Research Methods Course
Physiological Signals

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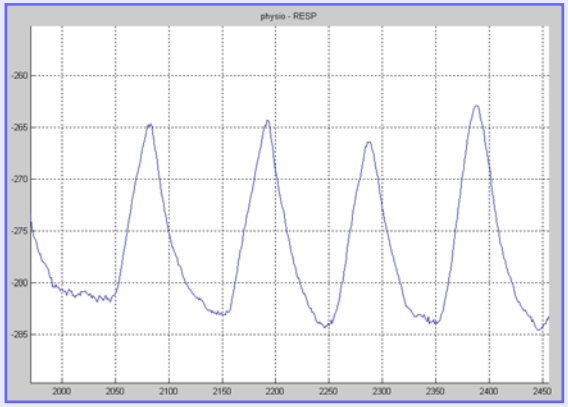
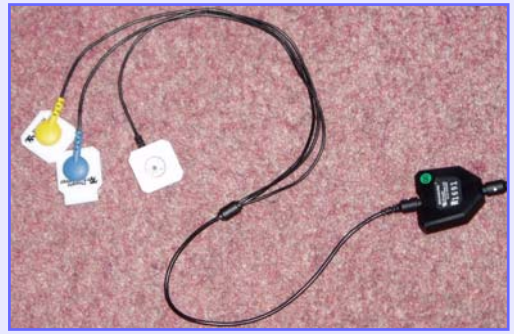




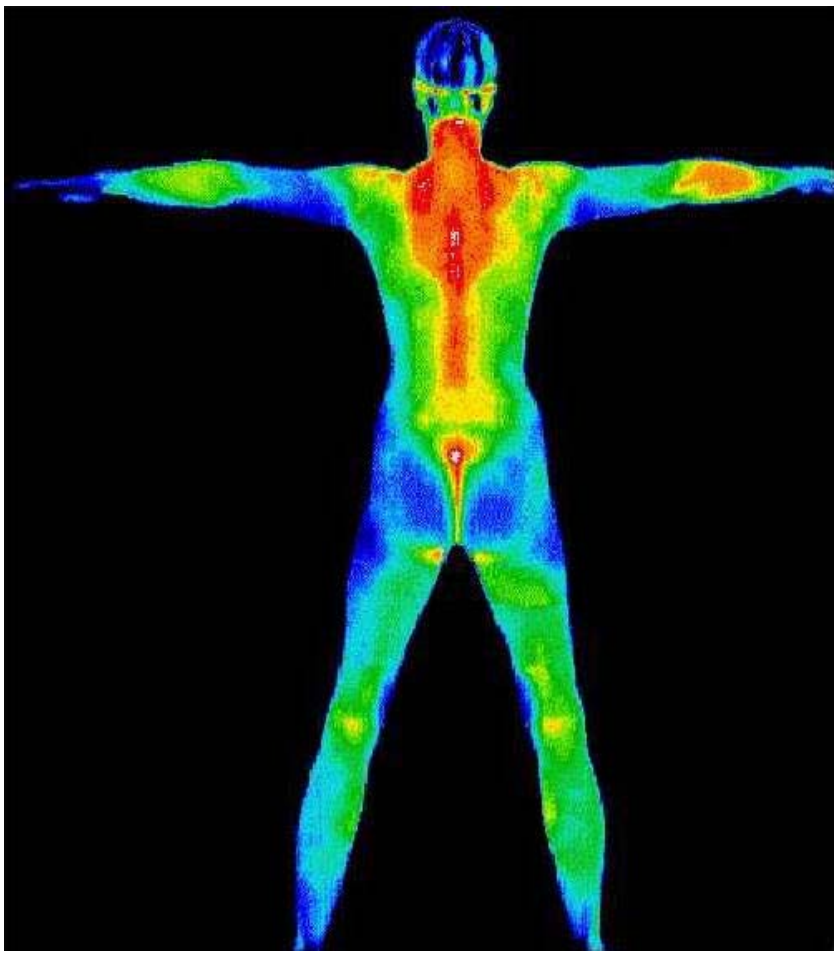
http://www.cs.ucl.ac.uk/staff/m.slater/Teaching/ResearchMethods/
http://www.cs.ucl.ac.uk/staff/a.brogni/Teaching/RM_physio

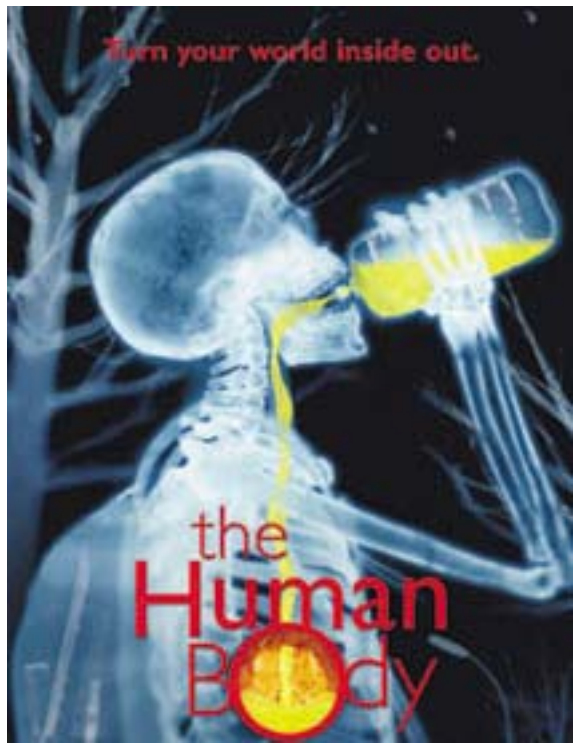
Outline

- Intro to Physio
- Physio & Stress
- Presence
- Physio & VR
- Signals

- Summary

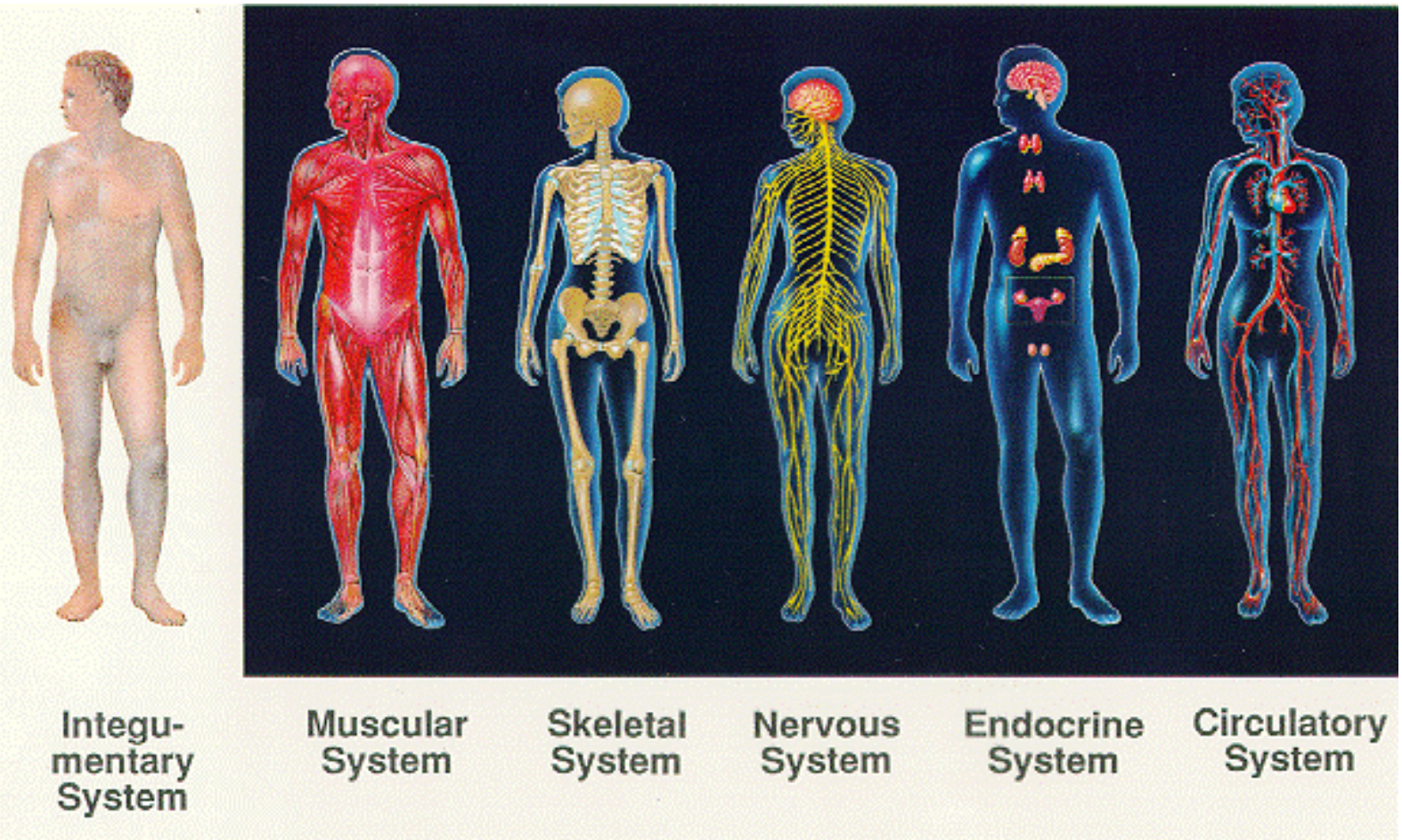
Human Body





Human Body

Human Body


Integu-
mentary
System
Muscular
System
Skeletal
System
Nervous
System
Endocrine
System
Circulatory
System

Psychophysiology

Human Behaviours & Physio Responses

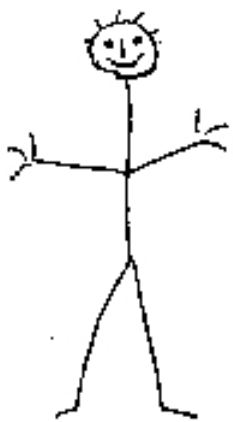
"*Psychophysiology is the study of relations between physiological* ***manipulations*** *and resulting physiological* ***responses****, …"*

John L. Andreassi

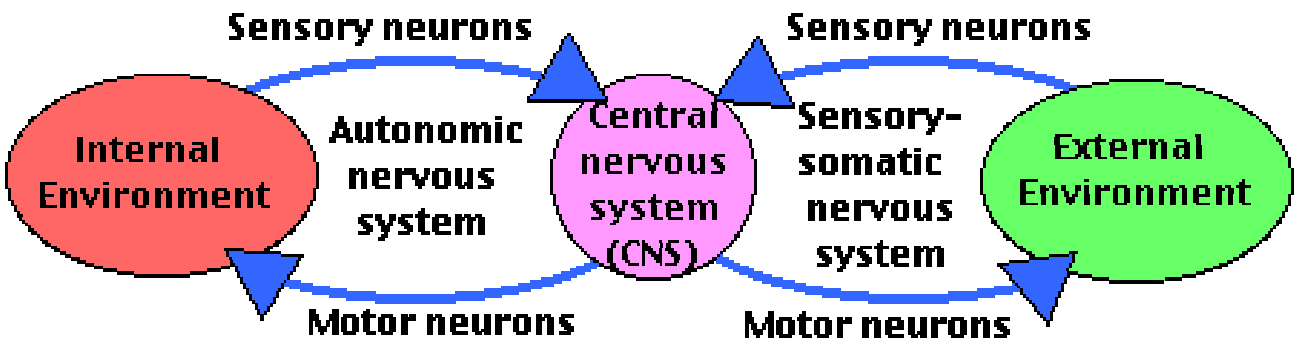
Psychophysiology

Human Behaviours & Physio Responses

Relations between MENTAL and BODILY processes



Physiology and Stress



Autonomic Nervous System

- ✓ It controls the activity of the internal organs
- ✓ It controls heart contraction and rate, sweat gland activity, skin temperature, metabolism, skeletal muscle strength ….. and many other visceral functions

Autonomic Nervous System

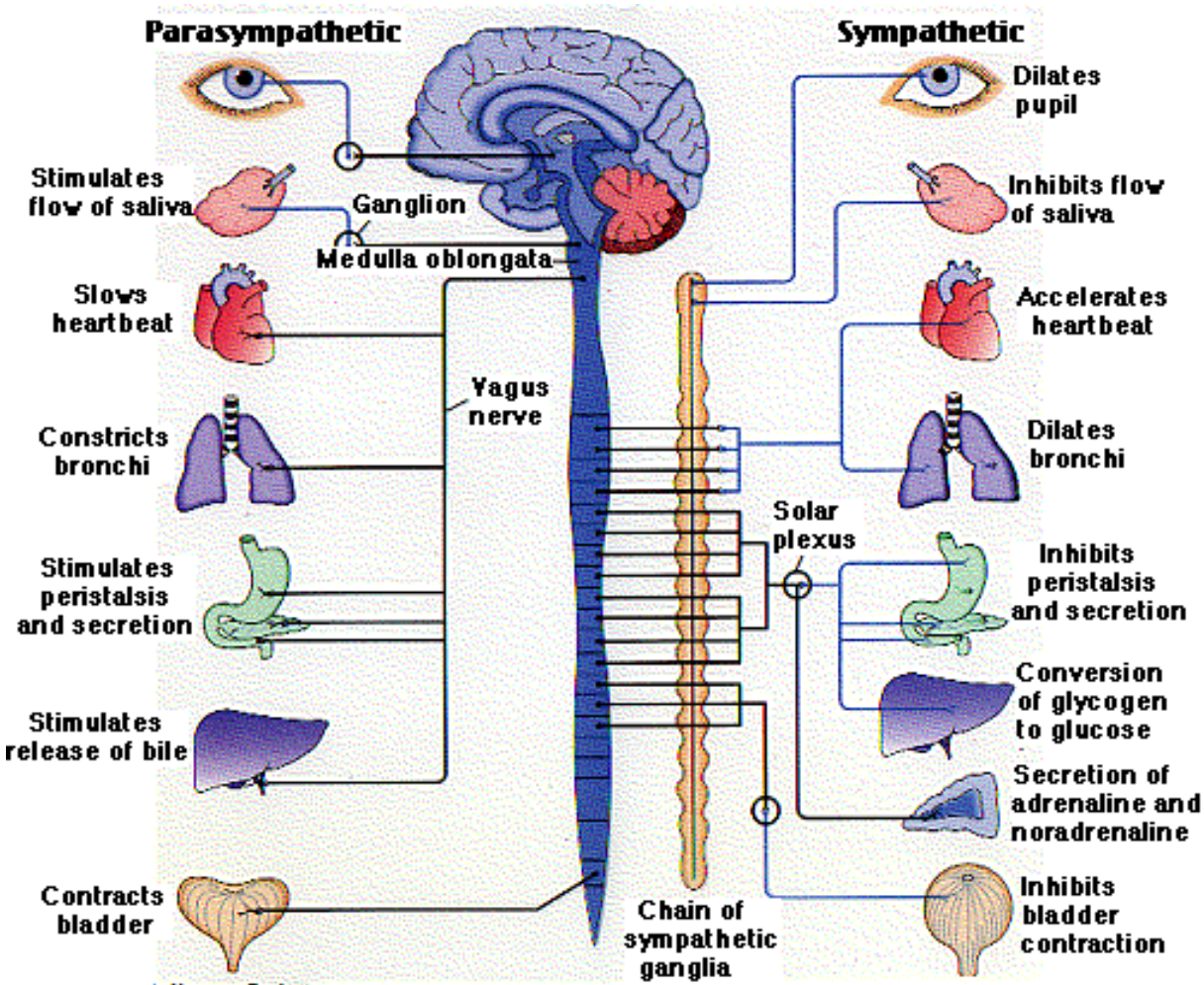
PNS – Parasympathetic Nervous System

it governs the resting and rehabilitation of the body (rebuild body tissue and reduce body stress levels)

SNS - Sympathetic Nervous System

it manages the body's reactions to stress and preparation for muscle activity

Autonomic Nervous System



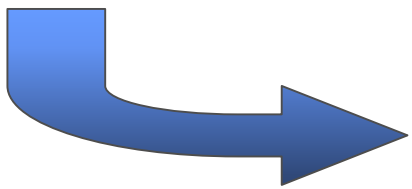
Sympathetic Nervous System

The SNS governs peripheral stress response …

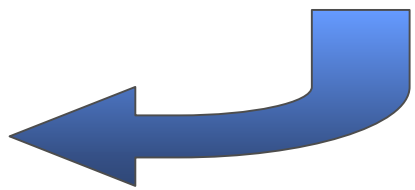
- ✓ … increasing the Heart Rate,
- ✓ … increasing the Electrodermal Activity,
- ✓… decreasing the skin temperature,
- ✓ … inducing rapid and shallow breathing,
- ✓ … reducing the blood flows to the intestines ….

Presence in VR

PRESENCE: the sense of being there *(in a virtual environment)*, even when one is physically situated in another place *(lab)* [1998, Witmer and Singer]



Perceiving "realistic" stimuli from the virtual environment



Obtain "realistic" physiological responses

Physiology and Virtual Reality

- Have been proposed as a tool for presence measurement, e.g.,
  - Dillon et al (2001)
  - Meehan (2002)

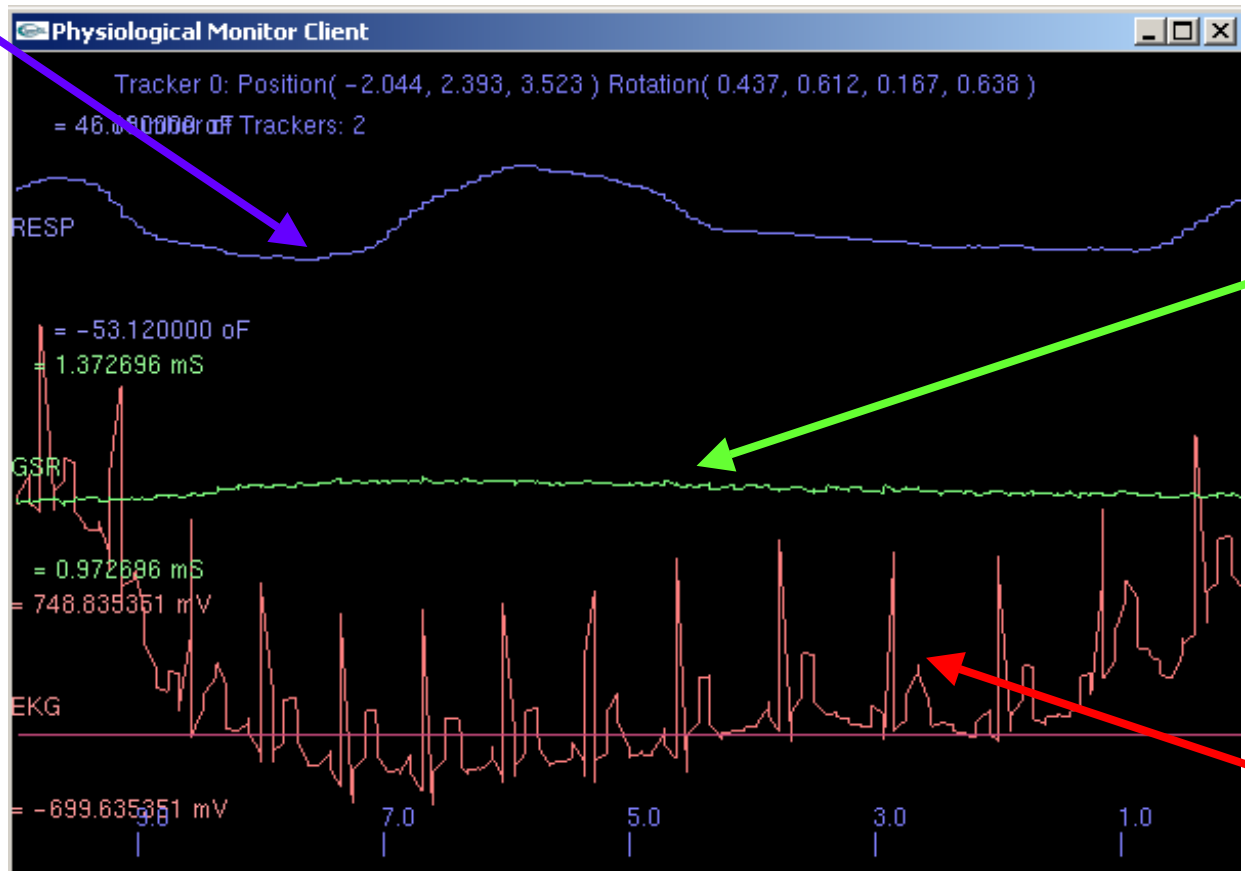
- Successfully used in stressful VEs
- Stress is used as a surrogate for presence

Many Signals but …

EEG – ElectroEncephaloGram
ECG – ElectroCardioGram (EKG)
GSR – Galvanic Skin Responses
Temperature
EMG – ElectroMyoGraphy
Respiration
BVP – Blood Volume Pulse

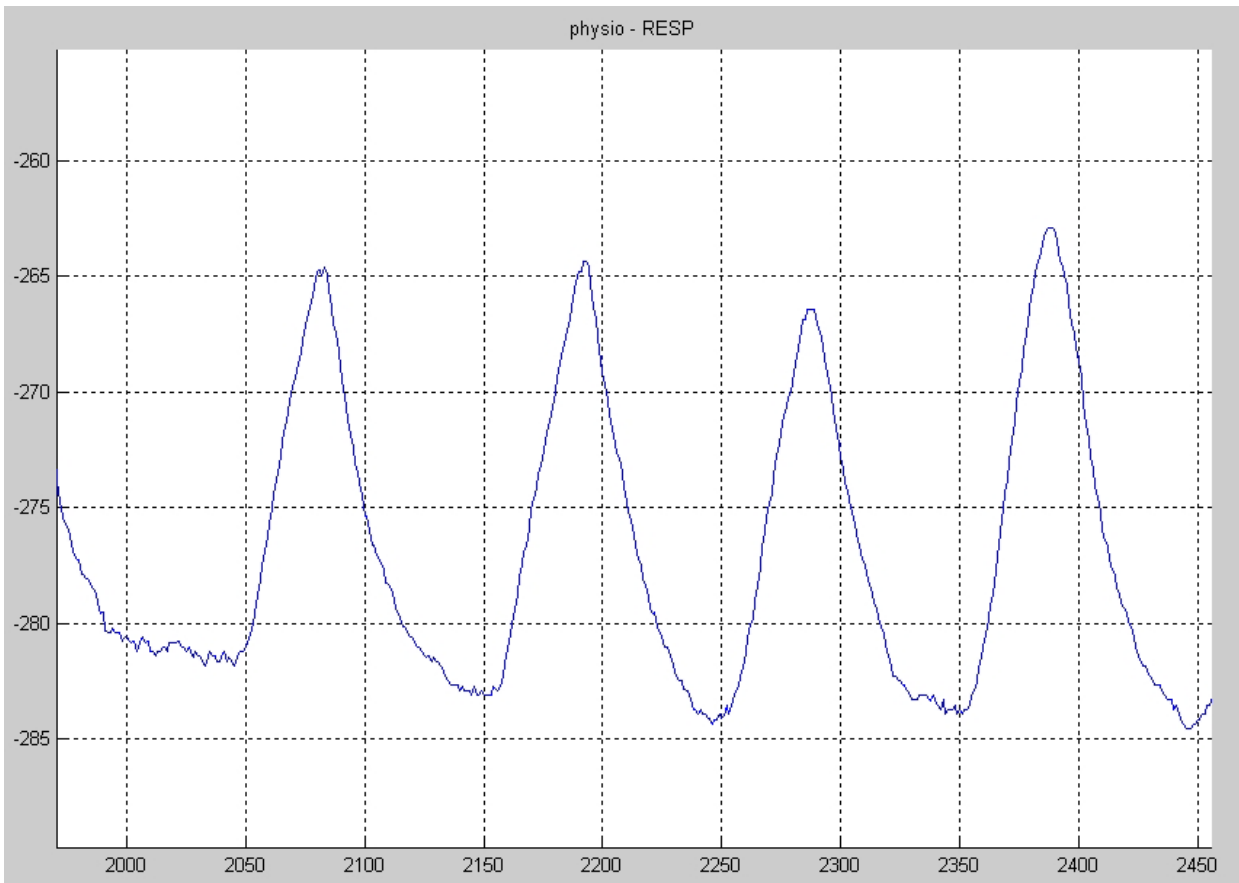
HR - Heart Rate
HRV – Heart Rate Variability

… not all of them !!



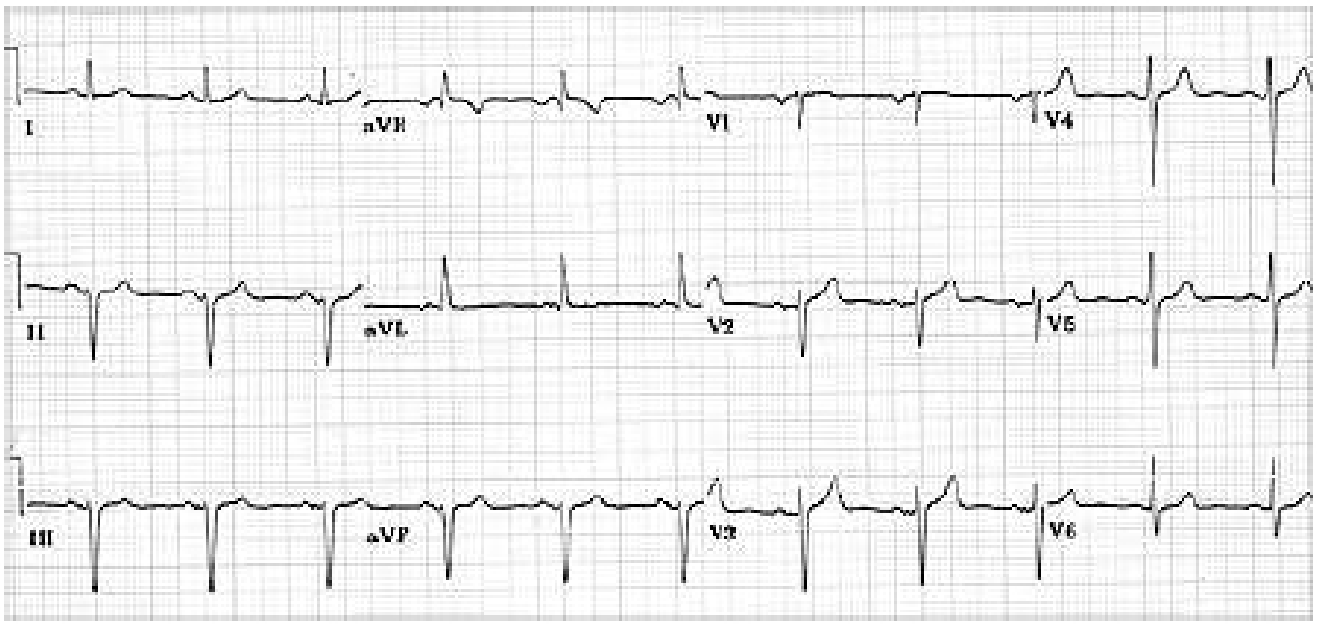
Respiration

✓ The respiration signal is a relative measure of chest expansion.
✓The sensor converts the expansion and contraction of the rib cage to a rise and fall of the signal.



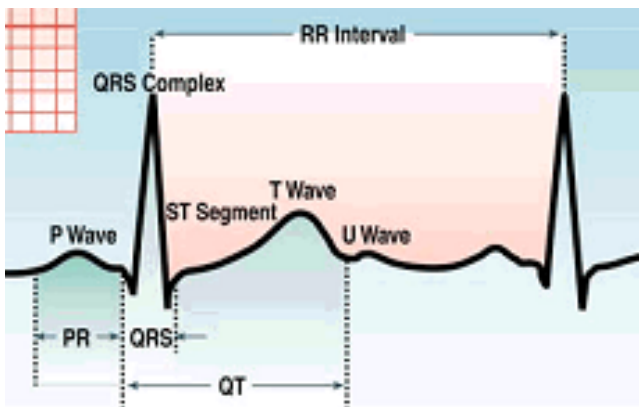
ECG

✓ ECG (or EKG) is a representation of the heart's electrical activity recorded from electrodes on the body surface



ECG

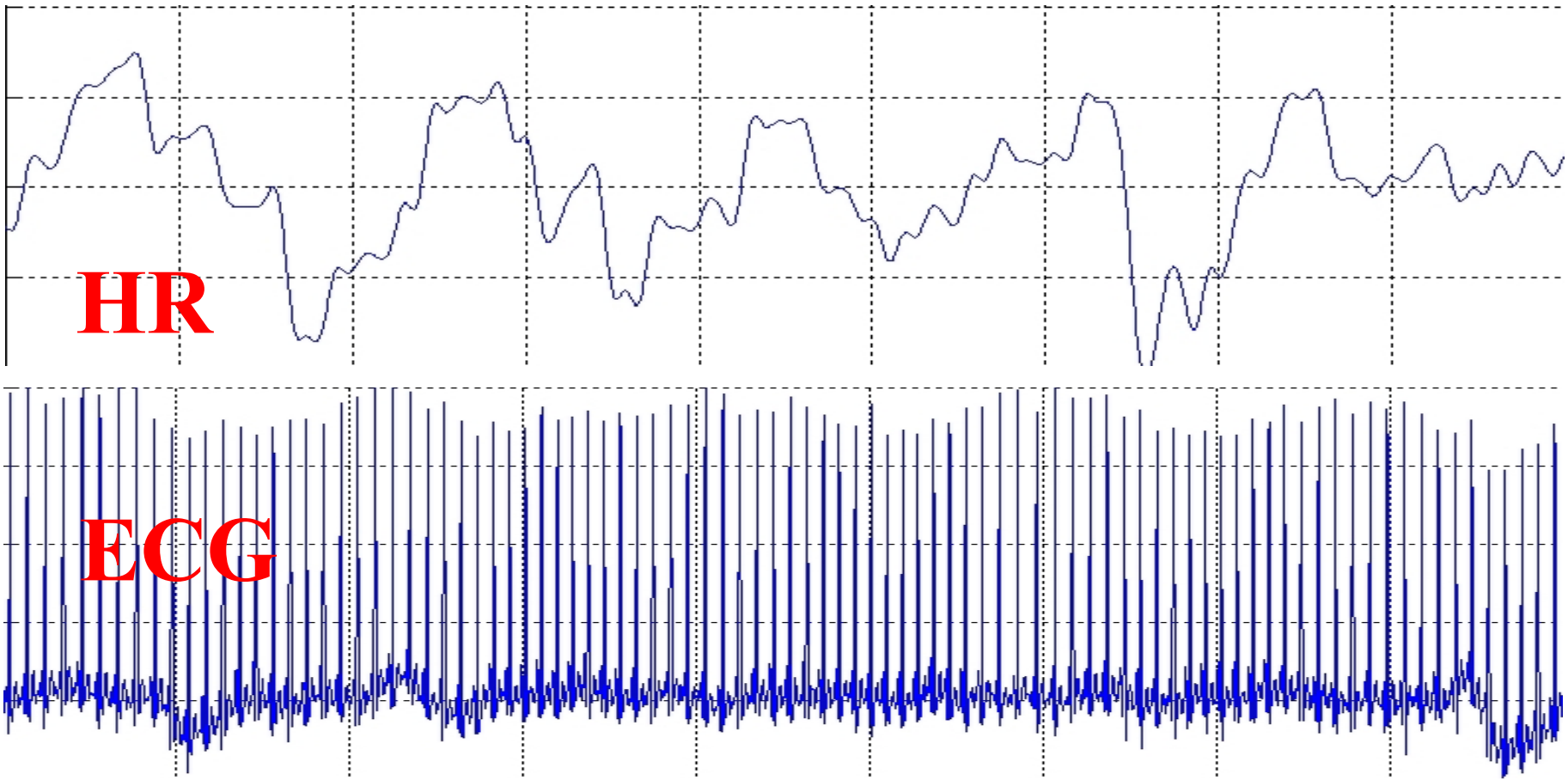
The typical measurement made in the medical researches are the **Heart Rate**, the intervals **PR** and **QT**, the width of the most representative **QRS** (duration) and the axis of the QRS.



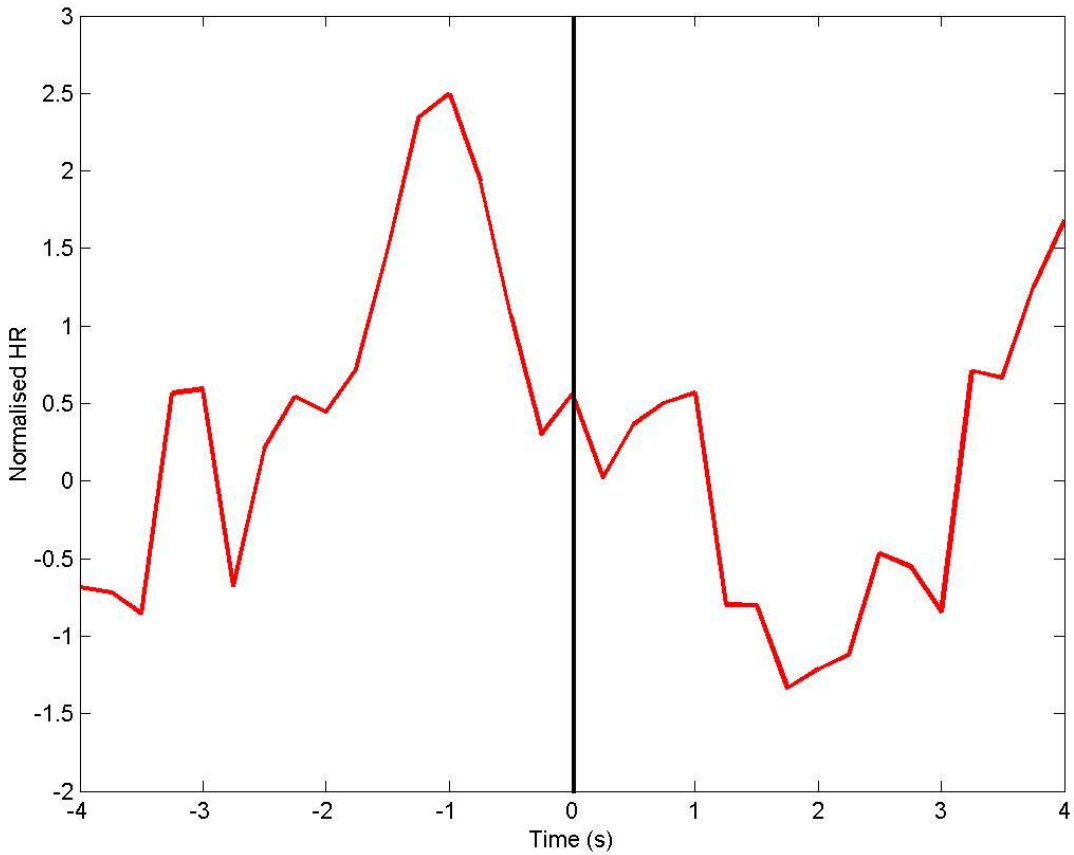
Signal	Description
P wave	The sequential activation (depolarization) of the right and left atria
QRS complex	Right and left ventricular depolarization (normally the ventricles are activated simultaneously)
ST-T wave	Ventricular re-polarization
U wave	Origin for this wave is not clear - but probably represents "after-depolarization" in the ventricles
PR interval	Time interval from onset of atrial depolarization (P wave) to onset of ventricular depolarization (QRS complex)
QRS duration	Duration of ventricular muscle depolarization
QT interval	Duration of ventricular depolarization and re-polarization
RR interval	Duration of ventricular cardiac cycle (an indicator of ventricular rate)
PP interval	Duration of atrial cycle (an indicator or atrial rate)

Heart Rate

- ✓ It indicates the times per minute the heart contracts
- ✓ The typical range is between 60 and 90 bpm (beats per minute)

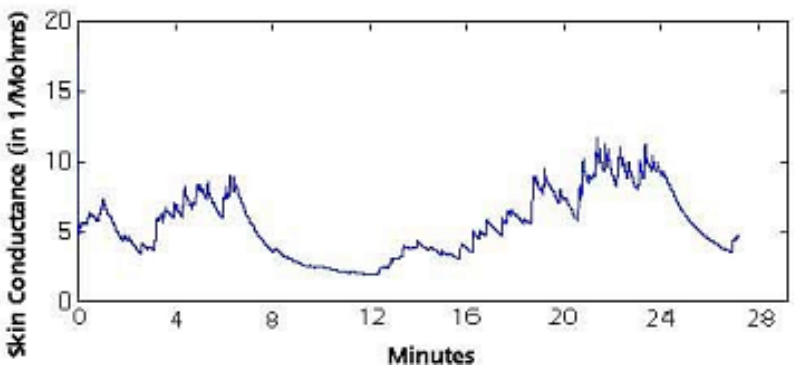


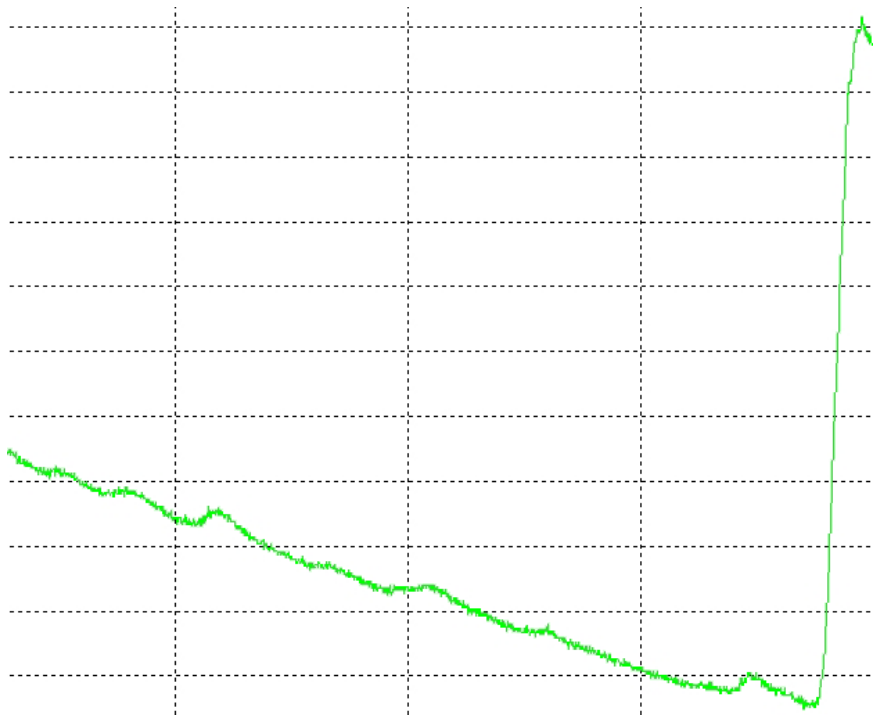
HR and Stress in VR



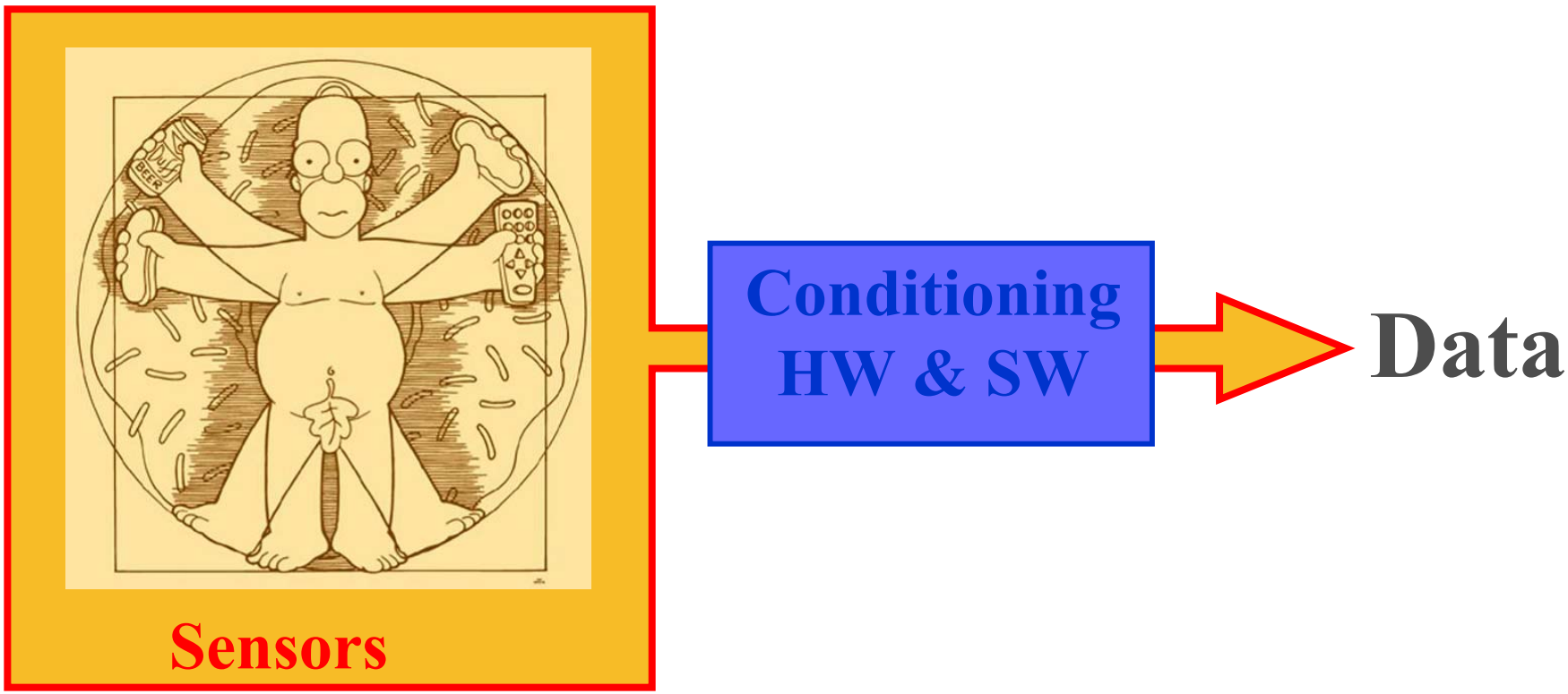
GSR

- ✓ 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
- ✓ The standard measurement unit for skin conductance is called micro-Siemens (or micro-mho)

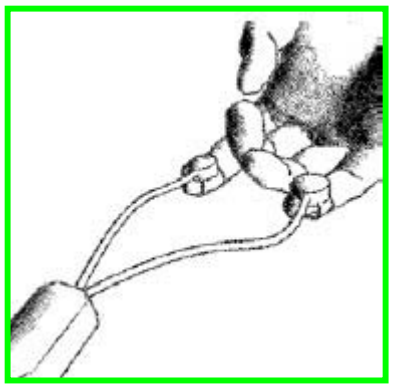




Recording Physio Signals



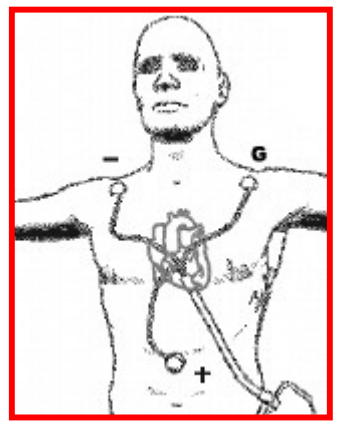
Hardware

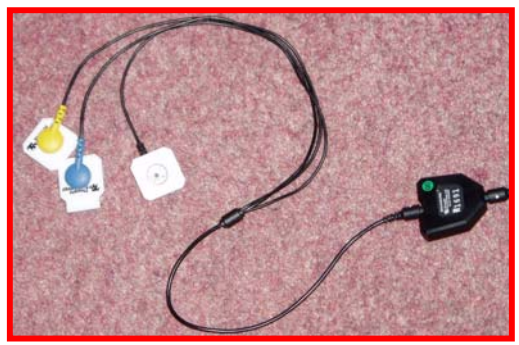


Galvanic Skin Responses

ProComp Infinity
Thought technology Ltd

ECG



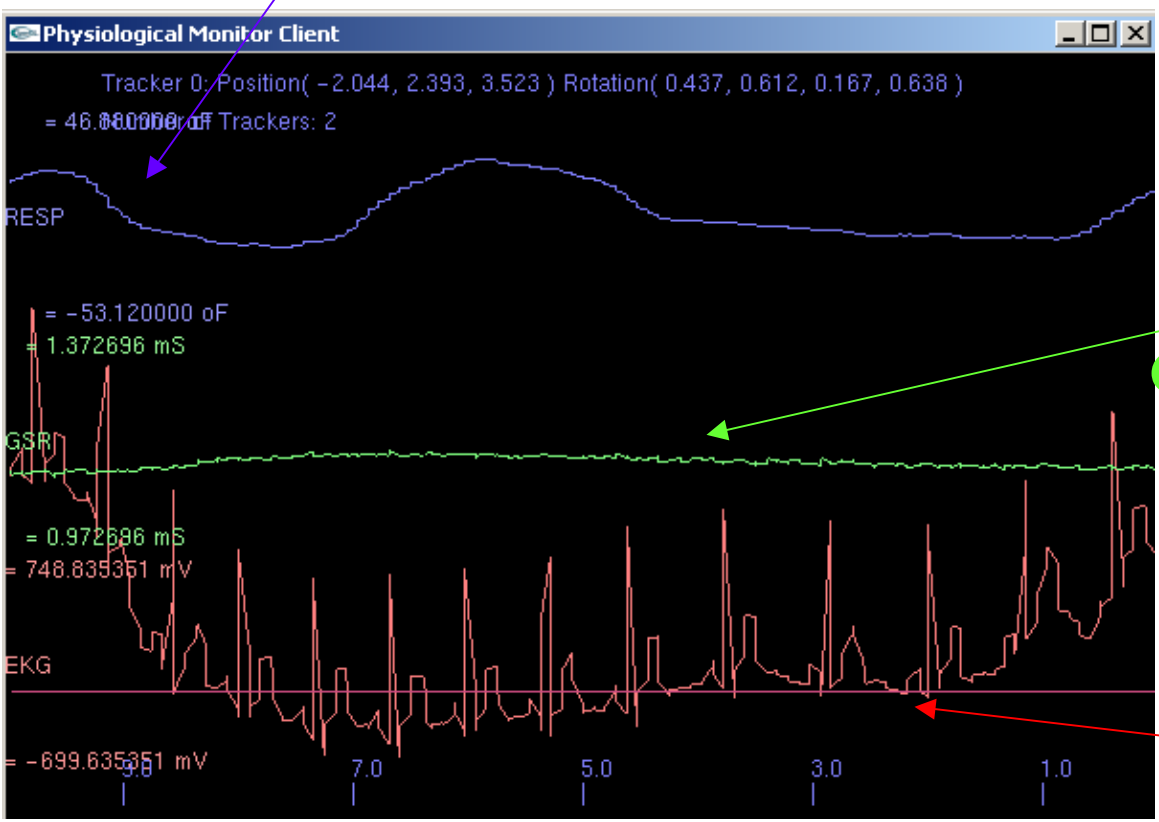


Respiration

Review of the Signals

Respiration

The respiration signal is a relative measure of chest expansion. The sensor converts the expansion and contraction of the rib cage to a rise and fall of the signal.



✓ Skin conductance is considered to be a function of the sweat gland activity and the skin's pore size

✓ The standard measurement unit for skin conductance is called micro-Siemens (or micro-mho)

Galvanic Skin Responses

✓ It represents the electrical activity of the heart

Electro Cardio Gram

Summary

- Relation between mental state and physiological responses
- Physiological Signals can be recorded
- ECG & GSR are the most common measures
- Physio signals analysis can give information about the on going experience