The Effect of Musical Familiarity and Expertise on Neural Connectivity: Retrospective Analyses of a Cross-cultural Music Comprehension Study

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Introduction

- Whereas music and language share some common acoustic features, there may be distinct neural resources that are optimal for processing one domain than the other (Albouy et al., 2020)
  - Different patterns of neural activations during the perception of
    - familiar vs unfamiliar languages (Schlosser et al., 1998)
    - different musical styles (Koelsch et al., 2000)
- **Morrison and colleagues (2003)** investigated the effects of music and language familiarity and expertise on brain activity using fMRI.
  - Small sample size: 6 trained and 6 untrained individuals
  - Concluded that listening to culturally different musical styles recruits similar neural resources.
    - No difference between familiar (Western) vs unfamiliar (Chinese) music
    - Different neural activity for familiar (English) vs unfamiliar (Cantonese) speech in left MTG, left inslua, left & right STG

Current Study

- Re-investigate Morrison and colleagues (2003) using **functional connectivity**
  - Functional Connectivity: statistical dependencies between distinct units within a nervous system
- Utilize Machine Learning to find patterns of neural connectivity
- Research Questions:
  - Do musicians show different patterns of neural connectivity than non-musicians?
  - Do people show different patterns of neural connectivity for:
    - familiar vs unfamiliar sounds
    - music vs speech

References

Albouy, P., Benjamin, L., Morillon, B., & Zatorre, R. J. (2020). Distinct sensitivity to spectrotemporal modulation supports brain asymmetry for speech and melody. *Science, 367,* 1043-1047.

Koelsch, S., Gunter, T., Friederici, A. D., & Schroger, E. (2000). Brain indices of music processing: "Nonmusicians" are musical. *J. Cogn Neurosci, 12,* 520-541.

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Morrison, S. J., Demorest, S. M., Aylward, E. H., Cramer, S. C., & Maravilla, K. R. (2003). fMRI investigation of cross-cultural music comprehension. *NeuroImage, 20*, 378-384.

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Method

Dataset

- Obtained MRI data from Morrison et al. (2003)
  - 5 Musically trained participants (Age: M = 36.00, SD = 9.76)
  - 4 Musically untrained participants (Age: M = 38.00, SD = 14.35)

Morrison et al. (2003) Study Design

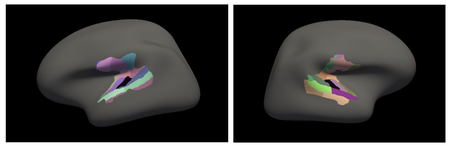
- Passive listening to familiar and unfamiliar music and speech
  - Music: Western (familiar) and Chinese (unfamiliar)
  - Speech: English (familiar) and Cantonese (unfamiliar)
- 4 runs: 2 Music runs and 2 Speech runs altering
  - Music run example:

Instruction	Western music	Chinese music	Western music	Chinese music	Western music	Chinese music

Data Analysis

1) General Linear Model Analysis for Regions of Interest

- Task vs No-task
- 56 regions of interest
  - 19 Left & 18 Right
  - 19 subcortical areas

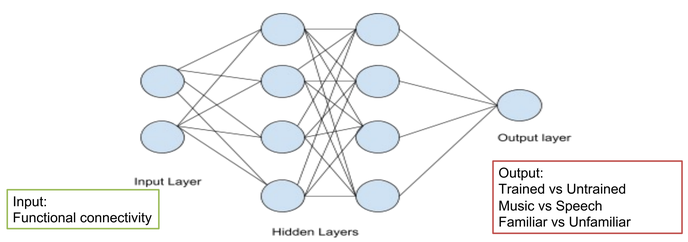


2) Functional Connectivity

- Functional connectivity between each pair of regions of interest (ROIs)
- 1540 connectivity per block per person

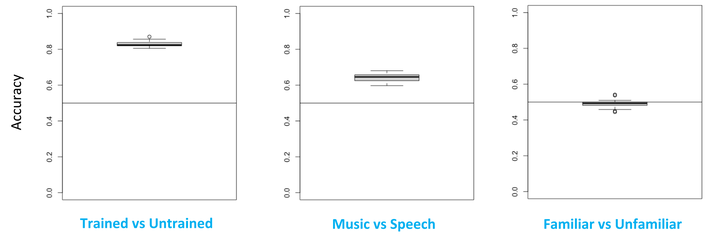
3) Machine Learning

- Classifier Training:
  - Stratified k-fold cross-validation (McNorgan et al., 2020)
- Model Evaluation:
  - Model accuracy using a validation data set
  - Weight analysis: most predictive connectivity of each category



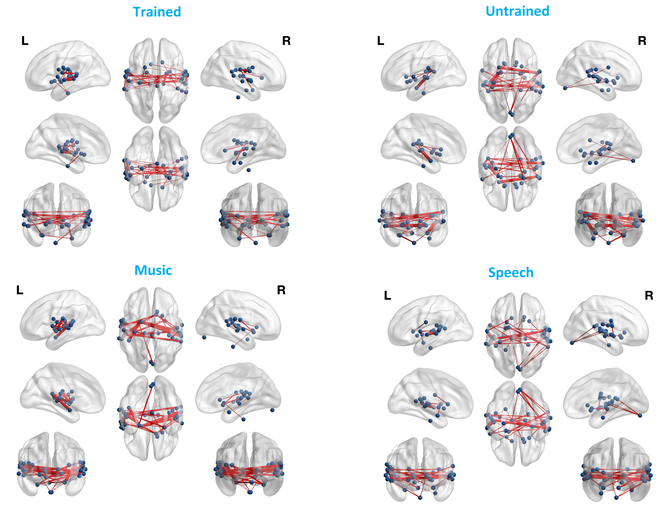
Results

Model Accuracy:



Weight Analysis:

- Blue dots indicate ROIs and red lines indicate connectivity. Width of the lines indicates the strength of the connectivity (weight).



Conclusions

- Machine learning models successfully identified the patterns of functional connectivity associated with musicians or non-musicians and music or speech.
- Certain top-down factors (i.e., musical training) and bottom-up factors (i.e., acoustic structures in language vs music) seem to influence neural connectivity for auditory processing, but there may not be specific patterns of neural connectivity that distinguish familiar stimuli from unfamiliar ones in the auditory system.