MedDecSup 2011

International Workshop on Next Generation
Intelligent Medical Support Systems
Târgu-Mureş Romania
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AnticipationScope©

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Director, Institute for Research in Anticipatory Systems; Distinguished Fellow,
Hanse Wissenschaftskolleg/Institute for Advanced Study, Delmenhorst, Germany

Invited Speaker

anté

Institute for Research in Anticipatory Systems

Design and implementation of an integrated information processing platform for quantifying an individual's adaptive capabilities

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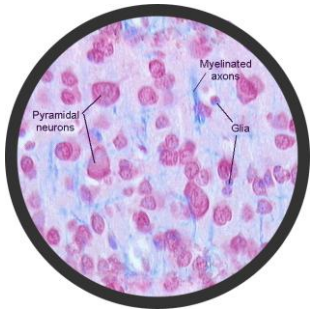
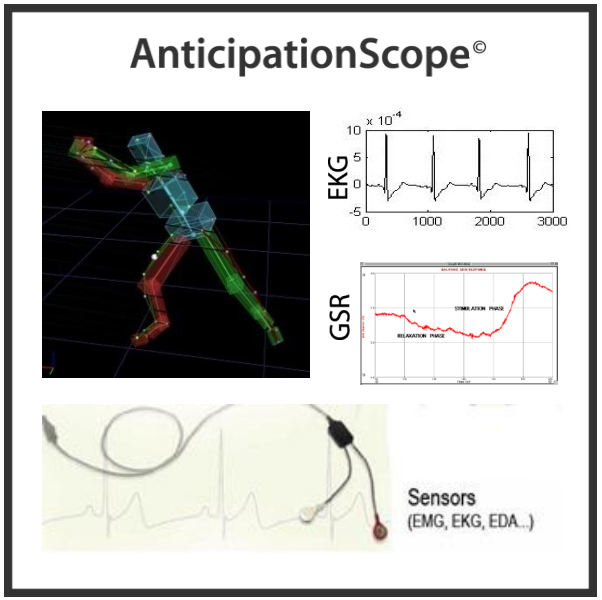


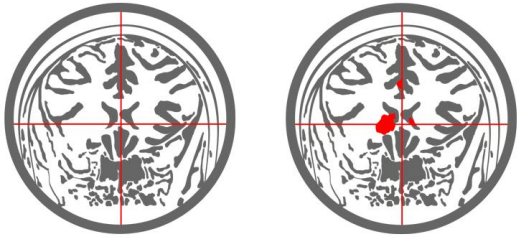
2006 in progress

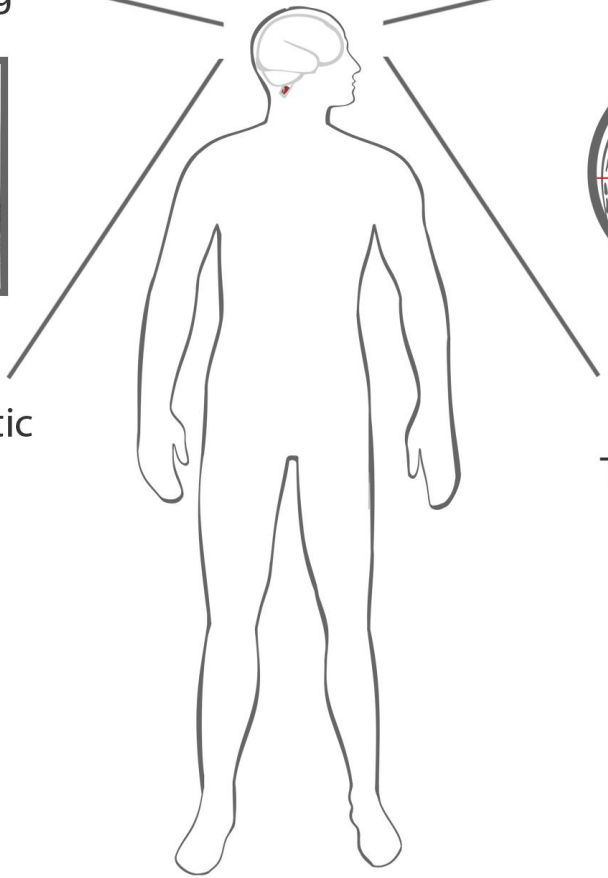


Neural profile

Infrared eye tracking

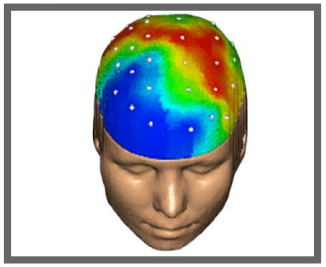
Functional brain imaging



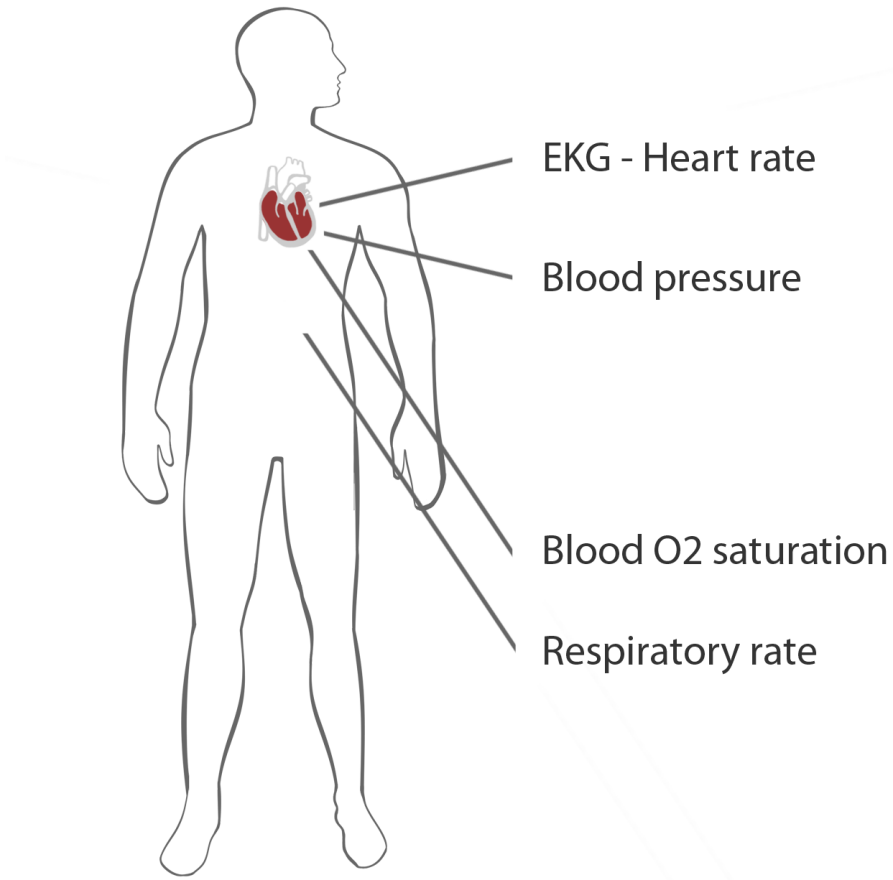


Transcranial magnetic stimulation (TMS)

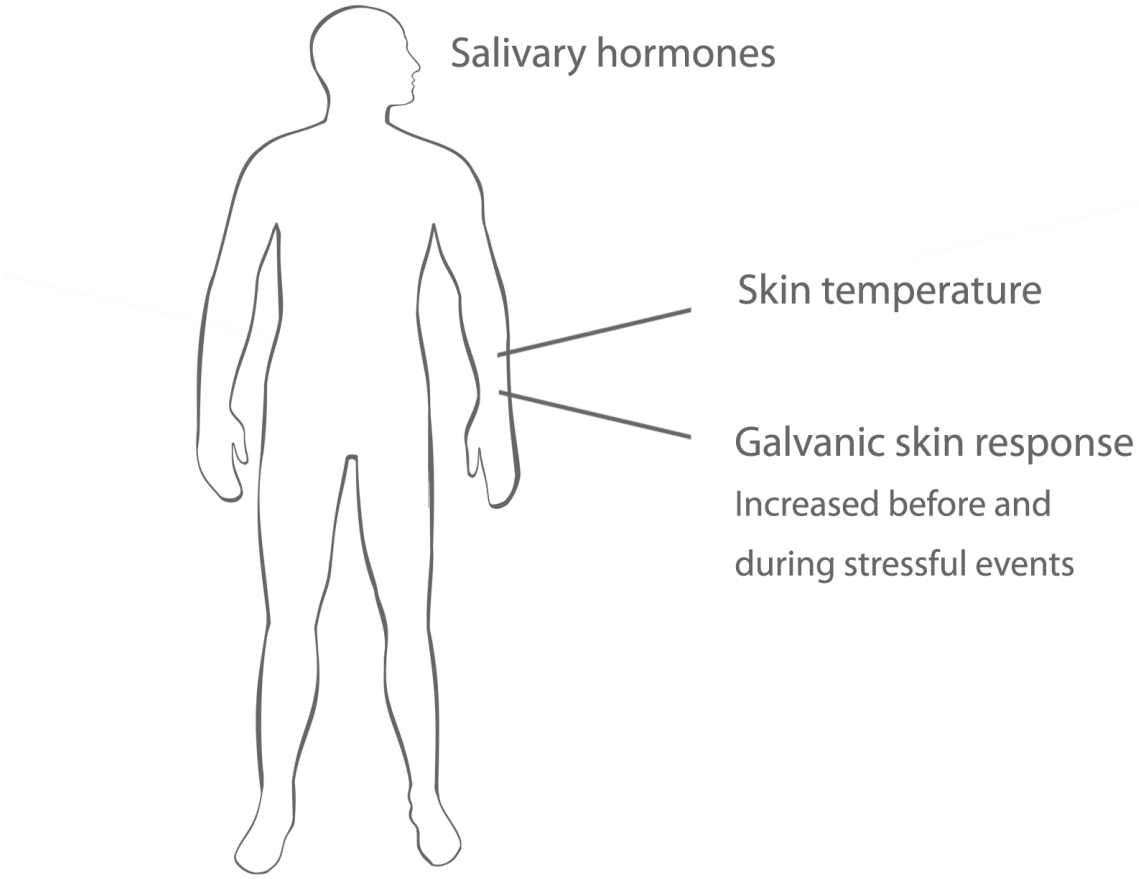
Topographic brain mapping



Cardiovascular profile



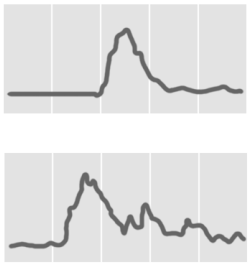
Temperature, stress and hormonal profile



Motor dynamics profile

Electromyogram (EMG)

Measurement of muscle activity



Accelerometry

Measurement of limb velocity

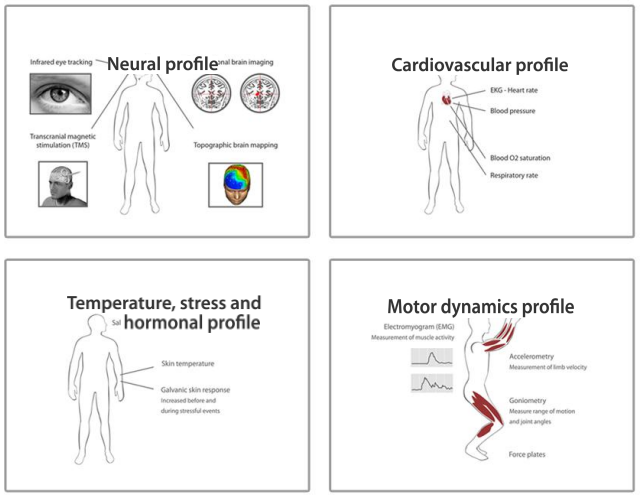
Goniometry

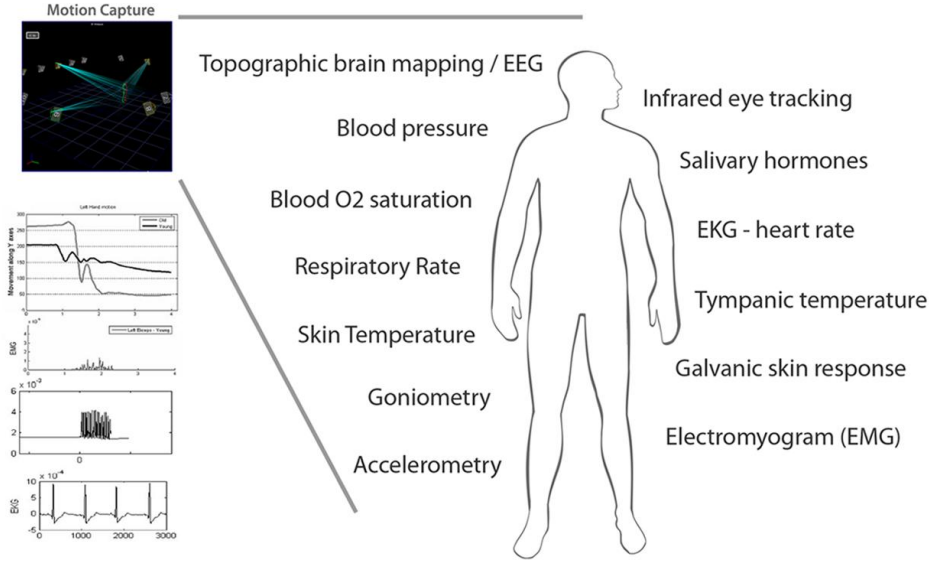
Measure range of motion

and joint angles

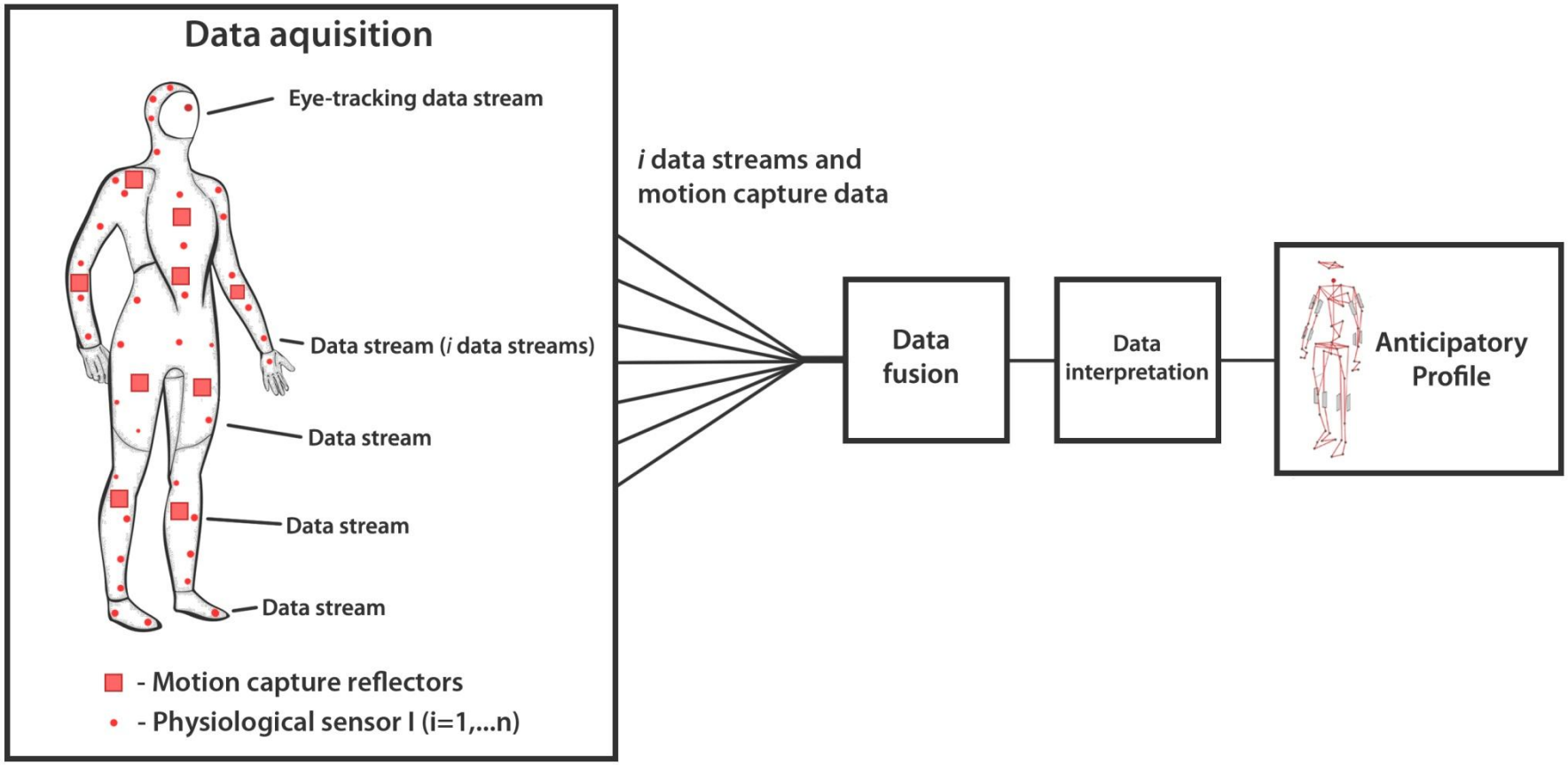
Force plates

Integration: The Anticipatory Profile

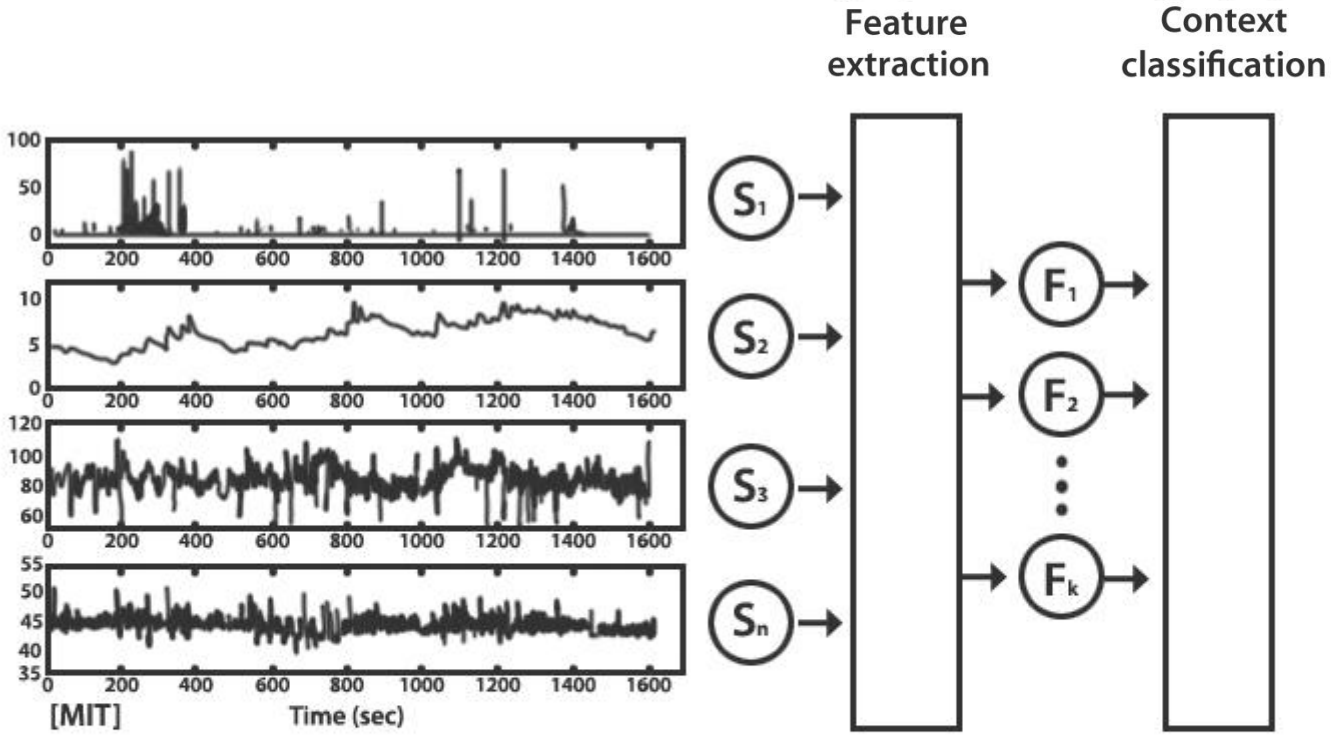




Information processing model



Multisensor integration and context prediction



Sensors - for example,
EMG on the masseter muscle (in microvolts)
Skin conductance waveform (in micro-Siemens)
Heart rate (in beats per minute)
Respiration waveform (in % expansion)
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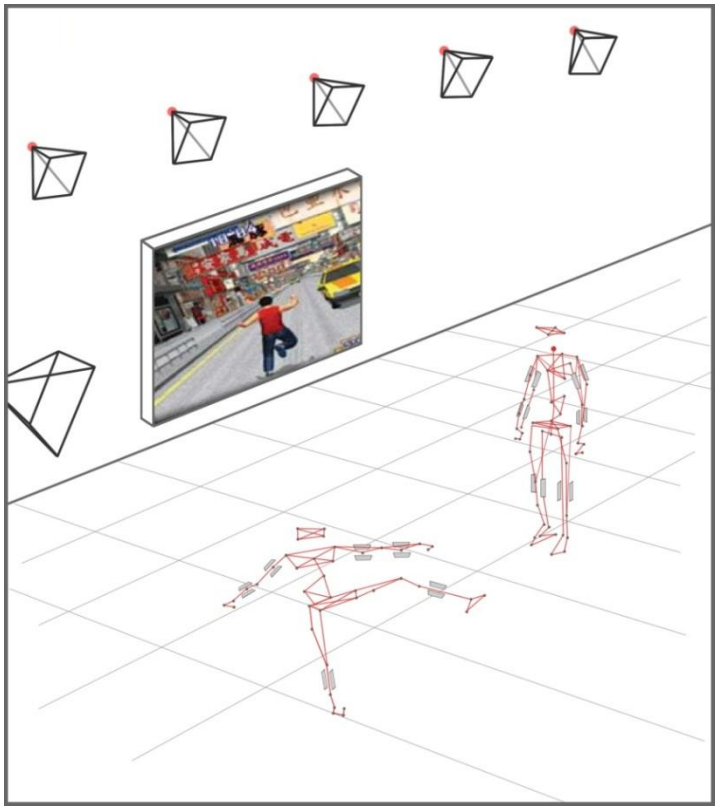
Pattern Recognition

Clustering:
Partitioning
Heirarchical
Density-based
Grid-based
Model-based

Architecture of the integrated AnticipationScope ©



Multi-dimensional time series streams (motion capture, heart rate, EMG, EKG, eye tracking, etc)

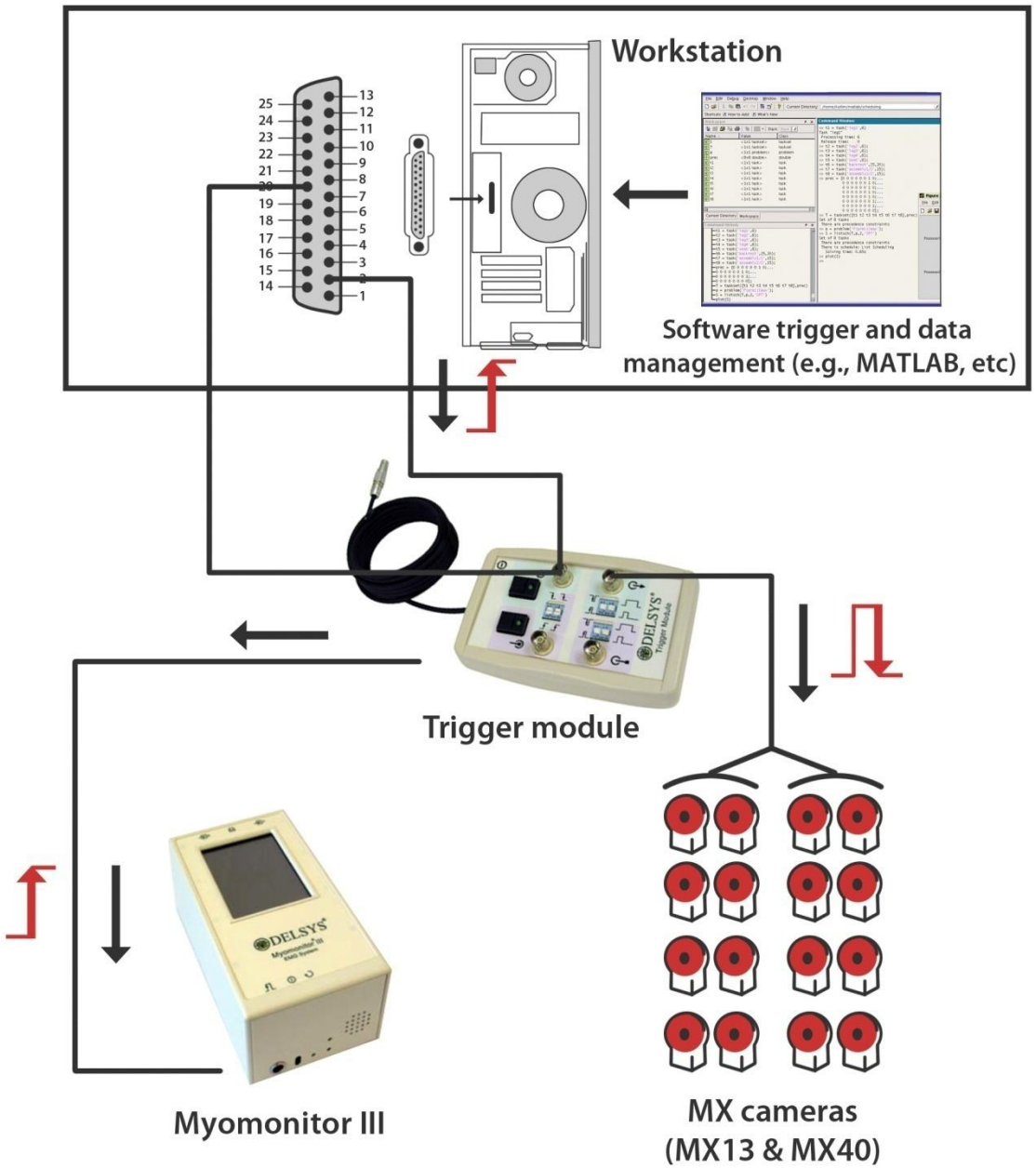
Data fusion
Satistical analysis

Multivariate classification

Correlations

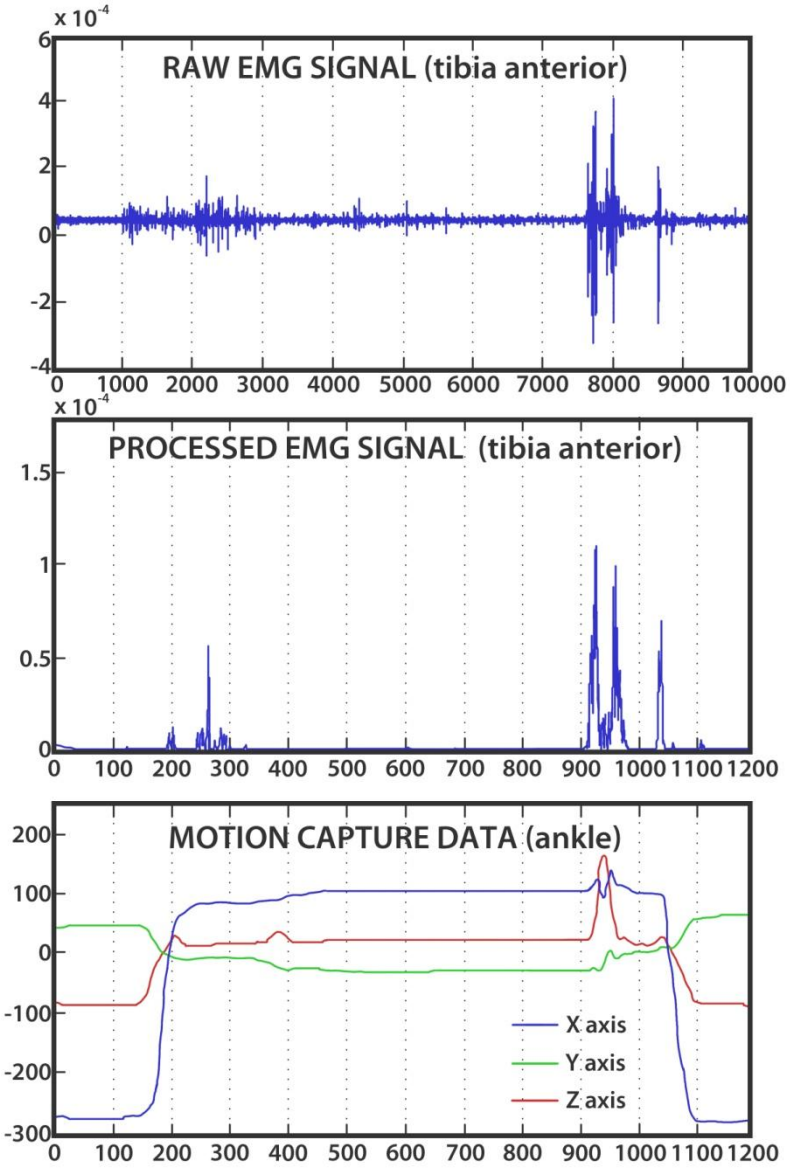
AnticipationScope©

Preliminary integrated setup

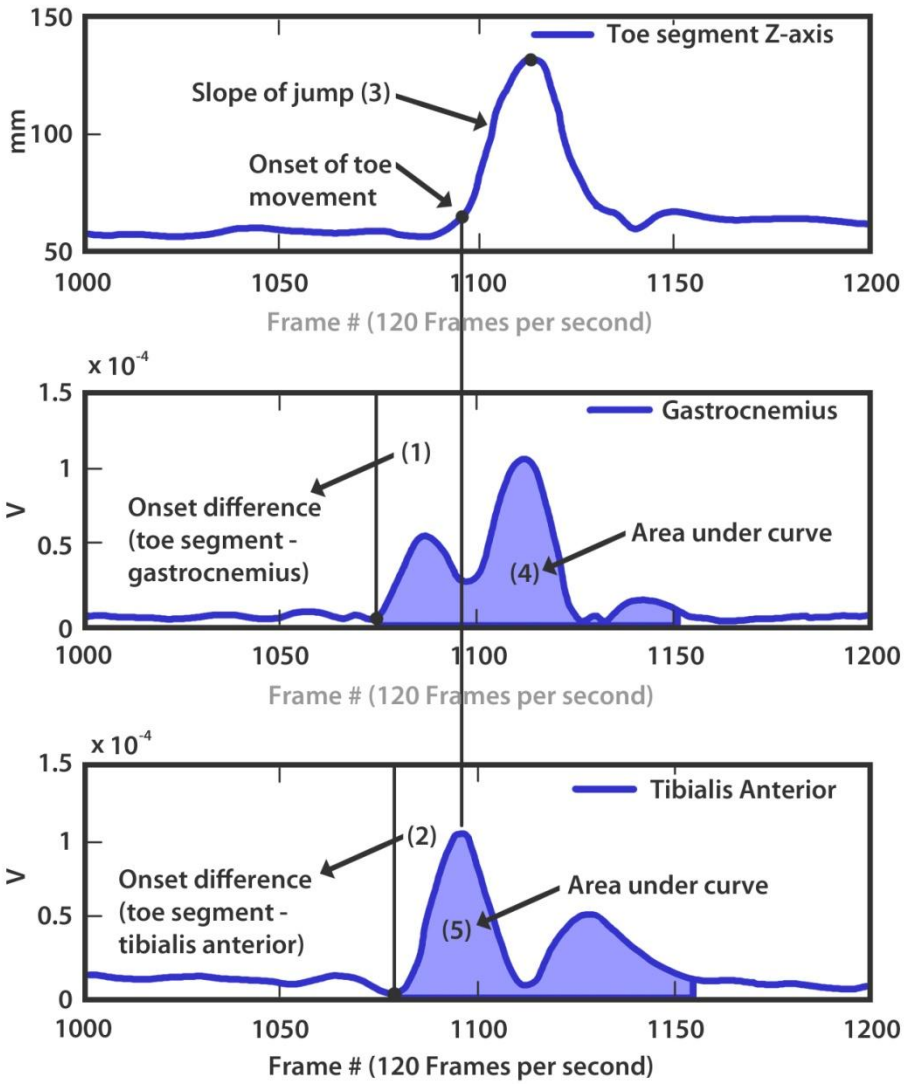


Preliminary data

Single trial of EMG and motion capture data



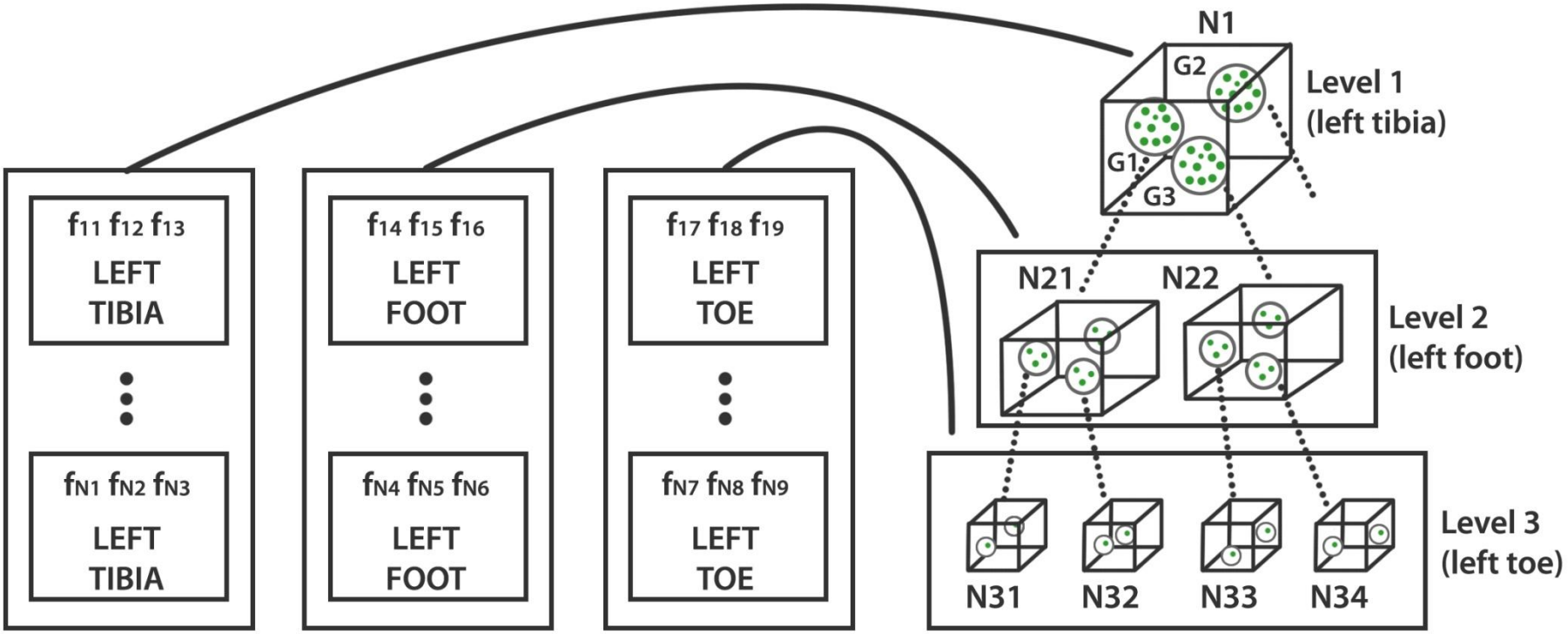
Extraction of EMG parameters



Example:

Interpreting and classifying human motions using 3D motion capture

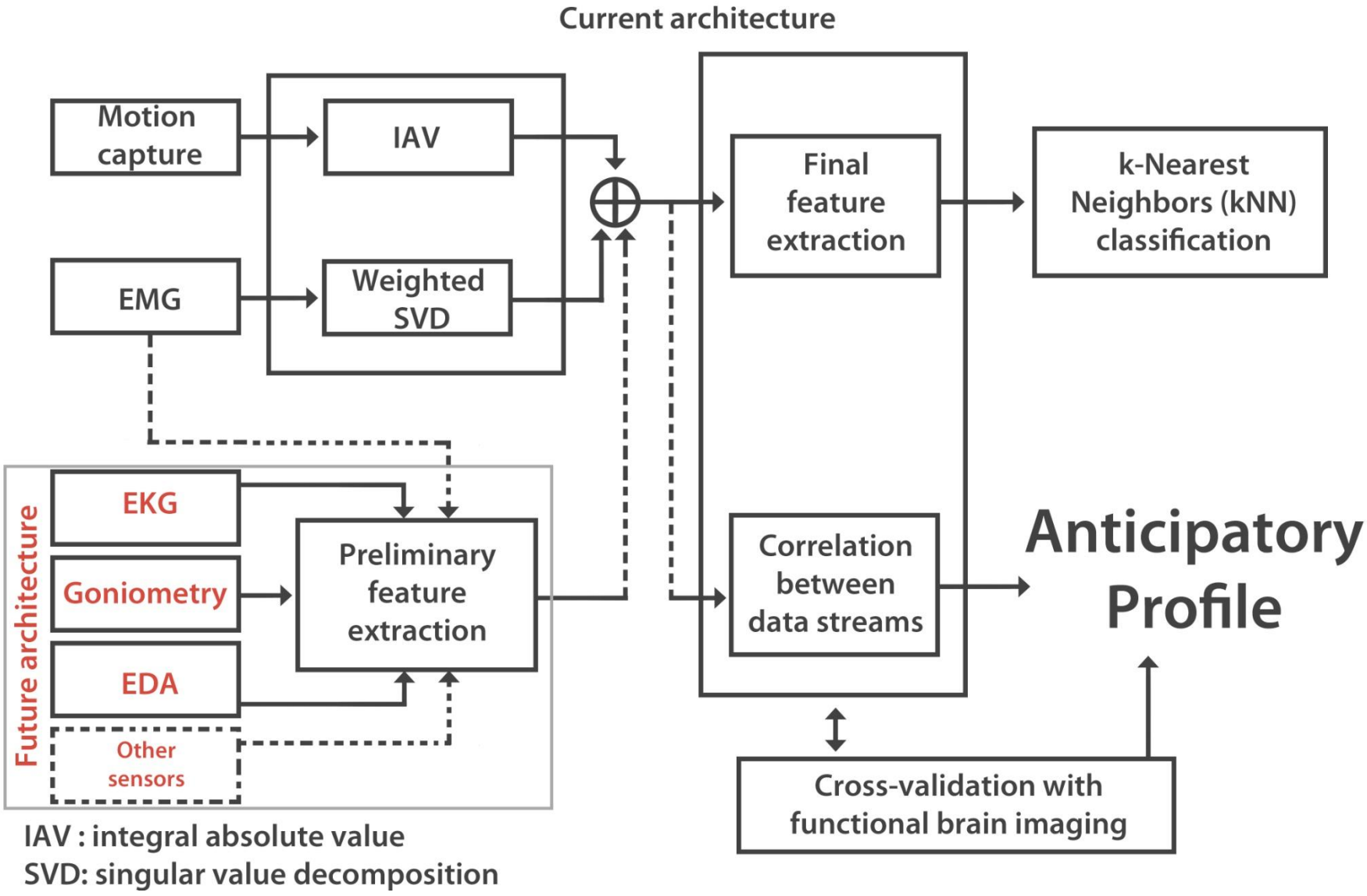
Sample hierarchical indexing tree structure for left leg segments:



[f_{i1} f_{i2} f_{i3}]: weighted SVD feature vectors for Motion "i"

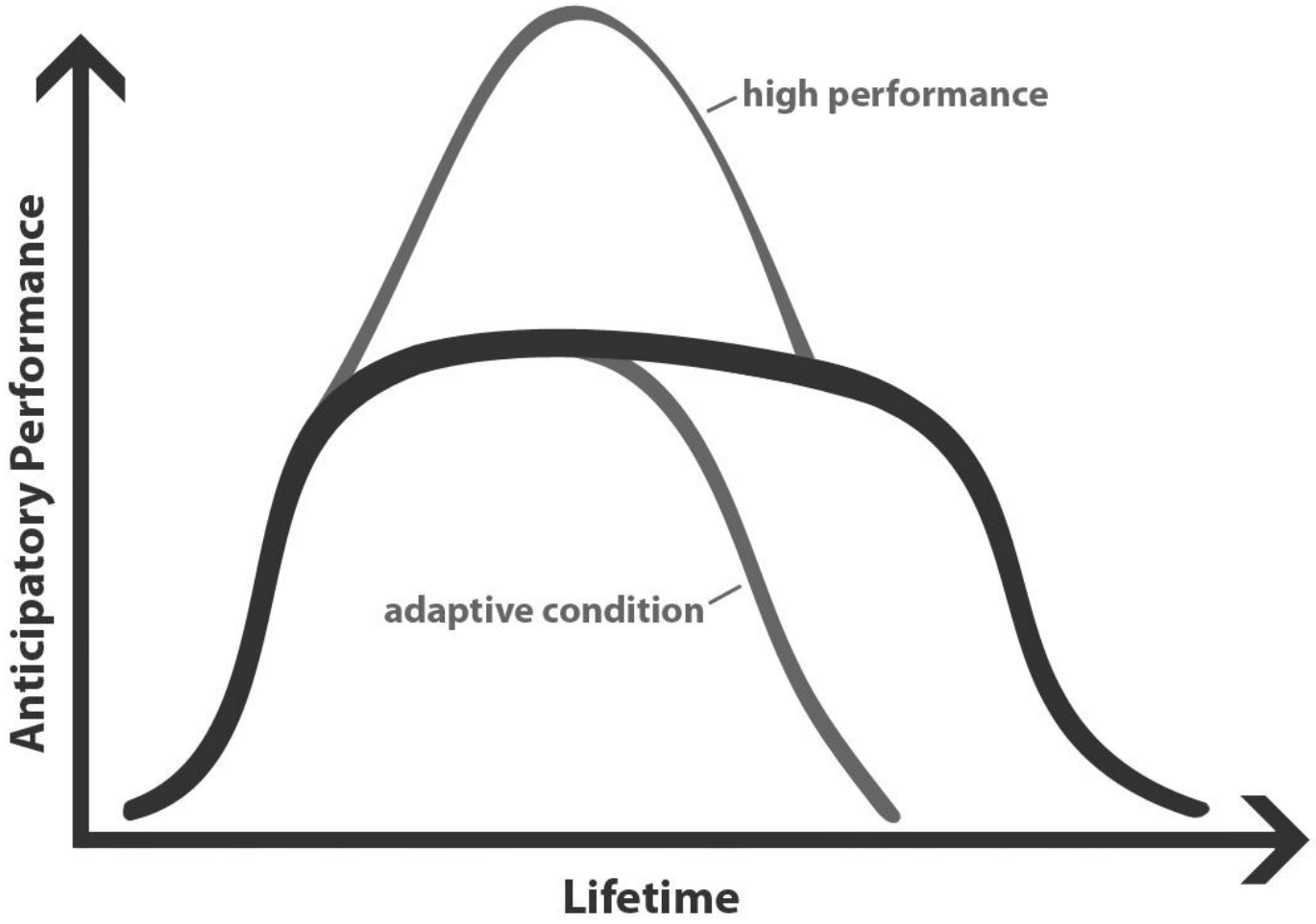
$1 \leq i \leq N$, where N = number of motions

Data fusion and analysis model

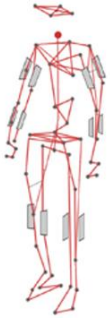


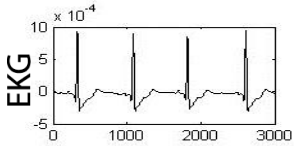
IAV : integral absolute value
SVD: singular value decomposition

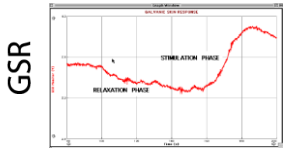
Dynamics of anticipatory performance

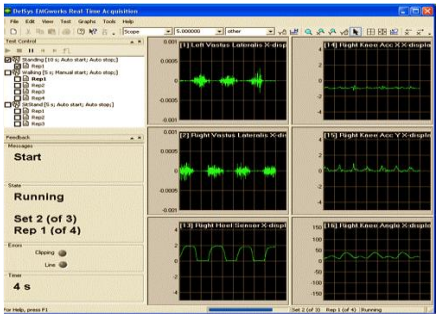


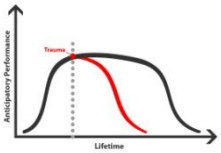
AnticipationScope© as a diagnostic information processing procedure





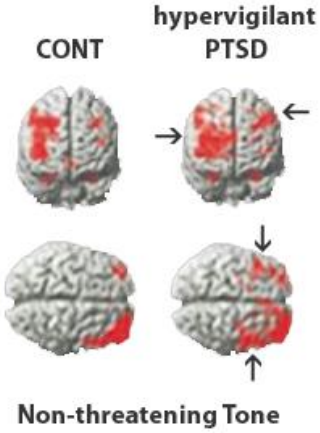




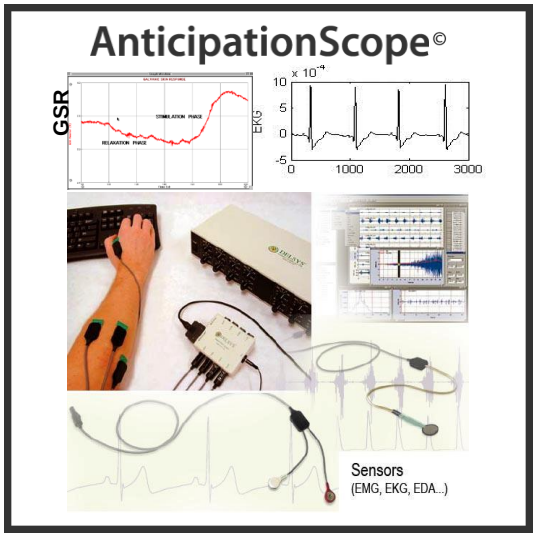


Post-traumatic stress disorder (PTSD)

Sound and light sensitivity



Validation with brain imaging



Electrodermal response

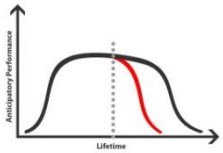
Blood pressure

Heart rate

Motion capture

Concept Development:

PTSD Scope
and
PTSD Profile



Parkinson's disease

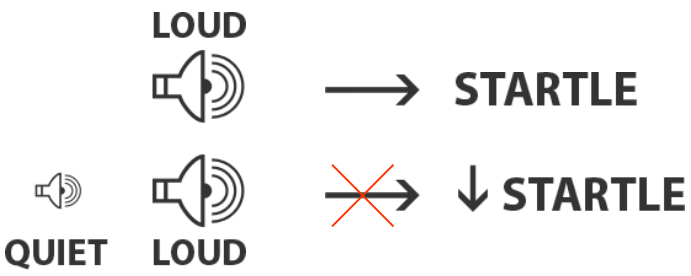
Loss of anticipatory characteristics

Early detection

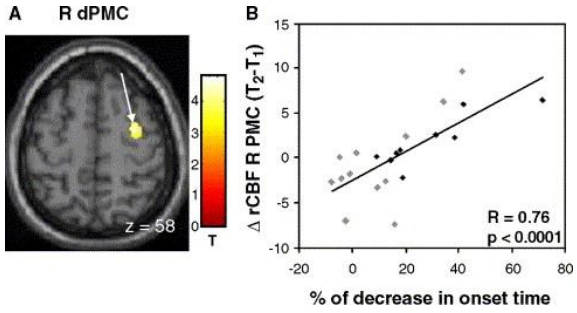
Evaluation and monitoring

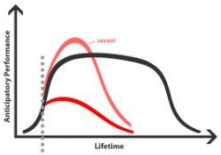
AnticipationScope©

Paired pulse inhibition



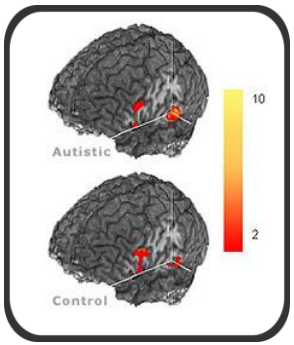
Validation with brain imaging



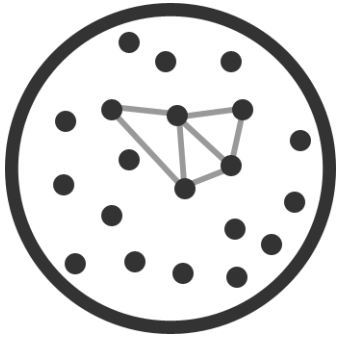


Autistic spectrum disorders

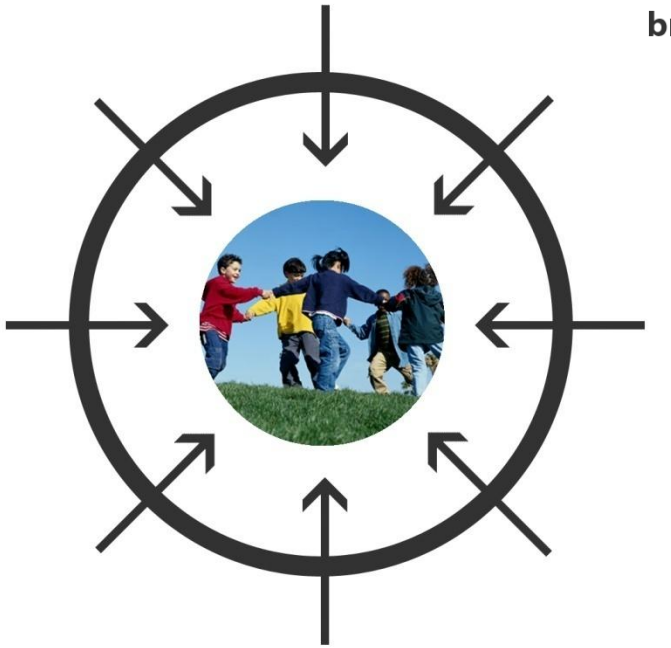
Multi-sensory stimulation
Social interaction

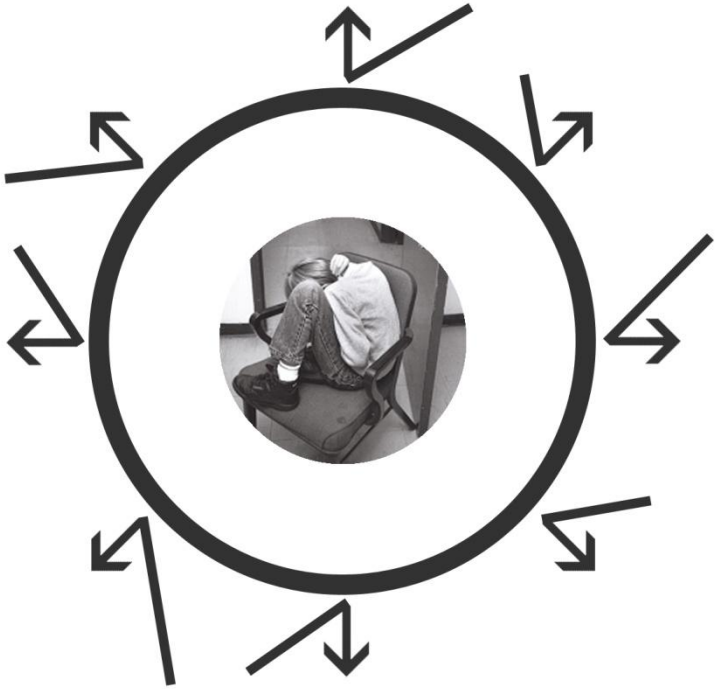


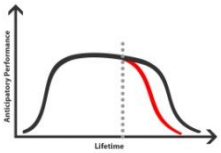
Validation with
brain imaging



Focused, repetitive behavior
Imitation
Social communication
Social isolation



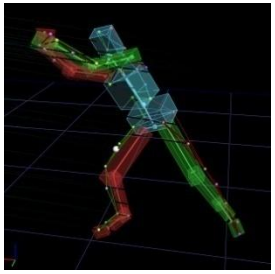


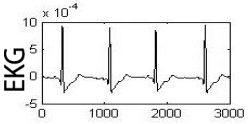


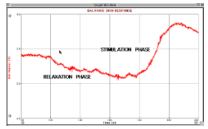
Alzheimer's disease

Early detection of mild cognitive impairment (MCI)

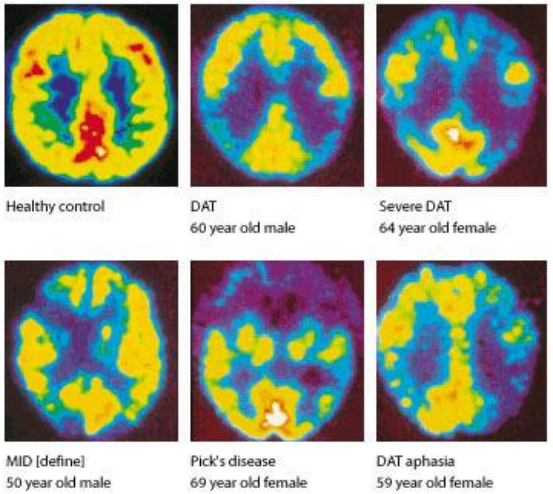
Anticipation Scope©







Evaluation and monitoring



Validation with brain imaging

Detecting subtypes and variations

Possible early detection of neurological and psychiatric conditions in the AnticipationScope ©

- Schizophrenia
- Bipolar disorders
- Obsessive compulsive disorder
- Attention deficit hyperactivity disorder
- Epilepsy
- Amyotrophic lateral sclerosis (Lou Gehrig's disease)

Possible cross-validation of the diagnostics in the AnticipationScope© for tracking therapeutic outcome

- AnticipationScope©

- Structural brain imaging:
  - -Diffusion tensor imaging and brain morphometry
  - -CT scan, MRI scan

- Functional brain imaging

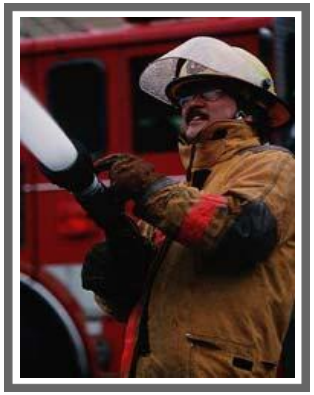
- Cerebrospinal fluid (CSF) and other pathology analysis

- DNA micro-array analysis (e.g., genetic predisposition)

- Correlation with clinical criteria (e.g., signs and symptoms)

- Hormones, neurotransmitter assays (e.g., stress)

Other possible functions of the AnticipationScope©



- Environment for matching abilities to performance requirements

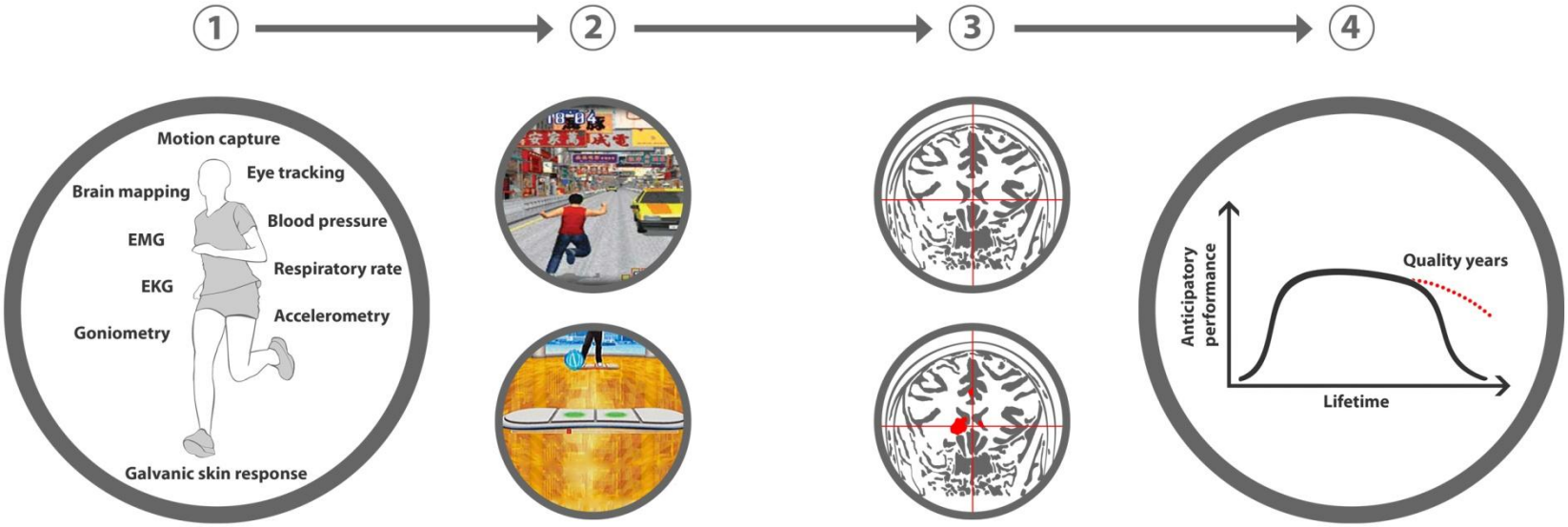
- Training and performance profile

- Homeland security profiling

- Computer compensated human performance (hybrid machines)

- Anticipation of extreme events and human response

Individualized game-based behavioral therapy



Quantify Anticipatory Profile

Develop game-based rich environments

- -Adaptive
- -Individualized
- -Based on Anticipatory Profile

Stimulate brain plasticity

-Improve:
- Sensory
- Motor
- Cognitive functions

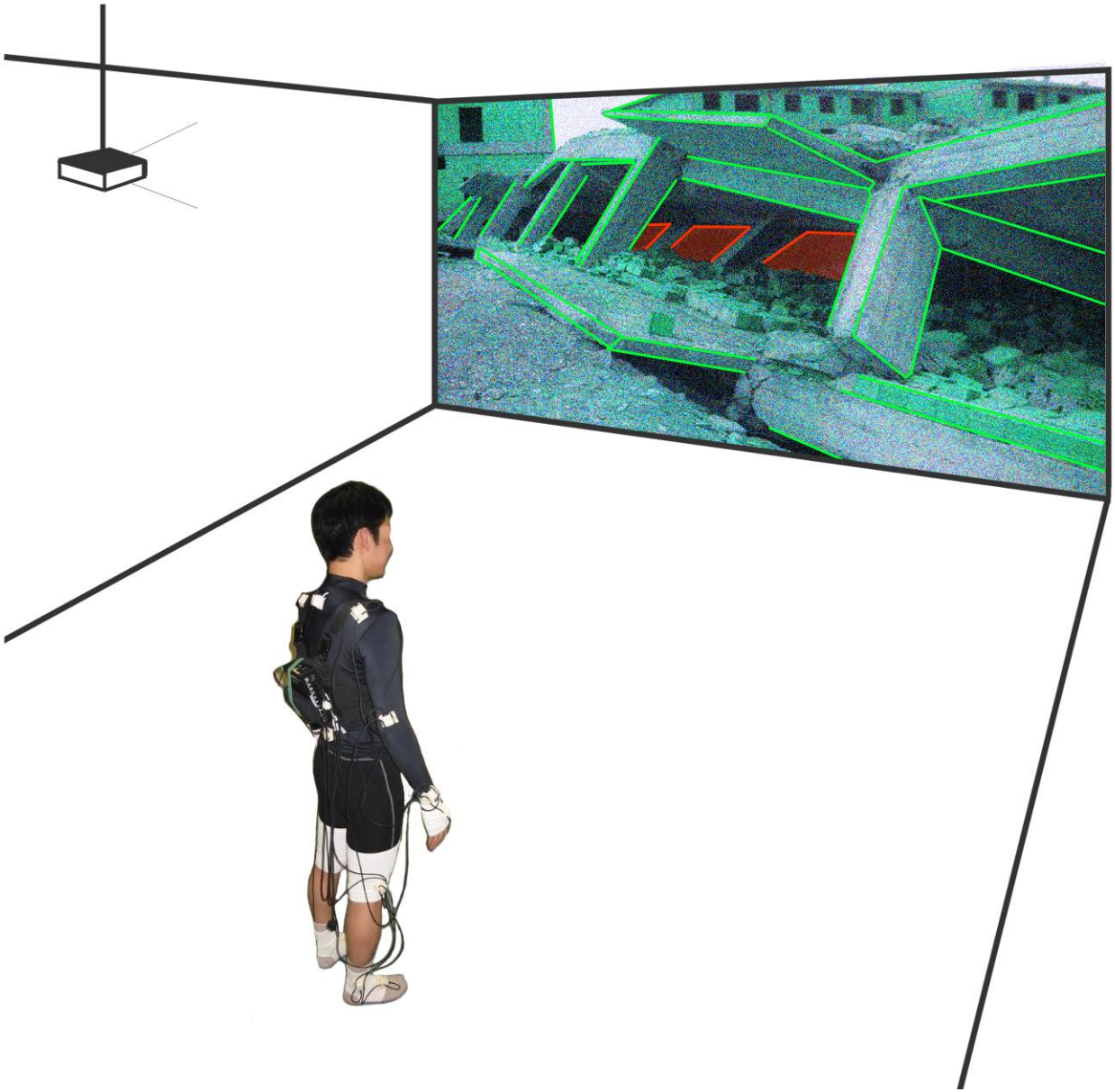
Re-evaluate Anticipatory Profile parameters

- -Correlate improved performance with physiological data
- -Improved Anticipatory Profile

AnticipationScope as therapy evaluation platform

Example:

Game based simulation of variable contexts for action (e.g. extreme events)



Plans for a mobile wireless AnticipationScope©: Integrated motion capture with biosensors

MOTION CAPTURE

Infrared Eye-tracking
Measurement of eye movements and saccades during cognitive and motor tasks

Tympanic Temperature
Brain activity during cognitive tasks ⟶ cortical blood flow ⟶ change in carotid blood flow ⟶ change in temperature

Blood Pressure
Measure fluctuations in systolic and diastolic pressure

Somatosensory Evoked Potentials
Scalp electrical potentials recorded from the somatosensory area of the brain

Pulse Oximeter
Measurement of blood oxygen saturation

Electrocardiogram (EKG)
Measure heart electrical activity (rate, rhythm, etc)

Skin Temperature
Measurement of the day to day, minute by minute variations

Spirometer
Measurement of respiratory rate, lung volume, etc

Goniometer
Measurement of joint angle (radians)

Galvanic Skin Response Meter
Measurement of changes in sweat gland salt conductance (e.g., increased in anticipation of stressful events)

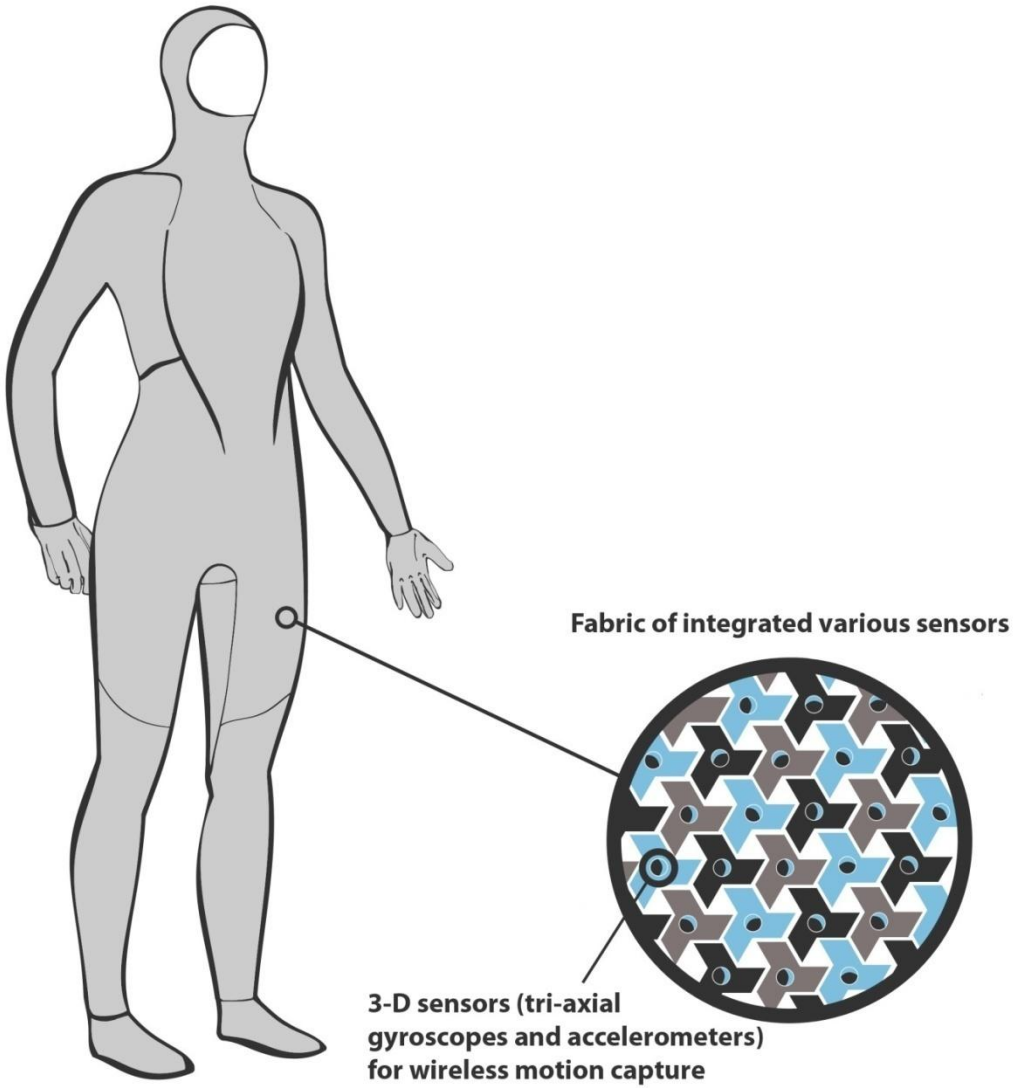
Electromyogram (EMG)
Measurement of bio-electrical muscle activity

Salivary Hormones
Measurement of sex hormones (estrogens and testosterone) that vary with cognitive tasks

Accelerometer
Measurement of limb acceleration

Topographic Brain Mapping/EEG:
Simultaneously mapping the electrical activity of diverse brain regions during cognitive tasks

The future: wearable AnticipationScope©



Institute for Research In Anticipatory Systems

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