Project 1

Experimental paradigm

The dataset consists of 306-channel MEG-BCI data recorded at 1KHz sampling frequency during four mental imagery tasks (i.e. hand imagery, feet imagery, subtraction imagery, and word generation imagery). The dataset contains two sessions of MEG recordings performed on separate days from 17 healthy participants using a typical BCI imagery paradigm. In the following figure, the experimental paradigm used for data acquisition has been shown.

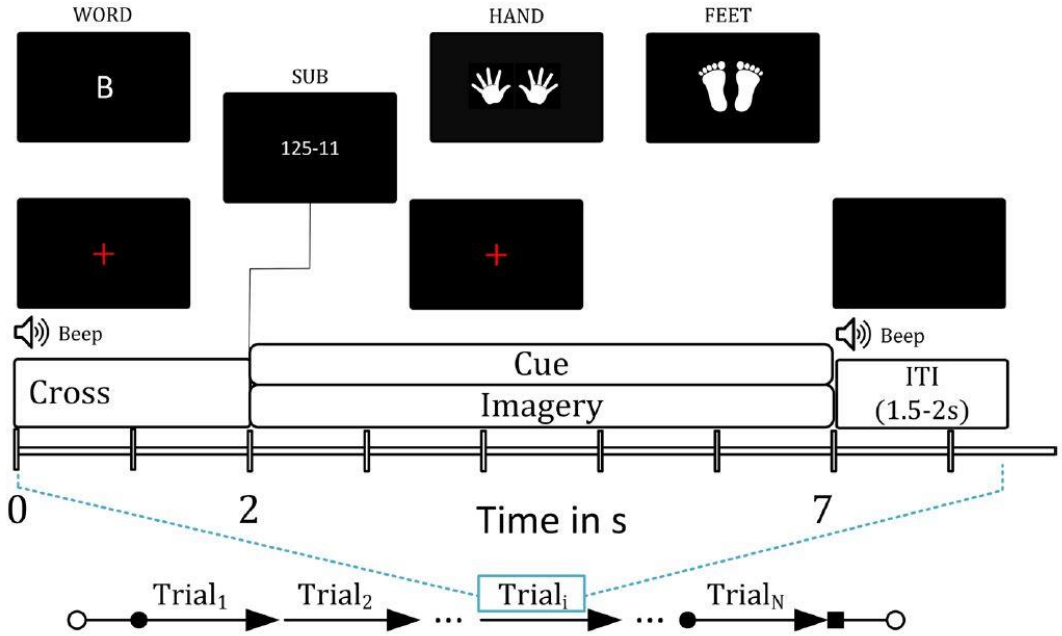

Figure: Timing diagram of MEG-BCI paradigm. Each trial starts with a rest period of 2s followed by 5s of imagery task period.

MEG data were acquired over two sessions (each session on a different day) using the same BCI paradigm. Each session consisted of 50 trials for each of the imagery tasks, thus includes a total of 200 trials. A break of 5 minute duration was provided in each session after completion of first 100 trials. The participants were kept seated during the break and asked to relax. The experimental paradigm was designed to cover four mental imagery tasks: two related to motor imagery (MI) i.e. both hands movement imagery, both feet movement imagery and two related to cognitive imagery (CI), i.e. mathematical subtraction imagery and word generation imagery. During the MI-related tasks, participants imagined the movement of both hands/both feet when the related cue appeared on the screen (i.e. during the task period). Similarly, for CI tasks, participants either subtracted two numbers presented as cue or generated words related to the English language alphabet appeared as cue.

Please note that you have received two sessions of pre-processed MEG data from five subjects as the complete dataset has a large size. Each '.mat' file includes a structured file named ‘Filt_MEG_Data.' Within this ' Filt_MEG_Data ' structure, you will

find a field labelled 'trial' containing 200 segmented MEG data epochs. Another field, 'trialinfo,' contains class labels for each epoch. The 'fsample' field specifies the sampling frequency of the recorded EEG signals, while the 'label' field contains the labels for all MEG channels. It's important to note that the data has already been subjected to bandpass filtering in the range of 0.5 to 100 Hz. classes are defined as follows: Class 1: Both Hand Imagery, Class 2: Both Feet Imagery, Class 3: Word Generation Imagery, and Class 4: Subtraction Imagery. Channel labels ending with 1 indicate magnetometer sensors and channel labels ending with 2 and 3 indicate orthogonal planar gradiometer sensors from the same location.

Project Objective

The goal of this project is to create a classification model using deep learning techniques for the purpose of categorizing various forms of motor imagery and motor cognitive tasks. Participants have the flexibility to define appropriate classification challenges, which could involve subject-specific or cross-subject classification. Participants can employ various signal processing methods and deep learning models, including CNN, GNN, Transformer, and LSTM, to achieve the desired classification accuracy. Upon project completion, participants should be prepared to present and elucidate their work, including their developed model, through appropriate feature visualization and statistical tests.

Reference: Rathee, D., Raza, H., Roy, S., Prasad, G. A magnetoencephalography dataset for motor and cognitive imagery-based brain-computer interface. *Sci Data* **8**, 120 (2021). https://doi.org/10.1038/s41597-021-00899-7