STANDARD TESTING DOCUMENT

Setup initialization:

The configuration/ setup process is designed in a way which allows us to have the greatest chance of success of data acquisition with the unreliable headset and software. The steps are shown below.

- Adjust headset electrodes to the subject ensuring that all electrodes are touching the scalp(skin not hair)
- Make sure that headset does not sway too much with head movements(headset quite comfortable so no problems should be noted here)
- Turn on headset to 2.4G communication(switch up) and insert dongle into PC usb port(dongle can act as a “ghost” mouse so change usb ports or restart for fix)
- Open OpenBci GUI and establish connection to see whether the signals seem expected(look for periodic oscillations, inconsistencies across all channels and if the pesky railed appears(the fixes for some of the problems are listed in the problems we faced section)
- If this works open openvibe acquisition and designer which should be appropriately setup with subject information(openvibe may have kernel errors or simply crash which can be fixed with a restart or using an older version of the app).
- Run the openvibe designer and store a raw signal and filtered copy to a chosen directory where the user has read/write access.
- Using either EEGLAB(matlab script) or EDFBrowser(external app) inspect channel data for any problems, if an encountered artefact is nearing the end or begin of the trial a respective amount of time can be croppen.(Blinks are quite easy to spot raw with motor execution requiring more work)
- **FOR MOTOR EXECUTION:** repeat experiment multiple times to gain an average across channels with a multitude of ways to try to visualise Motor Execution EEG signals.
- Run python code on preferred editor and plot either/all the given below
    - Spectrogram STFT(play around with window type and size for subjective best looking data) should show activity a few 100ms after stimulation in the 8-12hz region.
    - Averaged PSD plot of a channel should show a distinctive peak in the alpha/mu band
    - Averaged magnitude plot should show a distinct ERD followed by ERS after the stimulation
    - {Optional} use EEGlab in matlab to run ICA decomposition and run analysis by ICA which gives a 2d/3d topo map of activity and a prediction on what types of signal that is being read.
- To export live data a library in python of openbci-lsl can be used to receive streamed EEG from the headset where based on time intervals live filters can be applied.(not yet completely working)

- Be happy that you now have data that can be sent to the Machine learning group

Sensor montage:

Initially chosen sensor montage for the eeg, most systems with more than 8 eeg electrodes showed strongest activity around the c3 and c4(making them must haves) the rest except fp1 and fp2 were located near this region.

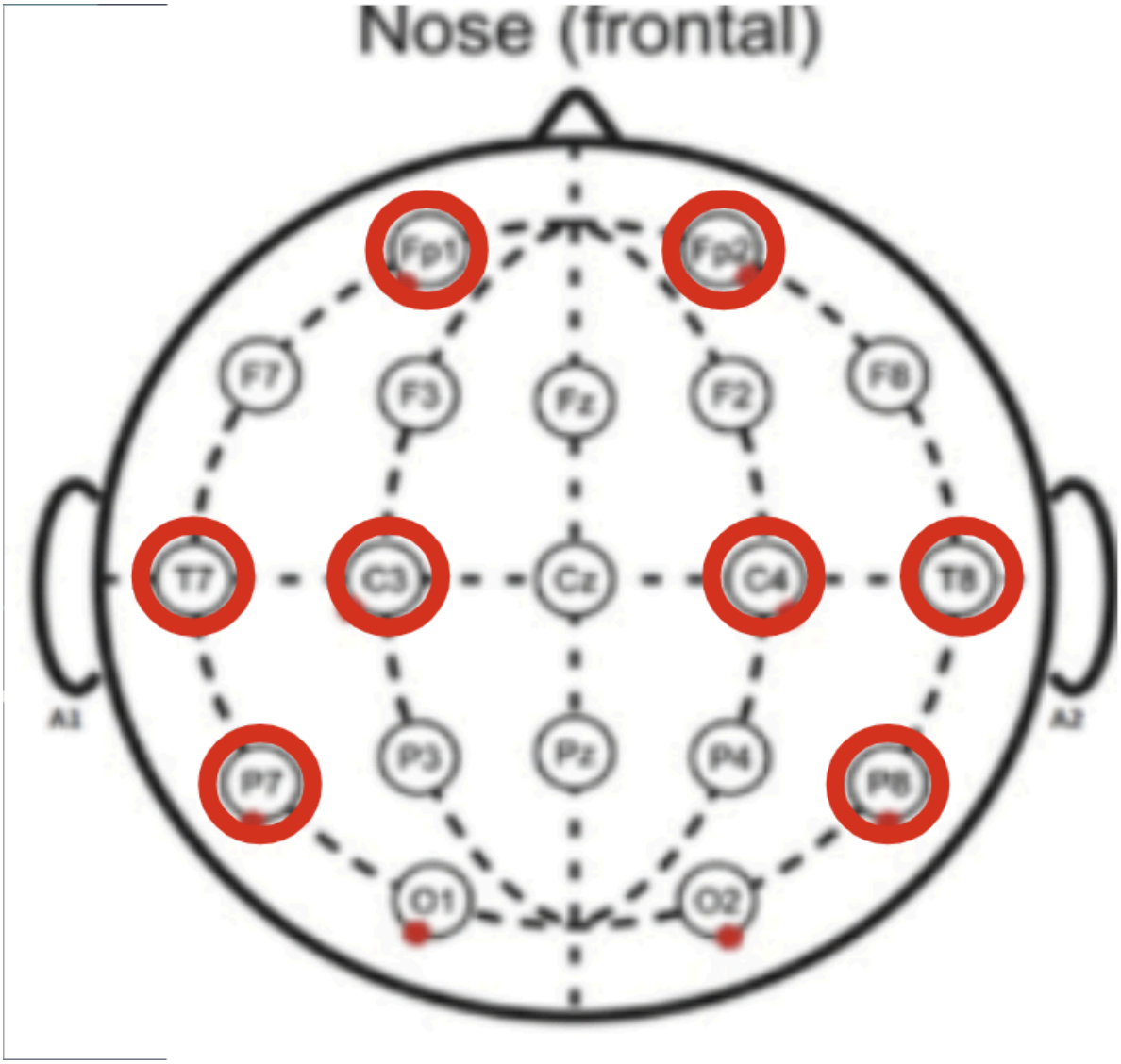


Figure 1: Showing initial sensor(30-4-24) layout with fixed sensors being FP1,FP2,C3 and C4, the others were chosen arbitrarily to try and pick up as much motor execution as possible.

The updated and mostly finalised sensor layout was chosen to be as shown below as we read and received feedback that T7, T8, P7 and P8 were all further to the active zones for Motor execution than F2,F3,P3 and P4. A revision therefore lead to the sensor layout as presented below

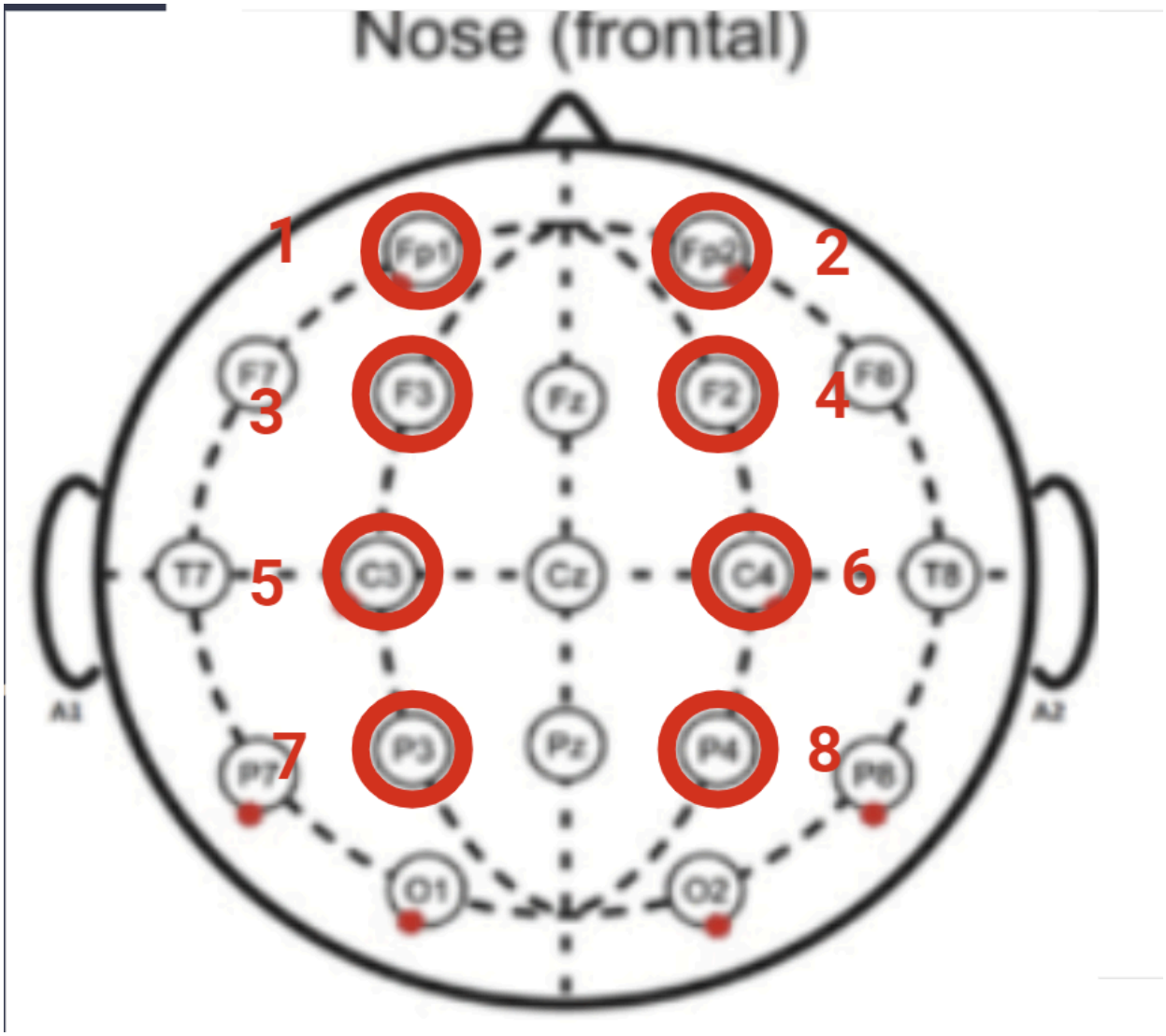


Figure 2: Showing revised sensor(13-5-24) layout with fixed sensors being FP1,FP2,C3 and C4, the others were now updated to better try and pick motor execution signals.

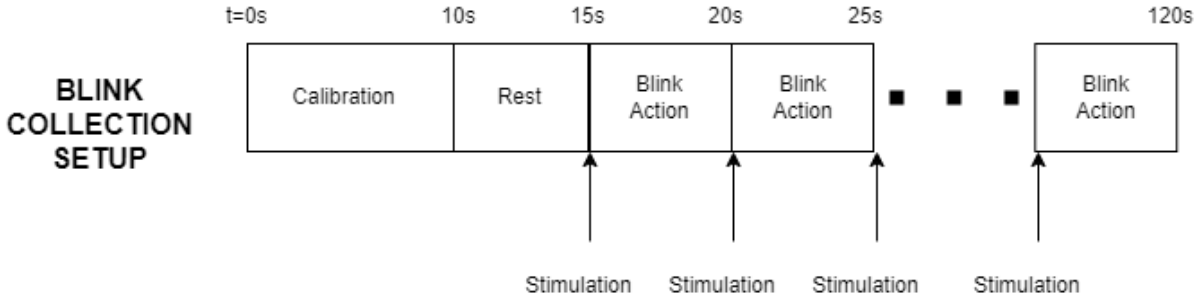
Test methods:

Defining our test methods is quite important to streamline our data collection process as frameworks allow efficient and repeatable experiments with high chances of success. We have split 2 tests being the blink experiments and motor execution tests. The designed experiments are shown below.

Blinks:

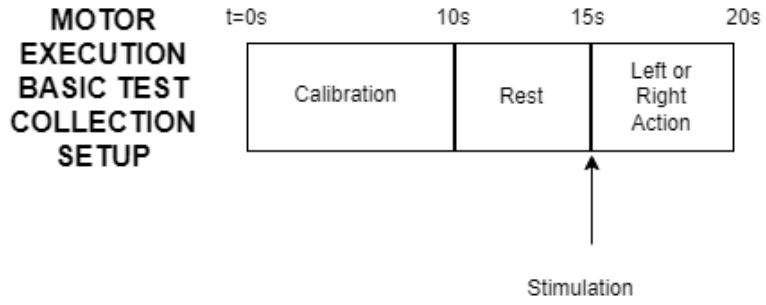
To split our blink trials we first need to ensure that blinks are detectable and then design an experiment which allows for the longest possible data collection without fatigue. Blinks are already visible with a simple 0.5hz high pass filter on the raw eeg signal. The blinks exhibit a

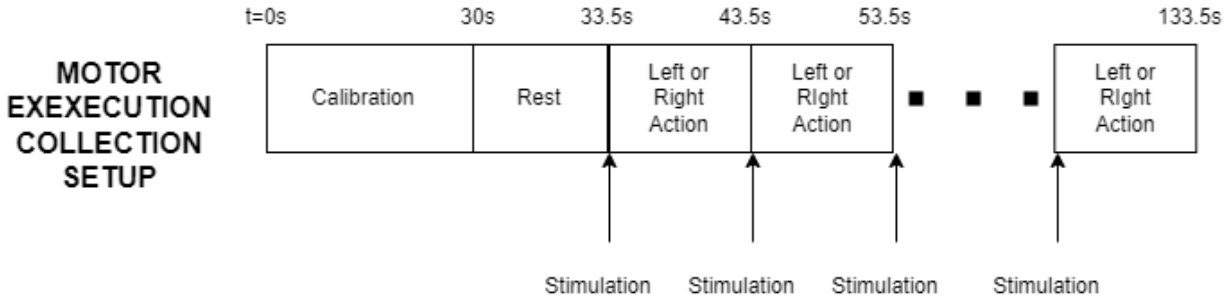
drop and then rise with a distinct peak. The experiment to gather the data was therefore done as shown below



This test allowed for the gathering of 110 blinks total

Motor execution:
To do motor execution is a little more difficult with a test also needed to show motor execution can be visualised. The steps for the method that will be used are shown below





The test methods were based on research papers regarding motor imagery and our own experiences with maintaining focus over a long period of time. The tests were also chosen to be

shorter so that the chance of an error occurring (ruining a whole dataset) becomes smaller as we believe this to be a linear relation with time.