Tense voice and the role of non-contrastive elements in sound change

Marc Garellek[1], Jianjing Kuang[2], Osbel López-Francisco[3] & Jonathan D. Amith[4]

[1]University of California, San Diego (USA), [2]University of Pennsylvania (USA), [3]Universidad Autónoma de México, Iztacala (Mexico), [4]Gettysburg College (USA)

mgarellek@ucsd.edu, kuangj@ling.upenn.edu, osbel9@gmail.com, jonamith@gmail.com

Sound changes involving non-modal (usually breathy or creaky) vowels typically describe their development; e.g., many languages develop breathy or creaky vowels from what is analyzed as a former glottal consonant. Thus Proto-Mazatec *VhV and *VʔV > V̤ and V̰ in Jalapa Mazatec [1]. We address the opposite direction: sound *changes away from* non-modal vowels. This question has been under-explored in research on phonation change (cf. [2] for loss of breathy vowels in Khmer).

We explore possible changes in non-modal vowels by focusing on tense vowels, which in comparison to prototypically 'creaky' vowels are characterized by a weaker form of glottal constriction, higher periodicity, and a higher f0 [3]. We focus on tense vowels because their overall weaker creak can lead to distinct changes from other kinds of creaky voice. The main empirical question is, *What are the secondary (non-contrastive) acoustic correlates (as indicators of different articulations) to tense vowels in three languages:* Zongozotla Totonac (Tepehua-Totonac), spoken in Mexico, and Bo and Southern Yi, two Yi (Sino-Tibetan) languages from China. Totonac is toneless and contrasts modal vs. 'glottalized' vowels, which recent work has shown to be tense. Bo and Southern Yi contrast tense vs. lax (weakly breathy) vowels, and tone is orthogonal to phonation.

Audio recordings for the three languages were made in the field: 8 Zongozotla Totonac (ZT) speakers, 9 Bo speakers, and 12 Southern Yi (SY) speakers. Target words are minimal pairs contrasting in phonation; only 8 pairs were included for ZT, because minimal pairs involving phonation are generally rare and of low functional load across Totonac languages [4], a point we will return to below. About 40 pairs were recorded for Bo and SY. Recordings were segmented for the tense vowel vs. non-tense (modal or lax) counterpart; target vowels were analyzed for measures of voice quality using VoiceSauce [5]. We first investigate measures primarily associated with changes in phonation, such as H1*-H2* (lower with increased constriction), CPP (lower with increased irregularity). Then we measure secondary correlates to phonation: f0 (primarily associated with tone, sometimes higher with tense voice) and F1 (primarily associated with vowel quality, sometimes higher with tense voice). For more details on the relationship between phonation types and these measures, see [3]. For each measure/language, linear mixed-effects models (with maximal random-effects structure) were run to test whether phonation type (tense vs. non-tense) significantly (at $p < 0.05$) predicts a change in the mean. (For concision model outputs are omitted here.)

For ZT, H1*-H2* distinguishes tense vs. modal vowels, with tense vowels showing slightly lower values along this measure. For all other measures, no significant differences were found. Thus tense vowels in Totonac are weakly glottalized, with no secondary correlates such as changes in pitch or vowel quality. For Bo, tense vowels have lower H1*-H2*, higher CPP (suggesting they are less noisy), and higher in f0 than lax ones. Some statistically significant differences in phonation on F1 and F2 do occur but these vary unsystematically by vowel type. For SY, tense vowels in comparison to lax vowels have lower H1*-H2* and higher CPP (suggesting they are less noisy), but no difference in f0. Additionally, F1 for tense vowels is consistently higher. Results for f0, F1, and H1*-H2* are shown in Figure 1.

The results suggest several paths of sound change *away from* tense voice, depending on whether articulatory configurations involve tongue root retraction (SY) or greater longitudinal tension in the vocal folds (Bo). Because tense voice is a weaker form of glottalization, well within the range of comfortable modal phonation (cf. [3]), it is possible to hold all other configurations constant and minimally differ from modal voice in terms of vocal fold contact [6]. This appears to be the case for ZT, whose tense vowels are only indexed by (slight) glottalization. In turn, this suggests that in ZT *tense voice is likely to merge with modal voice*, rather than change into another type of contrast, because there are no clear secondary correlates to the contrast that could undergo enhancement [7]. In contrast, the main secondary correlate to the phonation contrast in Bo is higher f0. This implies a path towards sound change whereby the *phonation contrast merges with and complexifies the preexisting tone system*. Something similar has arguably occurred in the Vietic branch of Austroasiatic [8]. In Southern Yi, however, the main secondary correlate is F1, whereby tense vowels have higher F1 than lax ones. The implication for sound change is that *tense voice can be transphonologized into a more complex set of vowel contrasts* than was present in the historical form of the language. Something similar has been argued to have occurred across the Khmer branch of Austroasiatic, due to transphonologization of the 'breathy' register to a more complex vowel system [2].

The differences across languages also suggest a role that the lexicon plays in the realization of tense voice. The weak phonetic nature of tense vowels in ZT might be related to the fact that the contrast in Totonac has few minimal pairs and an overall low functional load. Indeed, the phonation contrast in other varieties of Totonac is described as very weak or as having disappeared [4,9]. On the other hand, in the Yi languages the tense-lax contrast has a higher functional load, with many minimal pairs and with higher phonological significance. Overall, we see that even for a specific subtype of non-modal phonation – tense voice – there can exist language-specific non-contrastive elements, and together with the lexicon these may play a role in predicting distinct paths of sound change.

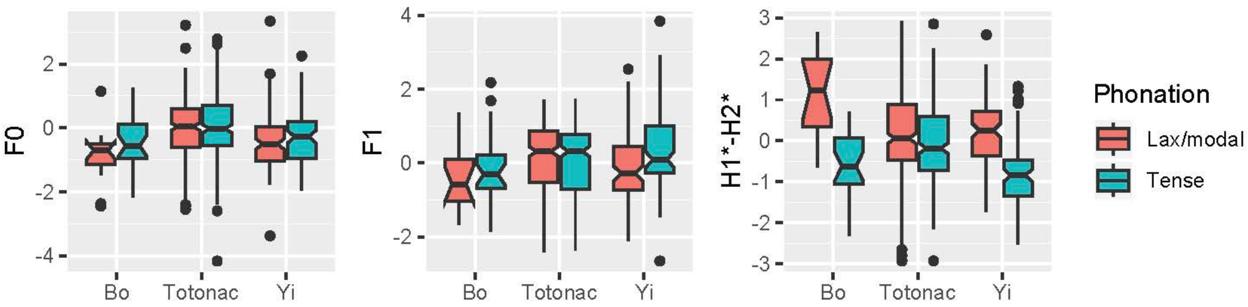

Fig.1 Boxplots of mean f0 (left), F1 (middle) and H1*-H2* (right), z-scored by speaker.

References

[1] Kirk, P. L. (1966). *Proto-Mazatec phonology*. Ph.D. thesis, University of Washington.

[2] Wayland, R. P. & Jongman, A. (2002). Registrogenesis in Khmer: A phonetic account. *Mon-Khmer Studies*, *32*, 101-115.

[3] Keating, P., Kuang, J., Garellek, M., Esposito, C., & Khan, S. (2023, in press). A cross-language acoustic space for vocalic phonation distinction. To appear in *Language*. URL : https://linguistics.ucla.edu/people/keating/Keating_etal_Language_accepted_Dec2022.pdf (accessed March 22, 2023).

[4] McFarland, T. A. (2009). *The phonology and morphology of Filomeno Mata Totonac*. Ph.D. thesis, University of California, Berkeley.

[5] Shue, Y. L., Keating, P., Vicenik, C., & Yu, K. (2011). Voicesauce: a program for voice analysis. Proceedings of the 17th international congress of phonetic sciences, 1846–1849.

[6] Kuang, J., & Keating, P. (2014). Vocal fold vibratory patterns in tense versus lax phonation contrasts. *The Journal of the Acoustical Society of America*, *136*(5), 2784-2797.

[7] Garrett, A., & Johnson, K. (2013). Phonetic bias in sound change. In A. C. L. Yu (ed.), *Origins of sound change: Approaches to phonologization* (pp. 51-97). Oxford, UK: Oxford University Press.

[8] Thurgood, G. (2002). Vietnamese and tonogenesis: Revising the model and the analysis. *Diachronica*, *19*, 333-363.

[9] MacKay, C. J., & Trechsel, F. R. (2018). An alternative reconstruction of Proto-Totonac-Tepehua. *International Journal of American Linguistics*, *84*(1), 51-92.