Measuring Physiological Nociceptive and Tactile Steady-state Evoked Potentials

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Introduction

One in five adults suffer from chronic pain, which is the result of disturbed processes in the central nervous system.

- Early detection enables better treatments and less clinical efforts.
- Disturbances are being studied using nociceptive detection thresholds (NDTs) and evoked potentials (NEPs).

Steady-state evoked potentials are less susceptible to artifacts, and have a broader range of applications.

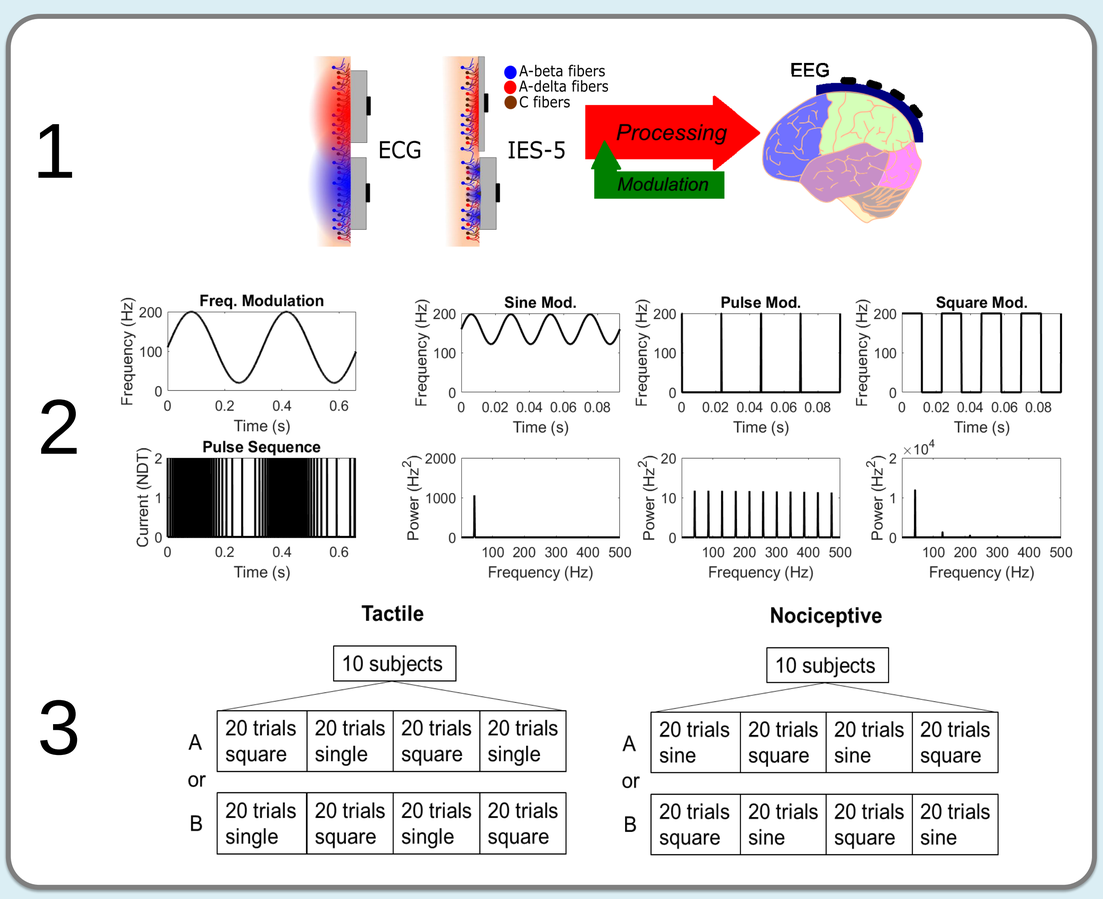
- Easily quantified and reproduced (Regan, 1982).
- Can reveal sensory integration (Colon et al., 2014).
- Harmonics and inter-modulation frequencies are useful for system identification (Yang et al., 2017).

Can we reliably elicit and measure nociceptive and tactile steady-state evoked potentials?

Method

Experiment

1. EEG in response to **electric stimulus sequences** via ECG (tactile) and IES5 (nociceptive) electrodes..
1. Frequency modulation using sine, pulse or square waves.
2. Sequences are applied in blocks to the subjects.



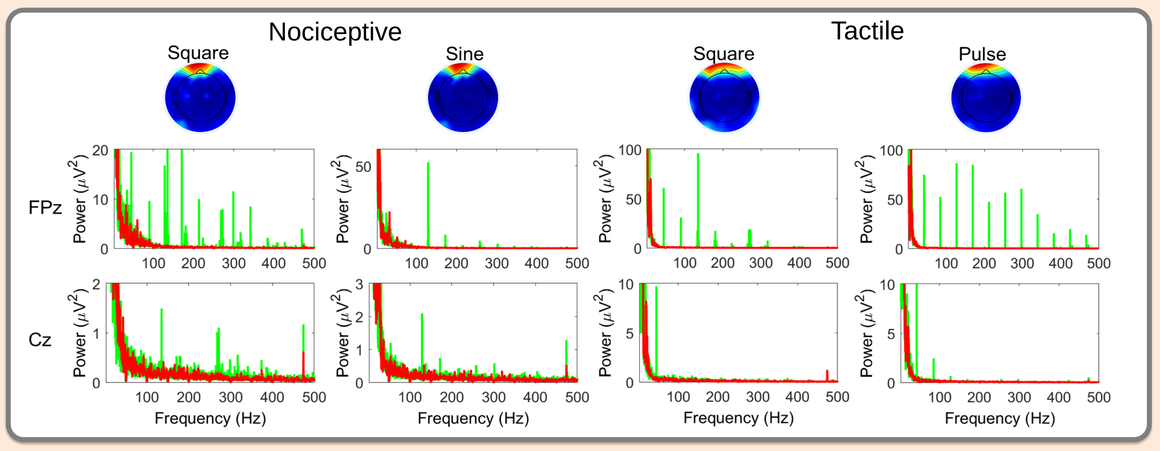
Analysis

1. Import continuous data
2. High-pass filter at 2 Hz
3. Notch filter at 50 Hz and harmonics
4. Data cleaning using ASR
5. Data re-referencing
6. Epoch from -2s to 10s for all sequence types
7. ICA using AMICA
8. Dipole fit
9. Separate epochs based on sequence type

First Results

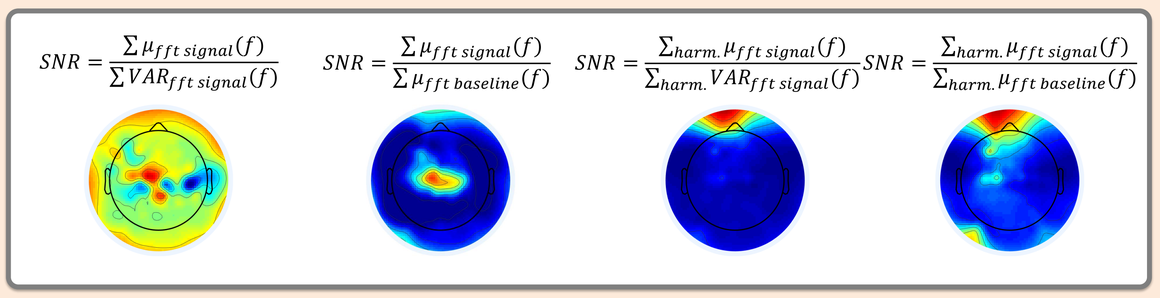
Stimulation frequency and/or harmonics present in EEG.

- Frontal distribution of power in harmonic frequencies.
- Harmonics decrease non-linearly over scalp.
- Harmonics up to 500 Hz.



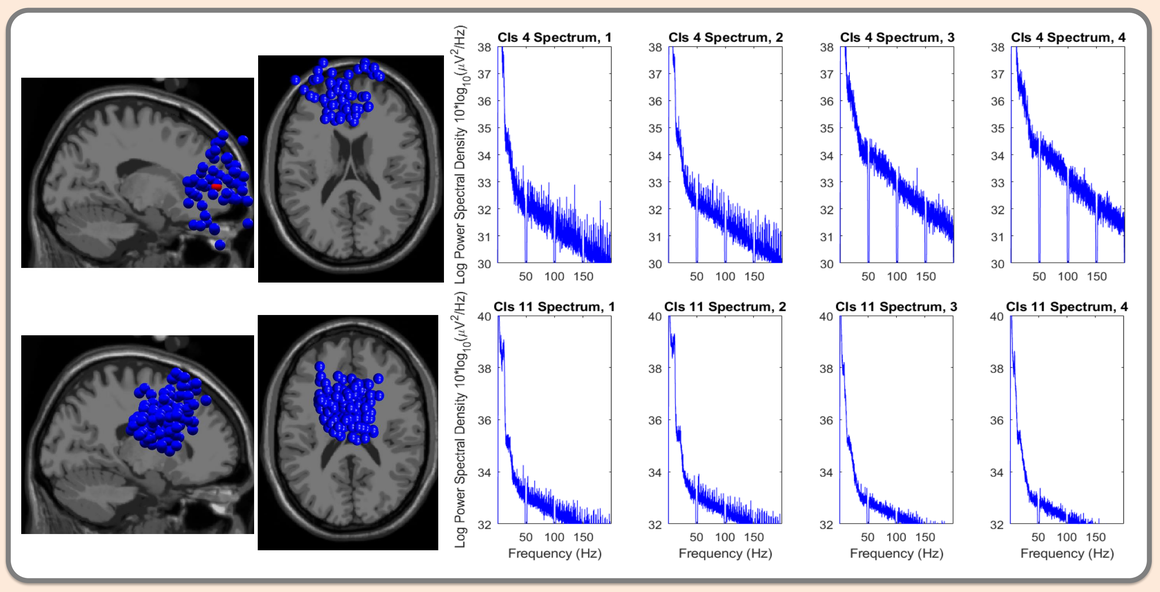
SNR distribution dependent on SNR equation.

- SNR over entire spectrum shows a central distribution.
- SNR over harmonic frequencies shows central distribution.



Clustering shows some component clusters with harmonics.

- Physiological location and spectrum.



Discussion

Stimulation Artefacts

- Visibly present in some subjects.
- How to distinguish between stimulus artefacts and physiological components?

Independent Component Selection

- Various possible measures of SNR.
- Components not selected consistently among subjects.
- How to reliably select physiological components?

Optimal Stimulus Sequence for SI

- Sine FM: Only 3rd harmonic and higher in response.
- Pulse FM: Power distributed over harmonics.
- Square FM: Power distributed over harmonics with preference for 3rd.

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