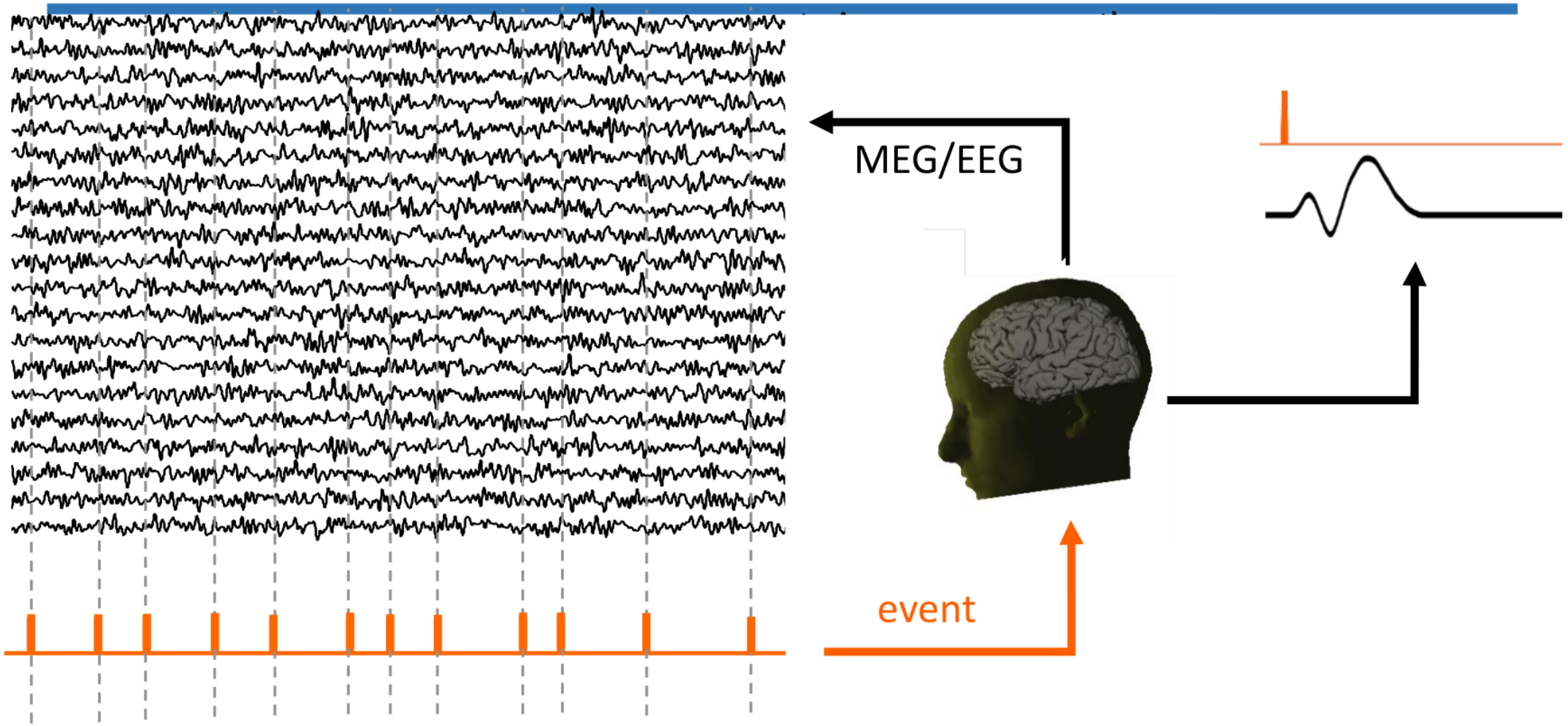
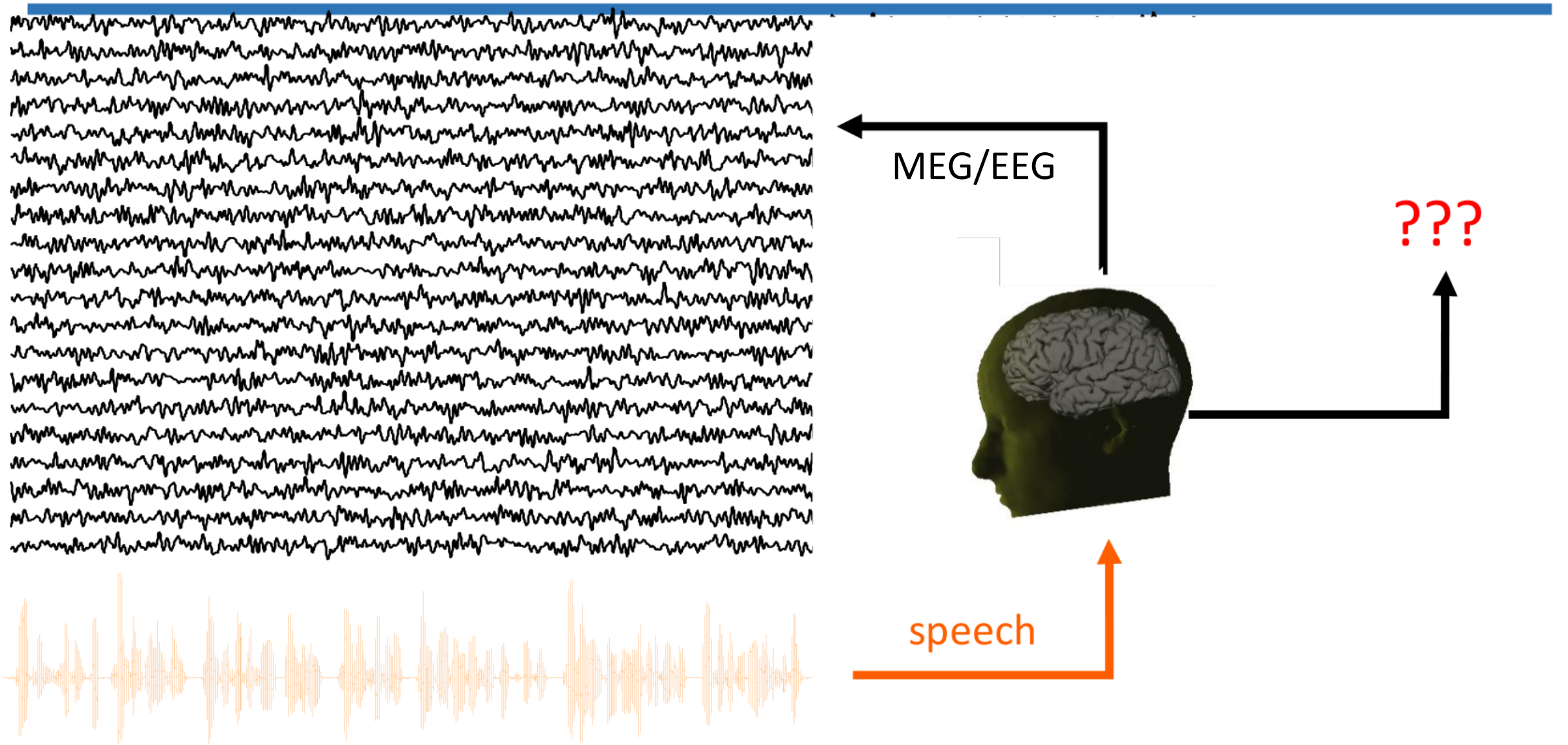
Background

Event-related potential/response

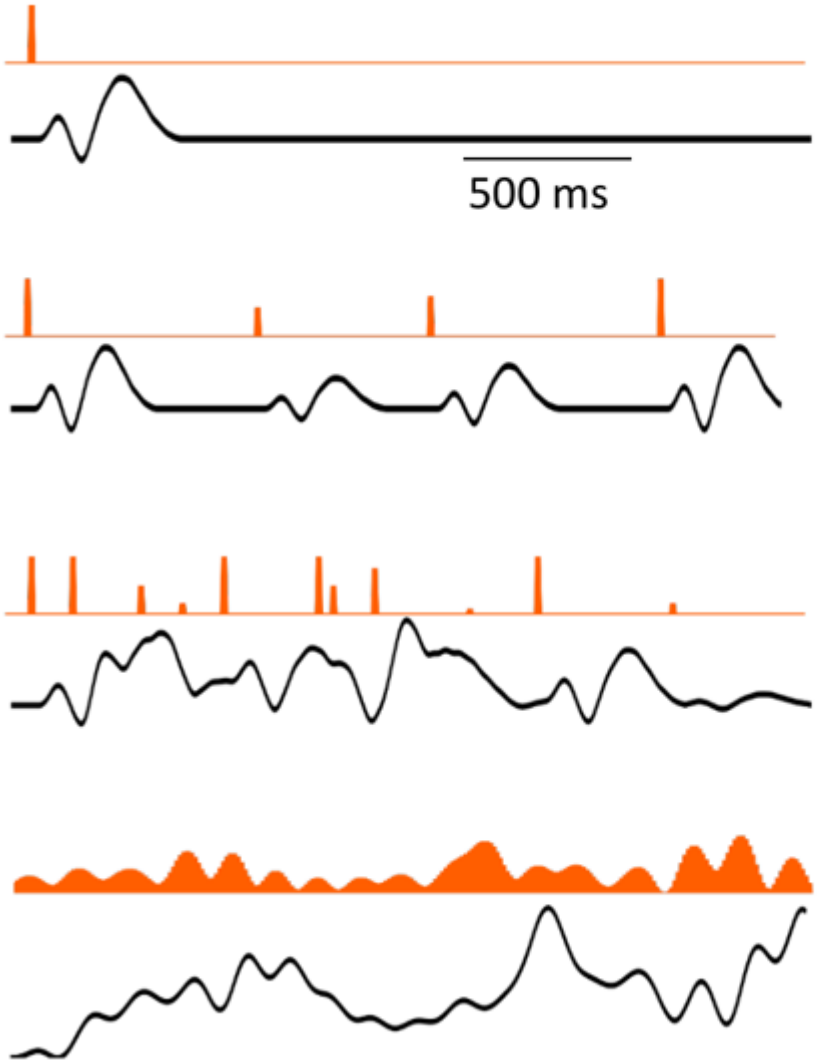


Background

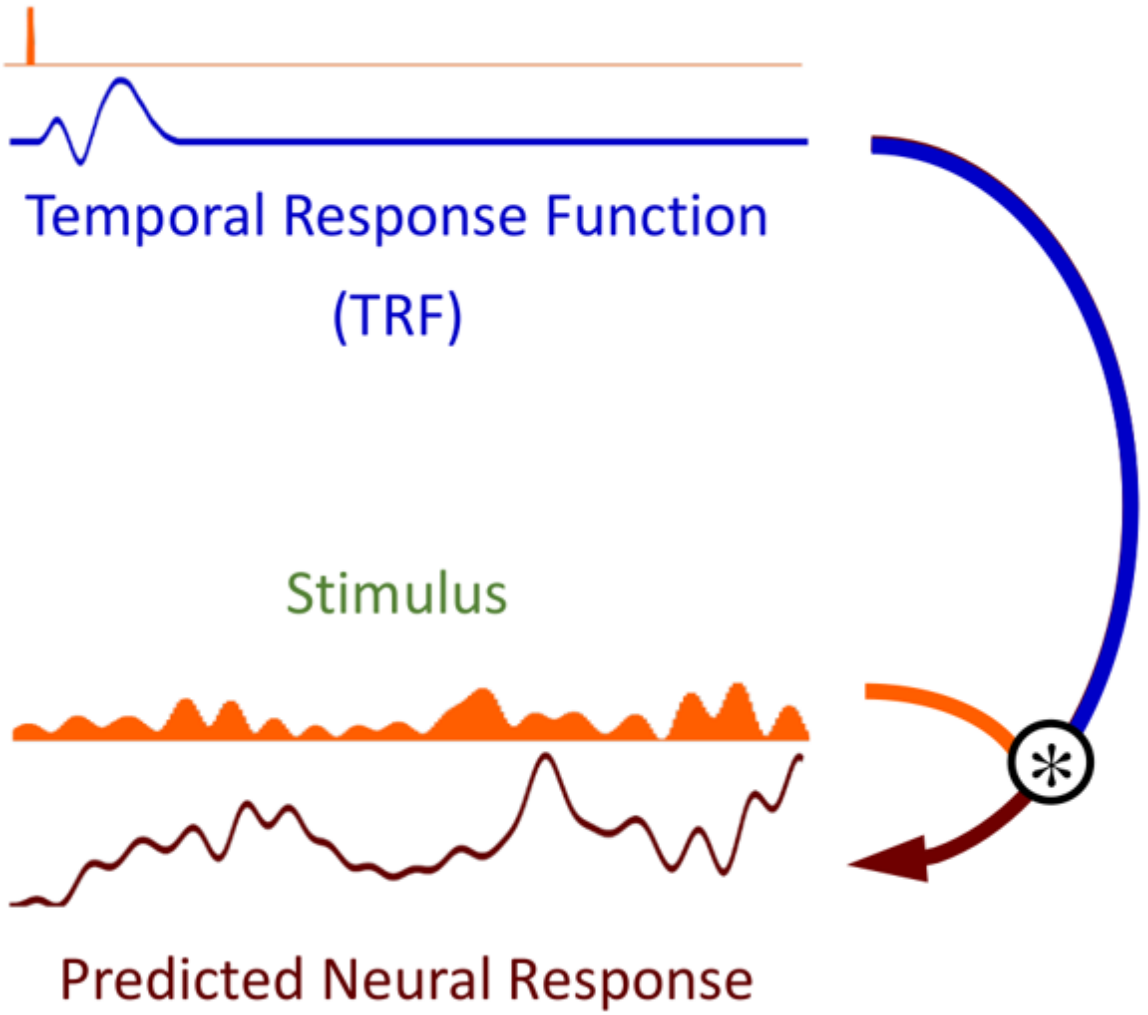
Temporal response function



Superposition of Neural Responses

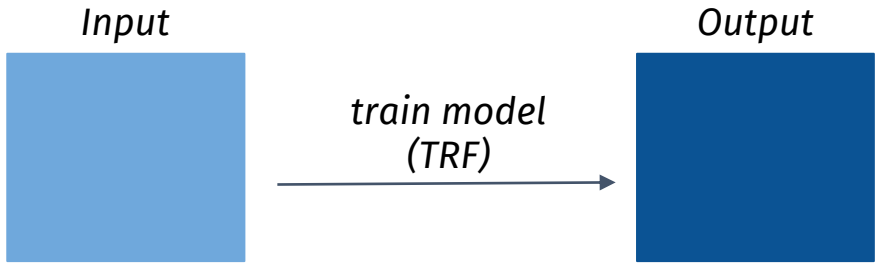


Inferring the impulse response to the stimuli



Temporal Response Functions (TRFs)

They are linear models/system identification techniques that describe a mapping from input to output
(for instance, speech -> some specific neural or physiological response).



Why this matters:

- Recovers a temporally resolved response to continuous/ongoing input.
- Handles diverse stimuli and experimental designs.
- Predicts continuous stimulus feature directly from EEG/MEG.

Lalor, Edmund C., et al. "Resolving precise temporal processing properties of the auditory system using continuous stimuli." *Journal of neurophysiology* (2009).

An overview of analysis pipeline

Dataset description:

- Subjects: 24 subjects (12 metal-haters ($liking \leq 3$); 12 metal-nonhaters ($liking > 3$))
- Preprocessing: [0.5 – 8 Hz] band-pass filtering -> down-sampling to 100 Hz

Prepare stimulus & EEG:

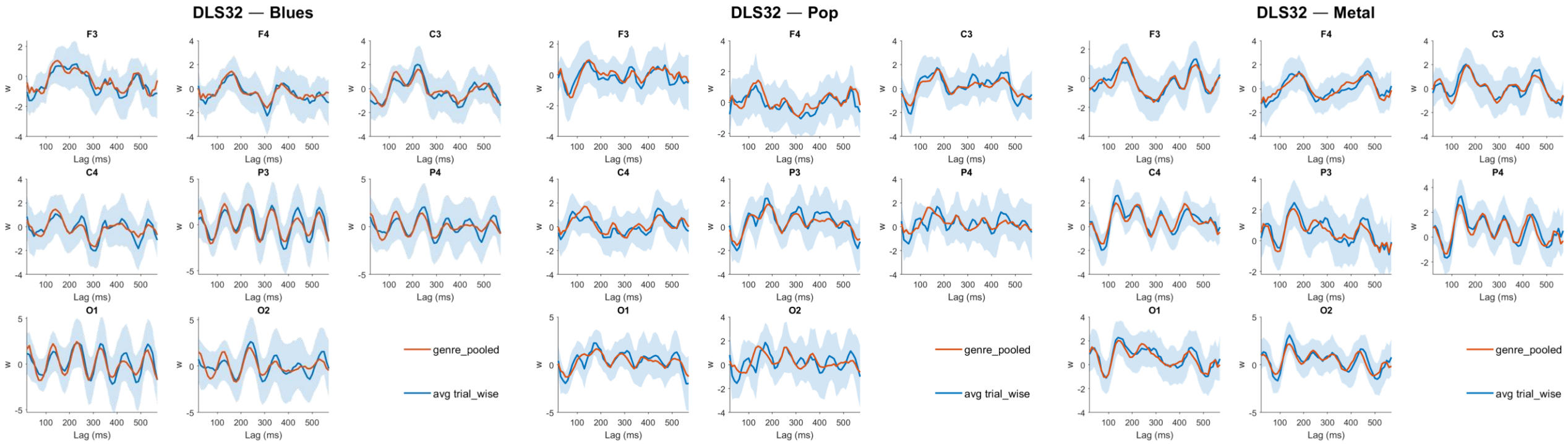
- Extract **audio envelope** (RMS with 10 ms window), **resample to EEG rate.**
- **Align** by compensating measured **audio → EEG delay ≈ 130 ms** (discard first 130ms of EEG within each epoch).
- 1) **trial-wise:** training TRF on each trial 2). **genre-pooled:** training TRF per genre to capture the general relationship between genre and brain responses.

Forward TRF (audio → EEG):

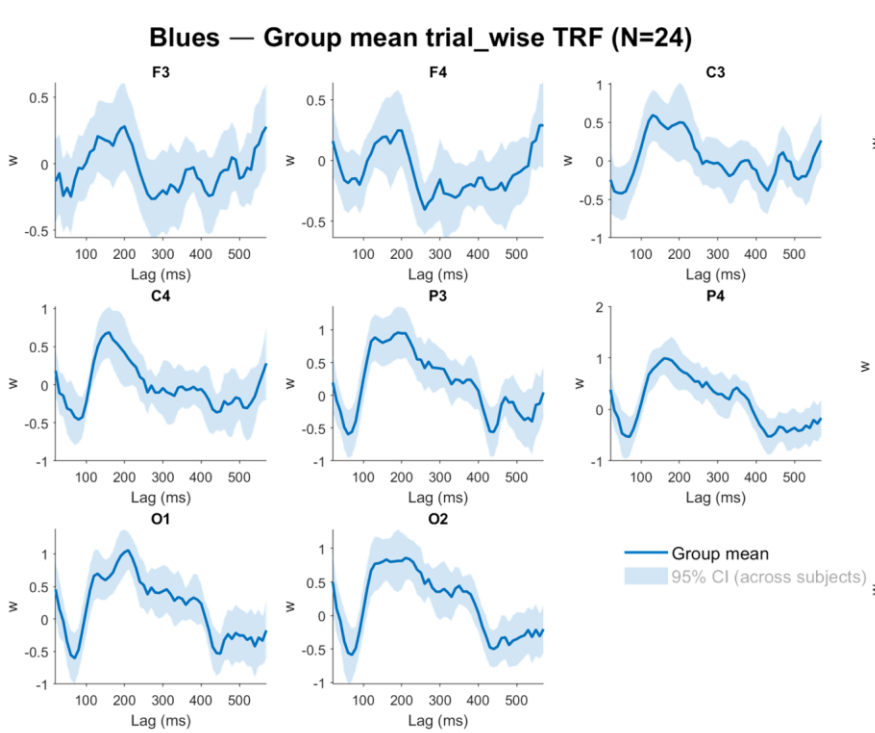
- **Parameter settings:** lag = $[0ms, 600ms]$, $\alpha = 10^{-1}$.

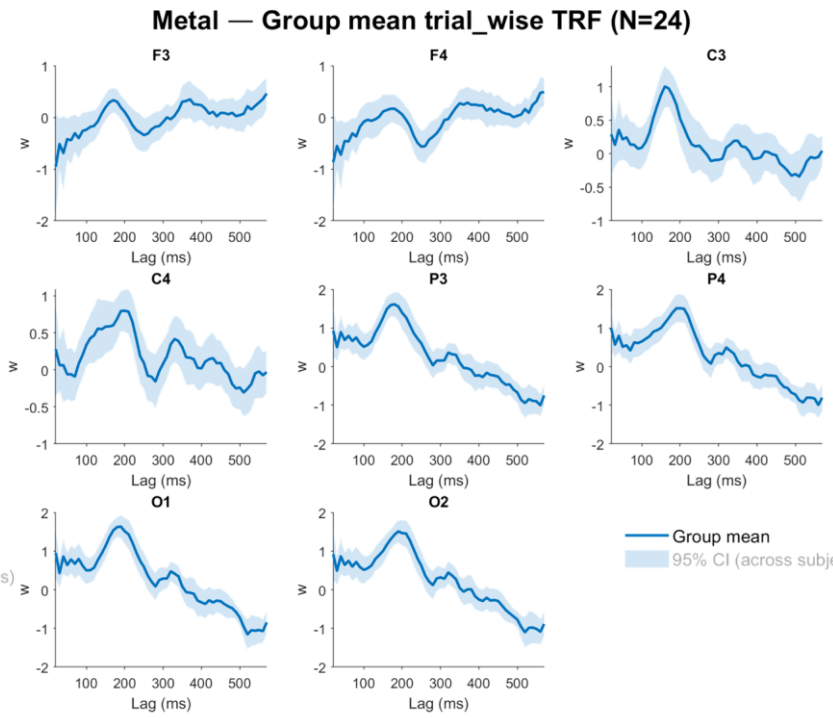
1. TRF kernel (*how does the impulse response look like?*)
2. Prediction (*how good the prediction is?*)
3. Statistics (*What do they reveal?*)

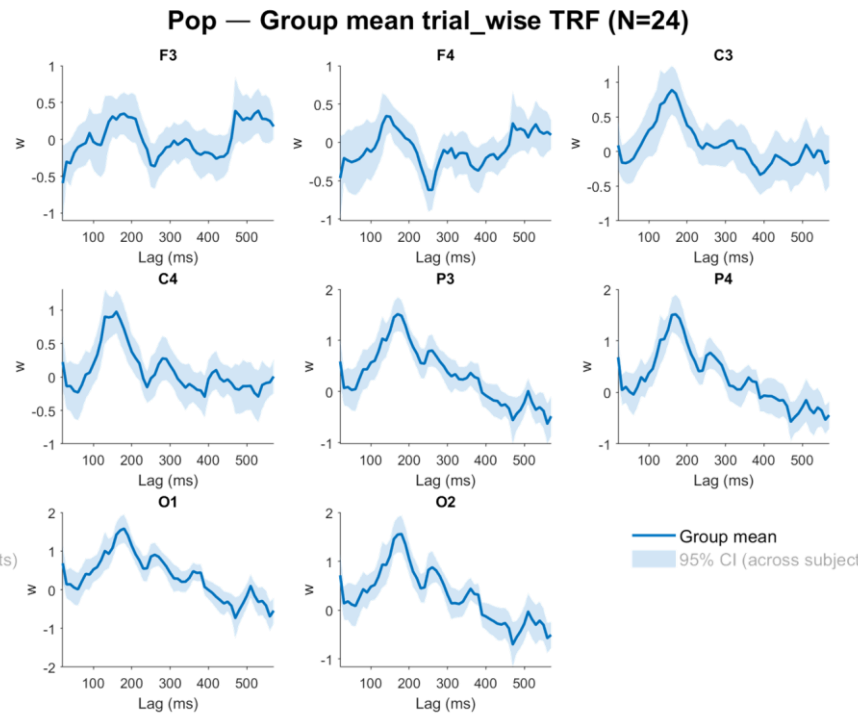
Single-subject TRF kernel



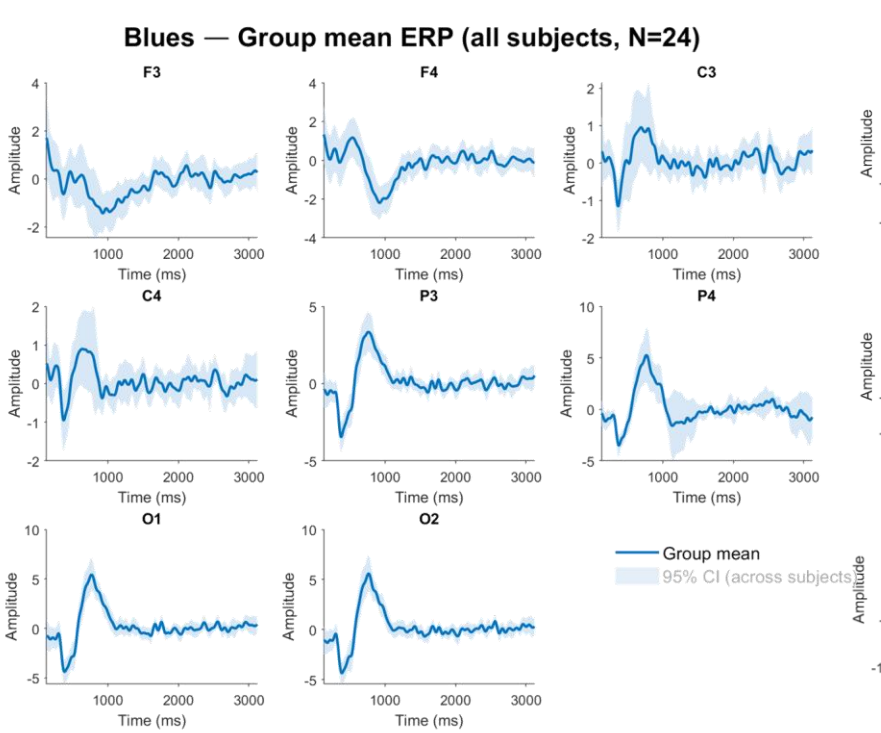
Group-level TRF kernel

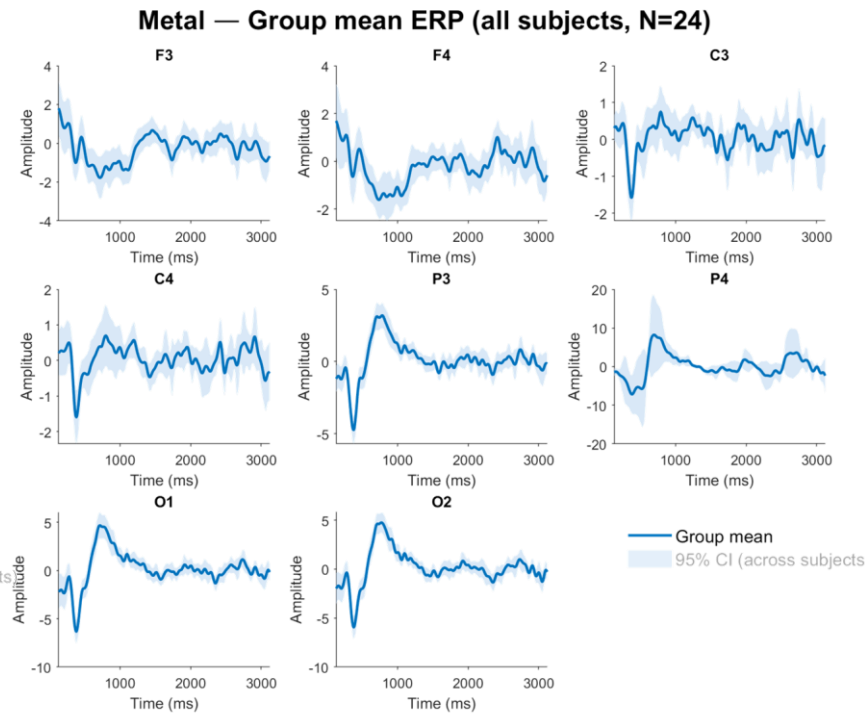


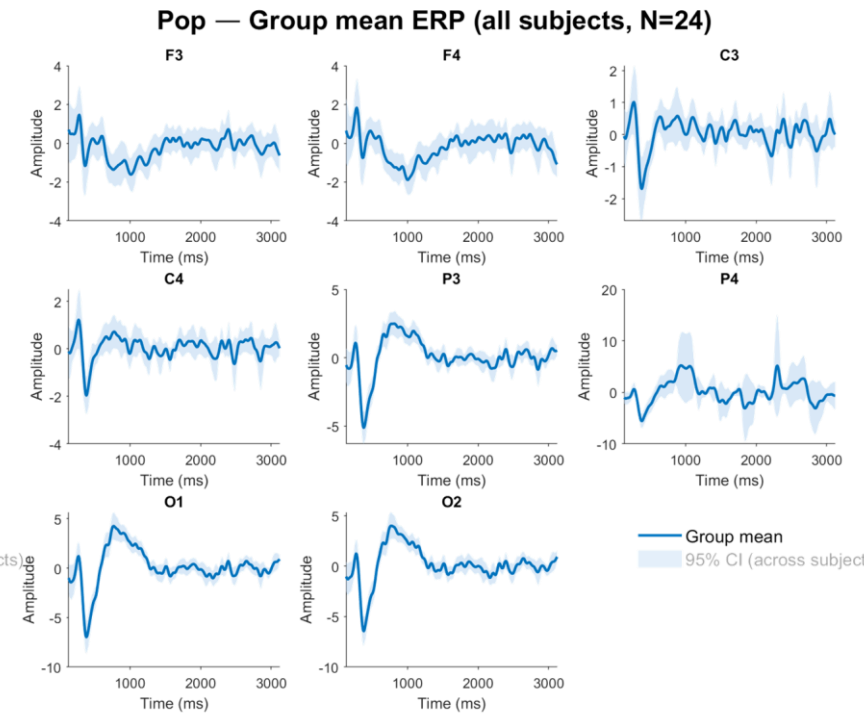




Group-level ERP waveform

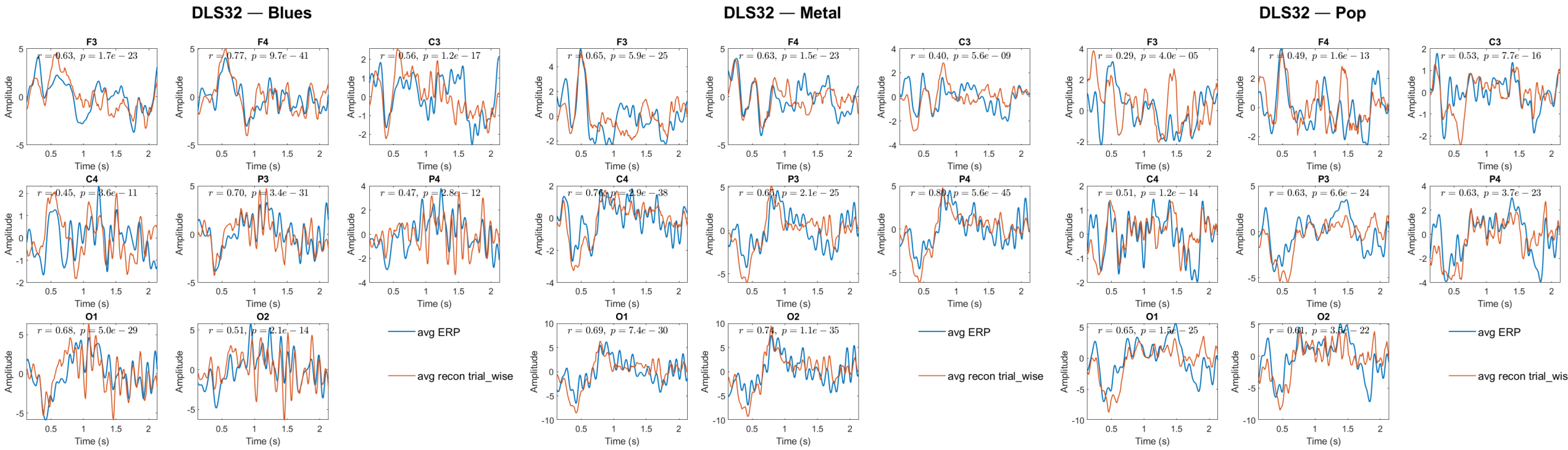






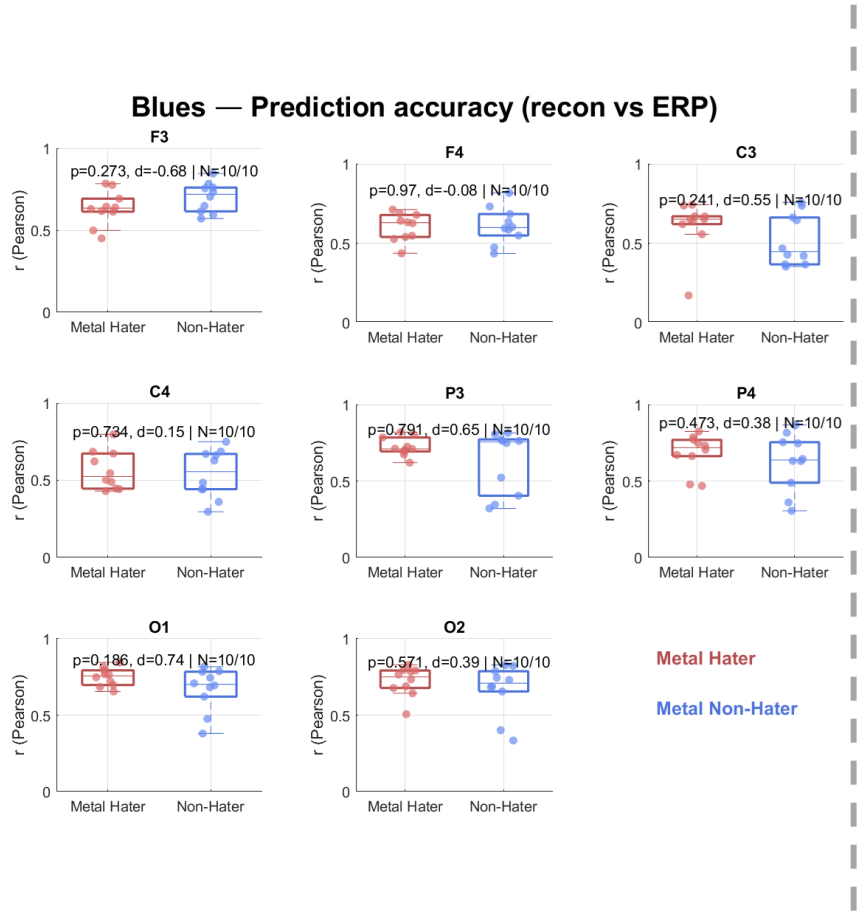
1. TRF kernel (how does the impulse response look like?)
2. Prediction (how good the prediction is?)
3. Statistics (*What do they reveal?*)

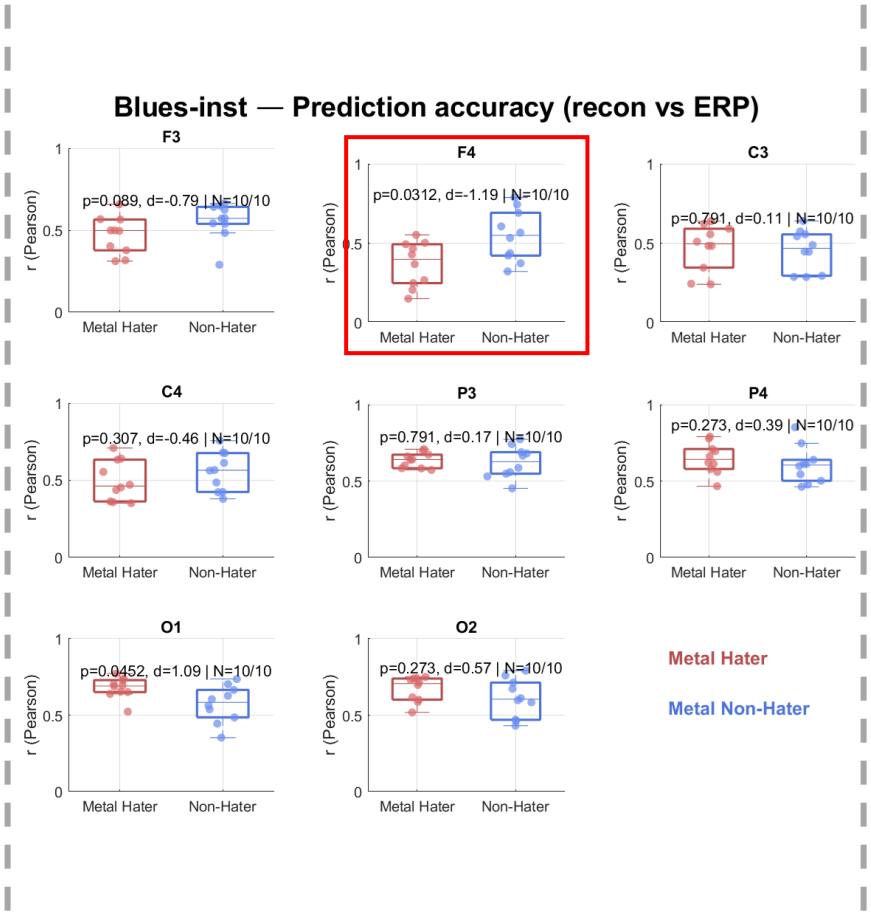
Single-subject reconstruction results

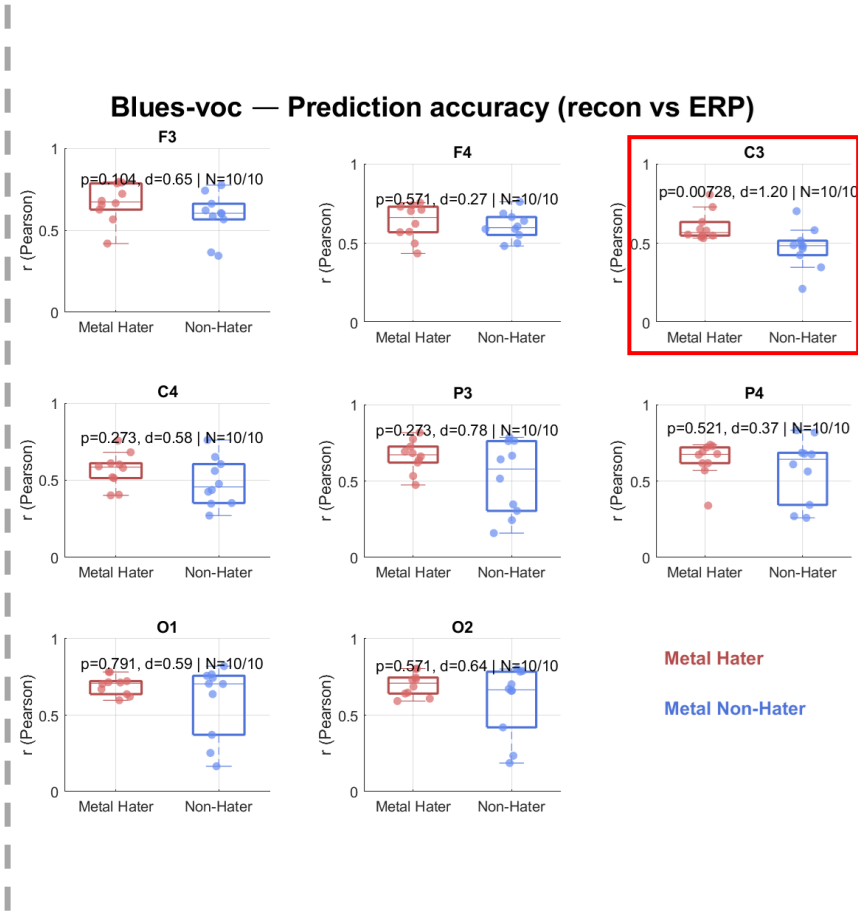


1. TRF kernel (how does the impulse response look like?)
2. Prediction (how good the prediction is?)
3. Statistics (What do they reveal?)
    - Do metal-hater and metal-nonhater track genres differently?
    - Is the tracking performance independent of acoustic property?

Comparing tracking performance of Blues between Metal hater and Metal non-hater



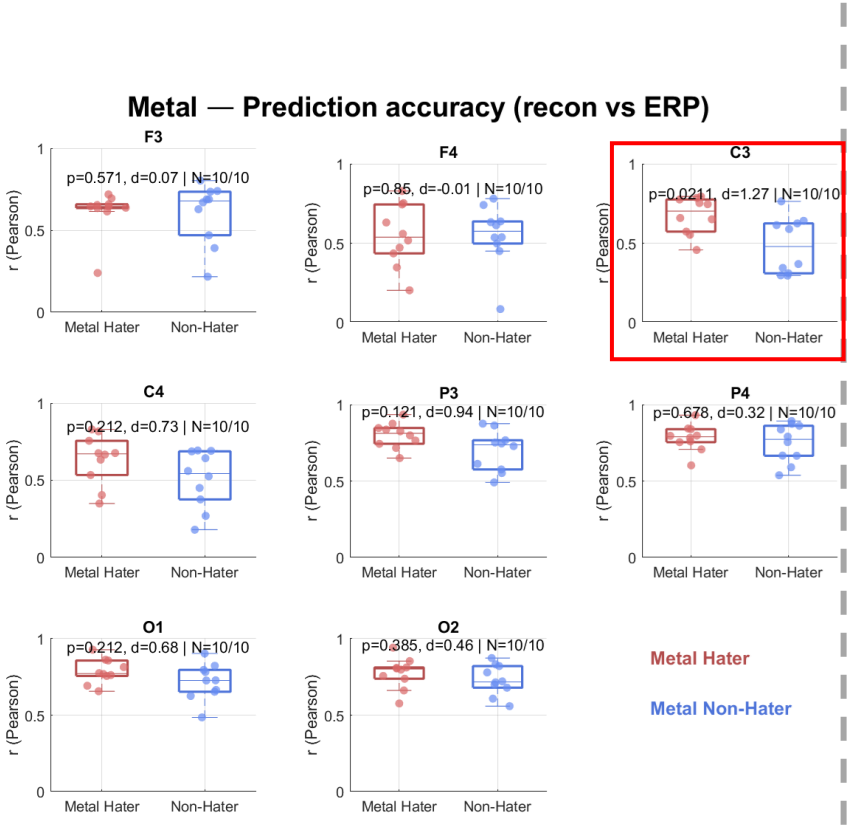


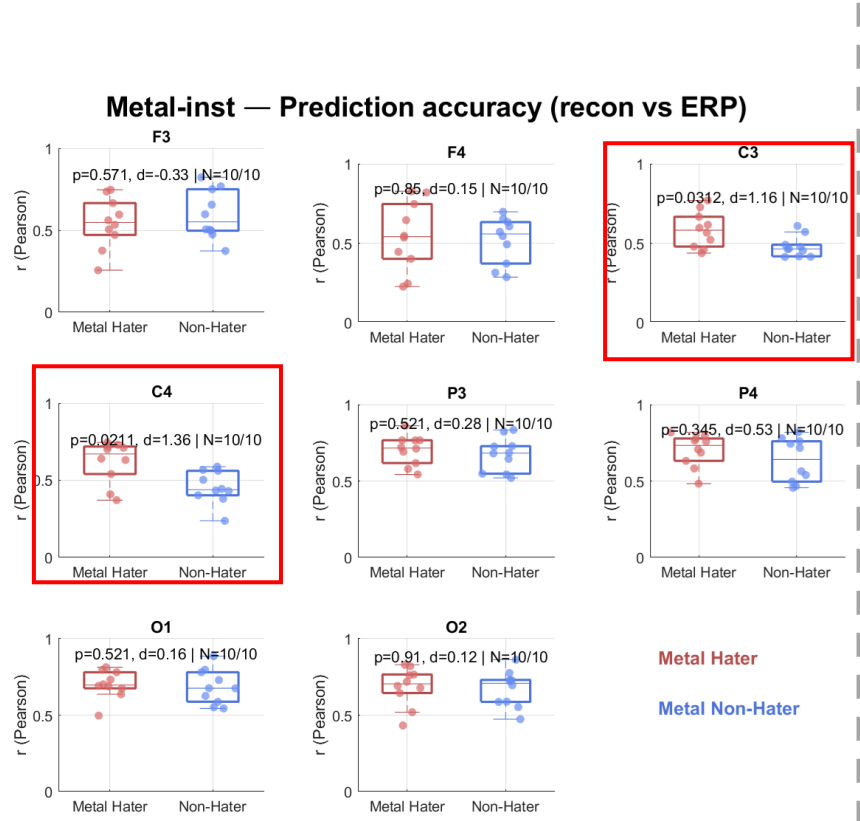


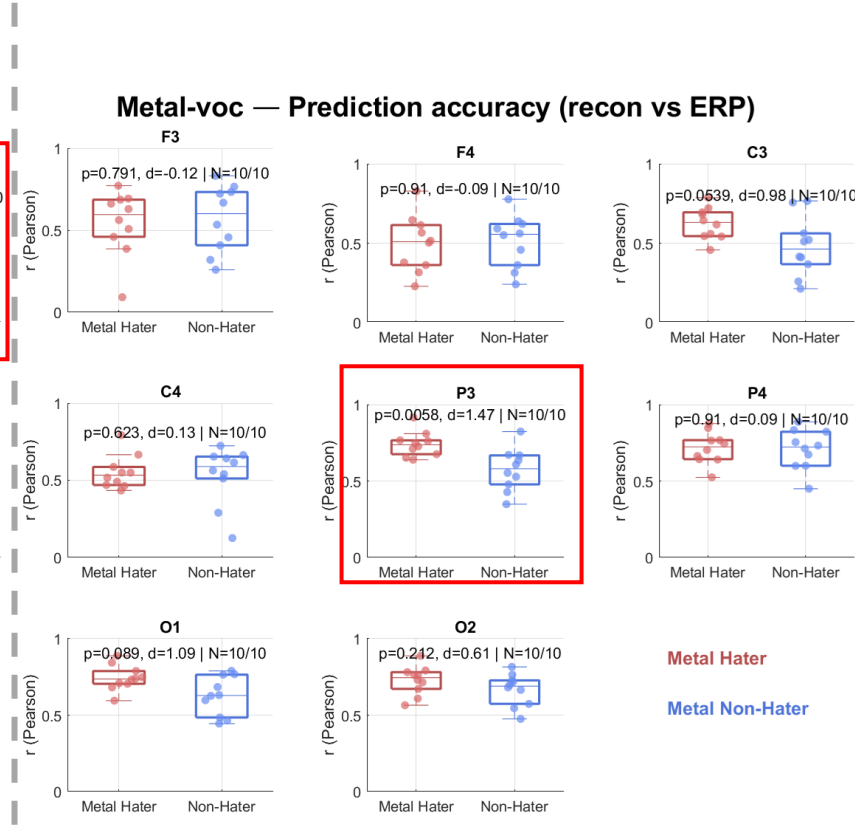
Metal non-hater shows significantly stronger tracking of Blues-inst at F4 channel.

Metal hater shows significantly stronger tracking of Blues-voc at C3 channel.

Comparing tracking performance of Metal between Metal hater and Metal non-hater

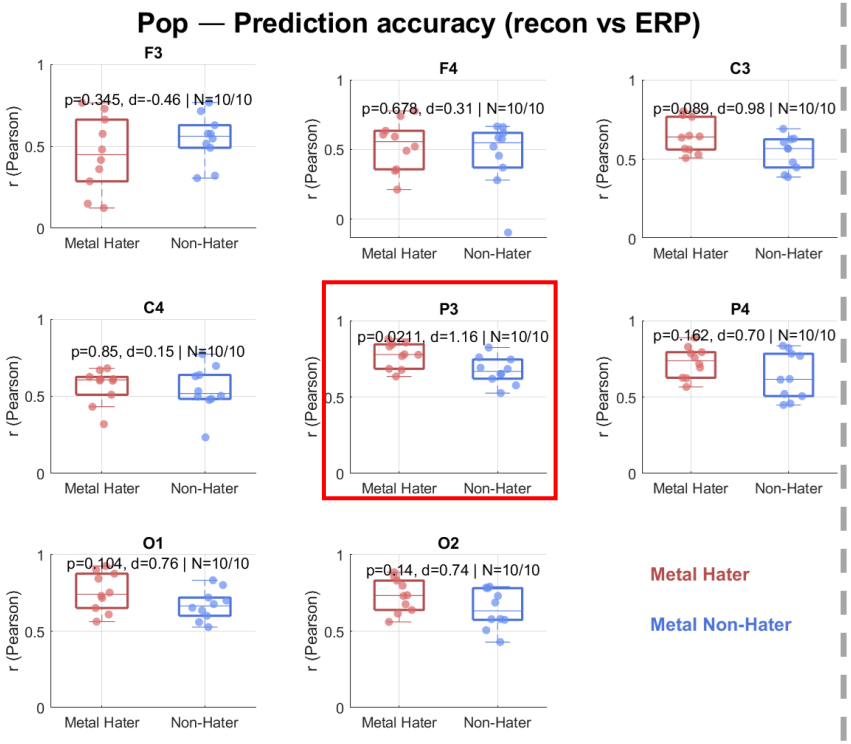


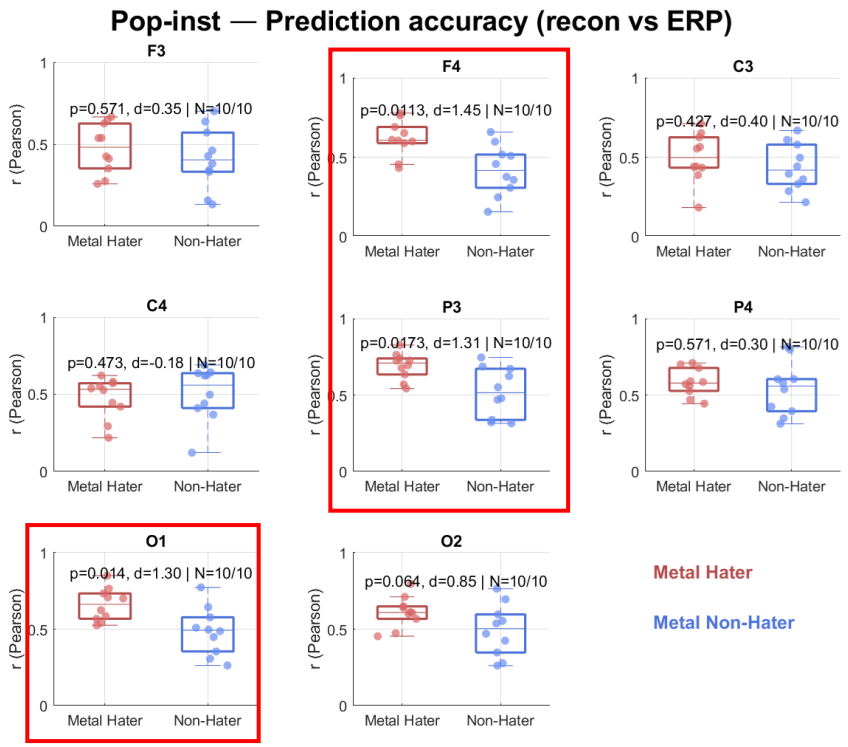


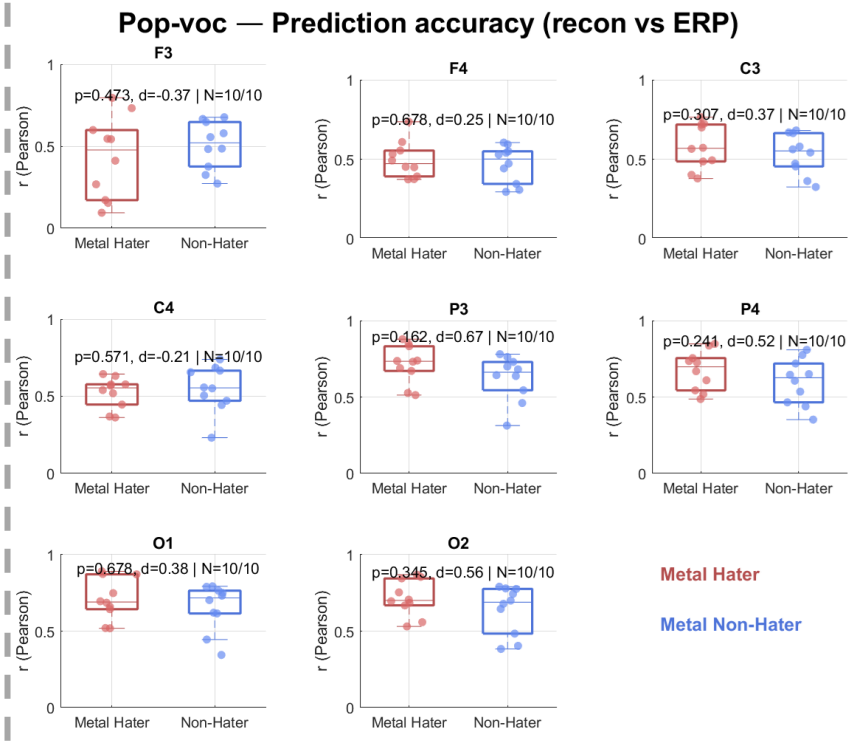


Metal hater shows significantly stronger tracking of Metal songs regardless the acoustic property (inst/voc).

Comparing tracking performance of Pop between Metal hater and Metal non-hater

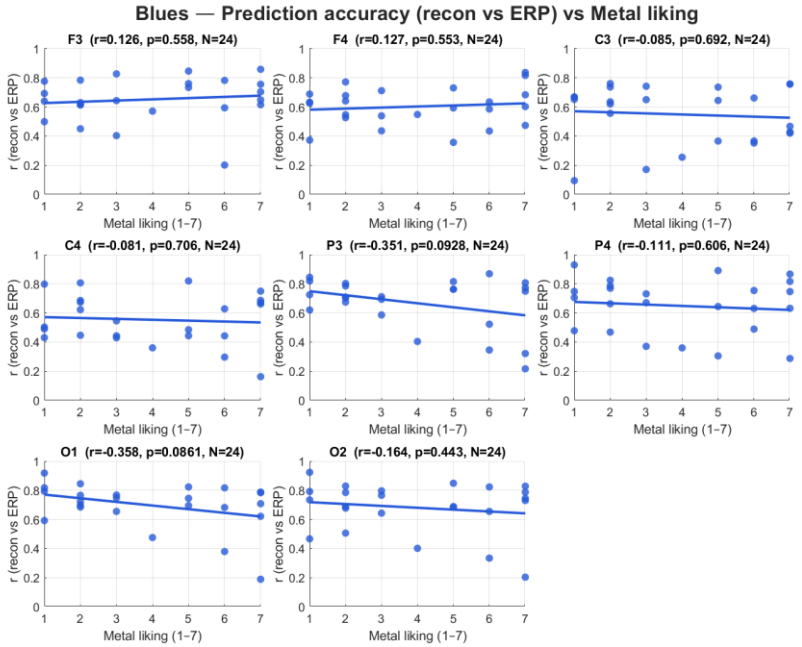


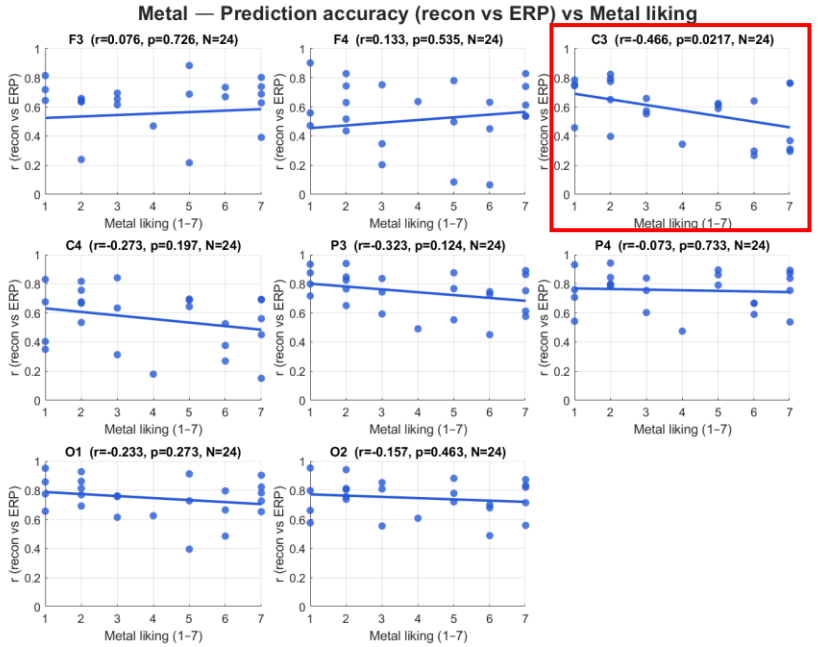


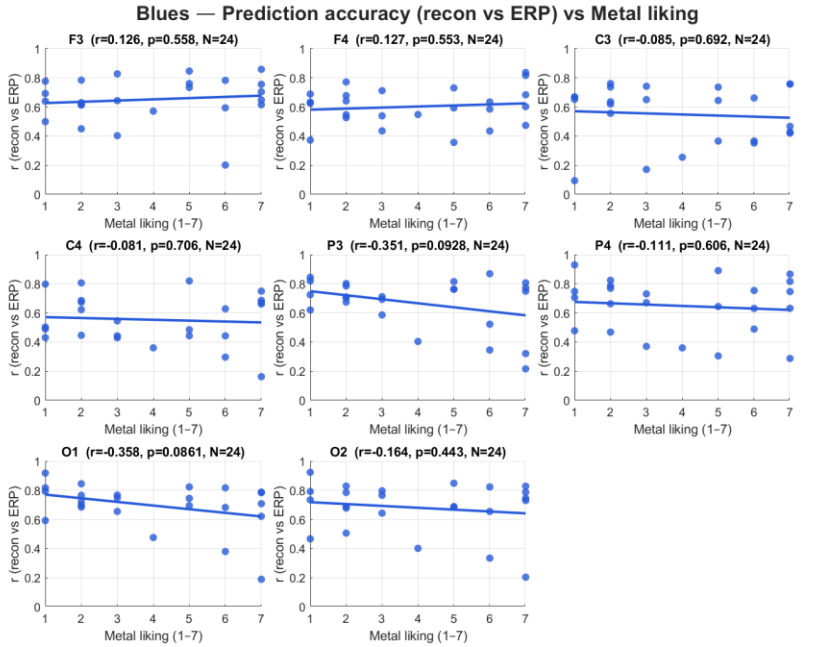


Metal hater shows significantly stronger tracking of Pop song, but only for the Pop-instrument condition

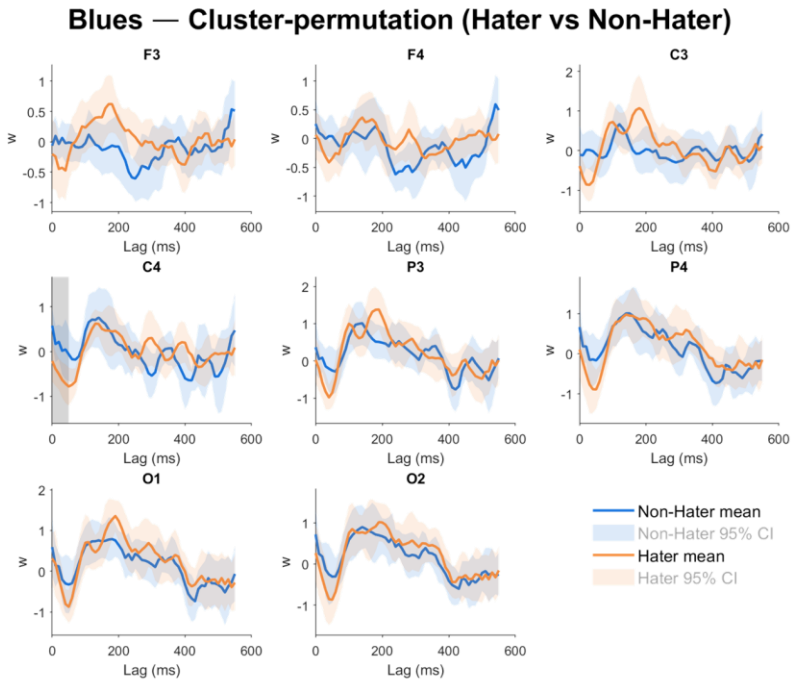
Correlation between prediction accuracy and the metal-liking scores

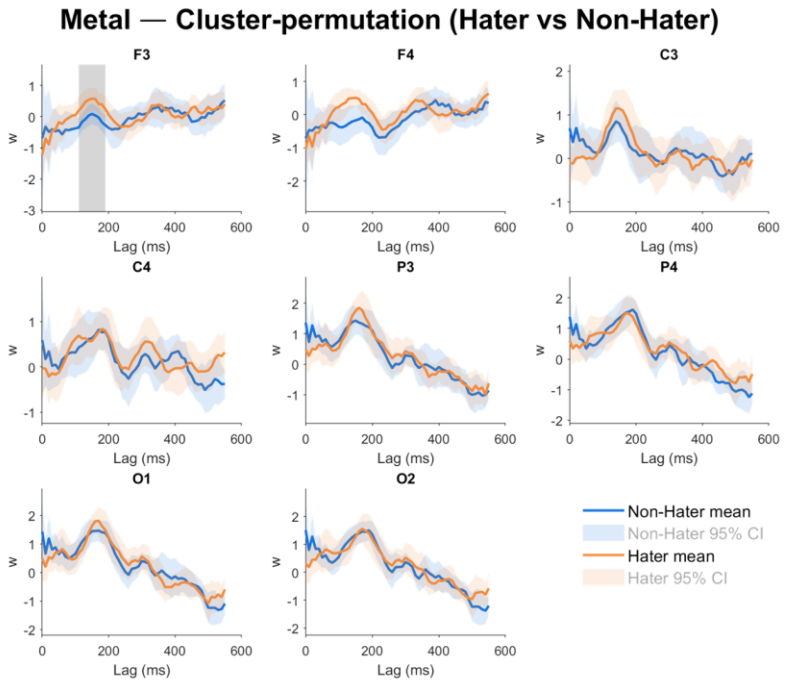


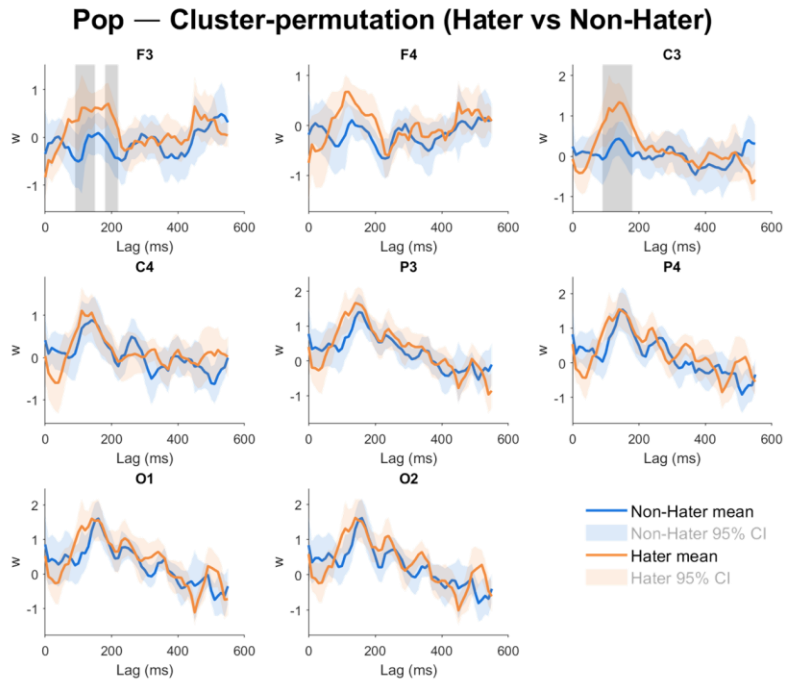




Comparing TRF kernel between Metal hater and Metal non-hater







Correlation between prediction accuracy and the pop-liking scores