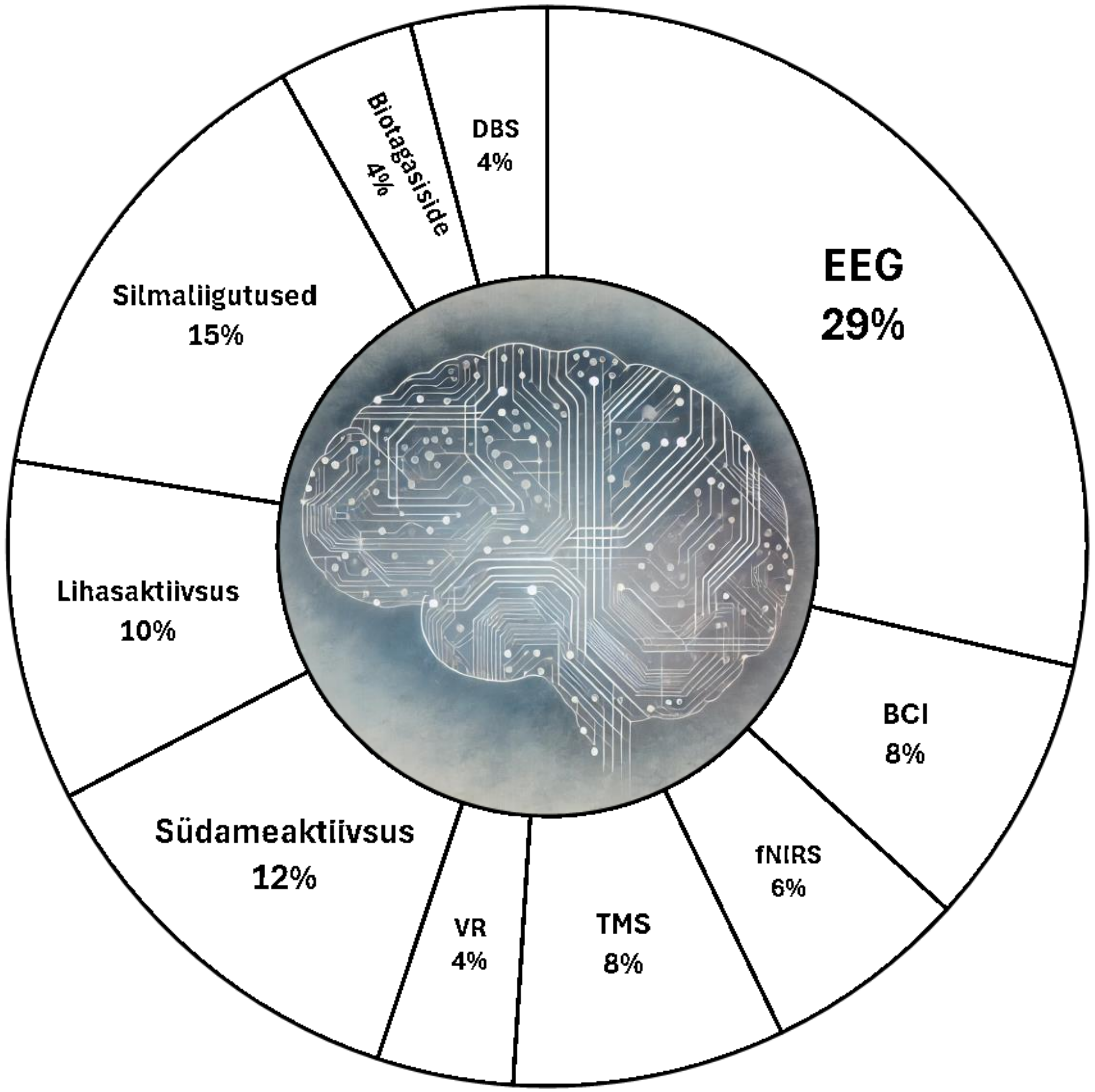
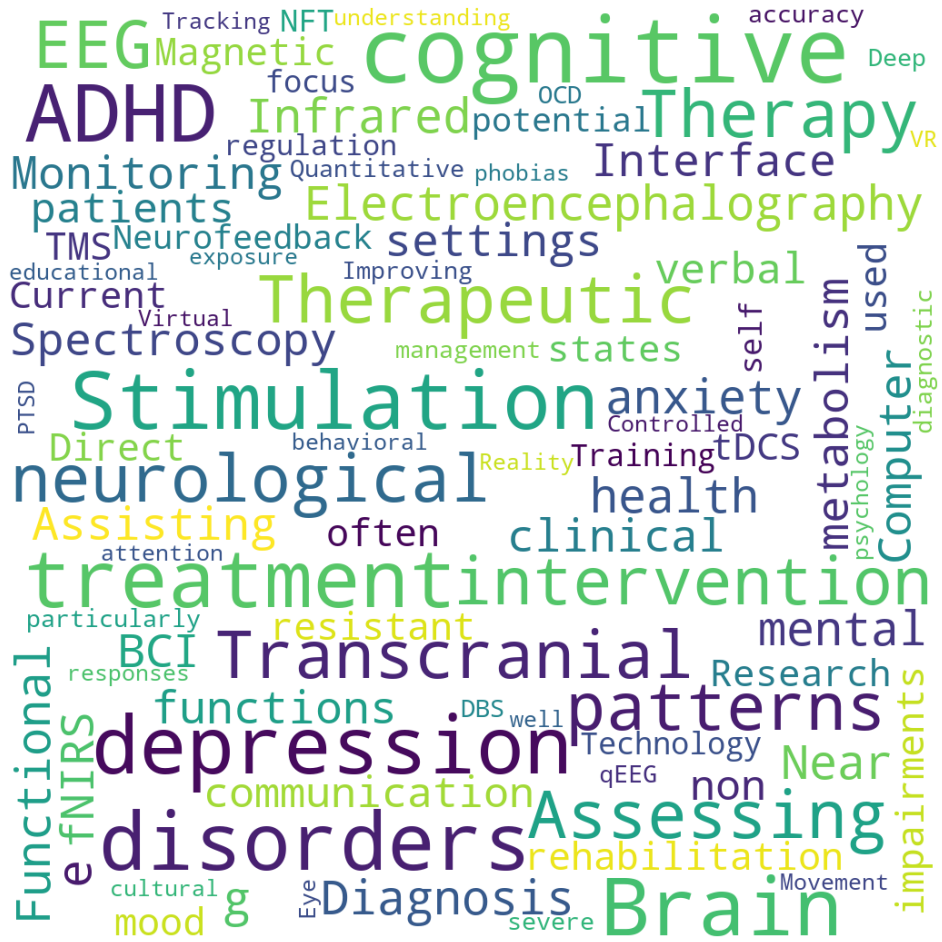
Sissejuhatus
psühhofüsioloogia
rakendustesse

Elektroentsefalograafia

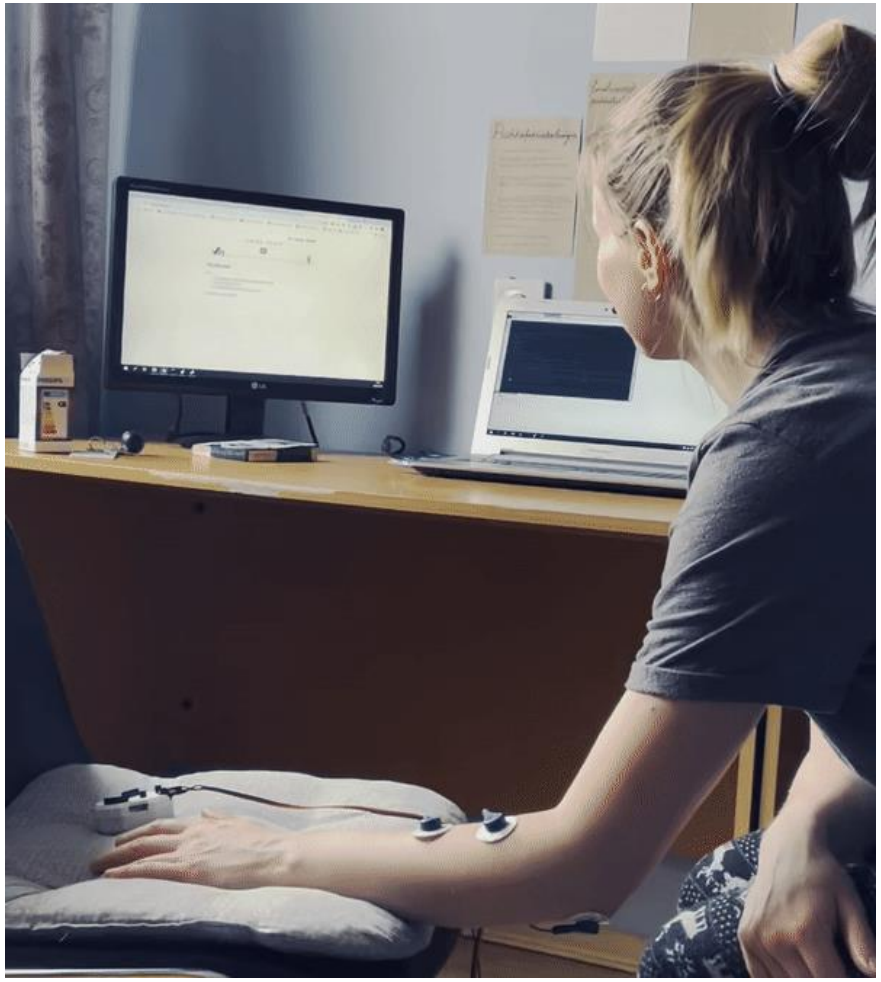
Richard Naar

Kursuse arendamist toetas Haridus- ja noorteameti IT-akadeemia


EEG
29%
BCI
8%
fNIRS
6%
TMS
8%
VR
4%
Südameaktiivsus
12%
Lihasaktiivsus
10%
Silmaliigutused
15%
Biotagasiside
4%
DBS
4%


EEG
Tracking
NFT
understanding
Magnetic
cognitive
accuracy
Deep
focus
ADHD
Infrared
OCD
potential
Therapy
VR
regulation
Monitoring
Quantitative
phobias
Interface
patients
Electroencephalography
TMS
Neurofeedback
settings
exposure
educational
Improving
verbal
Current
Therapeutic
Virtual
Spectroscopy
management
states
self
used
Stimulation
anxiety
PTSD
Controlled
Computer
metabolism
diagnostic
Direct
behavioral
tDCS
Reality
Training
psychology
neurological
health
Assisting
often
clinical
attention
treatment
intervention
particularly
resistant
mental
BCI
Transcranial
Research
responses
functions
DBS
well
patterns
Functional
fNIRS
depression
Technology
Near
qEEG
communication
non
Assessing
disorders
rehabilitation
impairments
cultural
Eye
Diagnosis
Movement
mood
severe
Brain

OpenBCI näidisprojektid



OpenBCI Documentation

Main Site Shop Forum Documentation Github

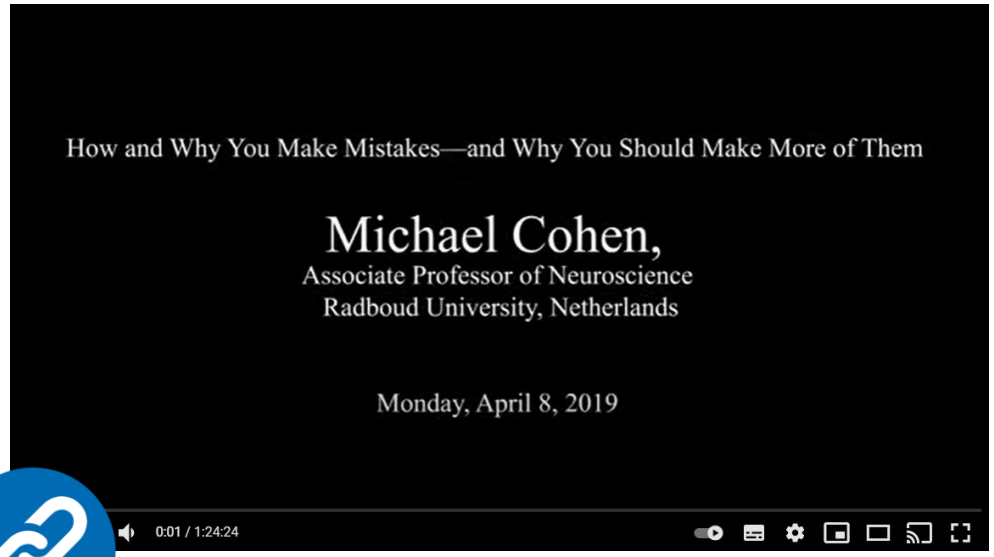
- Welcome to OpenBCI
- Getting Started
- Cyton Board
- Ganglion Board
- Headwear & Electrodes
- Third-Party Hardware
- Software
- For Developers
- Deprecated Documents
- Troubleshooting
- Example Projects
  - Example Projects
  - Experiments
    - Puppies and Kittens Experiment
  - Community Page Projects
    - Community Page Projects
  - EMG Projects and Tutorials
    - EMG Scrolling
    - EMG-controlled Stop/Start Music

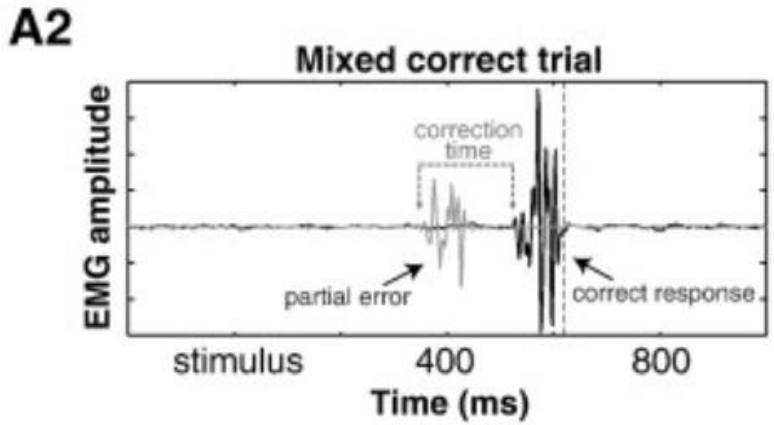
EMG Chrome Dino Game

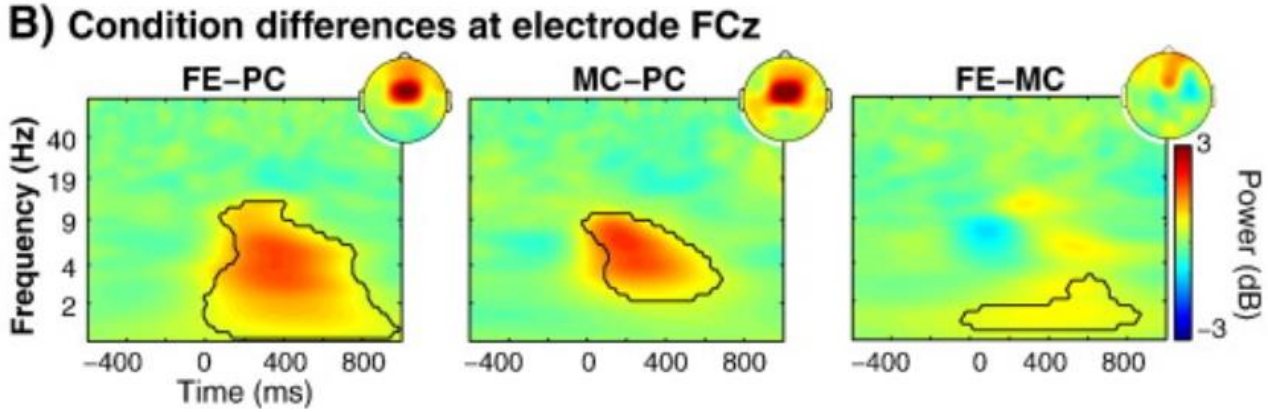
EDIT

In this tutorial we will show you how to play the Google Chrome Dinosaur Game without touching your laptop. To do that, we will read EMG data from your arm muscles and find the peaks which correspond to flexing, using them to trigger a jump of the dinosaur.

Check out an example video of this tutorial being put into action!

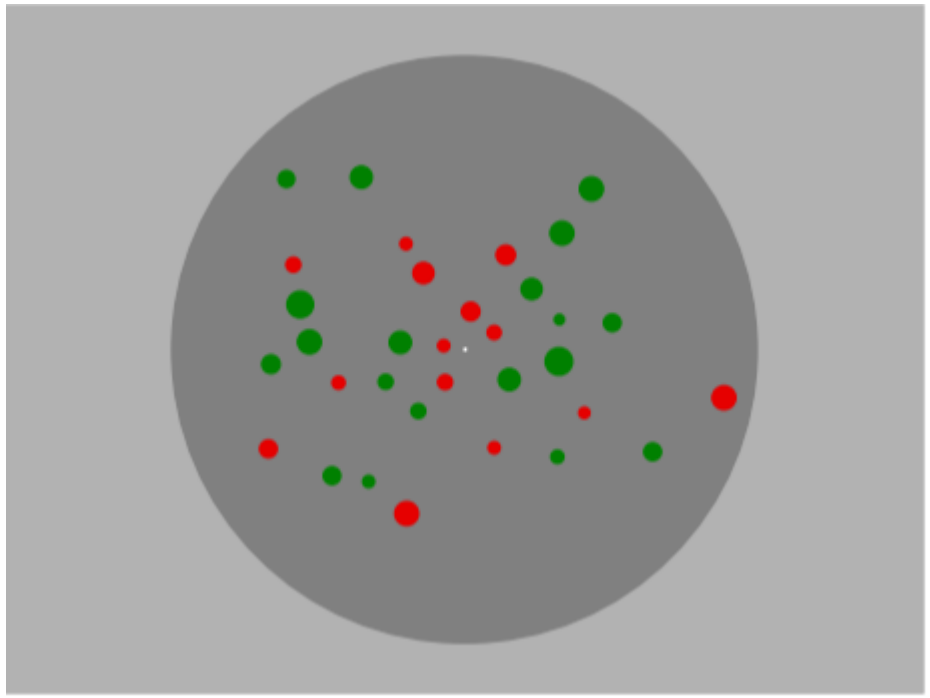






(Cohen, & van Gaal, 2014)

EEG sündmuspotentsiaalid (ERP)



Kui sekkuvat muutujat pole võimalik kontrollida, siis on mõistlik see vabaks lasta ehk muuta katsemanipulatsioonist sõltumatuks (st sekkuv muutuja ei tohiks olla süstemaatiliselt seotud katsetingimustega)

(Raidvee, Lember, & Allik, 2017)

EEG sündmuspotentsiaalid (ERP)

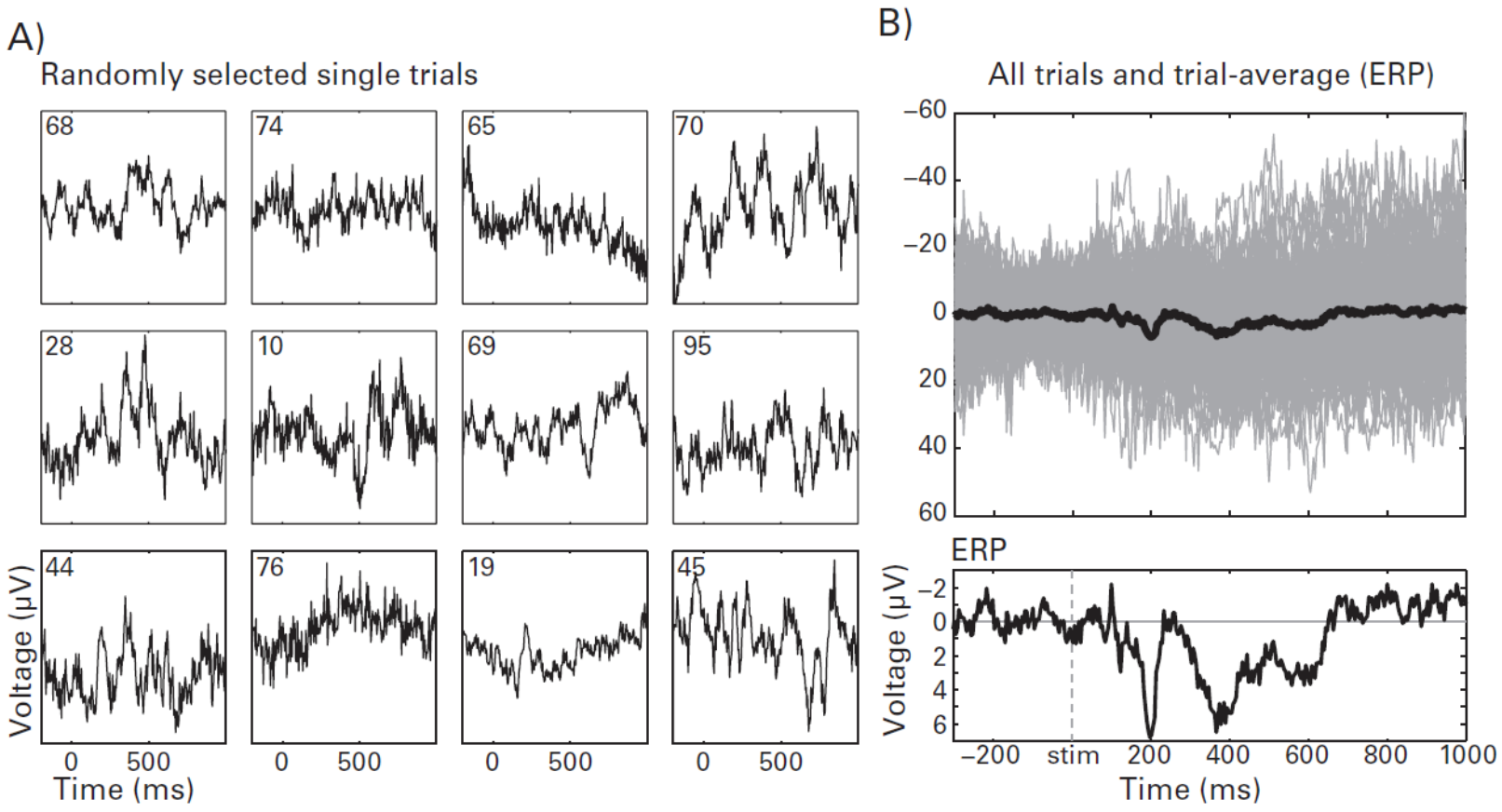
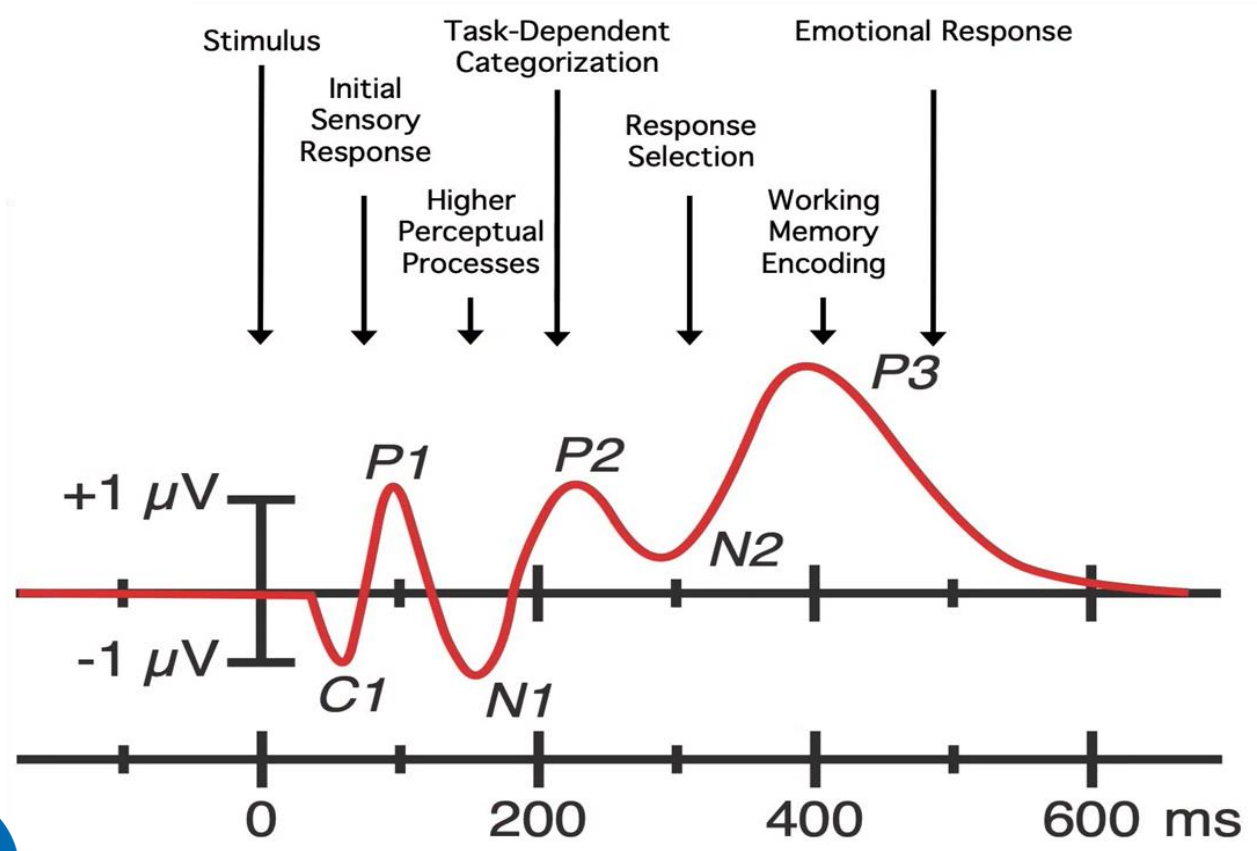


Figure 9.1

Üle paljude esituste keskmistatud EEG signaal on kordades **väiksema** amplituudiga kui mürarikkal üksikseerial

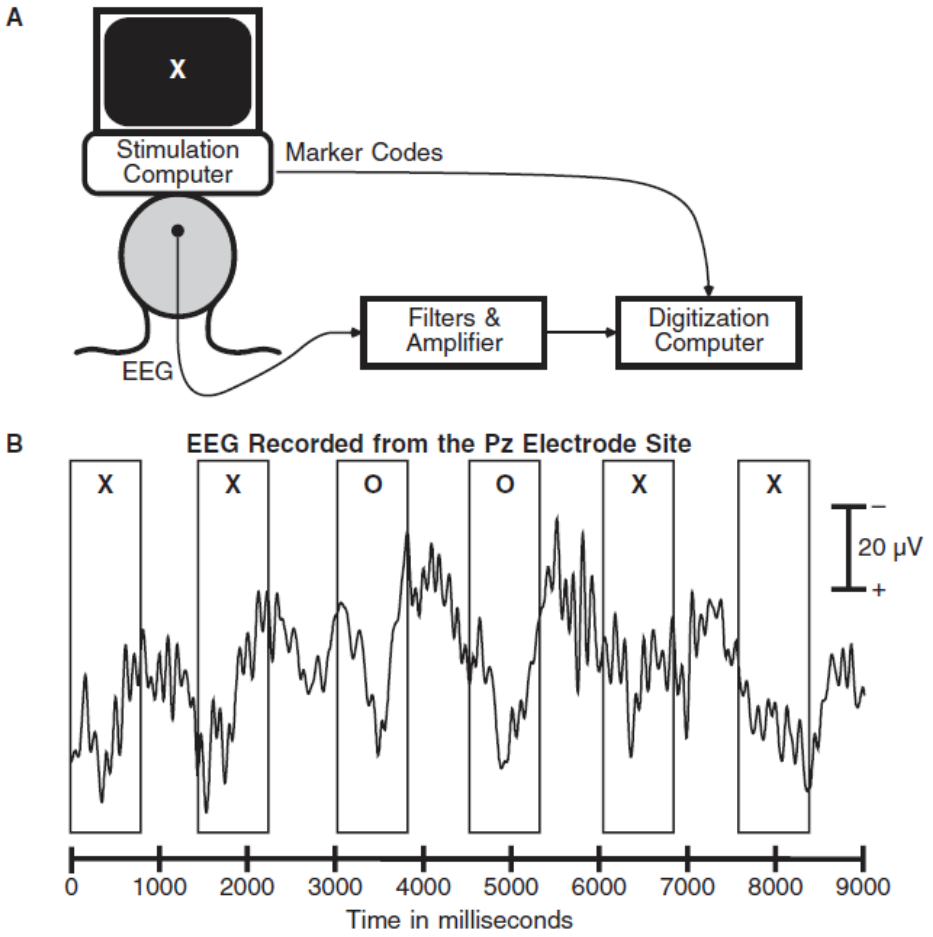
(Cohen, 2014, lk 98)

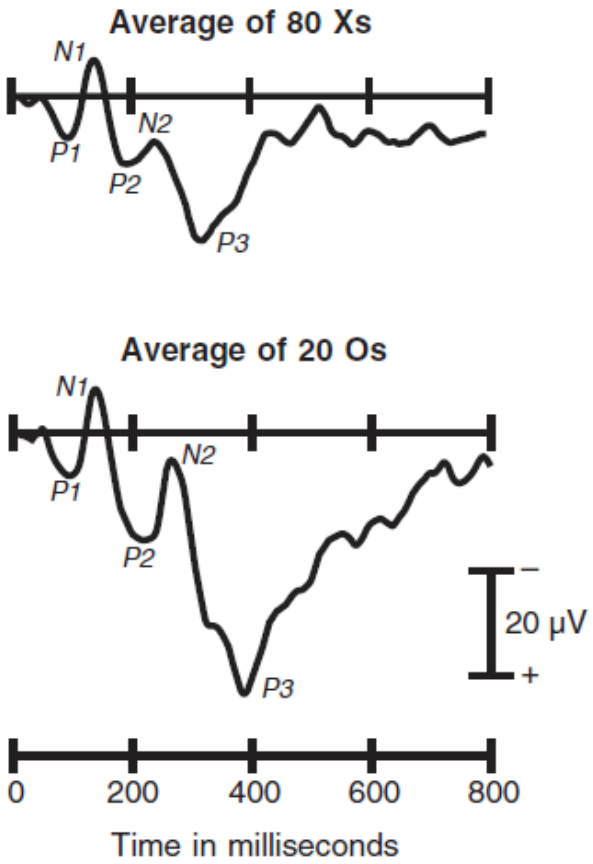
EEG sündmuspotentsiaalid (ERP)



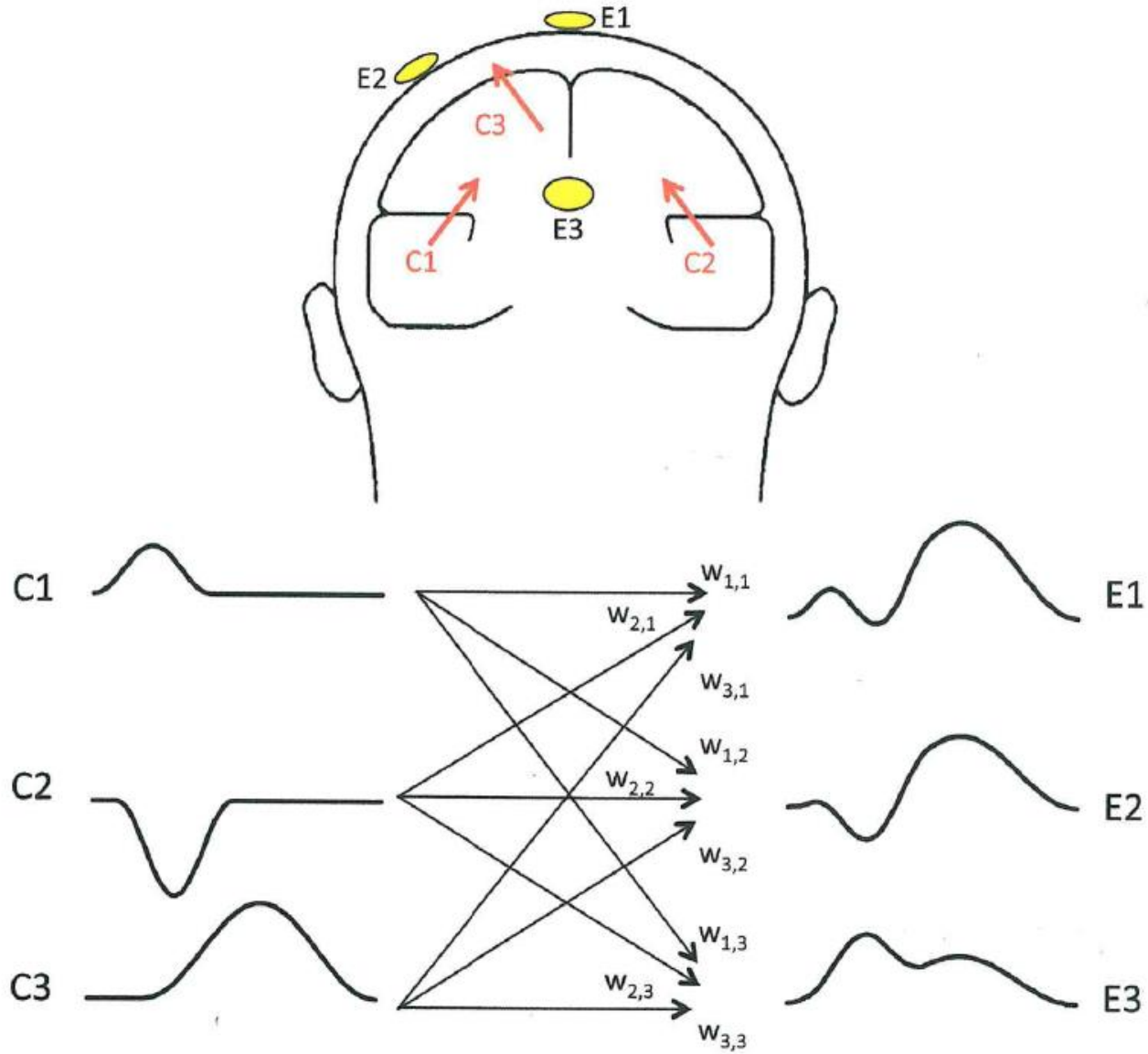
EEG sündmuspotentsiaal (*event related potential* - ERP) – sündmuse poolt esile kutsutud aju elektriliste potentsiaalide muutus

EEG sündmuspotentsiaalid (ERP)

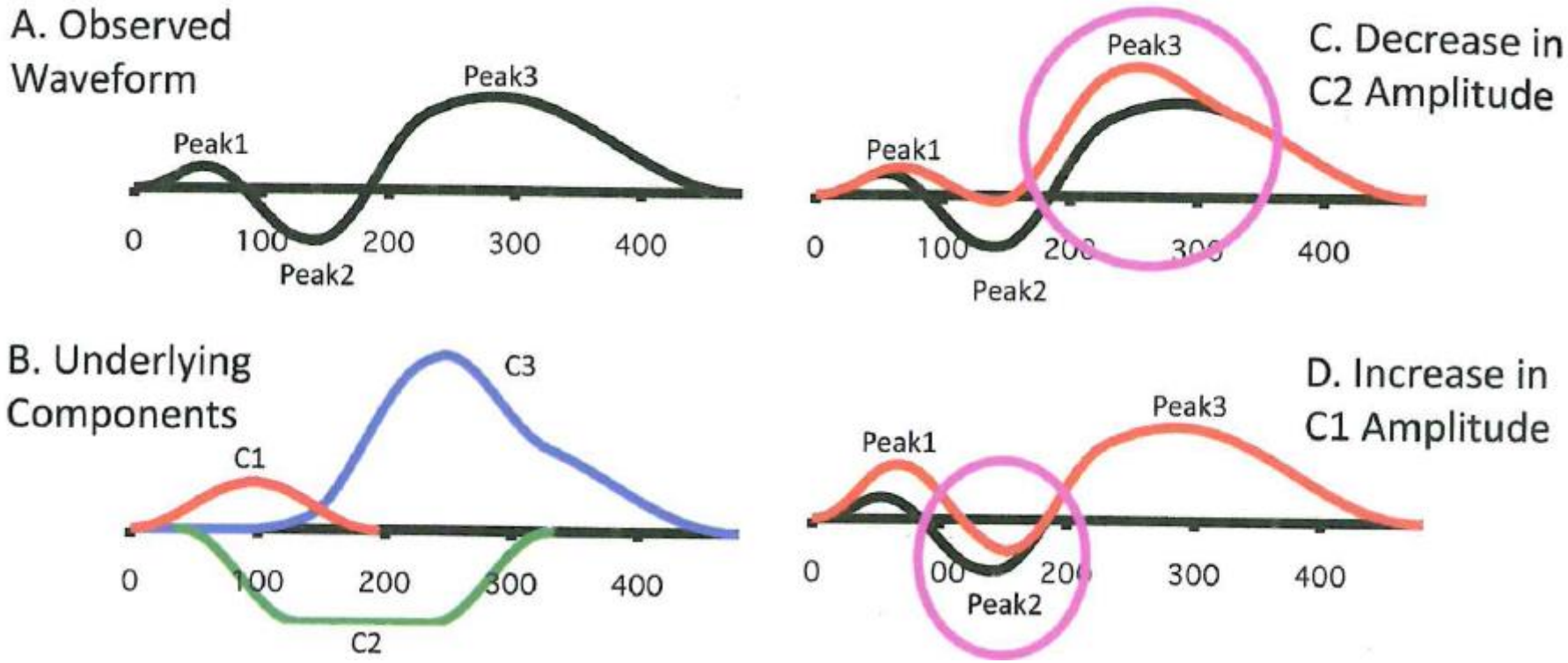




(Luck, 2005, lk 8)

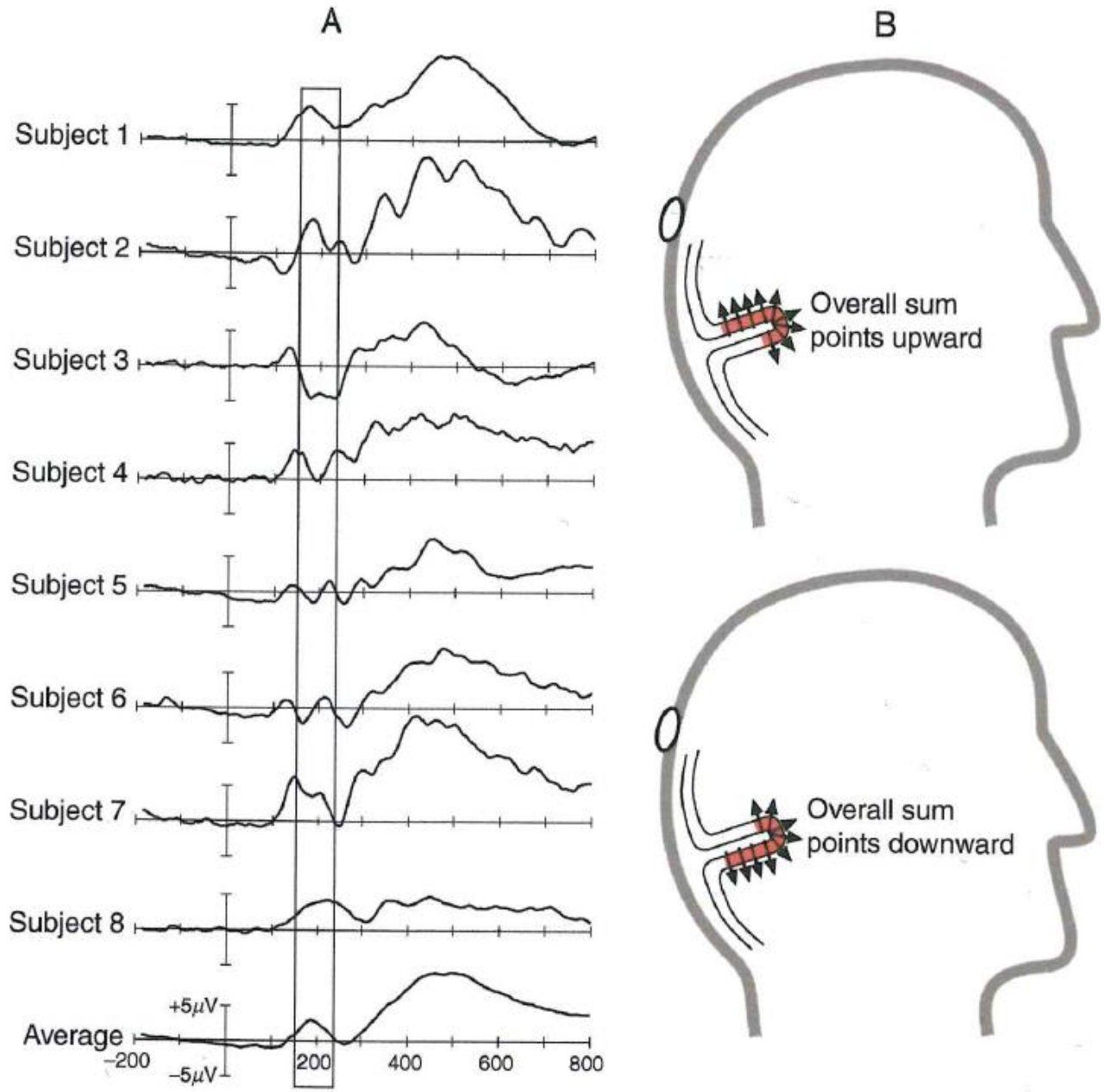


(Luck, 2011, lk 7)



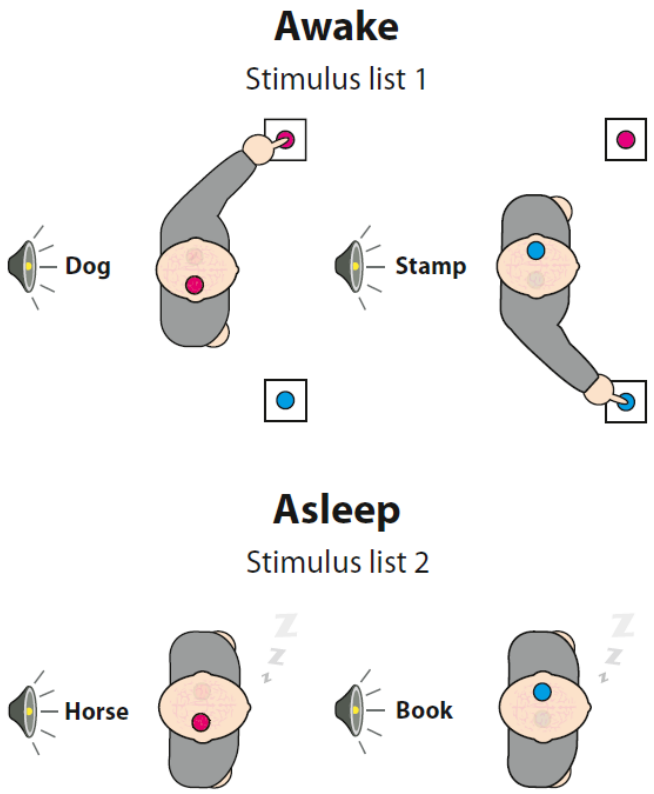
Luck, S. J., & Kappenman, E. S. (Eds.). (2011). *The Oxford handbook of event-related potential components*. Oxford university press.

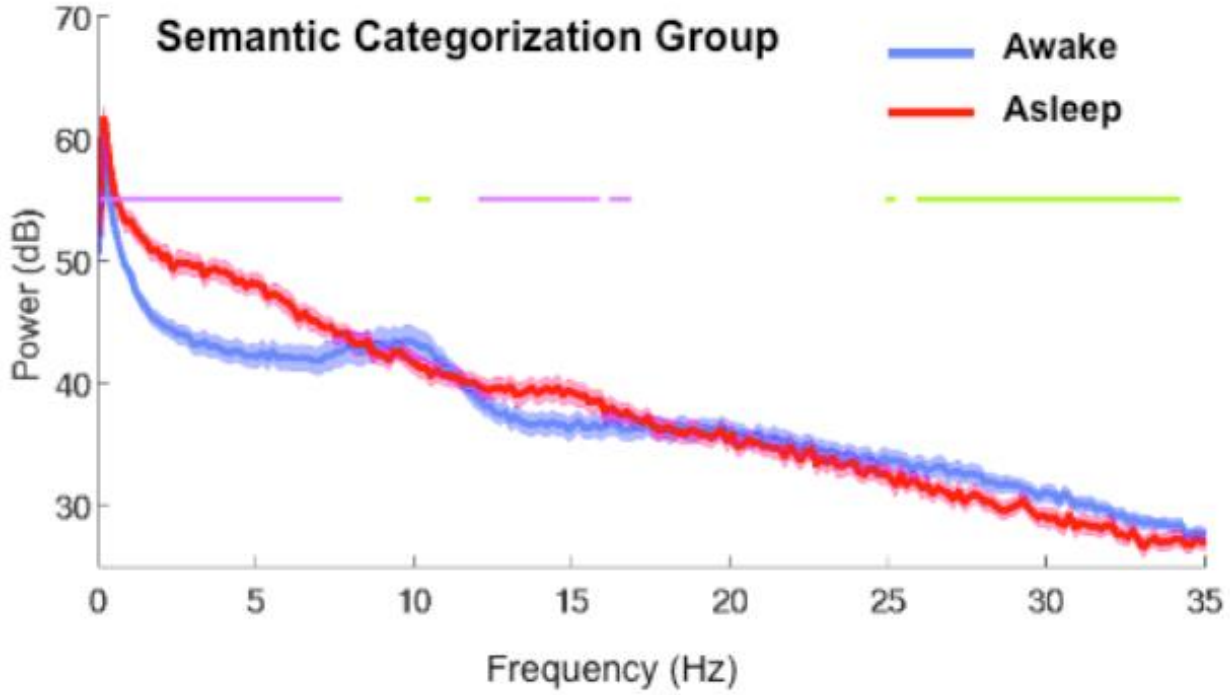
(Luck, 2011, lk 11)



(Luck, 2011, lk 7)

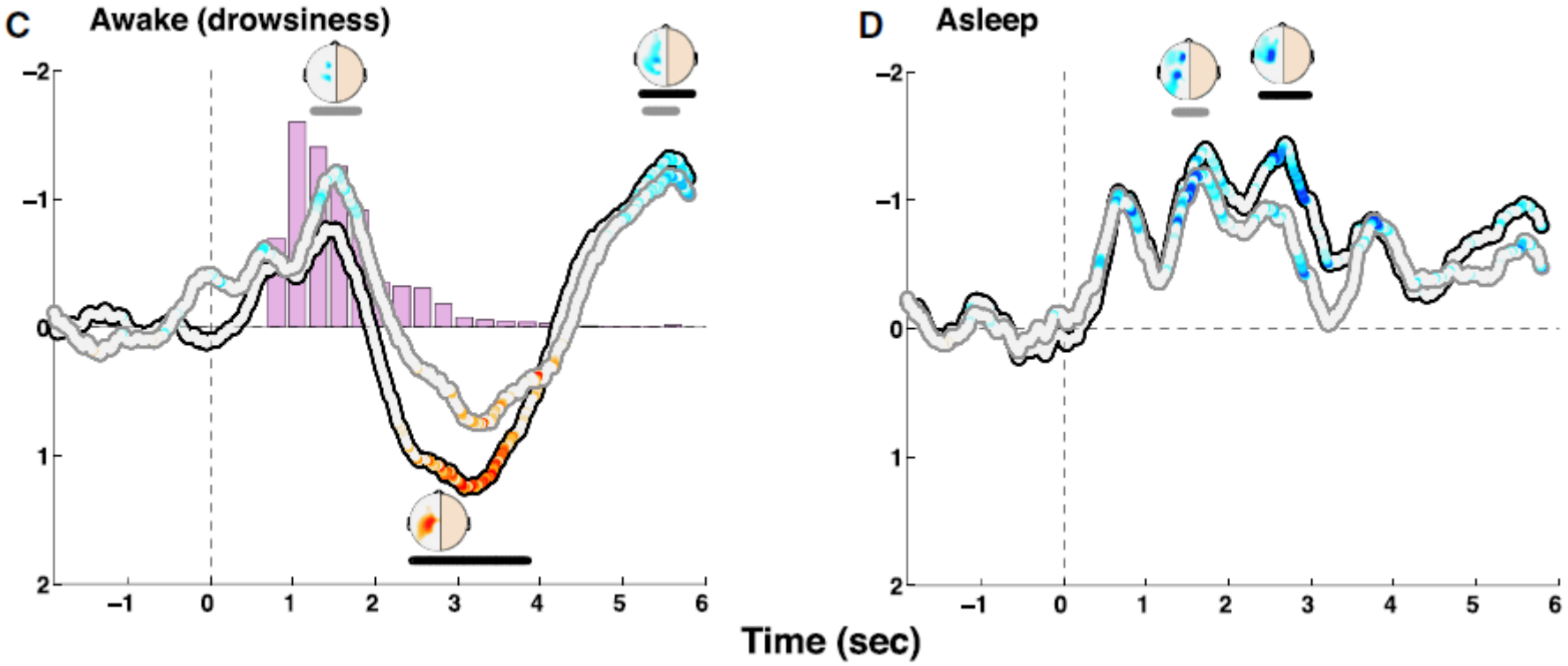
Milleks EEG?



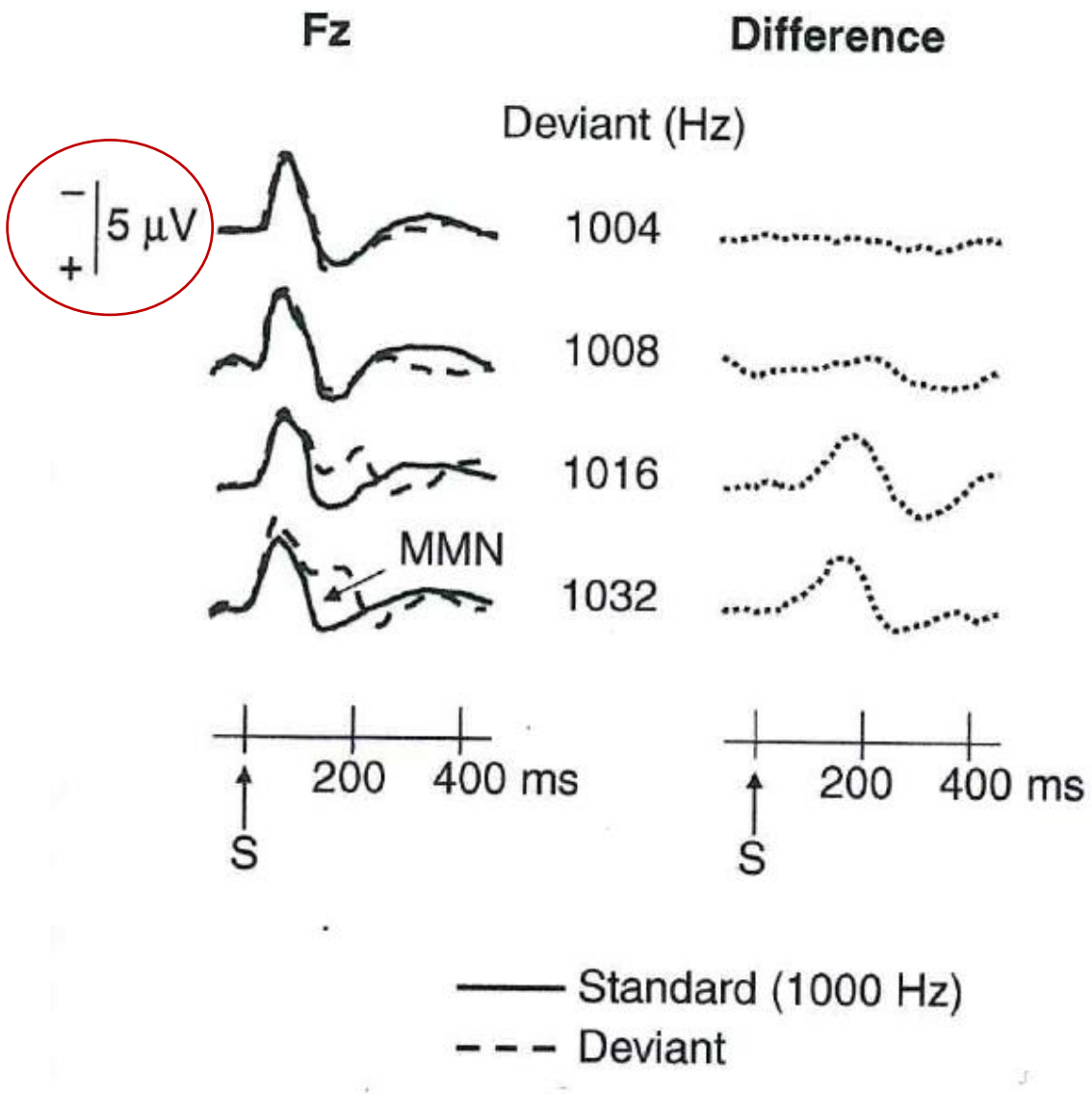


(Kouider, Andrillon, Barbosa, Goupil, & Bekinschtein, 2014)

Milleks EEG?



(Kouider, Andrillon, Barbosa, Goupil, & Bekinschtein, 2014)



(Luck, 2011, lk 23)

Mõned sündmuspotentsiaalide kasutusvaldkonnad

Uurida kognitiivsete ja tajuliste protsesside ajalist dünaamikat

Uurida katseisikuid, kes ei saa või ei suuda eksplitsiidseid vastuseid anda (nt imikuid, magavaid katseisikuid, kooma patsiente)

Uurida töötlust, mille puhul vastuse andmine võiks töötlust oluliselt muuta (nt stiimulite tähelepanuvälise töötluse puhul)

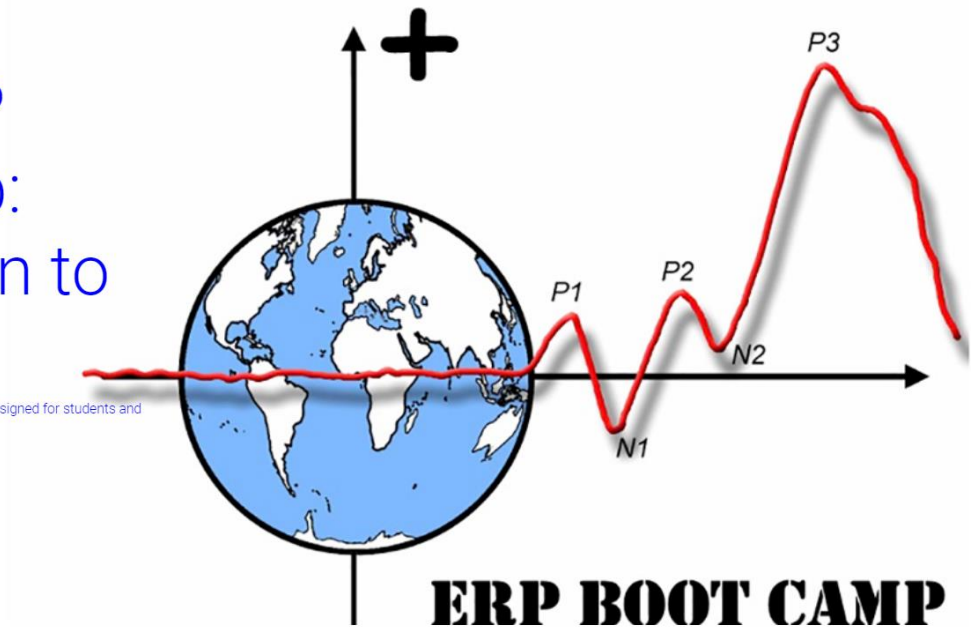
Uurida töötlust, mis ei pruugi käitumises väljenduda (nt maskeeritud stiimulite töötlemine).

EEG sündmuspotentsiaalid

Virtual ERP Boot Camp: Introduction to ERPs

Introduction to the event-related potential technique, designed for students and researchers with little or no prior ERP experience.

Enroll for free



Professor Steven Luck

(Kalifornia Ülikool, Davis)

Kaasprofessor Emily Kappenman

(San Diego Osariiklik Ülikool)

Clinical Neurophysiology
Volume 112, Issue 3, March 2001, Pages 536-544

Takistus

Scalp electrode impedance, infection risk, and EEG data quality

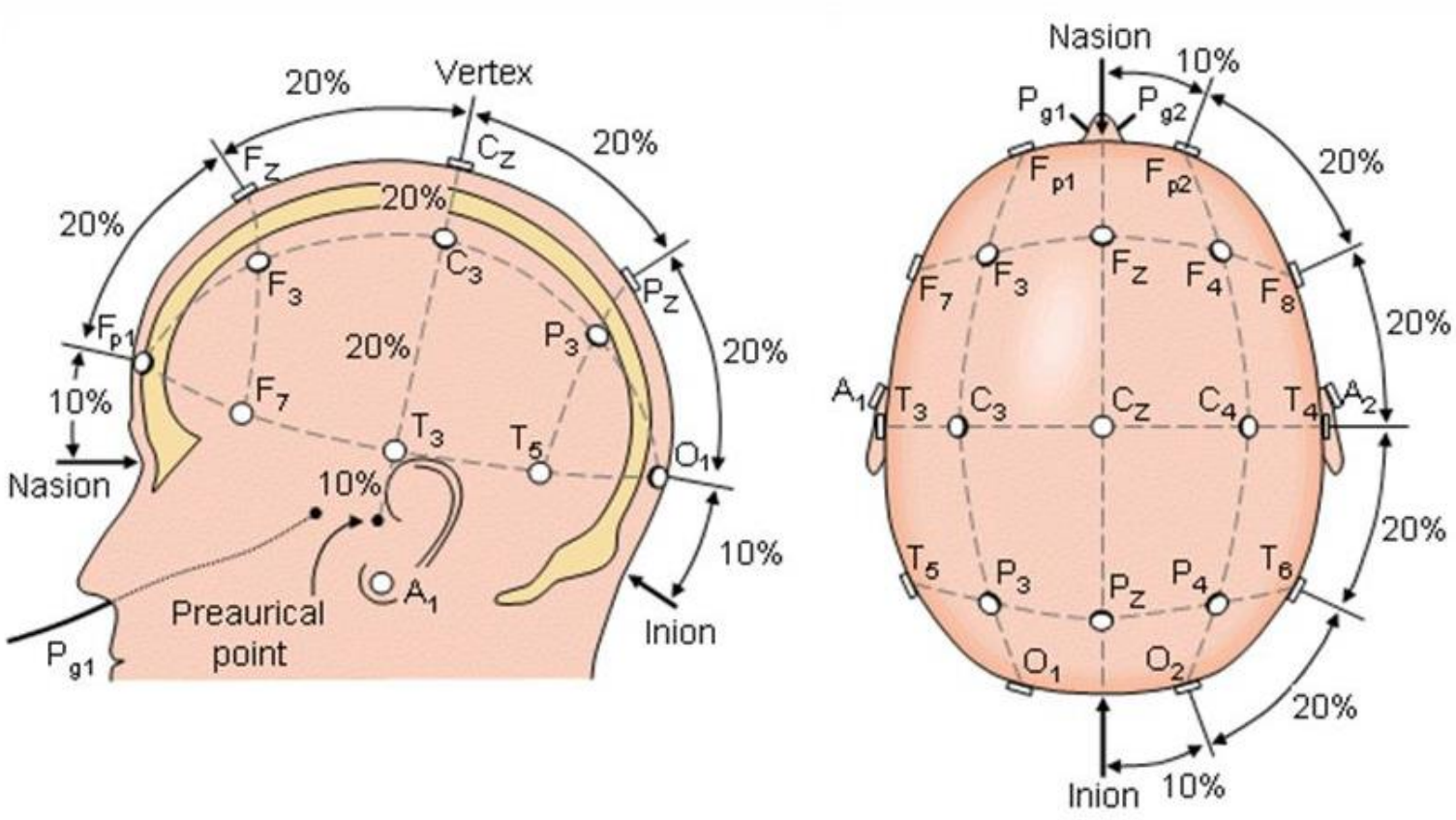
Thomas C Ferree [a, b], Phan Luu [a, c], Gerald S Russell [a, d], Don M Tucker [a, c]

„Modern engineering principles suggest that excellent EEG signals can be collected with high scalp impedance (**≈40 kΩ**) without scalp abrasion. The present study was designed to evaluate the effect of electrode-scalp impedance on EEG data quality.“

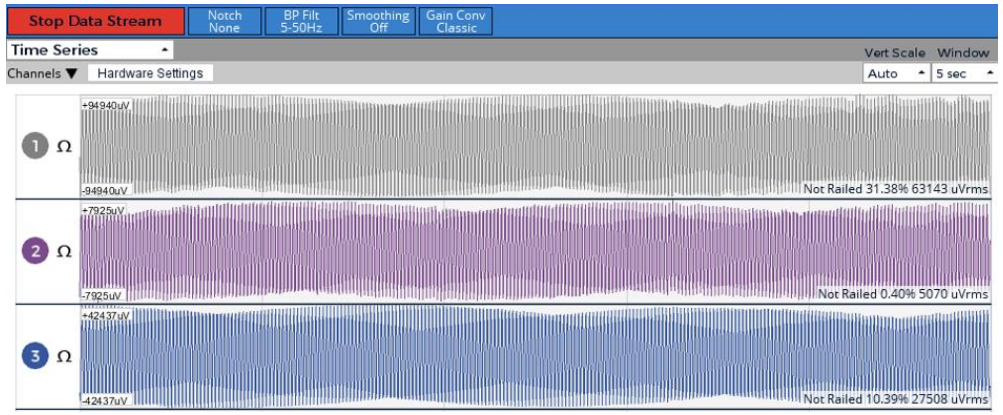
Results: There was no significant change in amplitude of any EEG frequency as scalp-electrode impedance increased from less than 5 kΩ (abraded skin) to 40 kΩ (intact skin). As expected, 60 Hz noise increased linearly as a function of the absolute impedance and impedance mismatch between the measurement and reference electrodes.

Conclusion: With modern high input-impedance amplifiers and accurate digital filters for power line noise, high-quality EEG can be recorded without skin lesions.

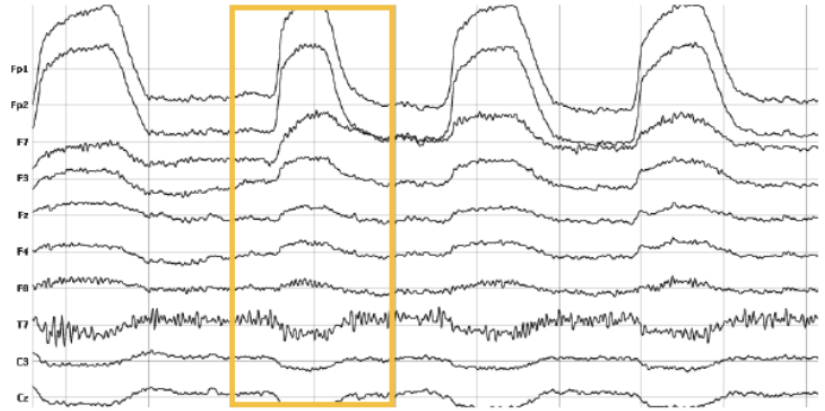
Elektroodide paigutamine



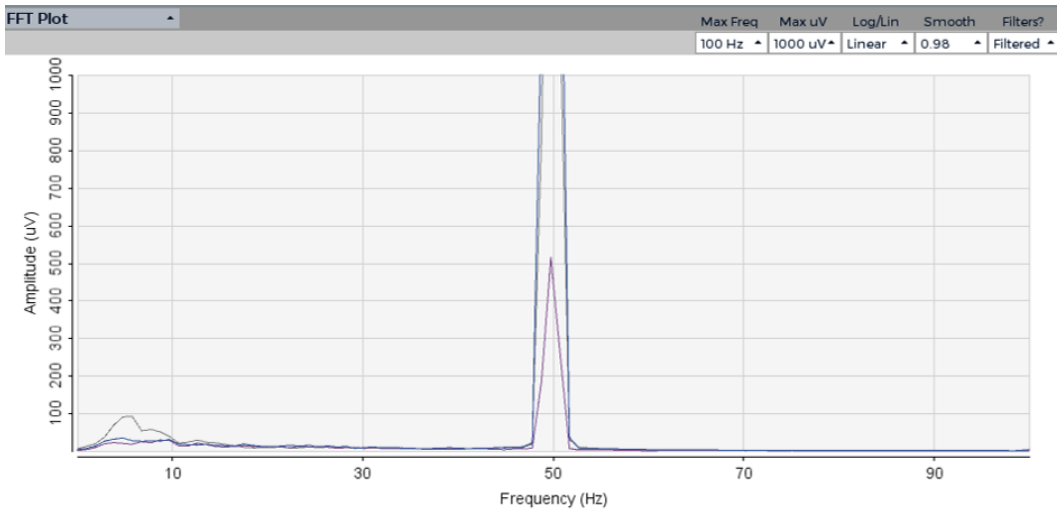
A1


Stop Data Stream
Notch None
BP Filt 5-50Hz
Smoothing Off
Gain Conv Classic
Time Series
Vert Scale
Window
Channels
Hardware Settings
Auto
5 sec
+94940uV
-94940uV
Not Railed 31.38% 63143 uVrms
+7925uV
-7925uV
Not Railed 0.40% 5070 uVrms
+42437uV
-42437uV
Not Railed 10.39% 27508 uVrms

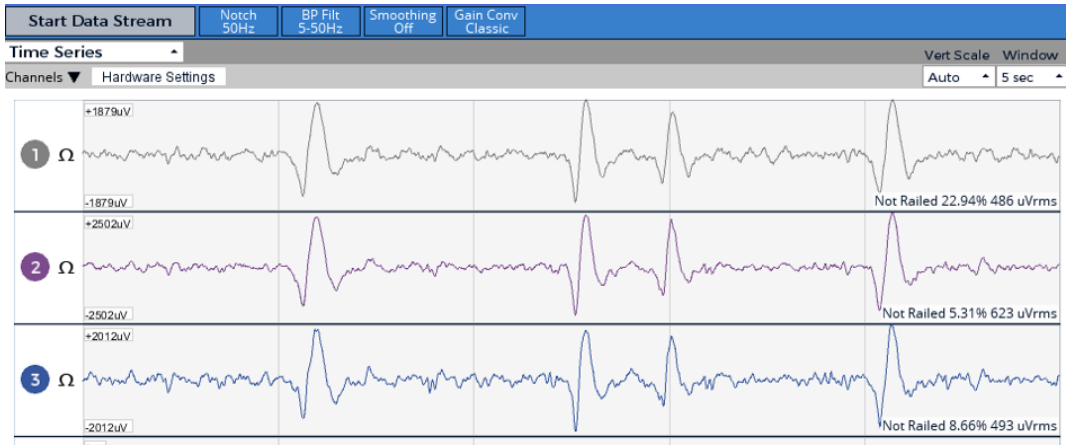
B1


Fp1
Fp2
F7
F3
Fz
F4
F8
T7
C3
Cz

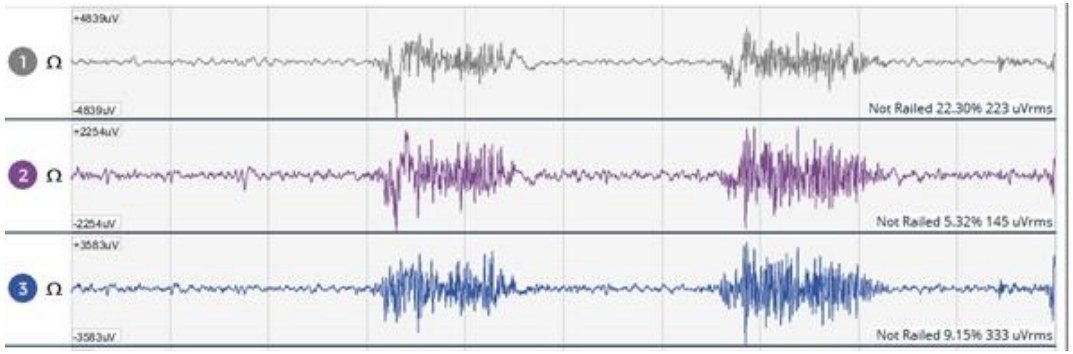
A2


FFT Plot
Max Freq
Max uV
Log/Lin
Smooth
Filters?
100 Hz
1000 uV
Linear
0.98
Filtered
Amplitude (uV)
100
200
300
400
500
600
700
800
900
1000
10
30
50
70
90
Frequency (Hz)

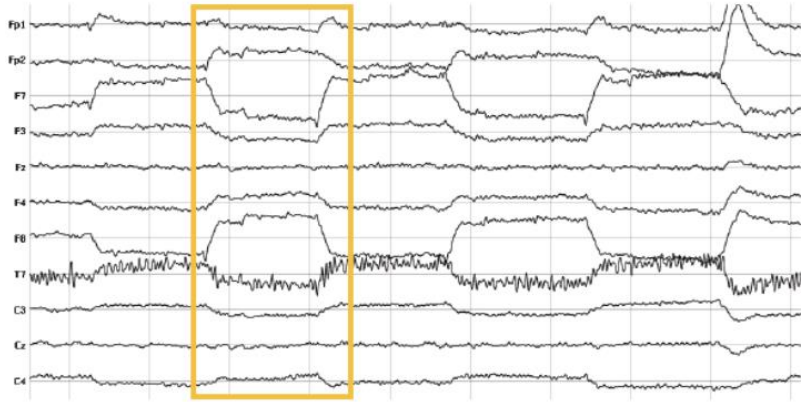
B2


Start Data Stream
Notch 50Hz
BP Filt 5-50Hz
Smoothing Off
Gain Conv Classic
Time Series
Vert Scale
Window
Channels
Hardware Settings
Auto
5 sec
+1879uV
-1879uV
Not Railed 22.94% 486 uVrms
+2502uV
-2502uV
Not Railed 5.31% 623 uVrms
+2012uV
-2012uV
Not Railed 8.66% 493 uVrms

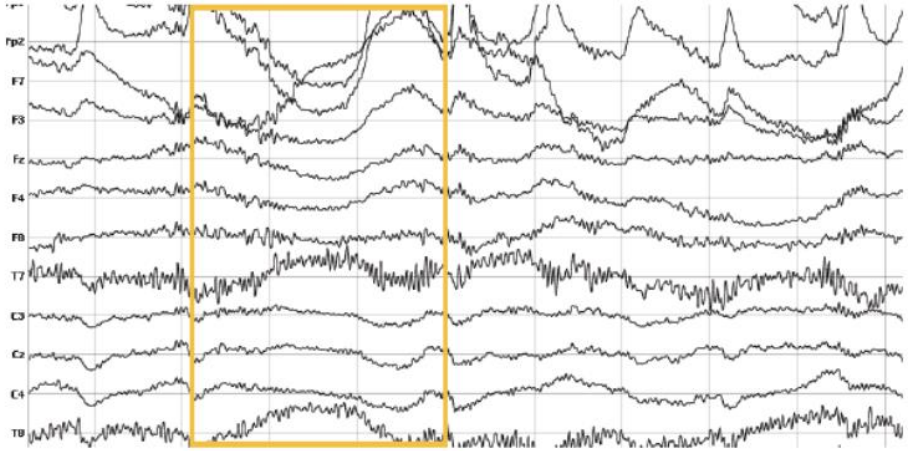
C1

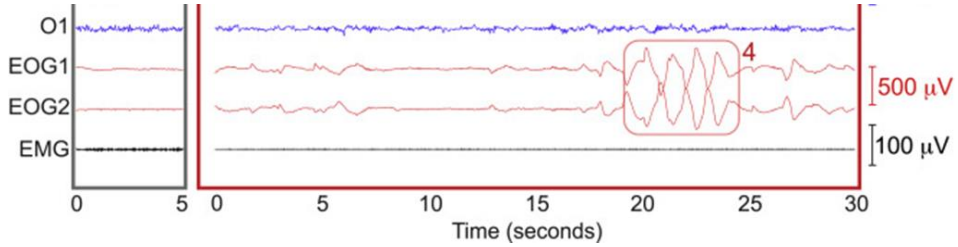

+4839uV
-4839uV
Not Railed 22.30% 223 uVrms
+2254uV
-2254uV
Not Railed 5.32% 145 uVrms
+3583uV
-3583uV
Not Railed 9.15% 333 uVrms

D1

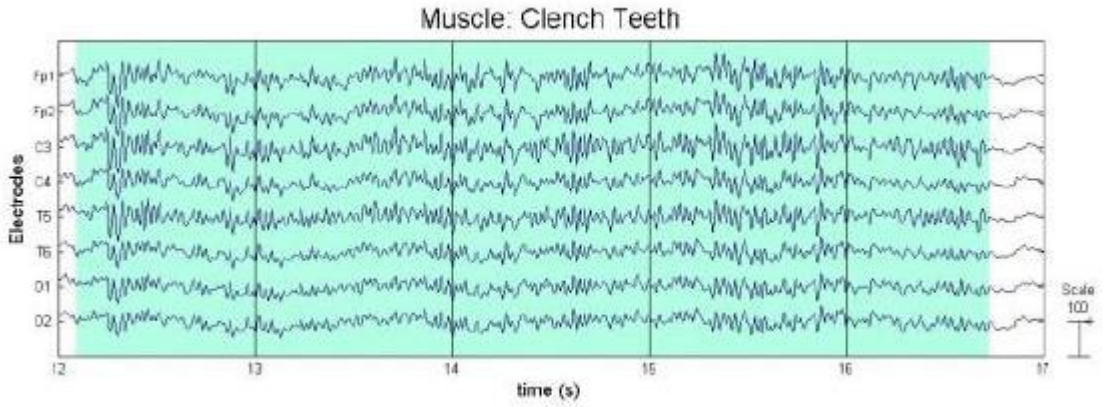

Fp1
Fp2
F7
F3
Fz
F4
F8
T7
C3
Cz
C4

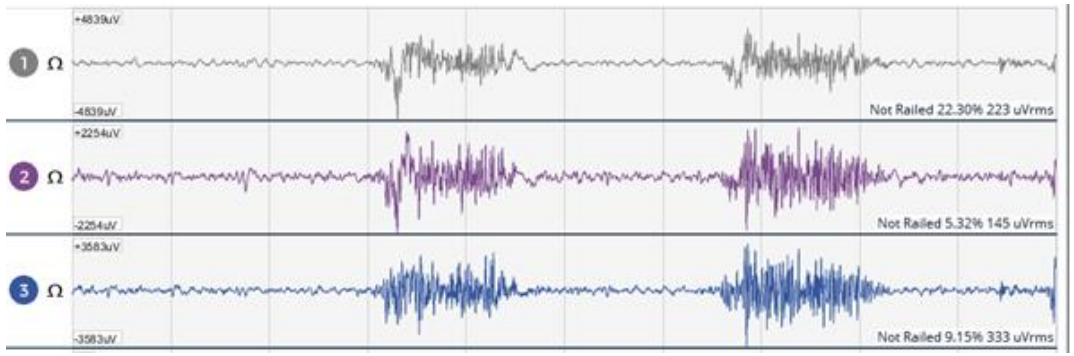
E1

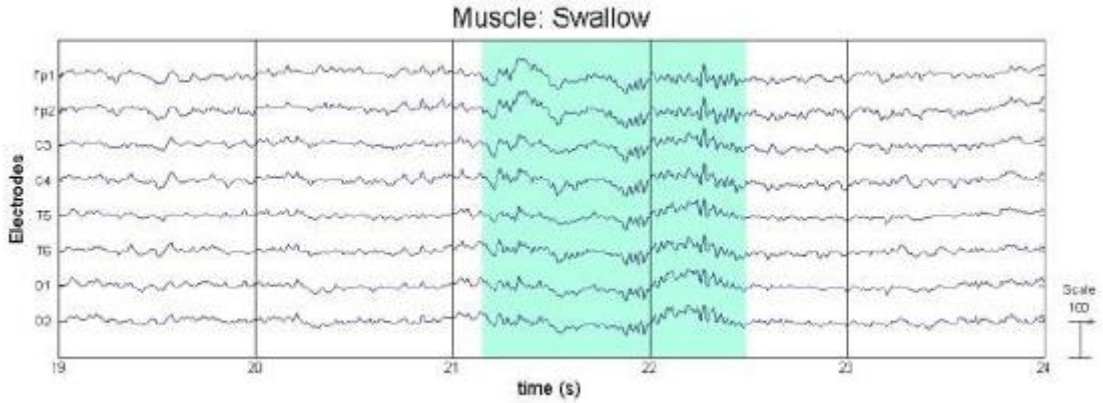

Fp2
F7
F3
Fz
F4
F8
T7
C3
Cz
C4
T8


O1
EOG1
EOG2
EMG
4
500 µV
100 µV
0
5
0
5
10
15
20
25
30
Time (seconds)

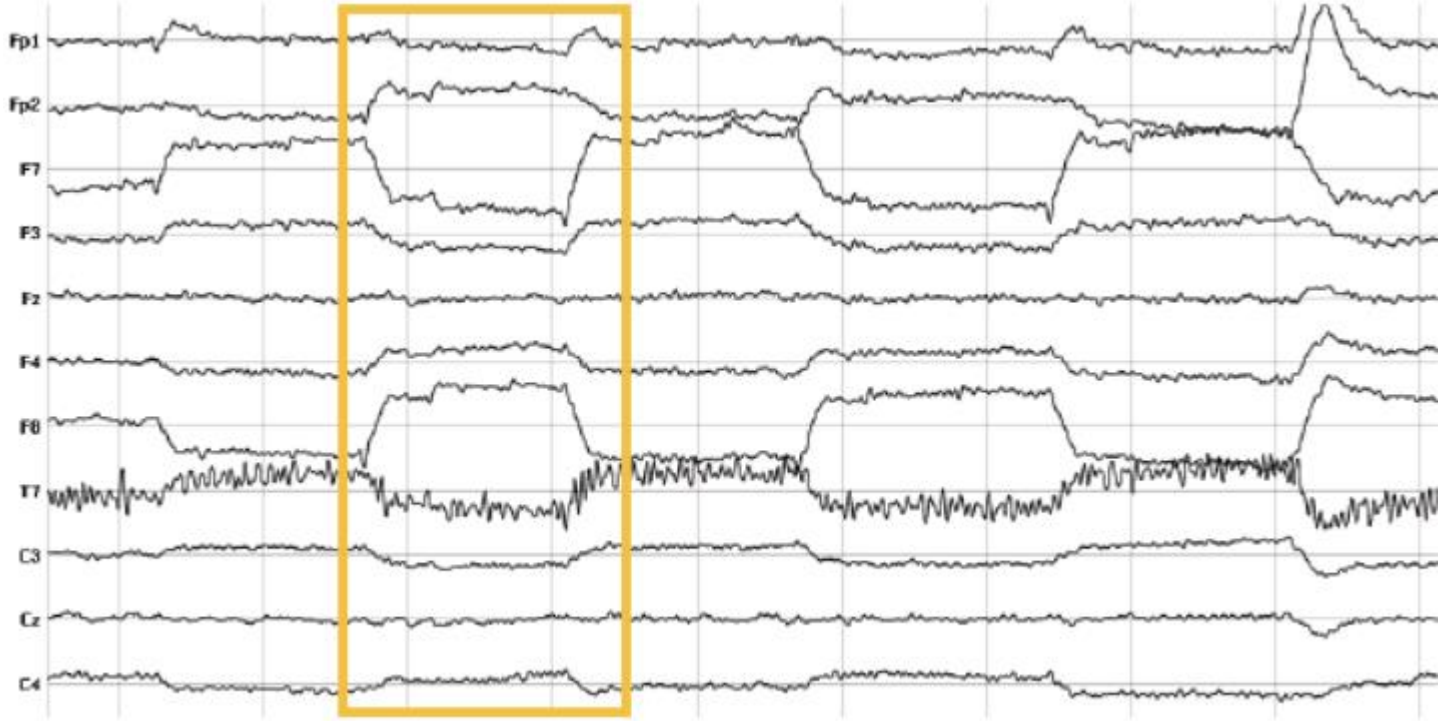
Lihasmüra (EMG, ECG)





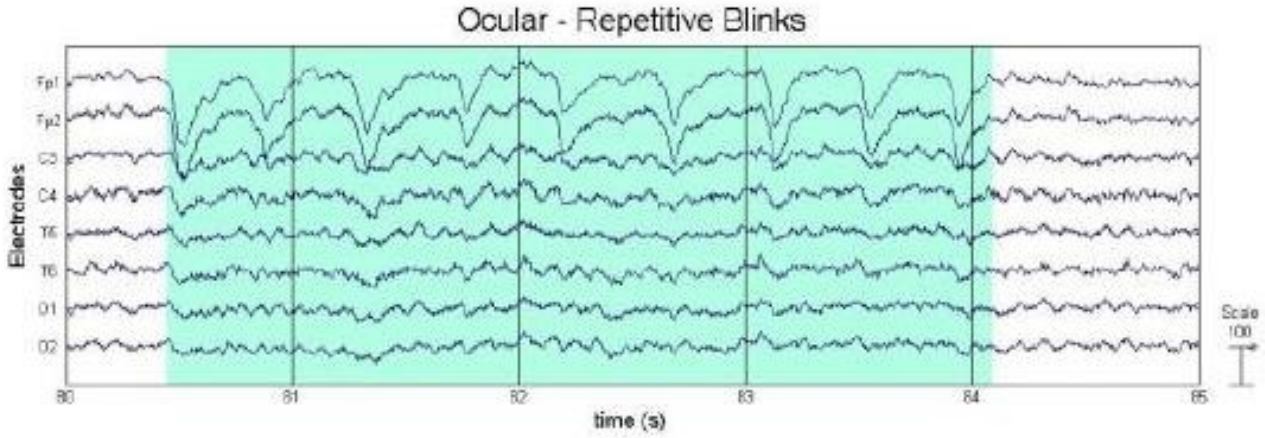


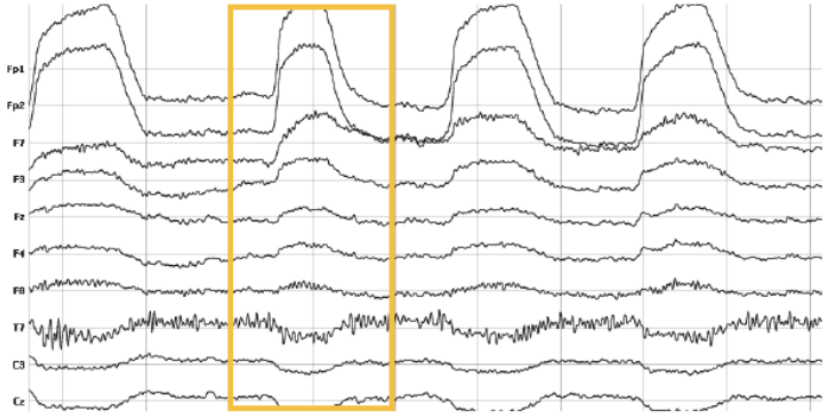
Silmaliigutused



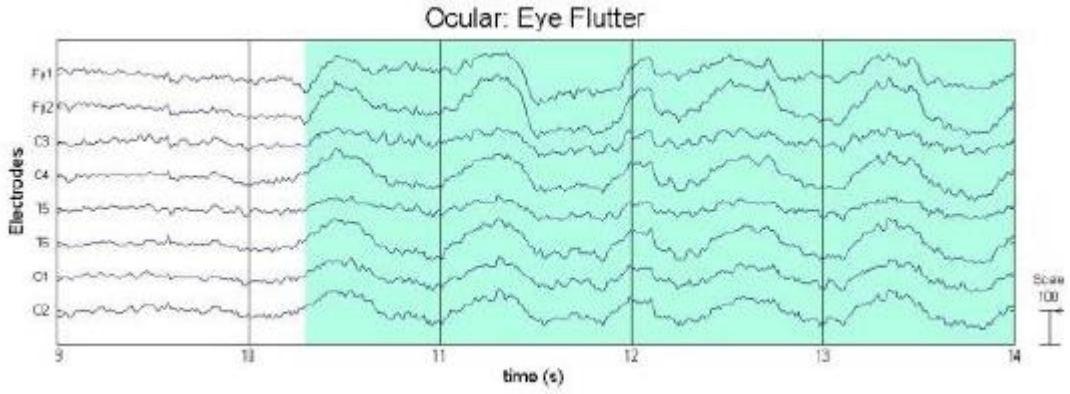
(Farnsworth, 2019)

Pilgutused



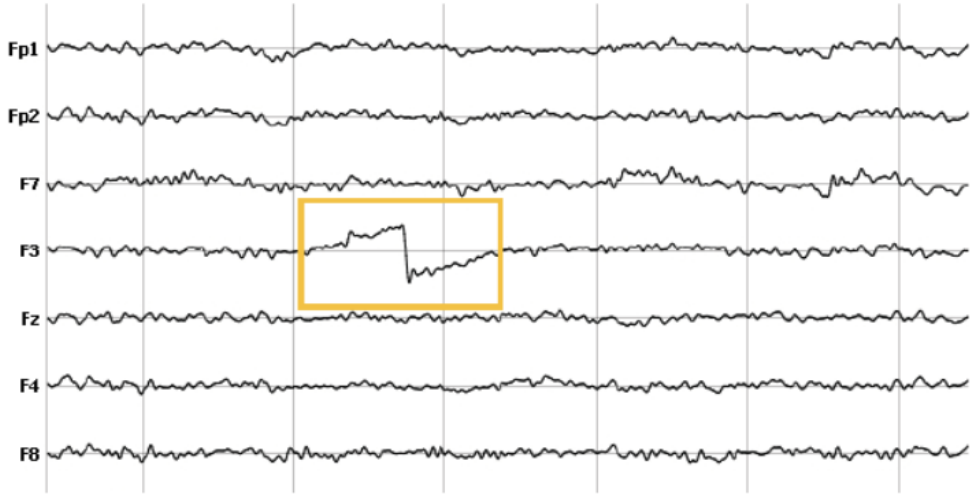


(Farnsworth, 2019)

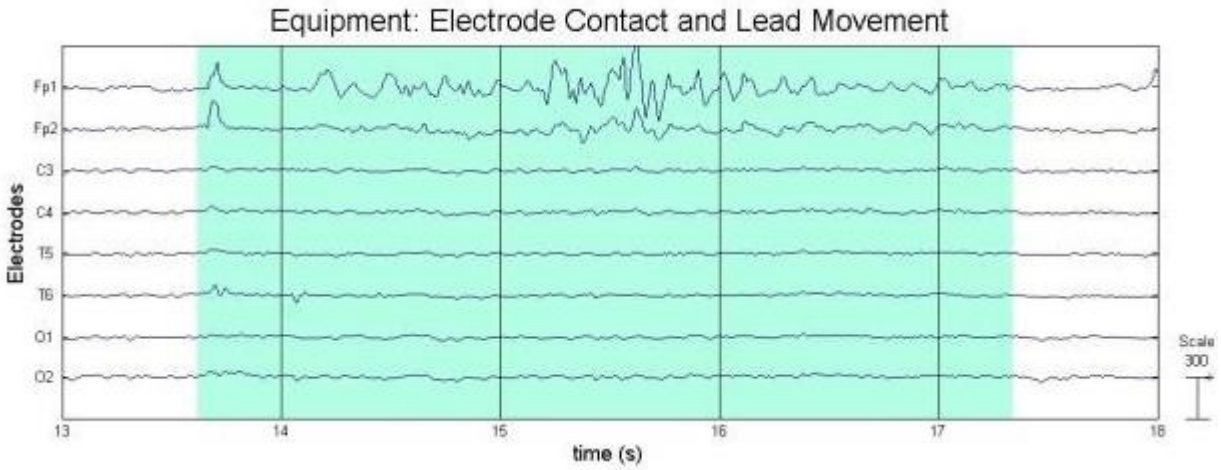


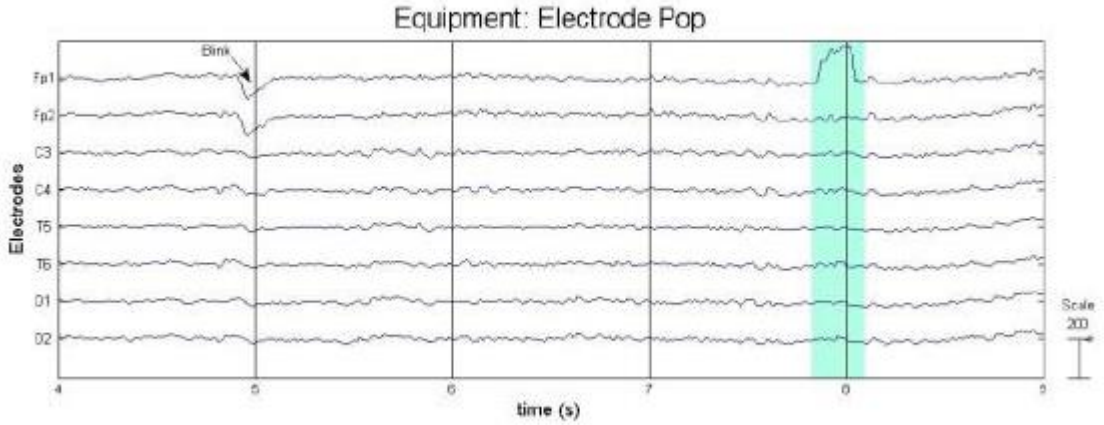
(Schembri, Anthony, & Pelc, 2017)

Elektroodide liikumine ja ühenduse probleemid



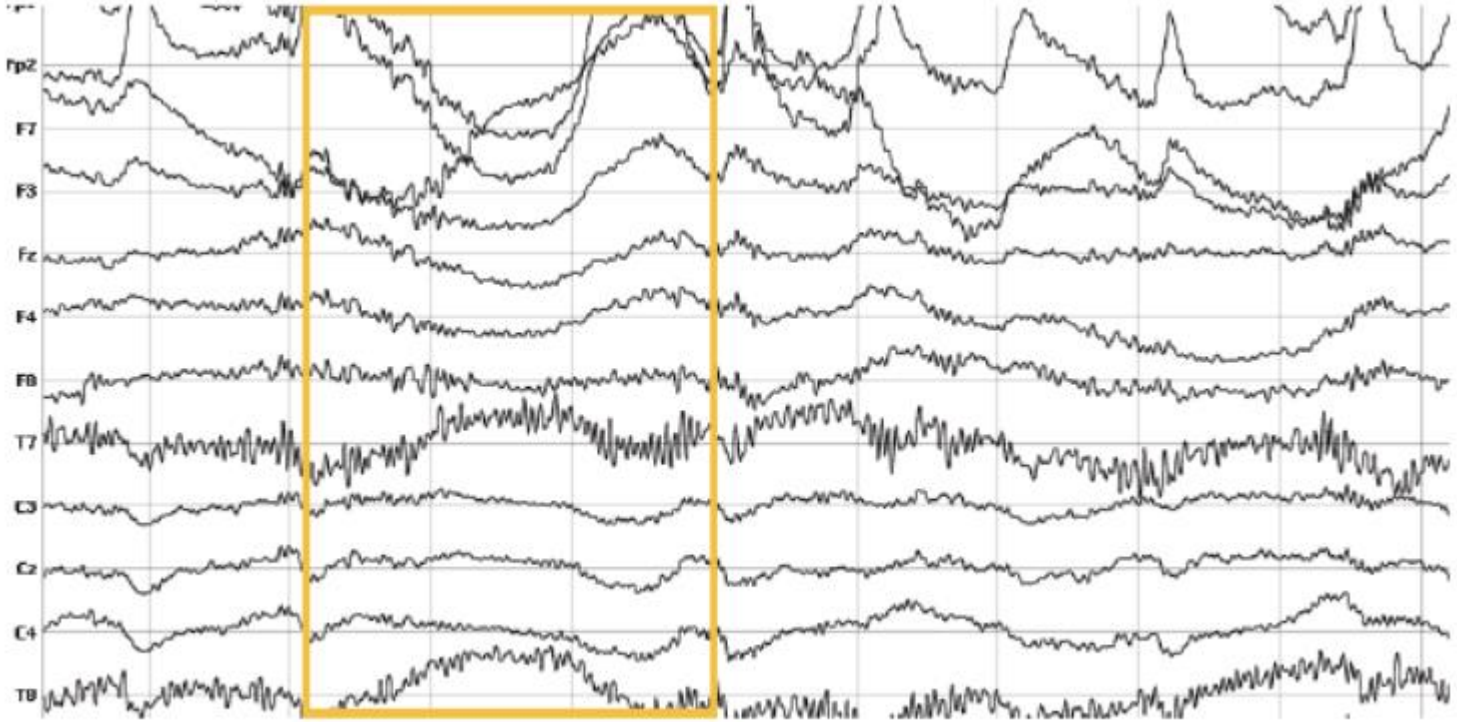
(Farnsworth, 2019)





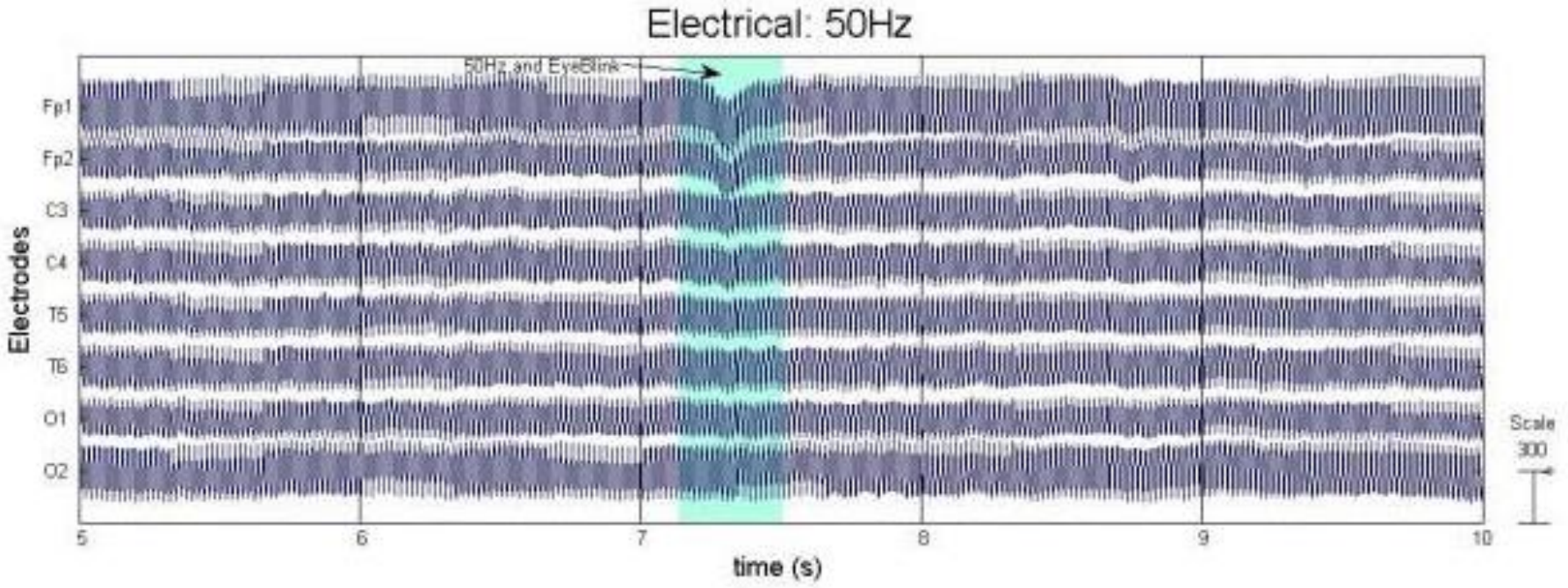
(Schembri, Anthony, & Pelc, 2017)

Katseisiku pea liikumine



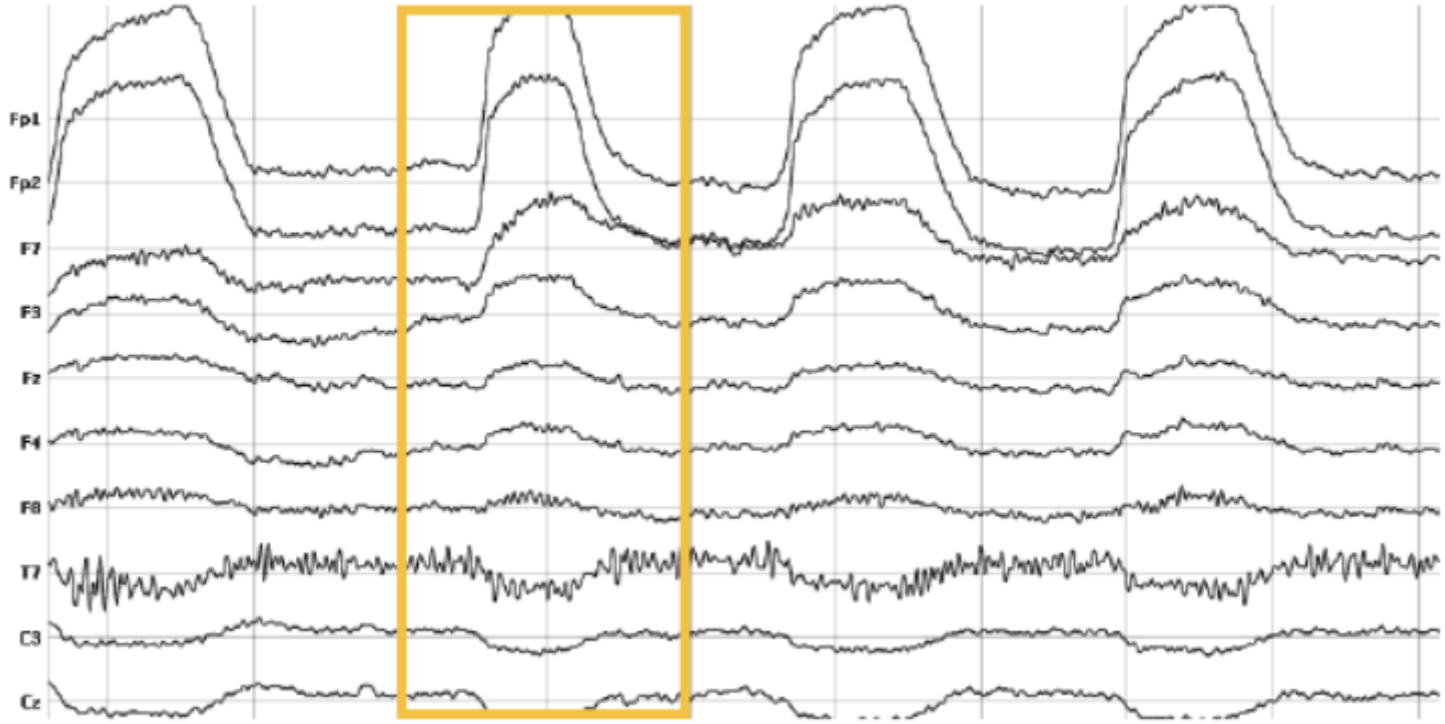
(Farnsworth, 2019)

Vahelduvvooluga seotud müra



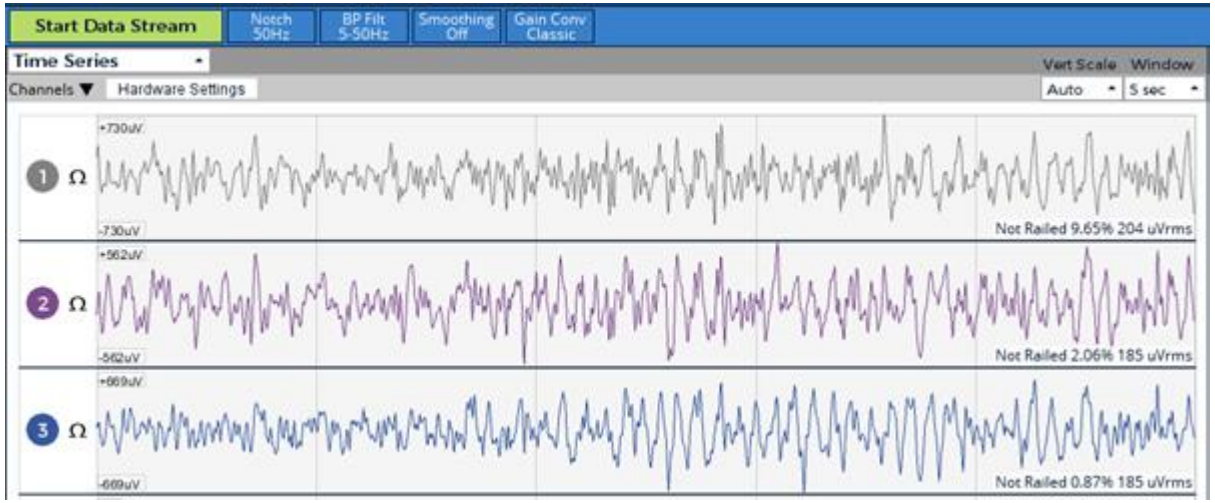
(Schembri, Anthony, & Pelc, 2017)

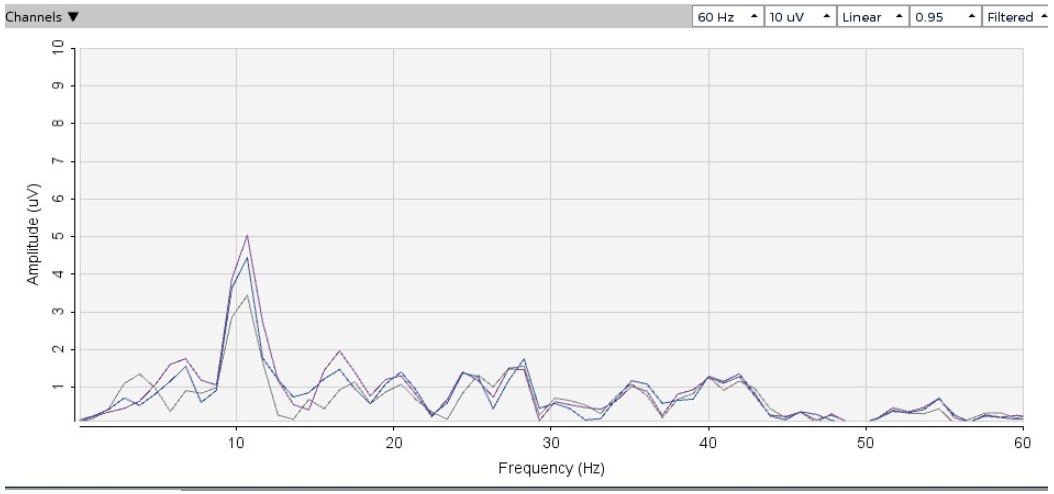
Pilgutused



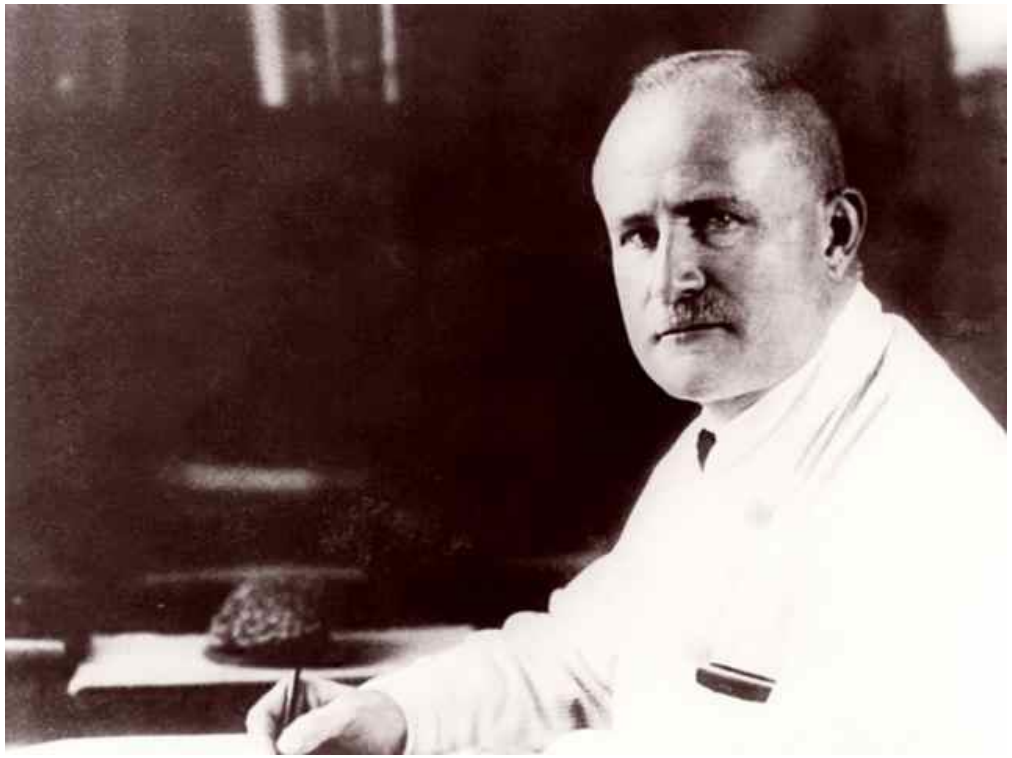
(Farnsworth, 2019)

F1


Start Data Stream
Notch 50Hz
BP Filt 5-50Hz
Smoothing Off
Gain Conv Classic
Time Series
Vert Scale
Window
Channels
Hardware Settings
Auto
5 sec
+730uV
-730uV
Not Railed 9.65% 204 uVrms
+562uV
-562uV
Not Railed 2.06% 185 uVrms
+669uV
-669uV
Not Railed 0.87% 185 uVrms


Channels
60 Hz
10 uV
Linear
0.95
Filtered
Amplitude (uV)
Frequency (Hz)

Esimesed mõõtmised inimestel



Hans Berger (1873-1941)

1929 – esimene peanahalt mõõdetud EEG inimesel

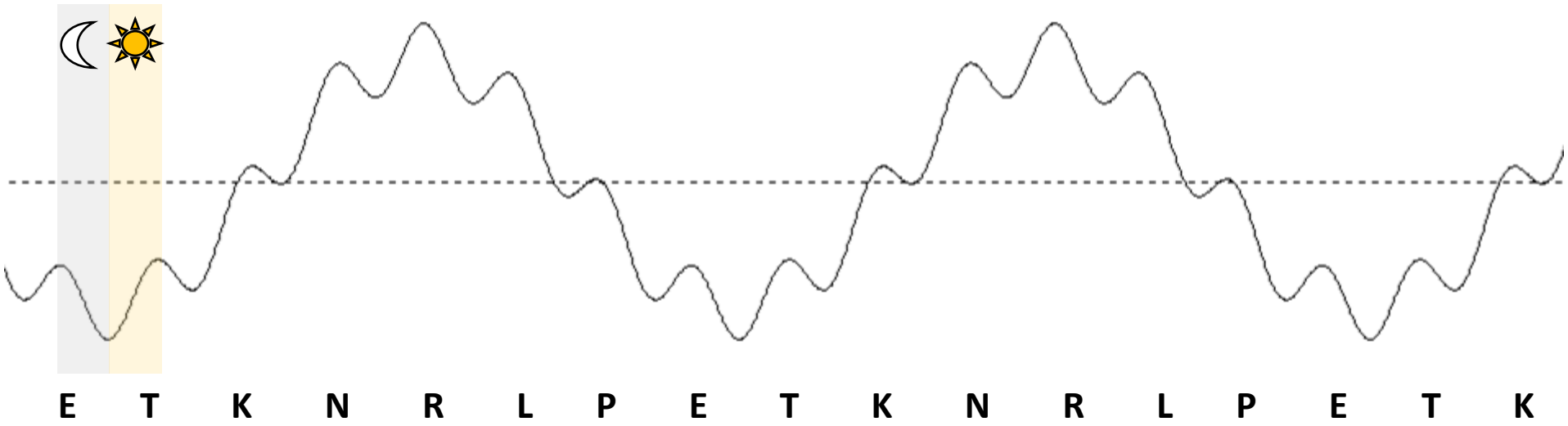
Elektroentsefalograafia termini sünd

Alfa ja Beeta rütmide kirjeldamine

1934 – Adrian and Matthews kordavad Bergeri tulemusi

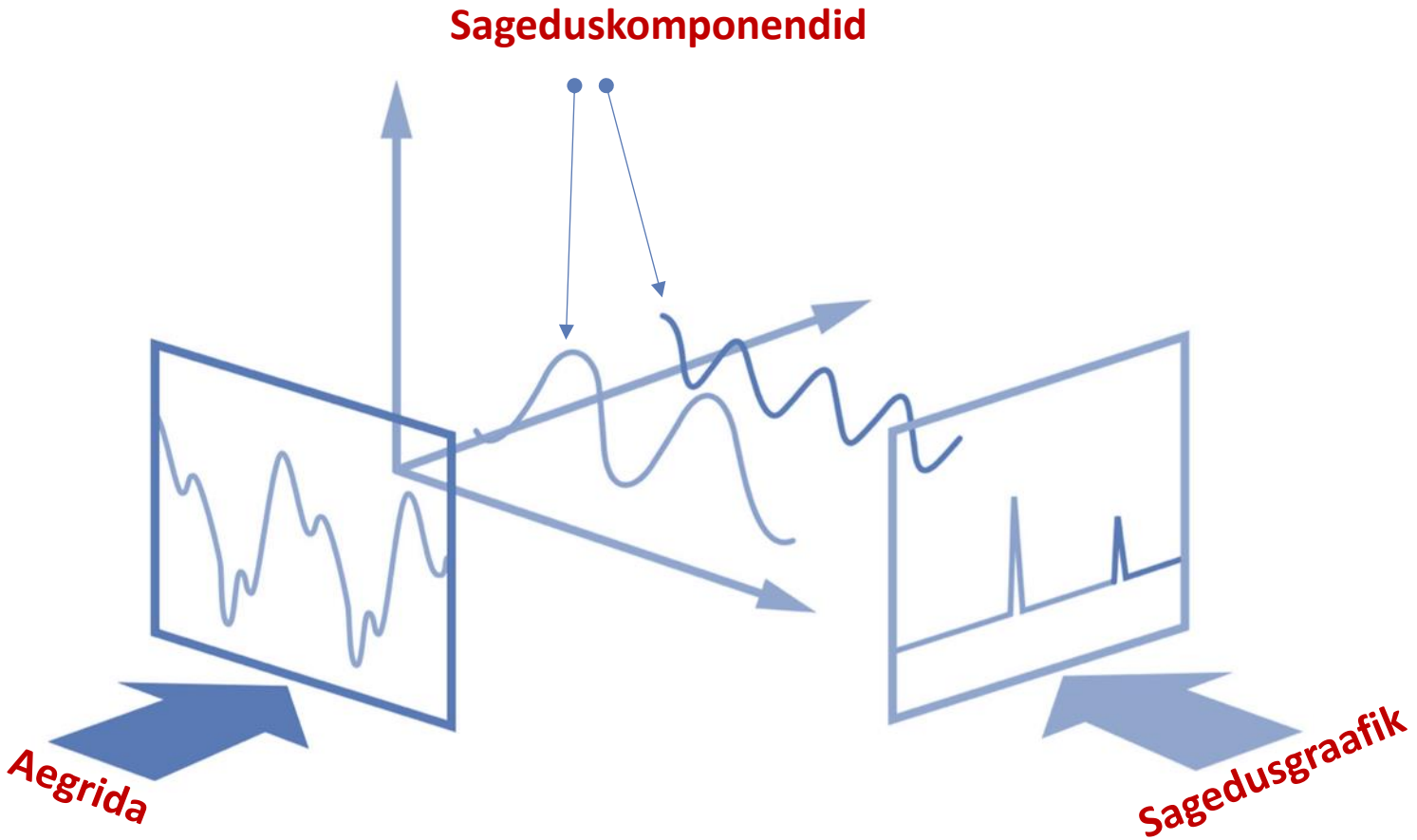
(İnce et al., 2020; Teplan, 2002)

Sagedused igapäevases kontekstis



Fourier analüüs

Jean-Baptiste Joseph Fourier (1768 –1830)



Brain Rhythms 101

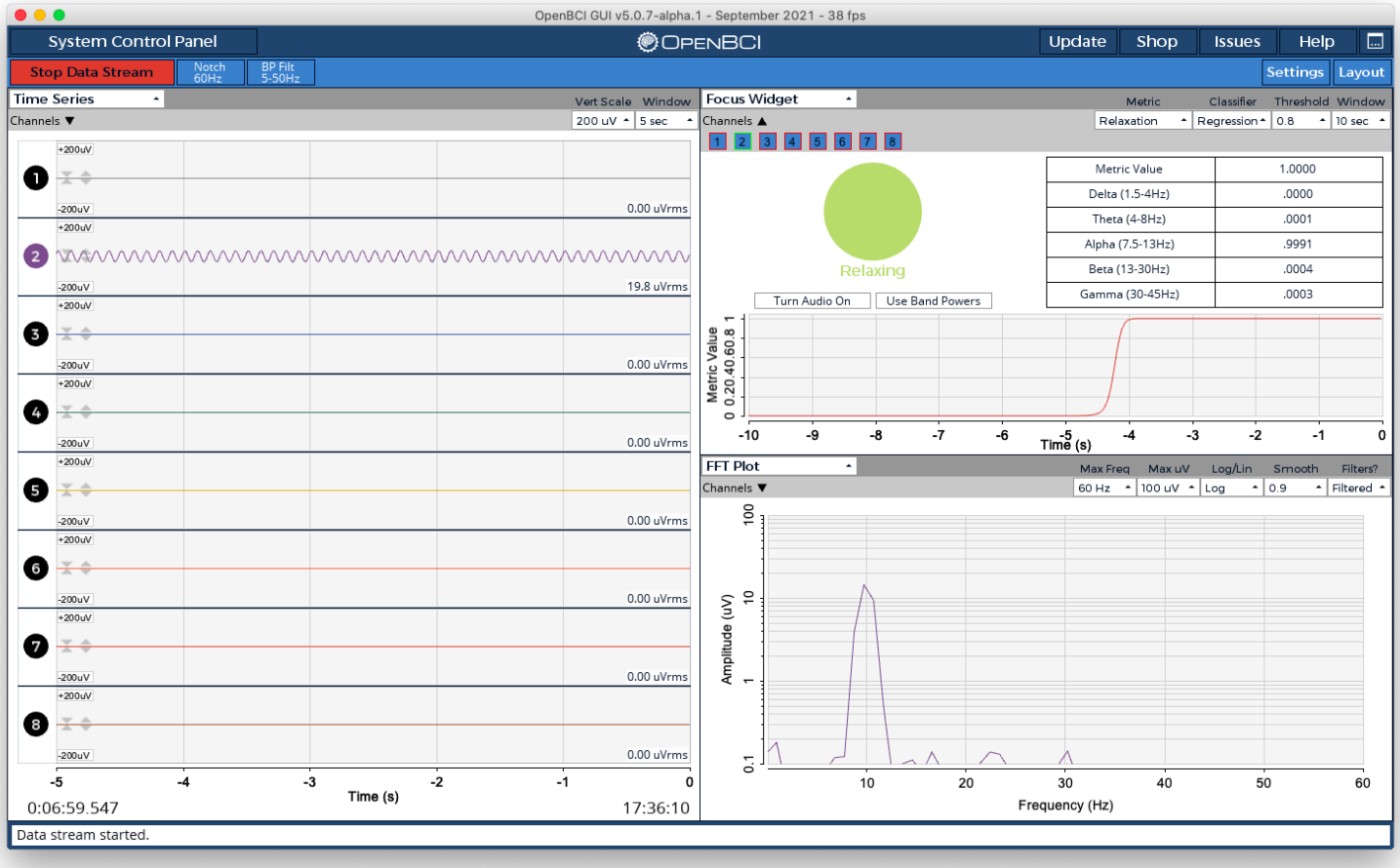
Harvard Brain Science Initiative
2.62K subscribers

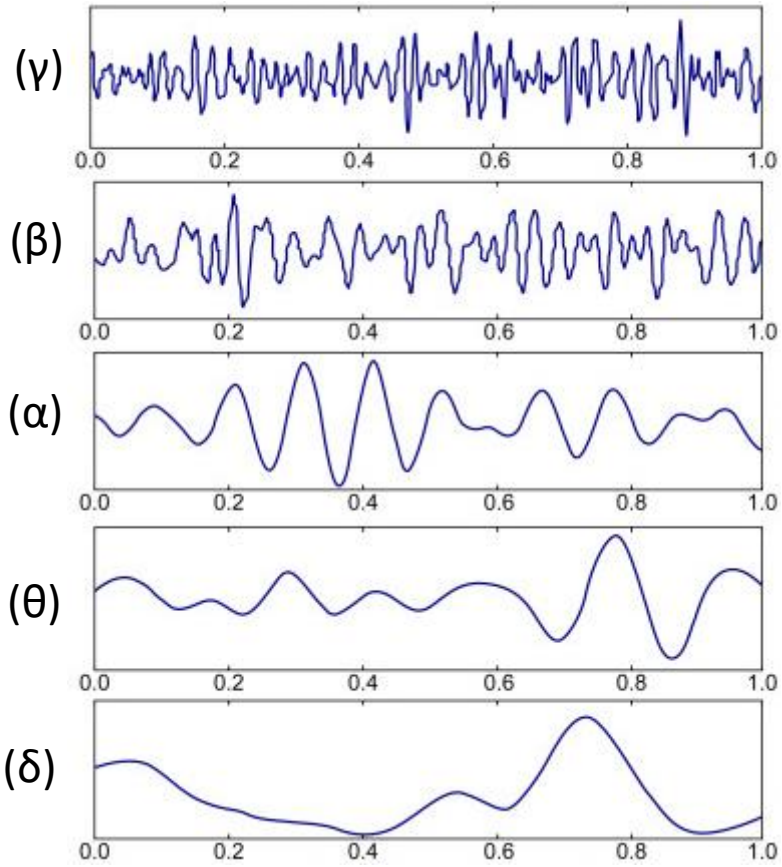
Sydney S. Cash, M.D., Ph.D.
Massachusetts General Hospital
Harvard Medical School
December 16, 2021

Sydney Cash
Associate Professor of Neurology, Harvard Medical School;
Assistant in Neurology, Massachusetts General Hospital

Dr. Cash discusses what is known about different types of brain oscillations, how they are measured and studied, what the biggest unanswered questions in this research area are, and why achieving a better understanding of brain oscillations matters clinically.

Focus Widget





Eeltöötlus

0. Kontrollin, kas kõik on nii nagu peab (sh stiimulite ja vastamisklahvide ajastus, randomiseerimine, sündmussignaalid ja nende ajastus)

1. Andmete importimine, referentsi valimine ja rakendamine, filtreerimine (nt 0,1/0,5 Hz kõrgpääsu filter, ribatõkke filter 48-52 Hz / 30 Hz madalpääsu filter), ajaakende defineerimine (nt -1 s ja +3 s) ja leidmine, baastaseme lahutamine (nt -0,2 s), mürarikaste seeriate väljajätmine (manuaalne/automaatne), mürarikaste kanalite interpoleerimine

EEG is better left alone

Arnaud Delorme

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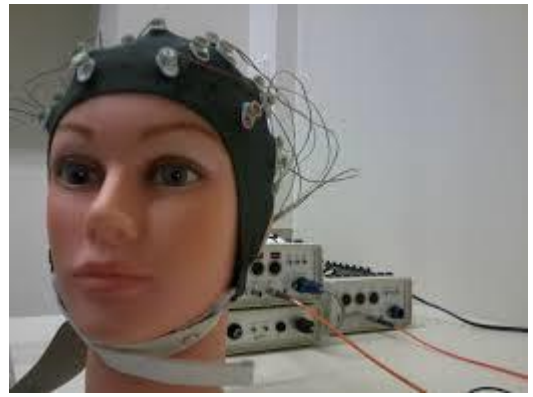

„We have found that re-referencing in all three datasets did not increase the percentage of significant channels.“

AGA

The **BIOSEMI** raw signal for the Oddball dataset is considered unsuited for offline data analysis, and the BIOSEMI company recommends choosing an offline reference to add 40 dB extra CMRR (common mode rejection ratio) (https://www.biosemi.com/faq/cms&drl.htm).

Eeltöötlus

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„[…] the performance improvement of line noise correction was minor (on the order of a few percent), in contrast to the effect of high-pass filtering, which led to performance increases of about 50% on two datasets. “

Eeltöötlus

0. Kontrollin, kas kõik on nii nagu peab (sh stiimulite ja vastamisklahvide ajastus, randomiseerimine, sündmussignaalid ja nende ajastus)

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„We have observed that, if the data is high-pass filtered at or above 0.5 Hz, subtracting mean baseline activity should be omitted for event-related analyses.“

Eeltöötlus

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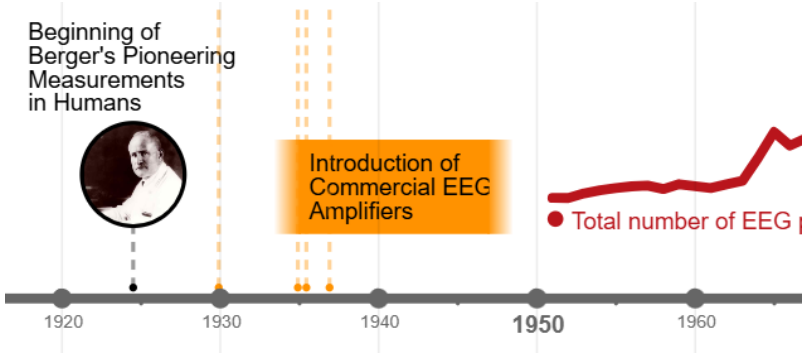
„[…] the removal of bad trials most often failed to compensate for the decrease in the number of trials and associated decrease in statistical power compared to the control condition where no trials were removed.“

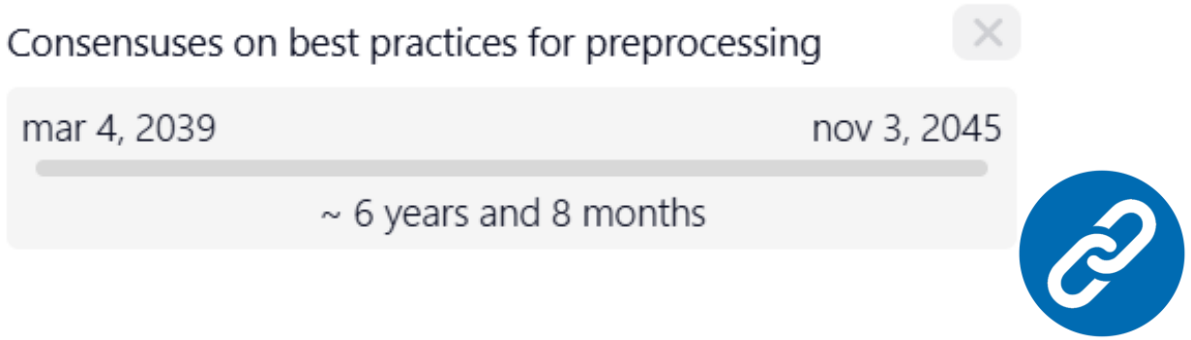
Eeltöötlus

(2. Põhiliselt silmaliigutustega seotud ICA komponentide eemaldamine)

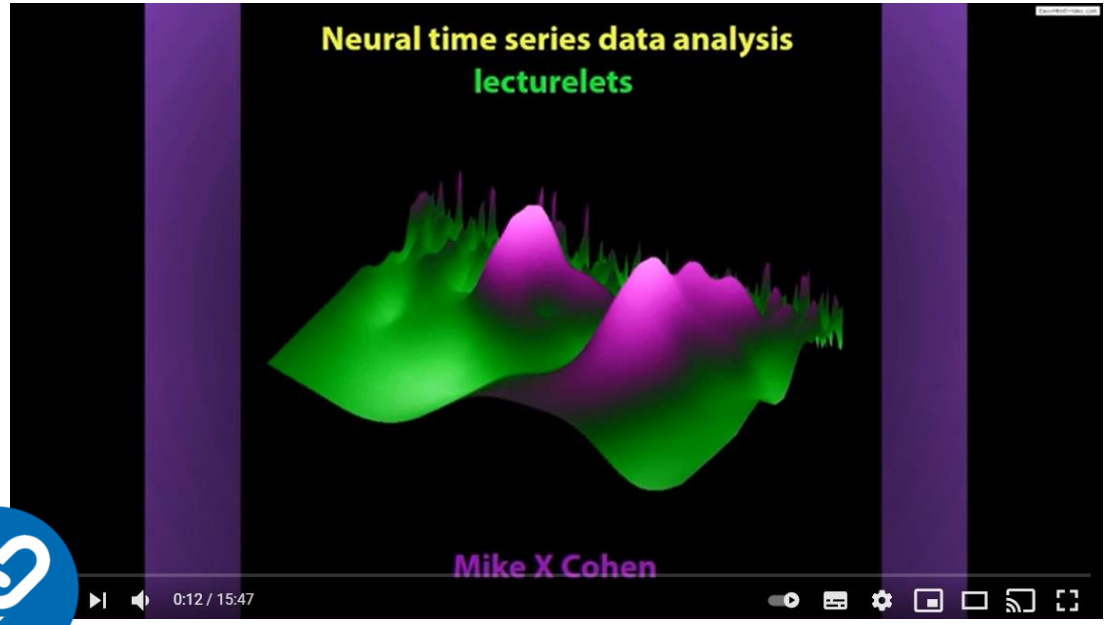
3. Ajaakende ja tingimuste keskmise leidmine, sagedusanalüüs jne

4. Andmete visualiseerimine ja tabelisse salvestamine, statistika jne

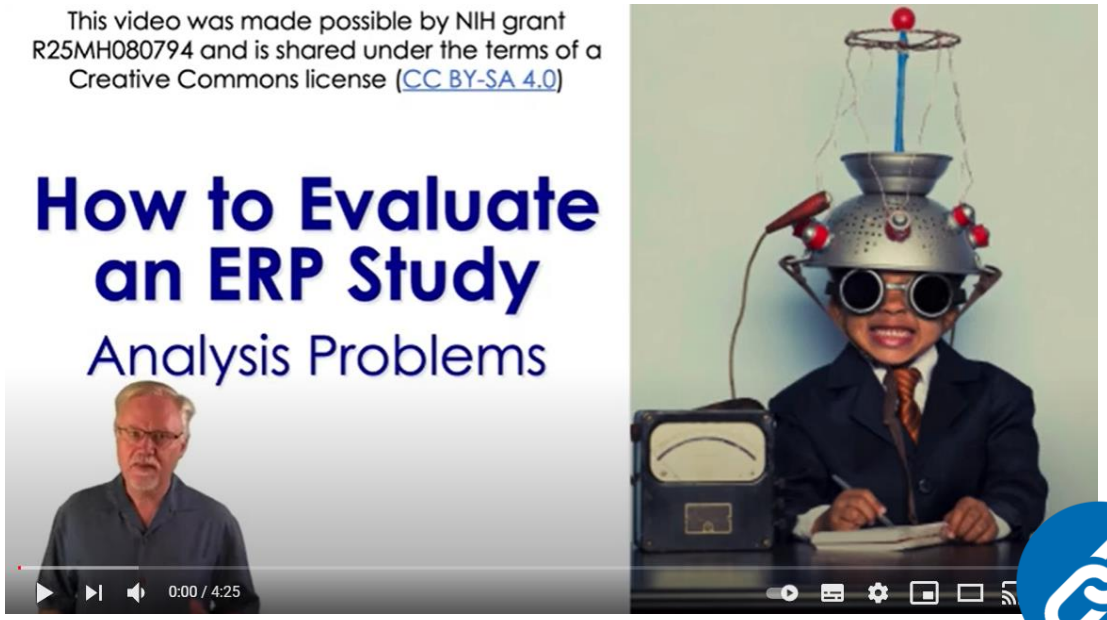




Ülevaade EEG signaali eeltöötlusest



Professor Mike X Cohen (Radboudi Ülikool ja Dondersi instituut)



Professor Steven Luck (Kalifornia Ülikool, Davis)

Kaasprofessor Emily Kappenman (San Diego Osariiklik Ülikool)

EEG is better left alone

Arnaud Delorme

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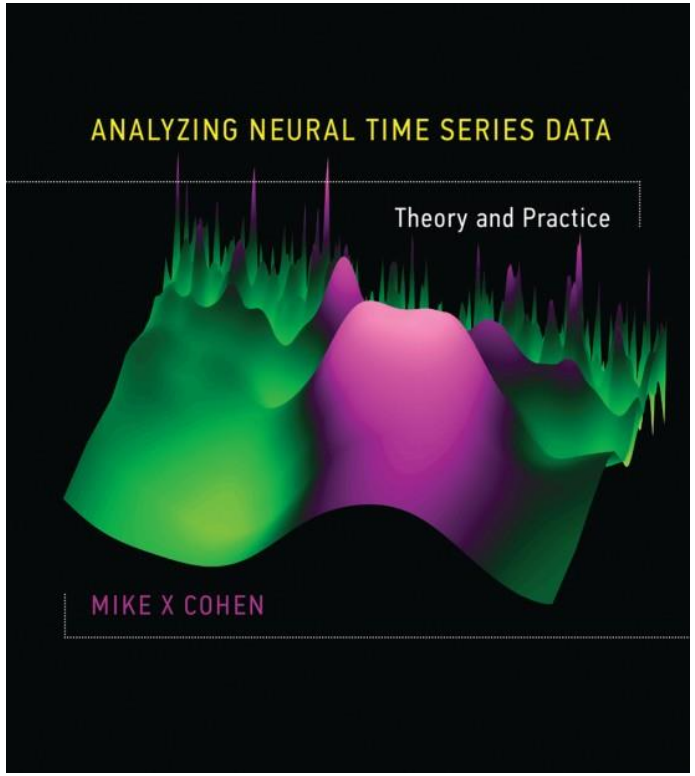
Abstract

Automated preprocessing methods are critically needed to process the large publicly-available EEG databases, but the optimal approach remains unknown because we lack data quality metrics to compare them. Here, we designed a simple yet robust EEG data quality metric assessing the percentage of significant channels between two experimental conditions within a 100 ms post-stimulus time range. Because of volume conduction in EEG, given no noise, most brain-evoked related potentials (ERP) should be visible on every single channel. Using three publicly available collections of EEG data, we showed that, with the exceptions of high-pass filtering and bad channel interpolation, automated data corrections had no effect on or significantly decreased the percentage of significant channels. Referencing and advanced baseline removal methods were significantly detrimental to performance. Rejecting bad data segments or trials could not compensate for the loss in statistical power. Automated Independent Component Analysis rejection of eyes and muscles failed to increase performance reliably. We compared optimized pipelines for preprocessing EEG data maximizing ERP significance using the leading open-source EEG software: EEGLAB, FieldTrip, MNE, and Brainstorm. Only one pipeline performed significantly better than high-pass filtering the data.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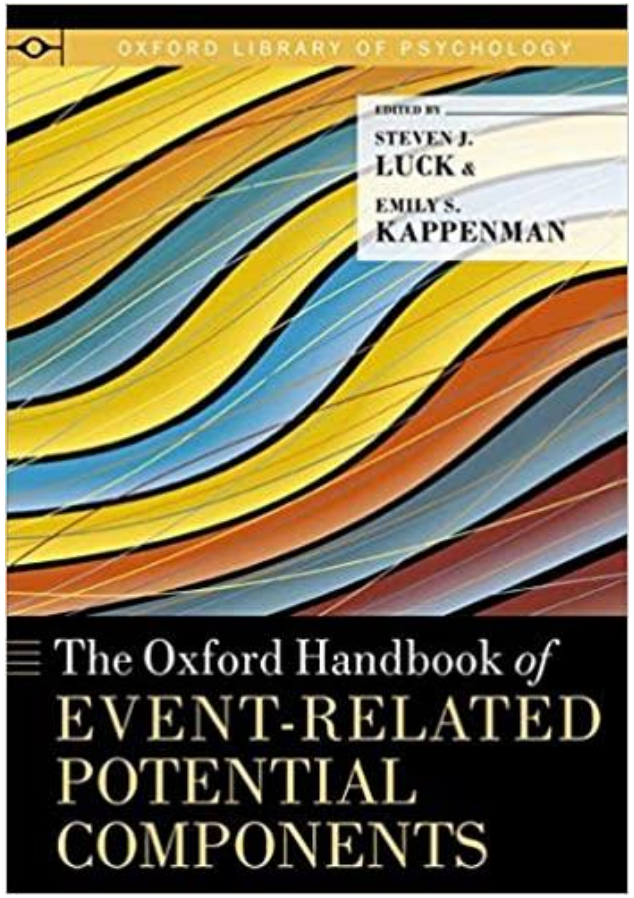
Theory and Practice
MIKE X COHEN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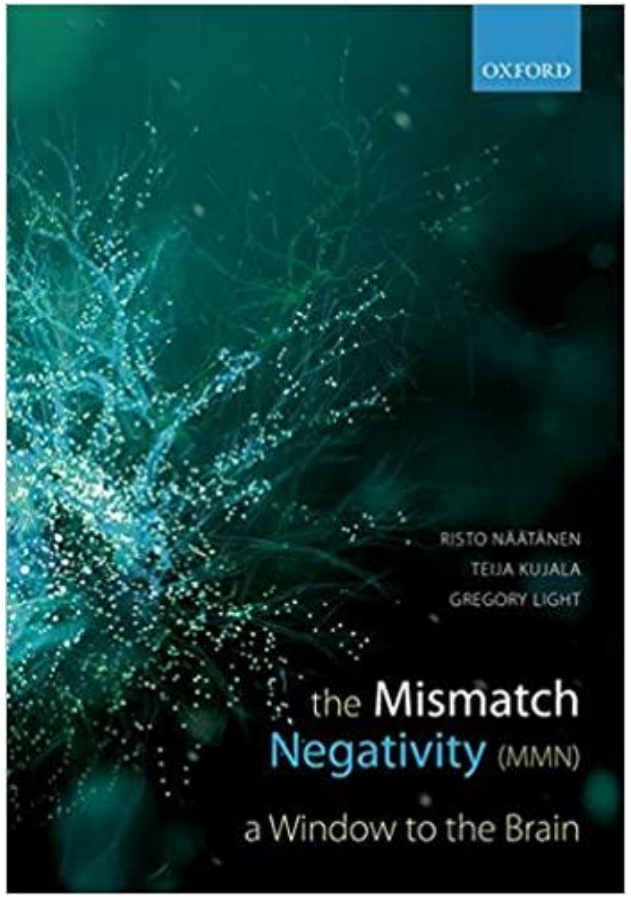
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the Mismatch Negativity (MMN)
a Window to the Brain

The Mismatch Negativity (MMN)

Risto Näätänen and Kairi Kreegipuu

The Oxford Handbook of Event-Related Potential Components
Edited by Emily S. Kappenman and Steven J. Luck

Print Publication Date: Dec 2011 Subject: Psychology, Cognitive Psychology, Cognitive Neuroscience
Online Publication Date: Sep 2012 DOI: 10.1093/oxfordhb/9780195374148.013.0081

[–] Abstract and Keywords

The auditory mismatch negativity (MMN) is a change-specific component of the auditory event-related brain potential (ERP) that is elicited even in the absence of attention and can be used as an objective index of sound-discrimination accuracy and auditory sensory memory. The MMN enables one to reach a new level of understanding of the brain processes forming the biological substrate of central auditory perception and the different forms of auditory memory. A review of MMN studies indicates that the central auditory system performs complex cognitive operations, such as generalization leading to simple concept formation (e.g., a rising pair irrespective of the specific frequency values), rule extraction, and the anticipation of the next stimulus at the preattentive level. These findings demonstrate the presence of a cognitive change-detection mechanism in the auditory cortex.

Keywords: mismatch negativity (MMN), auditory event-related potential, sound discrimination, auditory sensory memory

Kasutatud kirjandus (esinemise järjekorras)

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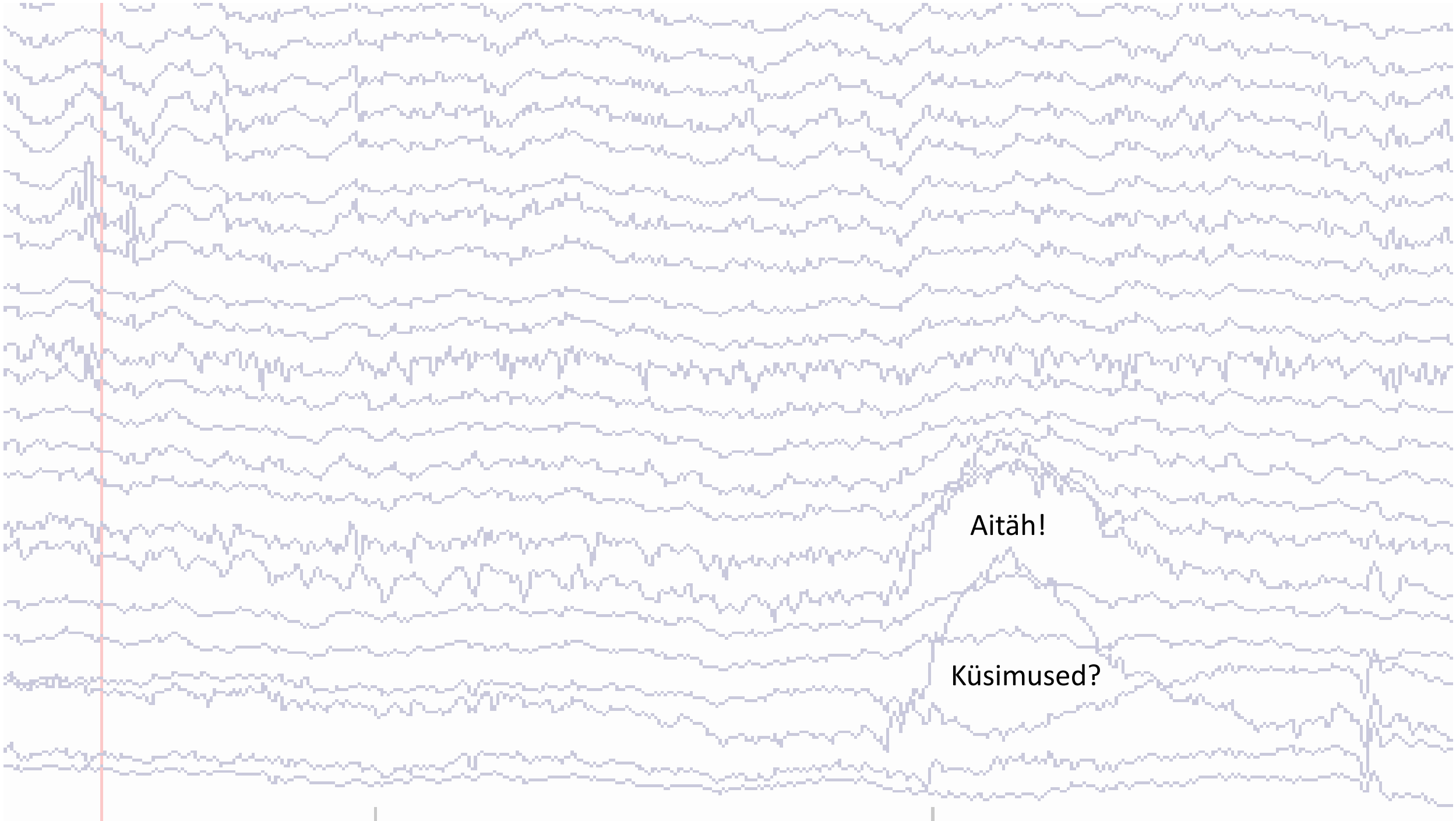
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