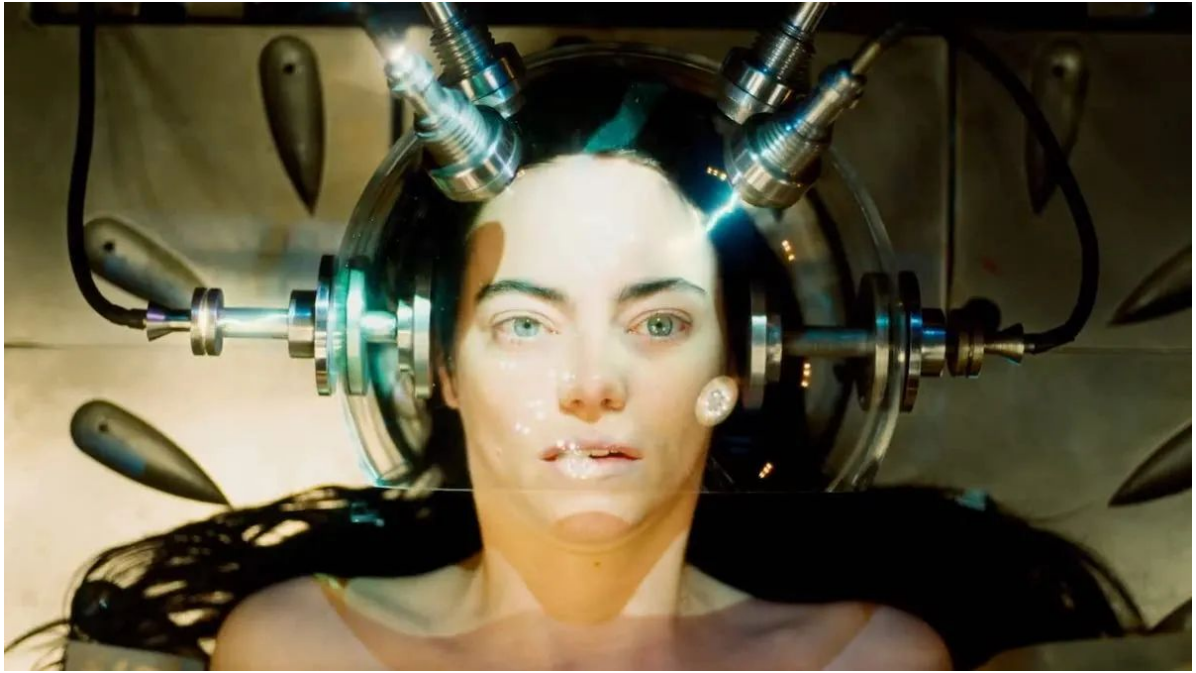
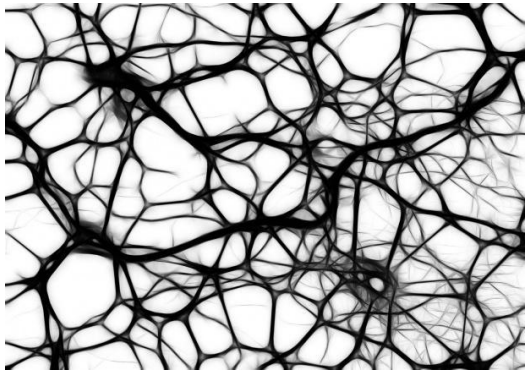
What is EEG?

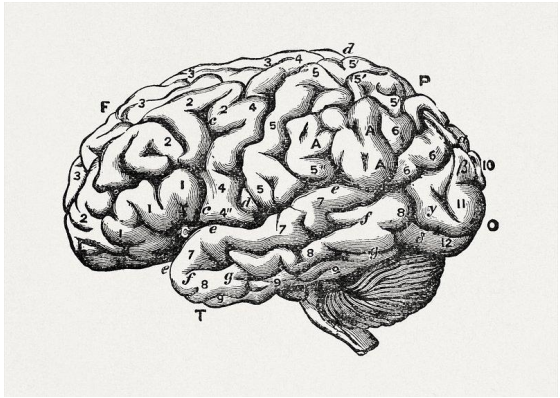


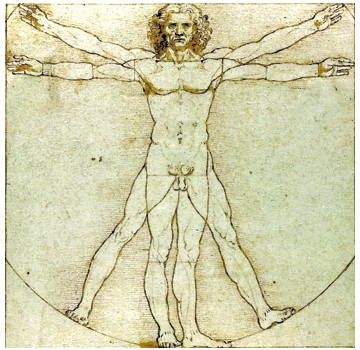
Ca N

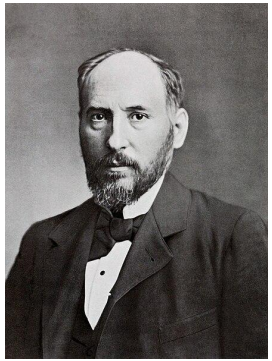
C P

O



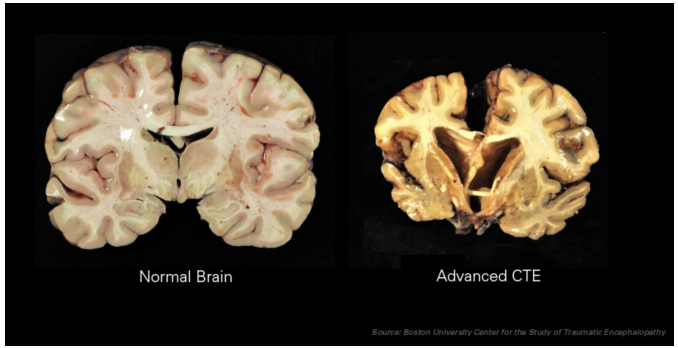






What does the brain tell us about the human?

Post-mortem examination



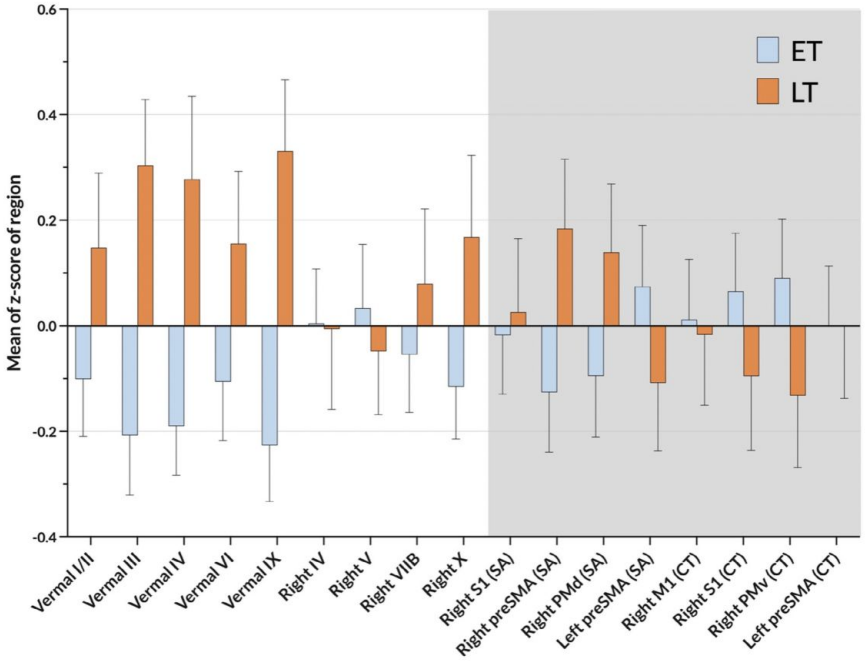
Received: 29 November 2022 | Revised: 19 April 2023 | Accepted: 25 May 2023
DOI: 10.1002/hbm.26395

WILEY

RESEARCH ARTICLE

Using cortico-cerebellar structural patterns to classify early- and late-trained musicians

Joseph J. Shenker[1,2] | Christopher J. Steele[1,3] | Robert J. Zatorre[2,4] | Virginia B. Penhune[1,2]



Biological psychology

Biological psychology

How to describe behaviour using biological explanations

Biological psychology

How to describe behaviour using biological explanations

Synonyms:

- Biopsychology
- Psychobiology
- Physiological psychology
- Behavioural neuroscience → we will relate most of the behaviours to our brain

Behavioural vs. neural data

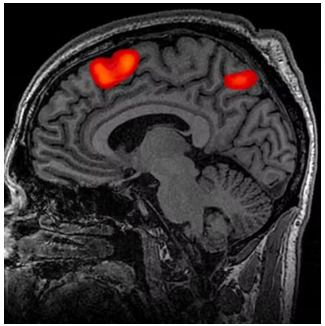
Behaviour

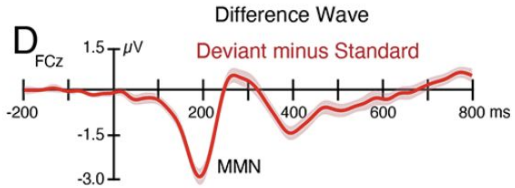
Participants need to do something

- Questionnaire
- Task

Observation of brain activity

Just exposure to a stimulus is enough to observe reaction





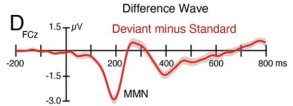
Behavioural vs. neural data - what can we measure?

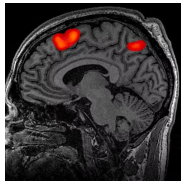
Behaviour

- Response time
- Accuracy

Brain activity

- Latency
- Intensity of response





Behavioural vs. neural data - what can we measure?

Behaviour

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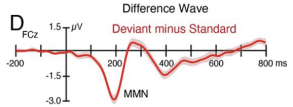
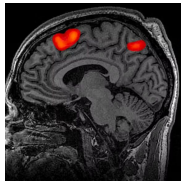
Brain activity



- Latency
- Intensity of response



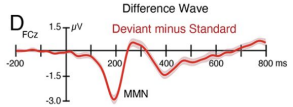
- Approx. location of the activity

Behavioural vs. neural data - what can we measure?

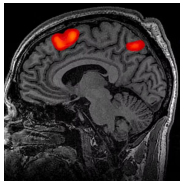
Behaviour

- Response time
- Accuracy

Brain activity



- Latency
- Intensity of response



- Approx. location of the activity

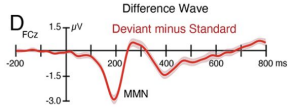
Can’t switch off all the other processes in the brain

Behavioural vs. neural data - what can we measure?

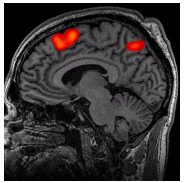
Behaviour

- Response time
- Accuracy

Brain activity



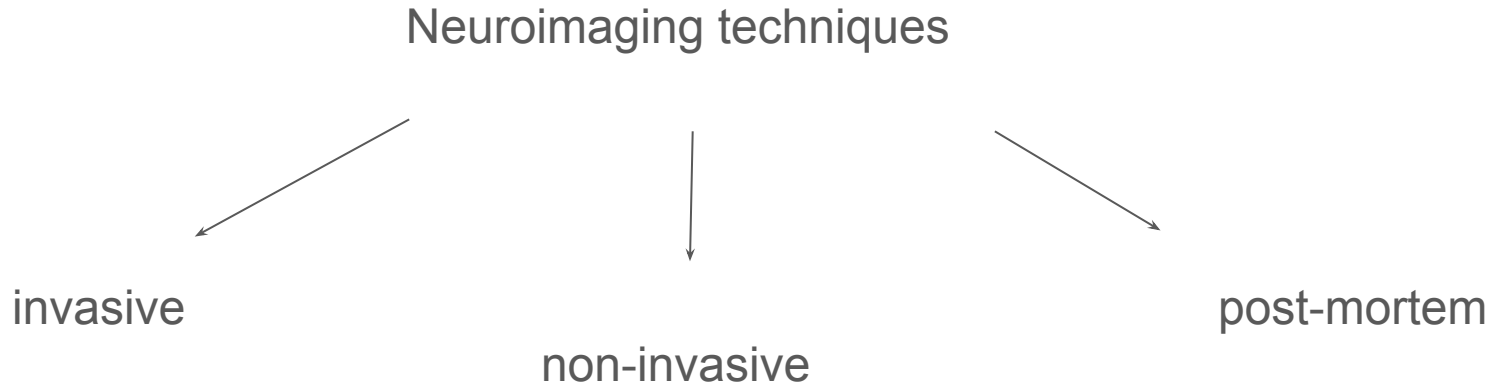
- Latency
- Intensity of response

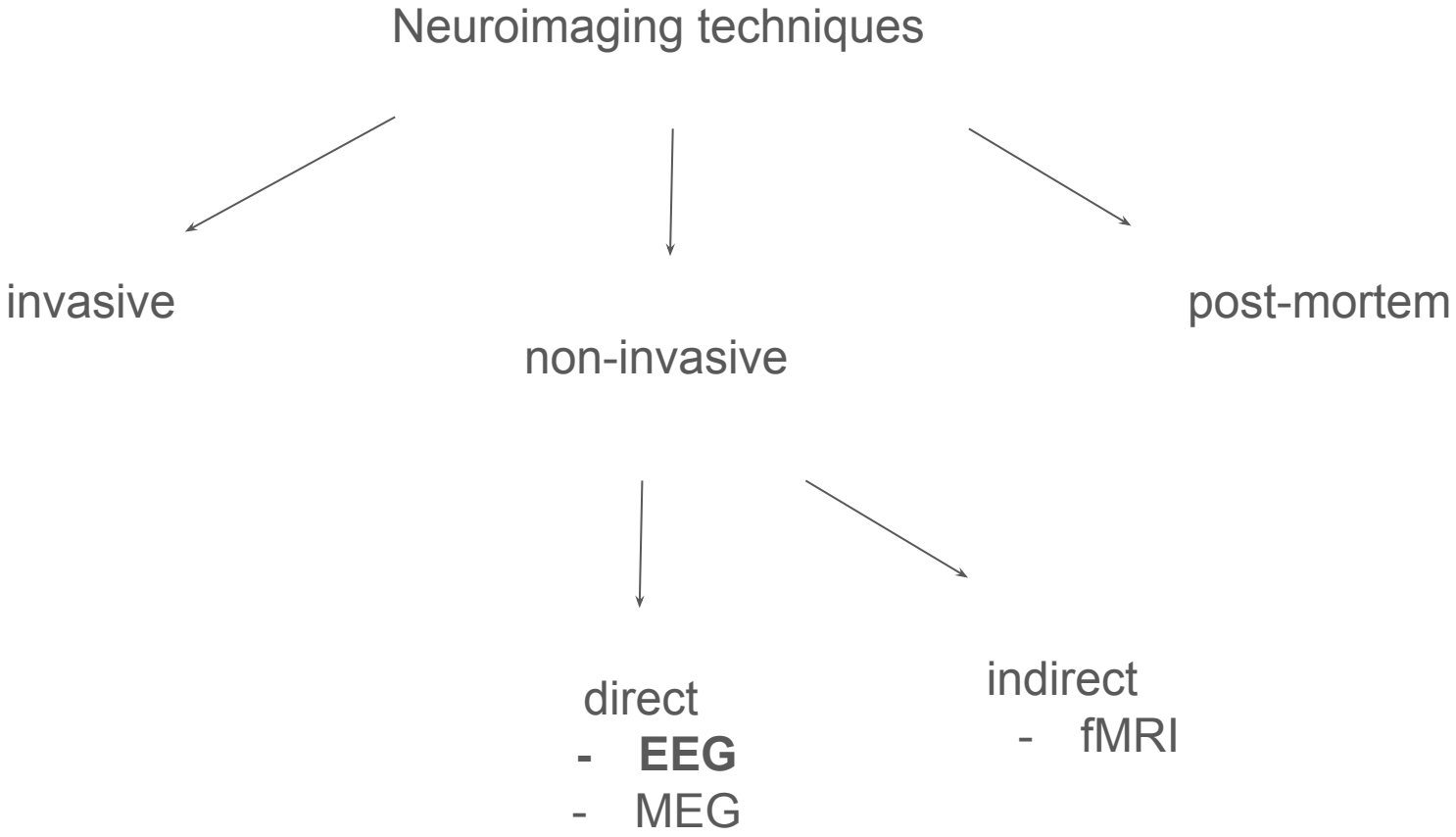


- Approx. location of the activity

Can’t switch off all the other processes in the brain

No need to ask participants to do something


Neuroimaging techniques
invasive
non-invasive
post-mortem


Neuroimaging techniques
invasive
non-invasive
post-mortem
direct
- EEG
- MEG
indirect
- fMRI

Neuroimaging techniques

invasive

non-invasive

post-mortem

- iEEG
- PET

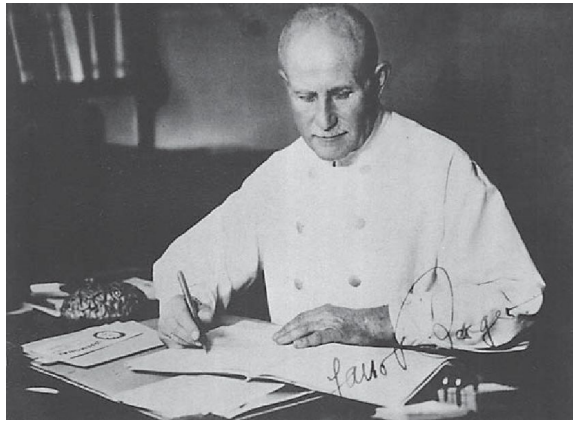
Über das Elektrenkephalogramm des Menschen.

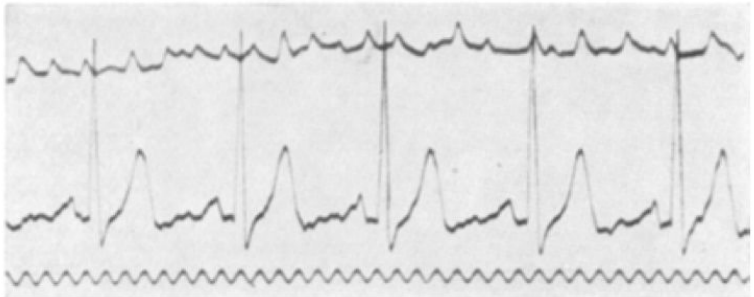
Von

Professor Dr. **Hans Berger**, Jena.

(Mit 17 Textabbildungen.)

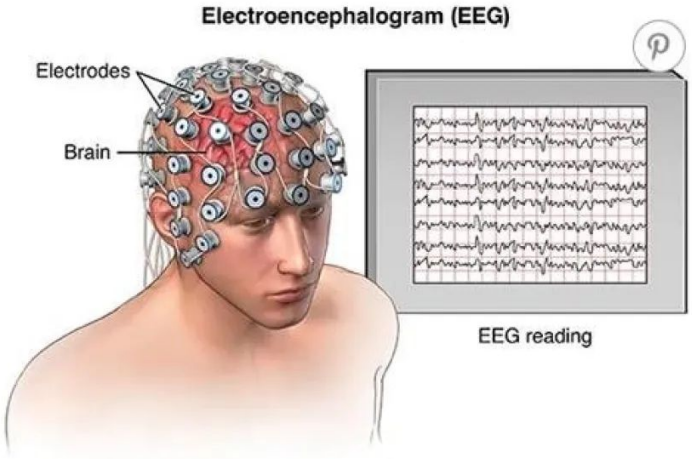
(Eingegangen am 22. April 1929.)

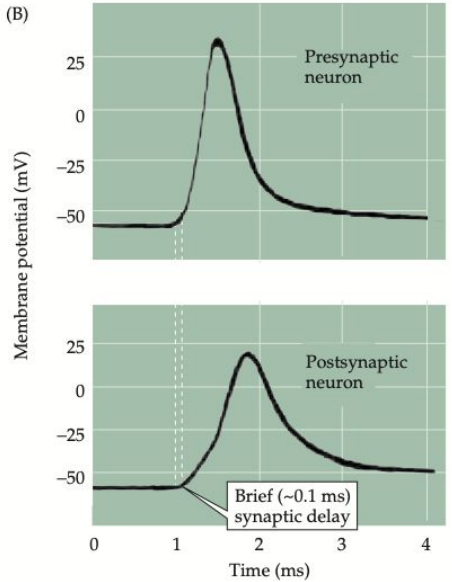




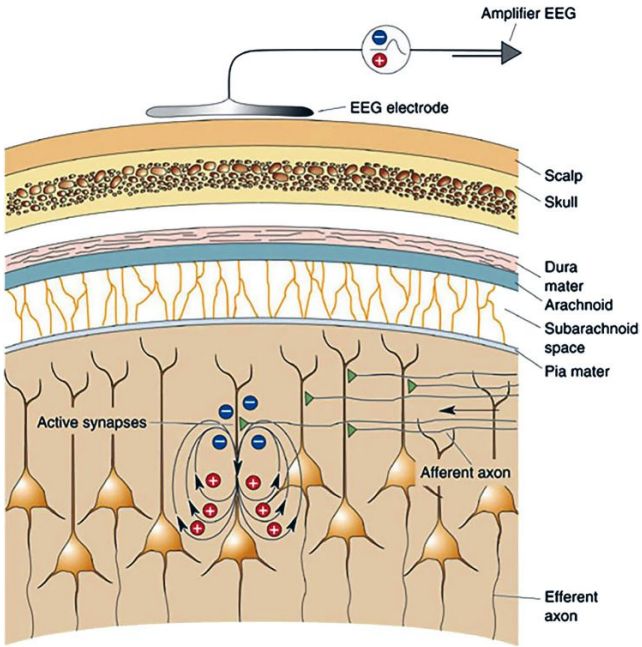
What is EEG?

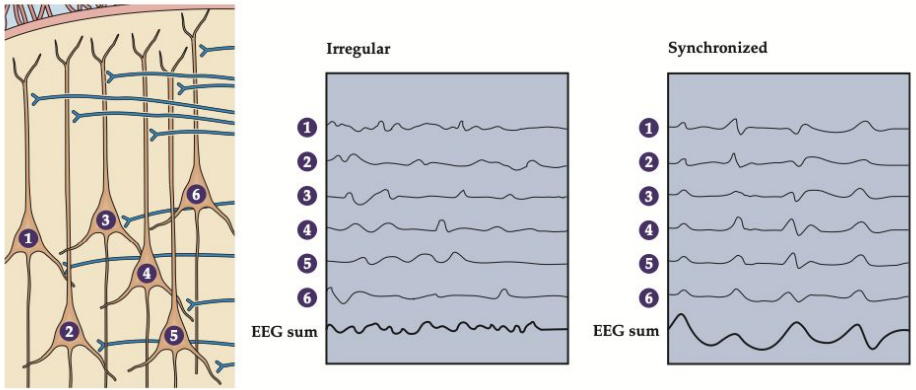
- Electrodes placed on the skull
- Measuring postsynaptic activity of the neurons in the cerebral cortex





Characteristics of the signal

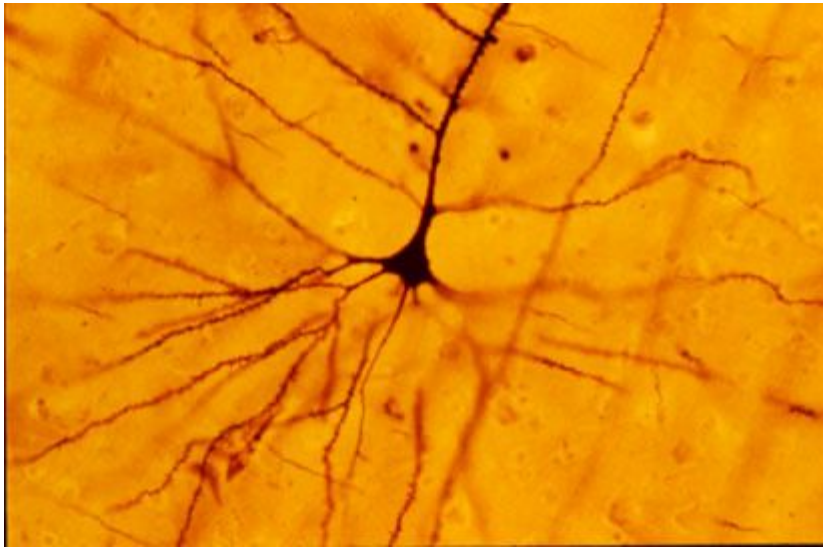




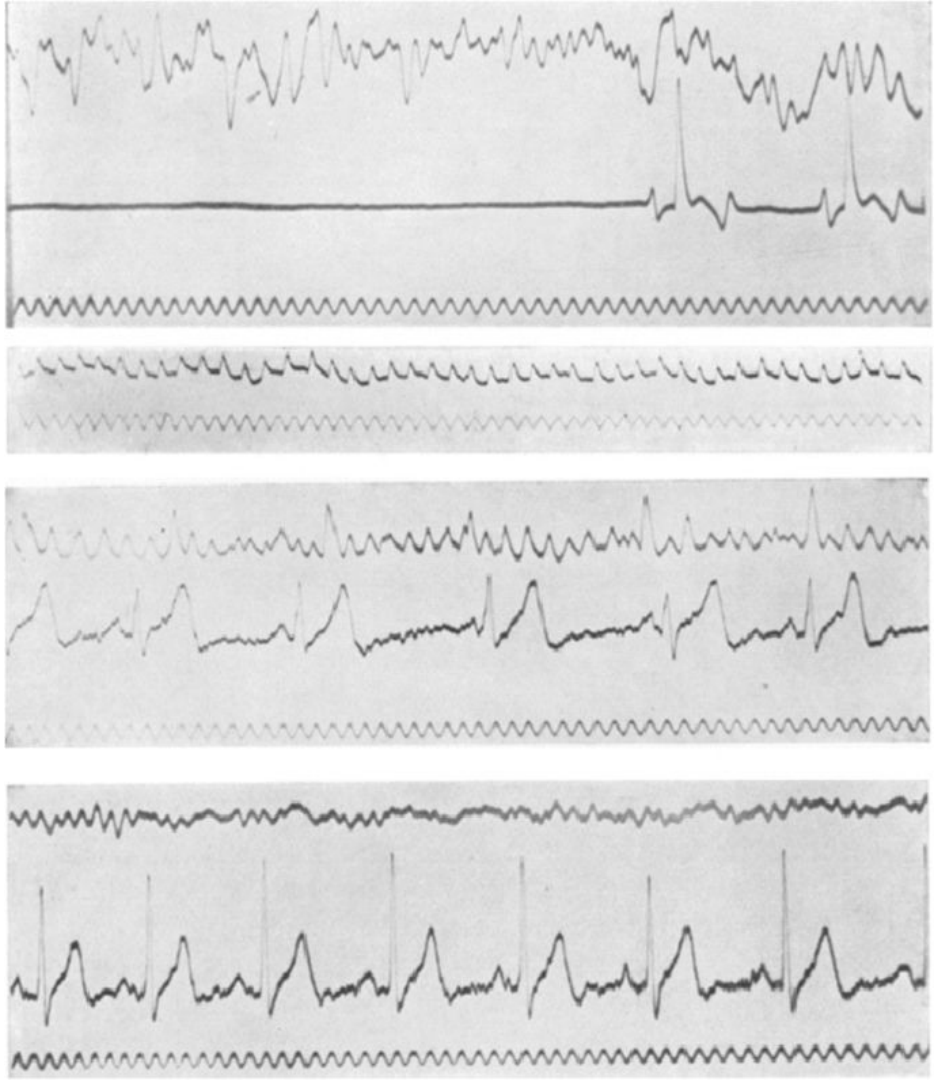
***Neurosciences*, Bear, Connors, and Paradiso, Éditions Pradel, 2002**

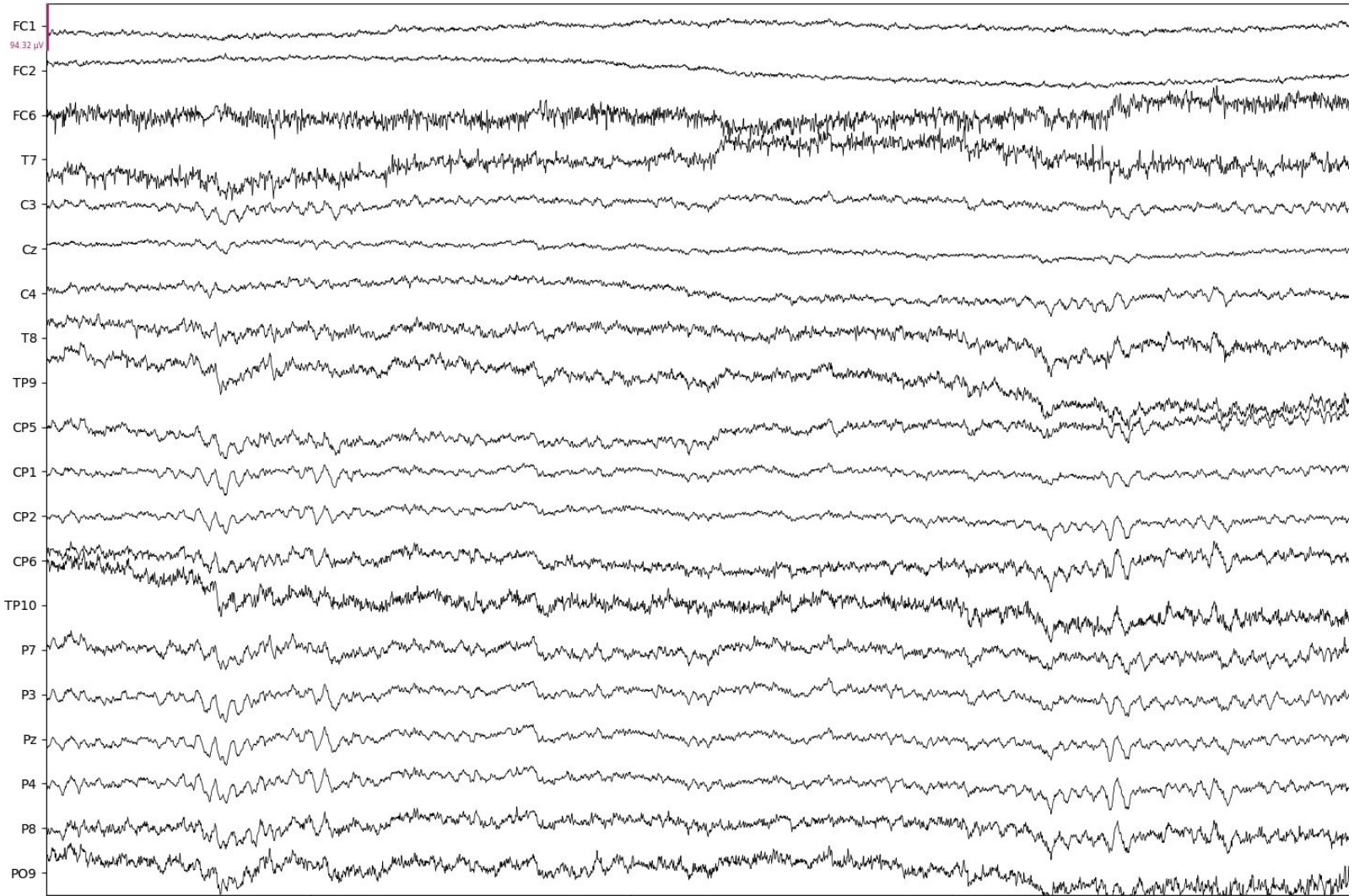
Why pyramidal cells?

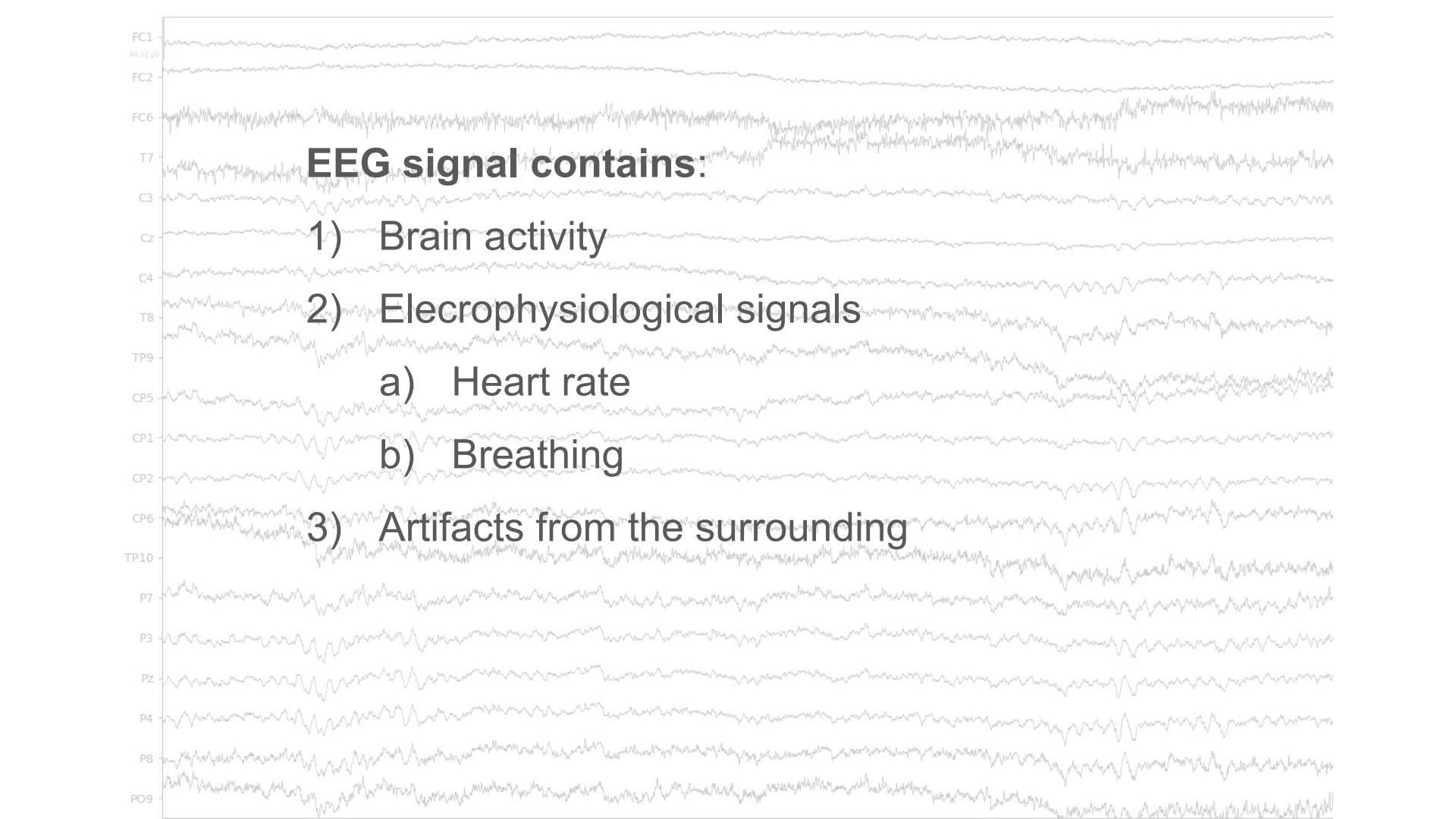
- Strongly interconnected - the activity is syncronised
- A lot of them in the cortex



How does EEG signal look like?

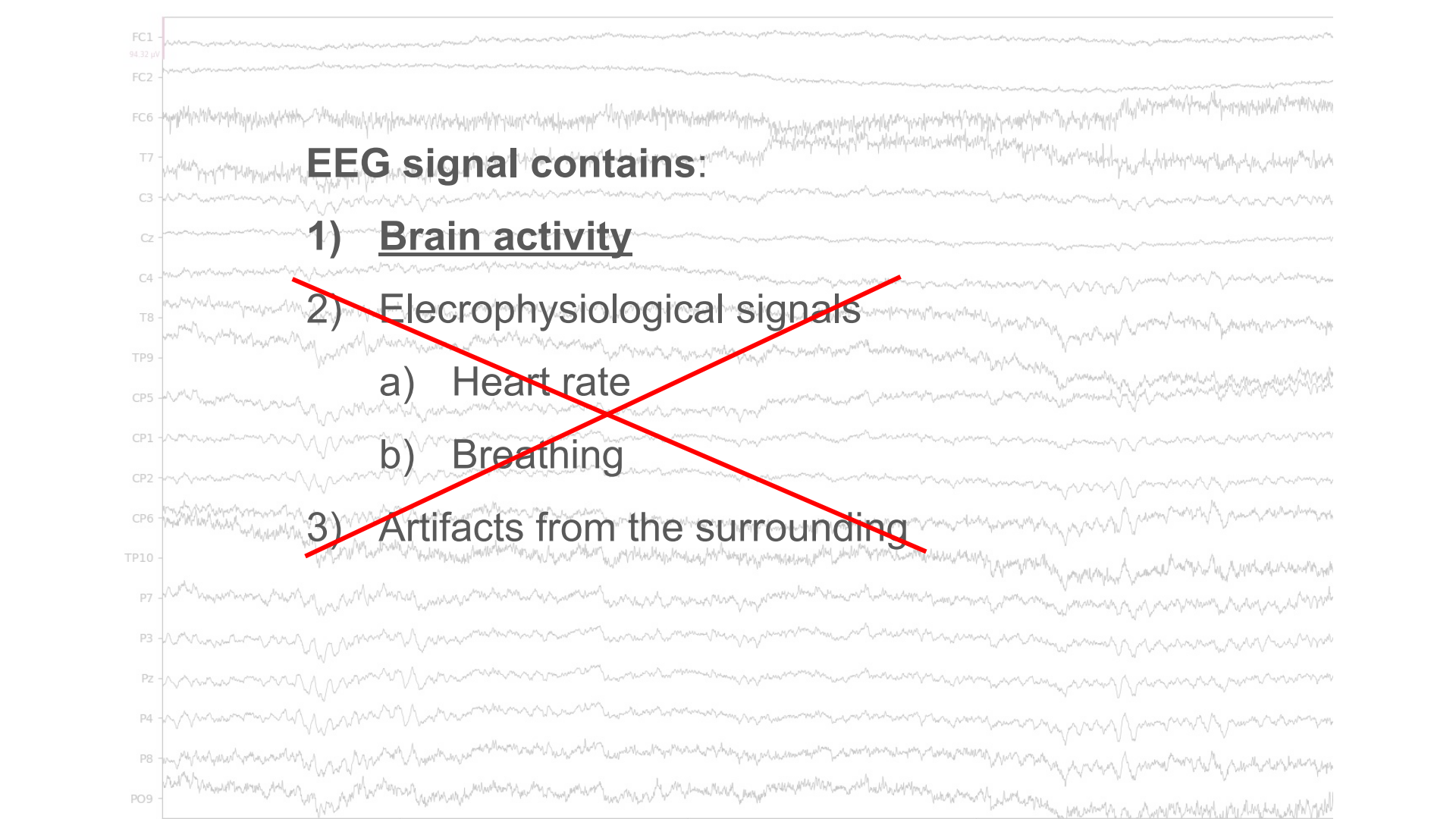



FC1
94.32 µV
FC2
FC6
T7
C3
Cz
C4
T8
TP9
CP5
CP1
CP2
CP6
TP10
P7
P3
Pz
P4
P8
PO9



EEG signal contains:

1) Brain activity
2) Elecrophysiological signals
    a) Heart rate
    b) Breathing
3) Artifacts from the surrounding



EEG signal contains:

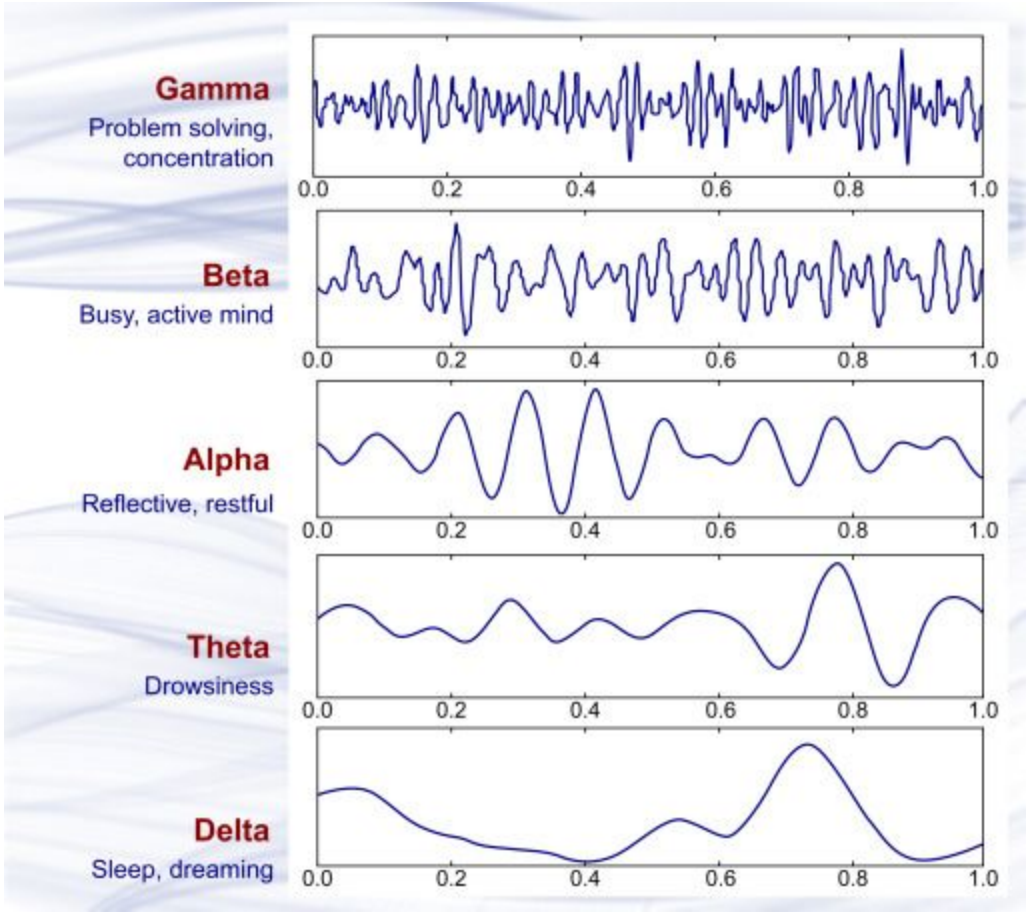
1) **<u>Brain activity</u>**
2) Elecrophysiological signals
    a) Heart rate
    b) Breathing
3) Artifacts from the surrounding

How to analyse the data?

a) Spectro-temporal analysis
b) Event-related potentials
c) Temporal response function

How to analyse the data

a) Spectro-temporal analysis
b) Event-related potentials
c) Temporal response function



>30 Hz

12 - 30 Hz

8 - 12 Hz

4 - 8 Hz

0.5 - 4 Hz

How to analyse the data

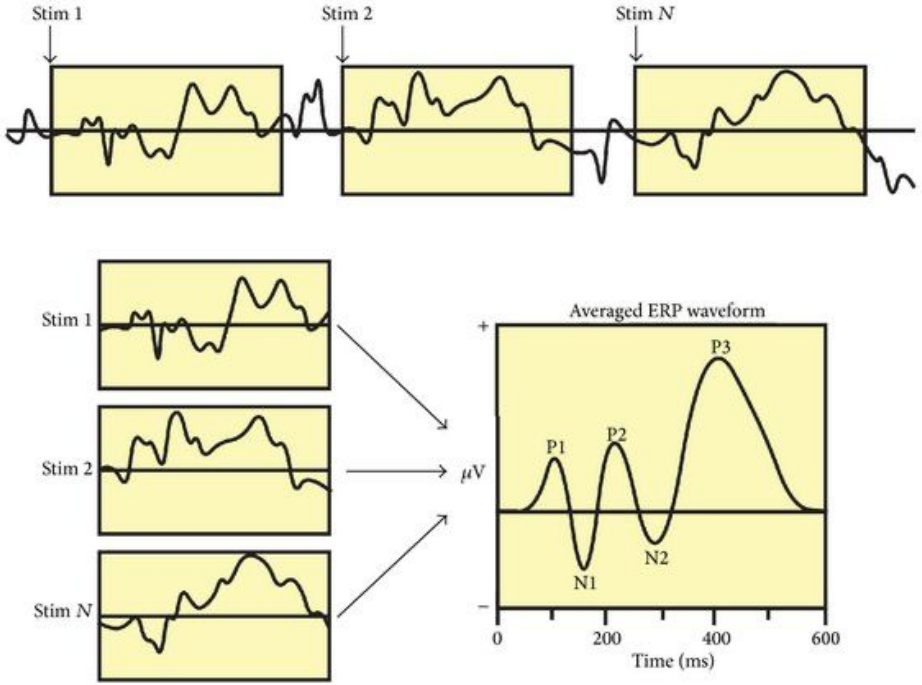
a) Spectro-temporal analysis
b) Event-related potentials
c) Temporal response function

Event-related potentials (ERP)

Brain response to a stimulus + noise

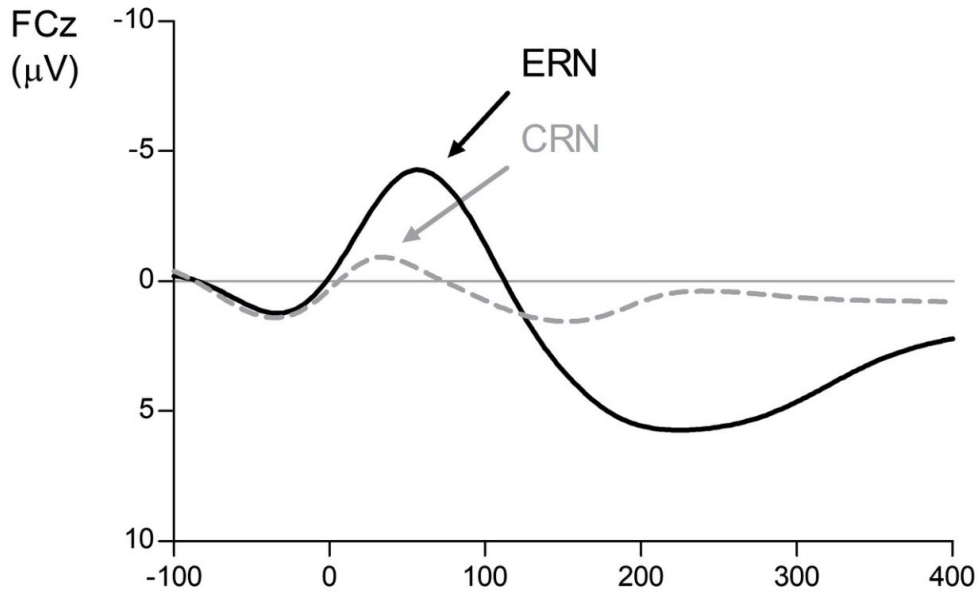
Averaging removes the noise

Brief changes in an EEG signal in response to a discrete event (stimulus)



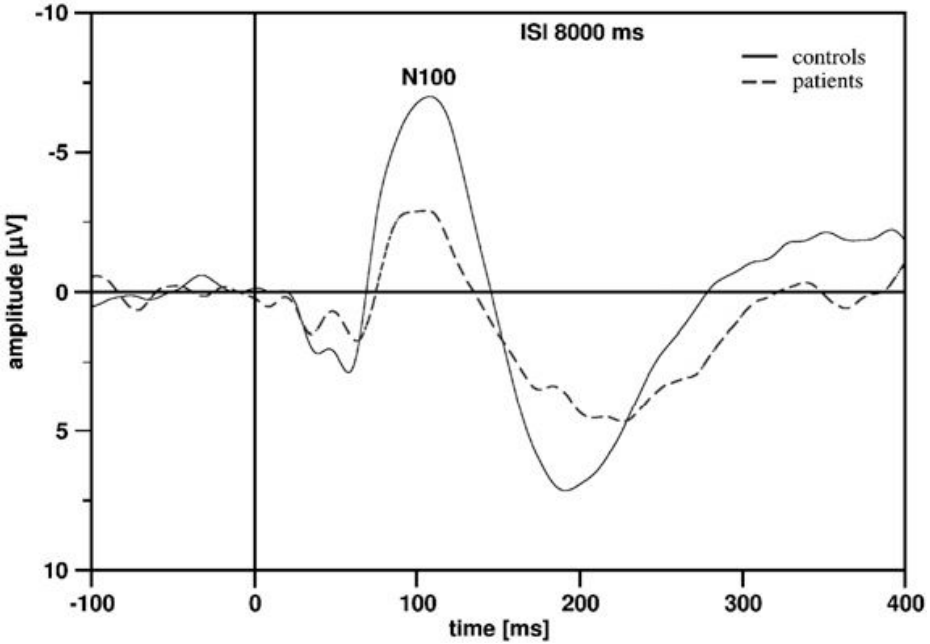
Examples of ERPs

- ERN (error-related negativity)



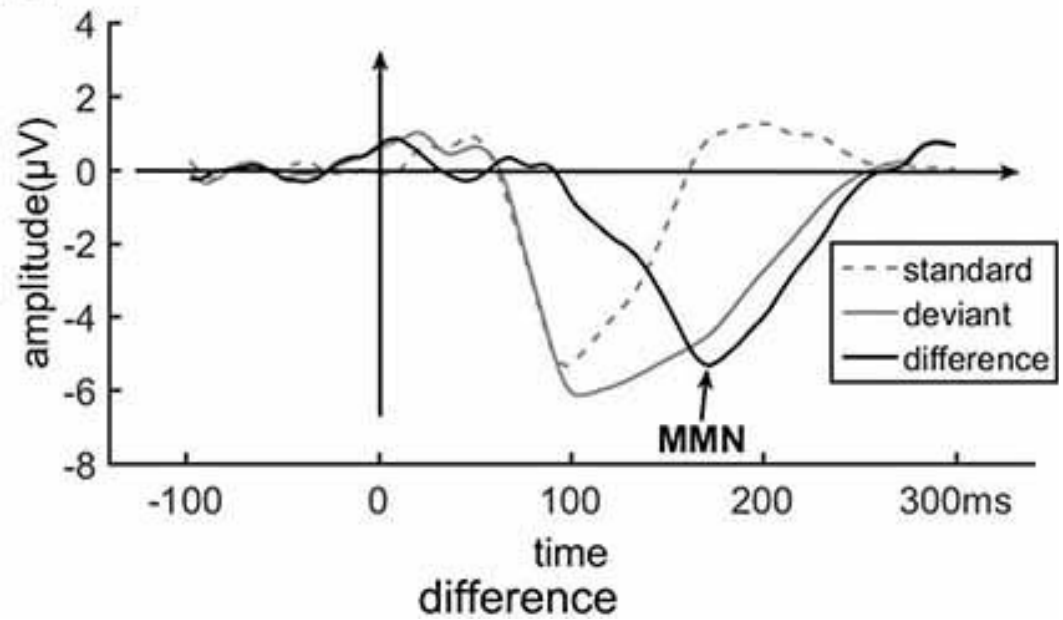
Examples of ERPs

- N100



Examples of ERPs

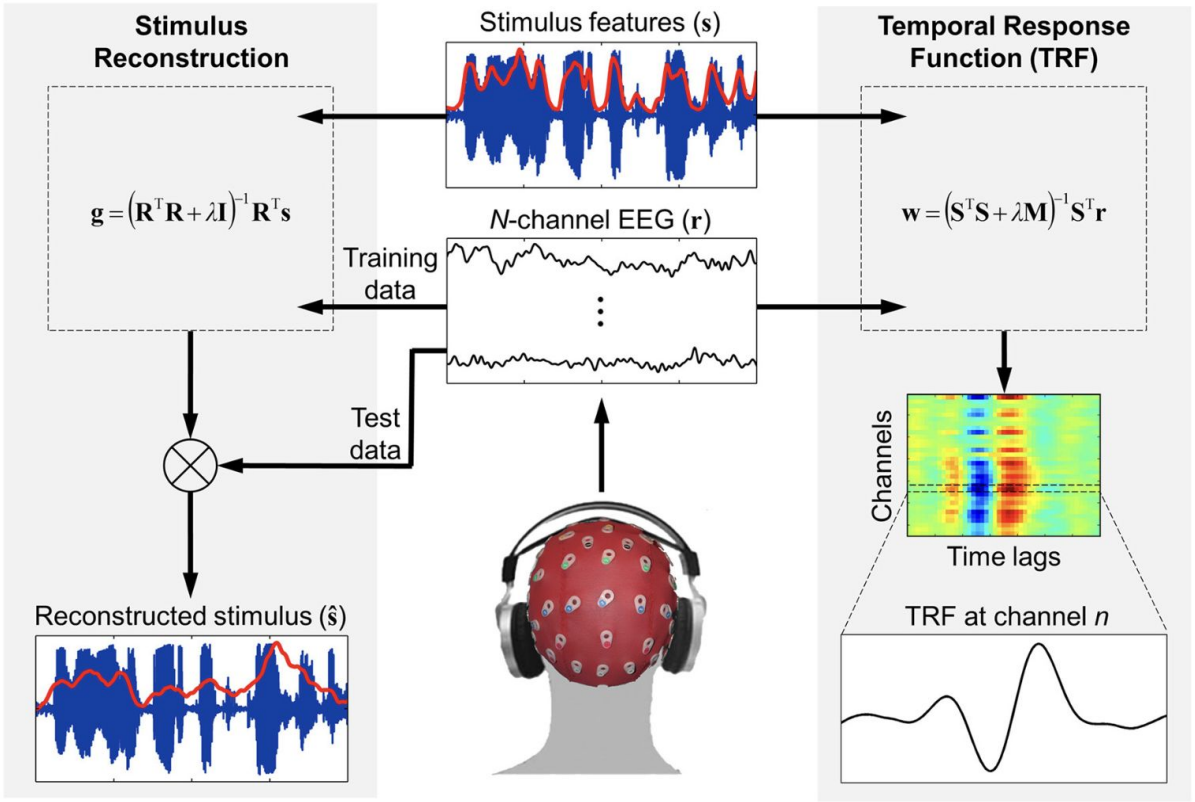
- MMN (mismatch negativity)



How to analyse the data

a) Spectro-temporal analysis
b) Event-related potentials
c) Temporal response function

Temporal response function (TRF)



Crosse et al., 2016

Summary

Pros:

- Non-invasive, cheap, portable
- Very precise in the time domain
- Different ways of analysing the data
- Clinical application
- Few contraindications
- Can be combined with different methods - fMRI, TMS

Cons:

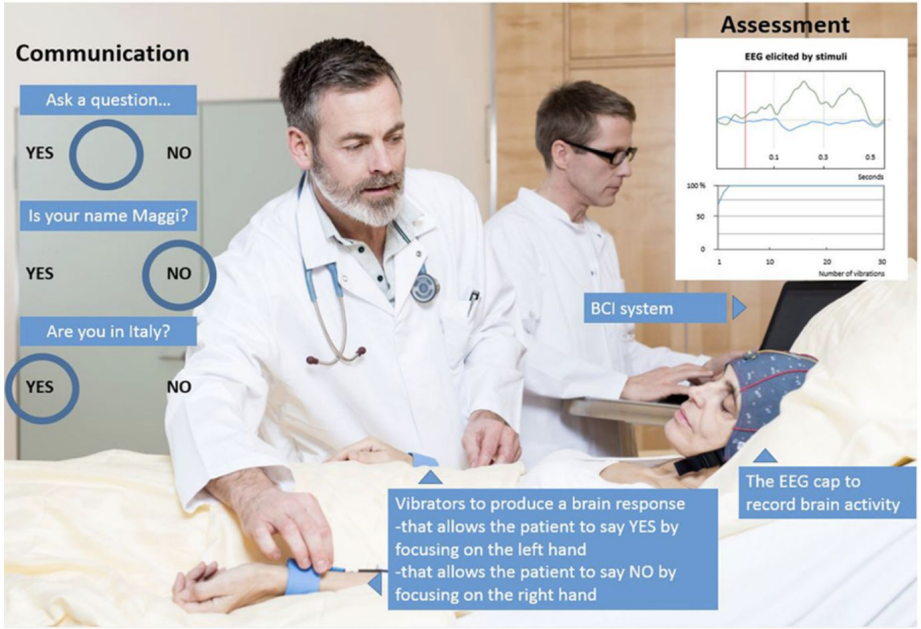
- Poor spatial resolution (hard to determine the source of the signal)
- Many artifacts

New technologies using EEG

Complete Locked-in and Locked-in Patients: Command Following Assessment and Communication with Vibro-Tactile P300 and Motor Imagery Brain-Computer Interface Tools

Christoph Guger[1,2], Rossella Spataro[3], Brendan Z. Allison[1], Alexander Heilinger[1], Rupert Ortner[2], Woosang Cho[2] and Vincenzo La Bella[3]*

[1] Guger Technologies OG, Graz, Austria, [2] g.tec Medical Engineering GmbH, Schiedlberg, Austria, [3] ALS Clinical Research Center, Biomedicina e Neuroscienze Cliniche (BioNeC), University of Palermo, Palermo, Italy

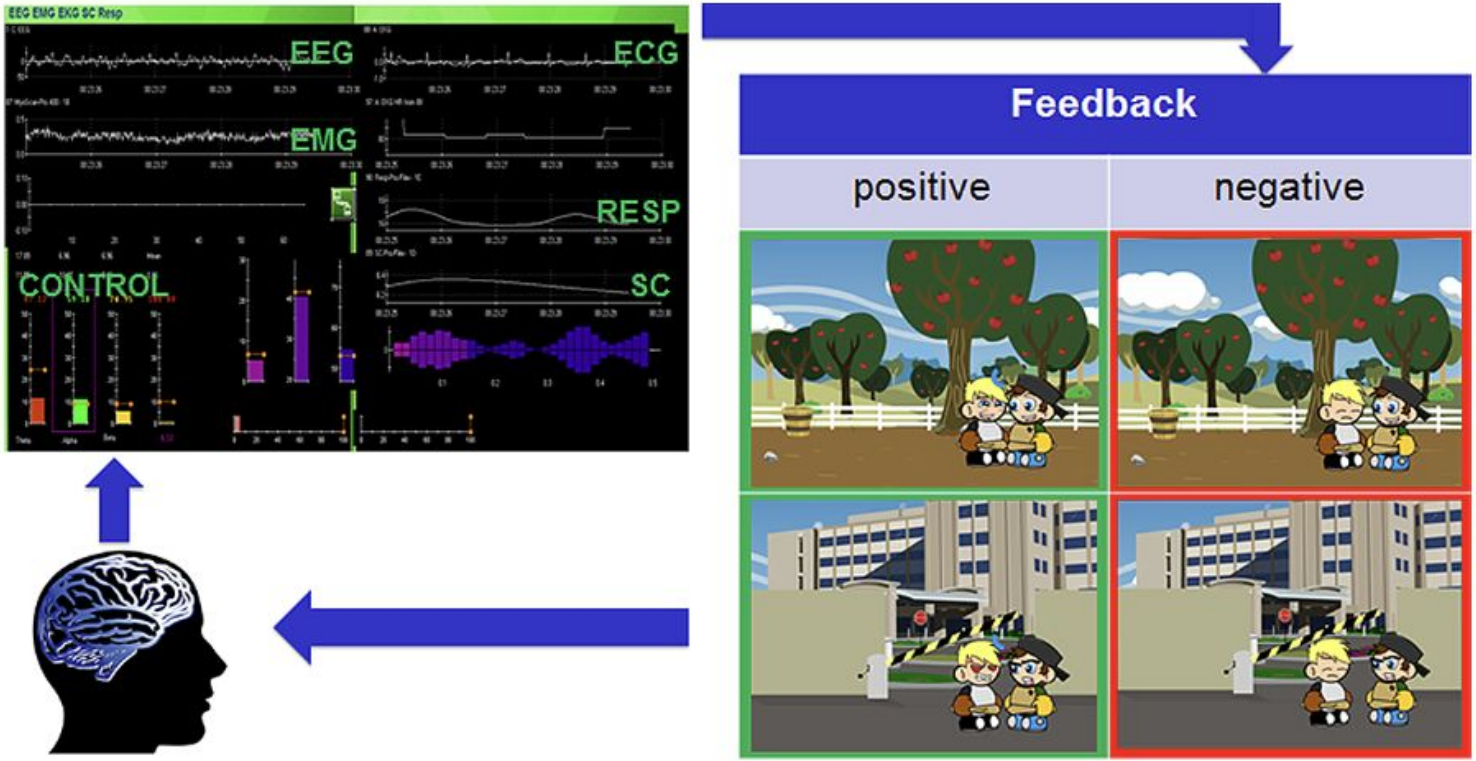


EEG-powered wheelchair

- Alpha wave signal
- P300
- …

Neurowear

Neuro-feedback games



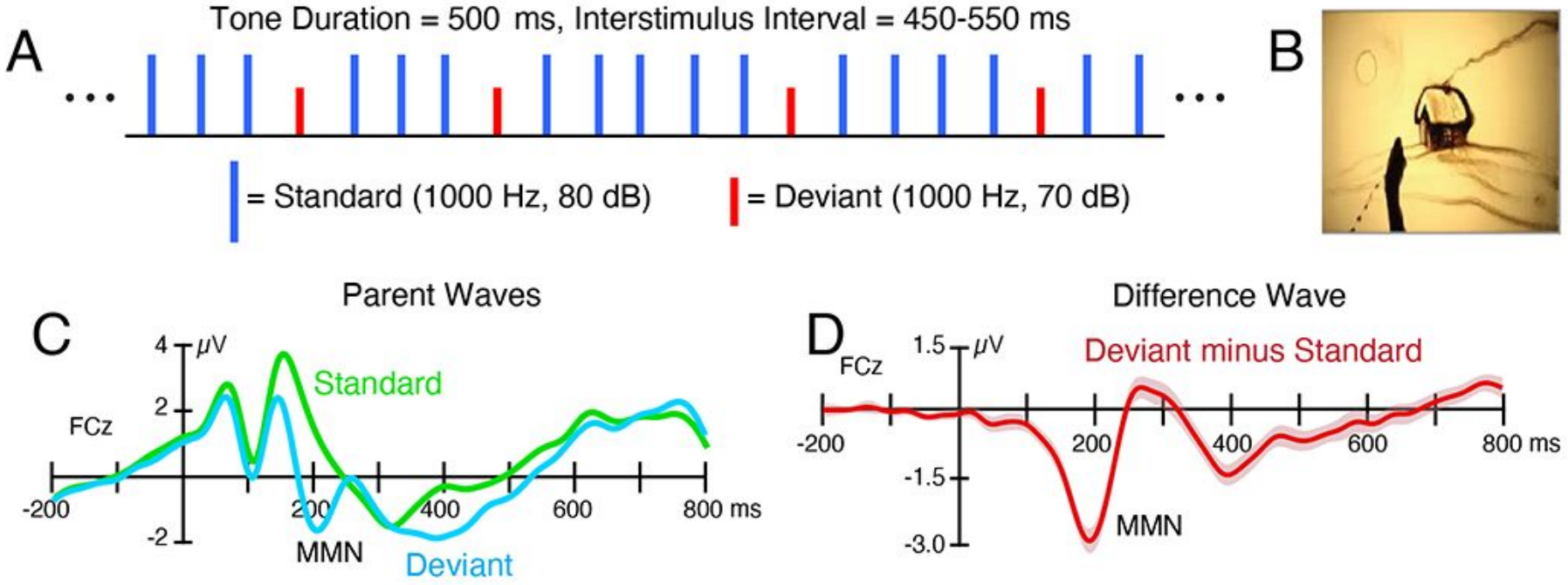
Mismatch Negativity (MMN)

Acta Psychologica 42 (1978) 313–329
© North-Holland Publishing Company

EARLY SELECTIVE-ATTENTION EFFECT ON EVOKED POTENTIAL REINTERPRETED*

R. NÄÄTÄNEN,** A. W. K. GAILLARD and S. MÄNTYSALO**
Institute for Perception, TNO, Soesterberg, The Netherlands

Received April 1977



Luck, S. J. (2022). *Applied Event-Related Potential Data Analysis*

ELSEVIER

Clinical Neurophysiology 115 (2004) 140–144

www.elsevier.com/locate/clinph

The mismatch negativity (MMN): towards the optimal paradigm

Risto Näätänen[a,b,*], Satu Pakarinen[a,b], Teemu Rinne[a], Rika Takegata[a,b]

[a]*Cognitive Brain Research Unit, Department of Psychology, P.O. Box 9, University of Helsinki, FIN-00014 Helsinki, Finland*
[b]*Helsinki Brain Research Centre, Helsinki, Finland*

Accepted 9 April 2003

Deviants:

1. Frequency (500 Hz → 550 Hz)
2. Loudness (75 dB → 85 dB)
3. Duration (75 ms → 25 ms)
4. Location (0° → 52°)

Presentation this Friday

ORIGINAL ARTICLE

Mismatch Negativity in Chronic Schizophrenia and First-Episode Schizophrenia

Dean F. Salisbury, PhD; Martha E. Shenton, PhD; Carlye B. Griggs, BA; Aaron Bonner-Jackson; Robert W. McCarley, MD

Music Perception
Spring 1993, Vol. 10, No. 3, 305–316

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Absolute Pitch and Event-Related Brain Potentials

M. TERVANIEMI, K. ALHO, P. PAAVILAINEN, M. SAMS, & R. NÄÄTÄNEN
University of Helsinki

Psychophysiology, 40 (2003), 430–435. Blackwell Publishing Inc. Printed in the USA.
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MMN and attention: Competition for deviance detection

ELYSE SUSSMAN,[a,b] ISTVÁN WINKLER,[c,d] AND WENJUNG WANG[b,e]
[a]Department of Neuroscience, Albert Einstein College of Medicine, New York, New York, USA
[b]Department of Otolaryngology, Albert Einstein College of Medicine, New York, New York, USA
[c]Institute of Psychology, Hungarian Academy of Sciences, Budapest, Hungary
[d]Cognitive Brain Research Unit, University of Helsinki, Helsinki, Finland
[e]Department of Speech and Hearing Sciences, Graduate Center of the City University of New York, New York, New York, USA

Psychophysiology, 45 (2008), 60–69. Blackwell Publishing Inc. Printed in the USA.
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DOI: 10.1111/j.1469-8986.2007.00599.x

MMN or no MMN: No magnitude of deviance effect on the MMN amplitude

JÁNOS HORVÁTH,[a,b] ISTVÁN CZIGLER,[b] THOMAS JACOBSEN,[a] BURKHARD MAESS,[c] ERICH SCHRÖGER,[a] AND ISTVÁN WINKLER[b]
[a]Institute of Psychology I, University of Leipzig, Leipzig, Germany
[b]Institute for Psychology, Hungarian Academy of Sciences, Budapest, Hungary
[c]Max-Planck-Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Presentation this Friday

- **15 minutes**
- Structure:
  - Background
  - Methods
  - Results
  - Further development

Github: EEG-Praktikum → Guides → *Guidelines for presentations*