

Contrast affects intraspeaker variability: Individual differences in Mandarin sibilants

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Introduction: There is a large body of work examining the linguistic and social factors that condition intraspeaker variation. There has been relatively less work on linguistic factors that influence *extent* of intraspeaker variation. We use data from Mandarin sibilants to demonstrate that individual differences in extent of intraspeaker variation are systematic and can be predicted by differences in phonological contrast implementation. These findings have implications for theories of cue weighting, sound change, and perceptual adaptation.

Many dialects of Mandarin contrast three voiceless sibilants /s ʃ ʂ/ (Ladefoged and Wu, 1984), primarily distinguished by two phonetic cues: spectral center of gravity (COG) and the second formant of the following vowel (F2). All three sibilants can appear before [a u] (Duanmu, 2007; Li, 2008). Speakers exhibit individual differences in the phonetic dimensions employed in the implementation of the sibilant contrast in these contexts. Some speakers produce a 3-way COG contrast (e.g. Lee-Kim, 2011); other speakers combine a 2-way COG distinction with a 2-way F2 distinction (e.g. Stevens et al., 2004). Example speakers are shown in Fig. 1. Our main finding is that speakers who use COG more contrastively in production also exhibit more variation in F2. In other words, we see a trade-off between contrast and variation across speakers.

Methods: 17 native Mandarin speakers were recorded in a laboratory experiment. The stimuli were mono- and bisyllabic words with initial sibilants followed by vowels [a u] placed in the carrier phrase ‘wǒ bǎ X dú yī biàn’. COG was calculated with time-normalization over the middle 80% of the fricative and F2 was extracted at 10ms into the following vowel. F2 variation was quantified using the coefficient of variation calculated within speaker, vowel context, and phonological category. Following previous work (e.g. Shultz et al., 2012; Schertz et al., 2015), the coefficients from a linear discriminant analysis were used as a relative measure of COG cue weight in production.

Results: As expected, we observed gradient individual differences in contrast implementation. The Fig. 1 examples show the speaker with the highest COG cue weight (left panel) and the speaker with the lowest COG cue weight (right panel). We predict a positive relationship between COG cue weight and extent of within-category F2 variation across speakers. Results for /s/ are shown in Fig. 2. We found generally less F2 variation in /a/ relative to /u/, but did observe a correlation with COG cue weight for both vowels. A linear mixed effects regression model predicting F2 variation showed COG cue weight as a significant predictor of F2 variation for /s/ and /ʃ/ but not /ʂ/.

Discussion: Speakers who use COG more distinctively in production also show more within-category variation in F2, though this relationship was not observed for /ʃ/. Our experiment does not distinguish between two factors that could independently affect retroflex variation: greater articulatory variability (Hu, 2008), and the /ʃ/-/s/ merger present in some dialects (Kubler, 1985; Duanmu, 2007). None of our speakers are from regions associated with the merger and all speakers produced distinct /s ʃ/ categories. However, if the speakers realize even some /ʃ/ tokens as more alveolar, this would result in additional variability, which could obscure any contrast effects.

These findings demonstrate that extent of intraspeaker variability is systematic, conditioned by individual differences in cue weight. It is sometimes claimed that high amounts of intraspeaker variation lead to diachronic instability (e.g., Bukmaier et al. (2014) make this argument for Polish, which has a similar sibilant system). This does not seem to be the case here. In our results, speakers with the most variation in F2 actually show the greatest overall separability between the sibilant categories. These findings also have implications for models of perceptual adaptation: listeners could potentially use the relationship between COG contrast and F2 variation to make inferences

about how much variation to expect from a new speaker after just a few tokens of exposure.

Figure 1: Individual differences in contrast implementation from the present study. Left panel: Speaker with a 3-way COG contrast. Right panel: Speaker with a 2-way F2 contrast and 2-way COG contrast. F2 and COG in Hz.

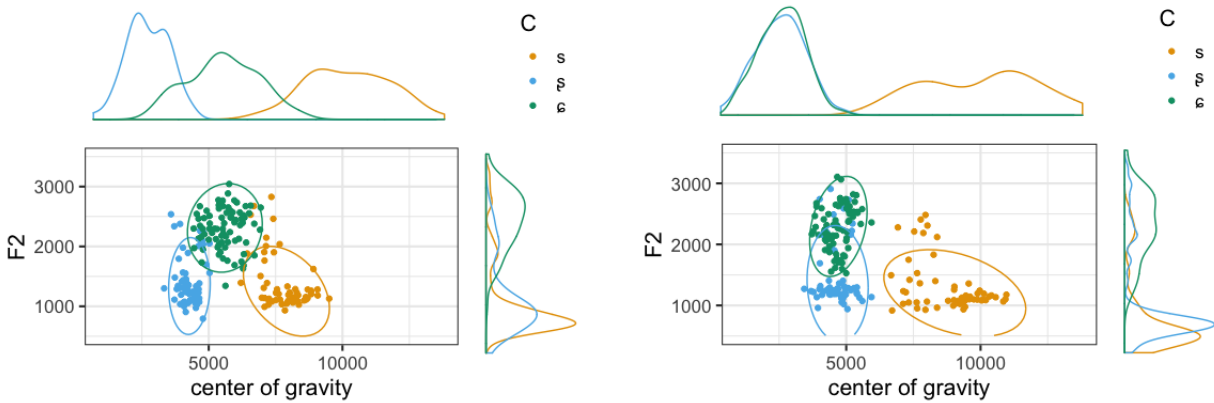
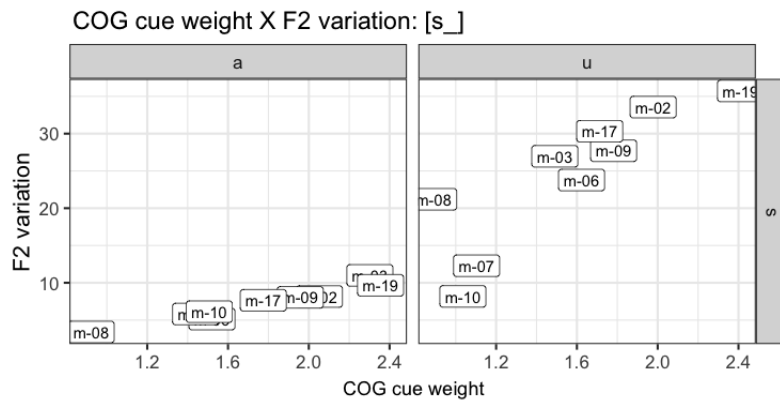


Figure 2: Relationship between COG cue weight and F2 variation across speakers. Each point represents an individual speaker.



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