

# **Acoustic methods in the study of tone: applications to Du'an Zhuang and Burmese**

Seunghun Lee<sup>1)</sup>, Jeremy Perkins<sup>2)</sup> & Julián Villegas<sup>2)</sup>  
International Christian U/U of Johannesburg<sup>1)</sup> & The University of Aizu<sup>2)</sup>

Tone has multiple acoustic correlates: F0, duration, phonation etc. This talk reports the use of two acoustic analysis methods to understand tone systems of two languages: Du'an Zhuang (a Tai-Kadai language) and Burmese (a Tibeto-Burman language). First, the creaky voice detection method utilizes various acoustic signals for detecting the probability of creaky voice and generating a creaky voice profile. These creaky voice profiles are in turn used to examine the interplay between creaky voice and tone. Second, SSANOVA is a statistical method that allows comparing splines, in our case, time series of mean F0 and creakiness. This method allows a comparison of F0 and creakiness profiles across tonal categories. In this talk, we present two case studies (Du'an Zhuang and Burmese) where both creakiness and F0 are analyzed using these methods.

In Du'an Zhuang, a study of F0 has been complemented with the creaky voice detection method. In unchecked syllables (open syllables and syllables with a nasal coda), a puzzle emerges in which two tonal categories display a mid falling tone; one has an early fall and the other has a late fall. Upon examining the creakiness, we found that the timing of the early-falling tone shows strong correlations with the increase of creakiness. The late-falling tone does not show creakiness. These results suggest that a phonological tone contrast in Du'an Zhuang involves both mean F0 and creakiness.

In Burmese, creakiness and F0 are measured in creaky tone roots and suffixes. We examine creaky tone and low tone target syllables within a sentence, finding that there is no evidence of increased creakiness in creaky tones. Instead, we find that creaky tone syllables have significantly increased F0, in both suffixes and roots, indicating that F0, but not creakiness is involved in distinguishing creaky and low tone in this context. On the other hand, we find that creakiness and F0 together play a role in marking prosodic boundaries: Clause-final low tone syllables have increased creakiness (not F0) but clause-final creaky tone syllables have increased F0 (not creakiness).

In conclusion, this talk has outlined methods to analyze complex tone systems that may involve F0 and creaky phonation using an acoustic-based creakiness detection algorithm developed in Matlab. These analyses allowed for the discovery of a contrast between creaky and modal tones in the tone system of Du'an Zhuang. It also suggested that in Burmese, creaky tone and low tone are distinguished mainly via F0 and not creakiness. These analysis tools can aid linguists who wish to use production study data to piece apart the roles of F0 and phonation in complex tone systems.