Complexity Matching to EEG Response of Speech and Music

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Introduction

- Speech and music both have Hierarchical Temporal Structure (HTS)
- Complexity Matching (CM) has been found in behavioral measures through the similarity in HTS of coupled signals e.g., dyadic conversations
- Different types of speech and music have been shown to have distinct HTS through the use of Allan Factor (AF)
- **We test the viability of AF to capture CM in distinct speech & music stimuli to corresponding EEG responses**

Method

- N = 11; Stimuli: Electronic Music, Bird Song, Ted Talk, Ted Talk (Sine), classical music, classical music (repeated); Stimuli Length ~ 4:20 mins
- 32 channel cap; stimuli presented once at random order; down sampled to 2056 Hz
- Adaptive Mixture Independent Component Analysis (AMICA) was used to topographically cluster signals based on points of interest
- Amplitude envelope of each stimuli and EEG components had their relevant peak amplitude events create a time series for AF to find the degree of event clustering at a given timescale
- Support Vector Machine (SVM) used to classify stimuli category based on AF scores
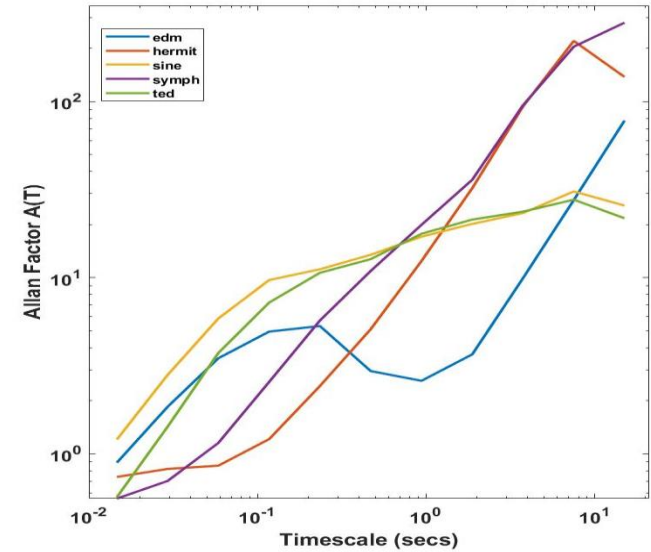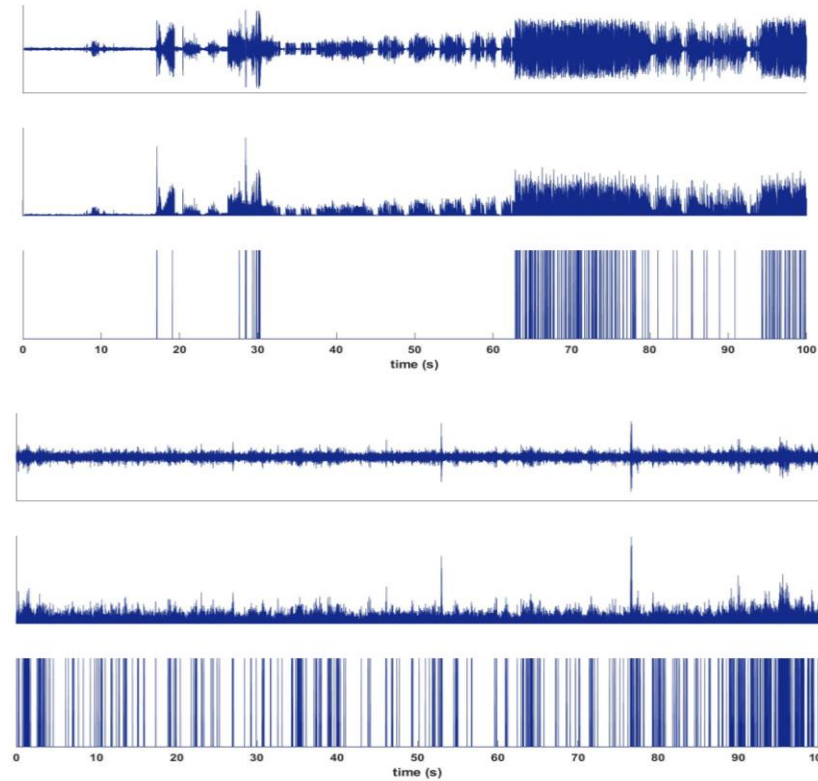
Discussion

- Down sampled stimuli replicate HTS from (Kello et al., 2017) but all EEG components present 1/f like AF functions despite component locations coming from auditory cortex regions
- ANOVA & Tukey Honest Significant Difference Test show a significant effect (p .0471) between the linear slope of the longest time scales in classical music repetitions
- Classification results demonstrated that the longest timescales had the best performance (28.4%)
- **HTS can be captured in EEG, CM remains elusive but longer timescales carry the most information and repetition of stimuli capture a decrease in AF variability (less HTS scaling)**
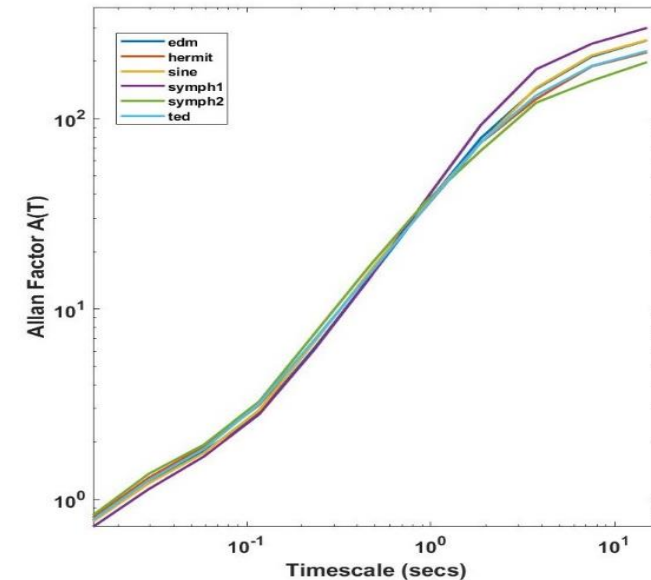
References

1. Kello, C. T., Bella, S. D., Médé, B., & Balasubramaniam, R. (2017). Hierarchical temporal structure in music, speech and animal vocalizations: jazz is like a conversation, humpbacks sing like hermit thrushes. *Journal of The Royal Society Interface*, *14*(135), 20170231.
2. Lalor, E. C., & Foxe, J. J. (2010). Neural responses to uninterrupted natural speech can be extracted with precise temporal resolution. *European journal of neuroscience*, *31*(1), 189-193.

$$A(T) = \frac{\left\langle \left(N_i(T) - N_{i+1}(T) \right)^2 \right\rangle}{2\langle N_i(T) \rangle}$$