Exercise Block10: Visualisation of ERPs using the Averaging Theorem

Table of Contents

In the lab exercise you acquired EEG recordings during the occurrence of many (trainig characters times flashes per character) visual stimuli. Each % of them should evoke an event related potential (ERP). In this exercise you should make visible the a typical P300-ERP waveform from your measurements in the lab using the avaraging theorem.

V1.0 - Traxler

Import the Calibration File

open your `*.txt`-file using the provided function

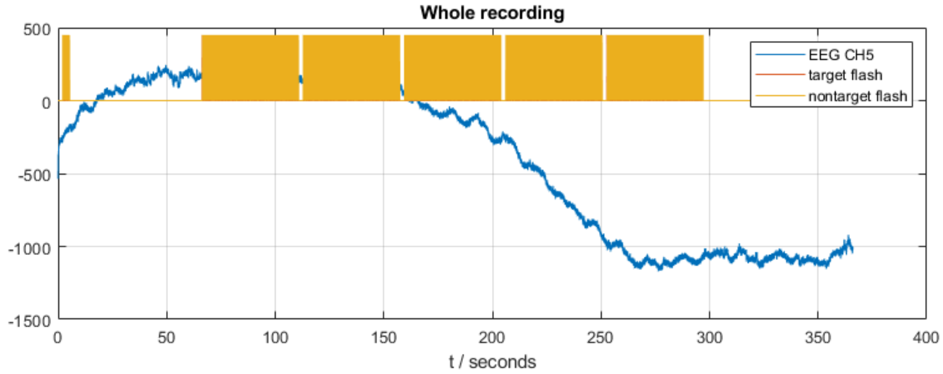
```
[fn, pn] = uigetfile('*.txt','Select a file');
[data, samplingRate, numberOfChannels, numberOfSamples] =...
ImportUnicornSpellerRecording([pn fn]);
```

`data` will contain the following data structure

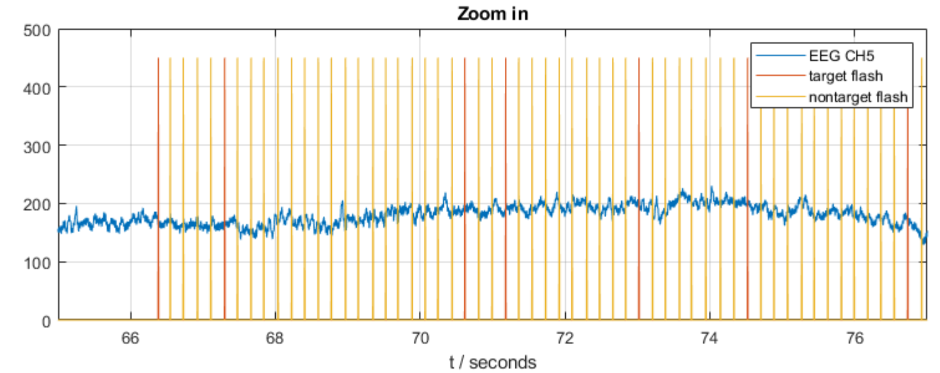
```
channel 1 ......... timestamp
channel 2-9 ....... raw EEG
channel 10 - 69 ... items
channel 70 ........ target triggers
channel 71 ........ non-target triggers
```

Plot the raw Signal

Check your raw signals: in this example we see channel number 5, the locations of target flashes and the location of nontarget flashes. During the calibration in this example a 5-character training word was used, thus we can see 5 blocks of visual stimuli for each calibration character. Check if you can find the same structure in your data.

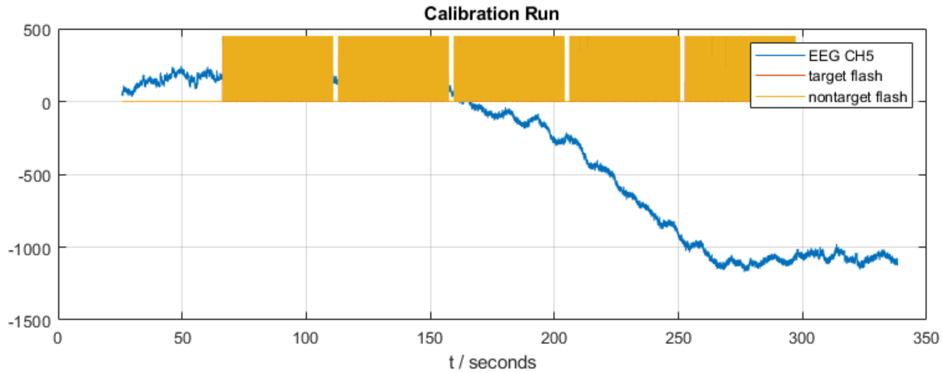


Zoom in to see if you can identify target and non-target flashes.



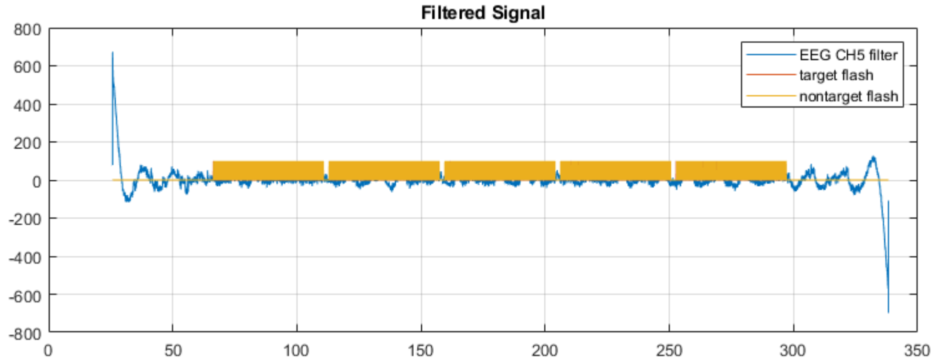
Remove Date Outside the Calibration

In this step crop the signal to the calibration phase - remove all other date (pre and post calibration). To account for possible filter oscillations in the next processing step, add around 30 seconds pre and post calibration phase. The result should look similar to this:



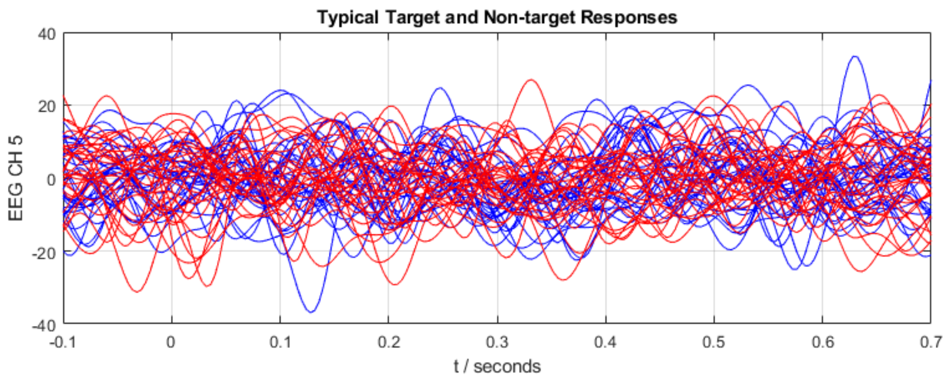
Filter the EEG-Signals with a Bandpass 0,08 to 20 Hz

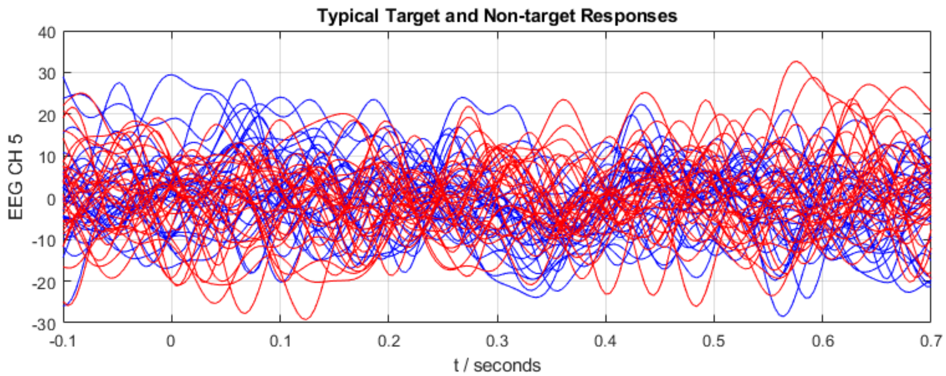
Apply a bandpass filter we are further interested in the frequency band of 0,08 Hz to 20 Hz. Depending on your recording properties you can adapt these frequencies. Exemplary the channel number 5 looks like this:

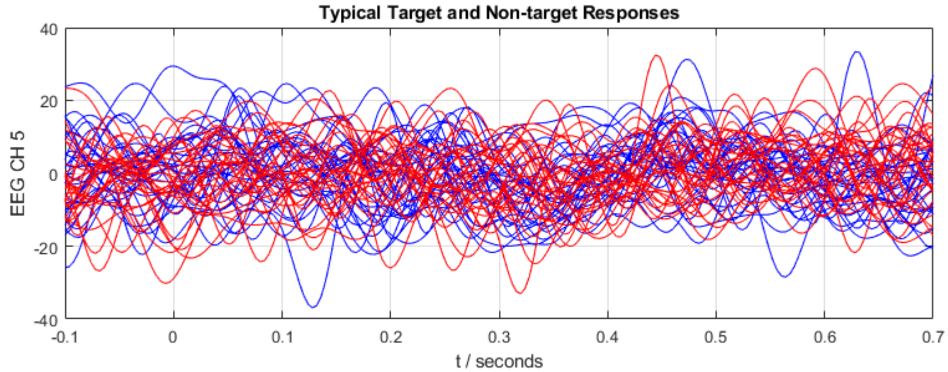


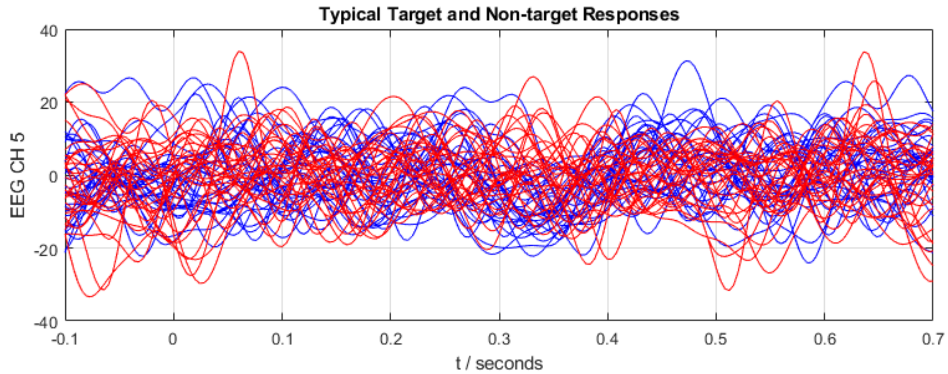
Visualisation of Target and Non-target responses

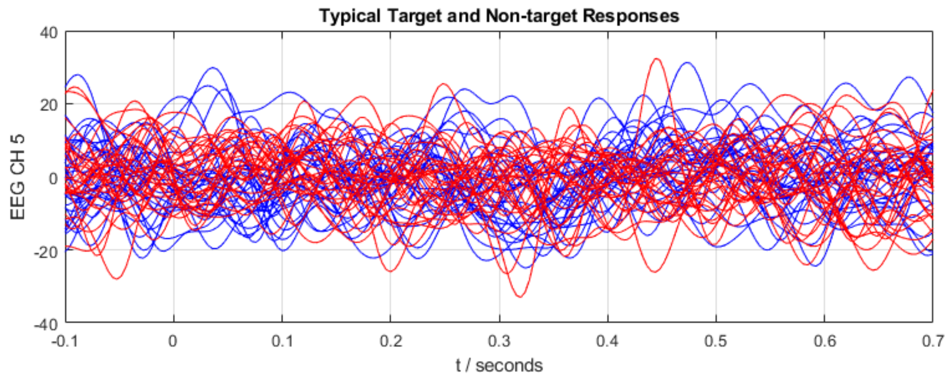
Plot 30 EEG responses (-100 ms to +700 ms windows per/post stimulus) for each category (target and non-target). Randomly pick thirty stimuli each. We repeat this five times. No systematic difference between targets blue and the non-targets red are visible:





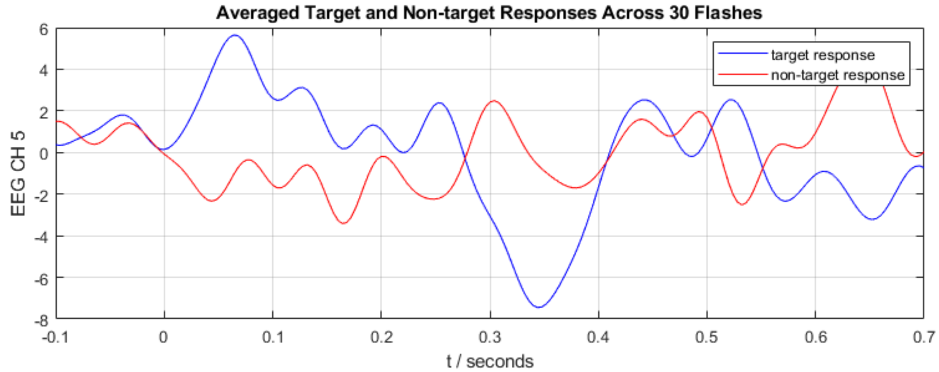


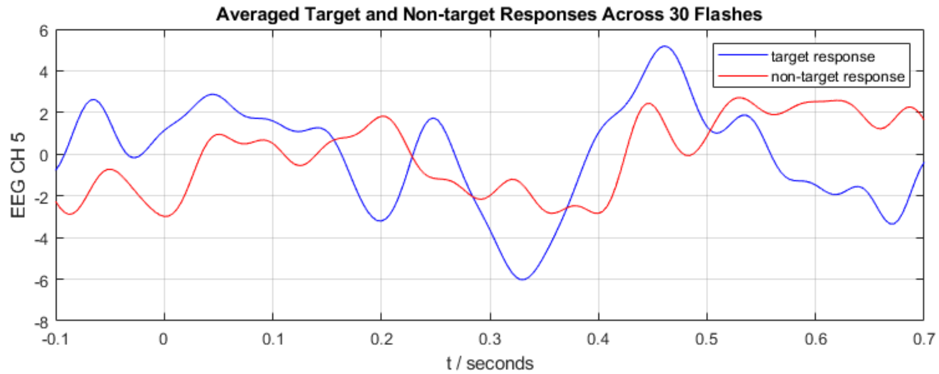




Averaging Theorem

now use the same random selection of 30 flashes but this time plot the average of all 30 responses. Now we see in all 5 random selections a systematic approximately 300 ms post stimulus (hence the name P300).


Averaged Target and Non-target Responses Across 30 Flashes
target response
non-target response
EEG CH 5
t / seconds

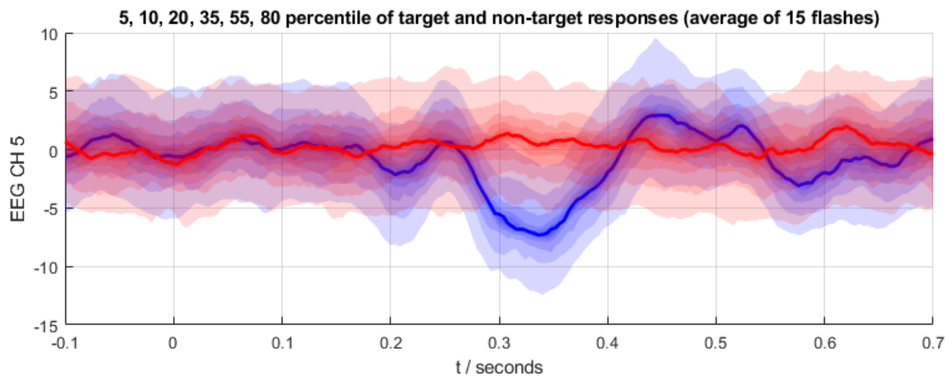

Averaged Target and Non-target Responses Across 30 Flashes
target response
non-target response
EEG CH 5
t / seconds


Averaged Target and Non-target Responses Across 30 Flashes
target response
non-target response
EEG CH 5
t / seconds


Averaged Target and Non-target Responses Across 30 Flashes
target response
non-target response
EEG CH 5
t / seconds

Estimation of the Required Number of Flashes for Averaging

Form the previous results we can see: For a single response we cannot distinguish between target and non-target responses. As an extreme case, first plot the average across all target flashes and all non-target flashes. Estimate what is the minimum requeired number to destinguish the between target and nontarget falsches. To get a feeling for the statistical distribution you can use the `plot_distribution_prctile` form MATLAB Central https://de.mathworks.com/matlabcentral/fileexchange/69203-shaded-plots-and-statistical-distribution-visualizations Here we see the statistical distribution when averaging 15 flashes (5, 10, 20, 35, 55, 80 - percentile distribution of the averaged signals). Find out at which level the distributions can be distinguished.



Requerements for Exercise Hand-in

Step by step work out all the processing and analysis steps as described above. Write a MATLAB Script file containing the requred code. The script should outout exactly as many results as shown in this document. Use the command `publish('replace_this_by_your_script_file_name.m','pdf')` to generate a MATLAB code documentation contining the script, commments, explainations and plots. Upload the PDF in the moodle course for grading.

Published with MATLAB® R2020b