



# Wearable systems for monitoring of emotions, mood and consciousness disorders

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## Some bioengineering research topics of the Research Center "E. Piaggio" - Faculty of Engineering

**Artificial Senses and Artificial Muscles** Tactile, kinesthesia and vision. Smart materials (gel, carbon nanotubes, conducting polymers)

**Biofabrication** Development of several microfabrication techniques, including PAM (Pressure Assisted MicroSyringe), PAM2 (Piston Assisted Microsyringe), and SOFT-MI (soft molecular imprinting). Other methods in use are lithography, ink-jet, microlaser ablation and sintering and single-screw extrusion.

**Affective Computing** Cross-disciplinary research domain on the design of systems that can recognize, interpret, and stimulate human emotions and related affective phenomena.

**Wearable Monitoring Systems** Wearable technologies- such as sensor embedded garments for fashion and leisure, healthcare and emergency.

**Human Machine Social-Emotional Interaction** Can a machine express emotions? How people feel during interaction with robots or machines able to socially act like human beings?

# Special focus on

**Emotions**

Entertainment, virtual reality, physiological response, man-machine interface, artificial devices



The **C**ollective **E**xperience of  
**E**mpathic **D**ata **S**ystems

**Mood disorders**

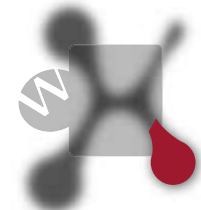
Psychiatric or mental disorders such as major depression, bipolar disorders, anxiety, social phobia, etc...



Personalised monitoring **S**ystems for  
**C**are in mental **H**Health

**Consciousness disorders**

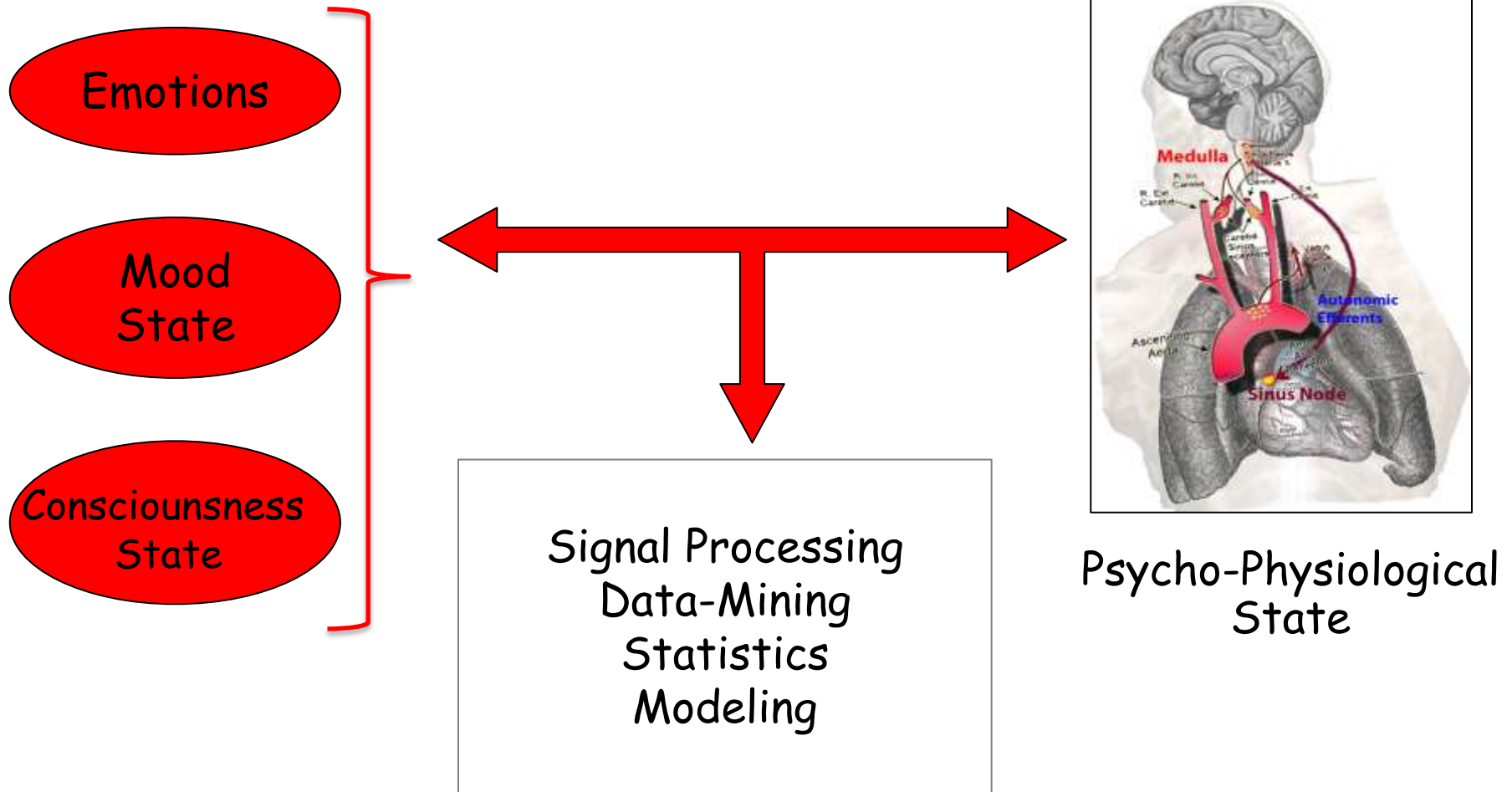
Patients in vegetative states or minimally consciousness state



**WEAR**able **HAPT**ics  
for Humans and Robots

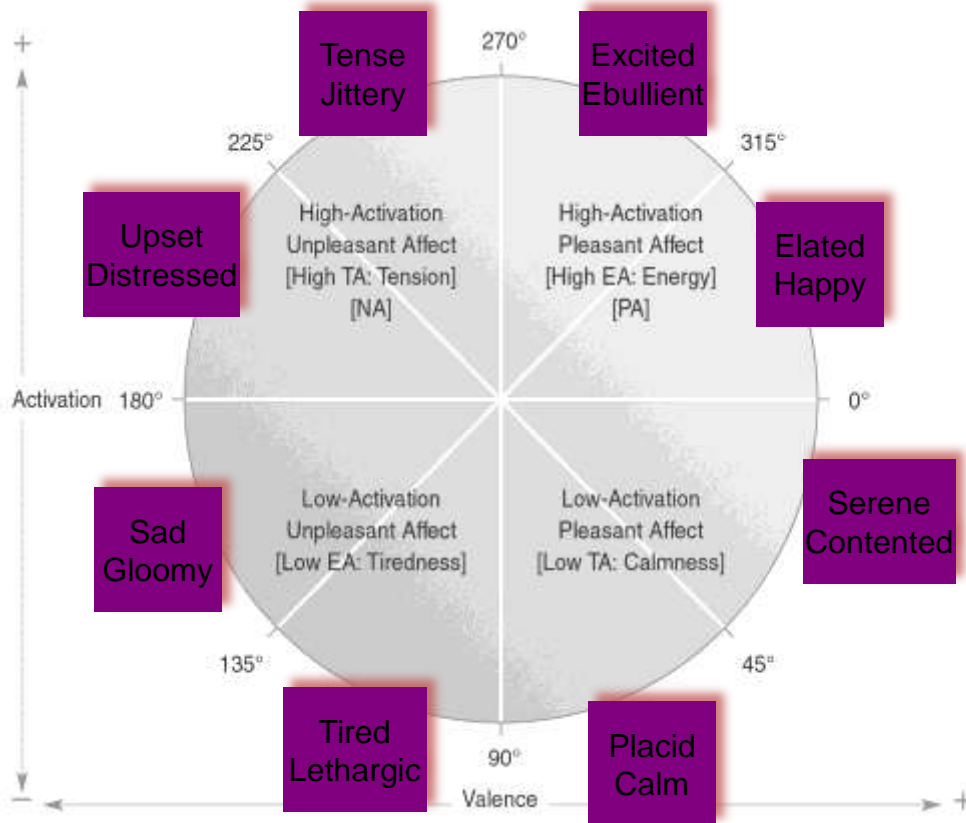


# Link between Emotions, Mood States, Consciousness and Autonomic Nervous System Dynamics





# Russell's Circumplex Model of Affect



Two dimensions of affective states:  
**Valence (pleasure-displeasure)**  
**Arousal (high-low)**

Dimensional scores are derived from the rated intensity of four types of feelings

Positive-activated (PA), e.g., excited

Positive-deactivated (PD), e.g., calmness

Negative-deactivated (ND), e.g., bored

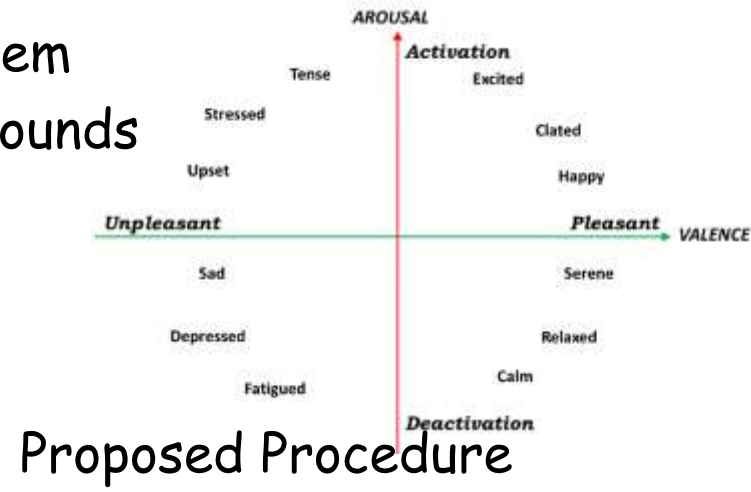
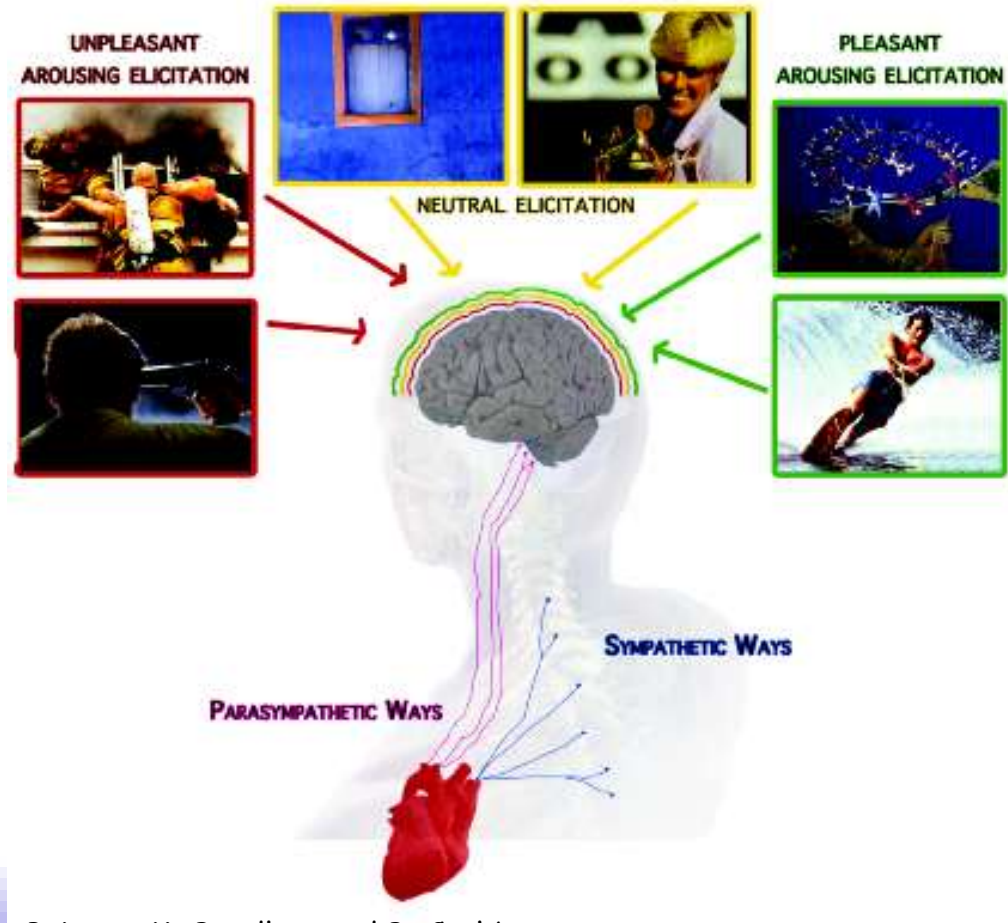
Negative-activated (NA), e.g., anxious, tense, stressed



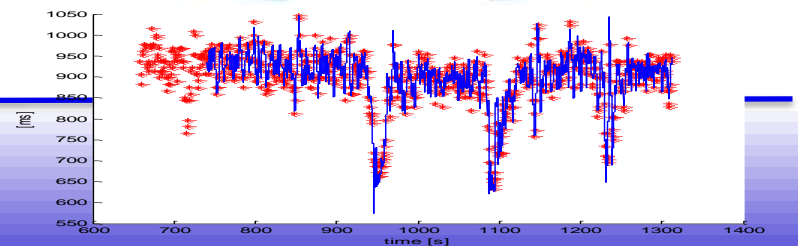
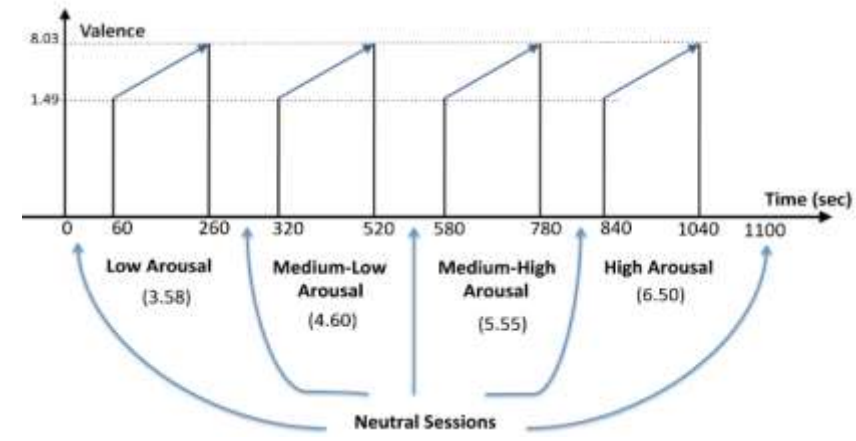
# Eliciting Emotions

IAPS - International Affective Pictures System

IADS - International Affective Digitalized Sounds



Proposed Procedure





# What are DOC patients?

Patients suffering from Disorders Of Consciousness.

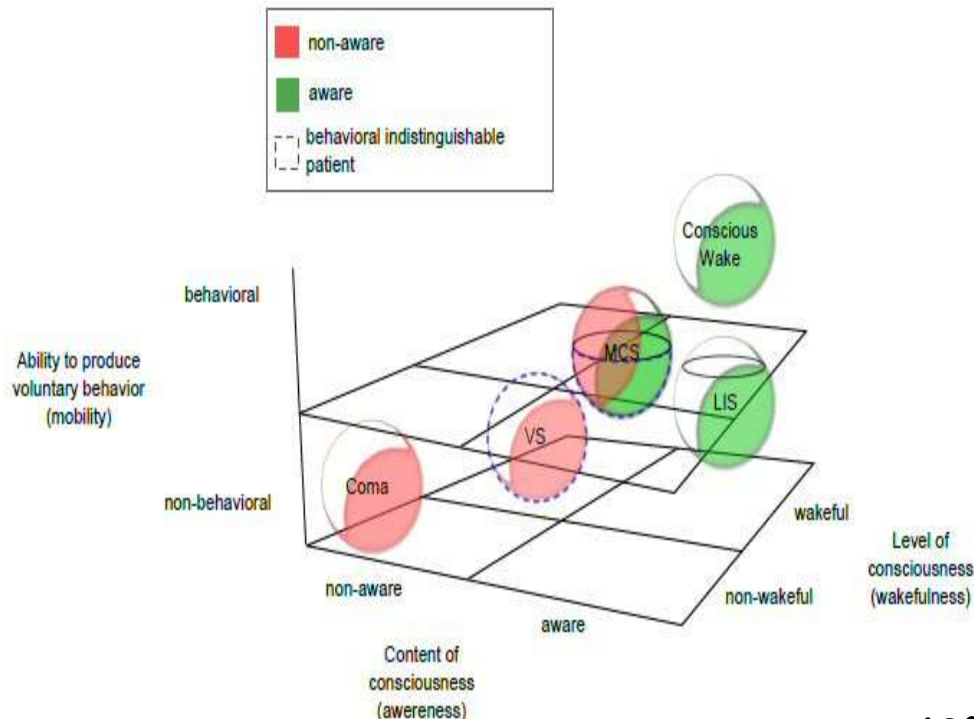
## Vegetative State

- Complete absence of behavioral evidence for self or environmental awareness
- Patients can show autonomic activity
- Sleep-wake cycles could also be shown

Imaging (e.g. fMRI)

Neurobehavioral rating scales LCFS(1:8)

Electrophysiology (e.g. EEG, ANS signals etc.)



## Minimally Conscious State

One or more signs of knowledge about self or the environment

## Severe Disorders of Consciousness

Lostness of several cognitive functions

40% of Vegetative State Patients are Misdiagnosed

- Ref: Laureys et al. *Lancet Neurol* 2004; 3: 537–46

- Ref: C. Schnakers, et al., "Diagnostic accuracy of the vegetative and minimally conscious state: Clinical consensus versus standardized neurobehavioral assessment," *BMC neurology*, vol. 9, no. 1, p. 35, 2009.



# Major Depressive and Manic Episodes

## Manic-depressive disorder

Immoderate and unusual mood swing from extremely happy and energized (mania) to extremely sad (depression)

Damages relationships & performance

Can be life-threatening: often ends in suicide

Chronic illness

Most often diagnosed in adolescence



## Persistent feelings of:

Sadness - Anxiety - Guilt - Anger - Isolation - Hopelessness - Disturbances in sleep and appetite - Fatigue and loss of interest in sexual activity - Irritability - Lack of motivation - Morbid suicidal ideation



## Distinct period of:

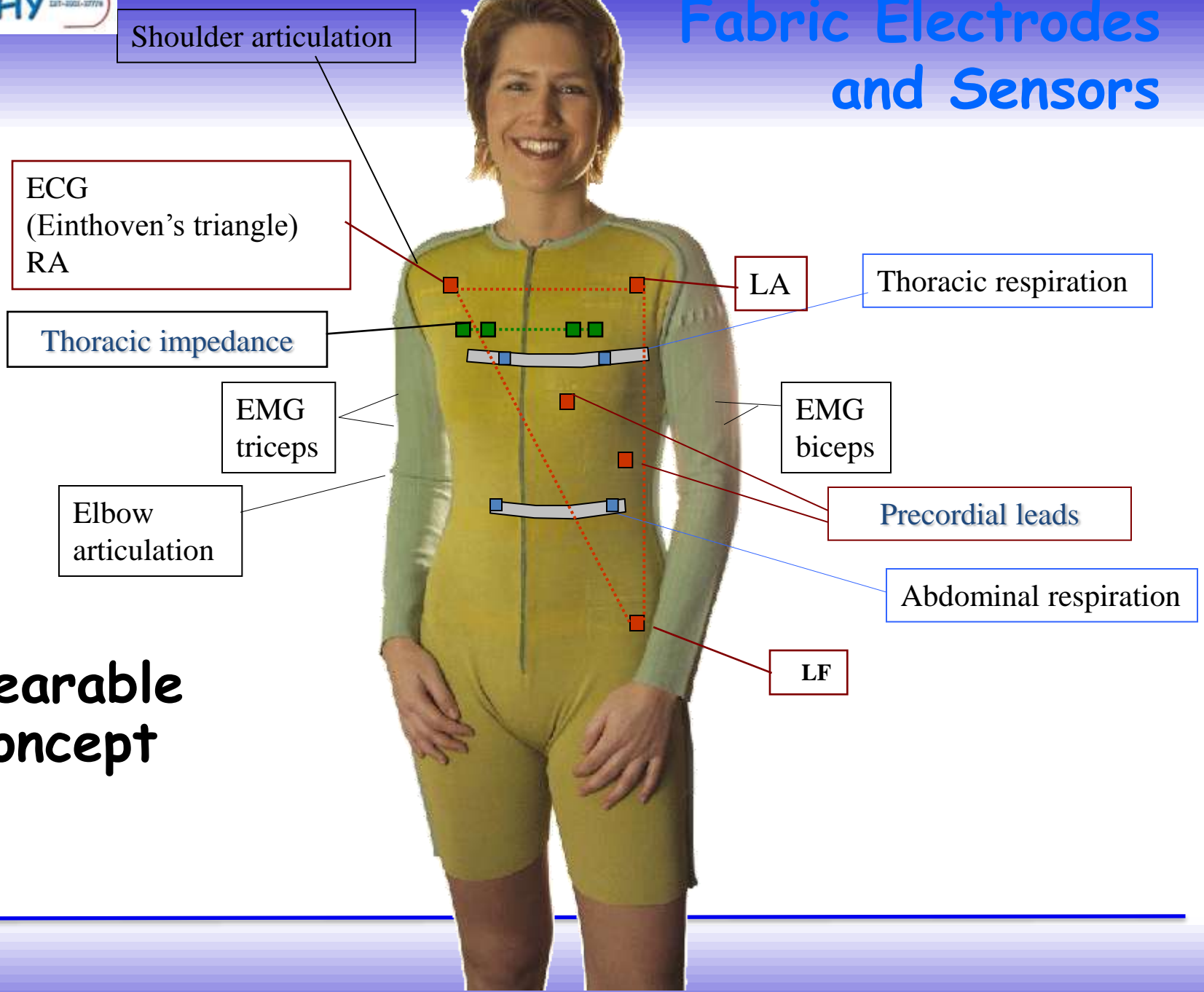
Elevated, expansive, irritable mood state - Racing thoughts - Low attention span - Easily distracted - Impaired judgment - Spending sprees, unusual behavior - Substance abuse (esp. alcohol, stimulants) - Aggressive behavior - Increased sexual drive







# Fabric Electrodes and Sensors



**Wearable  
concept**

# Wearable system specifications

Autonomy up to 15 hours

Data storage up to 7 days

Bluetooth communication (10 m)

Observed signals

- One ECG derivative
- Resistive gauge
- 3D accelerometer

On-body generic processing

- Heart rate, heart rate variability
- Breathing rate, breathing activity
- Activity level and classification, pace





Processing Unit

Processing and Interpretation Unit

SERVER

Reminders Messages

Processed Data

Professional Portal

Reminders, Messages, Educational content

Medical Professional

Physiological

Behavioural

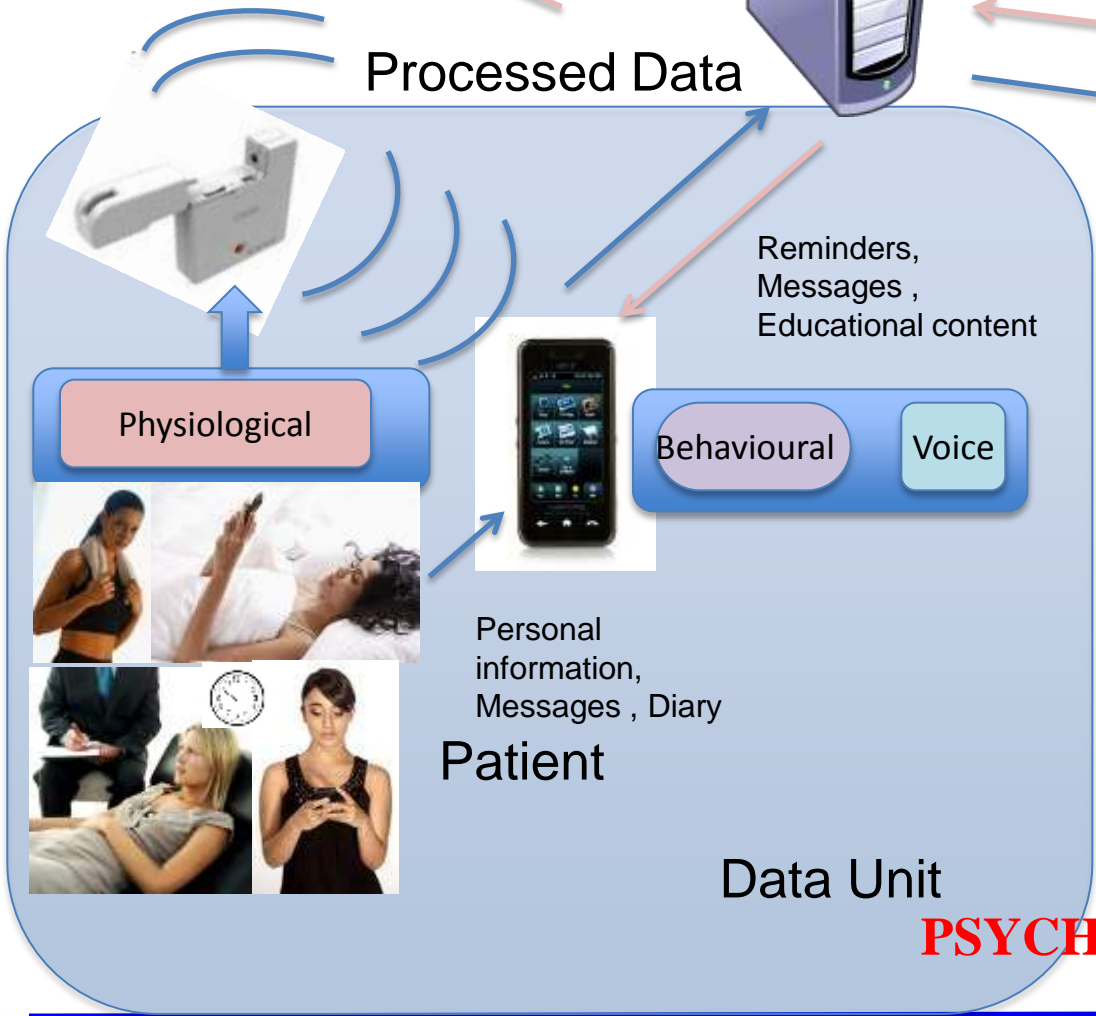
Voice

Personal information, Messages, Diary

Patient

Data Unit

**PSYCHE personalised monitoring system**





# Thank You



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