Age-related Changes in Neural Synchronization with Naturalistic Music

Authors: Yue Ren[1], Kristin Weineck[2,3], Björn Herrmann[1,4], Molly J. Henry[2,5]

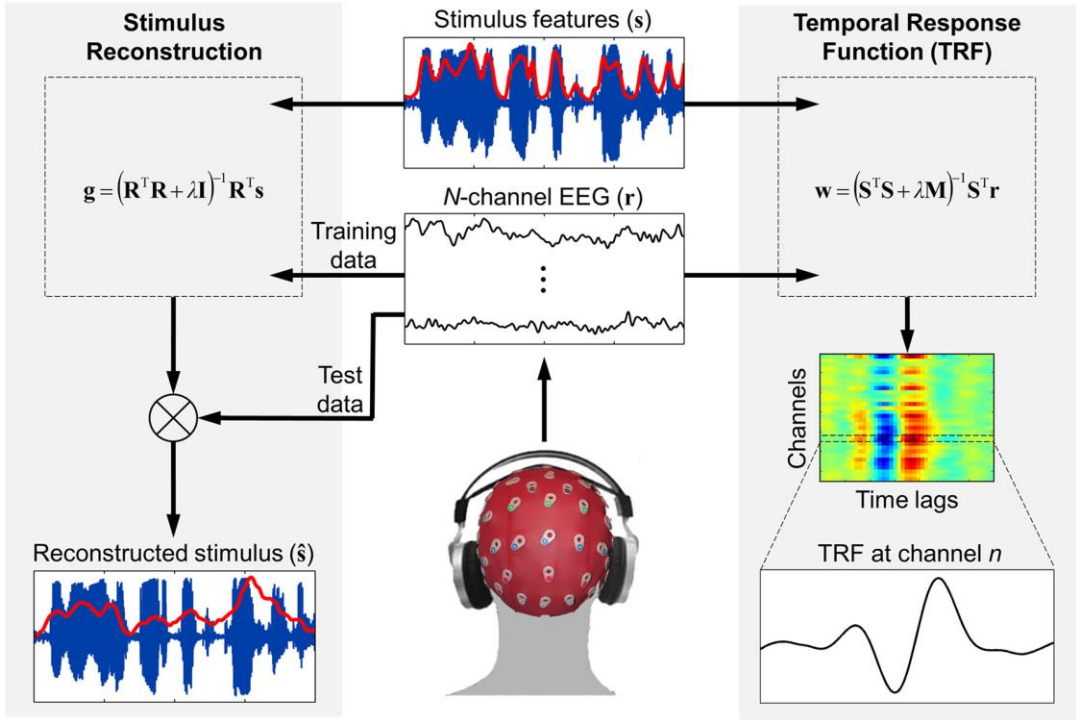
Affiliations:
1. Rotman Research Institute, Baycrest Academy for Research and Education, Toronto, Canada.
2. Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany.
3. Goethe University Frankfurt, Institute for Cell Biology and Neuroscience, Germany
4. Department of Psychology, University of Toronto, Toronto, Canada.
5. Department of Psychology, Toronto Metropolitan University, Toronto, Canada.

BACKGROUND & MAIN METHOD

While a substantial body of prior research has focused on how older adults process and comprehend speech, less attention has been devoted to how older adults encode and perceive naturalistic music. This research gap can be attributed, in part, to the inherent intricacies of the music encountered in everyday life, making it challenging to employ in laboratory settings. However, recent advances in neuro-analytic approach enable the investigation of how well neural responses track or synchronize with specific features of naturalistic auditory materials. In the current electroencephalography (EEG) study, we investigated whether neural synchronization to different musical features in naturalistic music differs between younger and older adults.

Temporal Response Function (TRF)

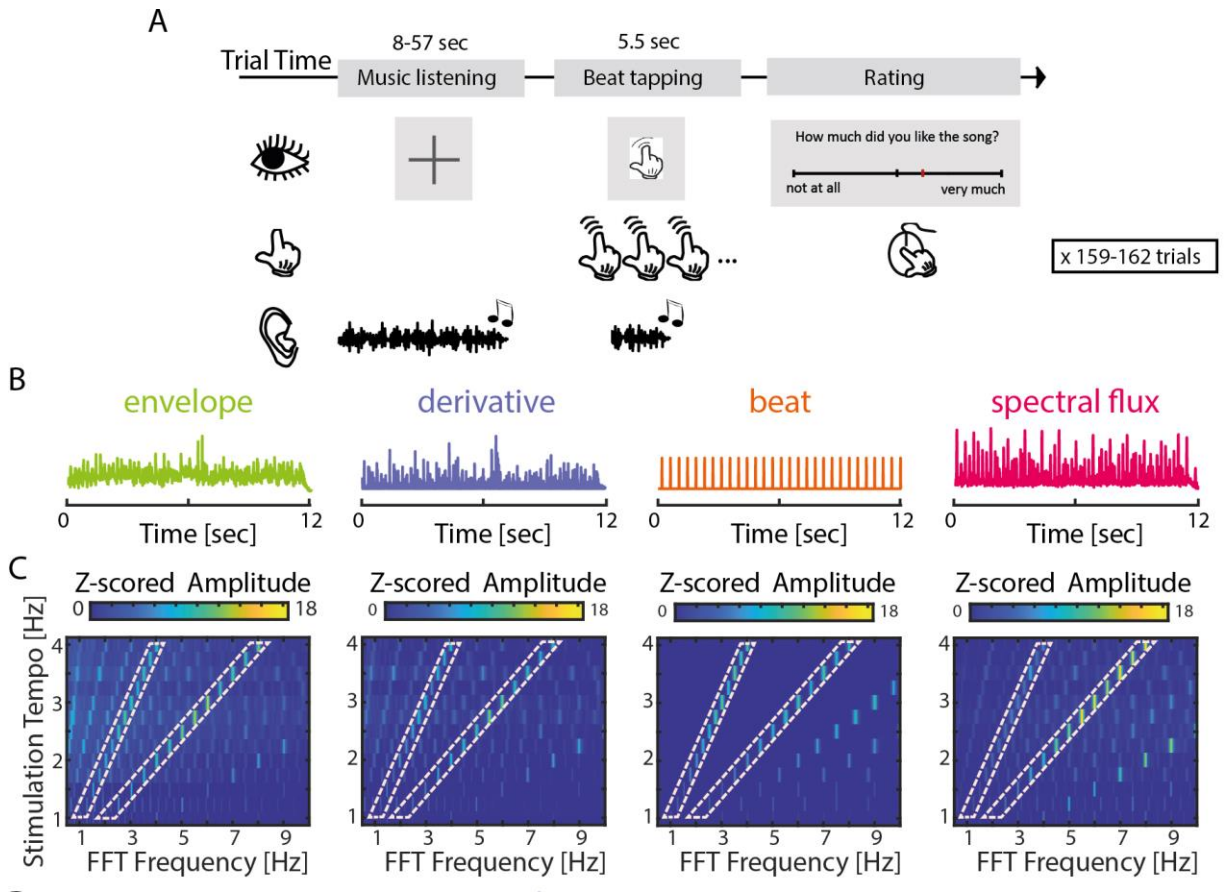
To characterize the neural synchronization to the ongoing auditory stimuli, we adopted the temporal response function (TRF) - a modeling technique that establishes the relationship between the brain response and acoustic features of auditory stimuli. Two outputs of the TRFs - TRF weights and EEG reconstruction accuracy - provide metrics that reflect the strength of neural synchronization with specific music features.



EXPERIMENTAL DESIGN

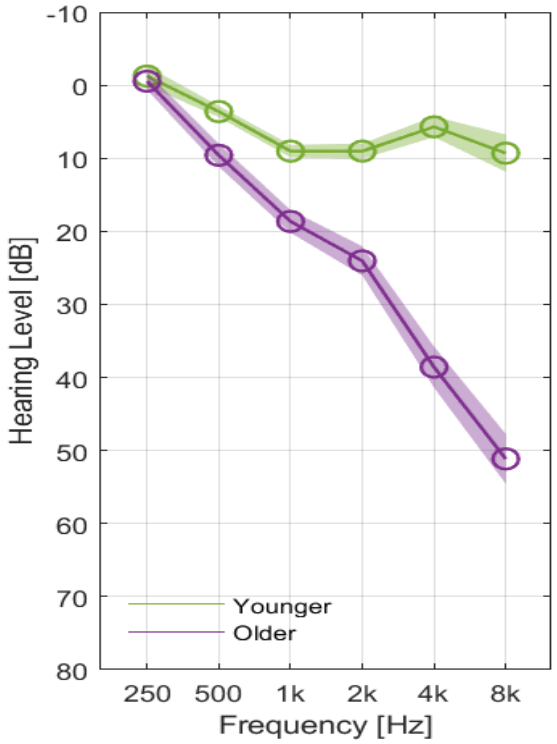
37 younger (19-36 years) and 38 older adults (55-84 years) with self-reported normal hearing participated in the experiment. Auditory stimuli were segments from 39 instrumental pieces from different genres, and tempo-modulated between 1 to 4 Hz in steps of 0.25 Hz, leading to 703 music stimuli with durations of 8.3-56.6 s.

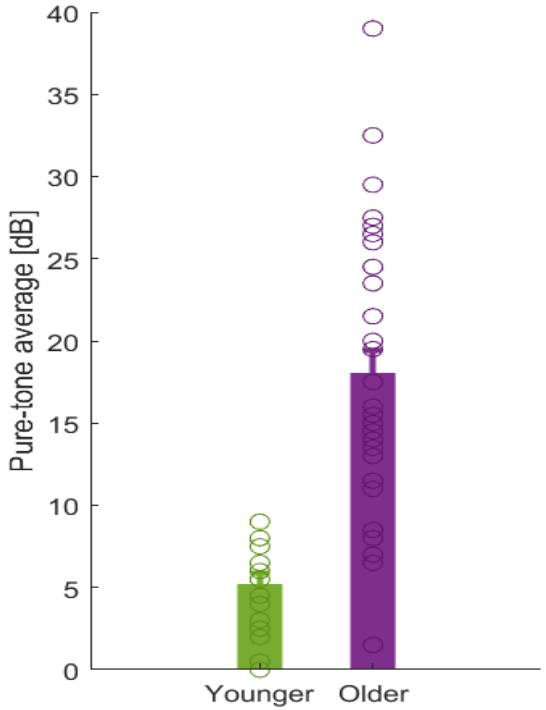
Four musical features were calculated: acoustic onset, envelope, beat, spectral flux, which reflected different aspects of temporal-spectral fluctuations of the acoustic time courses. Participants were asked to attentively listen to the music stimuli, while 32-channel EEG signals were recorded.



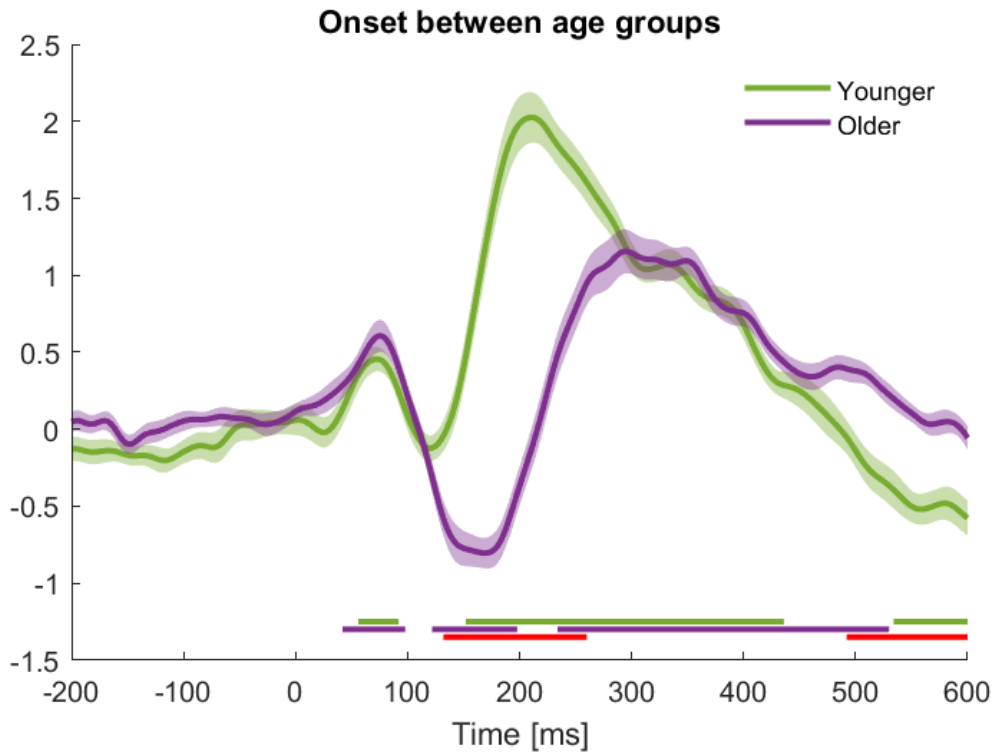
RESULTS

Audiometric Hearing Assessment & Hearing Thresholds



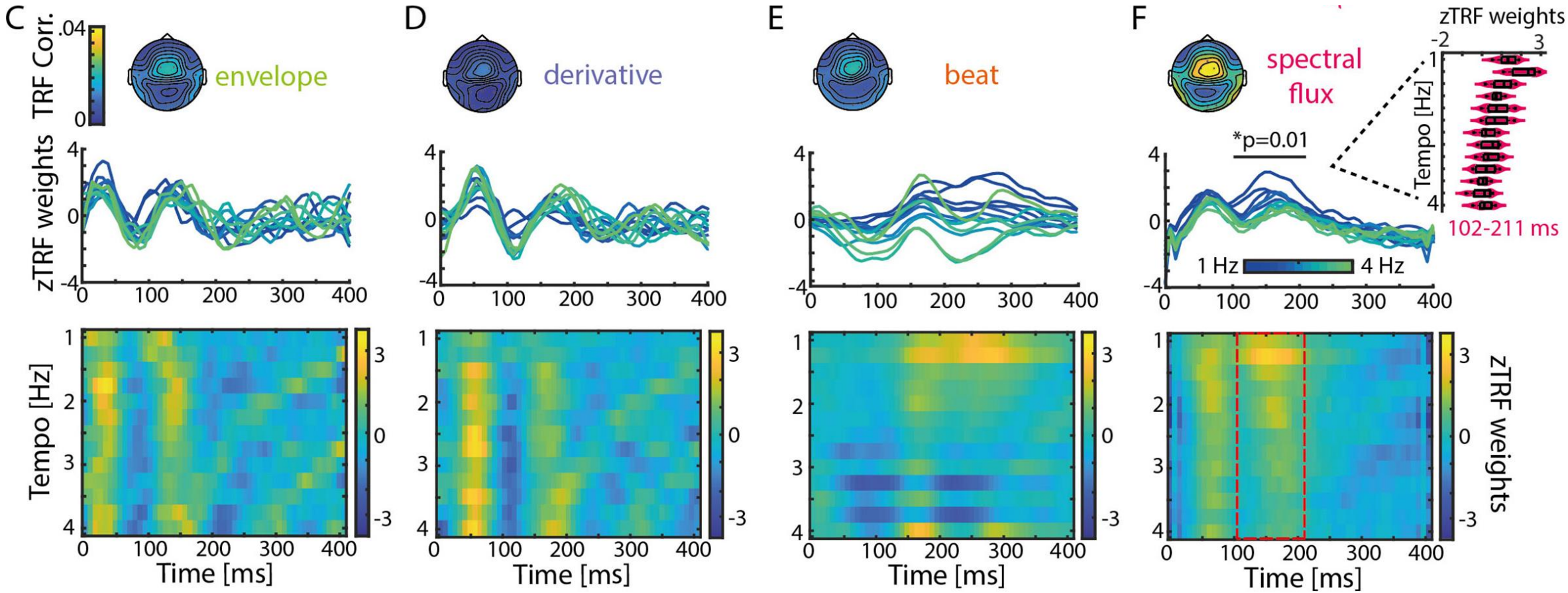


Response to sound onset



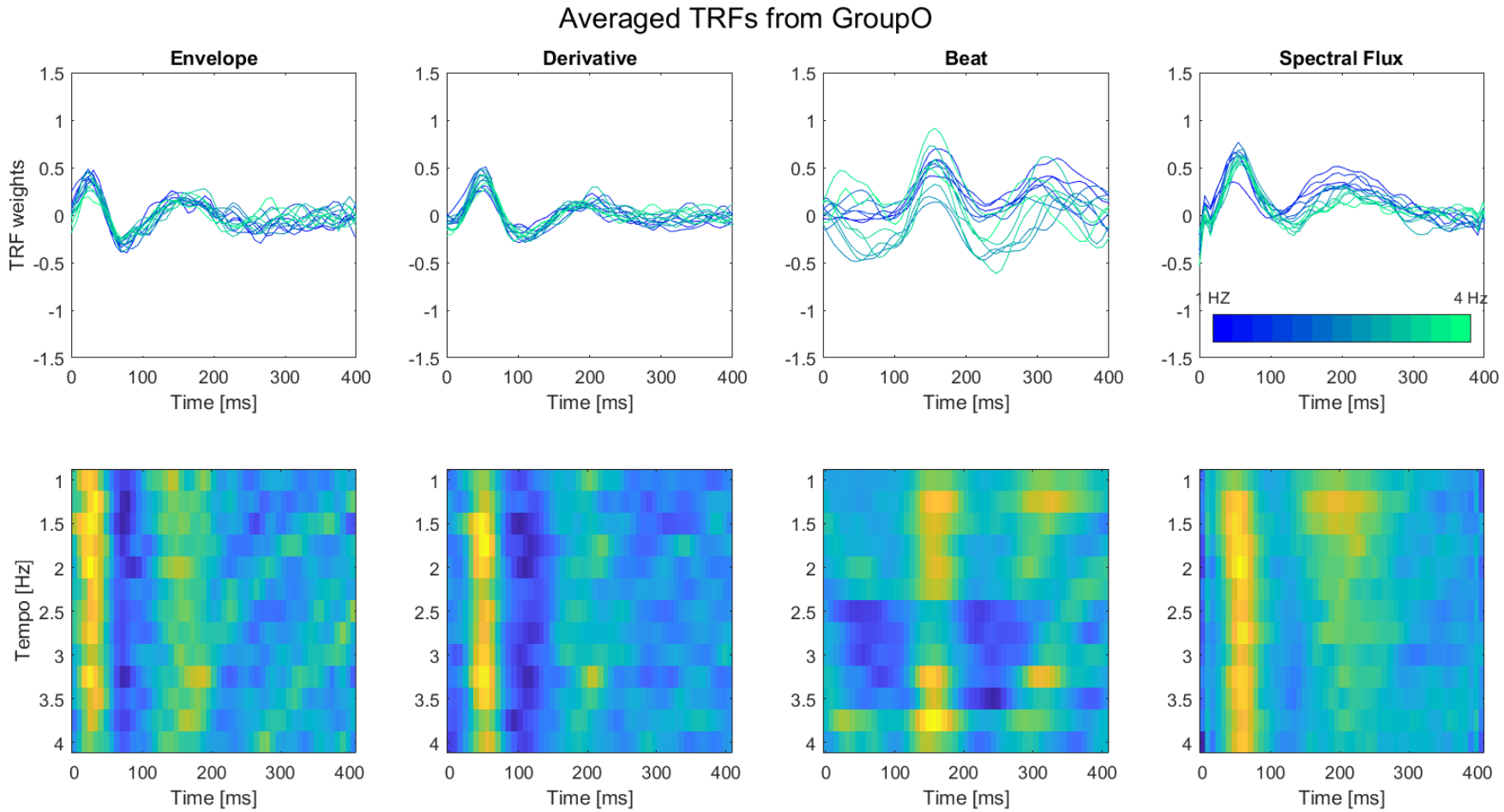
RESULTS

TRFs in response to 4 musical features in Group Younger



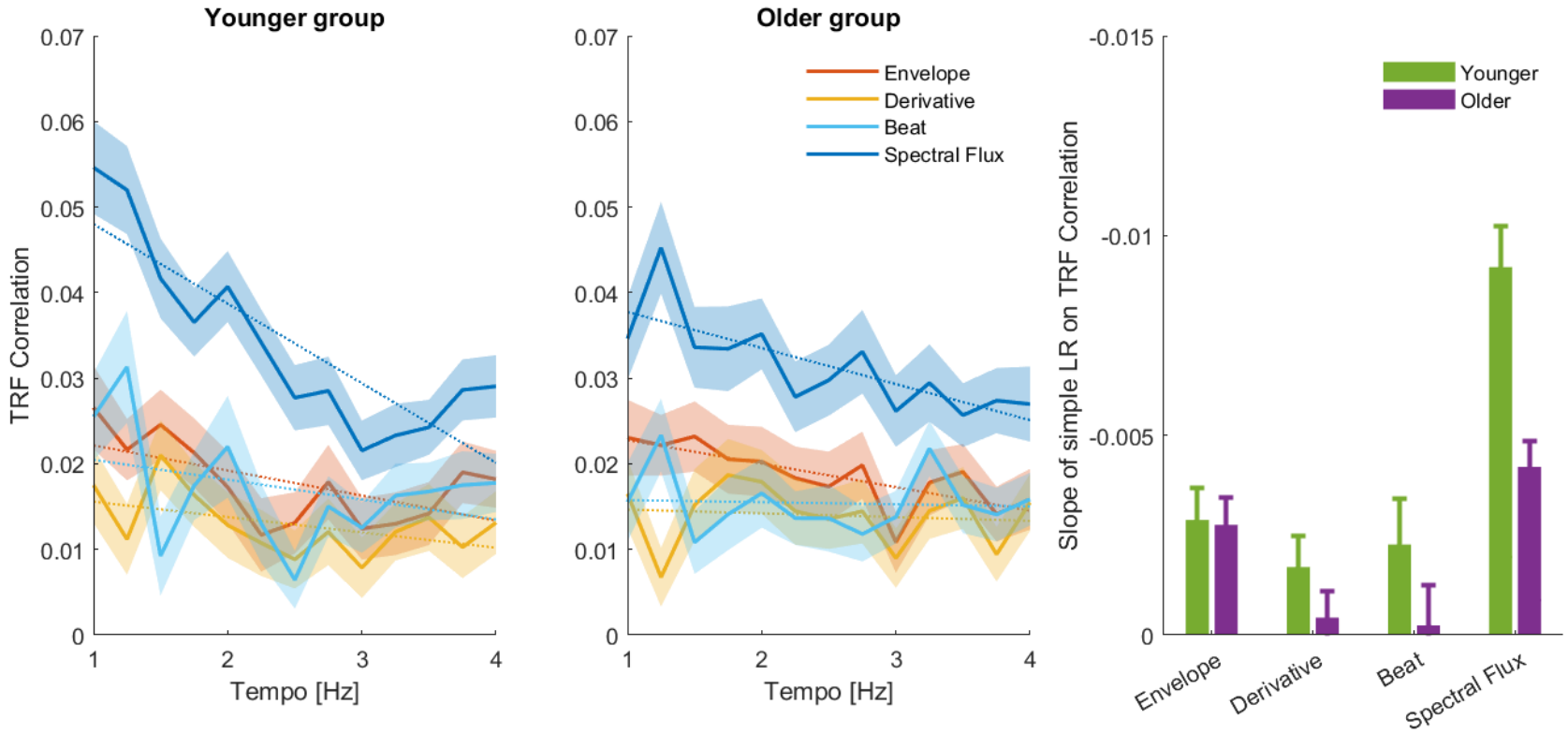
RESULTS

TRFs in response to 4 musical features in Group Older



RESULTS

TRFs correlation along the 14 tempi between 2 age groups



CONCLUSIONS

In our investigation, we provide insights into the role of spectral-temporal fluctuations within music, specifically as indexed by spectral flux, in driving neural synchronization in older individuals. Our findings align with previous research on the hyperactivity phenomenon, suggesting that older participants may exhibit enhanced sensitivity to variations in amplitude. Despite this age-related hyperactivity, sensitivity to musical tempo was reduced, suggesting that encoding of music is changed in various ways in older adulthood. These results shed light on the complex interplay between age-related neural responses and musical features, contributing to our understanding of auditory processing in the aging population.