Cue reweighting in Shanghainese sandhi patterns

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Abstract

The role of cue reweighting in reshaping tone sandhi patterns is rarely discussed. The consensus is that in the disyllabic prosodic words in Shanghainese, F0 differences in lexical tones are neutralized in the second syllable and that VOT and closure duration are the primary cues in maintaining the voicing/register contrast. However, a cue reweighting process in reshaping Shanghainese sandhi patterns: F0 is started to replace VOT and closure duration as the primary cue for voicing/register contrast in the second syllable position. This process of F0 gradually acquiring the status of the primary cue in the sandhi tone is very similar to tone split in initial positions in other language.

Keywords: Tonogenesis, Cue weighting, Sound change, Sandhi pattern, Shanghainese.

Introduction

It is well-known that obstruents affect the F0 of the following vowel, and the vowels following a voiceless onset tend to have relatively higher F0 in many languages (e.g., Kirby & Ladd, 2015). Furthermore, in tonal languages where F0 differences indicate lexical contrasts, the relation between voicing and F0 is often manifested as co-occurrence restrictions between tone and the onset consonant of tone-bearing syllables.

In Shanghainese, a disyllabic prosodic word gets its surface sandhi tone by delinking the tone of the second syllable and spreading the tonemes of the first syllable over the two syllables. For example, the prosodic word /ʦɔ^{3a} vɛ^{3b}/ 'fried rice' that could be autosegmentally represented as /ʦ^{h}ɔ^{MH} vɛ^{LH}/ has a surface form [ʦ^{h}ɔ^{M} vɛ^{H}] (e.g., Yip, 1995). In Shanghainese, as traditionally described, the functional cost of neutralizing tone in second syllables is mitigated by the preservation of vocal fold vibration. Some previous studies suggested that vocal fold vibration is no longer the primary cue (e.g., Chen & Wang, 2012), while others show that the two categories have multidimensional acoustic and articulatory correlates, including a significant difference in Closure of Duration of onset stop (CD) (Shen, Wooter & Wang, 1987) and in breathiness concentrated mainly at the onset of the following vowel (e.g., Ren, 1992).

The lexical contrasts can still be maintained when the primary cue changes. Such a change is reminiscent of tonogenesis, a type of cue shift that has been studied extensively (e.g., Hyman, 1973). In this work, we want to explore how

the cue reweighting of F0, VOT, CD, and various phonation-related measurements reshapes Shanghainese sandhi patterns.

Experiment

Stimuli

Four disyllabic names, /pɔ^{3a} tɛ^{1a}/, /pɔ^{3a} dɛ^{3b}/, /bɔ^{3b} tɛ^{1a}/, and /bɔ^{3b} dɛ^{3b}/, were used as target words (XY) in a frame sentence /ŋu^{3b} ʔiɔ^{3a} ʑin^{3b} ɦəʔ^{4b} ɲin^{3b} tɕiɔ^{3a} XY/ (The person whom I am finding is XY). In total, 180 tokens were used in the experiment (4 disyllabic prosodic words × 3 repetitions × 15 speakers).

Speakers

Fifteen native speakers of Shanghainese participated in this work and were divided into three age groups: younger than 40 (7 participants), 40 – 60 (5 participants), and older than 60 (3 participants). All participants were recorded on a Komplete Audio 6 recorder with a C544L Vocal microphone.

Data analysis

The data were normalized using z-score. Principal Component Analysis (PCA) (Jackson, J. E., 1991) was used to reduce the dimensionality of phonation-related measures. Linear Discriminant Analysis (LDA) (Schertz, 2020) was used to determine the weights of each acoustic property in production.

Results

A principal component analysis was first run on all phonation-related spectral tilt (H1*-H2*, H2*-H4*, H4*-H2K*, H2K*-H5K*, H1*-A1*, H1*-A2*, H1*-A3*) and noise measures (CPP, HNR 0-500 Hz, HNR 0-1500 Hz, HNR 0-2500 Hz, HNR 0-3500 Hz). The main results are that the first principal component (PC1) accounted for 49.2% of the variance of the measures, and the second principal component (PC2) accounted for 27.1%. PC1 was highly correlated with HNR 0-1500 Hz (r = -0.502), HNR 0-2500 Hz (r = -0.501), HNR 0-500 Hz (r = -0.495) and HNR 0-3500 Hz (r = -0.494), and PC2 was highly correlated with H1*-A2* (r = -0.59), H1*-A2* (r = -0.526), and H1*-A3* (r = -0.515). Therefore, PC1 and PC2 were used to represent phonation in the LDA models below.

According to Figure 1 and 2, each age group has its own strategy. In /pɔ^{3a} Tɛ$^{1a/3b}$/, VOT is the primary cue only for elder speakers, and F0 becomes the primary cue in /pɔ^{3a} Tɛ$^{1a/3b}$/ in young speakers. In /bɔ^{3b} Tɛ$^{1a/3b}$/, VOT is always the primary cue, but its relative weight has been greatly diminished for middle-aged and young speakers. In /bɔ^{3b} Tɛ$^{1a/3b}$/, there was no such increase of F0. However, since the relative weight of VOT is greatly weakened, we can likewise observe an increase of F0 in the transition from the middle-aged to the young generation.

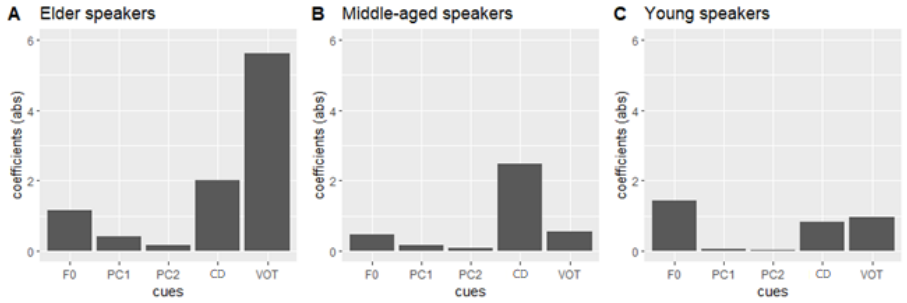

Figure 1. Visualized LDA results for /pɔ^{3a} tɛ^{1a}/ and /pɔ^{3a} dɛ^{3b}/.

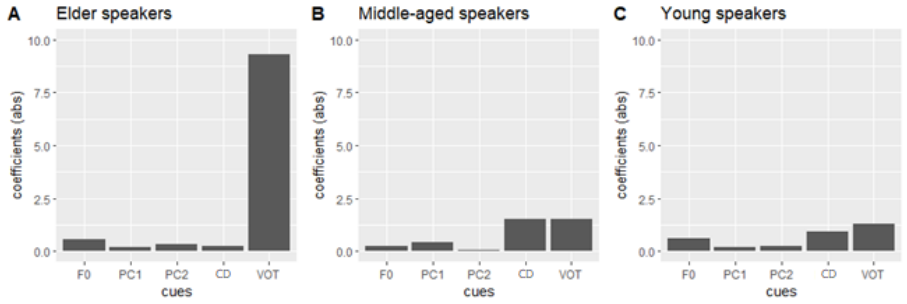

Figure 2. Visualized LDA results for /bɔ^{3b} tɛ^{1a}/ and /bɔ^{3b} dɛ^{3b}/.

Overall, the LDA results exhibit a negative trend in that the height of the bars reflecting CD went down as much as F0 went up. Whether it keeps its status as a secondary cue in each generation depends on the relationship between F0 and VOT. Meanwhile, the relative weights of PC1 and PC2 are lower than that of the previously mentioned F0, VOT, and CD on the second syllable in both sandhi patterns, suggesting the relative unimportance of phonation for the voicing/register contrast.

Discussion and conclusion

The first conclusion we can draw from the results is the relative unimportance of phonation. It is well known that the effect of obstruents on F0 is manifested mainly through the F0-onset co-occurrence restriction on the tone-bearing syllables (e.g., Hyman, 1973), and both the obstruent properties and F0 are controlled by laryngeal adjustment (e.g., Ohala, 1978). Many studies investigate the mechanisms of consonant articulation that account for the local F0 perturbation (e.g., Halle & Stevens, 1971). Since our experiment is done within the sandhi domain, whether this inconsistency that exposed the F0-phonation relationship behaves differently in different contexts requires further study.

In addition, the relative weight of VOT undergoes a significant decrease, and the relative importance of CD exhibits a negative correlation with F0. Chen's

research (2011) on the consonant-F0 interaction on the second syllables in Shanghainese suggests that there was usually a significant F0 perturbation caused by vocal fold vibration, which is generally consistent with the present study's findings. Still, the consonant-F0 interaction does not result in a direct trade-off between the two cues: the decrease in the absolute weight value of VOT between elders and middle-aged speakers is not mirrored by an increase in F0 or CD. On the contrary, the absolute value of F0 rises more in 3a-1a/3b and finally achieves predominant cue status in the younger group's production of 3a-1a/3b. The results indicate an interesting fact: the essence of this sound change at the production level is that F0 is gradually gaining its importance.

The results suggest that the tone sandhi pattern in Shanghainese is changing: in the second syllable of a sandhi domain, F0 is overtaking CD and VOT as the primary cue in younger generations. From a wider perspective, looking at the phonetic nature of the cue reweighting in Shanghainese sandhi patterns will enable us to understand better the tone split that widely happens among Eastern and Southeastern Asian languages.

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