



The Cognitive Neural Mechanism Underlying Music Sequences Learning: An EEG Study

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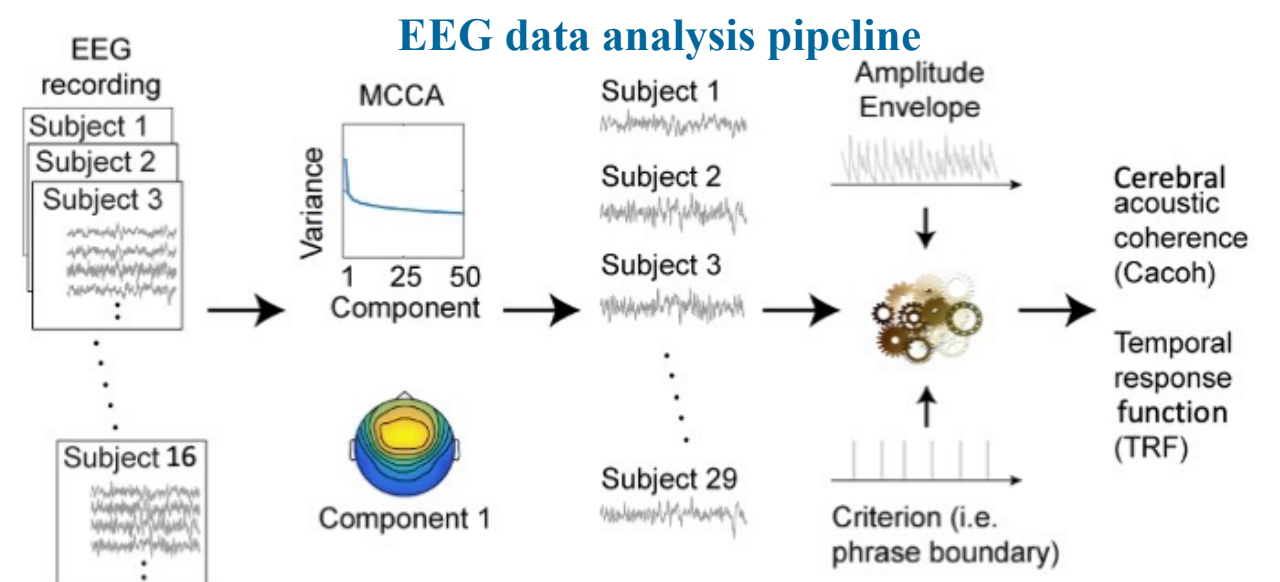


INTRODUCTION

- Same as language, perceptually discrete elements are organized into **hierarchically structured sequences** in music.
- Previous works in music have shown cortical tracking of music **beat and meter** (Lenc et al., 2018) and participants shown a low-frequency neural component that modulated the neural rhythms of **beat tracking** and reliably parsed **musical phrases** even the music is only presented once (Teng et al., 2021).
- However, how does the brain **learn and online establish high-level structure during music listening** remains unclear.
- In the current research, we select 10 highly structured Bach music pieces (including multiple regular phrases) as materials, and simulate the music learning procedure in natural environment by repeatedly presenting each music piece to participants for 10 times.

METHODS

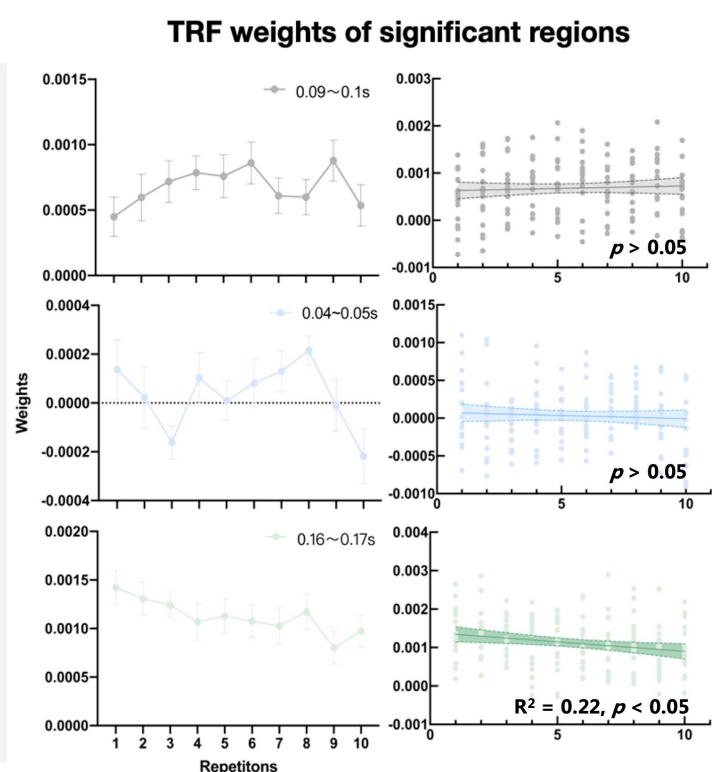
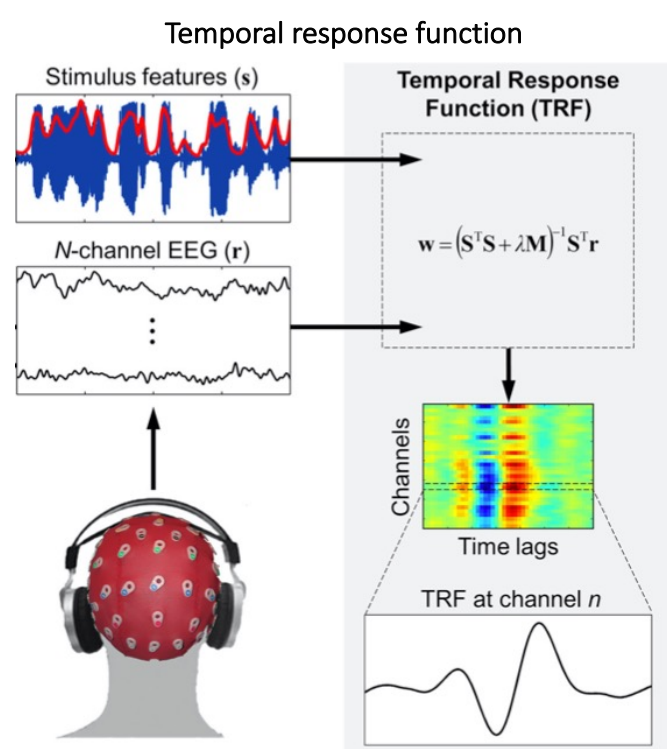
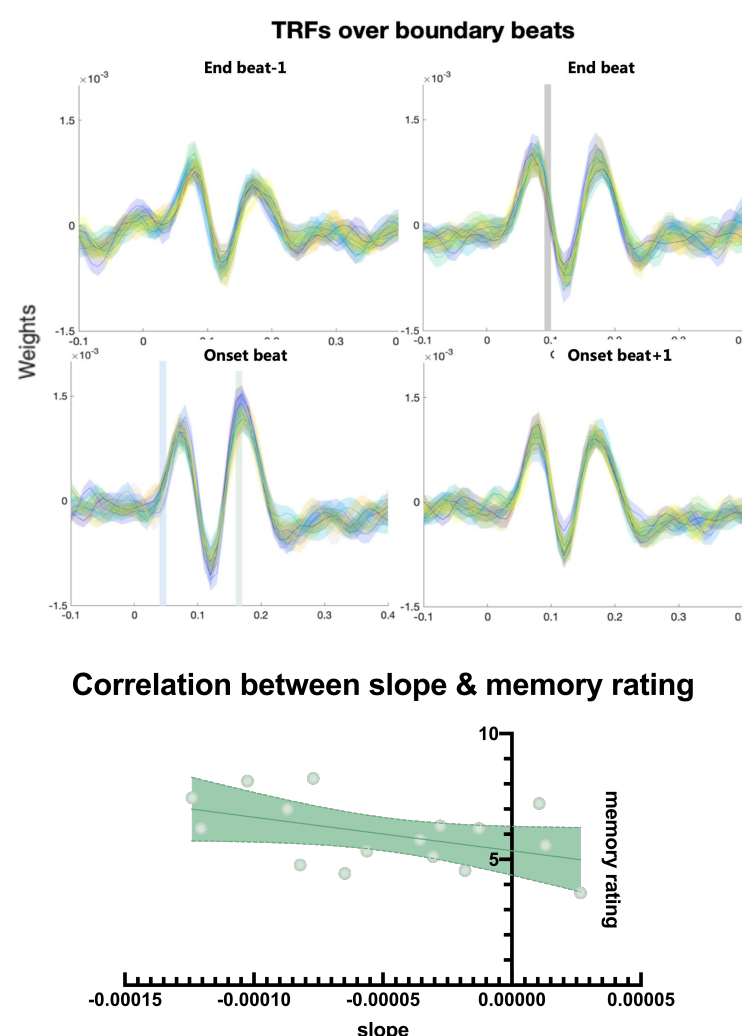
- We recorded the EEG signal of the 21 participants (only 16 were included) during their passive listening procedure and collected the participants' music training experience and the degree of memory of each music piece after learning through questionnaires.



RESULTS

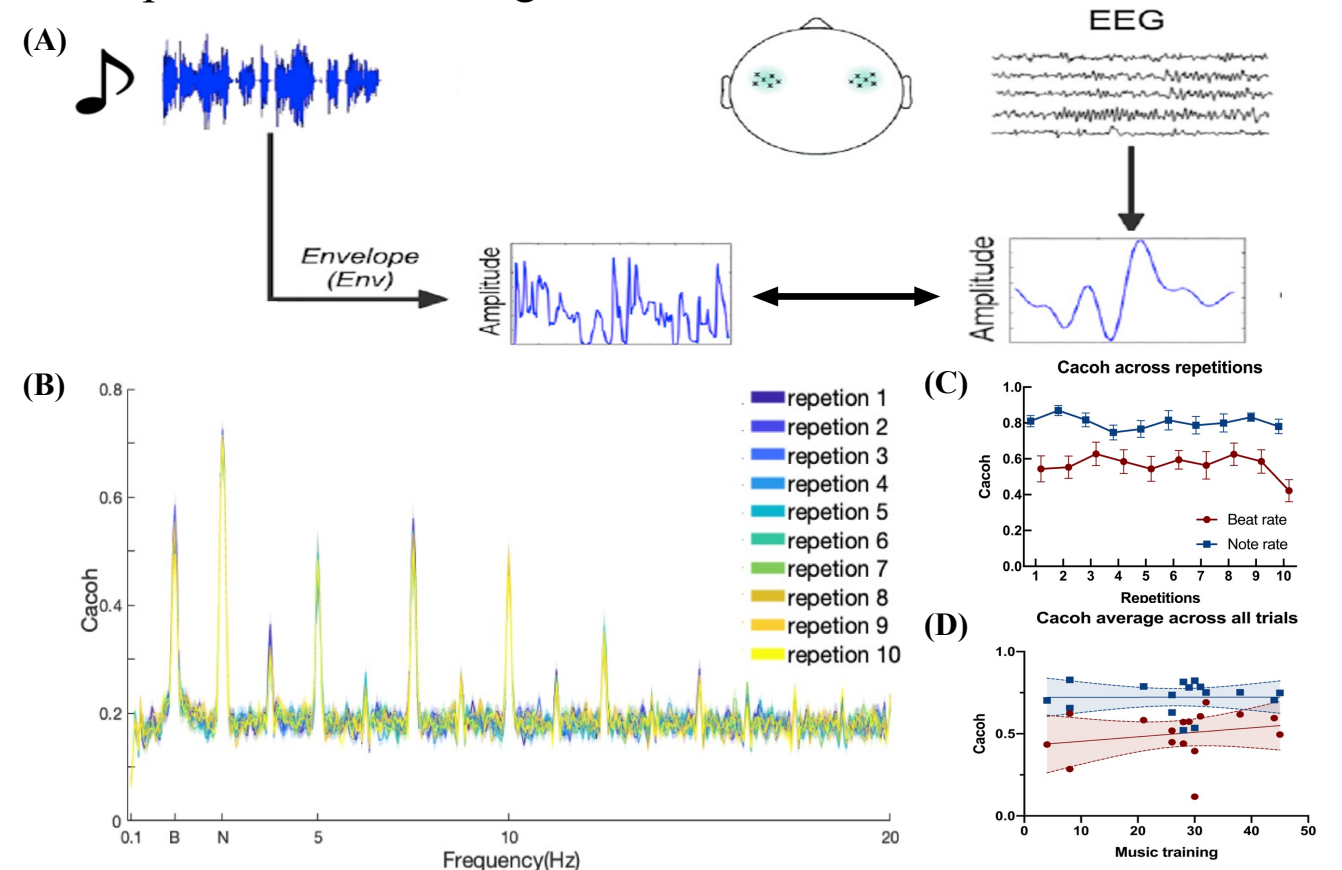
TRF (temporal response function)

- TRF on boundary beats:** We found a significant decreasing trend of TRF over phrase onset beat through repetitions.
- The slope of each participant's decreasing trend is correlated with each participant's memory rating of the music pieces.
- The results indicate that participants have learned the higher-level structure of music gradually.
- The better you memorize, the faster the TRF decreases.**



Cacoh (cerebral acoustic coherence)

- Neural tracking of beat and note:** The Cacoh peaks at the frequency of beat rate and note rate.
- However, the tracking is not modulated by subject's music training and repetitions of listening.



(A) The method to calculate Cacoh. (B) Cacoh at each frequency (B: beat rate; N: note rate). (C) Cacoh of each repetition (D) Correlation between average cacoh and music training.

CONCLUSION

- Overall, our research proves that the human brain is capable of gradually learning the high-level structure of musical phrases by passive repeatedly listening to music.
- And TRF can precisely reflect the learning effect on the hierarchical structure of music related to the individuals' memory, thus provides a sensitive tool to explore the cognitive neural mechanisms.

Key references:

- Teng, X., Larrouy-Maestri, P., & Poeppel, D. (2021). Segmenting and Predicting Musical Phrase Structure Exploits Neural Gain Modulation and Phase Precession. bioRxiv.