Research Methods Course

Physiological Signals

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Outline

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

• Summary
Human Body
Human Body
Human Body
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

Parasympathetic:
- Stimulates flow of saliva
- Slows heartbeat
- Constricts bronchi
- Stimulates peristalsis and secretion
- Stimulates release of bile
- Contracts bladder

Sympathetic:
- Dilates pupil
- Inhibits flow of saliva
- Accelerates heartbeat
- Dilates bronchi
- Inhibits peristalsis and secretion
- Conversion of glycogen to glucose
- Secretion of adrenaline and noradrenaline
- Inhibits bladder contraction

Ganglion
Medulla oblongata
Vagus nerve
Solar plexus
Chain of sympathetic ganglia
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**: 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!!
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
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.

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

Sensors

Conditioning HW & SW

Data
Hardware

- ECG
- Galvanic Skin Responses
- ProComp Infinity
  Thought technology Ltd
- 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.

Galvanic Skin Responses

- 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).

Electro Cardio Gram

- It represents the electrical activity of the heart.
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 ongoing experience