This dataset has been released as a contribution to the Frontiers Research Topic "Datasets for Brain-Computer Interface Applications"
https://www.frontiersin.org/research-topics/9784/datasets-for-brain-computer-interface-applications

Associated publication

Reichert et al., 2020, Impact of stimulus features on the performance of a gaze-independent brain-computer interface based on covert spatial attention shifts. *Frontiers in Neuroscience. (accepted)*
https://dx.doi.org/10.3389/fnins.2020.591777

Experimental procedure

Participants were presented with a sequence of ten visual stimuli (comprising a single trial) in which a red "x"-cross and a green "+"-cross were presented simultaneously in the opposite visual hemifields. The order of presentation side of each type was pseudo-randomized. Participants were asked to associate the green cross with the word "yes" and the red cross with the word "no" while responding to questions and statements, which were shown on the screen before the stimulus sequence presentation started. They communicated their response only by directing their attention to the respective cross, while fixating their visual gaze on a cross in the center of the screen. The size and eccentricity of the symbols varied between trials (sequence of 10 stimuli). The online decoded response was presented as feedback on the screen, showing the word "yes" or "no". One run consisted of 24 trials. In the first run, no question was presented, but the participant was asked to pay attention to the green cross for the whole duration of the run. In the second run, again no question was presented, but the participant was asked to pay attention instead to the red cross throughout the entire run. In runs 3-6 (except P01 who performed only two of these runs), objective questions were asked (e.g., 'Is Berlin a city?'). In the last run, subjective questions were asked (e.g., 'Are you a vegetarian?').
EEG was recorded with a Brainamp DC amplifier using 30 Ag/AgCl electrodes referenced against the right mastoid as well as the horizontal and vertical EOG. Sampling rate was 250 Hz and a 0.1 Hz highpass filter but no notch filters were applied by the recording software.
Before the experiment started, eye movements were recorded to determine the relationship between EOG signal strength and shift of gaze angle. For this purpose, participants were asked to track a cross jumping to peripheral positions and back to the center.

Aim of the BCI

The BCI is intended for the decoding of binary decisions from a series of stimuli. The decoding task is to determine to which of the simultaneously presented items the participant shifted his/her attention. Assuming that the attention is always shifted to the visual field in which the target is presented, we can determine the target color (corresponding with a "yes"/"no" response to the presented question) from the stimulus sequence.

Dataset

We provide 18 Matlab files, each containing EEG data from one participant.
Each file contains three structures:

- `subject`
  - `age:` age at time of recording
  - `sex:` ‘male’ or ‘female’
  - `handedness:` ‘left’ or ‘right’
  - `language:` language in which questions and feedback were presented
  - `ID:` participant identifier

- `eyemov`
  - `srate`: sampling rate
  - `data:` data recorded from EEG channels
  - `heog:` horizontal EOG (bipolar)
  - `veog:` vertical EOG (bipolar)
  - `xdeg:` horizontal angle of gaze shift relative to center
  - `ydeg:` vertical angle of gaze shift relative to center
  - `blinkcue:` a trigger for volitional execution of a blink
  - `label:` names of the EEG channels according to the order in `data`

`eyemov` contains both EEG and EOG data from the initial recording of eye movements. The data are not segmented but involve the whole recording.

- `bciexp`
  - `srate`: sampling rate
  - `data:` data recorded from EEG channels, segmented into trials
  - `heog:` horizontal EOG (bipolar), segmented into trials
  - `veog:` vertical EOG (bipolar), segmented into trials
  - `stim:` trigger channels, which show stimulus onsets
1st channel: 1 - green cross left / red cross right, else 0
2nd channel: 1 - red cross left / green cross right, else 0
  - `eccentricity:` visual angle of horizontal displacement of the symbols relative to fixation cross, constant throughout a trial
  - `symbolsize:` size of symbols in pixels, constant throughout a trial
  - `intention:` response participant intended to give, i.e., the assumed ground truth used to train and test the classifier
  - `feedback:` response the BCI determined online; empty if no feedback was provided

- `feedbacksamp:` time point when feedback was presented
- `expected:` response expected to an objective question; empty if question was subjective
- `label:` names of EEG channels according to order in `data`
- `targetside:` trigger channel, which shows the presentation side of the target as determined from the fields `stim` and `intention`:
  1 - target presented right, -1 – target presented left, else 0

Example code

We provide example code that analyses the data in the manner described in the paper. To run it, change to the folder "*example*" and execute the script "`analyze_bciexp`".

The code is available here:

https://gitlab.stimulate.ovgu.de/christoph.reichert/visual-spatial-attention-bci