

[1] C. D. López Ixcoy, Gramática K'ichee'. Guatemala: Fundación Cholsamaj, 1997.
[2]] T. Kaufman, "Initial glottal stop in Mayan languages," Unpublished ms, 2015.
[3] R. Barrett, "The evolutionary phonology of glottal stops in K'ichean," in Proceedings of the Annual Meeting of the Berkeley Linguistics Society, vol. 33, no. 1, 2007, pp. 19–29.
[4] T. W. Larsen, "Manifestations of ergativity in Quiché grammar," Ph.D. dissertation, University of California, Berkeley, 1988.
[5] S. Romero, "Bill Gates speaks K'ichee'! The corporatization of linguistic revitalization in Guatemala," Language & Communication vol 47, pp. 154-166, 2016.
[6] E. Wood, "The K'iche' collection of Elizabeth Wood," The Archive of the Indigenous Languages of Latin America, ailla.utexas.org, 2019-, access: public. PID ailla: 271517.
[7] P. Boersma and D. Weenink, "Praat: doing phonetics by computer," 2019, [Computer program]. Version 6.0.49, retrieved from http://www.praat.org/.
[8] R Core Team, R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria, 2019, [Computer program]. Version 1.4.1103, retrieved from https://www.R-project.org/.
[9] D. Bates, M. Mächler, B. Bolker, and S. Walker, "Fitting linear mixed-effects models using lme4," Journal of Statistical Software, vol. 67, no. 1, pp. 1–48, 2015.
[10] R. Henderson, "Morphological alternations at the intonational phrase edge: The case of K'ichee'," Natural Language & Linguistic Theory, vol. 30, no. 3, pp. 741–787, 2012.
[11] S. AnderBois, "Strong positions and laryngeal features in Yukatek Maya," in NELS 39, 2008
[12] L. Dilley, S. Shattuck-Hufnagel, and M. Ostendorf, "Glottalization of word-initial vowels as a function of prosodic structure," Journal of phonetics, vol. 24, no. 4, pp. 423–444, 1996.