Perceptual Discrimination, Categorization, and Vocal Imitation of Pitch

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Introduction

- **Vocal imitation** plays a critical role in music and language. People imitate pitch differently when mimicking speech vs. song:
  - Larger pitch deviation for speech (Mantell & Pfordresher, 2013)
  - Better fine-grained pitch tracking for speech (Pfordresher, 2022)
- **Differences influenced by Top-down vs Bottom-up processing**

  Bottom-up = Stimulus-driven
  Top-down = Goal-oriented, Experience-based
  (McMains & Kastner, 2011; Beck and Kastner, 2009)
  - Image salience and spatial attention bias visual processing. (Reynolds et al., 1999)
  - Pitch structures and patten detection affect auditory processing. (Kraus & Chandrasekran, 2010)

  Bottom-up factors in Pitch Processing
  - Pitch more stable over time in sung notes than in spoken syllables (Ozaki et al., 2024)
  - Pitch stability may account for song advantage.

  Top-down factors in Pitch Processing
  - Musical training facilitates pitch processing in speech, such as lexical tone identifications and prosody. (Honda et al., 2023; Lee & Hung, 2008; Thompson et al., 2004)
  - Tone language speakers have better perceptual ability, such as pitch discrimination and melody discrimination, than non-tone language speakers. (Guiliano et al., 2011; Bidelman et al., 2013)

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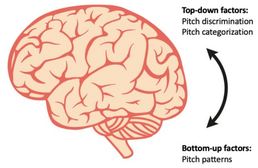
Research Question

How do top-down and bottom-up factors interact in influencing vocal imitation?



Bottom-up factor:
- Pitch stability

Top-down factors:
- Conscious perception of pitch change
- Categorization of pitch patterns as speech or song

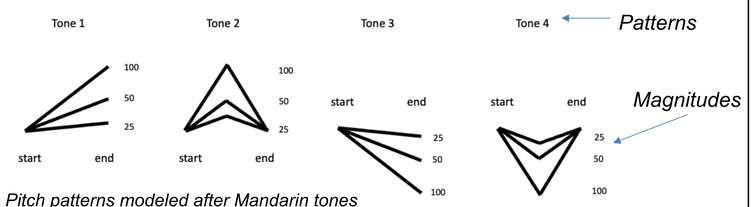
Method

Participants

	N	Mean Age (SD)
Experiment 1	41 (21F, 20M)	18.76 (0.89)
Experiment 2 & 3 (pilot)	41 (16F, 22M)	20.71 (5.76)

Stimuli

- 350 ms pitch with phonetically neutral sounds (“hum”)
- 4 pitch patterns x 8 magnitudes of pitch change
  - Magnitudes: 5, 10, 25, 50, 75, 100, 150, 200



Pitch patterns modeled after Mandarin tones

Procedure

Vocal Imitation
Listen to each stimulus and vocally imitate it.

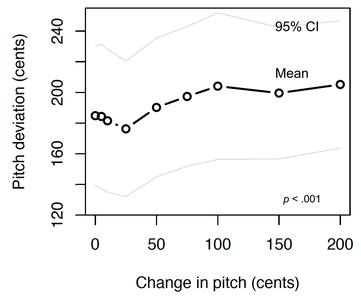
Discrimination Task (Experiment 2 pilot)
Listen to each stimulus and answer whether the pitch changed or not.

Categorization Task (Experiment 3 pilot)
Listen to each stimulus and answer the pitch sounded like a musical note or speech syllable.

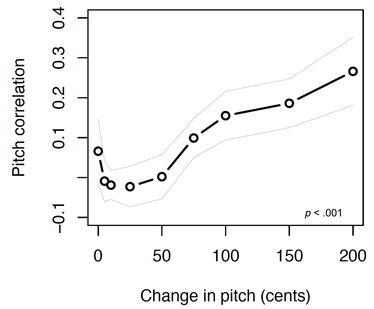
Results

Production responses (Experiment 1)

Greater Deviation of produced from target pitch with larger pitch change = **Poorer performance**



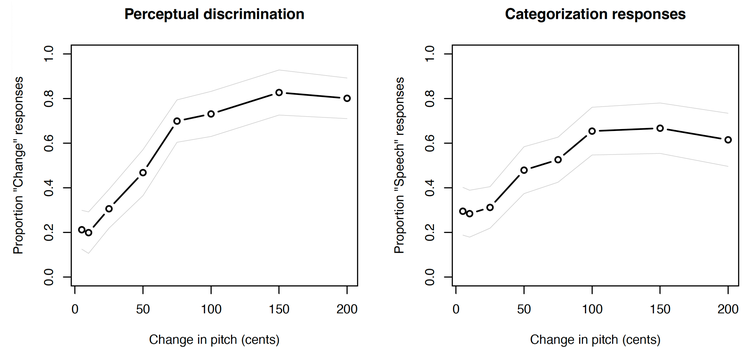
Greater correlation of produced with target pitch with larger pitch change = **Better performance**



Note: Trials with pitch deviations < 600 cents dropped (7% of trials)

Perceptual Responses (Experiment 2 & 3 pilot)

- Increased pitch change response and speech categorization response for larger pitch change.



Conclusions

- **Bottom-up factor (pitch stability)** affect vocal imitation. Greater instability associated with larger deviations and stronger correlations
  - Resembles dissociation observed in real-world stimuli (Pfordresher, 2022)
- **Top-down factors (discriminability and categorization) are correlated with pitch stability**
  - More instability heard as more like speech, even in single tones
- Future studies will investigate how these top-down factors affect bottom-up processing of pitch in vocal imitation.