Reexamining cue enhancement: The case of whispered tones in Mandarin

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1. Introduction

- 4 basic lexical tones in Mandarin
  - Tone 1: high level (55)
  - Tone 2: mid rise (25)
  - Tone 3: low fall-rise (214)
  - Tone 4: high fall (51)

2. Methods

- Materials: list of 30 minimal tone quadruplets (= total of 120 test items)
  - open syllables with unaspirated stop or fricative onsets
- Subjects: 4 native Mandarin speakers from mainland China (2 m, 2 f)
  - 3 from Beijing, 1 from Shanghai
  - all in their 20s–30s, no history of articulatory or auditory problems
- Recording: speech recorded digitally in quiet rooms at 44.1 kHz / 16 bps
- Materials:
  - Tone 1: high level (55)
  - Harmonic fine structure
  - Tone 2: mid rise (25)
  - Tone 3: low fall-rise (214)
  - Tone 4: high fall (51)
- Subjects:
  - 3 from Beijing, 1 from Shanghai
  - all in their 20s–30s, no history of articulatory or auditory problems

3. Results

- Duration: same hierarchy among tones in normal speech and whisper
  - Tone 3 > Tone 1/Tone 2 > Tone 4
  - duration differences in normal speech significant at p < .05 except Tone 1 vs. Tone 2 for Sp. 1, 2
  - duration differences in whisper significant at p < .05 except Tone 2 vs. Tone 3 for Sp. 2
  - main effect of all speakers (L to R: Sp. 1-4)
  - main effect of speech genre for Sp. 1, 3, 4
  - [tone x speech genre] interaction for all speakers

- Intensity: similar hierarchies in both speech genres
  - normal speech: Tone 1 > Tone 2 > Tone 4 > Tone 3
  - whisper: Tone 4 > Tone 1, Tone 2, Tone 3
  - main effect of all speakers (L to R: Sp. 1-4)
  - main effect of speech genre for all speakers
  - [tone x speech genre] interaction for all speakers

4. Conclusions

- There are significant differences in duration and intensity among the 4 Mandarin tones in both normal and whispered speech
  - relative differences are similar across speech genres
- Talkers are not exaggerating secondary cues in whispered speech
  - duration/intensity differences among tones become smaller in whispered speech (contra [5])
  - [5]'s perception results are probably due to unnaturalness of the "machine whispered" stimuli rather than exaggerated cues in the "human whispered" stimuli
- There is significant individual variation in the production of whispered tones, which may be correlated with gender and/or dialect

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References