PSYC 406 Introduction to EEG Assignment 2

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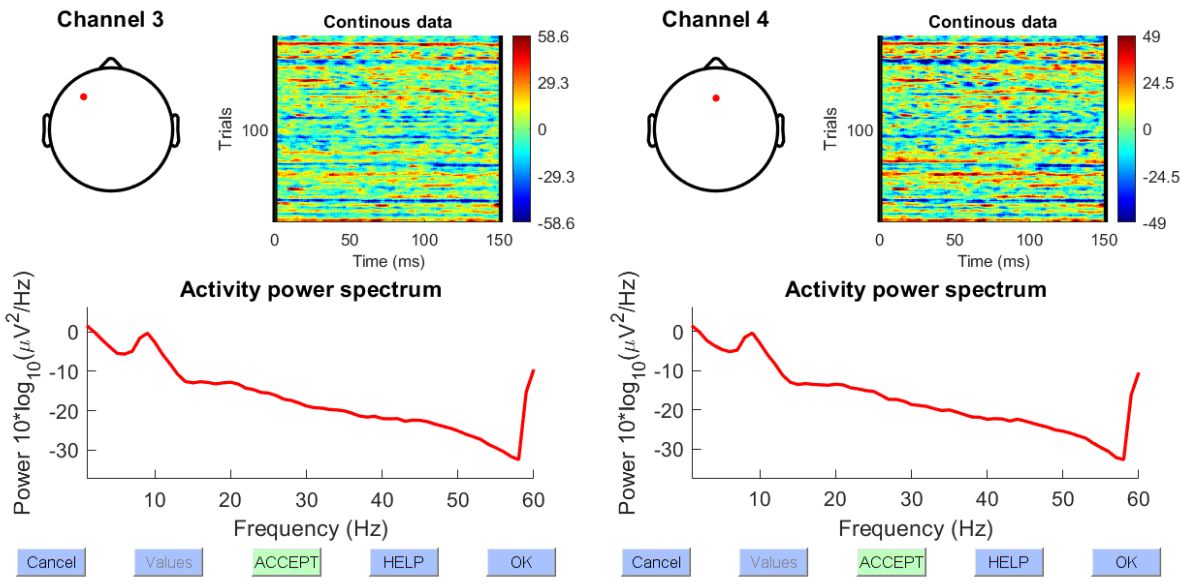
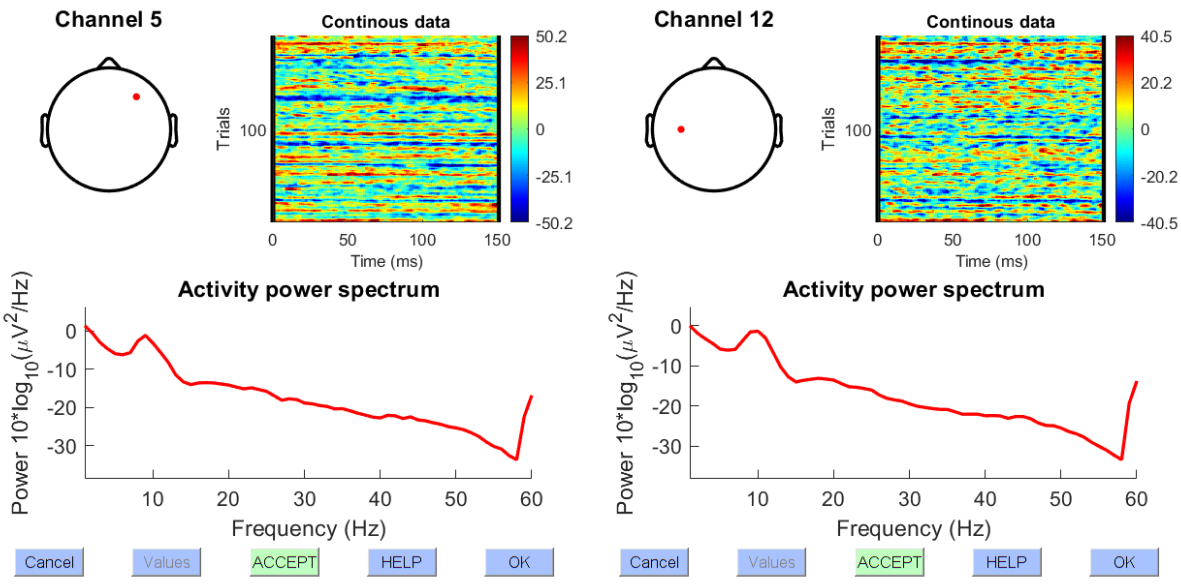
Introduction

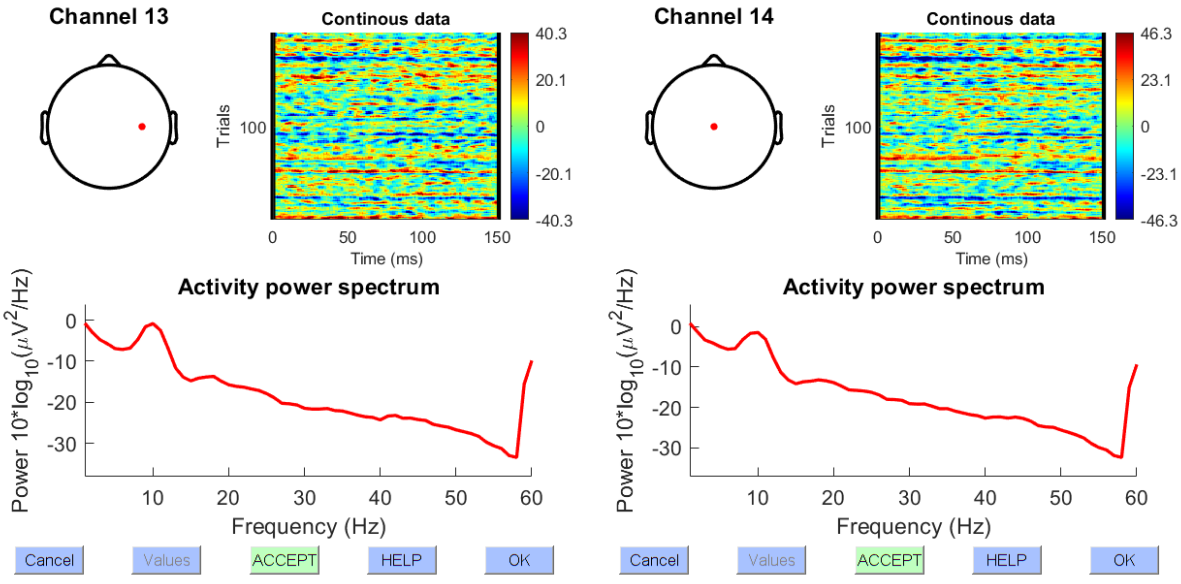
In this assignment, I have conducted an EEG Lab processing using the sample *eeglab_data.set* which is provided by EEGLAB. I have applied following processes: filtering data, re-referencing, extracting epoches and artifact rejection on epoched data. In each step which we need to provide graph, I added each channels' graph 3,4,5 located in frontal cortex ,12,13,14 in parietal cortex ,21,22,23 in occipital lobe. These electrodes are located in such places but of course they get signals from all sculp not specialized locally so that the graphs are like each other. Additionally, to observe more about the frequencies and their assumed localization, I have added two more graphs for high and low pass filtered data.

Plots of sample_data

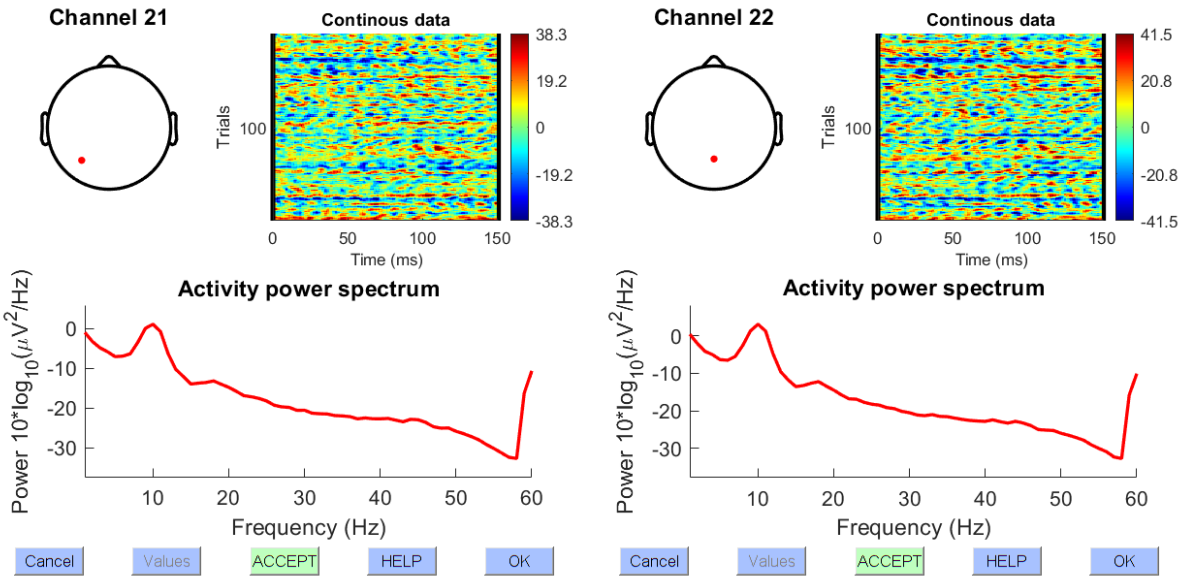



Channel 5
Continous data
Trials
100
0
50
100
150
Time (ms)
50.2
25.1
0
-25.1
-50.2
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

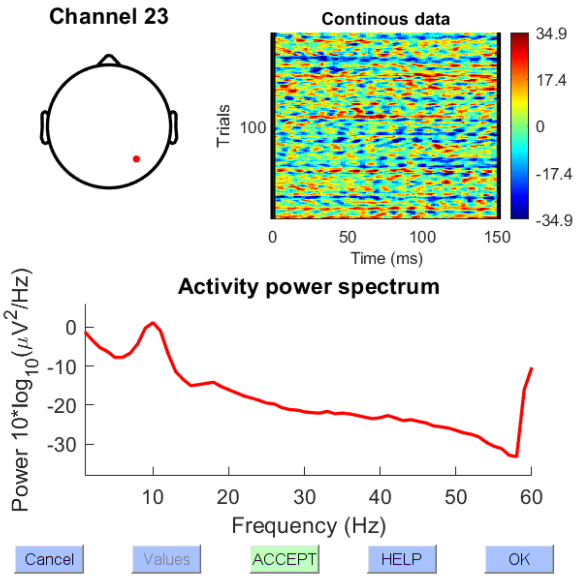
Channel 12
Continous data
Trials
100
0
50
100
150
Time (ms)
40.5
20.2
0
-20.2
-40.5
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 13
Continous data
Trials
100
0
50
100
150
Time (ms)
40.3
20.1
0
-20.1
-40.3
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

Channel 14
Continous data
Trials
100
0
50
100
150
Time (ms)
46.3
23.1
0
-23.1
-46.3
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 21
Continous data
Trials
100
0
50
100
150
Time (ms)
38.3
19.2
0
-19.2
-38.3
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

Channel 22
Continous data
Trials
100
0
50
100
150
Time (ms)
41.5
20.8
0
-20.8
-41.5
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK



Plots of after applying high pass filter with low edge 1Hz

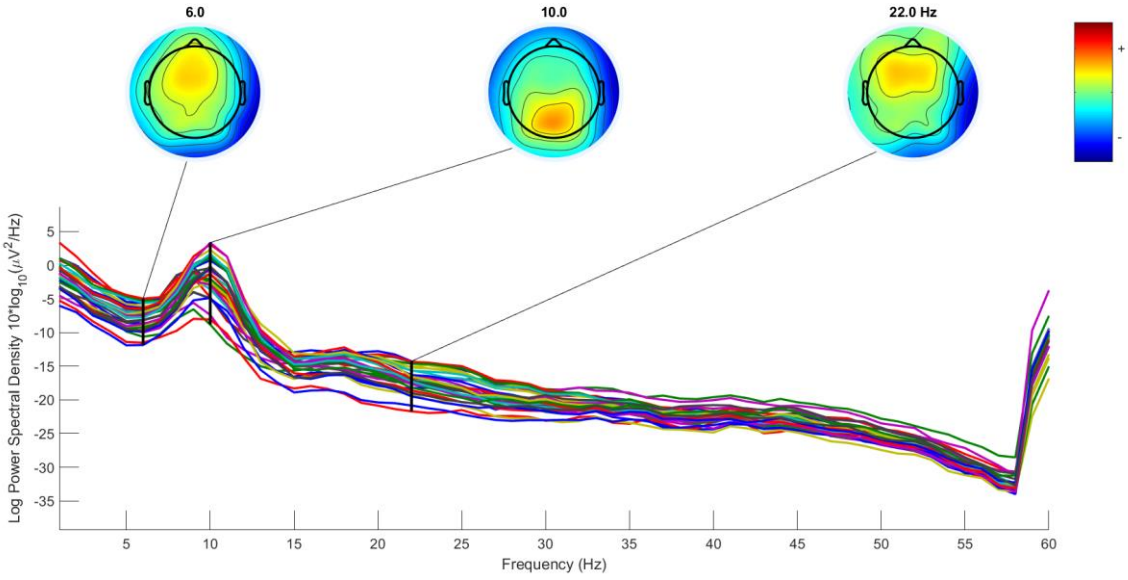


Figure 1

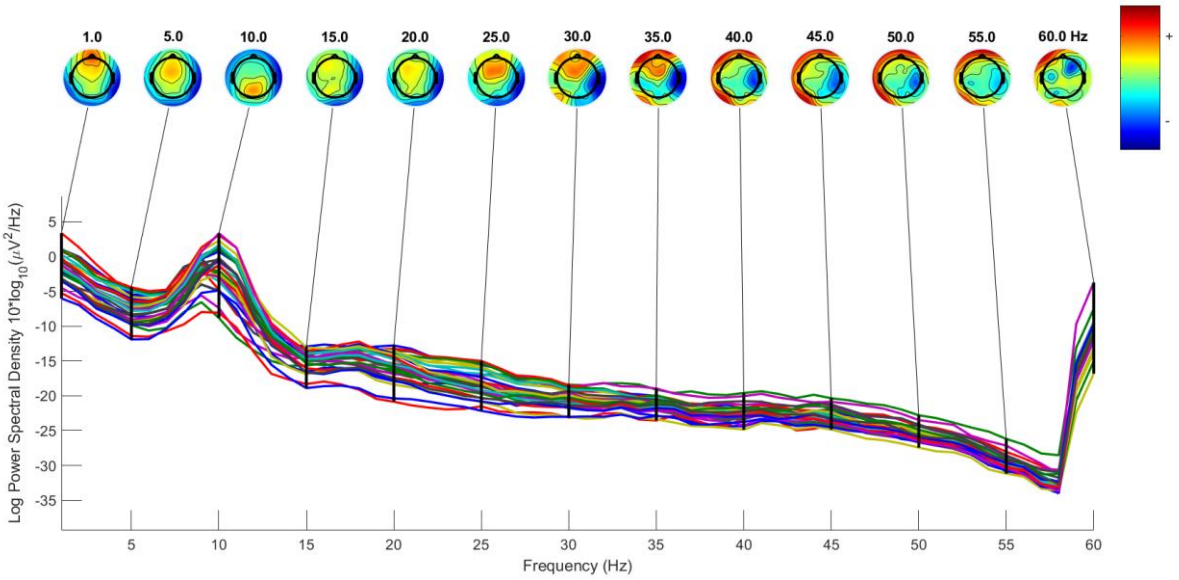
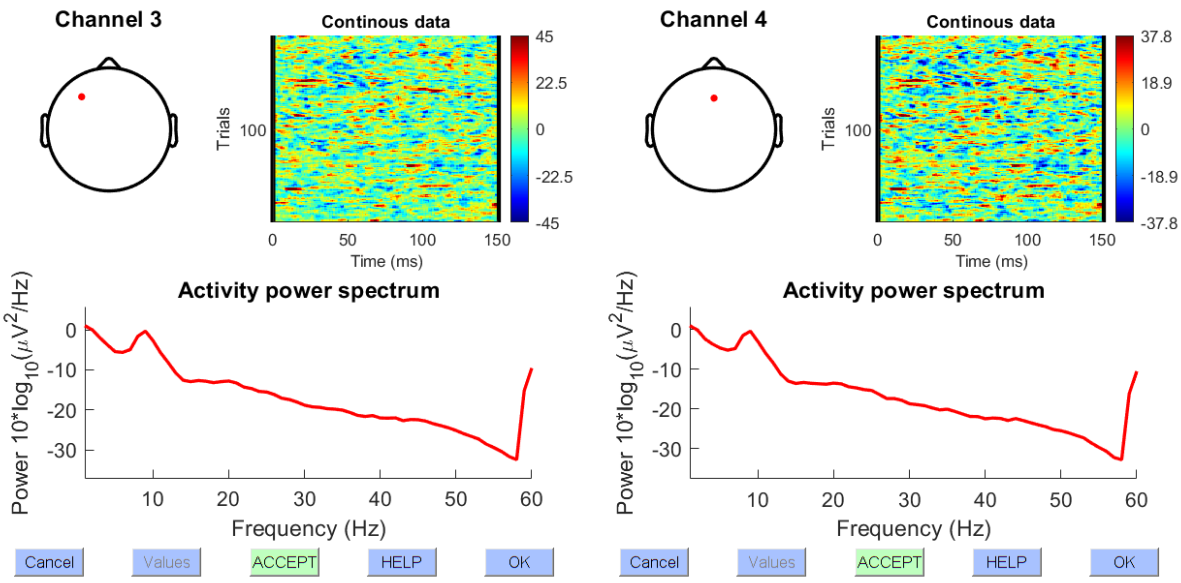


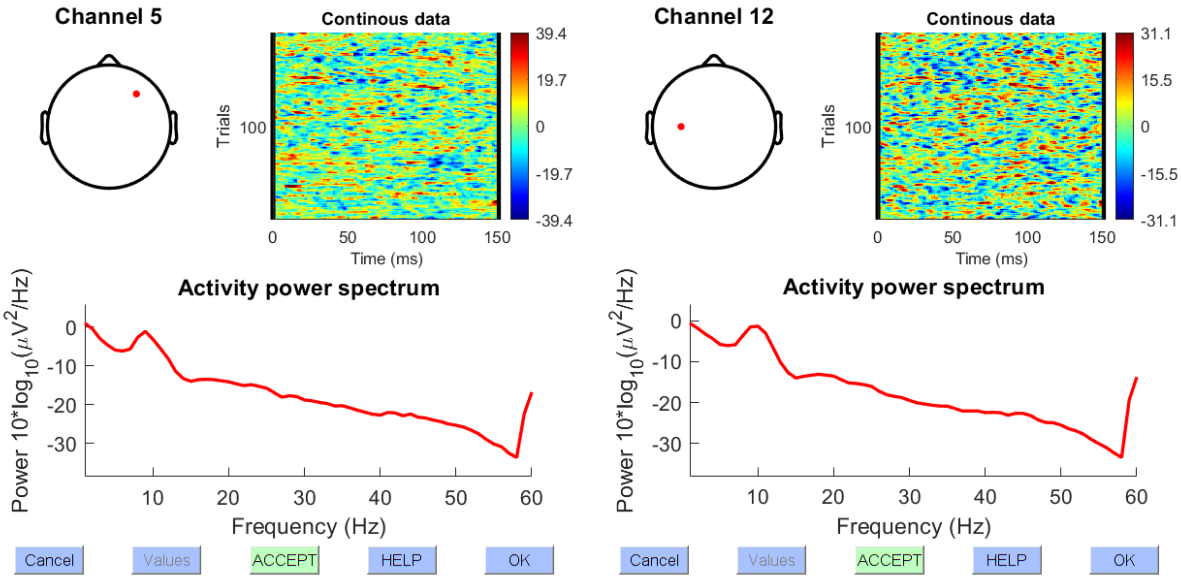
Figure 2

In Figure 1 of this part, we see how high pass filter affects our graph. Our graph represents density of each frequency (Hz). At the beginning, even though I have chosen 0 Hz, the graph is not showing before 1 Hz so that I could not observe a difference between before and after 1 Hz high pass filter. But with comparing two different graphs although there is no difference in the image, we see that eeglab only shows us 1 Hz and higher frequency waves.

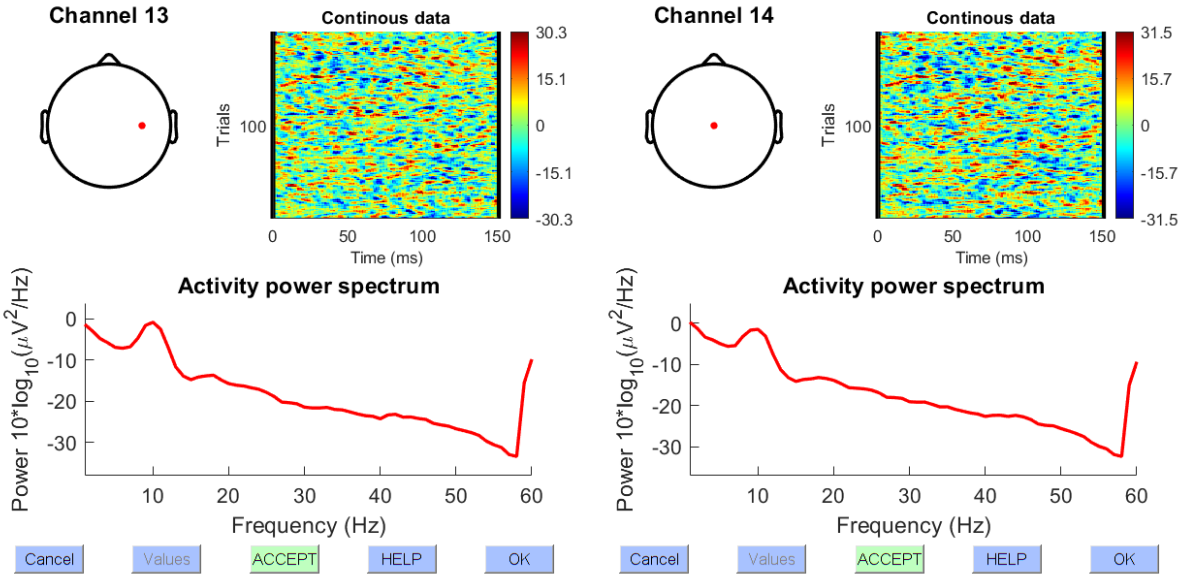
In the second graph (Figure 2), I added more frequency degrees than default. In here as we see the lower frequencies generally represents higher cognitive tasks like WM, decision making etc and it is more localized in prefrontal cortex as we see above. In higher frequencies, it is more likely that we are observing lower cognitions like visual attention (bottom-up version) etc. In here, this filter may be used for detecting low-level cognitions since high-pass filter is applied. However, in here it does not mean that the EEG signals are localized in brain. In here, it just shows assumption according to activities related to frequencies of our data.


Channel 3
Continous data
Trials
100
0
50
100
150
Time (ms)
45
22.5
0
-22.5
-45
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

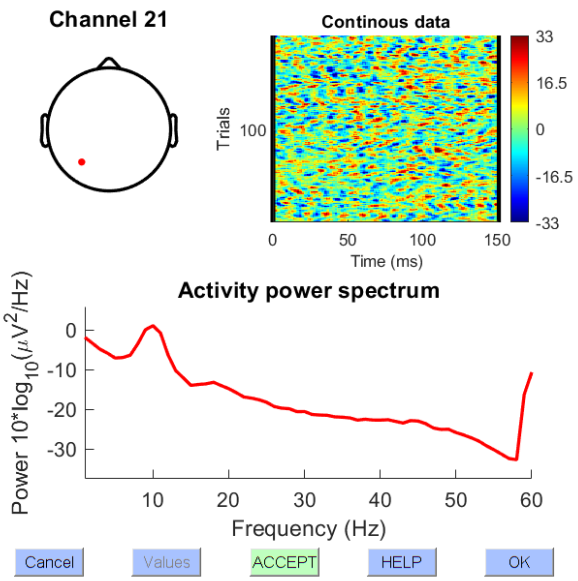
Channel 4
Continous data
Trials
100
0
50
100
150
Time (ms)
37.8
18.9
0
-18.9
-37.8
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

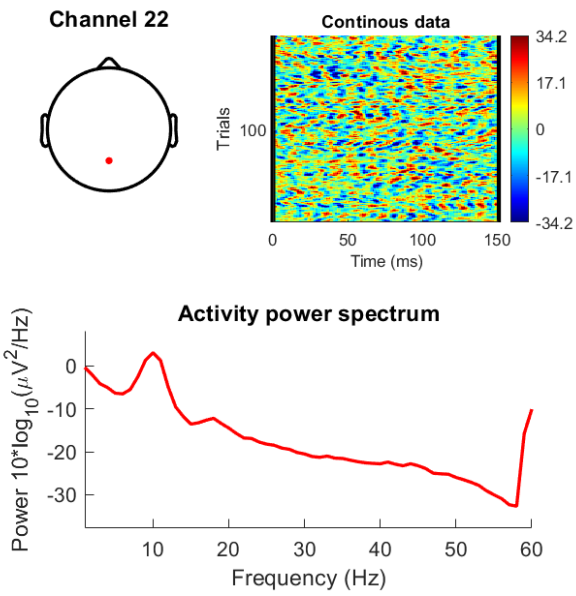

Channel 5
Continous data
Trials
100
0
50
100
150
Time (ms)
39.4
19.7
0
-19.7
-39.4
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

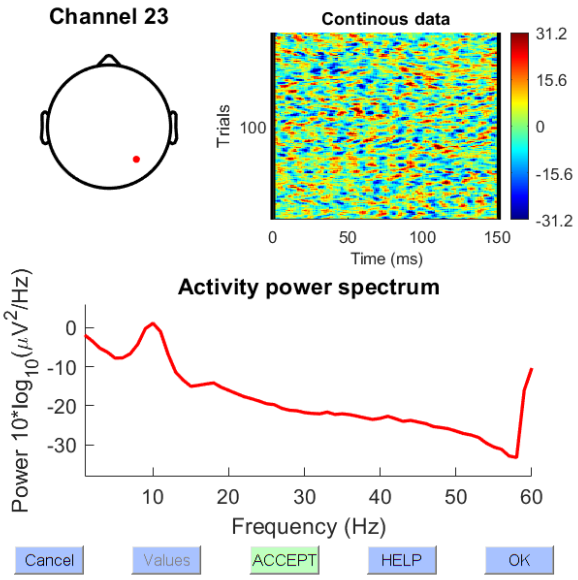
Channel 12
Continous data
Trials
100
0
50
100
150
Time (ms)
31.1
15.5
0
-15.5
-31.1
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 13
Continous data
Trials
100
0
50
100
150
Time (ms)
30.3
15.1
0
-15.1
-30.3
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

Channel 14
Continous data
Trials
100
0
50
100
150
Time (ms)
31.5
15.7
0
-15.7
-31.5
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 21
Continous data
Trials
100
0
50
100
150
Time (ms)
33
16.5
0
-16.5
-33
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 22
Continous data
Trials
100
0
50
100
150
Time (ms)
34.2
17.1
0
-17.1
-34.2
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)


Channel 23
Continous data
Trials
100
0
50
100
150
Time (ms)
31.2
15.6
0
-15.6
-31.2
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-10
-20
-30
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

Plots of after applying low pass filter with high edge 50Hz

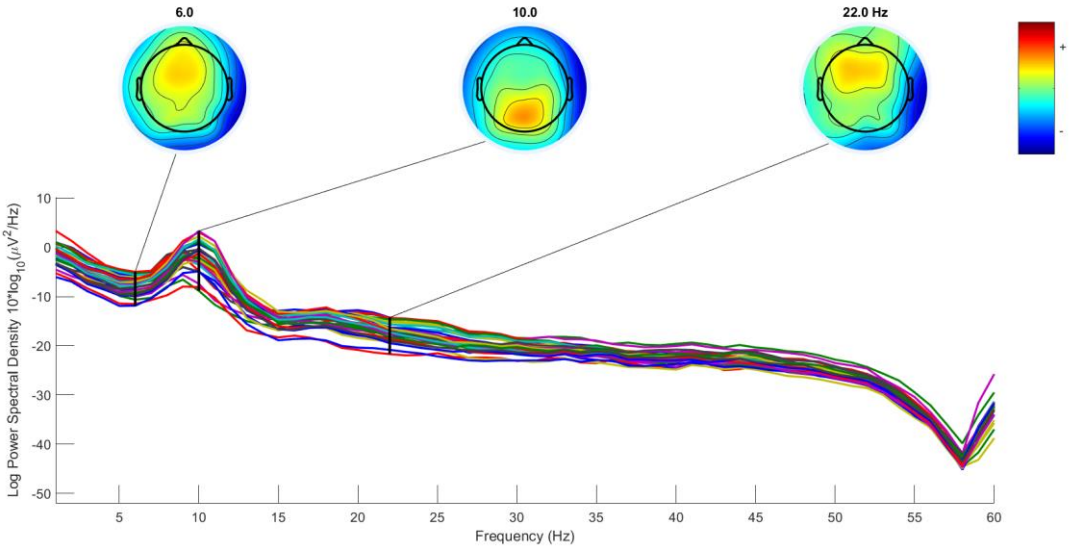


Figure 3

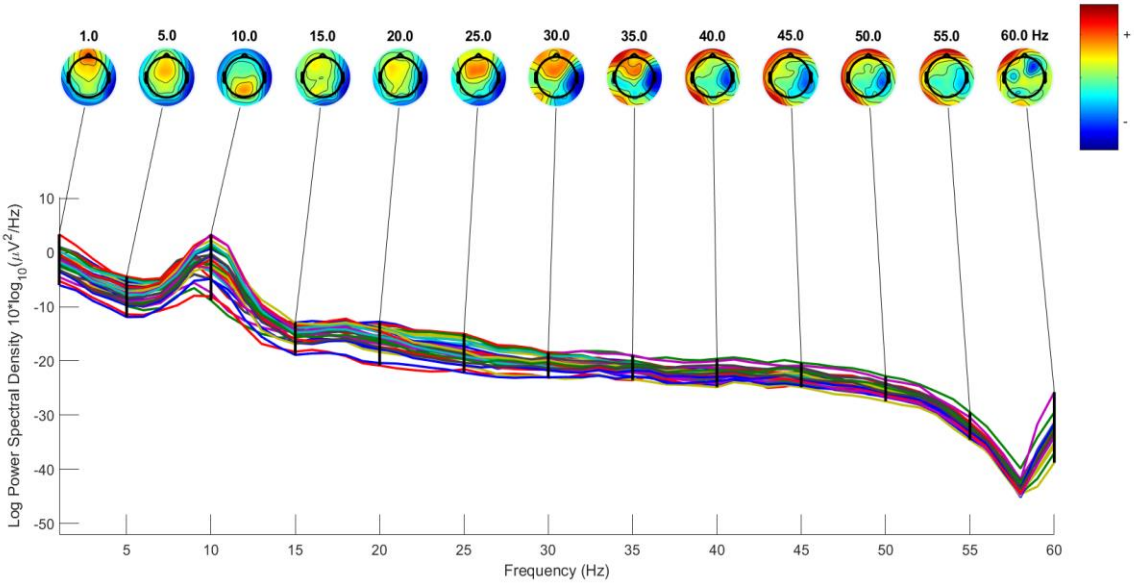
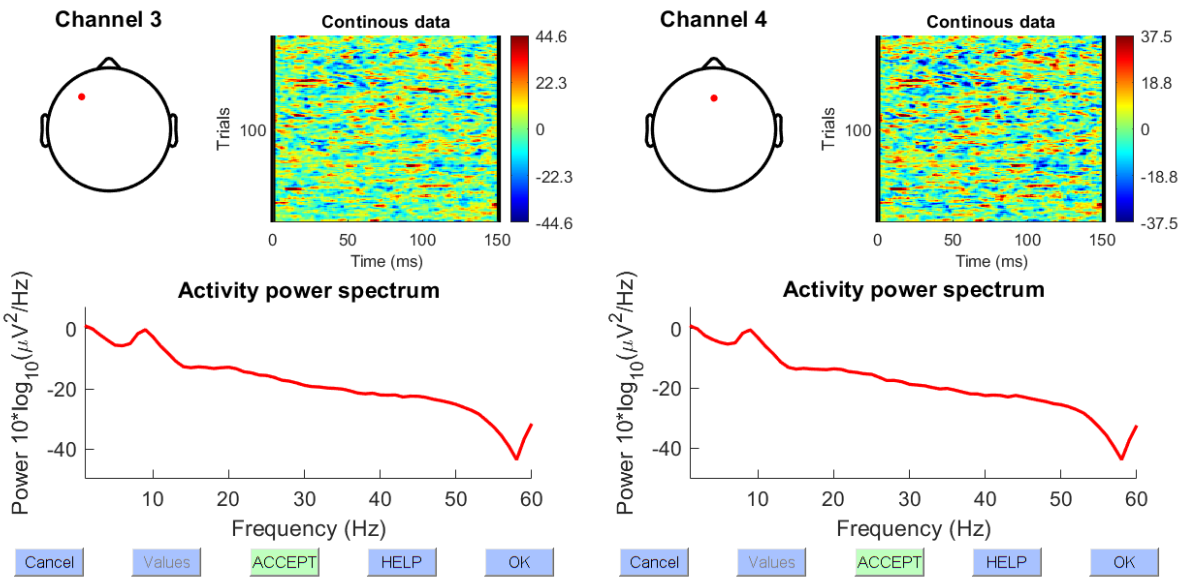
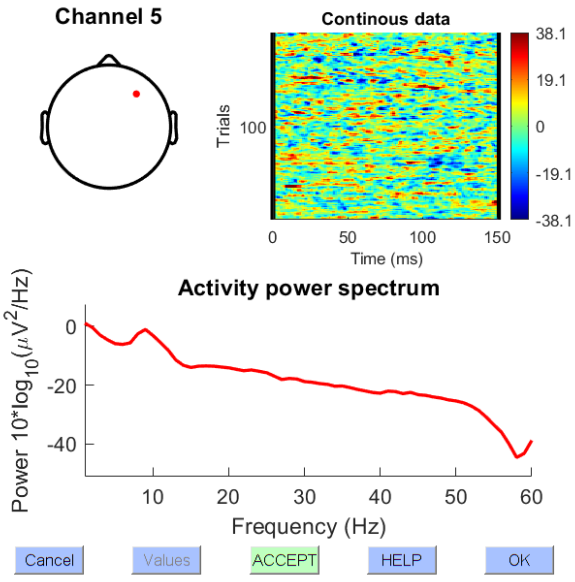


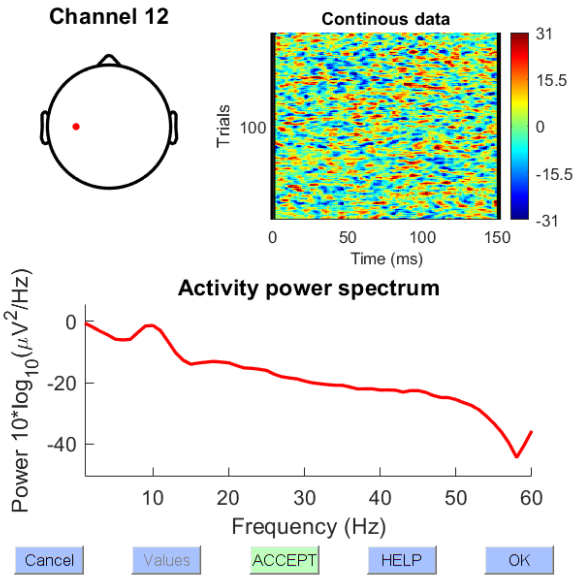
Figure 4

In the first graph of this part (Figure 3), we see a significant difference compared to high pass filtered data. After 50 Hz we see that the density rate is getting more and more lower since high frequencies are not allowed and low frequencies are passed. While in high pass filtered data the lowest density of high frequencies approach to -32, in low pass filtered data high frequency density is approaching to -45 which is significantly lower density since higher frequencies than 50Hz are filtered out. Using this filter is to reach higher cognitions as I have explained before. Moreover, matlab does not show much more than 60 Hz since more than that frequency is sourced by some movements other than cognitions like eye movements or other muscle movements as we can see on the top of second graph.


Channel 3
Continous data
Trials
100
0
50
100
150
Time (ms)
44.6
22.3
0
-22.3
-44.6
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

Channel 4
Continous data
Trials
100
0
50
100
150
Time (ms)
37.5
18.8
0
-18.8
-37.5
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 5
Continous data
Trials
100
0
50
100
150
Time (ms)
38.1
19.1
0
-19.1
-38.1
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 12
Continous data
Trials
100
0
50
100
150
Time (ms)
31
15.5
0
-15.5
-31
Activity power spectrum
Power 10*log10(μV2/Hz)
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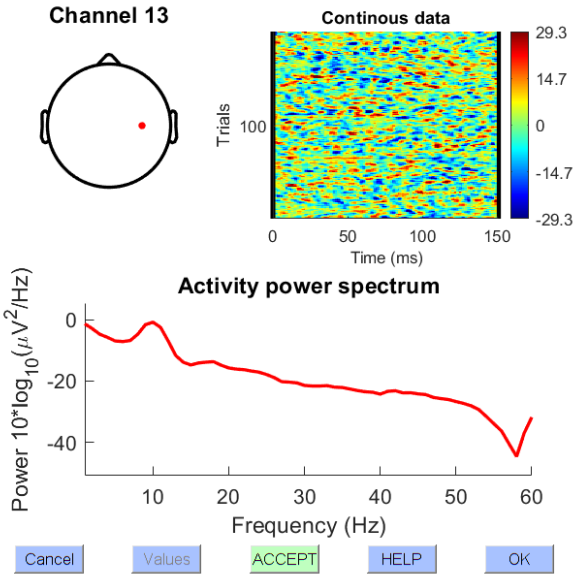
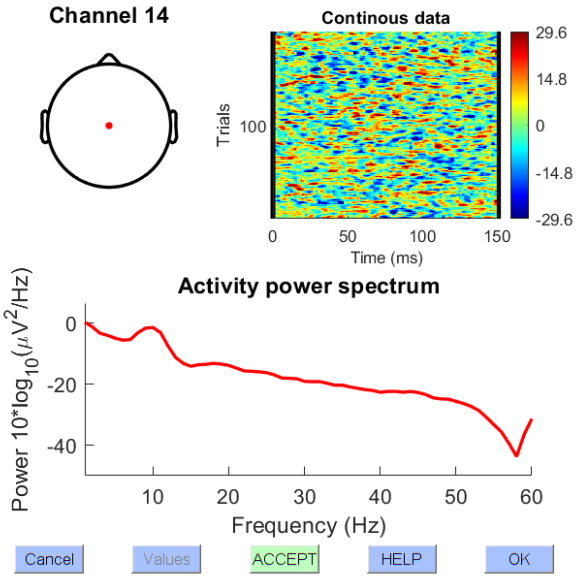
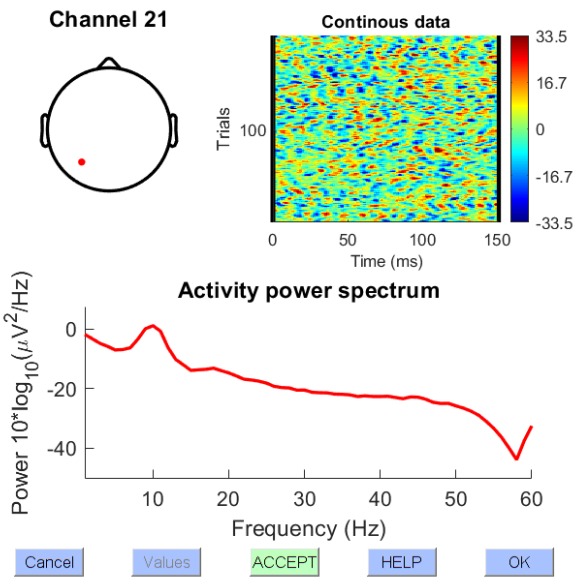
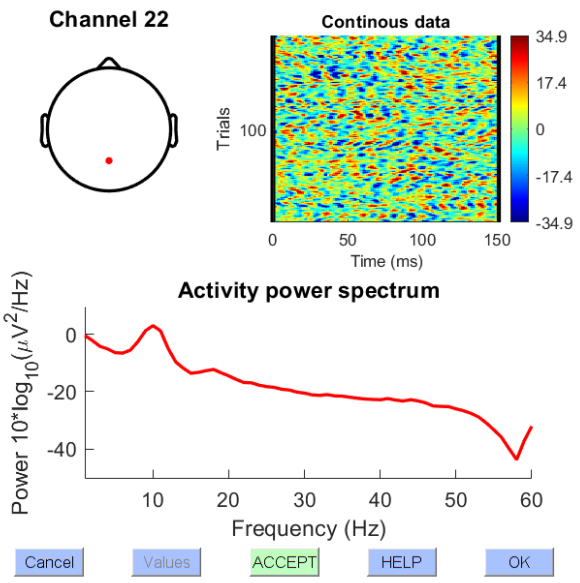
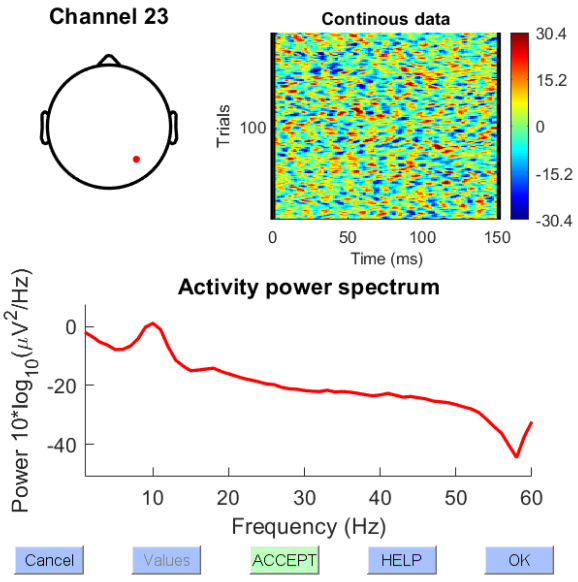
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 13
Continous data
Trials
100
0
50
100
150
Time (ms)
29.3
14.7
0
-14.7
-29.3
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

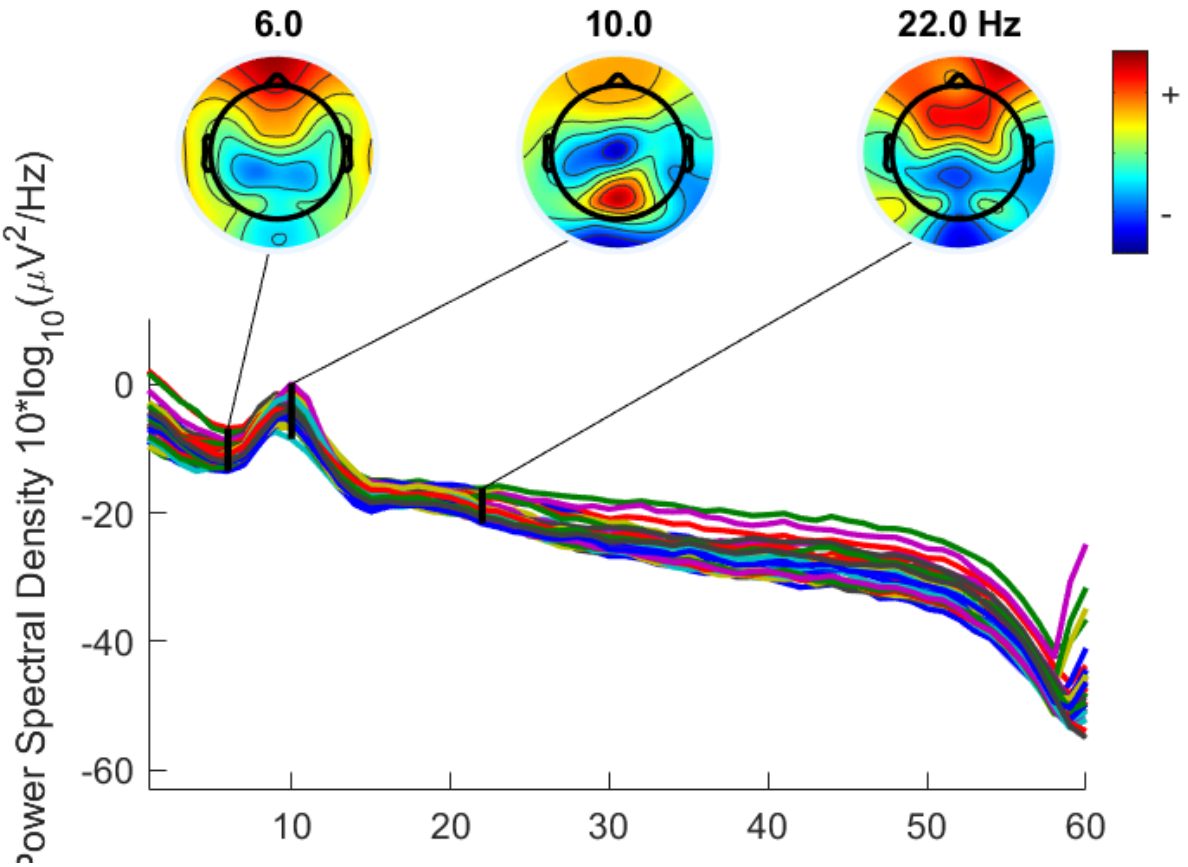

Channel 14
Continous data
Trials
100
0
50
100
150
Time (ms)
29.6
14.8
0
-14.8
-29.6
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 21
Continous data
Trials
100
0
50
100
150
Time (ms)
33.5
16.7
0
-16.7
-33.5
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

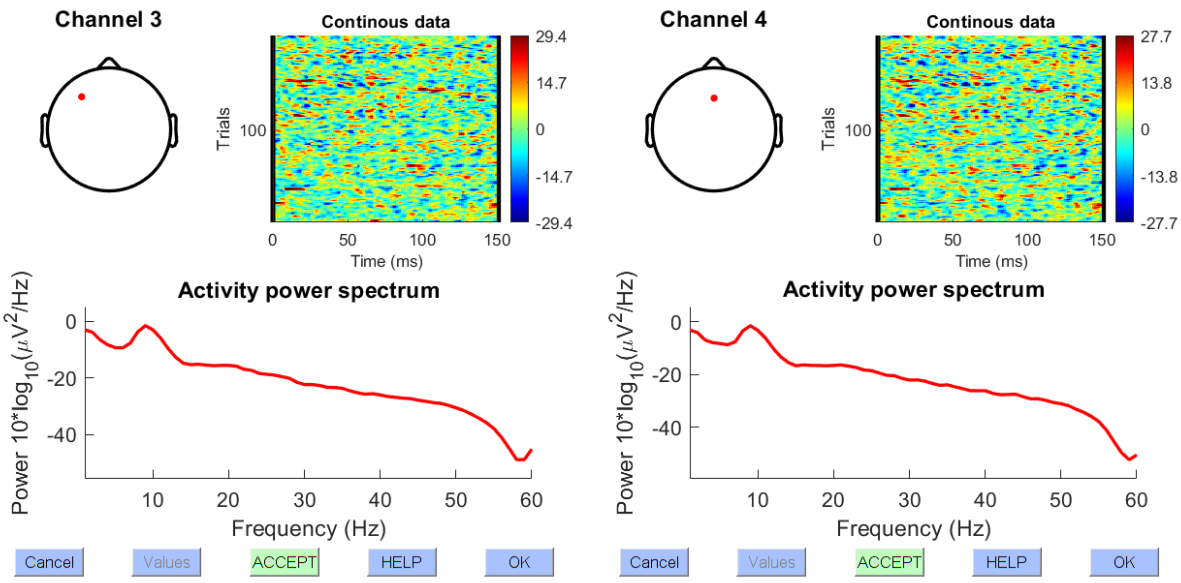

Channel 22
Continous data
Trials
100
0
50
100
150
Time (ms)
34.9
17.4
0
-17.4
-34.9
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 23
Continous data
Trials
100
0
50
100
150
Time (ms)
30.4
15.2
0
-15.2
-30.4
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

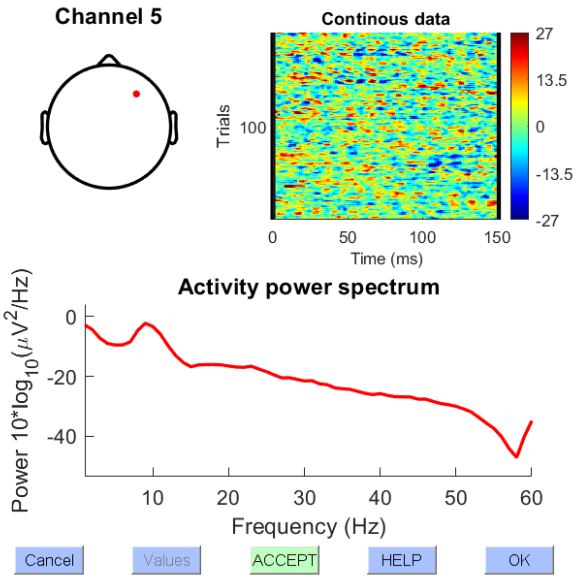
Plots of after average re-referencing

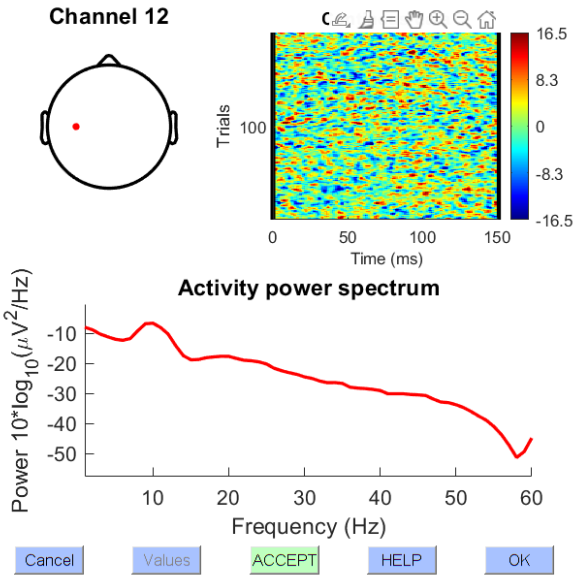


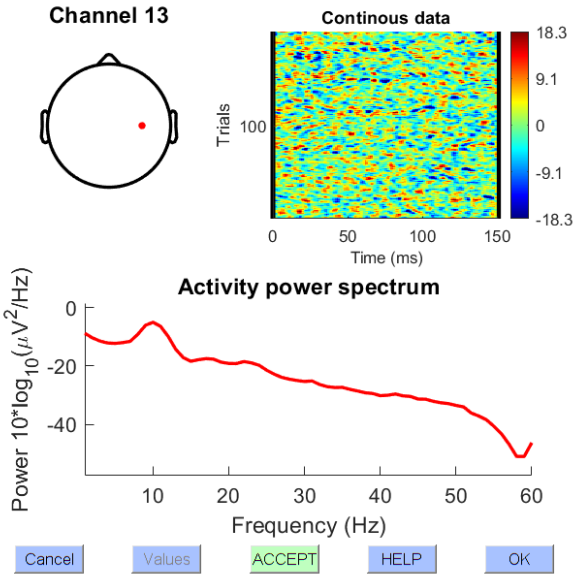
Re-referencing part is basically calculating the signals of other electrodes according to one or couple of electrodes or taking the average of electrodes. In this process, we are creating a baseline for our electrodes. Generally, this process is done by taking an electrode which is placed on somewhere around ear or on top of nose as a ground electrode. However, in here we have taken an average re-reference so our ground electrode is the average of signals coming from the electrodes.

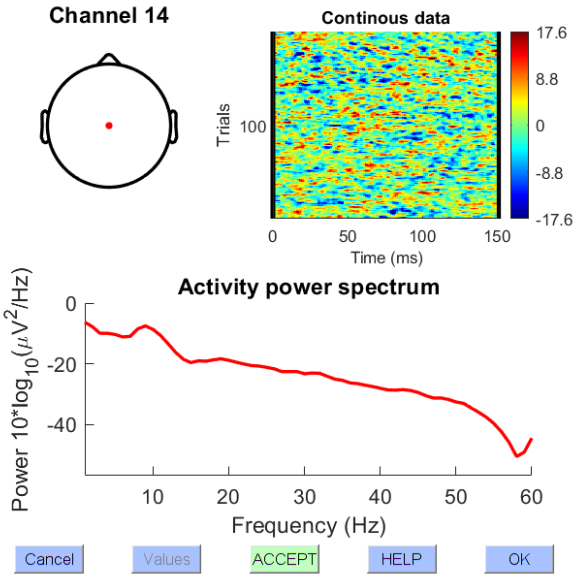

Channel 3
Continous data
Trials
100
0
50
100
150
Time (ms)
29.4
14.7
0
-14.7
-29.4
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

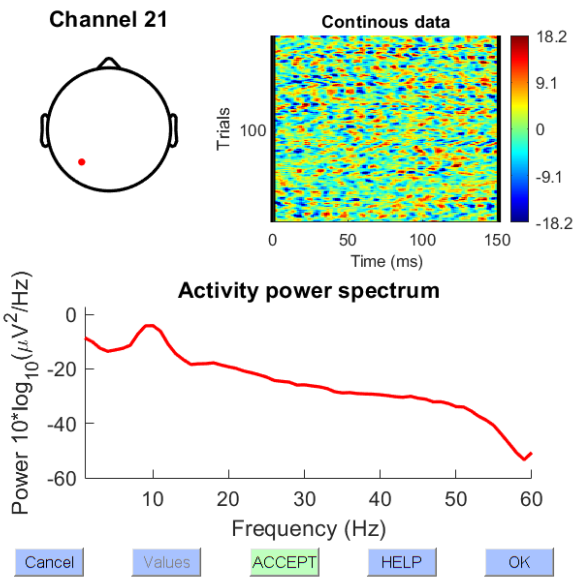
Channel 4
Continous data
Trials
100
0
50
100
150
Time (ms)
27.7
13.8
0
-13.8
-27.7
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

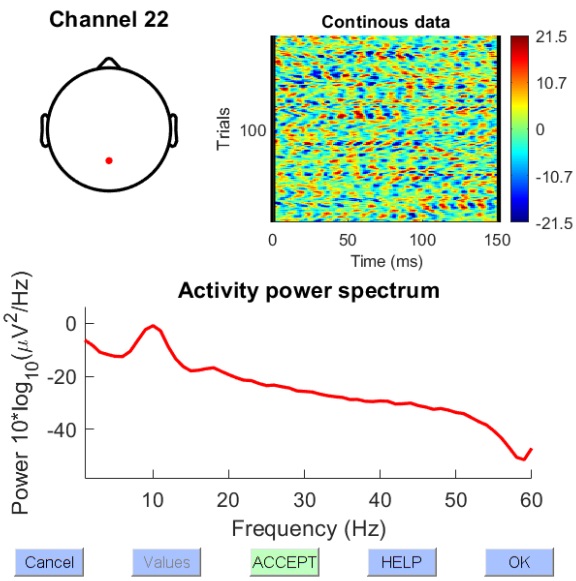

Channel 5
Continous data
Trials
100
0
50
100
150
Time (ms)
27
13.5
0
-13.5
-27
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

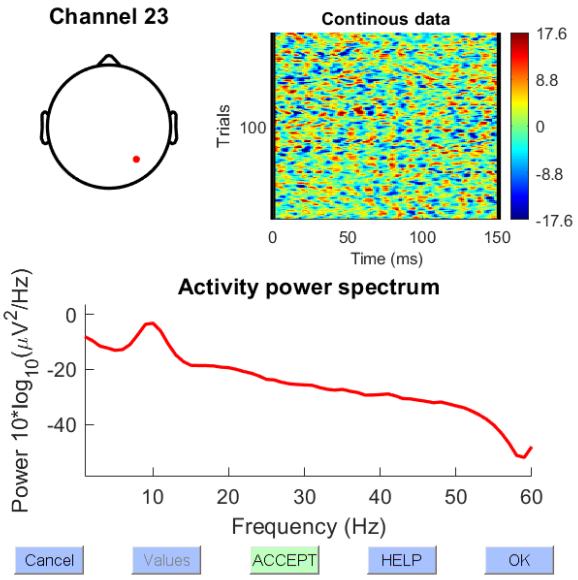

Channel 12
Trials
100
0
50
100
150
Time (ms)
16.5
8.3
0
-8.3
-16.5
Activity power spectrum
Power 10*log10(μV2/Hz)
-10
-20
-30
-40
-50
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Channel 13
Continous data
Trials
100
0
50
100
150
Time (ms)
18.3
9.1
0
-9.1
-18.3
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

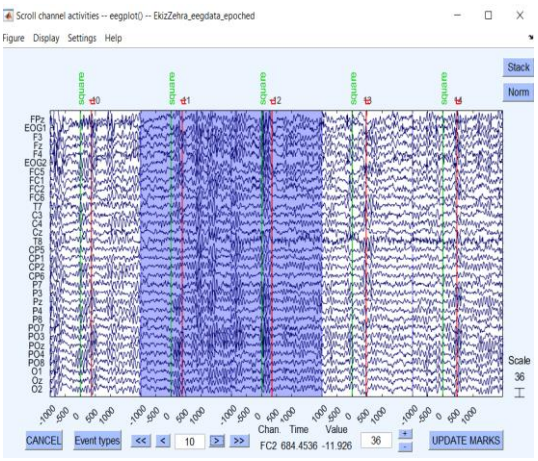

Channel 14
Continous data
Trials
100
0
50
100
150
Time (ms)
17.6
8.8
0
-8.8
-17.6
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

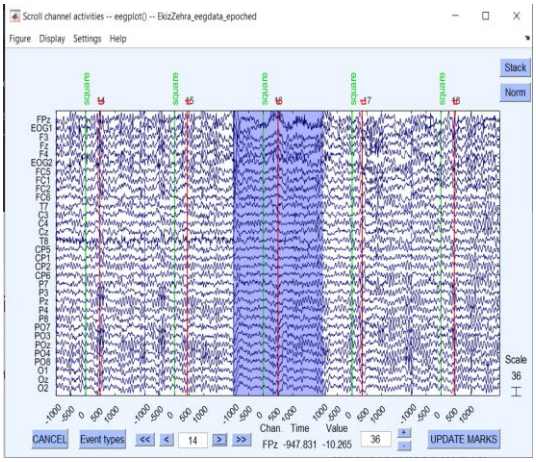

Channel 21
Continous data
Trials
100
0
50
100
150
Time (ms)
18.2
9.1
0
-9.1
-18.2
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
-60
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

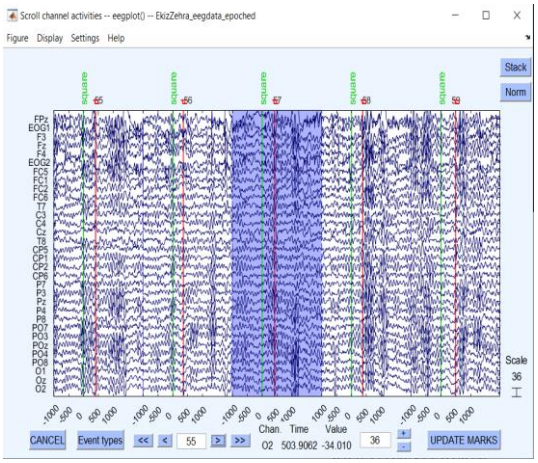

Channel 22
Continous data
Trials
100
0
50
100
150
Time (ms)
21.5
10.7
0
-10.7
-21.5
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

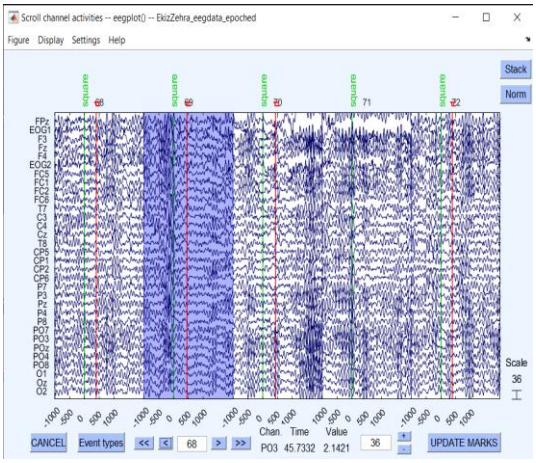

Channel 23
Continous data
Trials
100
0
50
100
150
Time (ms)
17.6
8.8
0
-8.8
-17.6
Activity power spectrum
Power 10*log10(μV2/Hz)
0
-20
-40
10
20
30
40
50
60
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

Plots of Artifact Rejection Part









In rejecting improbable data part (4.d.i) “0” trials marked for rejection among 80 trials so that there is no improbable data in our ERPs while in rejecting abnormally distributed data part (4.d.ii) “5” trials marked for rejection among 80 trials so that these are highly suspectable epoches in our data according to St.Dev. Of 5 as all of them are shown above (for the first one there are two epochs). Then, I rejected these marked epoches in following steps as you can see on matlab history file.