



Musical Sensitivity Correlates with Pitch Production Ability in Speech

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Introduction

- Most listeners (70%) perform at chance when classifying major vs. minor tone sequences, while 30% of listeners perform almost perfectly (Chubb et al., 2013).
- Performance of a given listener in this major-minor task and other tasks requiring discrimination of scale-defined qualities depends on the listener's level of a single auditory resource called *scale-sensitivity* (Dean and Chubb, 2017).
- Given that music and speech share similar acoustic properties and neural mechanisms (e.g., Patel, 2005), scale-sensitivity may transfer to speech processing. The current study focuses on speech production.

Does musical scale-sensitivity predict the ability to manipulate pitch patterns in one's speech?

Methods

Tonality Task:

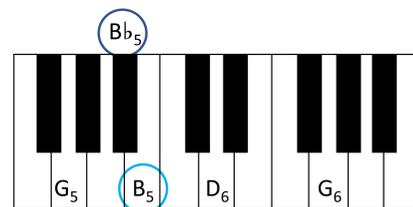
- Tone-scramble stimuli: sequences of 32 randomly-ordered, 65-ms tones

Major:

8 copies each of G₅, B₅, D₆, G₆

Minor:

8 copies each of G₅, B_{b5}, D₆, G₆



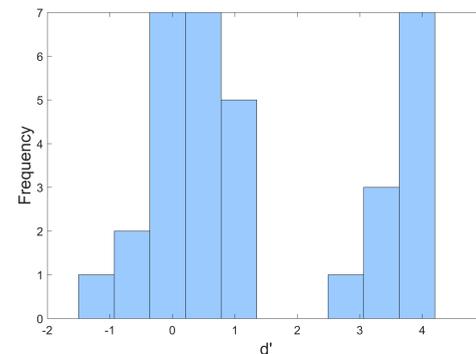
- Task: Judge whether the stimulus is Major (Type 1 or "Happy") or Minor (Type 2 or "Sad"), with trial-by-trial feedback
- 3 blocks of 50 trials

Speech Prosody Task:

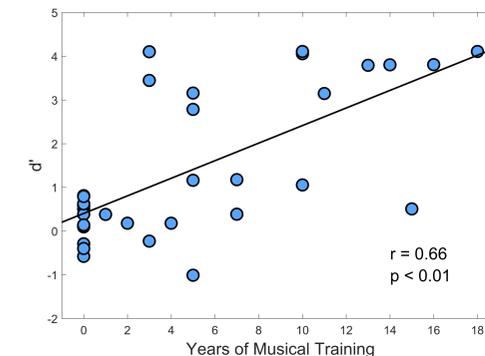
- Words: 3-syllable common words with the pitch accent normally positioned on the 1st, 2nd, or 3rd syllable
- Task: Speak target words using the pitch pattern of cue words
- Example: Cue: Vanilla Target: Calculus
- 3 blocks of 27 trials (81 unique cue/target pairs)
- Scoring: 4 raters blindly rated 12 cue-target pairs for each of the 33 participants, using a scale of 1 (extremely dissimilar) to 6 (extremely similar). The scores were then averaged.

Results

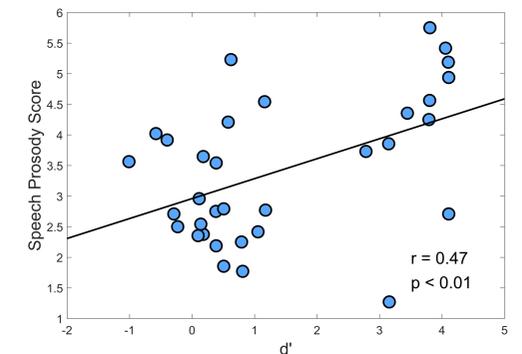
Tonality Task d' Histogram (n=33)



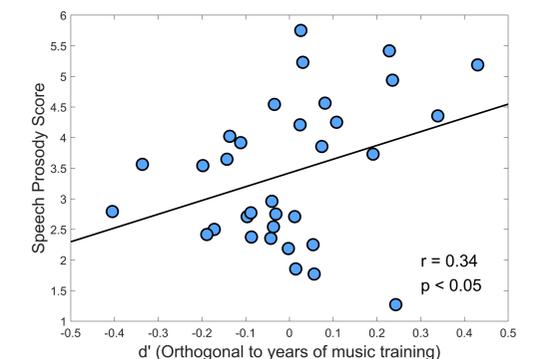
Years of Music Training vs. d'



Speech Prosody Score vs. d' (raw data)



Speech Prosody Score vs. d' (orthogonalized)



Partial correlation of d' and prosody score (factoring out effects due to music training) suggests that performance on the Tonality Task predicts performance on the Speech Prosody Task.

Conversely, years of music training fails to predict any additional variance in performance in the Prosody Task after effects due to scale-sensitivity have been removed. This suggests that performance in the Prosody Task depends on scale-sensitivity, not on years of music training. Any apparent dependency on years of music training is due to the strong positive correlation between years of music training and scale-sensitivity.

Conclusion

- Musical scale-sensitivity predicts prosody score, even when music training is factored out.
- The current results suggest that sensitivity to variations in musical scale and sensitivity to variations in speech prosody depend in part on shared mechanisms. We speculate that these mechanisms support the processing of emotional content.
- In a follow-up study, a speech perception task will clarify whether the prosodic sensitivity measured in this experiment stems from perception or motor ability.

References

- Chubb, C., Dickson, C. A., Dean, T., Fagan, C., Mann, D. S., Wright, C. E., Guan, M., Silva, A. E., Gregersen, P. K., and Kowalsky, E. (2013). Bimodal distribution of performance in discriminating major/minor modes. *The Journal of the Acoustical Society of America*, 134(4):3067-3078.
- Dean, T. and Chubb, C. (2017). Scale-sensitivity: A cognitive resource basic to music perception. *The Journal of the Acoustical Society of America*, 142(3):1432-1440.
- Patel, A. D. (2005). The relationship of music to the melody of speech and to syntactic processing disorders in aphasia. *Annals of the New York Academy of Sciences*, 1060(1):59-70.