

ACOUSTIC CHARACTERISTICS OF OBSTRUENTS IN HUEHUETLA TEPEHUA

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1 Introduction

The Totonacan languages of Mexico are spoken by approximately 244,000 people [2] in a region comprised of portions of the states of Veracruz, Puebla, and Hidalgo. Much of the documentation on Totonacan focuses on the complex morphosyntax of the language family. Phonological descriptions of Totonacan languages note the prevalence of glottal stop and contrastive laryngealization of vowels and consonants, but little is known about the phonetic realizations of these segments.

A major division has been established in the Totonacan family based largely on morphosyntactic and lexical differences between Totonac to the south and Tepehua to the north. An additional distinction between the two language groups is the incorporation of laryngealization: in Totonac languages laryngealization contrasts are typically realized on vowels, while in Tepehua languages laryngealization contrasts are expressed in the production of the preceding obstruent. The language spoken in Huehuetla, Hidalgo (hereafter HT) belongs to the Tepehua branch of the Totonacan family and exhibits a laryngealization contrast in stops at three places of articulation: /p p' t t' k k'/, and in affricates at two places of articulation: /ts ts' tʃ tʃ'/. This laryngealization contrast (also referred to as "glottalization") has been transcribed phonemically with the notation of the International Phonetic Alphabet indicating sounds produced with an egressive glottalic airstream, commonly referred to as ejectives. However, impressionistic descriptions of these segments indicate that only the velar segment /k'/ seems to fit this description. The sounds transcribed as /p'/ and /t'/ have instead been described as "phonetically closer to the implosives [b] and [d], respectively" [3]. Traditional phonetic definitions of implosives imply some period of voicing due to incomplete closure of the vocal folds while the larynx is being lowered, but both the pulmonic and laryngealized stop series in HT are described as phonemically voiceless. In contrast to the alveolar stop /t'/, both /ts'/ and /tʃ'/ are described as ejectives produced with an egressive airstream.

The present paper will provide some preliminary impressions of closure duration and voice onset time of stops and affricates in HT. Duration has long been known to be a salient cue to place of articulation, manner, and voicing in many speech segments. This study is part of a larger project investigating the acoustic realization of laryngealization in Totonacan, a characteristic that has not yet received satisfactory analysis within Totonacan phonology. This pilot study contributes to a basic phonetic description of obstruents in HT, which will allow for

broader crosslinguistic comparison.

2 Methods

2.1 Speakers

Acoustic data from three speakers, two women and one man, are reported here. The speakers were all between the ages of 50 and 60 years old lifelong speakers of HT.

2.2 Materials and Procedures

The wordlist consisted of 116 words previously documented in a formal grammar of HT [3]. The list was designed to highlight contrasts between laryngeal configuration or airstream (pulmonic/glottalic), place (bilabial, alveolar, velar), and manner (stop, affricate), as indicated in the practical orthography. Target segments were elicited within a frame sentence, such as *juu chawai ____ iknajun* /hu: tʃawai ____ iknahun/ 'Now I say ____'. Each target word was repeated in the frame three times. Due to the unfamiliar nature of the task, speakers sometimes altered the frame to place the target at the end instead of the middle of the sentence. Because HT is not commonly written, speakers were prompted orally in English and HT with the assistance of one of the speakers, who sometimes offered oral explanation in HT of which term was intended.

Digital recordings were made with a head mounted microphone and a Marantz portable digital recorder (PMD 660) at a sample rate of 44 kHz. The recordings were segmented by hand in Praat [1]. Praat scripts were used to extract acoustic information from the annotated recordings. Graphical analyses were undertaken in R [4].

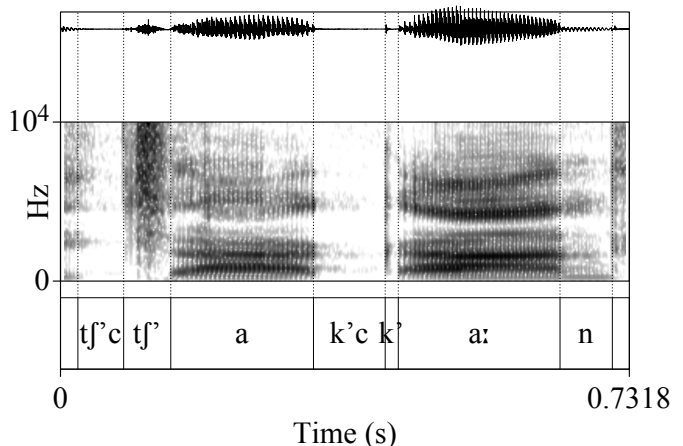


Figure 1. Example spectrogram from female speaker J60 with segmental annotation, *ch'ak'aan* 'armadillo'.

2.3 Acoustic segmentation

Closure duration and voice onset time (VOT) were taken of both stop and affricate segments. Figure 1 illustrates the placement of segment boundaries. The beginnings of closure periods were taken as the end of periodic vibration in the preceding vowel (or nasal in cases where the frame sentence was modified by the speaker). The closure period ended with the stop release, which was concurrent with the beginning of the VOT segment. In the case of affricates, this post-release segment includes both the stop burst and the following frication. This segment ended with the resumption of periodic vibration in the following vowel. No instances of prevoicing during the closure period were observed, supporting previous descriptions of HT stops as lacking a voicing distinction, but in some cases there was no obvious burst upon release of the closure. In such cases, a VOT value of zero was recorded. Duration values were log normalized before undergoing graphical analysis.

3 Results

Stop duration

Figure 2 summarizes the log normalized closure and VOT duration data across all three places of articulation and both laryngeal categories. Results of a cursory linear model with place of articulation and laryngeal setting as predictors show significant effects of place of articulation and laryngeal setting. An interaction between place and laryngeal setting was not found to improve the model. Bilabial closures tended to be longer than either alveolar or velar closures across laryngeal settings. Pulmonic stops were overall slightly shorter than laryngealized stops.

Affricate duration

Figure 3 summarizes the log normalized closure and release portions of affricates produced in both laryngeal settings. Unlike the stops, affricates have somewhat shorter closure periods, followed by a longer release portion. This is to be expected because of the sustained nature of fricative noise. A rather striking aspect of the duration data, however, is the stark contrast between pulmonic and laryngealized affricate release periods. Pulmonic affricates have release durations of roughly 80-90ms, while laryngealized affricate release periods last only about 55ms.

4 Discussion and Conclusion

Duration has long been established as a salient cue to stop categorization across languages. The Tepehua data aligns with previous reports that the further back the place of articulation, the longer VOT duration will be. Likewise, it was also found that stops articulated at more front places of articulation have longer closure durations. However, there does not seem to be a strong effect of laryngealization in word initial stop segments. On the other hand, the duration differences between pulmonic and laryngealized affricates are striking.

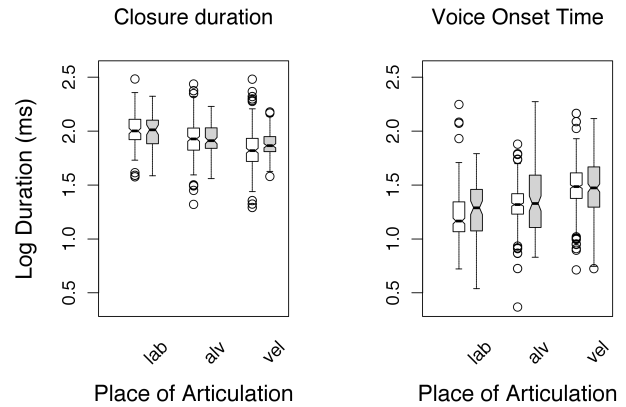


Figure 2. Closure duration and VOT of pulmonic (white) and laryngealized (gray) stops, reported in log milliseconds.



Figure 3: Closure duration and VOT of pulmonic (white) and laryngealized (gray) affricates, reported in log milliseconds.

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References

- [1] Boersma, Paul & Weenink, David (2016). Praat: doing phonetics by computer [Computer program]. Version 6.0.19, retrieved 13 June 2016 from <http://www.praat.org/>
- [2] Instituto Nacional de Estadística, Geografía e Informática (INEGI). 2010 Censo de Población y Vivienda 2010. Veracruz, México.
- [3] Kung, Susan Smythe. (2009). A Descriptive Grammar of Huehuetla Tepehua.
- [4] R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.