Musician Advantages in Pitch Processing: A Basis in Brain Connectivity?

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New research has shown that using intracranial recordings directly from neural tissues suggested that these signals, called frequency-following responses (FFRs), are unexpectedly present in a variety of other brain regions that are normally thought to play a role in much higher-level, more abstract cognitive functions (e.g. frontal cortex). Using data that we have already gathered we will be able to take the next steps in understanding how pitch processing works in the brain, and how it differs as a function of musical experience.

WHAT ARE FFRS?

- The auditory frequency-following response (FFR) is a non-invasive index of the fidelity of sound encoding in the brain, and is used to study the integrity, plasticity, and behavioral relevance of the neural encoding of sound. It is used to study the subcortical auditory system, and has been proposed as a biomarker for disorders that feature abnormal sound processing.
- Frequency-following responses (FFRs) are recordings of phase-locked neural activity that is synchronized to periodic and transient aspects of sound. Traditionally, FFRs have been measured in humans as electrophysiological potentials to sound, recorded from the scalp.

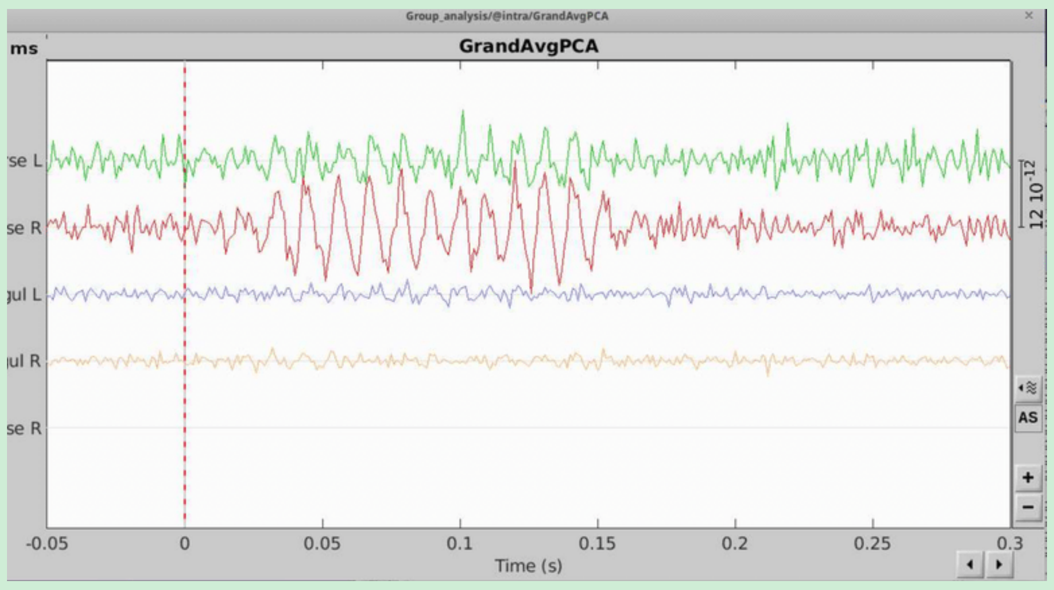
OBJECTIVE

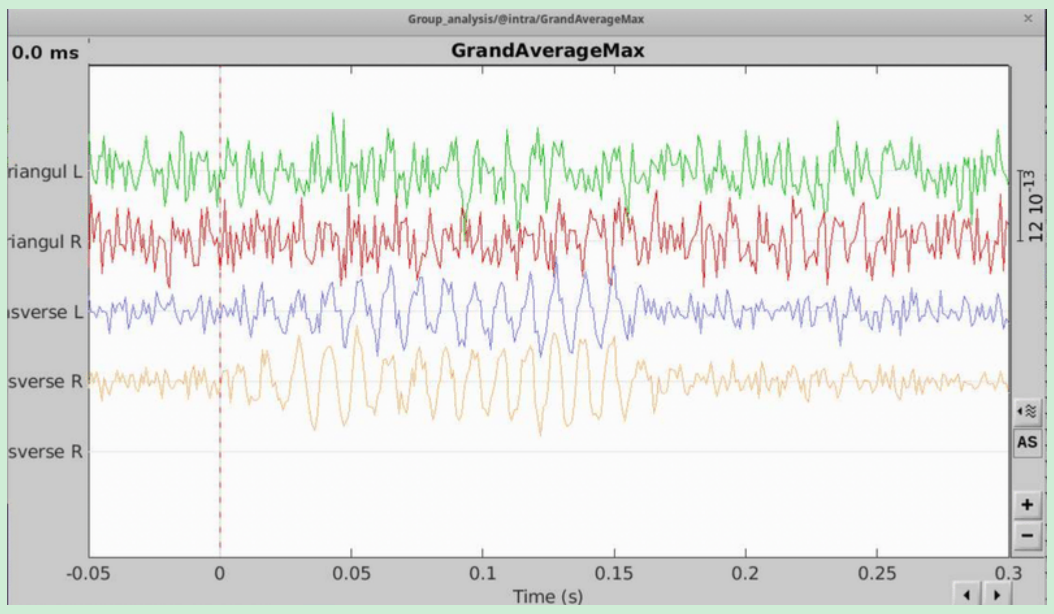
Is there a FFR in non auditory cortex regions?
The overall goal of the project is therefore to explore the communication between the auditory cortex and the rest of the cerebral cortex, and to see differences in cortical connectivity between musicians and non-musicians and explain musicians' enhancements.

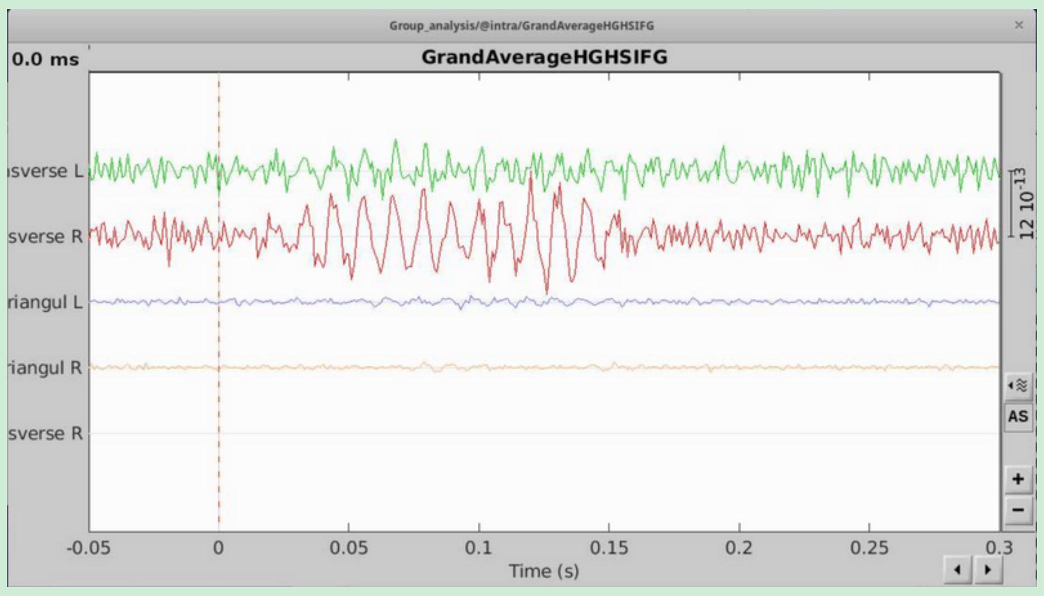
METHODOLOGY

- Look at signal from AC (Auditory Cortex) vs. other regions of interest qualitatively and at the lag between these two regions
- Try to find some connectivity between cortical regions, from the 4 regions we have identified
- Investigate whole brain connectivity using the AC as a seed
- Try some subcortical-cortical connectivity analyses and interpret the findings to see if anything is there

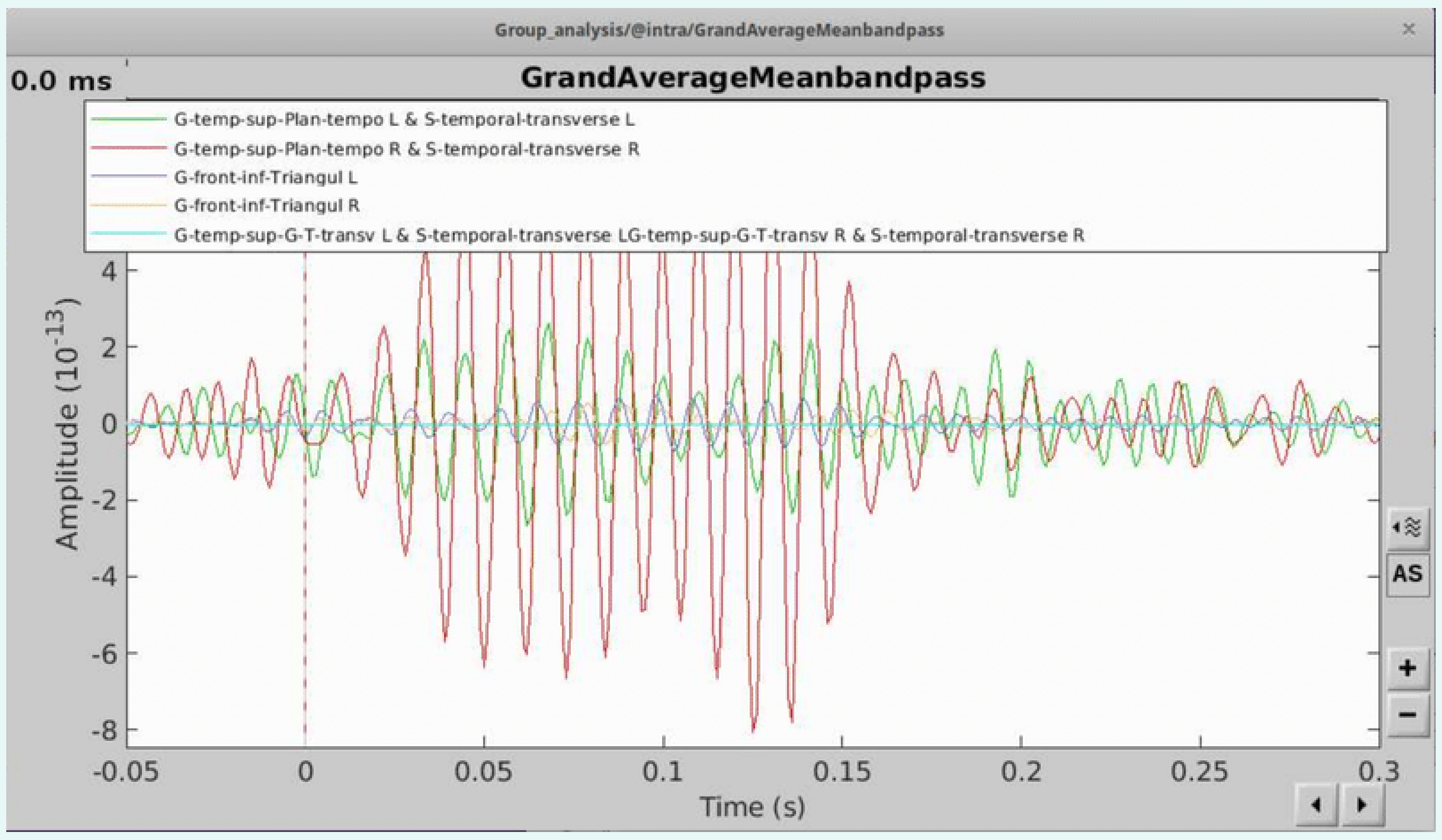
DATA EXTRACTION



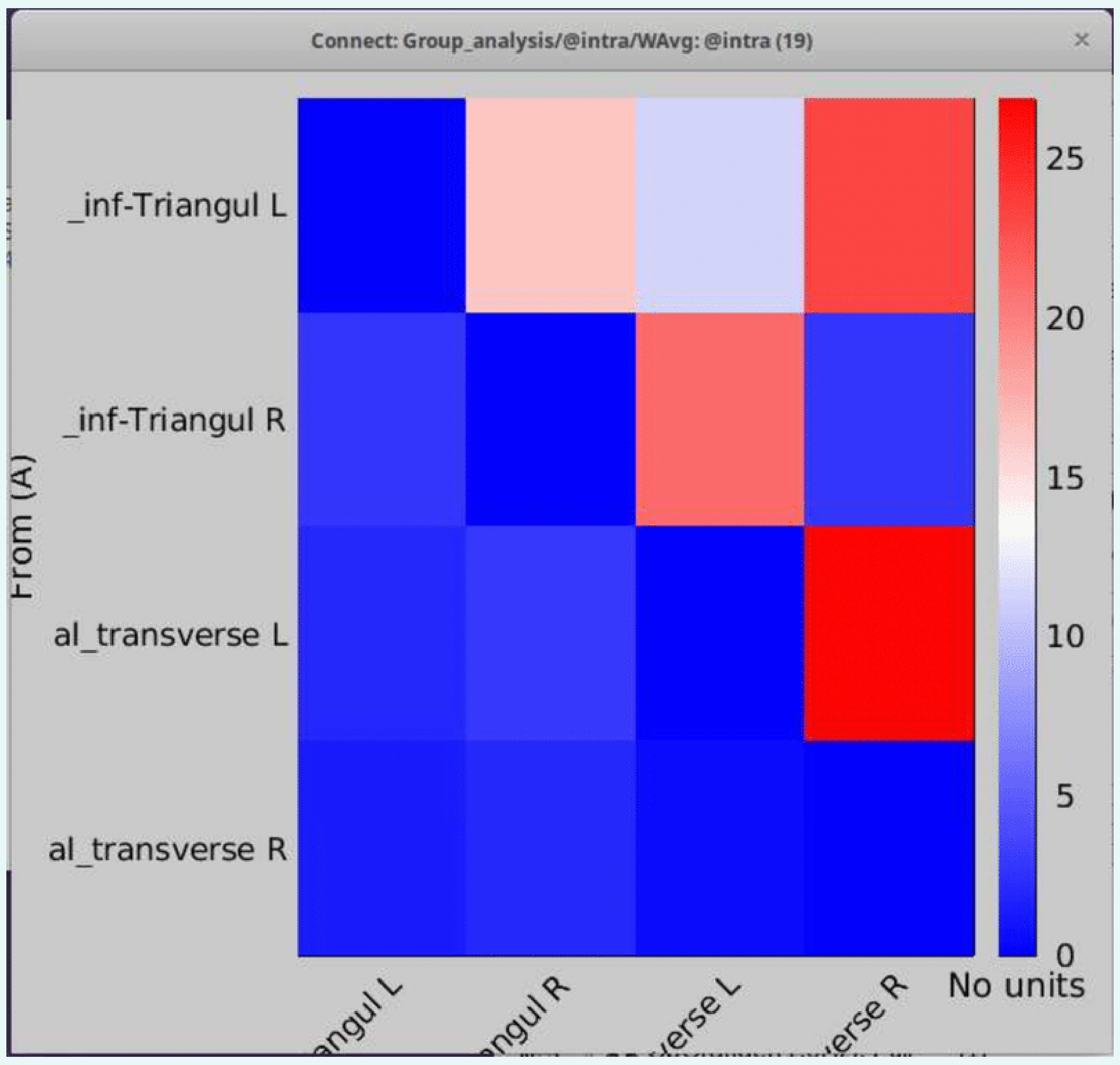




- We began by taking the cortical data of all our subjects and creating a grand average. We created a grand average using the mean, max and PCA to see which measure gives us the clearest (least noisy) signal - which was the mean! (shown below)



We then decided to carry out a functional connectivity Analysis using three different metrics to see where there is any causality between the IFG and AC regions. These metrics are used to quantify neural oscillations in the brain



RESULTS

The hypothesis that neuronal oscillations in general, and inter-areal synchronization of these oscillations in particular, are instrumental for normal brain function has resulted in widespread application of quantitative methods to evaluate neuronal synchrony in electrophysiological data.

The connectivity measure which gave us the most substantial results are Bivariate Granger Causality which indicated that there is some connectivity between the left IFG and the auditory cortex (shown on left) These are early results and are promising as it hints at the chance that there is some cortical activity going on in the frontal regions of our brain and that our auditory system might be more branched out than we may think!