

Eye tracking and physiological data

Tutorial ETRA

Tübingen/Germany, 30.05.2023

 BI SIGMA

Biosignal Measurement and Analysis

Schedule

9:00–10:00	introduction, presentation of methodology
10:00–10:15	coffee break
10:15–13:00	hands-on data collection
13:00–14:00	lunch break
14:00–15:30	group work to analyze the data – analysis of each sensor separately
15:30–15:45	coffee break
15:45–17:00	group work to analyze the data – analysis of all sensors combined,
17:00–17:30	discussion of the results and special solutions modules

Why eye tracking?

- ▶ Objective measure of perception that the respondent cannot influence.
- ▶ Simple and less invasive measure.
- ▶ Simple and intuitive metrics.

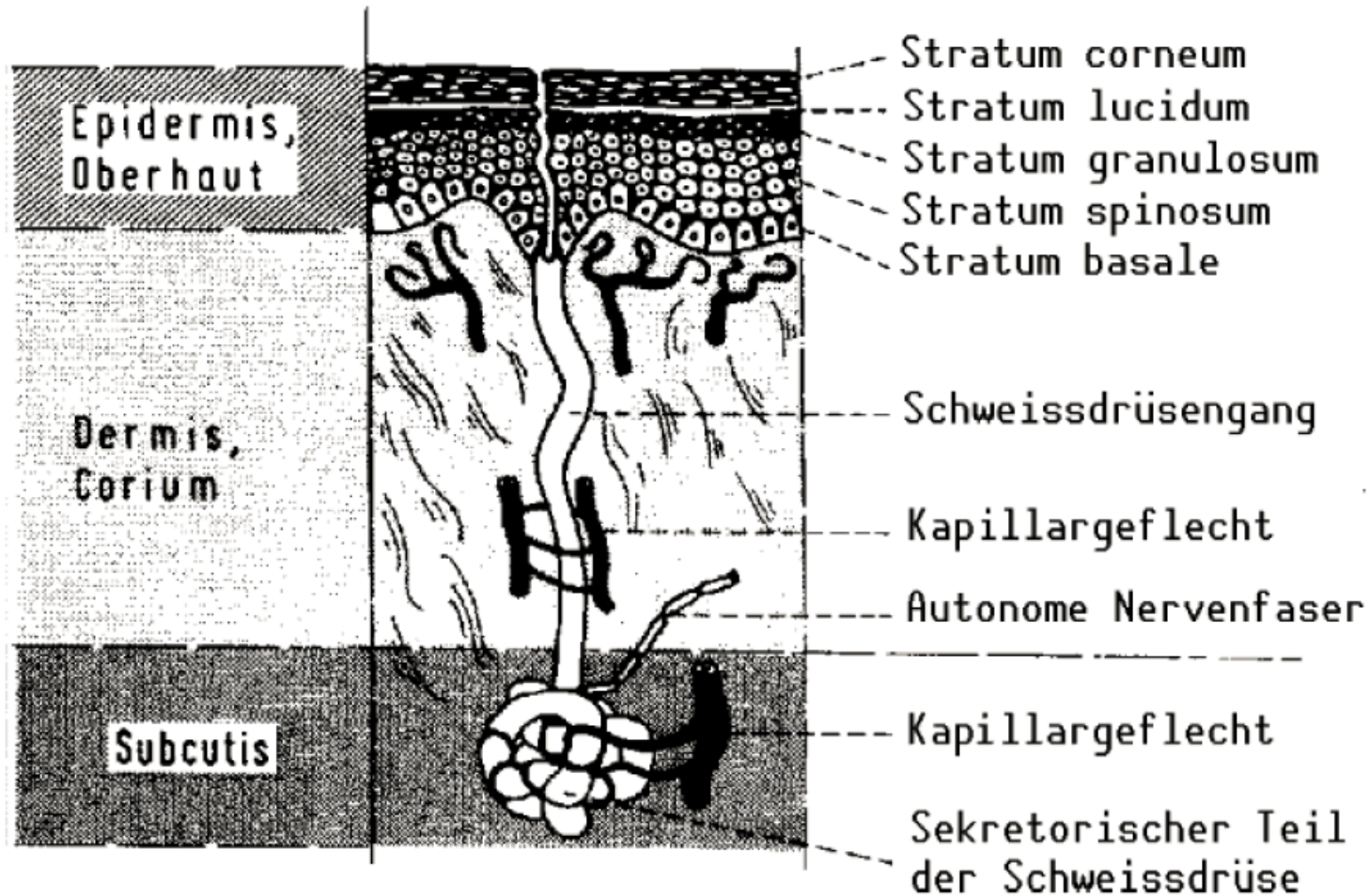
Why combine eye tracking with physiological data?

- ▶ Gaze alone says little about the subject's emotional state,
- ▶ Verification of neuromarketing statements,
- ▶ Obtaining other objective parameters,
- ▶ Market research: investigating whether a brand has an emotional impact
- ▶ UX: at what points is the respondent confused or stressed?

Which parameters are measured?

- ▶ DFA/GSR
- ▶ Pulse, heart rate, ECG
- ▶ Breathing
- ▶ EMG
- ▶ EEG
- ▶ NIRS
- ▶ Pupils
- ▶ Voice modulation

Electrodermal activity



Electrodermal activity

- ▶ Arises from increased sweat secretion in response to emotions or stress
- ▶ Controlled via the autonomic nervous system
- ▶ Normally not influenceable by will
- ▶ The electrical resistance or conductivity of the skin is measured (unit: microsiemens).

Classic applications

- ▶ Lie detector test
- ▶ Detection of the effect of pheromones
- ▶ Test for Capgras syndrome

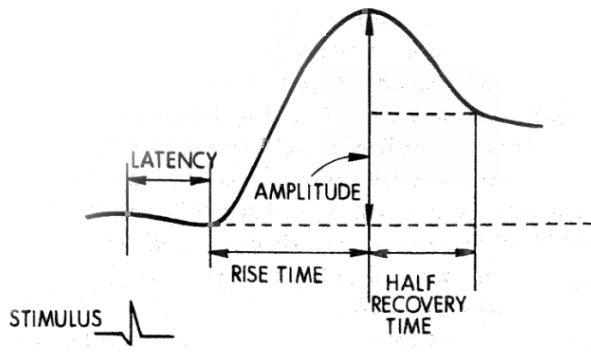
(Source Wikipedia)

Application in psychological experiments

- ▶ Emotional reactions to stimuli
- ▶ Type (direction) of the emotion cannot be determined, only the strength
- ▶ Absolute values of the curve for a point in time or range have no significance, parameters must be extracted

GSR parameters

Typical reaction of the skin conductivity:



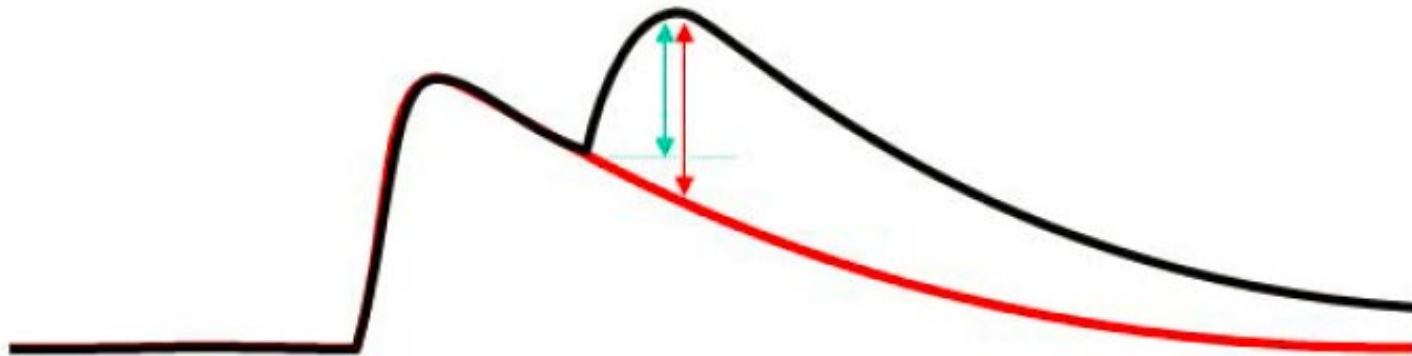
Parameters:

- Latency (reaction time)
- Rise time (excitation)
- Amplitude (stress level)
- Decay time (relaxation)

Extraction of the parameters from the raw data with the help of mathematical methods

Problems with parameter extraction

- ▶ Overlapping reactions lead to underestimation



Solution

- ▶ Interpolation of the EDA curve by mathematical functions
- ▶ Extraction of the parameters from the mathematically ideal curve

Placement of the electrodes

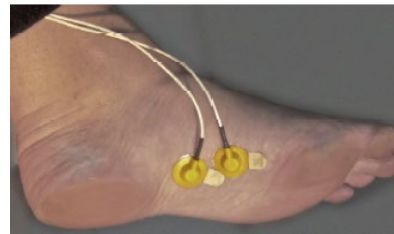
- ▶ Palm



- ▶ Fingertips



- ▶ Foot sole



ECG



ECG

- ▶ Measures the electrical activity of the heart muscles
- ▶ Periodic characteristic curves
- ▶ The ECG contains a variety of parameters that are used for diagnostic purposes. In combination with eye tracking, the heart rate is particularly important.

EMG

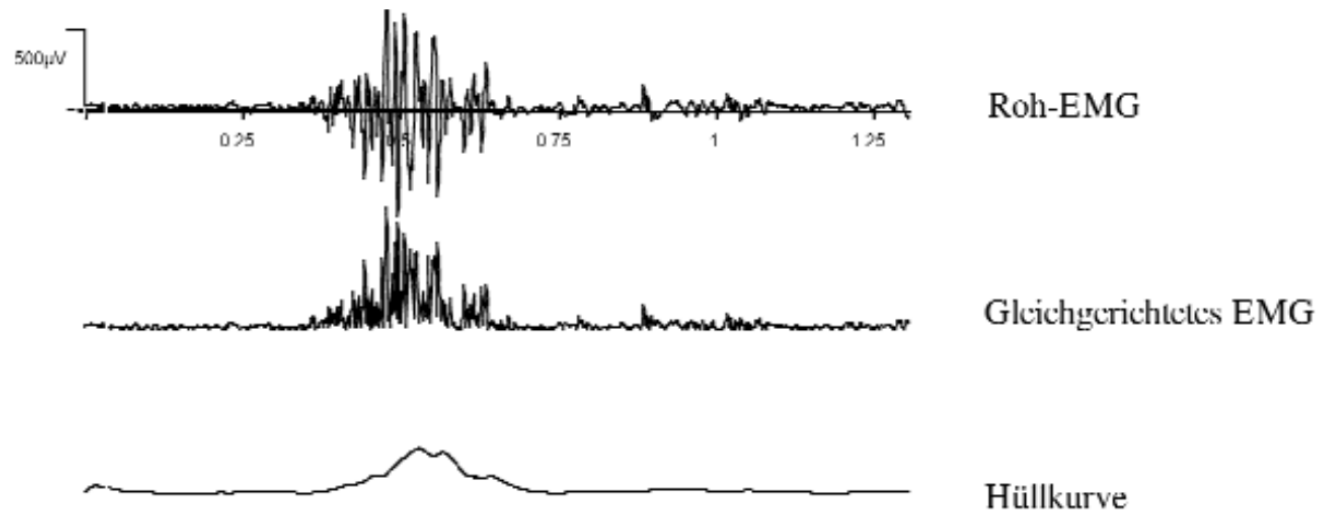
- ▶ Arises from the electrical stimulus to stimulate the musculature
- ▶ Series of short, spike-like pulses
- ▶ It is not the individual pulses that are relevant, but the envelope curve of the pulses.

Applications

- ▶ Diagnosis
- ▶ Sport, gait tests
- ▶ Working environment, tool studies
- ▶ Fatigue studies
- ▶ Facial expression

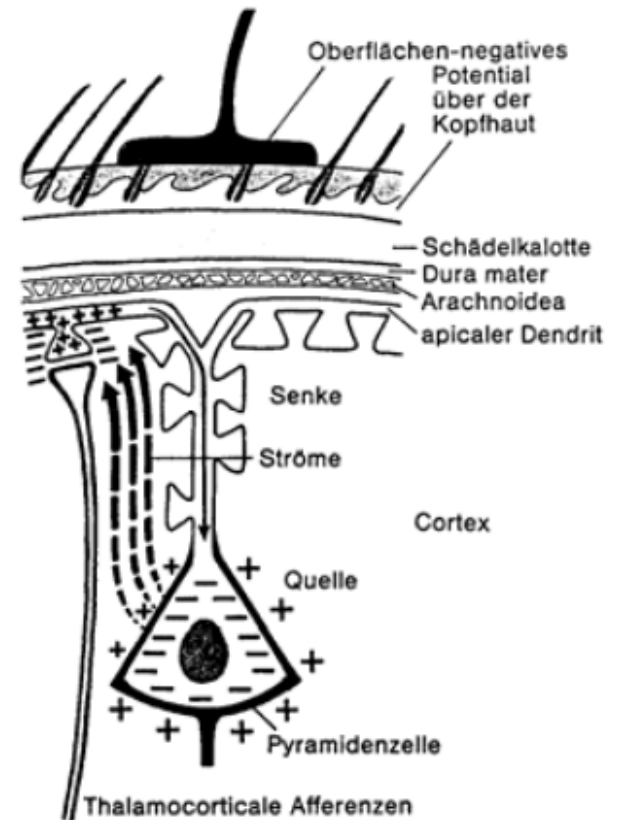
Procedure

- ▶ Rectification
- ▶ Filtering with low pass filter
- ▶ Evaluation of the envelope curve



EEG

- ▶ Arises from the electrical activation of groups of neurons in the brain
- ▶ Superposition of waves with evoked activities
- ▶ Evaluation strongly dependent on the research objective.



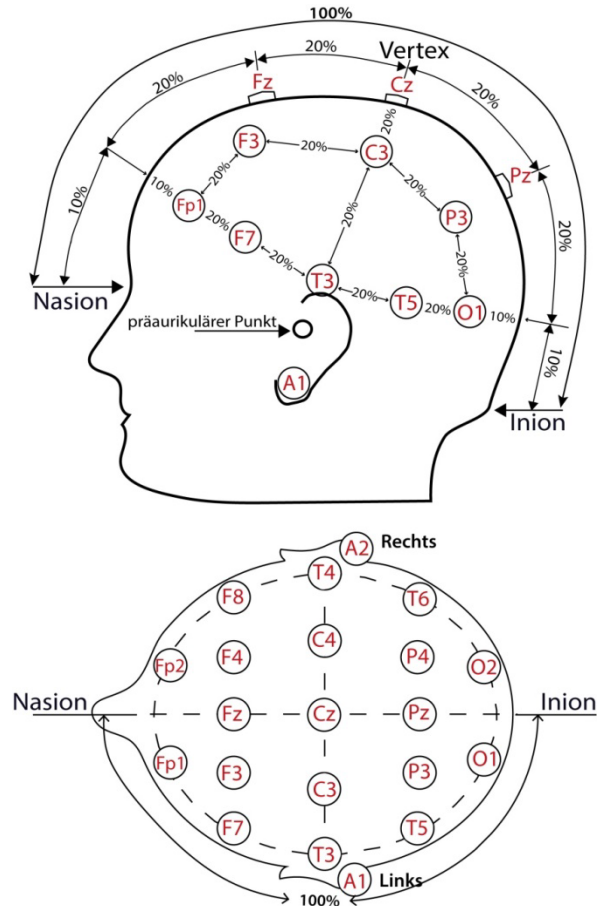
Birbaumer & Schmidt, 2003

Application

- ▶ Diagnosis
- ▶ Biofeedback
- ▶ Brain–Computer Interfaces
- ▶ Neuropsychological research

Electrodes

- ▶ The 10–20 system is common
- ▶ For some applications only a subset is used
- ▶ Evaluation depending on the brain regions
- ▶ Localisation of reactions also possible



Methods

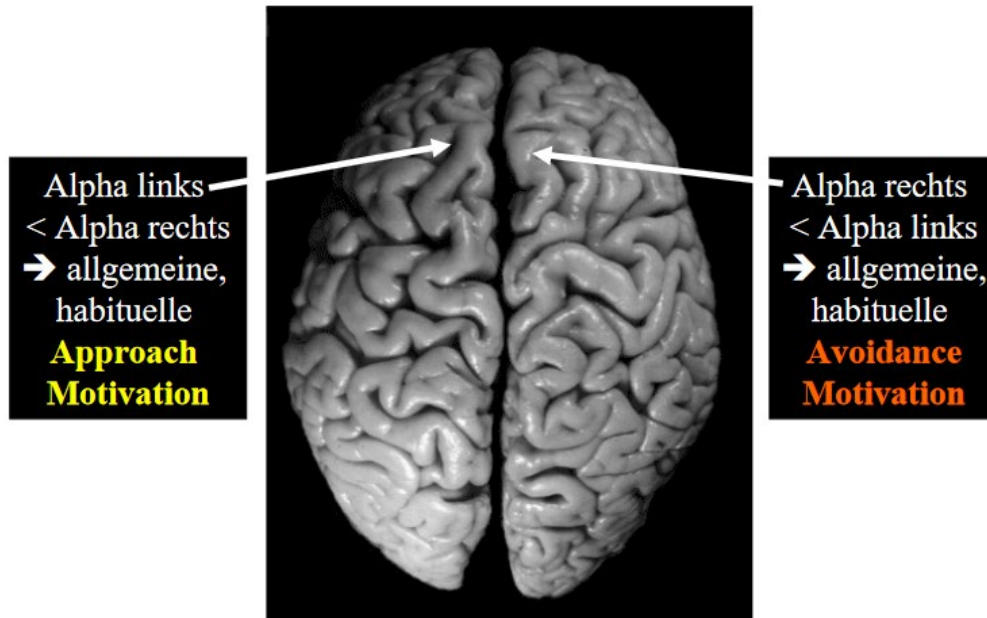
- ▶ Spontaneous EEG, frequency analysis
- ▶ Evoked potentials
- ▶ Event-triggered synchronisation/desynchronisation
- ▶ More...

Frequency analysis

- ▶ windowed Fourier transform
- ▶ Tapes:
 - Alpha (8–13Hz): Relaxation
 - Theta (4–7Hz): dozing, deep relaxation, meditation, hypnosis, lucid dreams
 - Beta (14–30Hz): frontal and precentral, active concentration or anxious tension.
 - Gamma (>30Hz): strong mental effort, learning processes, meditation, increased attention
 - Delta (1–3Hz): in infancy or pathological in dementia
- ▶ The lower the frequency of the EEG waves, the lower the activity

Frequency analysis – example

Alpha rhythm and motivation



Source: University of Trier

Pupils

- ▶ Pupil width Measure of mental workload
- ▶ Strongly dependent on incidence of light, ambient light, brightness of stimulation
- ▶ Measured directly by the eye tracker.
- ▶ Mental workload can be emotional, but it can also be caused by strong cognitive activity.

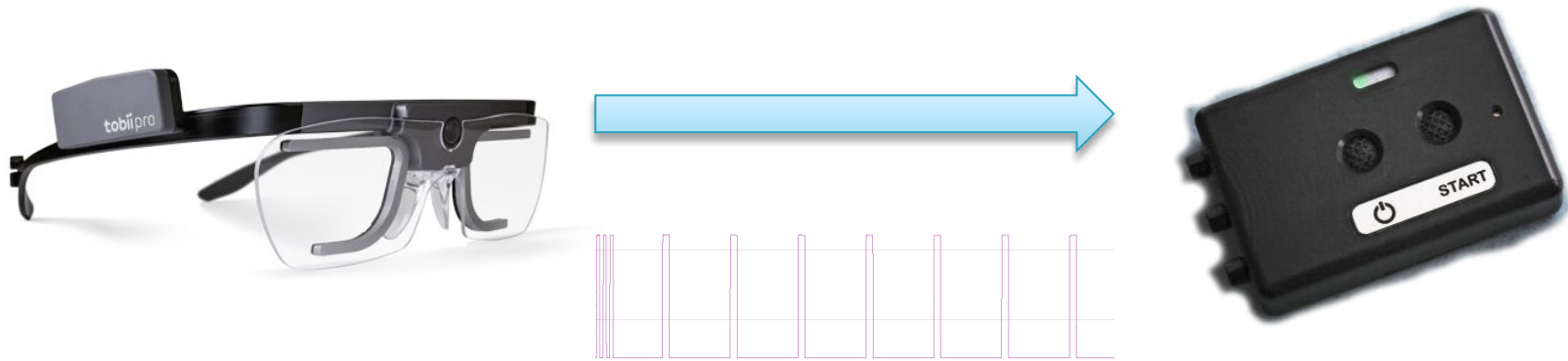
Time synchronisation

- ▶ Recording units have different sampling rates and different start times
- ▶ Online vs. offline synchronisation
- ▶ Offline synchronisation allowed
 - Use of precise hardware triggers
 - Recording with the appropriate hardware–software combination
 - Parallel recording

Time synchronisation

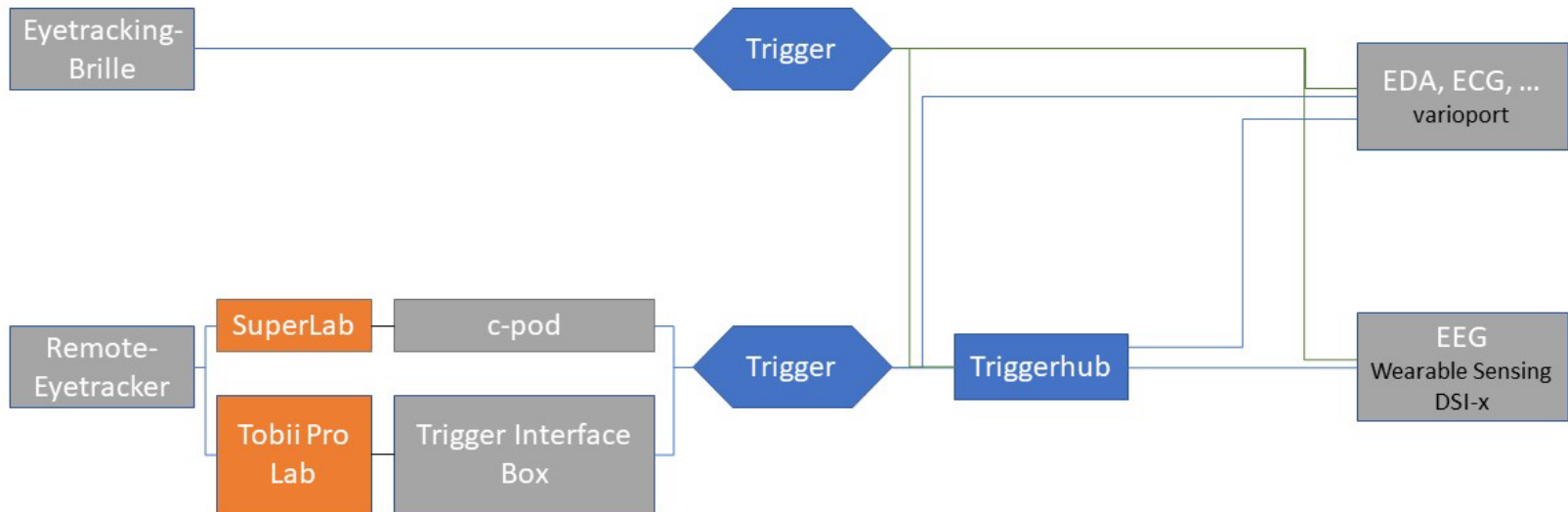
- ▶ Tobii Glasses2 or Tobii Lab send pulses for synchronisation
- ▶ varioport-e receives the pulses on its own channel
- ▶ Pulses are recognised in the Biometric Software Suite, data from both recordings are imported synchronously

Time synchronisation



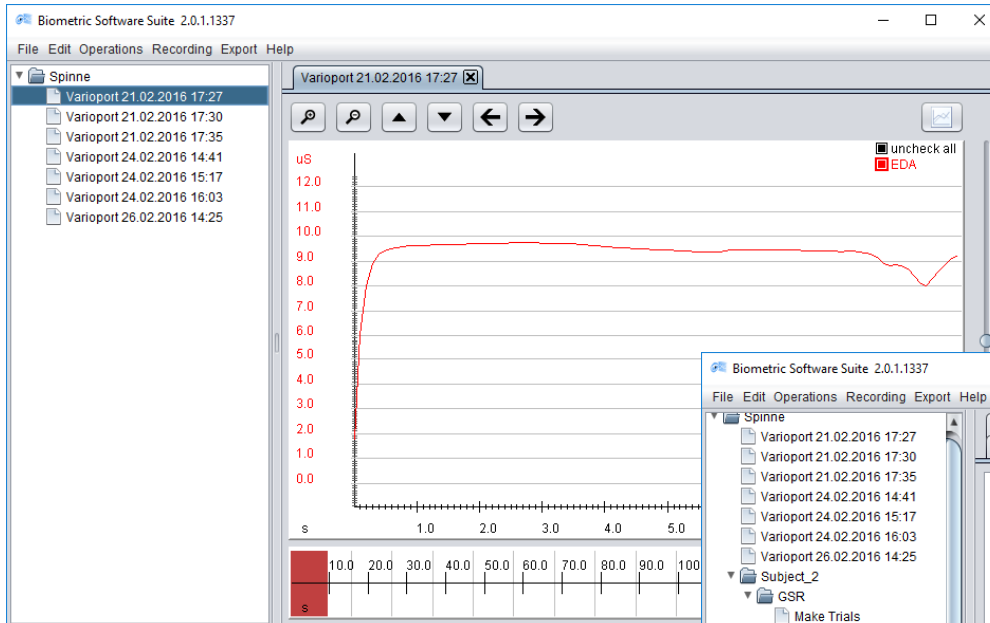
- ▶ Pulses at intervals of 10s
- ▶ 3 short pulses mark the beginning of the measurement

Time synchronisation



Aufbau für die Aufnahme der Biosignalmessung

Hands-on



Biometric Software Suite 2.0.1.1337

File Edit Operations Recording Export Help

Spinne

- Varioport 21.02.2016 17:27
- Varioport 21.02.2016 17:30
- Varioport 21.02.2016 17:35
- Varioport 24.02.2016 14:41
- Varioport 24.02.2016 15:17
- Varioport 24.02.2016 16:03
- Varioport 26.02.2016 14:25
- Subject_2
 - GSR
 - Make Trials
- Subject_1
 - GSR
 - Make Trials
- Subject_6
 - GSR
 - Make Trials
- Subject_5
 - GSR
 - Make Trials
- Subject_4
 - GSR
 - Make Trials
- Subject_3
 - GSR
 - Make Trials
- Subject_7
 - GSR
 - Make Trials
- GSR Metrics

Make Trials (x6) GSR Metrics (x1)

Average GSR Amplitudes (in uS)

Subject	Flower	Spider
Subject_2	-	0,03
Subject_1	0,33	0,17
Subject_6	0,64	1,16
Subject_5	0,18	0,16
Subject_4	2,23	3,80
Subject_3	0,29	0,07
Subject_7	0,19	0,22
Average	0,64	0,80

Average GSR Duration (in s)

Subject	Flower	Spider
Subject_2	-	4,21
Subject_1	15,30	6,89
Subject_6	7,35	9,51
Subject_5	5,58	2,48
Subject_4	8,18	14,22
Subject_3	13,93	4,44
Subject_7	3,56	2,48