Research Methods Course
Galvanic Skin Responses

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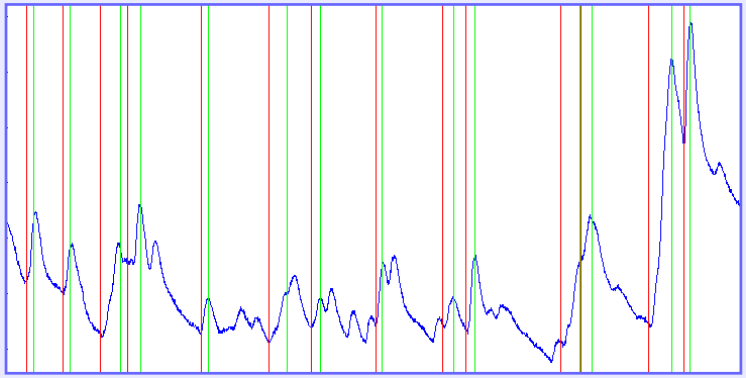
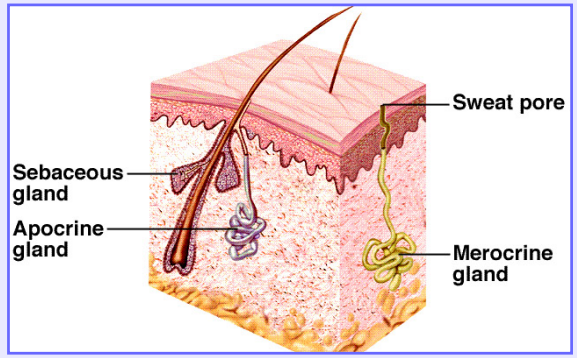




http://www.cs.ucl.ac.uk/staff/m.slater/Teaching/ResearchMethods/
http://www.cs.ucl.ac.uk/staff/a.brogni/Teaching/RM_physio

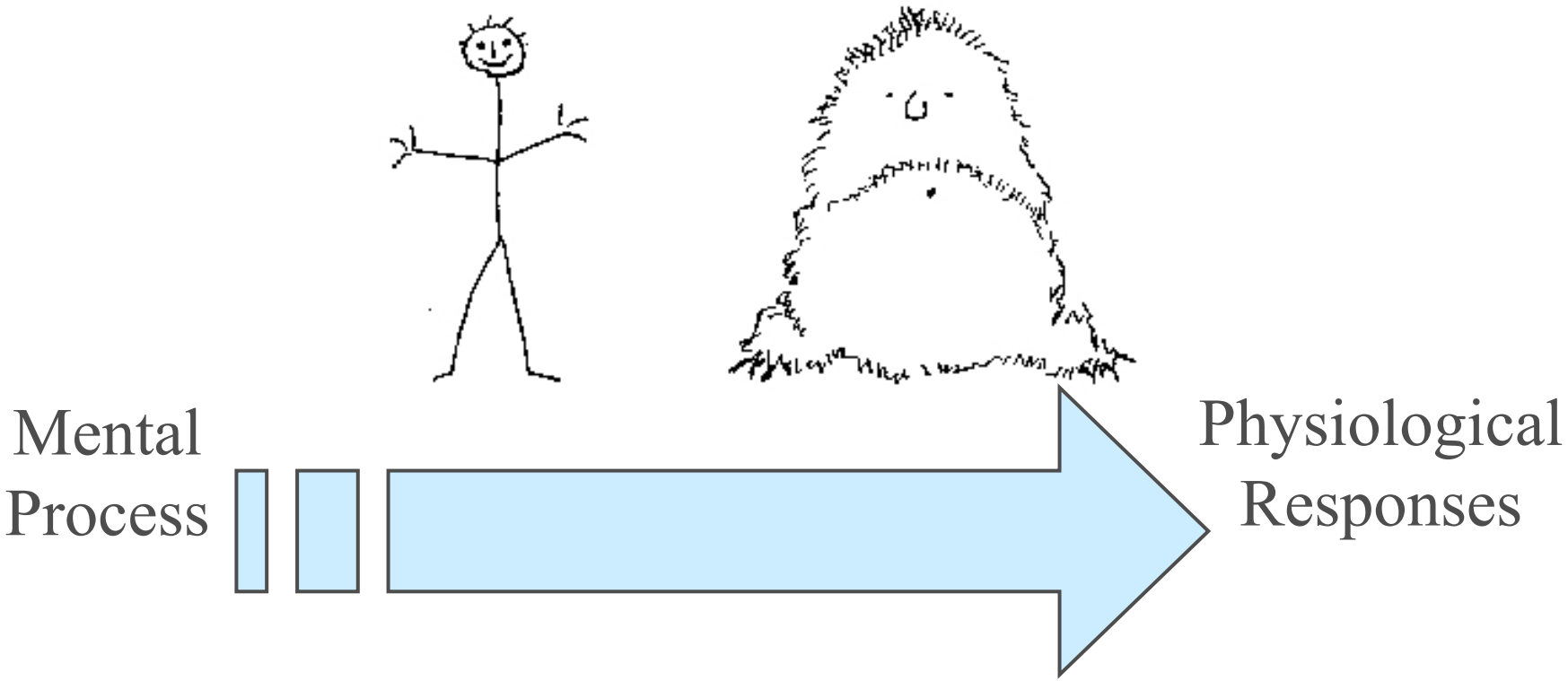
Outline

- GSR
- GSR & Stress
- GSR & VR

- File Format and Matlab Code

- Summary

Physiology

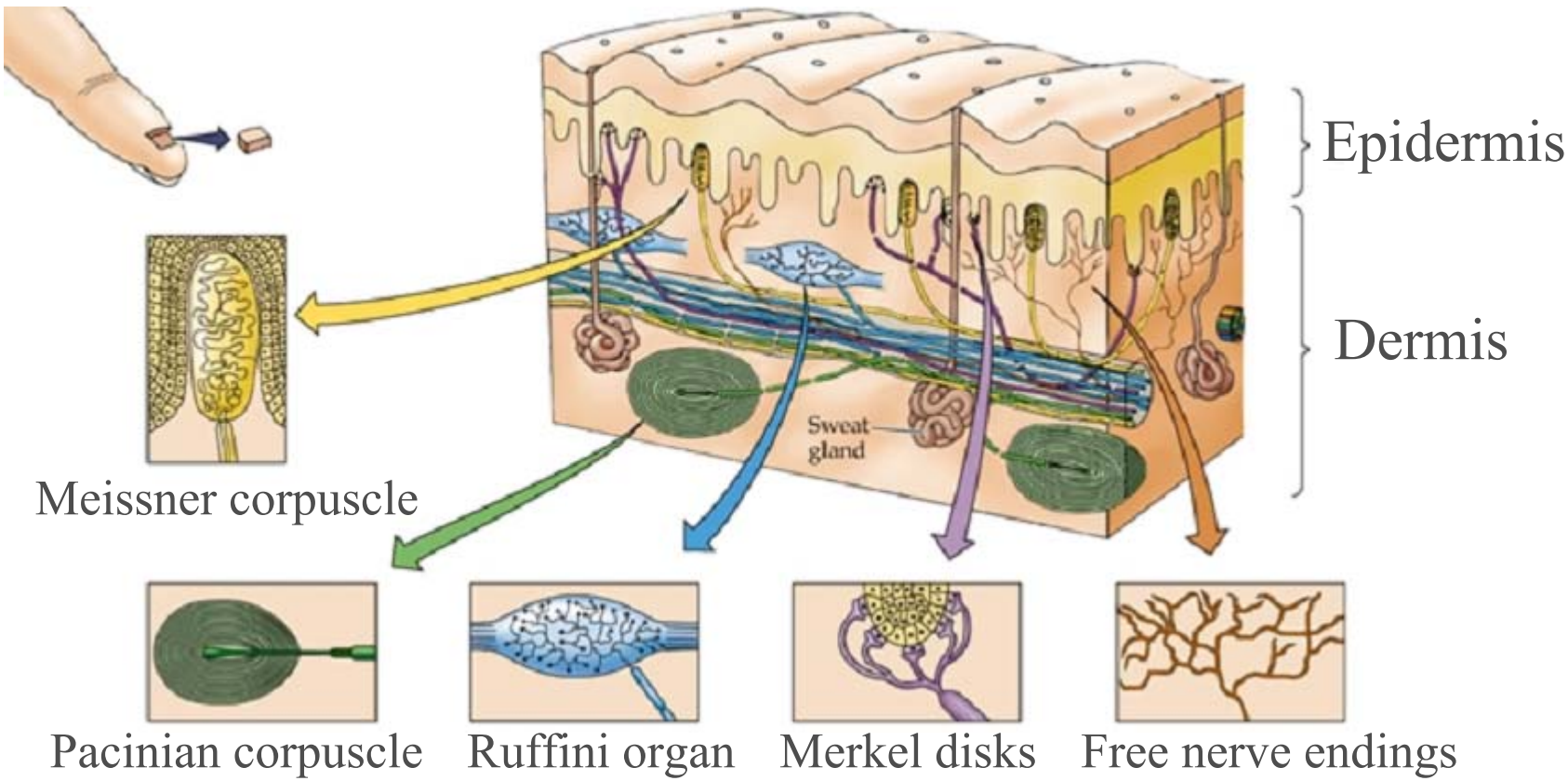


Sympathetic Nervous System

The SNS governs peripheral stress response …

- ✓ … increasing the Heart Rate,
- ✓ … increasing the **Electrodermal Activity**,
- ✓ … decreasing the skin temperature,
- ✓ … inducing rapid and shallow breathing,
- ✓ … reducing the blood flows to the intestines ….

Human Skin

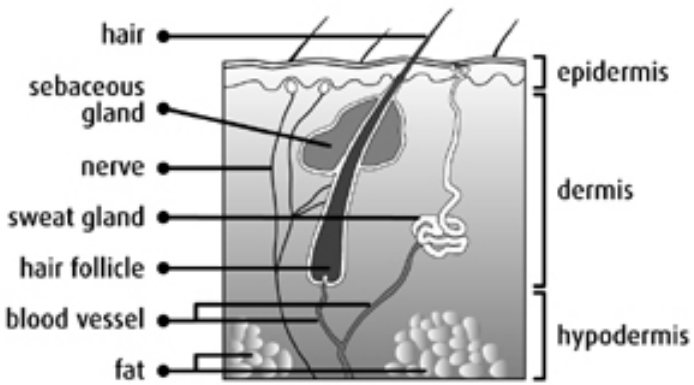

Epidermis
Dermis
Sweat gland
Meissner corpuscle
Pacinian corpuscle
Ruffini organ
Merkel disks
Free nerve endings

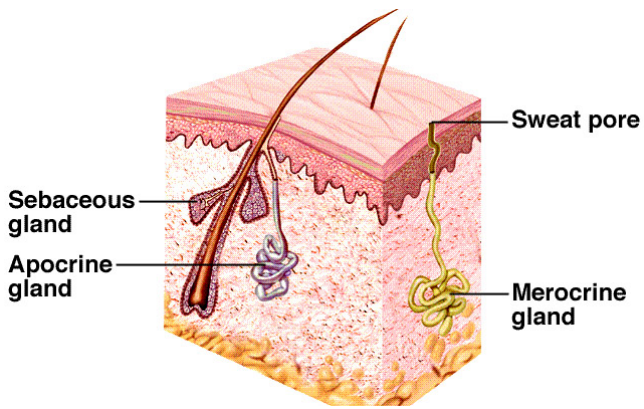
ElectroDermal Activity

Body sweat glands:

- ✓ Aprocrine glands
- ✓ Eccrine glands

They have a wide distribution over the body and respond primarily to SNS stimulation (stress), by increasing the sweat production

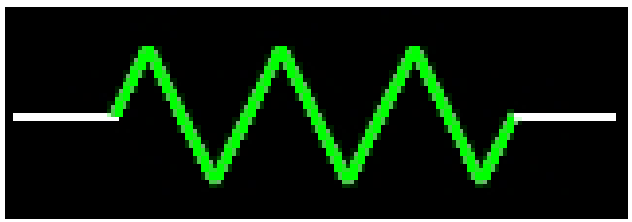




EDA – measuring: what

Measure

Skin Conductance – it's the measure of the variation of the electrical resistance of the skin, due to the increasing of the the amount of sweat



$$R = V / I$$

(volt/ampere = Ohm)

$$\text{Conductance} = C = 1/R$$

(1/ohm = mho = siemens)

EDA – measuring: how

Measure

- ✓ 2 electrodes are placed on the skin
- ✓ a small (~ 10 μ A) constant current is driven
- ✓ sweat is electrically active (water + salt + others)
- ✓ more stress → more sweat → skin less resistant → R decreases → C increases

$$R = V / I$$

(volt/ampere = Ohm)

$$\text{Conductance} = C = 1/R$$

(1/ohm = mho = siemens)

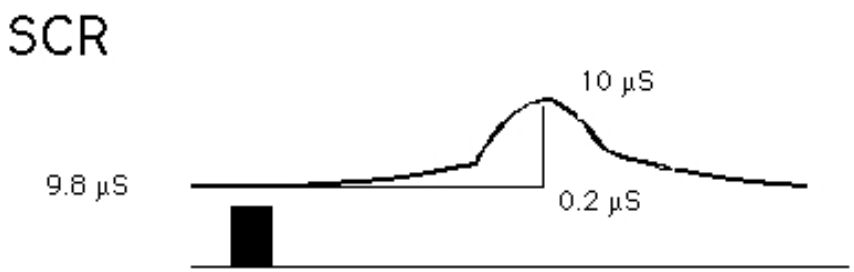
SC – Skin Conductance

SCL – Skin Conductance Level

is the low frequency change in SC

SCRs – Skin Conductance Reactions (Responses)

are the high frequency (short duration) changes in SC

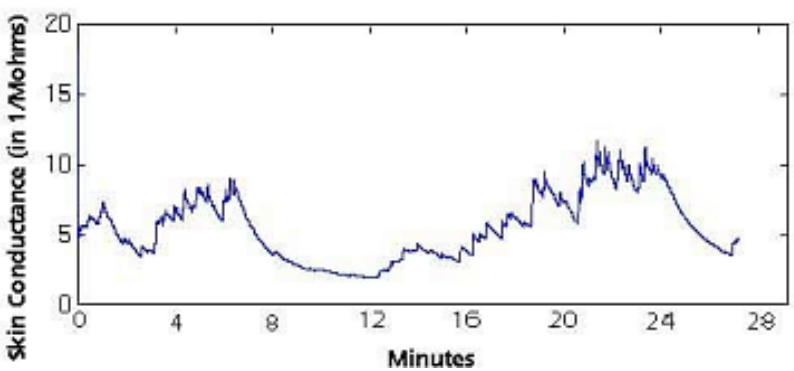


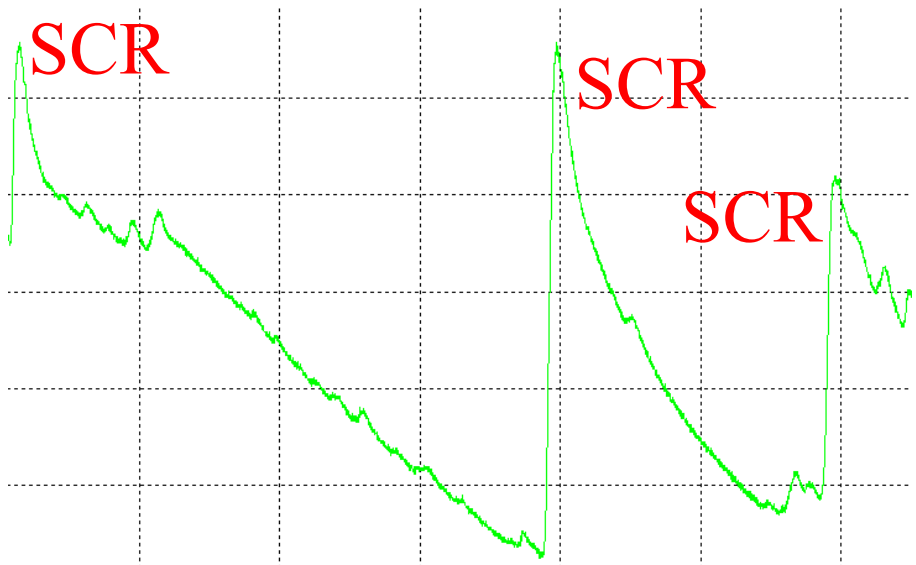
✓ Sympathetic Nervous System activity can cause both increasing SCL (long lasting activity) and SCR (short and quick activity)

✓ SC reactions to stimuli occurs within 2-3 secs and can last for 1-2 minutes

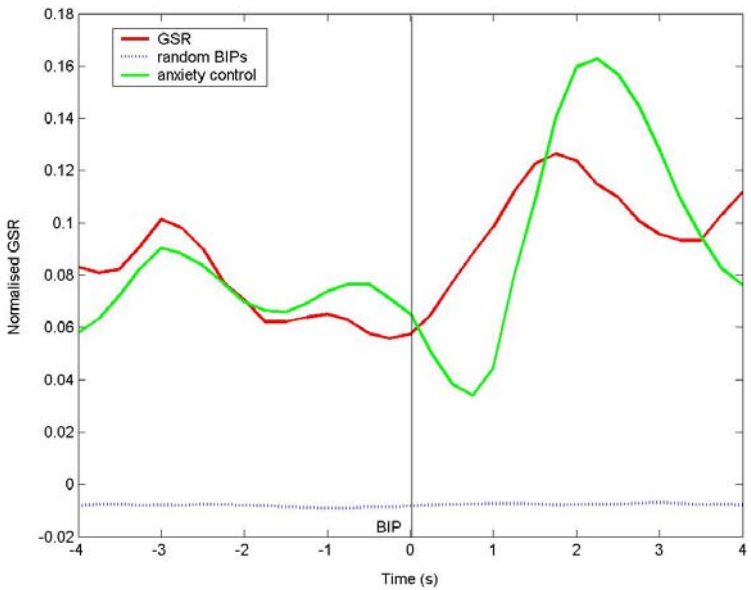
GSR

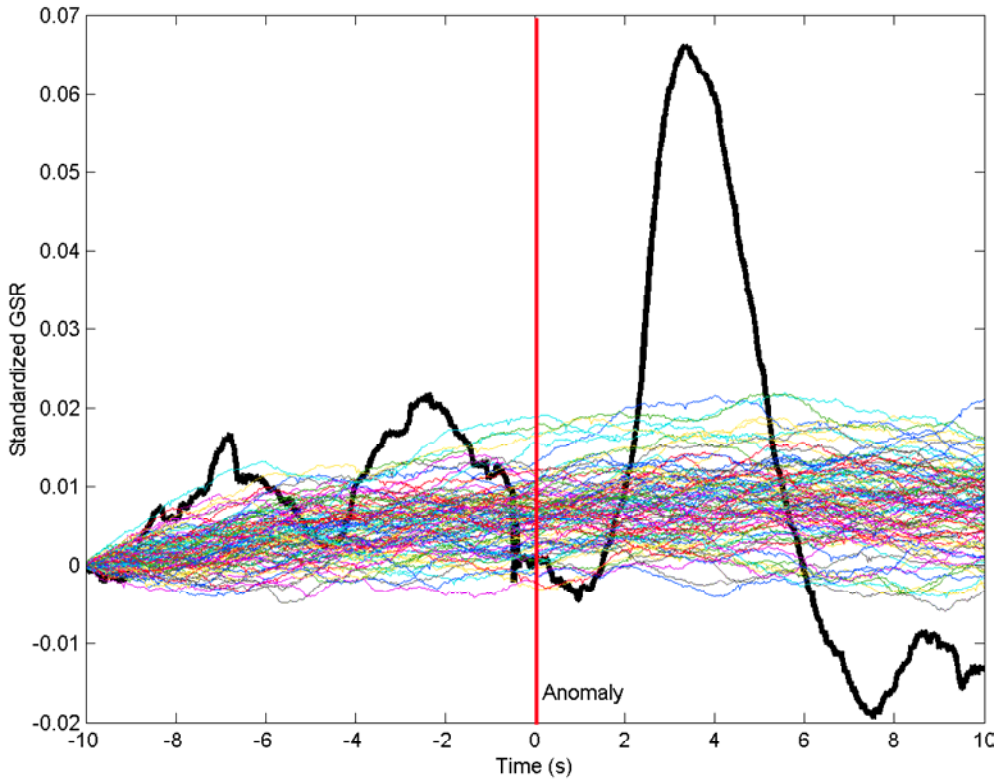
- ✓ It is a measure of the skin's conductance between two electrodes
- ✓ Skin conductance is considered to be a function of the sweat gland activity and the skin's pore size
- ✓ As a person becomes more or less stressed, the skin's conductance increases or decreases proportionally
- ✓ The standard measurement unit for skin conductance is called micro-Siemens (or micro-mho) (around 2 µS)





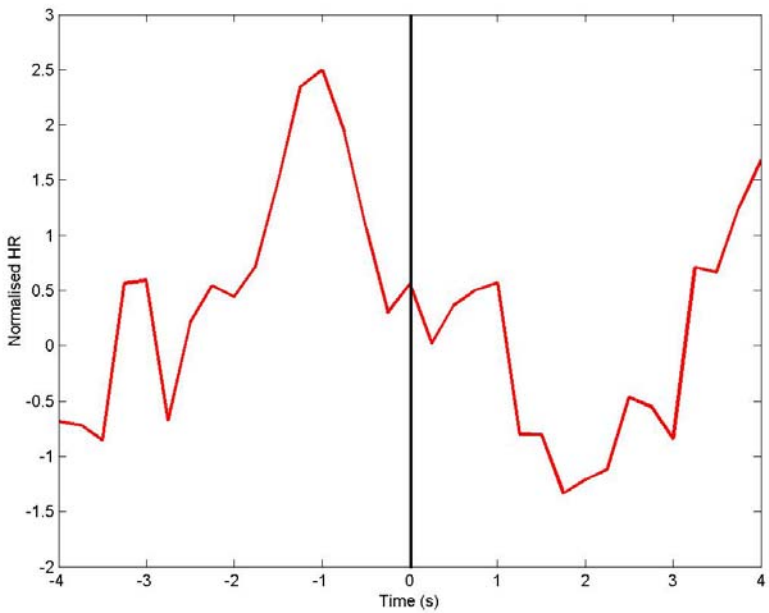
GSR and Stress in time domain

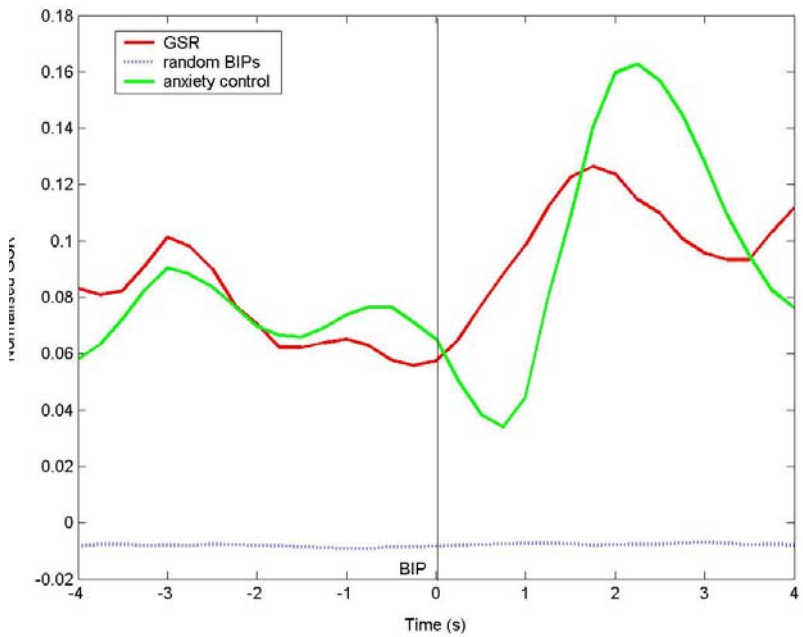




HR and GSR

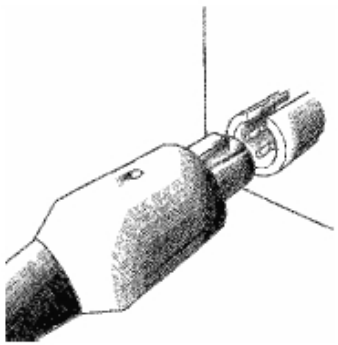
Time Domain

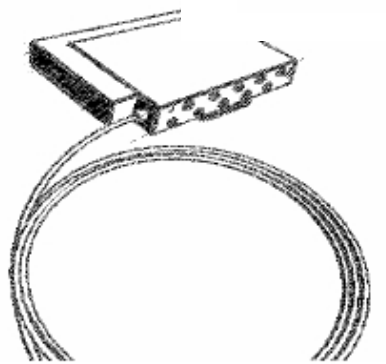




Hardware

ProComp Infinity - Thought technology Ltd



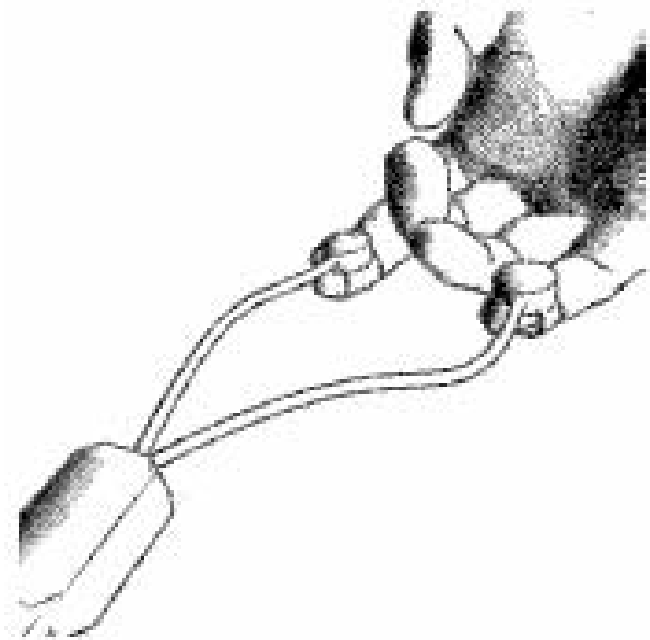


Sensor

Skin Conductance Flex/Pro Sensor (SA9309M)

Size without electrode leads (approx.)	3.5 cm (1.4″)
Size with electrode leads (approx.)	15 cm (6.0″)
Cable Length (approx.)	127 cm (50″)
Weight (approx.)	25 g (1 oz)
Signal Input Range	0 – 30.0 µS
Accuracy	±5% and ±0.2 µS

Placement



Data format - GSR

11111	11121	11211	11221	12111
18790	21021	18293	17455	20699
1.694	1.54	1.794	1.014	0.85
1.694	1.54	1.794	1.019	0.85
1.689	1.54	1.794	1.019	0.845
1.689	1.53	1.794	1.014	0.85
1.689	1.535	1.789	1.009	0.85
1.679	1.54	1.789	1.014	0.845
1.689	1.535	1.784	1.014	0.855
1.684	1.54	1.794	1.019	0.845
1.679	1.535	1.784	1.014	0.845
1.689	1.54	1.784	1.009	0.84
1.684	1.54	1.784	1.014	0.845
1.684	1.53	1.789	1.019	0.835
1.684	1.535	1.784	1.009	0.845
1.684	1.535	1.779	1.014	0.845
1.684	1.535	1.779	1.019	0.845
1.684	1.53	1.784	1.014	0.845
1.684	1.535	1.779	1.014	0.845
1.679	1.53	1.779	1.019	0.845
1.684	1.53	1.774	1.009	0.84
1.684	1.53	1.779	1.014	0.845
1.679	1.535	1.774	1.014	0.845
1.679	1.53	1.774	1.009	0.845
……	…...	…...	…...	…...

Volunteer ID

Number of occurrences

Data @ 32 Hz

1 sample every 1/32 secs (0.03125)

Data format – events (key pressed)

11111	11121	11211	11221	12111	12121	12211
2	8	3	1	0	11	2
16116	6948	14955	13806		17040	15603
17823	9345	15540			17346	24474
	14268	16737			17982	
	14295				18231	
	15231				18513	
	17247				19410	
	18600				19668	
	19920				19935	
					21354	
					21576	
					22296	

Volunteer ID

Number of occurrences

Data

The data indicate the samples when a key has been pressed

Data format – events (another format)

11111	12211	21212	23212
115.000	115.000	104.000	121.000
77.250	9.563	20.531	24.094
115.000	32.000	105.000	116.000
85.031	17.625	34.875	26.531
	116.000	32.000	109.000
	19.219	39.656	29.438
	116.000	106.000	99.000
	19.313	43.781	30.938
	106.000		121.000
	20.906		32.063
			105.000
			32.719

Volunteer ID

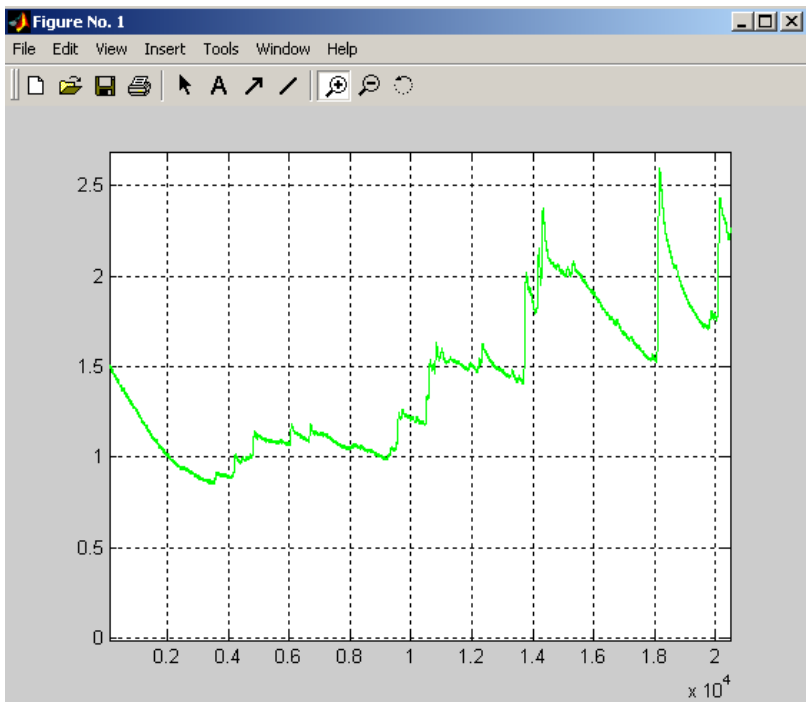
ASCII code of the pressed key

Time (in seconds) when the key has been pressed

The data indicate the seconds when the keys have been pressed

Matlab: plotting

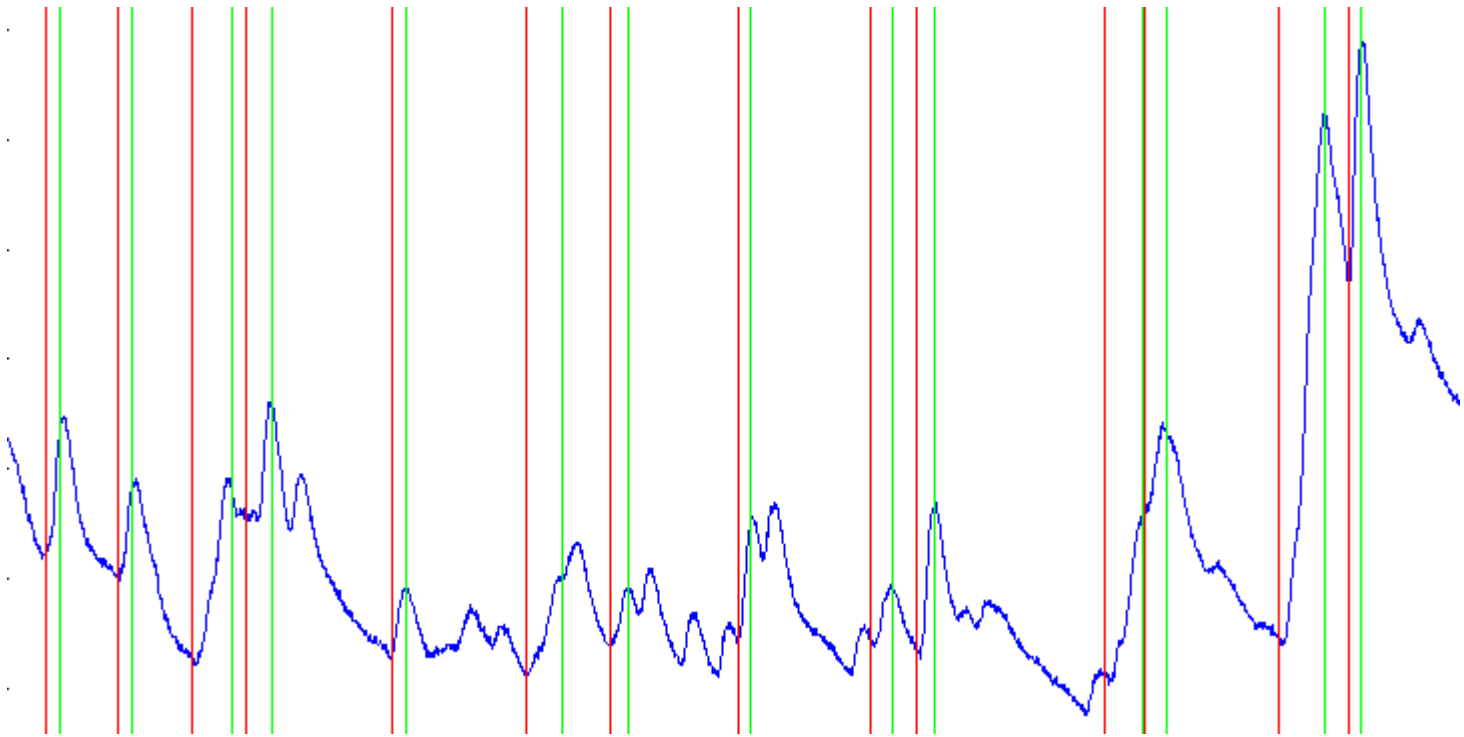
1. Import the file
2. The data are stored in a matlab matrix variable
3. plot(matrixname(time1:time2, id));



Tips:
- ✓ Time2 = end
- ✓ hold on;
- ✓ grid;
- ✓ axis auto;

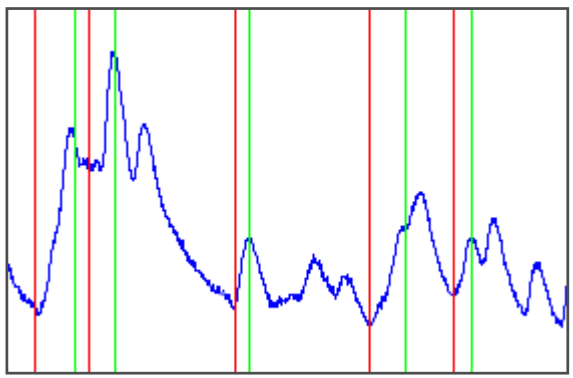
Matlab: SCR

The next code requires the packages SPLINE, WAVELET and STATISTICS in your matlab installation

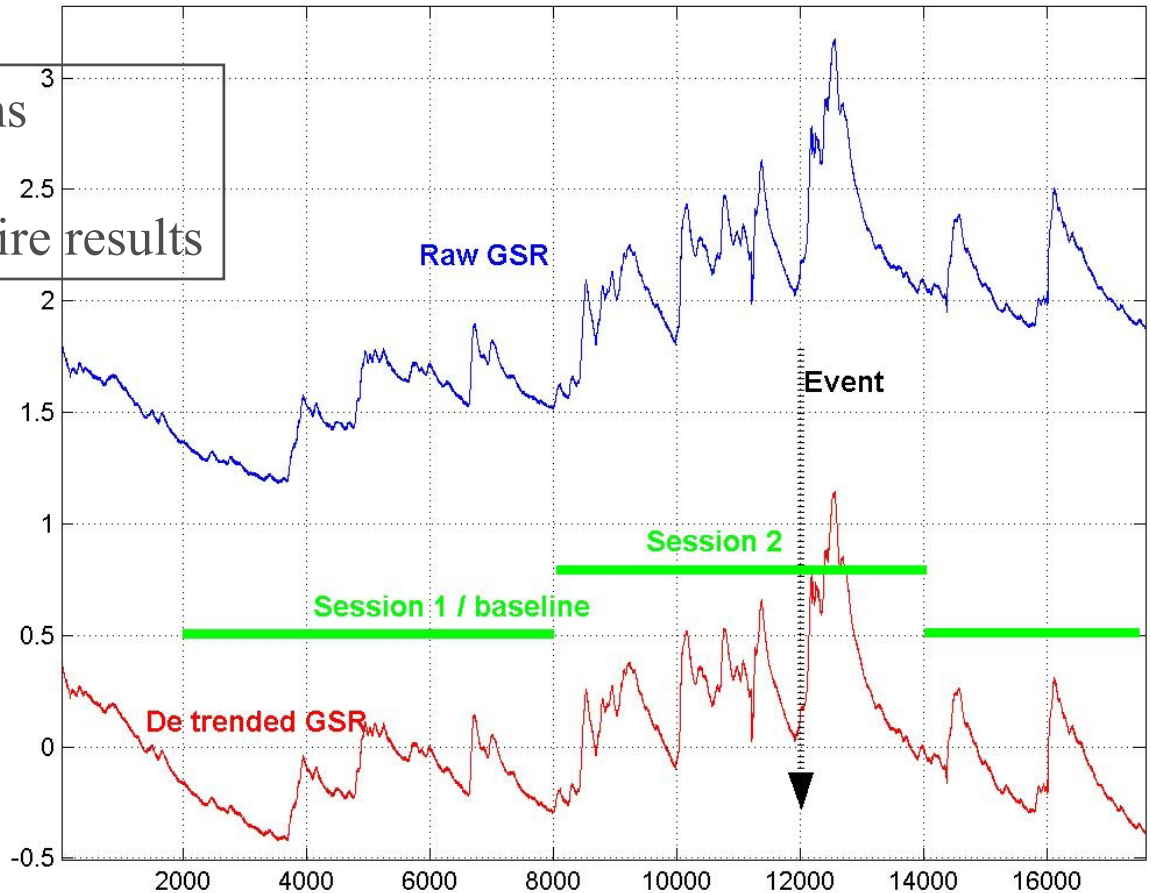


GSR - Analysis

- ✓ Compare different sessions
- ✓ Event related analysis
- ✓ Compare with questionnaire results



- ✓ Time domain
- ✓ SCRs



Summary

- GSR is a function of the sweat glands activity
- GSR is related to stress
- we can measure the SCRs

- Hardware and Sensor
- matlab code for SCRs detection
- GSR analysis