

EXERCISES – BIOLOGICAL SIGNALS

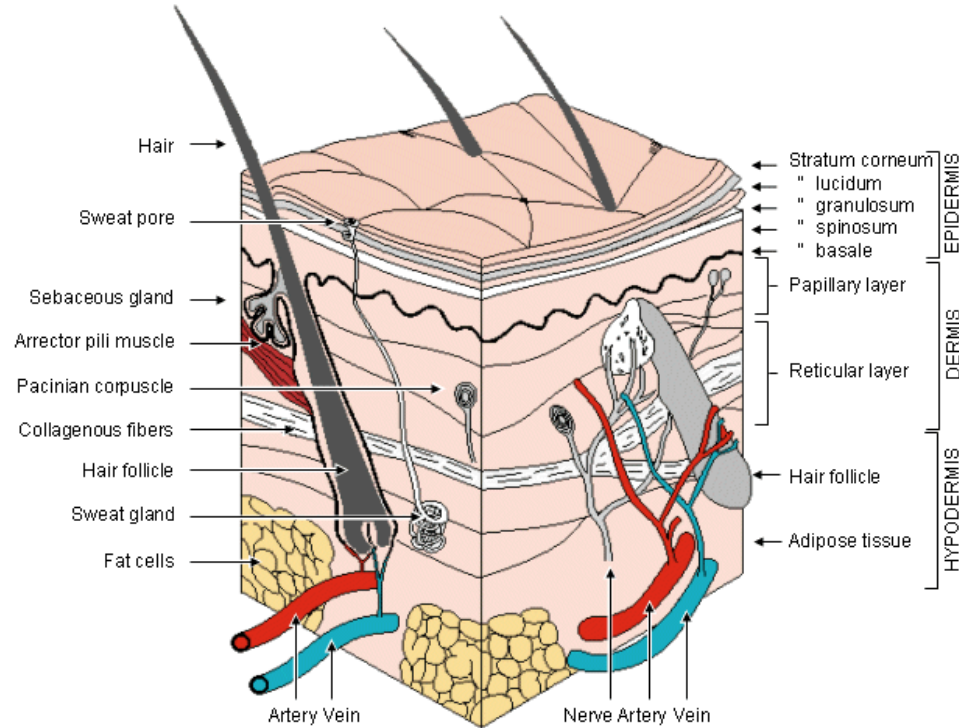
Exercise 3 - SS 2014 – Michel Kana

What will we do today?

1. **The physiology behind GSR**
2. **Structure of the GSR Signal**
3. **GSR measurement with BIOPAC**
4. **Summary**

The physiology behind GSR

- The skin is a three-layered (epidermis, dermis, subdermis) adaptive organ.
- Human skin is a good conductor of electricity.
- Change in conductance occurs when sweat glands fill or empty sweat.
- The glands respond to sympathetic nervous stimulation.
- When a weak electrical current is delivered to the skin, changes in the skin's conduction can be measured: the Galvanic Skin Response.
- GSR is expressed in units called microSiemens (μS or μMho).



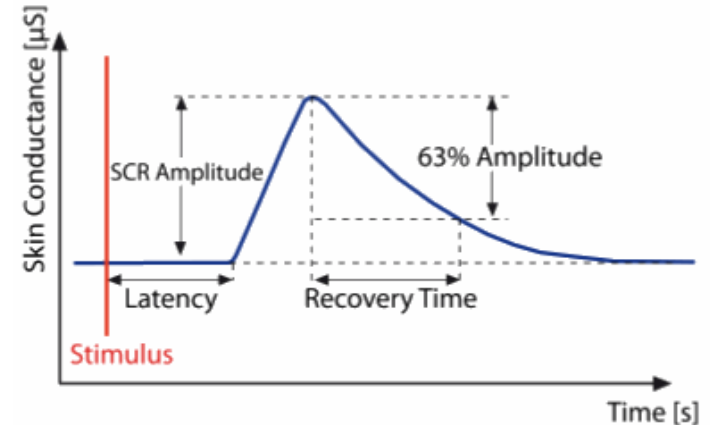
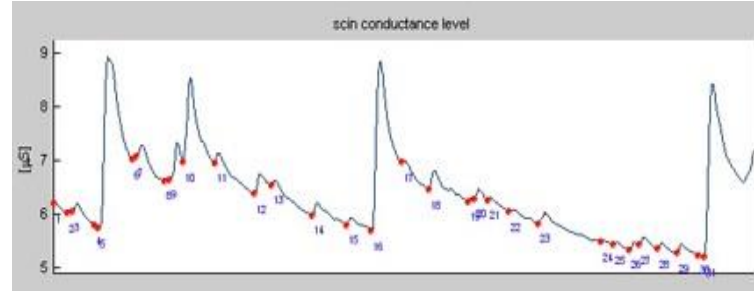
Structure of the GSR Signal

□ Waves in the GSR signal

- **SCL:** Skin Conductance Level. It is the baseline level and provides a measure of overall psycho-physical activation.
 - ca. 2-50 μS with a frequency range of 0 – 0.05 Hz
- **NSF:** Non-specific Spontaneous Fluctuations. They are not event related and are useful for calculating overall emotional state.
 - ca. 1 or 3 per min
- **SCR:** Skin Conductance Response. It reflects discrete environmental stimuli or events.
 - frequency range of 0.05 – 1.5 Hz

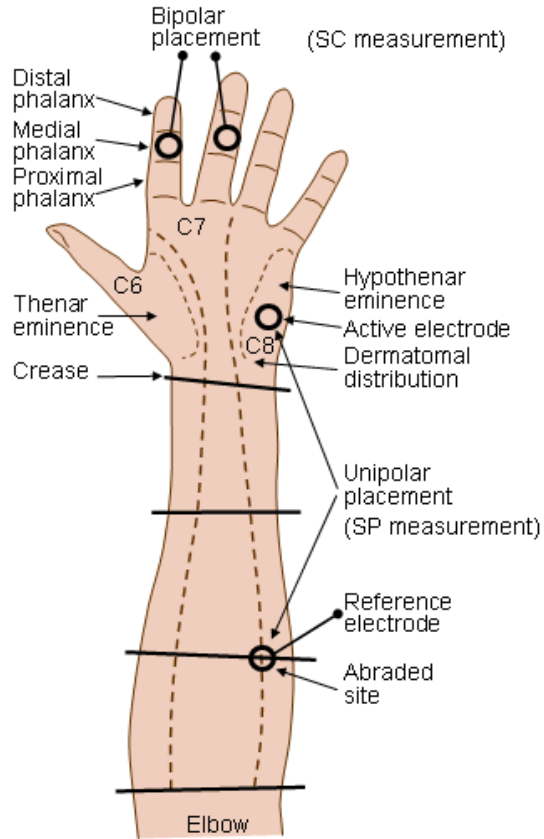
□ Parameters in the GSR signal

- **SCL:** baseline level of skin conductance (e.g. 7,5 μS)
- **SCR Amplitude:** amplitude of skin conductance response (e.g. 2,1 μS)
- **Latency:** time delay between the event and the response (less than 3 sec)
- **Rise Time:** duration between the onset of the response and its peak (1 to 3 sec)
- **Half-Recovery Time:** duration between the peak and the half or 63% of the peak (2 to 10 sec)



Ref.: 1. ANSLAB – 2. ETH Zurich, Wearable Computing Laboratory

GSR Measurement



□ Operational configuration

- A galvanic skin amplifier applies a constant low voltage to the skin through electrodes and measures the current flow.
- Using Ohm's law the resistance of the underlying conductor can be obtained.
- The inverse of the resistance is the skin conductance.

□ Noise sources

- Baseline drift
- Variation in temperature
- Power line interference

Exercise 1: GSR measurement with BIOPAC

❑ Biopac MP35 measurement system

- ❑ GSR is recorded using Biopac SS3LA transducer with built-in Ag/AgCl electrodes or SS57L wires with extra bipolar electrodes plugged in the second channel.
- ❑ Electrodes can be attached to the right hand, on the index and major finger (medial phalanx).

❑ Biopac Student Lab PRO software

- ❑ The acquisition is set up for a sampling rate of *200 Hz*.
- ❑ Analog Channel CH1 should have the following settings
 - ❑ DC coupling
 - ❑ Hardware-based filter 0.05 Hz High Pass, 35 Hz Low Pass
 - ❑ Total gain 2000
- ❑ Calibration needed for absolute measurements with SS3LA transducer: $0 \text{ mV} = 0 \text{ microMho}$, $1 \text{ mV} = 10 \text{ microMho}$.
 - ❑ MP menu > Set up Channels > View/Change Parameters > Scaling
- ❑ Calculation Channel C1 is setup for smoothing the raw GSR signal

❑ GSR parameters calculation

- ❑ Estimate the average SCL
- ❑ Select a skin conductance response and calculate SCR Amplitude, Latency, Rise Time and Half-Recovery Time
- ❑ Identify Non-specific Spontaneous Fluctuations and estimate the number of NSF per minute.

Exercise 2: Response to neutral questions

□ Procedure

- Subject is instrumented for GSR measurement with Biopac by the examiner.
- The examiner records the GSR signal until no skin conductance response is noticed.
- The examiner asks a question.
- Subject answers. A SCR should appear on the GSR signal.
- The examiner waits for the subject's skin conductance level to return close to the baseline level before asking the next question

1. Do you live in a dormitory?
2. Do you like broccoli?
3. Do you have a cat?
4. Are you a senior?
5. Have you ever gone ice skating?
6. Do you sometimes ride a bike to school?
7. Have you ever been to Alaska?
8. Do you have a sister?
9. Were you born in [State or Country]?
10. Are you a psychology major?

□ Evaluation

- Identify the SCRs for each question
- Calculate the Rise Time and SCR Amplitude for each question
- Calculate the mean rise time and amplitude for all questions

Exercise 3: Response to emotional questions

□ Procedure

- Subject is instrumented for GSR measurement with Biopac by the examiner.
- The examiner records the GSR signal until no skin conductance response is noticed.
- The examiner asks a question.
- Subject answers. A SCR should appear on the GSR signal.
- The examiner waits for the subject's skin conductance level to return close to the baseline level before asking the next question

□ Evaluation

- Identify the SCRs for each question
- Calculate the Rise Time and SCR Amplitude for each question
- Calculate the mean rise time and amplitude for all questions

- Are you in love?
- Do you ever cry?
- Does nudity embarrass you?
- Do you recall your first kiss?
- Does being alone at night frighten you?
- Have you ever seen a tragic auto accident?
- Have you ever heard about a date rape?
- Do you ever hide some of your feelings?
- Do you believe in the practice of "safe sex?"

Exercise 4: Response to stress

□ Procedure

- Subject is instrumented for GSR measurement with Biopac by the examiner. Fingers should be clean and dry.
- The examiner records the GSR signal until no skin conductance response is noticed.
- The examiner chooses a random number between 500 and 1000 and asks the subject to subtract 17 from that number, then 17 from the result and so on, as fast as possible with each calculation lasting max 5 seconds.
- Subject answers. Several SCR should appear on the GSR signal.
- The examiner stops the subject after 2 minutes.

□ Evaluation

- Estimate and compare SCL before and during the test
- Determine and compare the number of NSF before and during the test

Exercise 5: Lie detection test

□ Procedure

- Subject writes down correct answers to the questions and hide them from the examiner.
- Subject is instrumented for ECG and GSR measurement with Biopac by the examiner. ECG is measured in Channel 2 with preset ECG (.5 - 35 Hz). The calculation channel C2 is configured with the preset *Heart Rate*.
- The examiner records the GSR signal until no skin conductance response is noticed.
- The examiner asks a question.
- Subject answers (lie is allowed). Changes might appear on the signals.
- The examiner evaluates the answer as true or false based on his observations. Examiner writes down subject's answer and the evaluation.

□ Evaluation

- Subject reveals the correct answers after the test.
- Correct answers, subject answers and examiner's evaluation are compared.
- Compare mean heart rate, SCL, SCR amplitude, SCR rise time for true positives with the mean for false positives.

- Is today (Tuesday)?
- Did you watch TV last night?
- Do you like pizza?
- Have you ever been to a professional baseball game?
- Do you have a car?
- Are you taking a PE class?
- Do you like to go to movies?

Summary

[What did we learn today]

Physiology behind the galvanic skin response.

Structure of the GSR signals.

Measurements and signal analysis.

[Plan for the next week]

PPG