Psychoacoustic roughness as a measure of creakiness in two dialects of Zhuang

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ABSTRACT

We investigated the tonal systems of Wuming and Du'an Zhuang via a production study focusing on F0 and creaky phonation. Results revealed that (1) there is evidence of a phonation contrast among tones 2 and 4 in Wuming Zhuang and (2) no such phonation contrast exists in Du'an Zhuang, where F0 alone distinguishes each tone. The study utilized an objective measurement of psychoacoustic roughness as a proxy of creakiness, revealing the phonation contrast in Wuming Zhuang. In contrast, another method of creakiness detection, Covarep, did not reveal any such creakiness difference. Roughness and Covarep creakiness detection algorithms differ then, with roughness providing a more sensitive measure of creaky phonation in this case.

1. Introduction

The tone system of Wuming Zhuang has been described in [1] as one in which F0 is the main phonetic cue distinguishing tones. However, recent work [2] has found that phonation may play a significant role in the tonal system of the Du'an Zhuang dialect. In that research, a single speaker of Du'an Zhuang had a phonation contrast between tones 2 and 4. Additionally, a production study on Wuming Zhuang [3] agreed with what was reported in [1], in that only F0 and not phonation is involved in tonal contrasts.

The above findings suggest that a phonation contrast may be present in the tonal system of Du'an Zhuang, but not in that of Wuming Zhuang. To test this, we analyzed F0 and phonation contours among unchecked tones in Wuming Zhuang (8 speakers) and Du'an Zhuang (6 speakers). Unlike [2], which used a composite method to measure creakiness from the acoustic signal based on Covarep [4], we used an objective measure of psychoacoustic roughness [5] as an additional proxy for creaky phonation.

2. Method

The data and methods used here are the same as those in [3]. The same word list was used for participants of both dialects, presented in written form in Chinese orthography. Each token was time normalized before fitting a smoothing cubic spline ANOVA model.

3. Results & Discussion

Results for objective roughness show that there is no evidence of a phonation contrast among tones 2 and 4 in Du'an Zhuang (Fig. 1). This finding was replicated via the Covarep algorithm (Fig. 2). This is in contrast to the findings for the single speaker in [2].

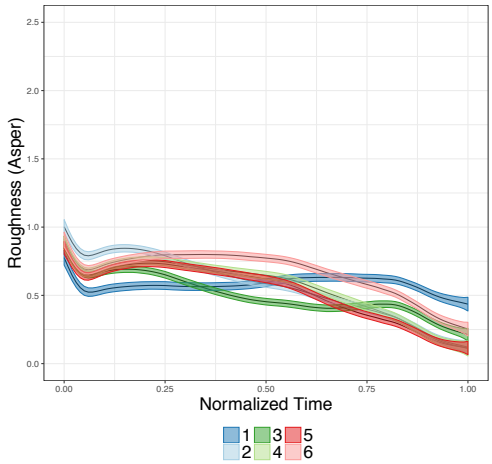

Figure 1. SS-ANOVA of roughness by tone across Du'an Zhuang speakers. Here and elsewhere, colored regions around the contour represent Bayesian 95% CI. Disjoint regions correspond to significant differences between contours.

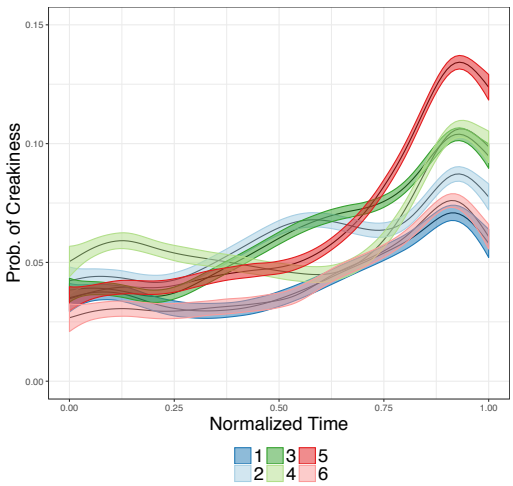

Figure 2. SS-ANOVA of probability of creakiness via Covarep by tone across Du'an Zhuang speakers.

In contrast to creakiness, F0 bears the contrastive function of the tonal system in Du'an Zhuang (Fig. 3). Greater degree of consistency across speakers is evidenced by tighter confidence intervals.

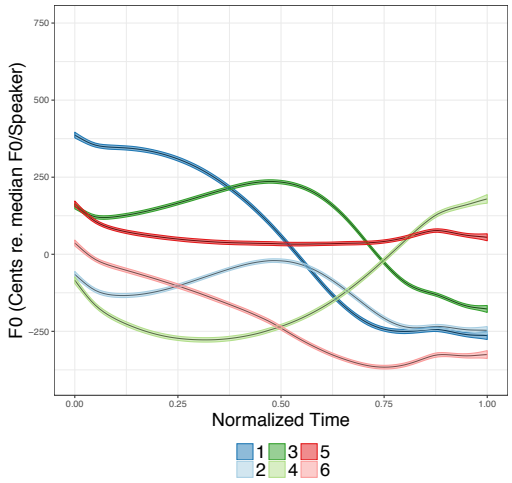

Figure 3. SS-ANOVA of F0 by tone across Du'an Zhuang speakers.

Evidence of a phonation contrast was found in Wuming Zhuang. I.e., tones 2 and 4 had different roughness contours, specifically in the final 25% of the vowel, where tone 4 increased and tone 2 decreased (see Fig. 4), but they had nearly identical F0 contours (see Fig. 5). Covarep did not yield any similar evidence of a phonation contrast between tones 2 and 4, however.

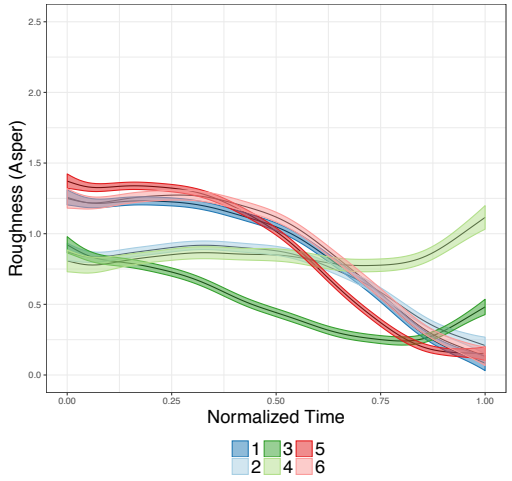

Figure 4. SS-ANOVA of roughness by tone across Wuming Zhuang speakers.

The tone systems of the two dialects can be seen to differ based on their respective F0 contours for each tone (Fig. 3 vs. Fig. 5). This tonal difference may explain why the dialects are said to be mutually unintelligible. Notably, while Du'an Zhuang speakers had nearly identical F0 contours, Wuming Zhuang speakers could be grouped in two categories: one having mid tone 6 and low tone 1; the other, exhibiting the reverse: a mid tone 1 and a low tone 6.

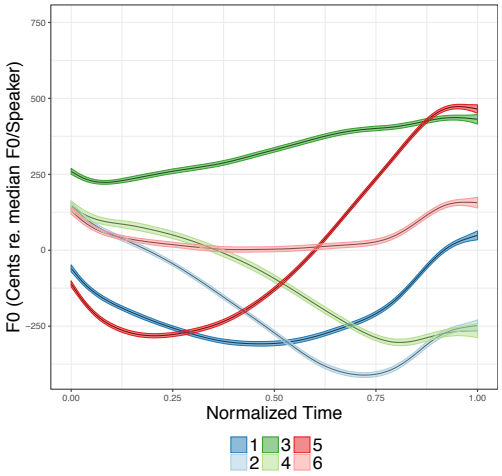

Figure 5. SS-ANOVA of F0 by tone across Wuming Zhuang speakers (mid tone 6 group)

4. Conclusion

Objective roughness measures suggest that Wuming Zhuang involves a phonation difference between tones 2 and 4. In addition, there was no evidence of a presumed phonation contrast in Du'an Zhuang. Results also indicate that the two dialects differ with respect to F0 contours, in agreement with their reported mutual unintelligibility.

Acknowledgments

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