



## Somatosensory Gating for an SSSEP-based BCI

Jimmy Petit, José Rouillard, François Cabestaing

### ► To cite this version:

Jimmy Petit, José Rouillard, François Cabestaing. Somatosensory Gating for an SSSEP-based BCI. CORTICO 2022: Invasive and non invasive Brain-Computer Interfaces - A handshake over the cliff, Mar 2022, Autrans, France. hal-03651273

HAL Id: hal-03651273

<https://hal.science/hal-03651273v1>

Submitted on 25 Apr 2022

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

# Somatosensory Gating for an SSSEP-based BCI

Jimmy Petit<sup>1</sup>, José Rouillard<sup>1</sup> & François Cabestaing<sup>1</sup>

1. Univ. Lille, CNRS, Centrale Lille, UMR 9189 CRISTAL, F-59000 Lille, France

I

## What are SSSEP?

A sustained vibrotactile stimulus of the skin produces resonance-like evoked potentials named Steady-State Somatosensory-Evoked Potentials or SSSEP. They appear as an increase of activity at the frequency of stimulation.

II

## What is Sensory Gating?<sup>1</sup>

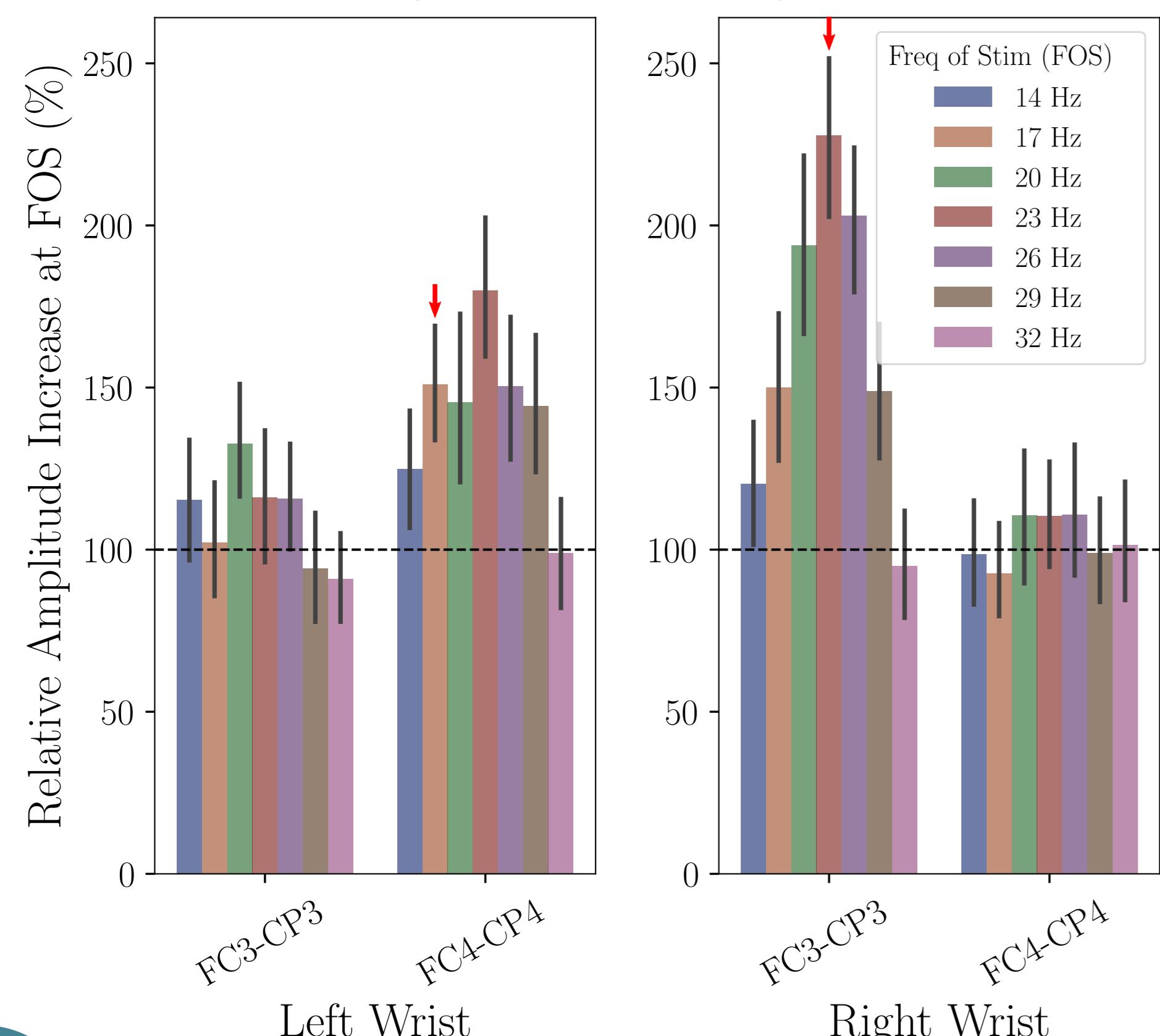
Sensory gating, or gating, is the capacity of the brain to filter out stimuli perceived as irrelevant during a goal-oriented activity.

IV

## Mandatory step: Screening procedure<sup>2,3</sup>

- Objective: Identify the stimulation frequency with the highest SSSEP.
- How: Train of stimulations of 2 s, at different frequencies: from 14 to 32 Hz.
- Amplitude estimation: fast Fourier Transform.

### Screening results (subject #10)



III

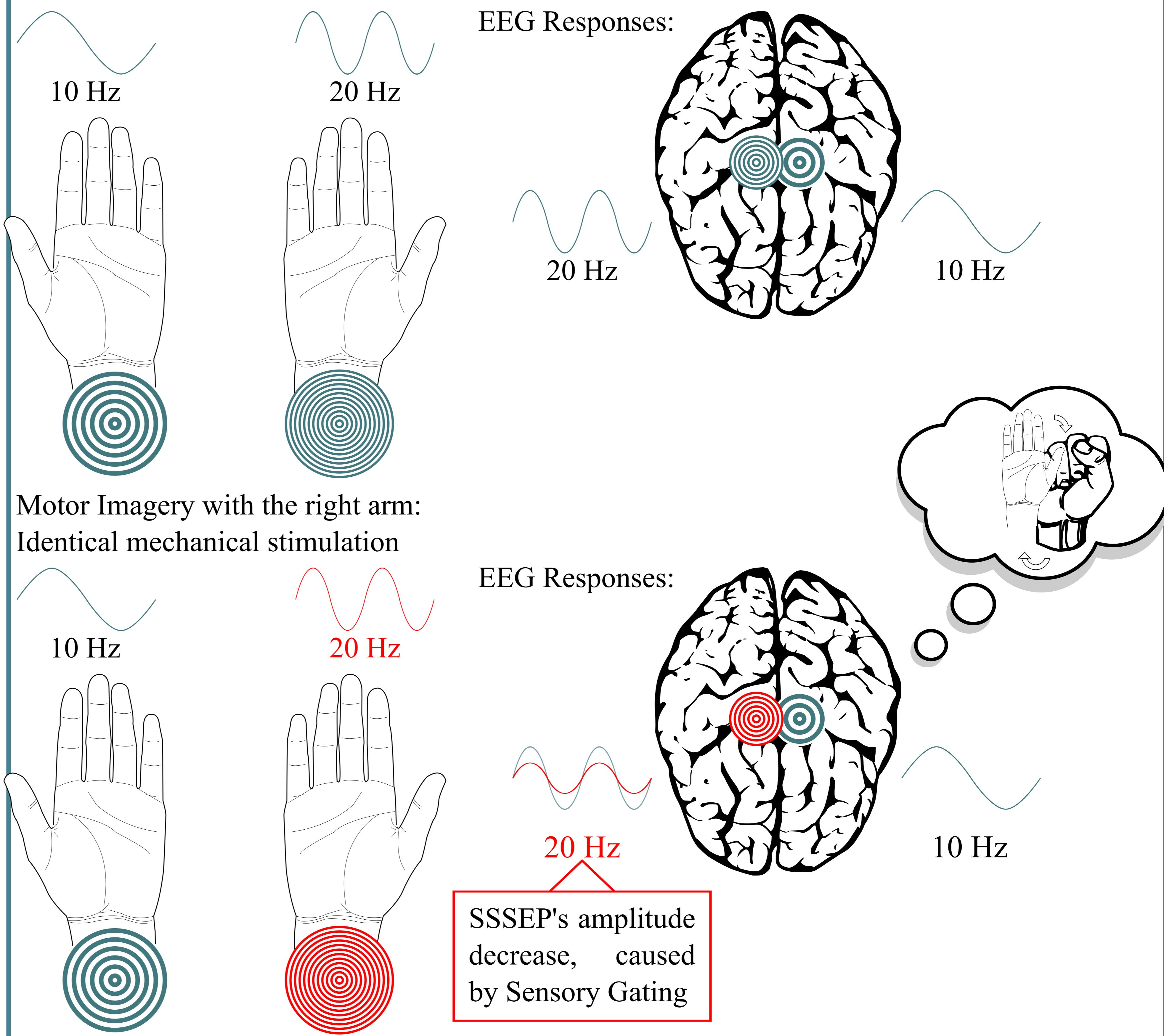
## Idea of an SSSEP-based BCI exploiting Somatosensory Gating

- Performing Motor Imagery (MI) with one or two arms.
- Sustained vibrotactile stimuli on both wrists produce two SSSEP.
- The Gating resulting from the MI should decrease the amplitude of the respective SSSEP.
- The amplitude of the two SSSEP are used as classification features.

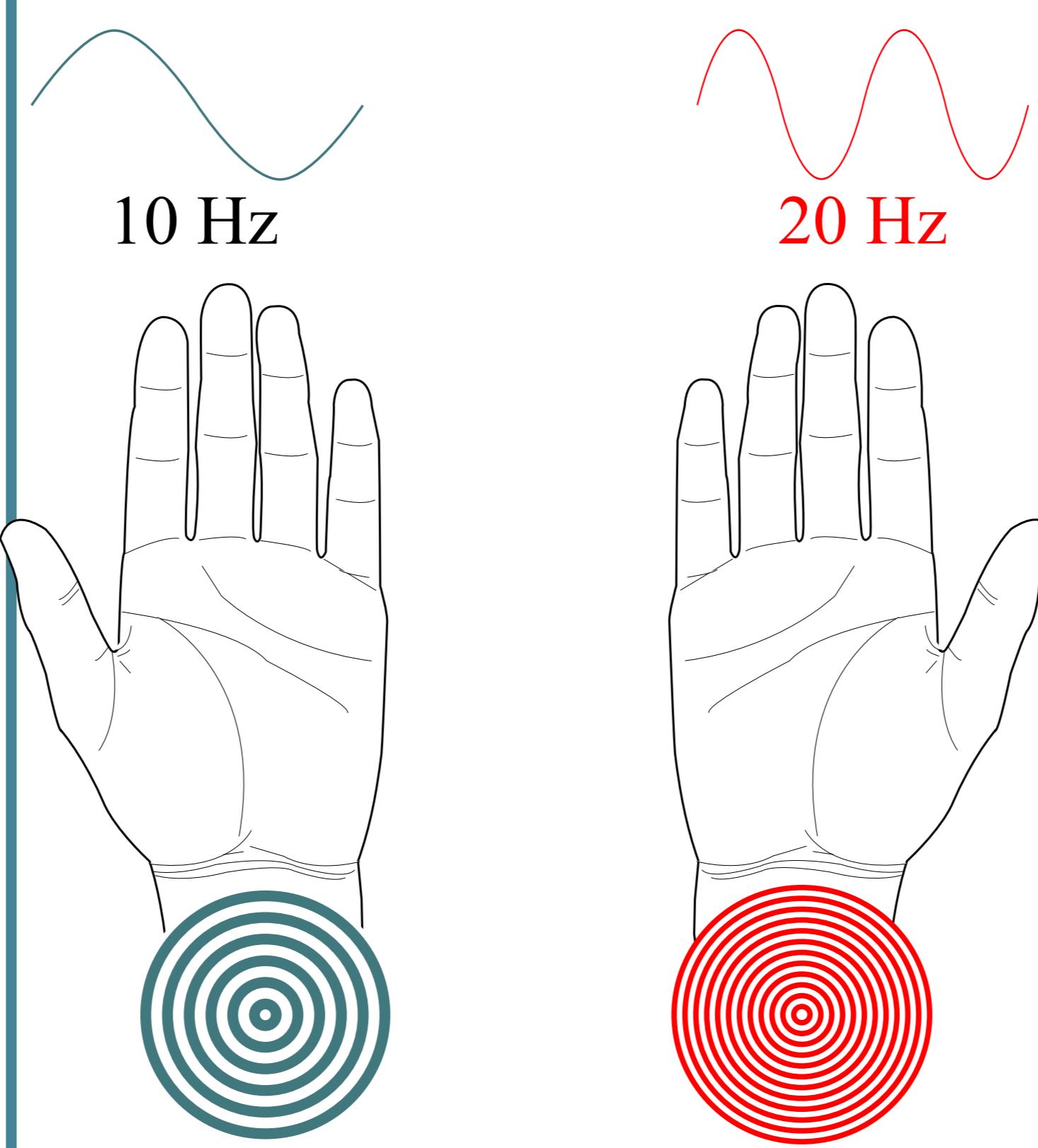
### Illustration of a command selection in this context

Initial State: IDLE

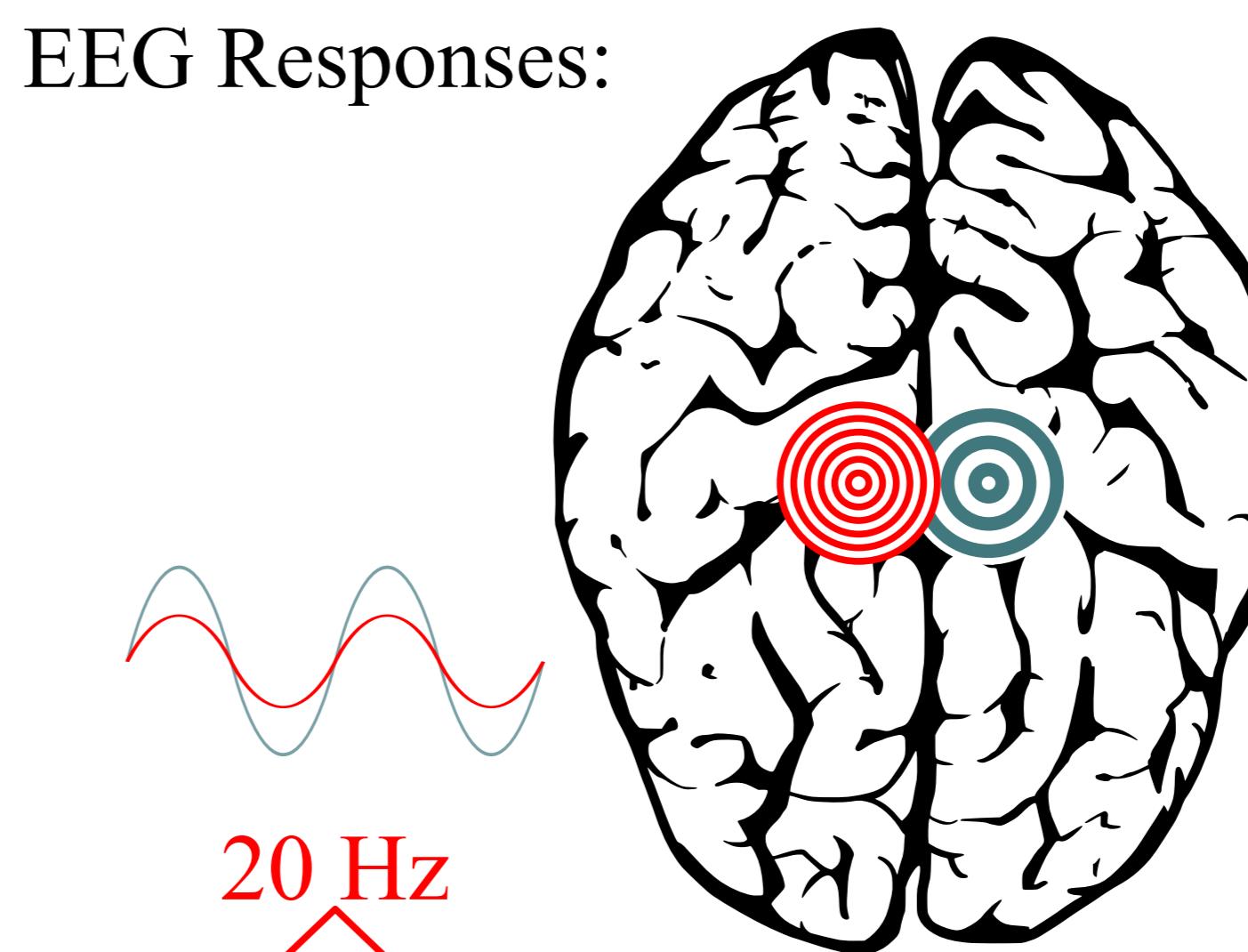
Mechanical stimulation frequencies



Motor Imagery with the right arm:  
Identical mechanical stimulation



EEG Responses:



SSSEP's amplitude decrease, caused by Sensory Gating

V

## An experiment to test the Somatosensory Gating for an SSSEP-based BCI

Setup:

- Subject is sitting in front of a computer.
- Frequency of Stimulation (FOS) identified during a screening session.
- C-2 Tactors tapped to both wrists<sup>4</sup>.
- EEG amplifier & Laptop: powered by batteries.

Experimental Conditions:

- Stay IDLE.
- Performing Motor Imagery (MI) with one arm.

Signal Processing:

Preprocessing:

- Non-causal highpass filter at 5 Hz.
- Peak-to-peak signal amplitude for eye blinks detection. Trial removed, if significant.

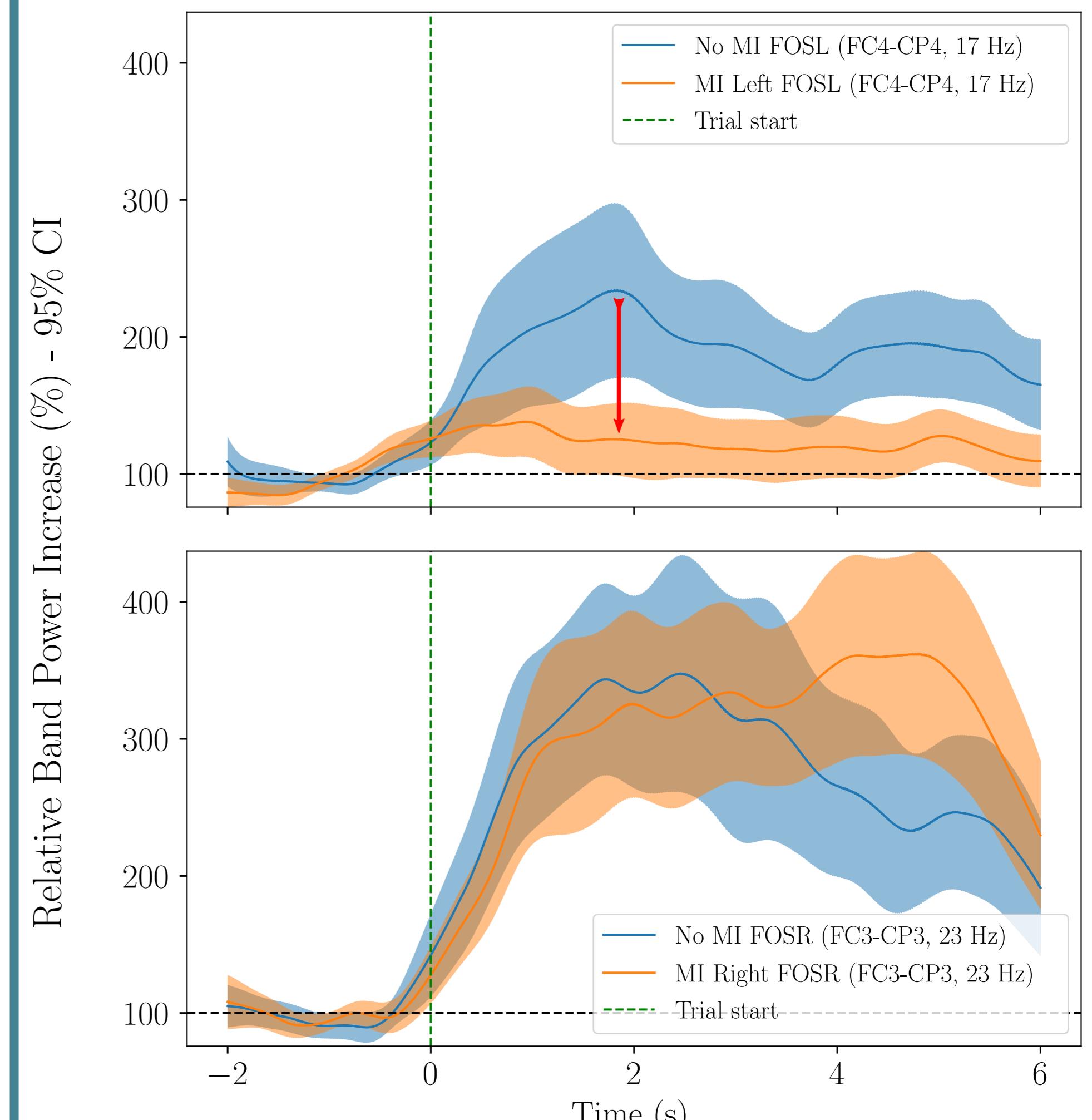
Subject #10:  $\approx 15\%$  of data rejection.

Amplitude estimation:

- Narrow non-causal bandpass filter.
- Signal squared.
- Smoothen by a moving average (window length = 30 x FOS periods).

VI

## Observed effect (subject #10)



[1] J. I. A. Voisin, C. Mercier, P. L. Jackson, C. L. Richards, and F. Malouin. Is somatosensory excitability more affected by the perspective or modality content of motor imagery? *Neuroscience Letters* (2011)

[2] C. Breitwieser, V. Kaiser, C. Neuper, and G. R. Müller-Putz. Stability and distribution of steady-state somatosensory evoked potentials elicited by vibro-tactile stimulation. *Medical & Biological Engineering & Computing* (2012)

[3] J. Petit, J. Rouillard, and F. Cabestaing. EEG-based Brain-Computer Interfaces exploiting Steady-State Somatosensory-Evoked Potentials: A Literature Review. *Journal of Neural Engineering* (2021)

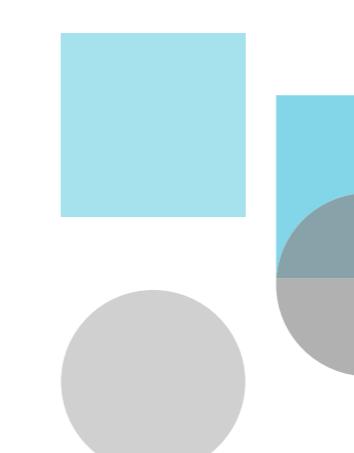
[4] C. Pokorny, C. Breitwieser, and G. R. Müller-Putz. A Tactile Stimulation Device for EEG Measurements in Clinical Use. *IEEE Transactions on Biomedical Circuits and Systems* (2014)



Université  
de Lille



centrale lille  
ÉCOLE CENTRALE DE LILLE



Centre de Recherche en Informatique,  
Signal et Automatique de Lille