

Deep Neural Network for Real-Time EEG Decoding of Musical Rhythm Imagery

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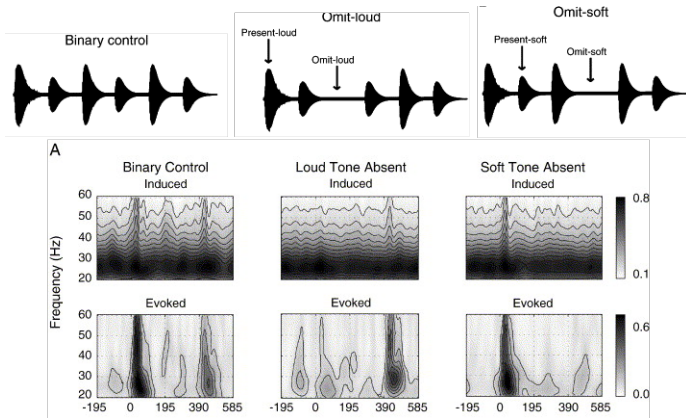
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Pulse and Meter as Neural Resonance

- ▶ Pulse: (aka beat) the repeating, periodic *pulsation* that we *perceive* through time when we listen to music
 - ▶ Tempo: the pulse's frequency over time
- ▶ Meter: The patterns of accentuation between pulses (i.e. march or waltz)
- ▶ Neural Resonance: Music can trigger rhythmic bursts of high-frequency neural activity, which may enable communication between auditory and motor cortices (Large & Snyder 2009)

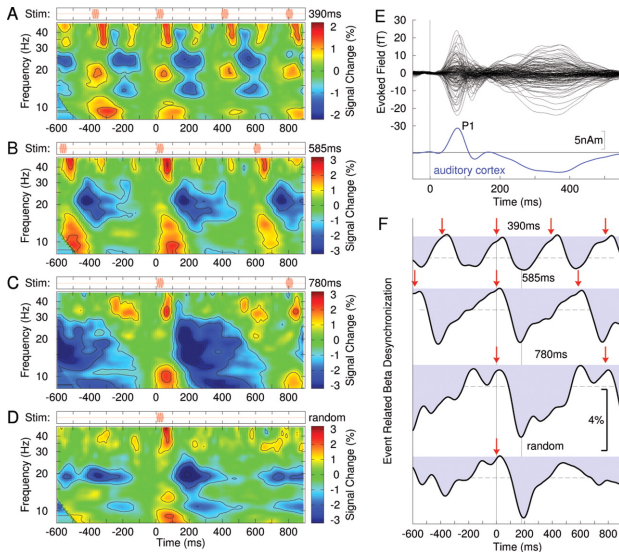
Early EEG Evidence for Neural Resonance

Induced and evoked oscillatory activity reflect the processing and expectation of periodic stimuli



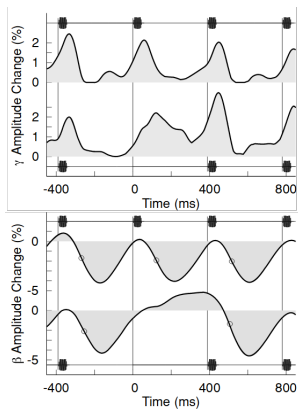
Snyder & Large 2005

Pulse timing is reflected in beta- and gamma-bands



Fujioka et al. 2009

Pulse timing is reflected in beta- and gamma-bands

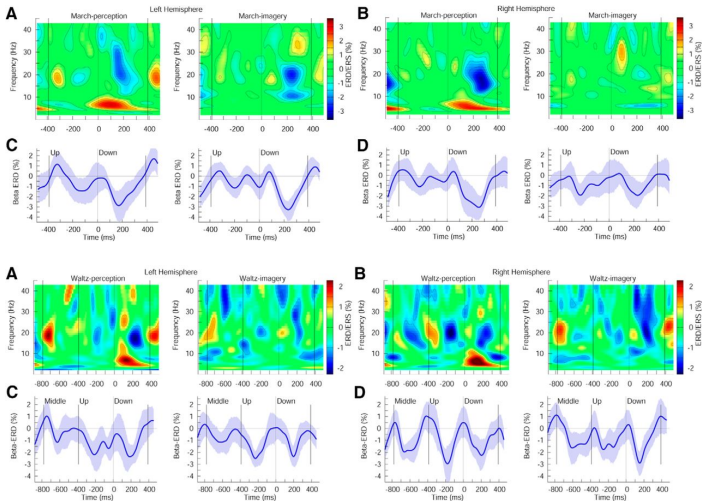


Fujioka et al. 2012

This kind of analysis involves the averaging of hundreds of trials

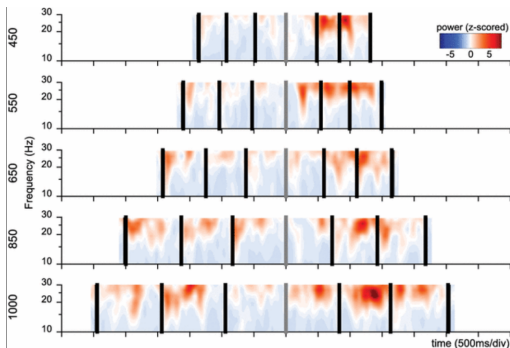
Imagined meters are also reflected in the beta-band

Imagination of different meters (i.e. binary march vs ternary waltz) results in different beta-band patterns



Primate oscillations reflect the metronome tempo

Dorsal putamen LFPs of macaques in a metronome tapping task



Merchant & Bartolo 2017

Bottomline: gamma reflects stimulus processing, while beta reflects the entrainment of large basal ganglia networks during internally driven pulse tapping

Research question and hypothesis

- ▶ Pulse, tempo and meter can be observed in the neural correlates measured with EEG and MEG.
- ▶ To maximize the SNR, these observations require the analysis of hundreds of trials.
- ▶ **Research Question:** could these features be identified in single trials? and if so, can we decode from human brain data, in real-time, perceived and imagined musical features like pulse, tempo and meter?
- ▶ **Hypothesis:** Deep neural networks, like CNNs, can learn to identify these musical features on a single-trial level.