
بسم الله الرحمن الرحيم

Isfahan University of Medical Sciences
Faculty of new technologies in medical sciences
Department of bioelectric

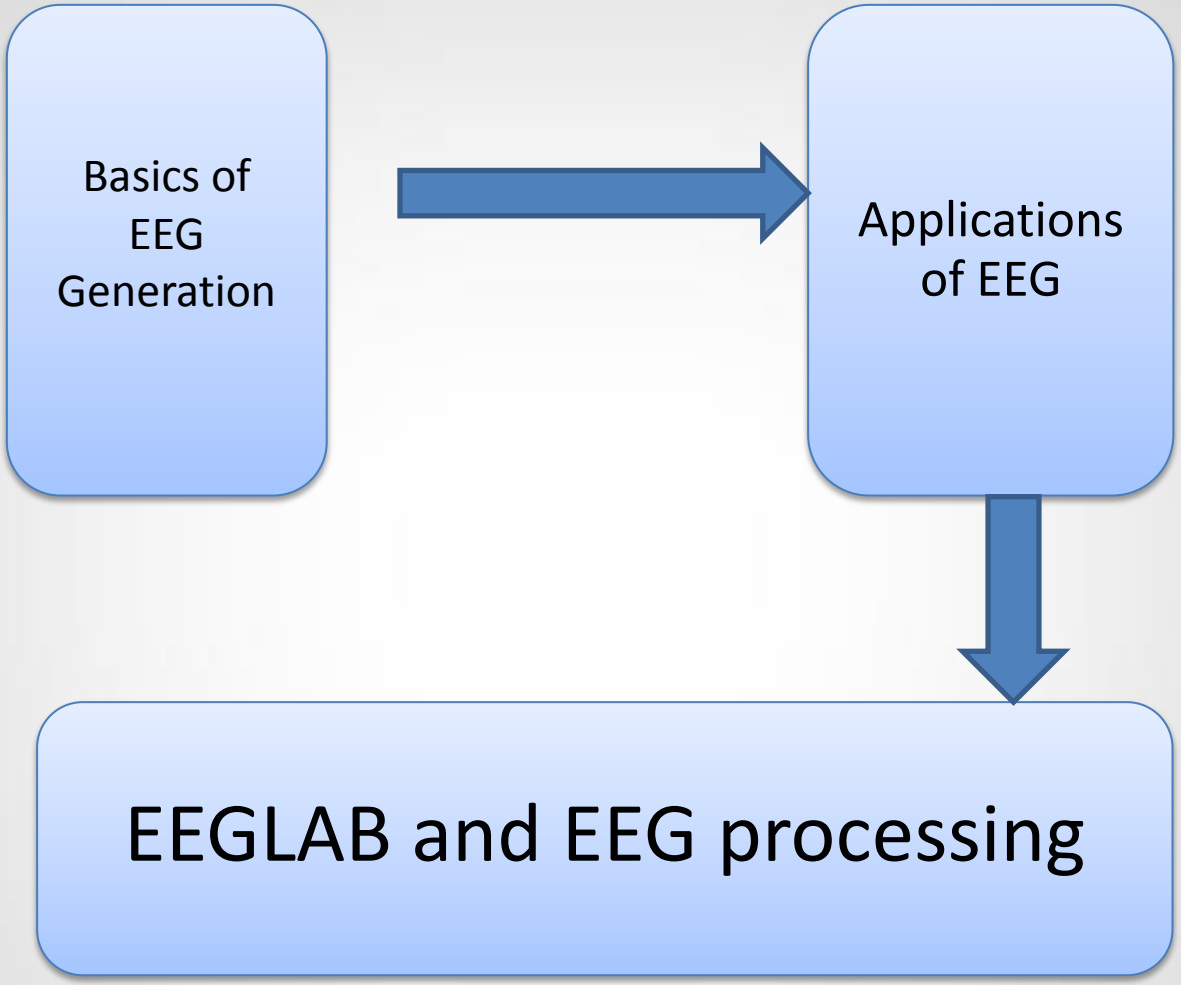
Title:

Electroencephalography

By:
Ehsan mohammadi siahboomi

summer 2019

table of content



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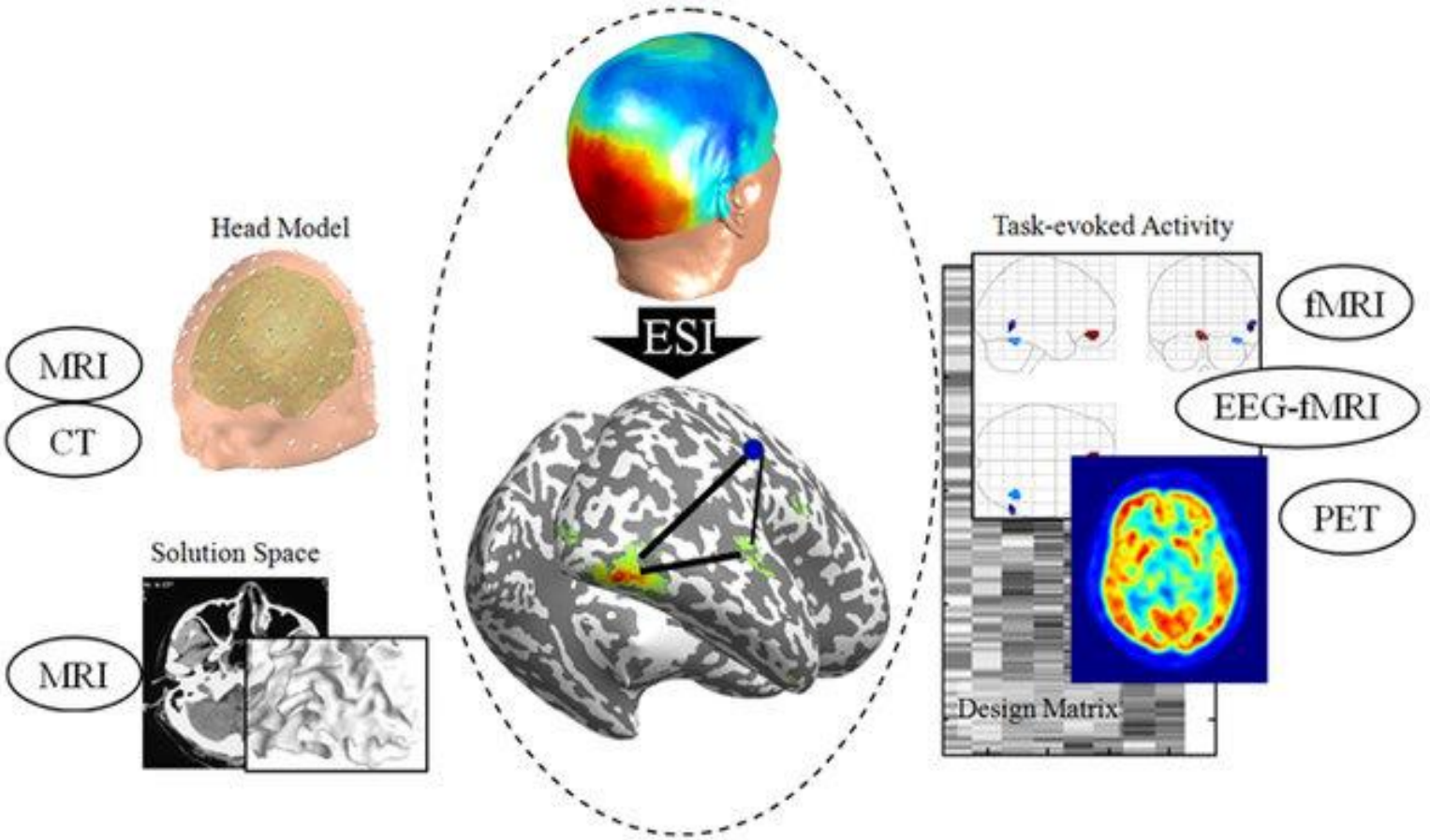

Picture from [1]

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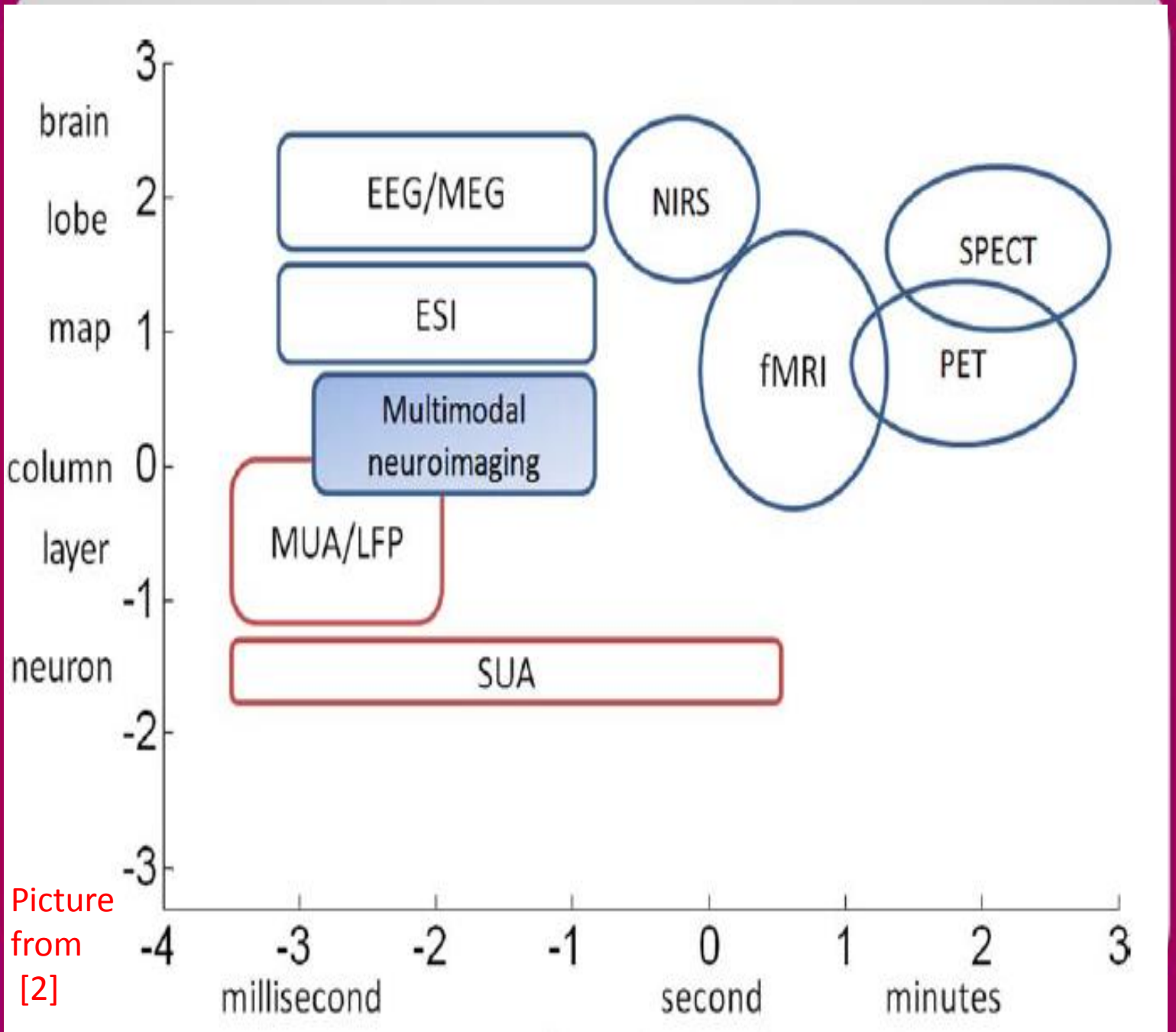

Picture from [2]

Basics of EEG Generation

Applications of EEG

EEGLAB and EEG processing

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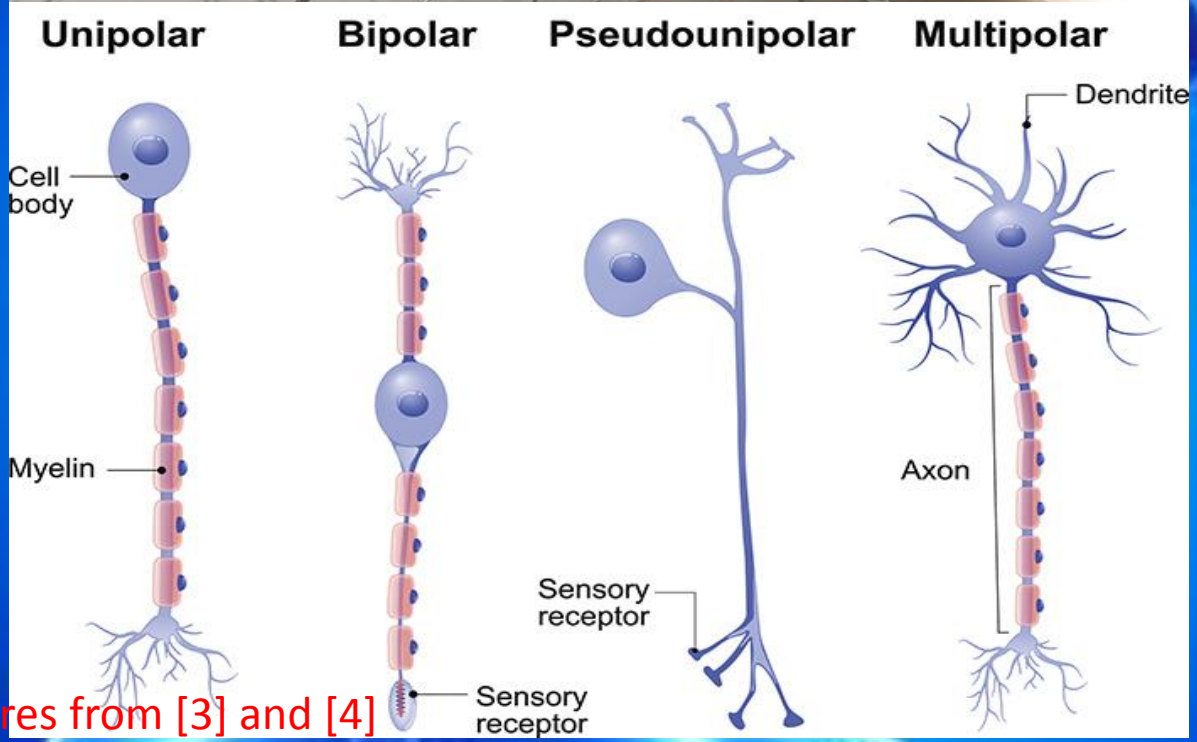

Pictures from [3] and [4]

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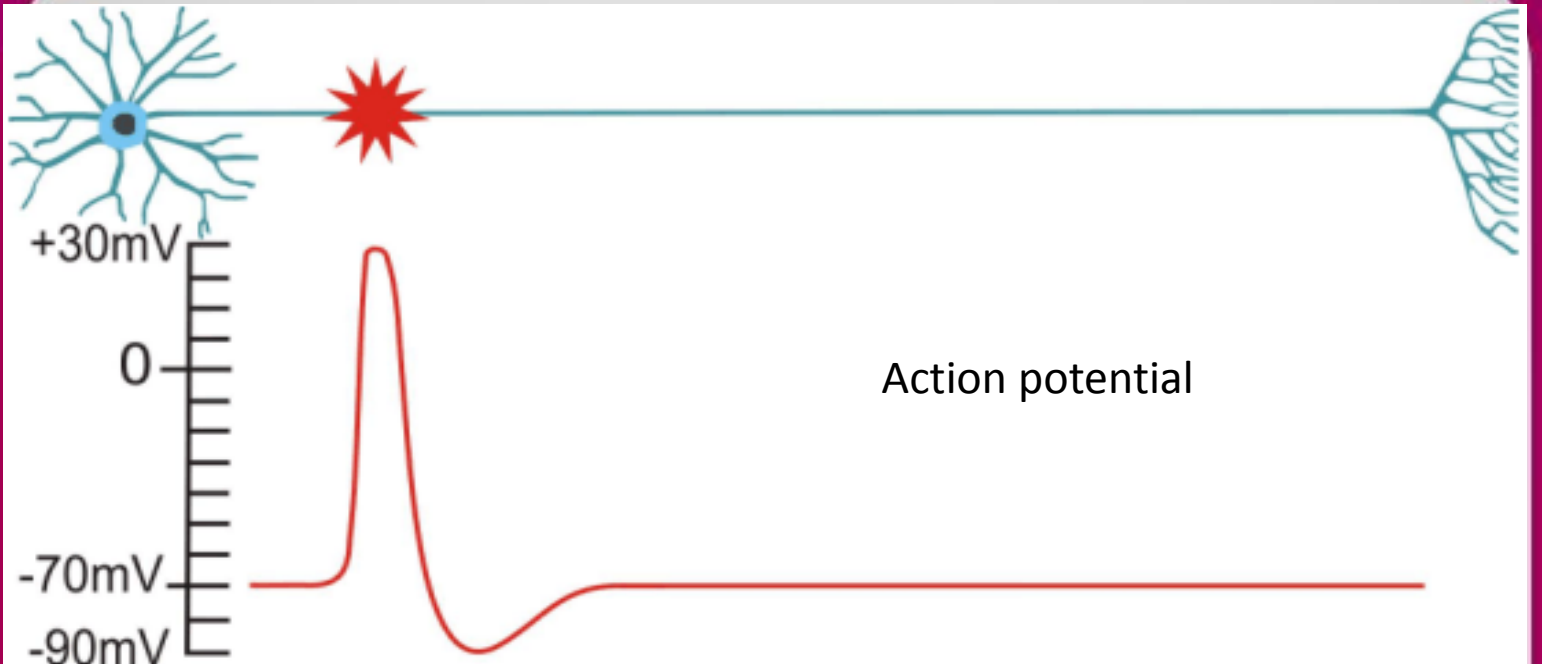
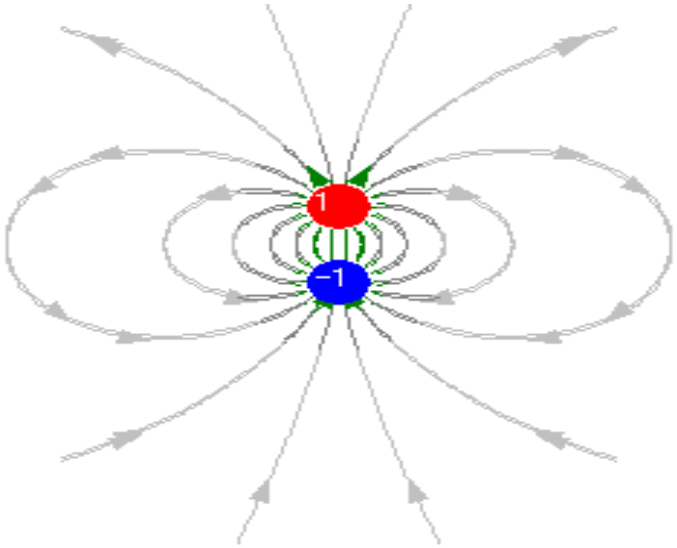
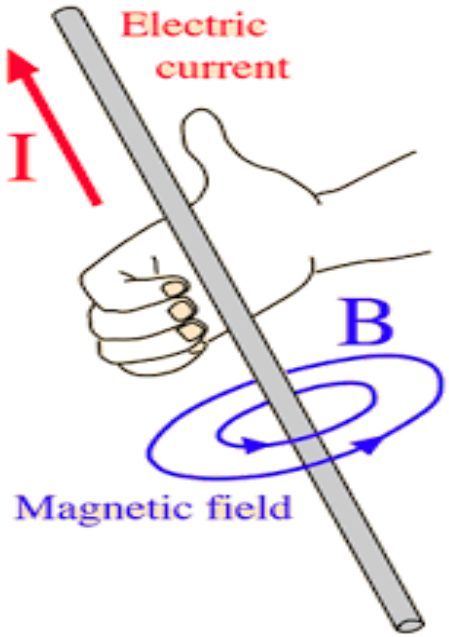
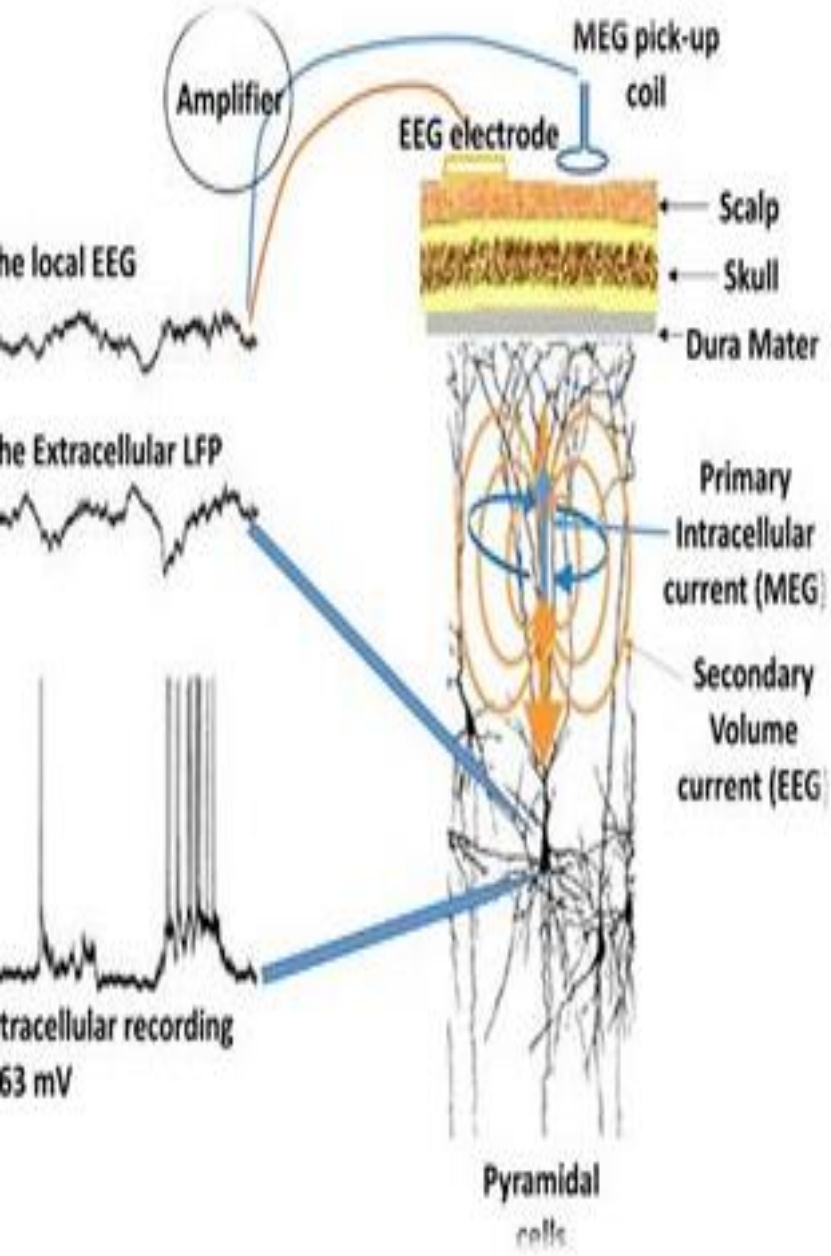
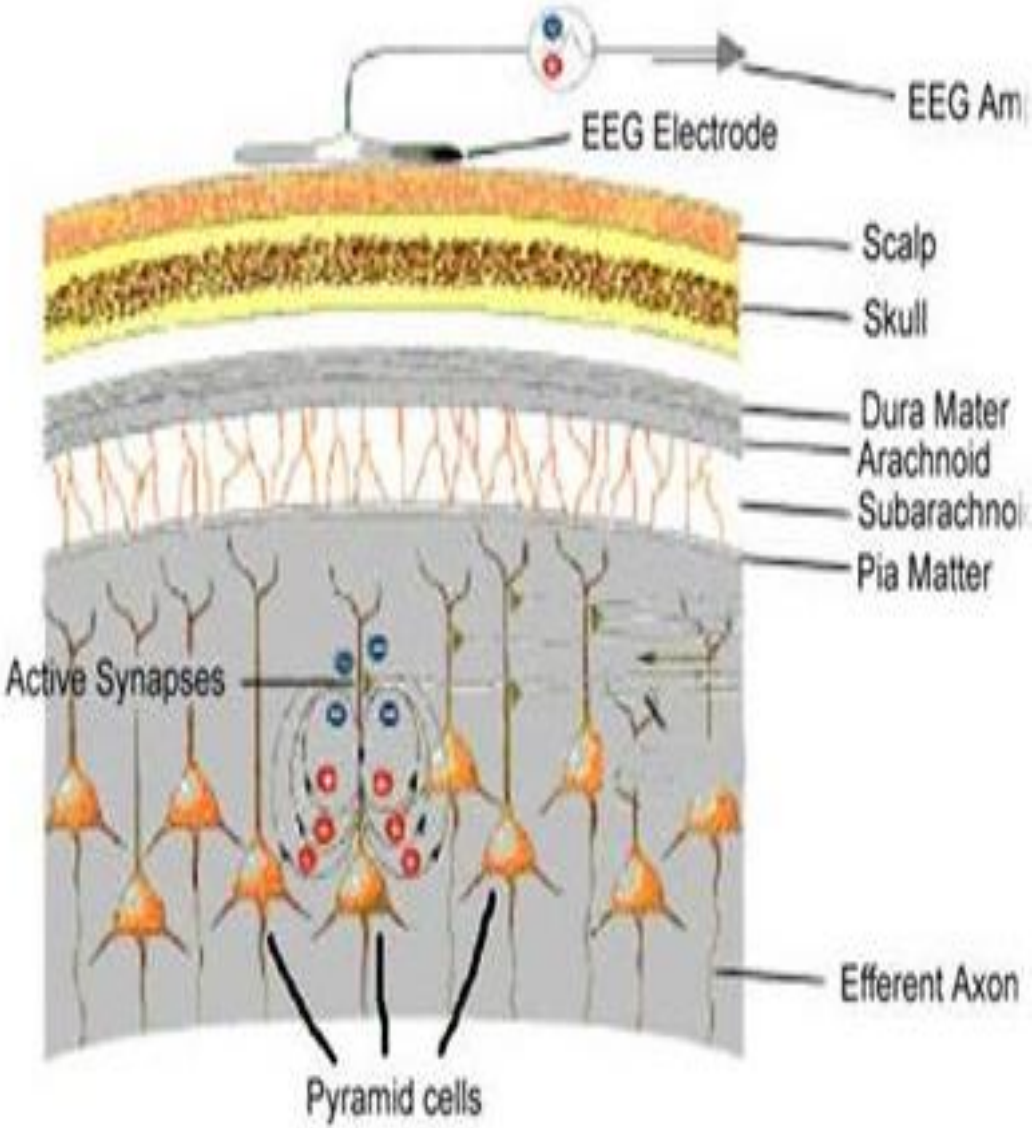






Pictures from [5]


Amplifier
MEG pick-up coil
EEG electrode
Scalp
Skull
Dura Mater
he local EEG
he Extracellular LFP
Primary Intracellular current (MEG
Secondary Volume current (EEG
tracellular recording
63 mV
Pyramidal


EEG Electrode
EEG Am
Scalp
Skull
Dura Mater
Arachnoid
Subarachnoi
Pia Matter
Active Synapses
Efferent Axon
Pyramid cells

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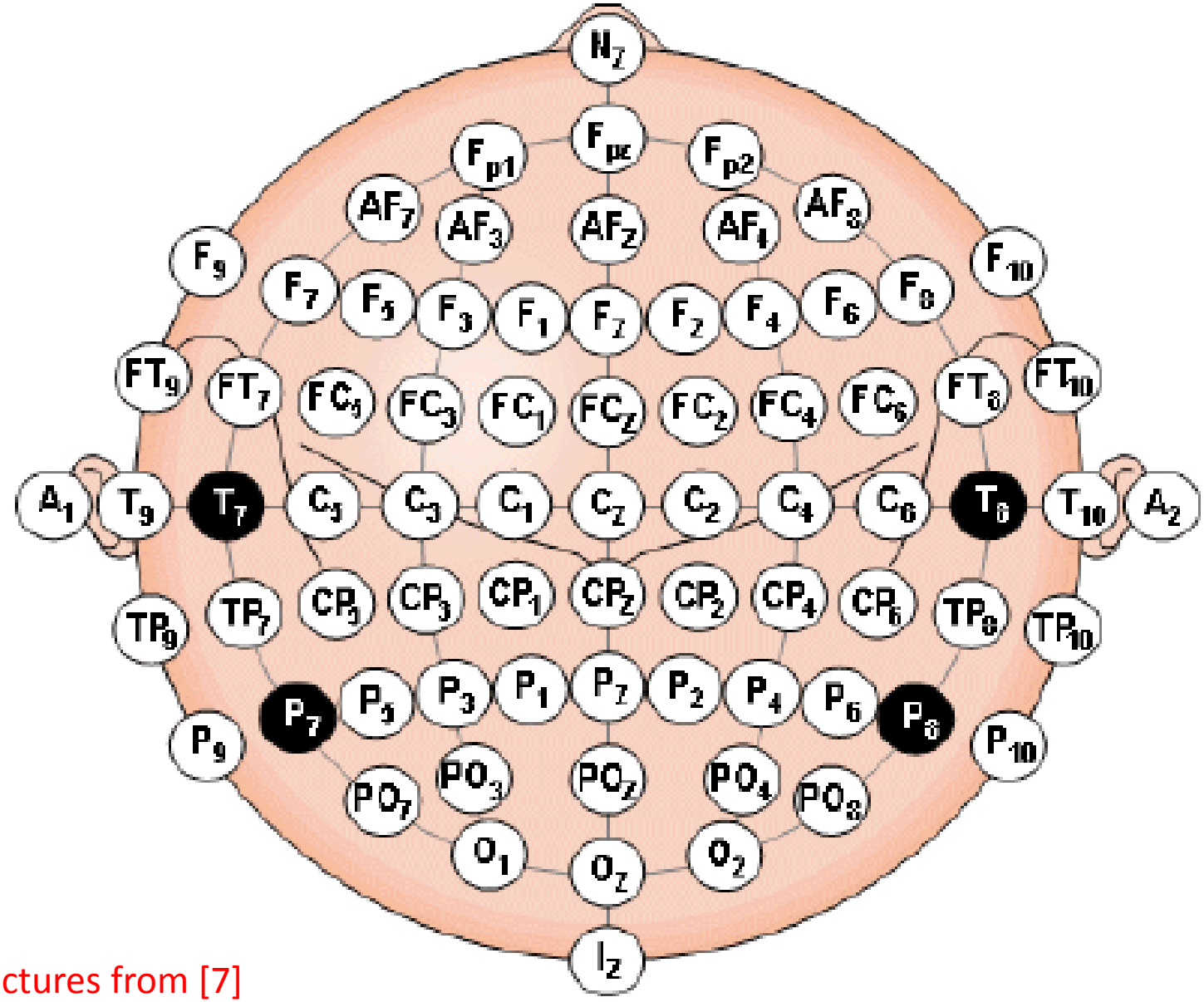

Pictures from [7]

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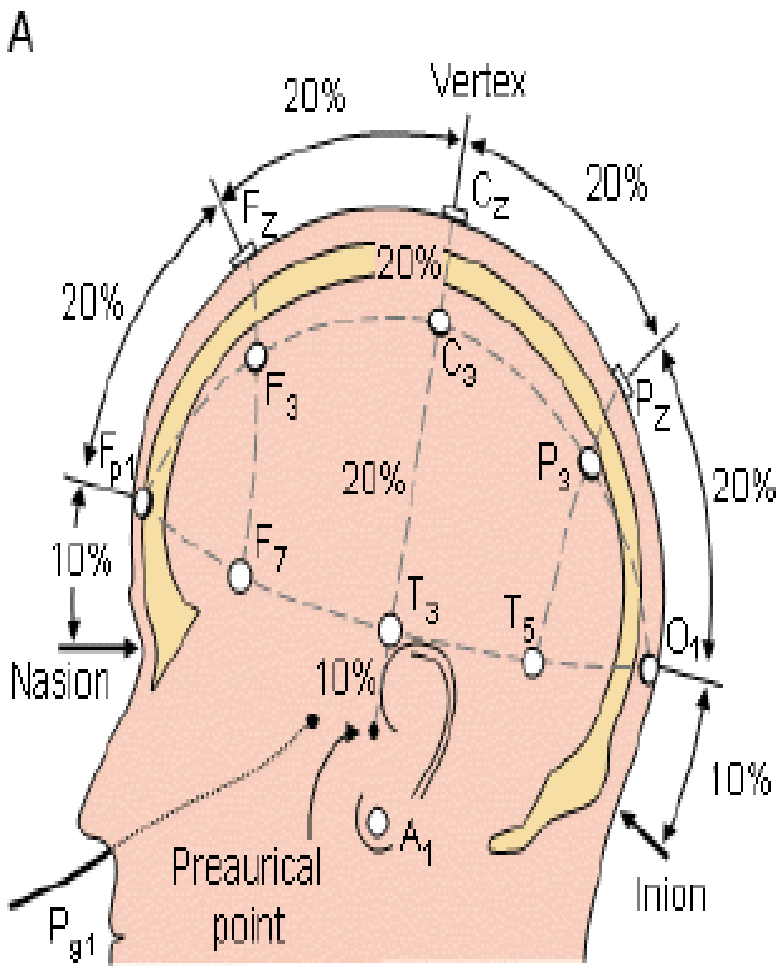

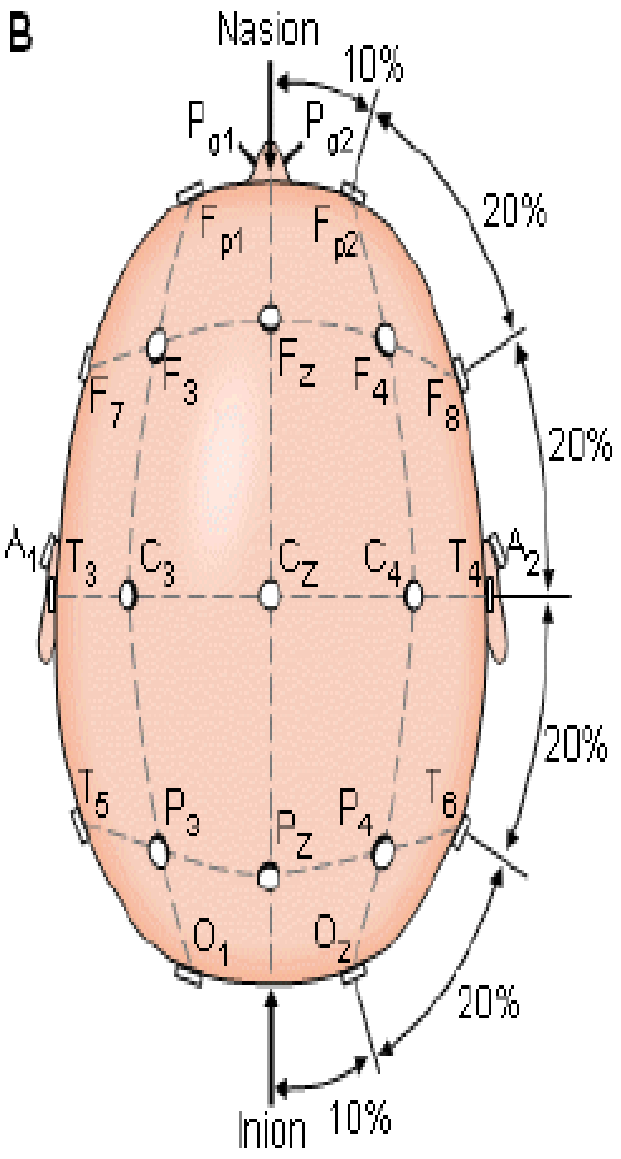

Pictures from [7]

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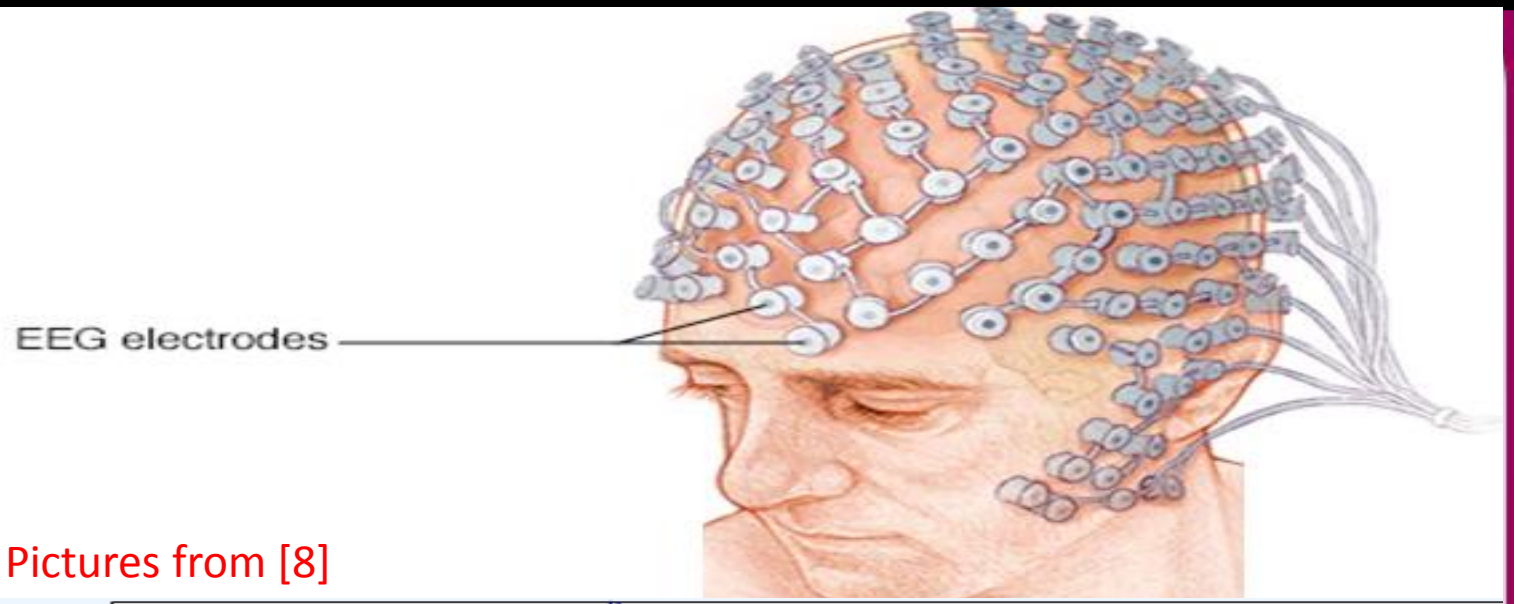
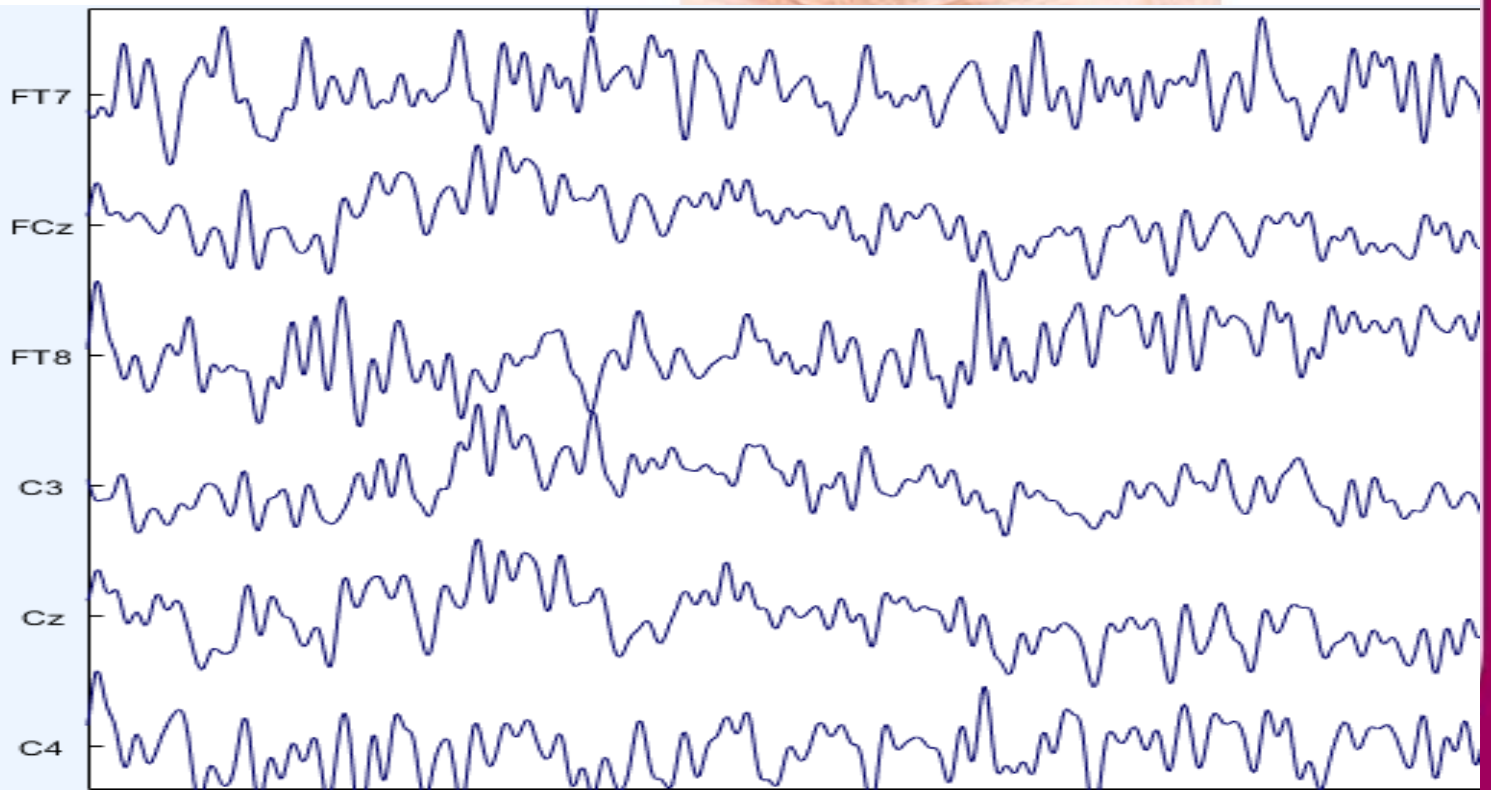


Pictures from [8]



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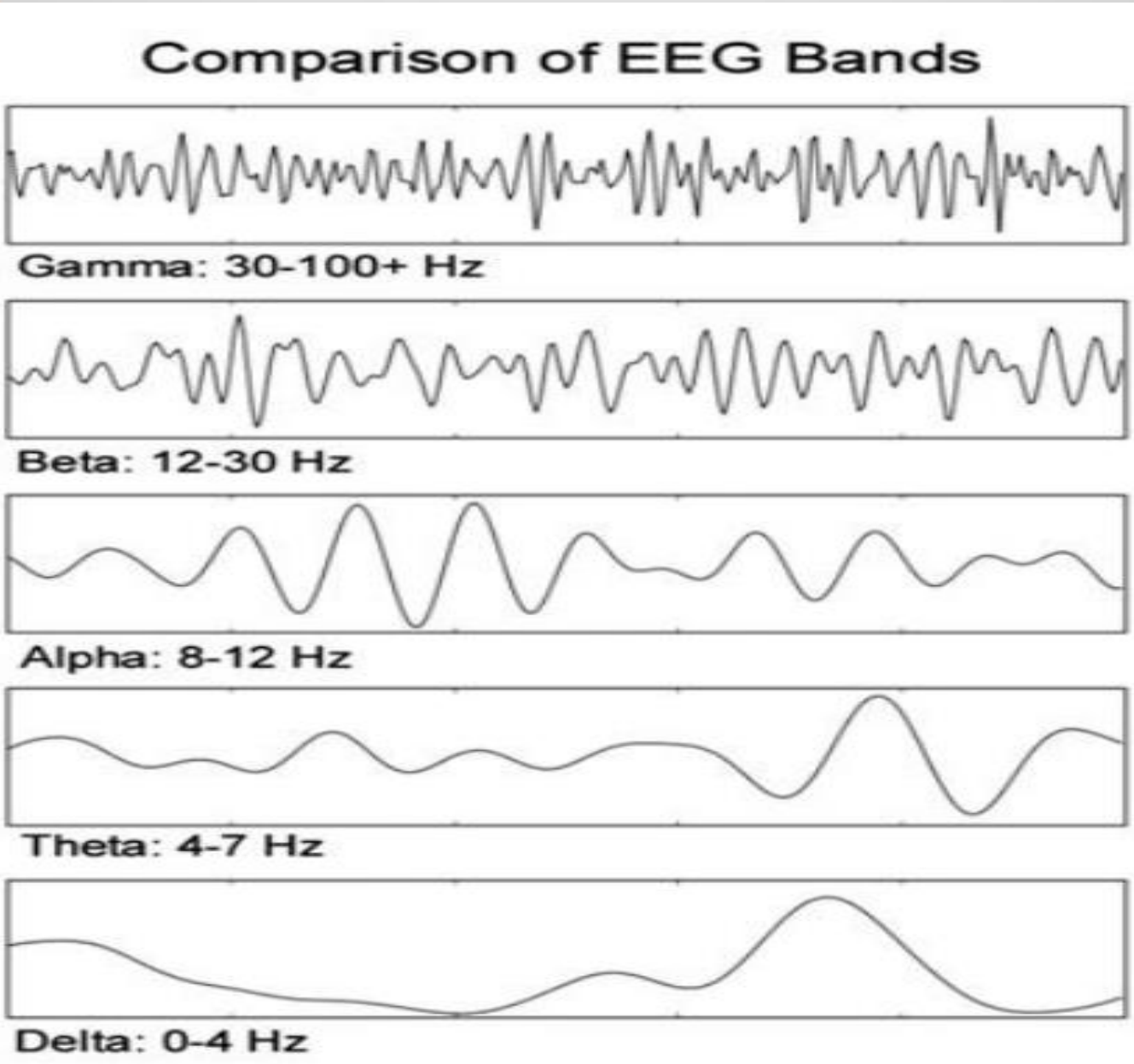

Pictures from [9]

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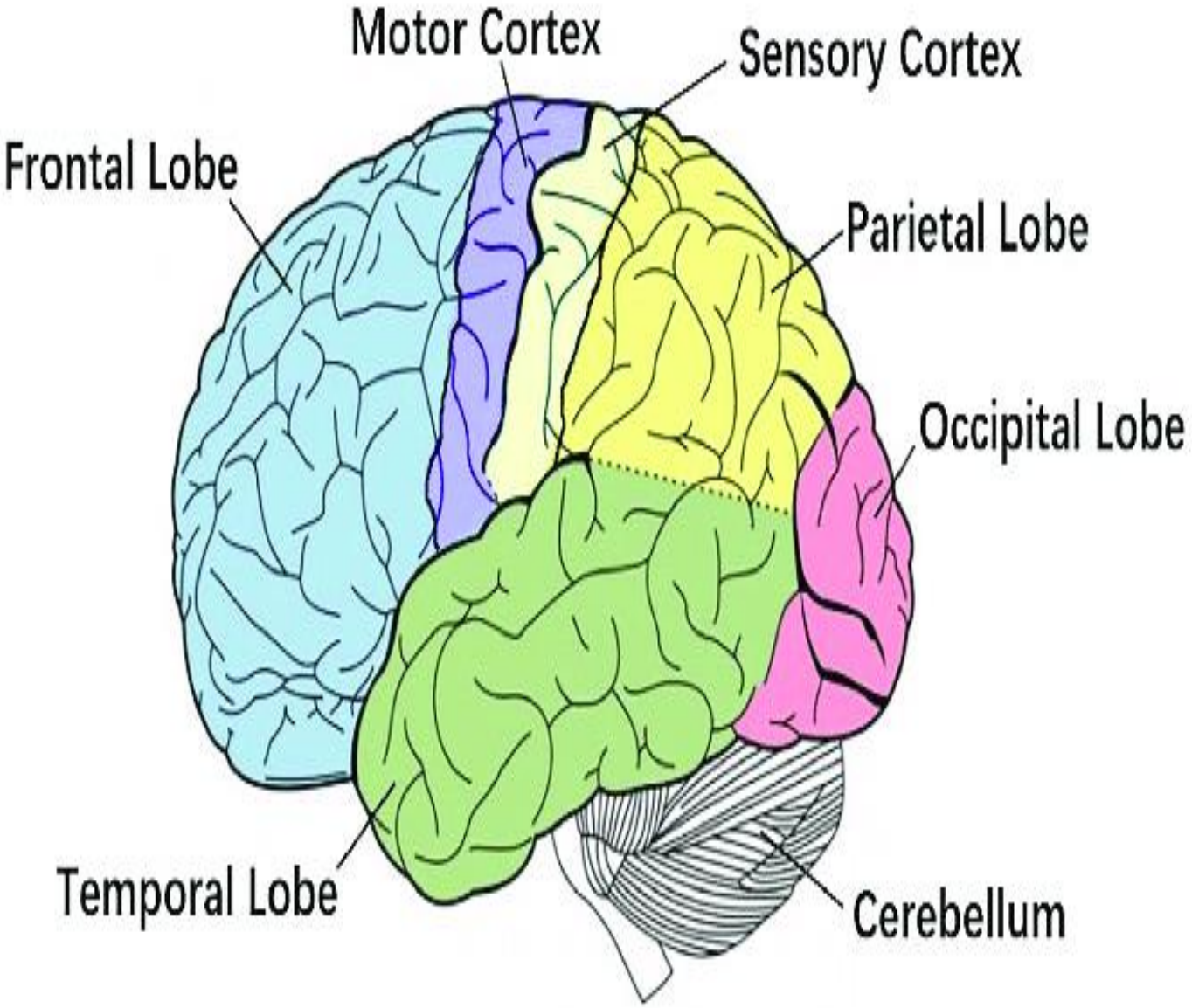

Picture from [12]

Basics of EEG Generation

Applications of EEG

EEGLAB and EEG processing

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EEGLAB

EEGLAB13 or EEGLAB14 and matlab R2013a

EEGLAB
http://sccn.ucsd.edu/wiki/How_to_download_EEGLAB
SIFT
http://sccn.ucsd.edu/wiki/SIFT
ARFIT
http://www.gps.caltech.edu/~tapio/arfit/arfit.zip
Tim Mullen Clean Line
http://www.nitrc.org/projects/cleanline/
MARA
http://www.user.tu-erlin.de/irene.winkler/artifacts/
DIPFIT
http://sccn.ucsd.edu/wiki/A08:_DIPFIT
Fieldtrip
ftp://ftp.fcdonders.nl/pub/fieldtrip/

Basics of EEG Generation

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HOW TO INSTALL

1- download EEGLAB and plugins

2- copy plugins in EEGLAB\plugins

3- add to path EEGLAB folder

4- type eeglab

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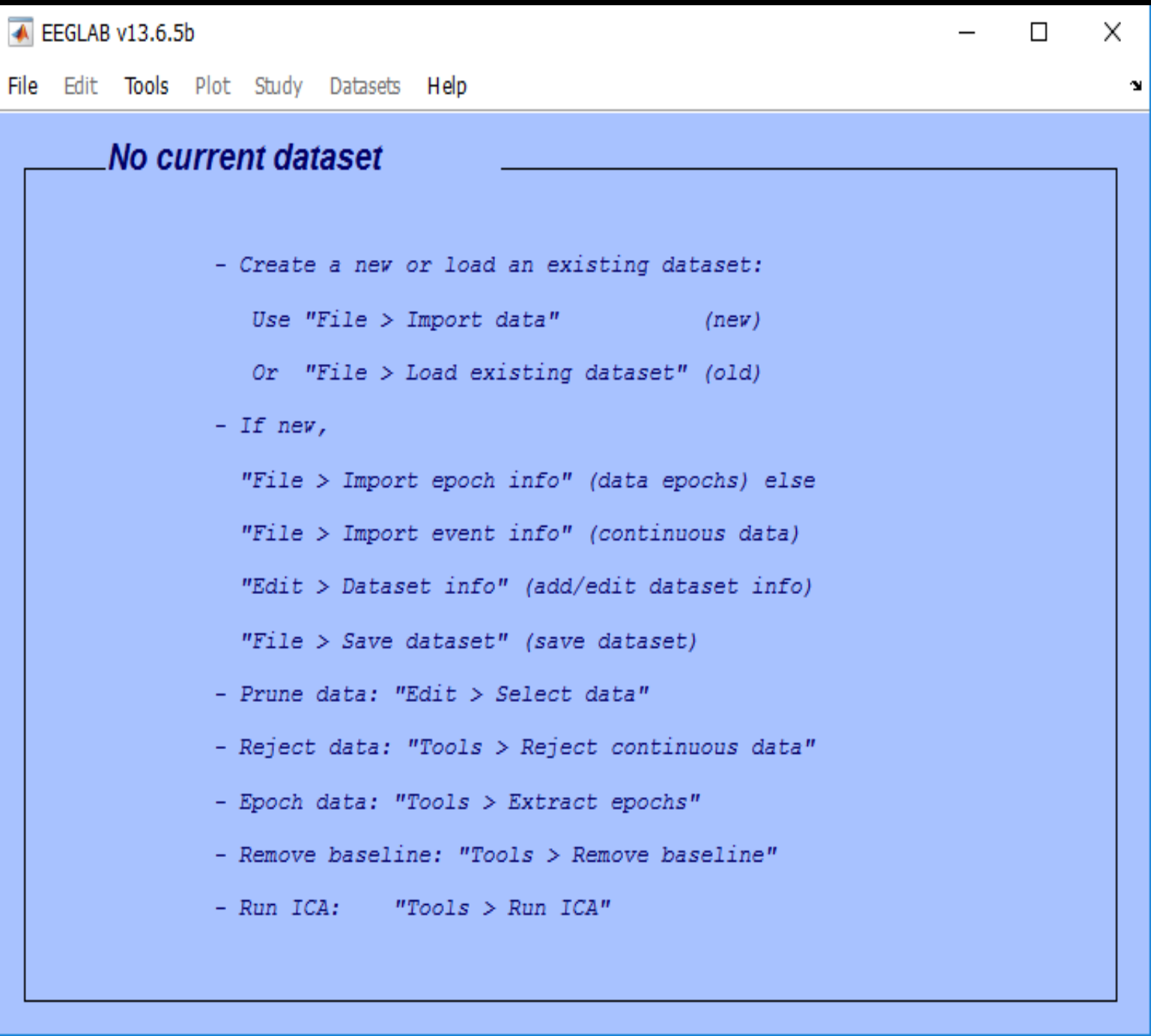

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Makoto's preprocessing pipeline [reference 10]

1- Change the option to use double precision
2- Check the path and import data and events
3- Downsample if necessary
4- High-pass filter the data at 1-Hz
5- Import channel info
6- Remove bad channels
7- Interpolate all the removed channels
8- Re-reference the data to average
9- Remove line noise using CleanLine
10- Epoch data to -1 to 2 sec
11- Reject epochs for cleaning
12- Adjust data rank for ICA
13- Run ICA

Memory options - pop_editoptions()

1- Change the option to use double precision

Set/Unset

STUDY and file options (set these checkboxes if you intend to work with studies)

If set, keep at most one dataset in memory. This allows processing hundreds of datasets within studies. ☐

If set, save not one but two files for each dataset (header and data). This allows faster data loading in studies. ☑

If set, write Matlab files in Matlab v6.5 (max compatibility). If not, write files in Matlab v7.3 (larger than 2Gb). ☑

Memory options

If set, use single precision under Matlab 7.x. This saves RAM but can lead to rare numerical imprecisions. ☑

If set, use memory mapped array under Matlab 7.x. This may slow down some computation (beta). ☐

If set, use the EEGLAB EEG object instead of the standard EEG structure (beta). ☐

2- Check the path and import data and events

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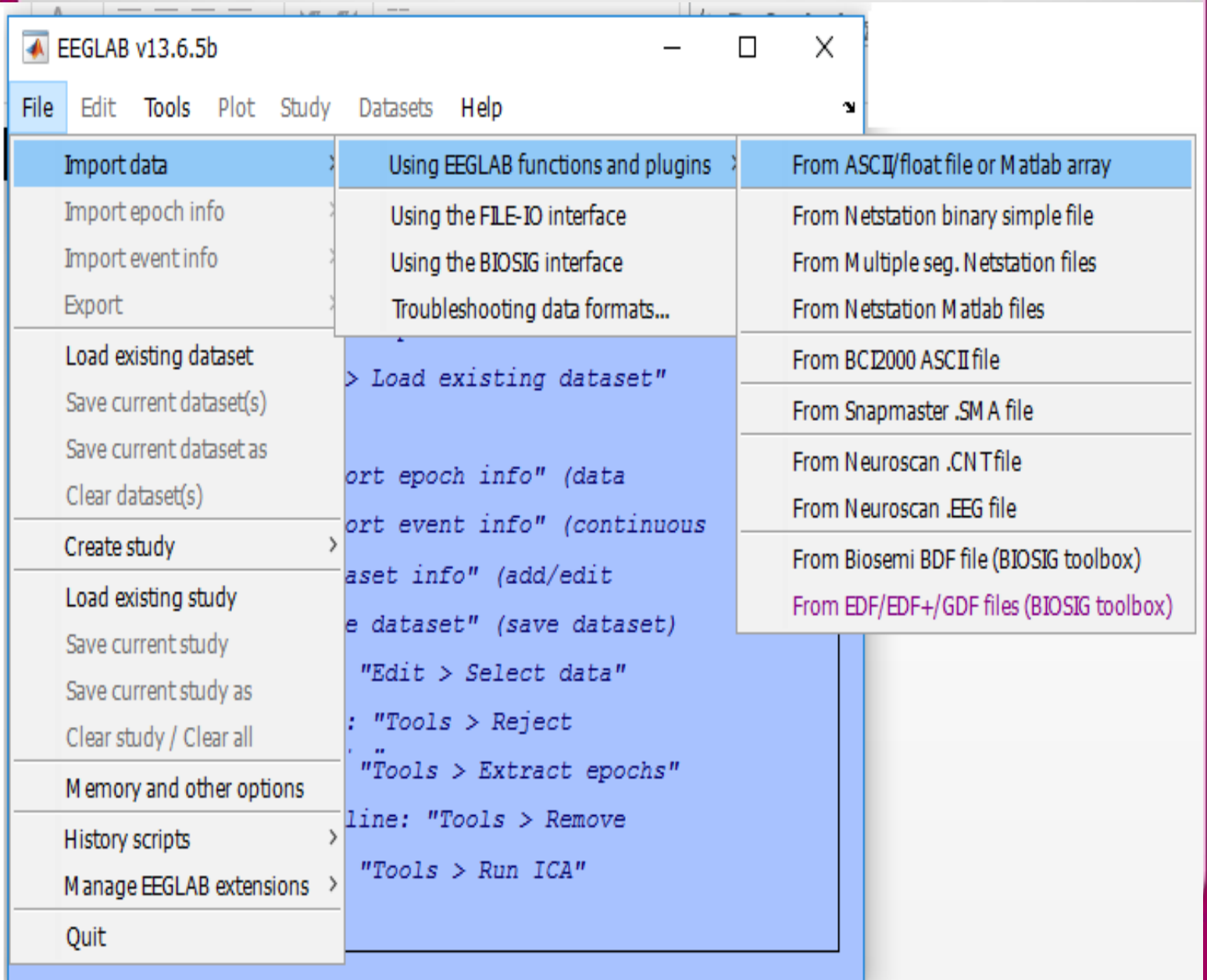
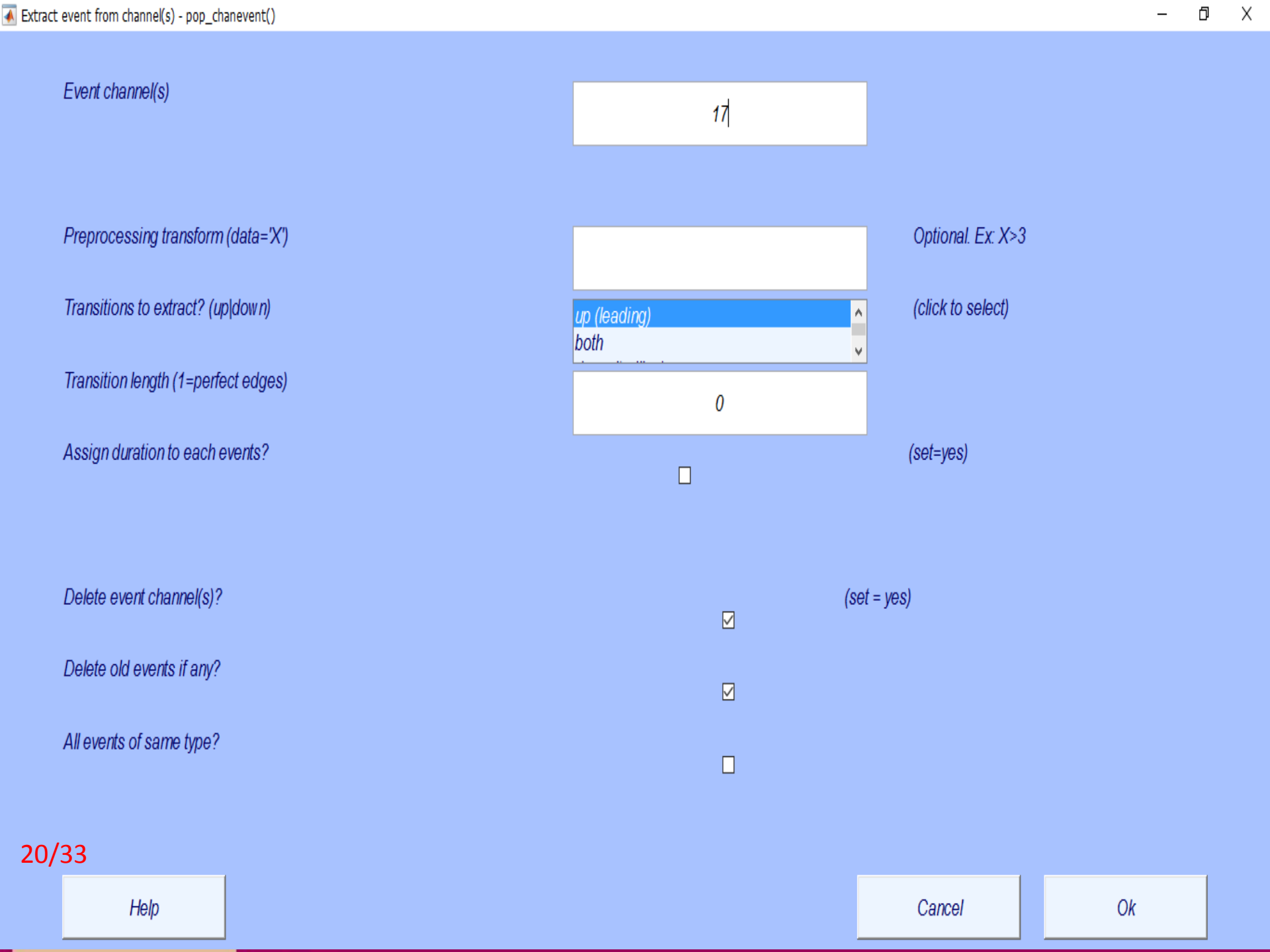



Data file/array (click on the selected option)
Matlab variable
class1
Browse
Dataset name
class1
Data sampling rate (Hz)
2400
Subject code
Time points per epoch (0->continuous)
0
Task condition
Start time (sec) (only for data epochs)
0
Session number
Number of channels (0->set from data)
0
Subject group
Ref. channel indices or mode (see help)
About this dataset
Enter comments
Channel location file or info
From other dataset
Browse
(note: autodetect file format using file extension; use menu "Edit > Channel locations" for more importing options)
ICA weights array or text/binary file (if any):
From other dataset
Browse
ICA sphere array or text/binary file (if any):
From other dataset
Browse
Help
19/33
Cancel
Ok


Extract event from channel(s) - pop_chanevent()
Event channel(s)
17
Preprocessing transform (data='X')
Optional. Ex: X>3
Transitions to extract? (up|down)
up (leading)
both
(click to select)
Transition length (1=perfect edges)
0
Assign duration to each events?
(set=yes)
Delete event channel(s)?
(set = yes)
Delete old events if any?
All events of same type?
20/33
Help
Cancel
Ok

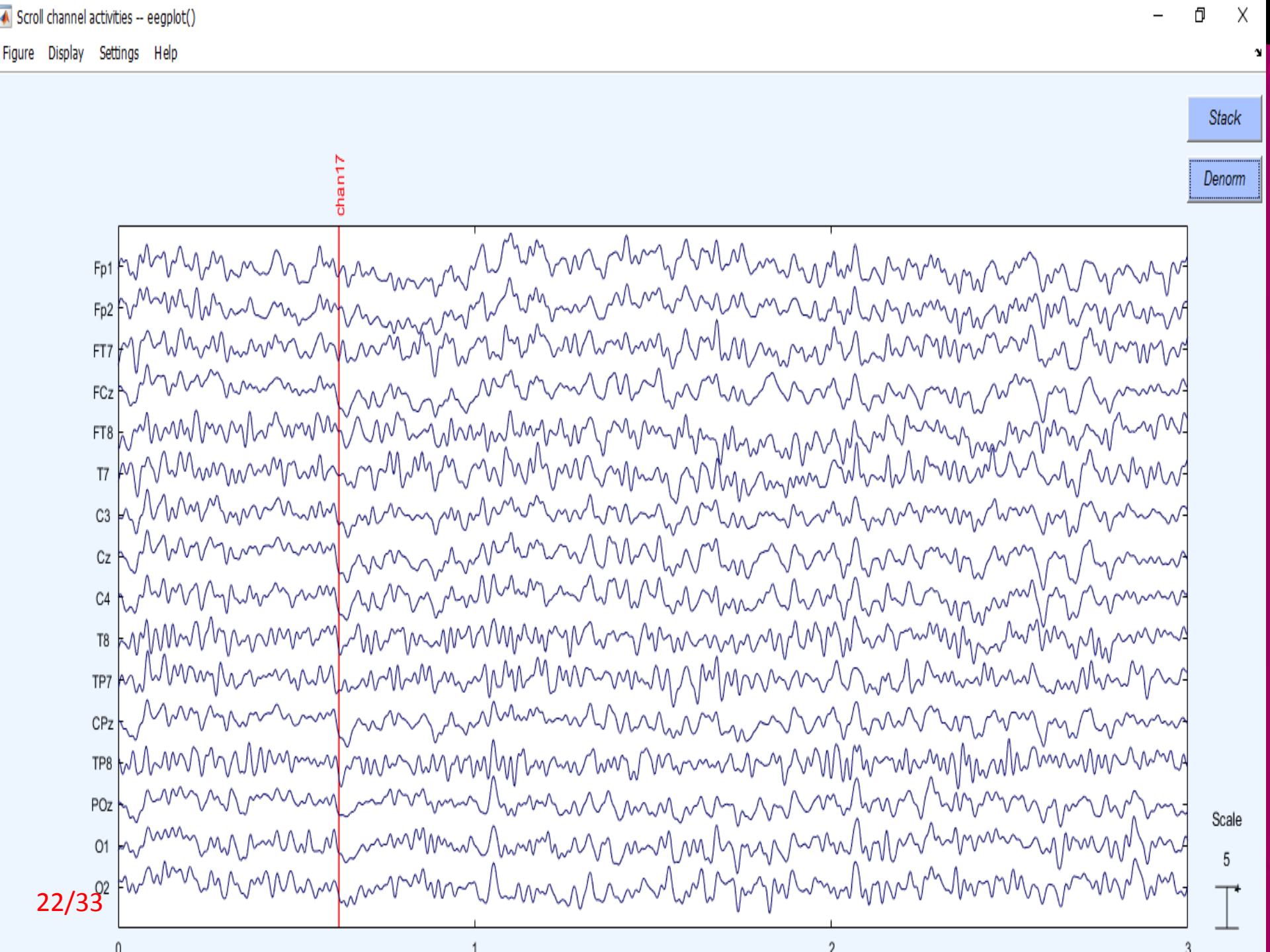
EEGLAB v13.6.5b

File Edit Tools Plot Study Datasets Help

- Dataset info
- Event fields
- Event values
- About this dataset
- Channel locations
- Select data
- Select data using events
- Select epochs or events
- Copy current dataset
- Append datasets
- Delete dataset(s) from memory

ss1

rame	16
ch	7200
	1
Events	1
Sampling rate (Hz)	2400
Epoch start (sec)	0.000
Epoch end (sec)	3.000
Reference	unknown
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	1


Scroll channel activities -- eegplot()
Figure
Display
Settings
Help
Stack
Denorm
chan17
Fp1
Fp2
FT7
FCz
FT8
T7
C3
Cz
C4
T8
TP7
CPz
TP8
POz
O1
O2
0
1
2
3
Scale
5
22/33

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3- Downsample if necessary

Tools\change sampling rate → 250 Hz

4- High-pass filter the data at 1-Hz

Tools\filter the data\ basic FIR

5- Import channel info

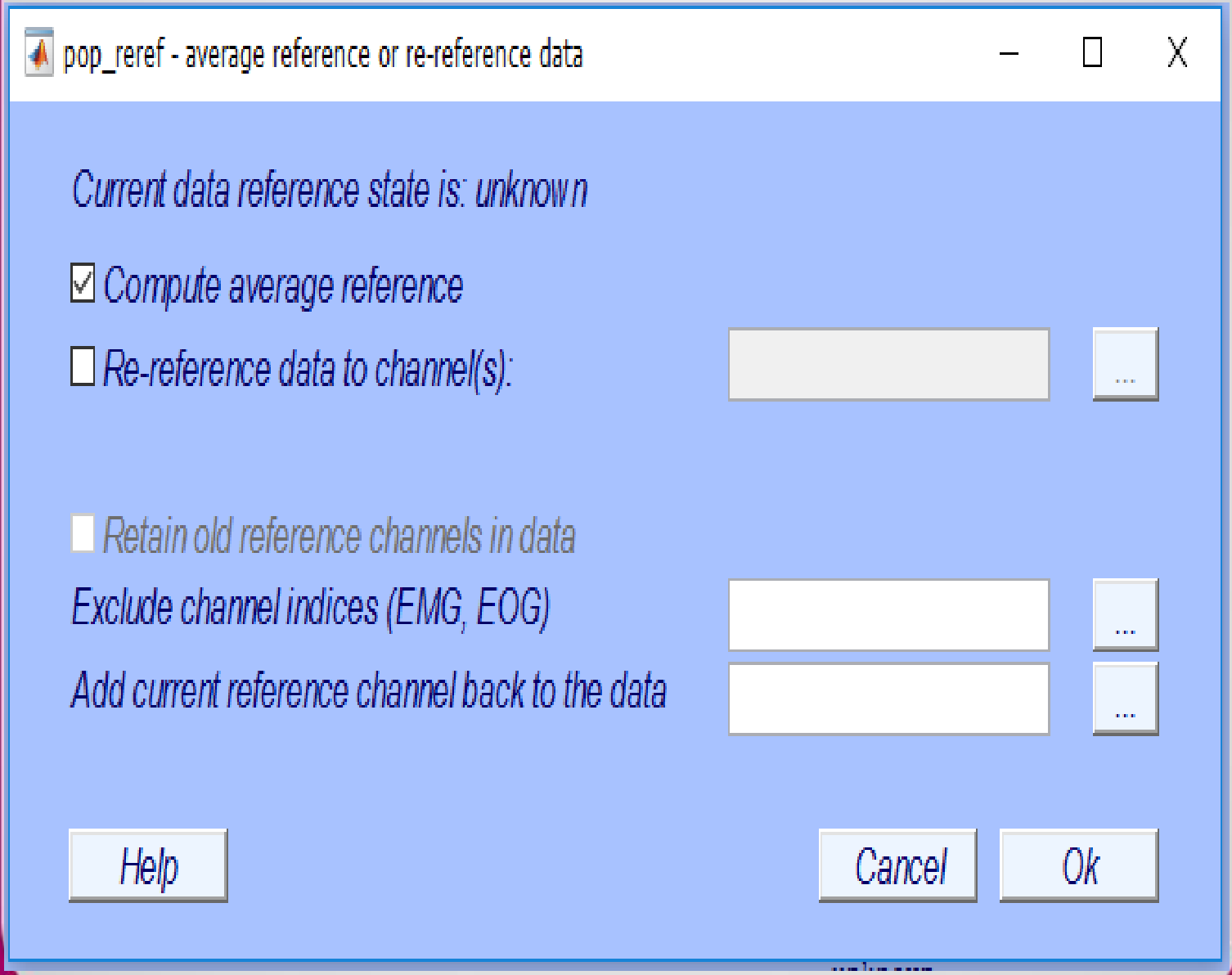
…….

6- Remove bad channels

ASR and …

7- Interpolate all the removed channels

8- Re-reference the data to average



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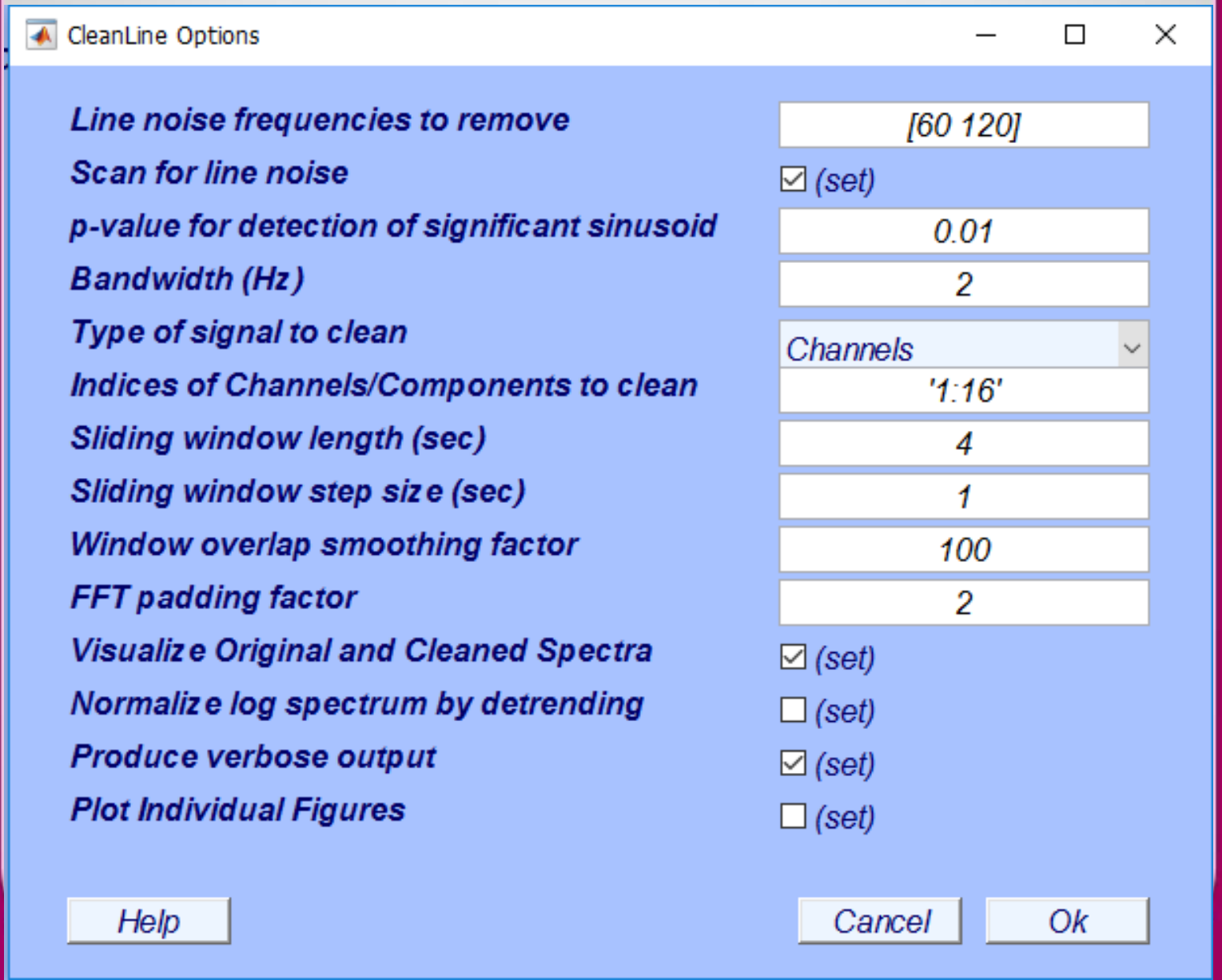
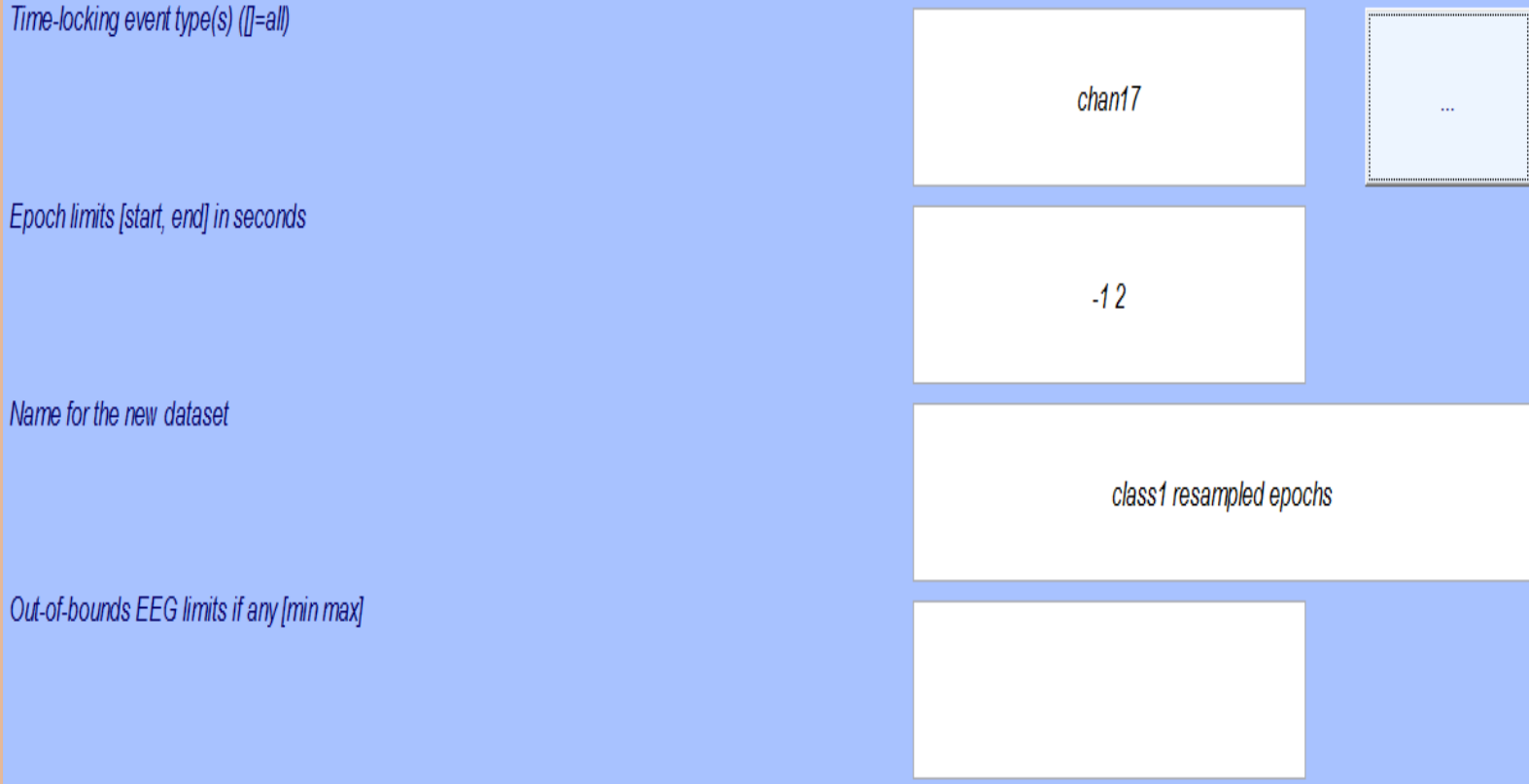
9- Remove line noise using CleanLine



10- Epoch data to -1 to 2 sec



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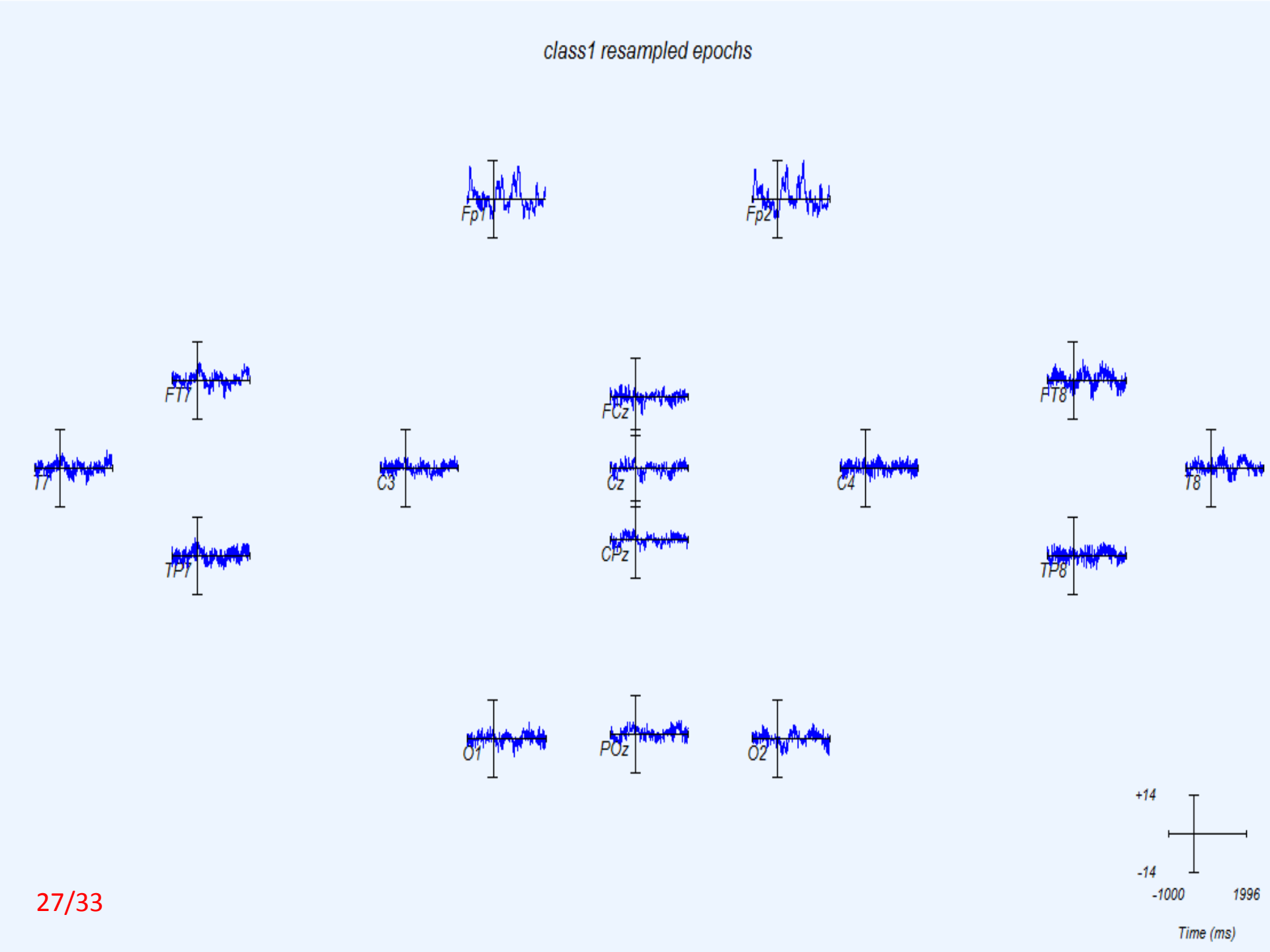
class1 resampled epochs
Fp1
Fp2
FT7
FCz
FT8
T7
C3
Cz
C4
T8
TP7
CPz
TP8
O1
POz
O2
+14
-14
-1000
1996
Time (ms)

11- Reject epochs for cleaning

.....

12- Adjust data rank for ICA

.....

13- Run ICA

Tools\ Run ICA

Hint 1 ---- > artifact components

Hint 2 --- > EEG.history

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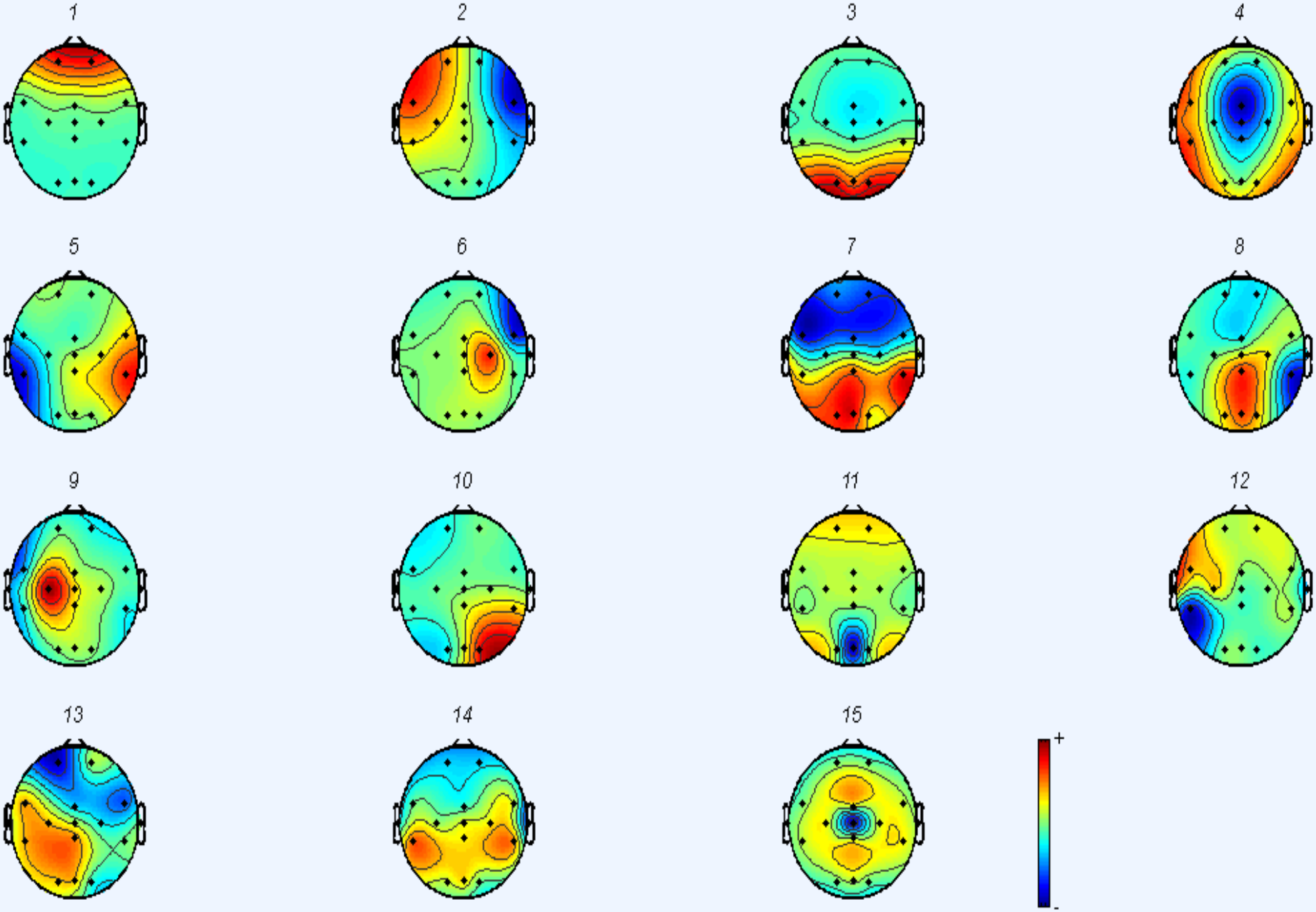

class1 resampled epochs

Plot channel time frequency -- pop_newtimef()

Channel number: 8

Sub epoch time limits [min max] (msec): -1000 1996 — Use 200 time points

Frequency limits [min max] (Hz) or sequence: — Use limits, padding 1 — ☐ Log spaced

Baseline limits [min max] (msec) (0->pre-stim.): 0 — Use divisive baseline (DIV) — ☐ No baseline

Wavelet cycles [min max/fact] or sequence: 3 0.5 — ☐ Use FFT

ERSP color limits [max] (min=-max): — ☑ see log power (set)

ITC color limits [max]: — ☐ plot ITC phase (set)

Bootstrap significance level (Ex: 0.01 -> 1%): — ☐ FDR correct (set)

Optional newtimef() arguments (see Help):

☑ Plot Event Related Spectral Power ☑ Plot Inter Trial Coherence ☐ Plot curve at each frequency

Help Cancel Ok

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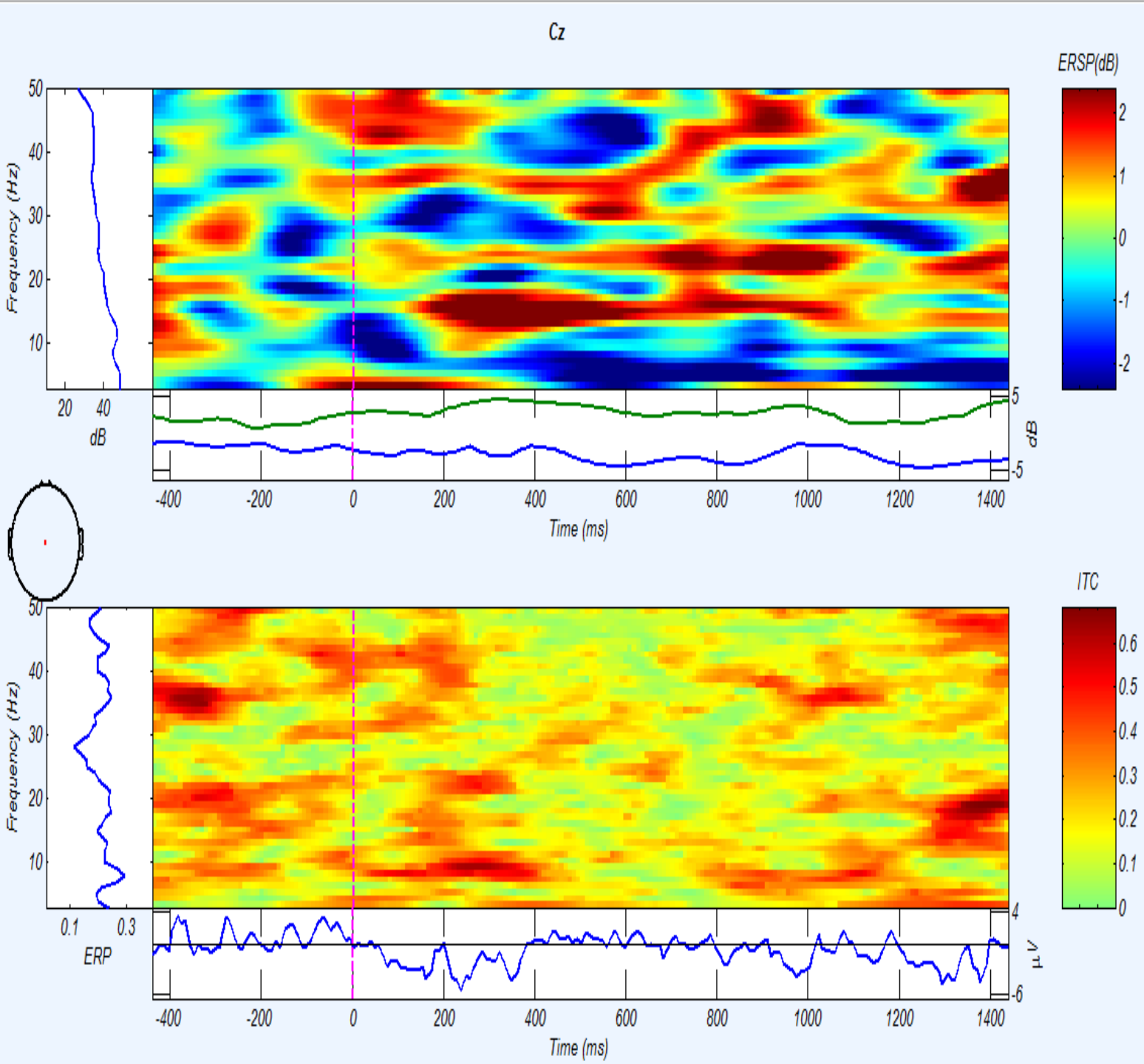

references

[1] Available via license: CC BY 4.0 ,Incorporating priors for EEG source imaging and connectivity analysis

[2] B. He and Z. Liu, “Multimodal functional neuroimaging: integrating functional MRI and EEG/MEG,” IEEE Rev. Biomed. Eng., vol. 1, pp. 23–40, 2008

[3] https://www.verywellmind.com/how-many-neurons-are-in-the-brain-2794889

[4] https://slate.com/technology/2016/03/how-big-is-the-brain-who-knows-even-our-best-efforts-to-calculate-its-capacity-are-flawed-and-meaningless.html

[5] http://resizeme.club/imageresizer-230_111123011.html

[6] https://www.researchgate.net/figure/EEG-principle-electrical-fields-generated-by-aligned-pyramidal-cells-Source-Bear-6_fig2_41387051

[7] Christian A. Kothe ,SCCN, UCSD Introduction to Modern Brain-Computer Interface Design Lecture 2: EEG Basics

[8] https://www.mayoclinic.org/diseases-conditions/temporal-lobe-seizure/diagnosis-treatment/drc-20378220

[9] http://neurosky.com/2015/05/greek-alphabet-soup-making-sense-of-eeg-bands/

[10] https://sccn.ucsd.edu/wiki/Makoto's_preprocessing_pipeline

[11] https://medicalxpress.com/news/2014-11-brain-regions-encode-words-grammar.html

[12] https://www.researchgate.net/publication/331905251_Corticomuscular_Coherence_and_Its_Applications_A_Review/figures?lo=1&utm_source=google&utm_medium=organic

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از توجه شما متشکرم