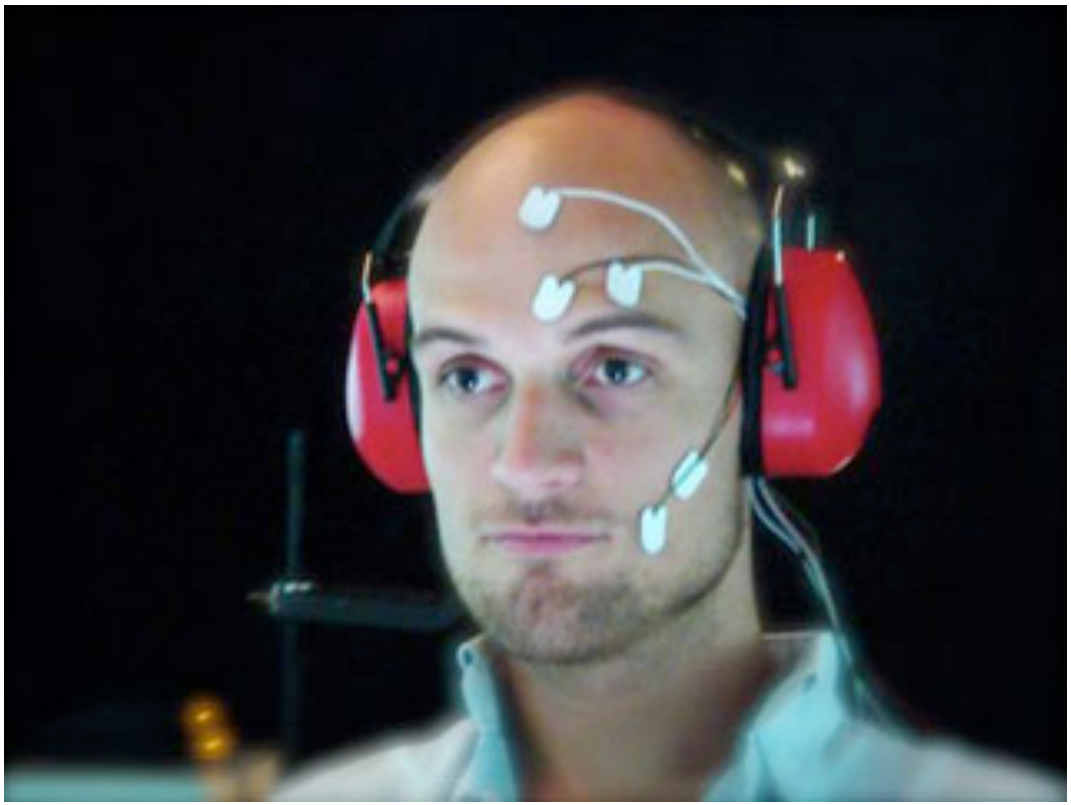
KBM – Biofeedback Measures

Frank Nack



Outline

- Last week
- Haptic – sensors and signs

Video Application – summary

Investigated

Three different ways of representing sound

Findings

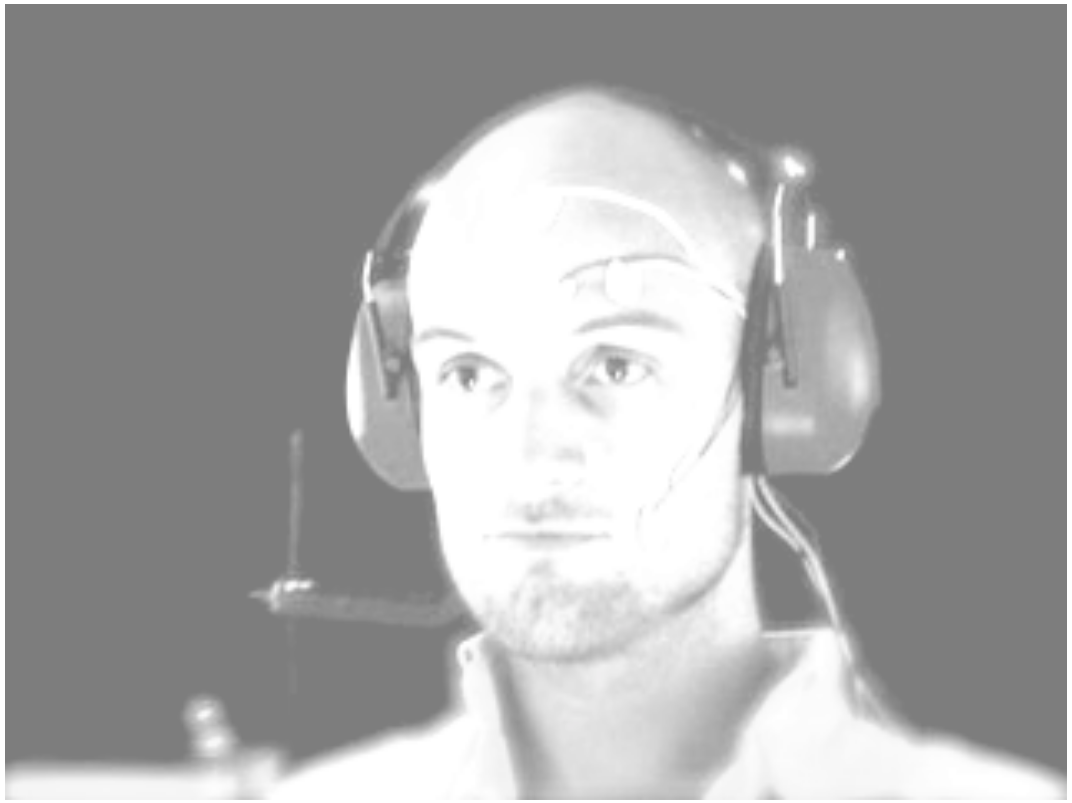
- Language templates are restrictive BUT allow for good characterisation
- Naïve Bayesian is a useful approach for classification of audio
- Small number of classifiers allows for more accurate results

Change

Audition is the sense of sound perception in response to changes in the pressure exerted by atmospheric particles within a range of 20 to 20000 Hz.

Physiological response measures used to interpret or simulate affective behaviour.

KBM – Relation Biometrics/Biofeedback



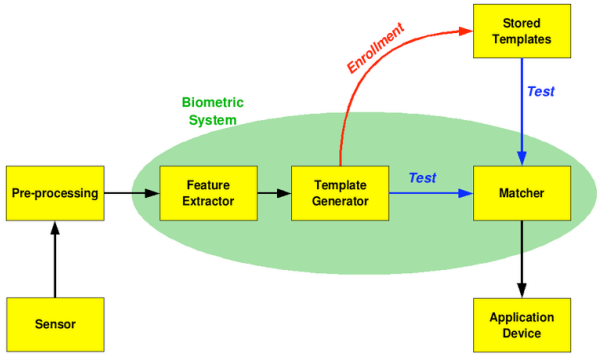
KBM – Biometrics

Biometrics consists of methods for uniquely recognizing humans based upon one or more intrinsic physical or behavioral traits.

=> identity access management, access control, surveillance.

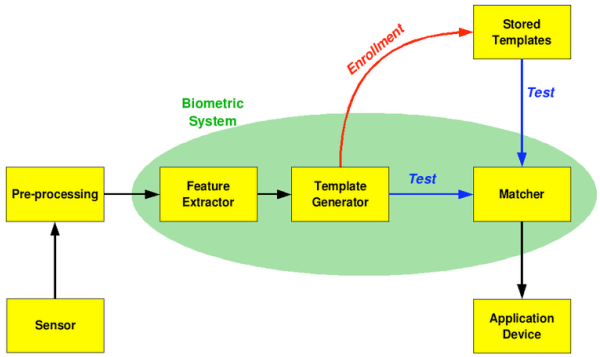
Physiological class:
fingerprint, face recognition, DNA, Palm print, hand geometry, iris recognition, and odor/scent.

Behavioral class:
moving rhythm, gait, and voice.



Usability of human characteristic (Jain et al 2004)

Universality	each person should have the characteristic.
Uniqueness	how well the biometric separates individuals from another.
Permanence	measures how well a biometric resists aging and other variance over time.
Collectability	ease of acquisition for measurement.
Performance	accuracy, speed, and robustness of technology used.
Acceptability	degree of approval of a technology.



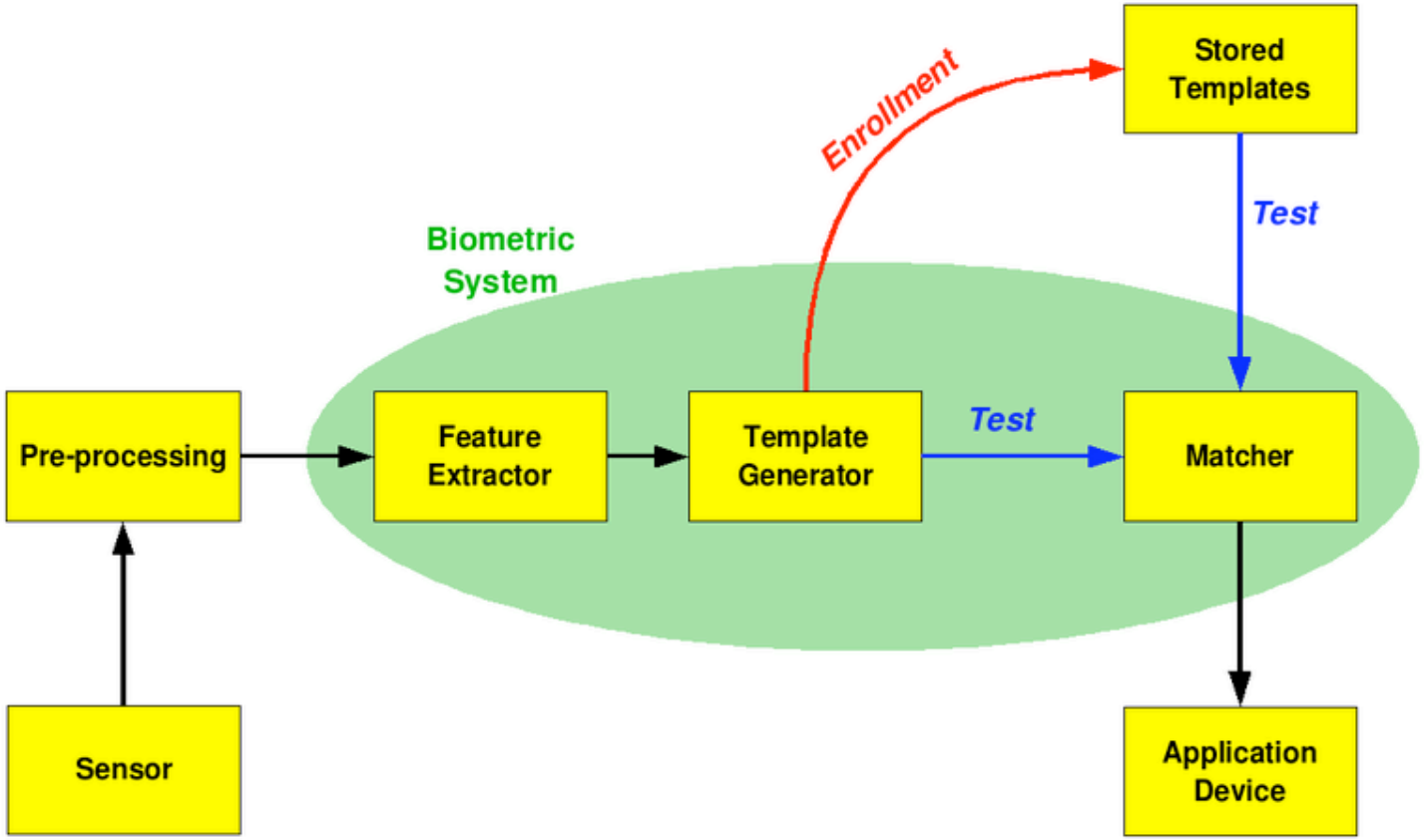
Operation mode (Jain et al 2004)

Verification – A one to one comparison of a captured biometric with a stored template to verify that the individual is who he claims to be.

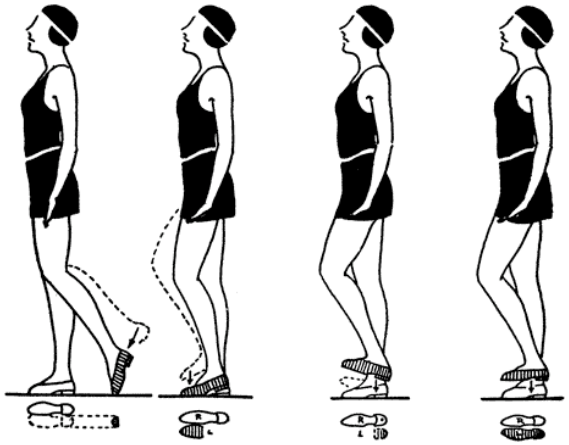
=> smart card, username or ID number (biometric passport)

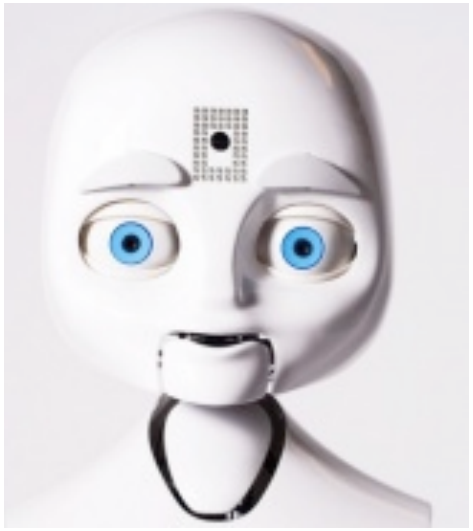
Identification – A one to many comparison of the captured biometric against a biometric database in attempt to identify an unknown individual.

KBM – Biometrics



KBM – Biofeedback





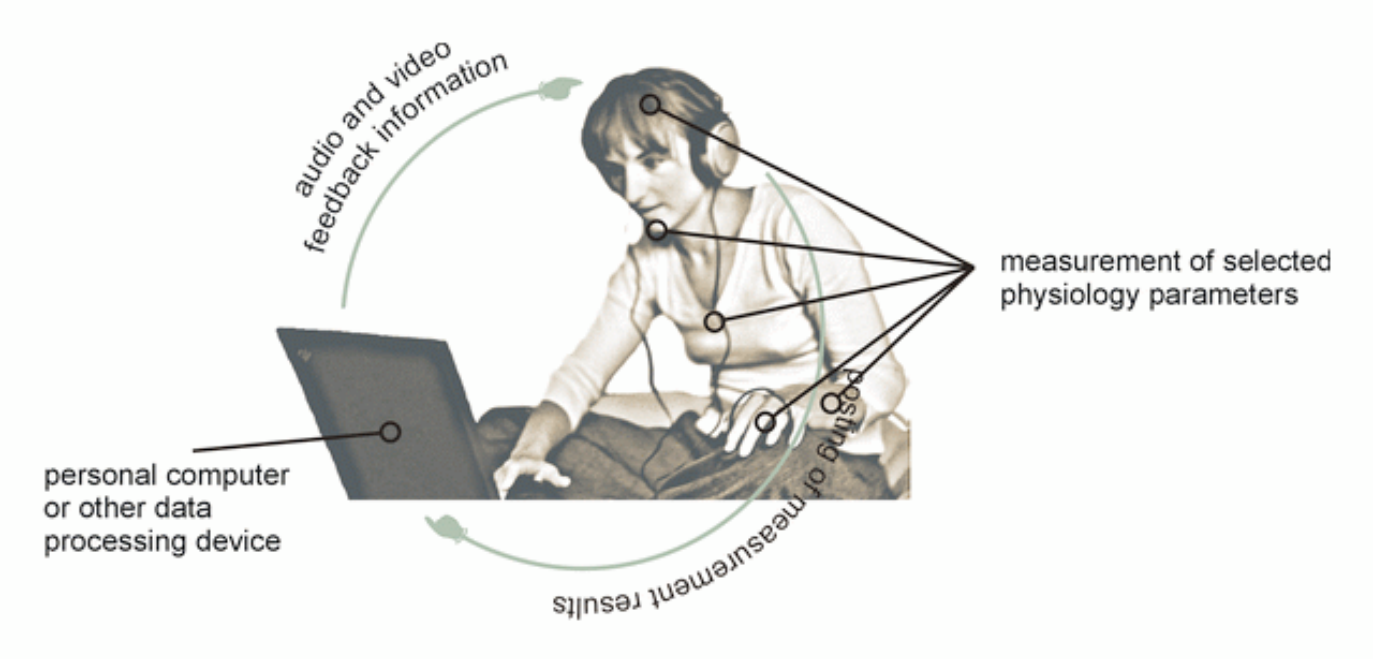
Biofeedback is the process of becoming aware of various physiological functions using instruments that provide information on the activity of those same systems, with a goal of being able to manipulate them at will.

Processes that can be controlled include brainwaves, muscle tone, skin conductance, heart rate and pain perception.

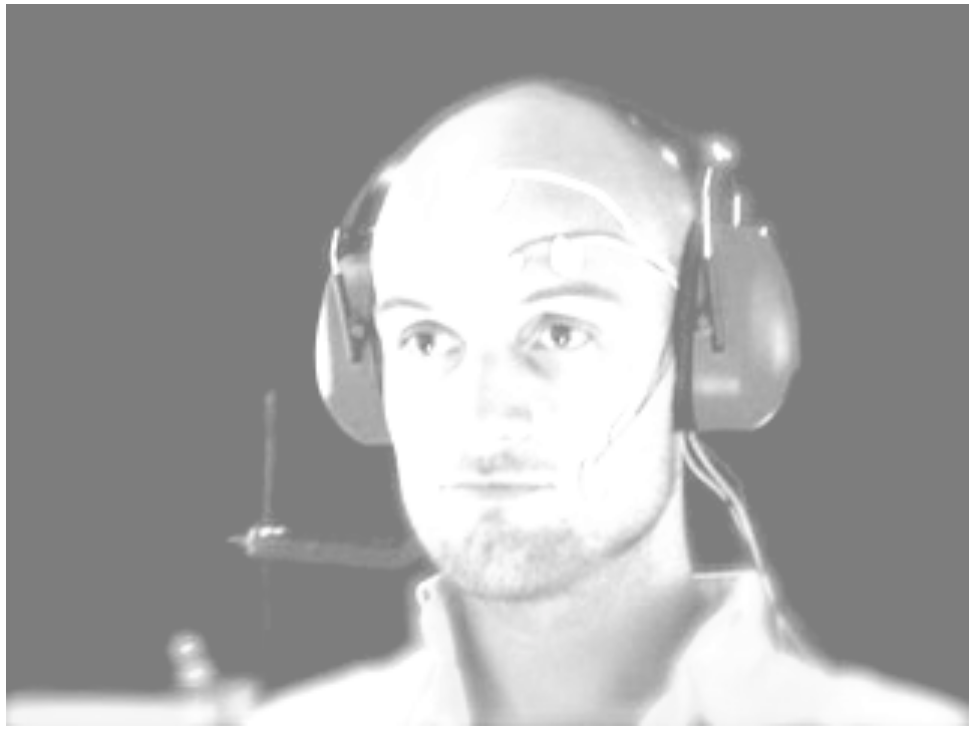
- education
- monitoring (e.g. healthcare)
- action support

The physiological changes often occur in conjunction with changes to thoughts, emotions, and behavior.

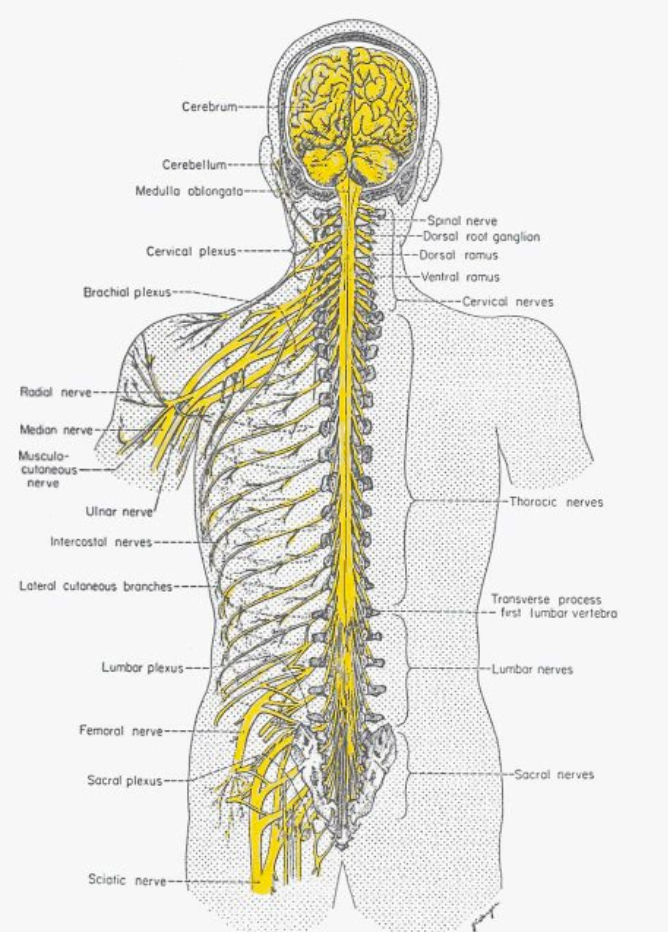
KBM – Biofeedback



Biometric measures – a matter of brain, pulse, skin



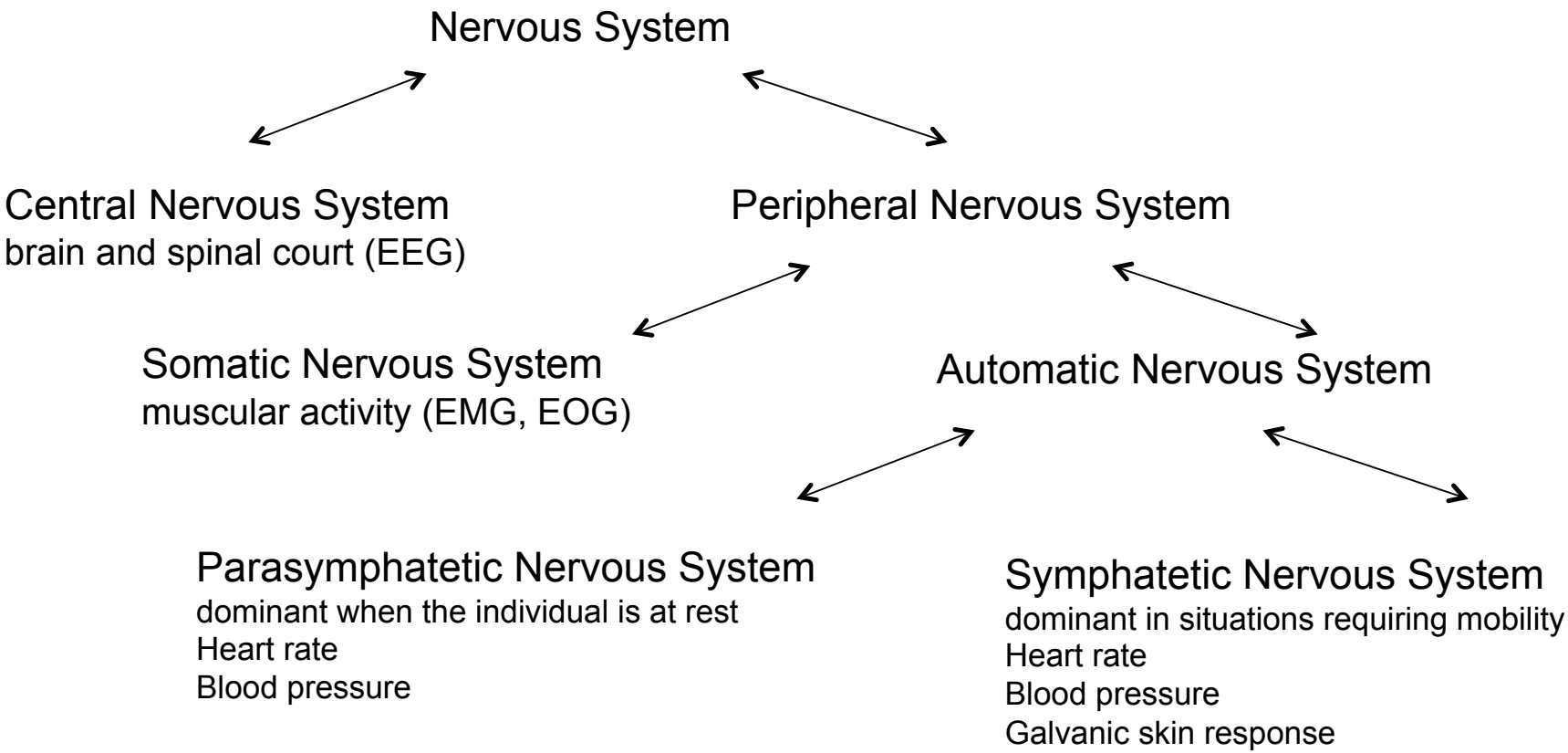
Sensation



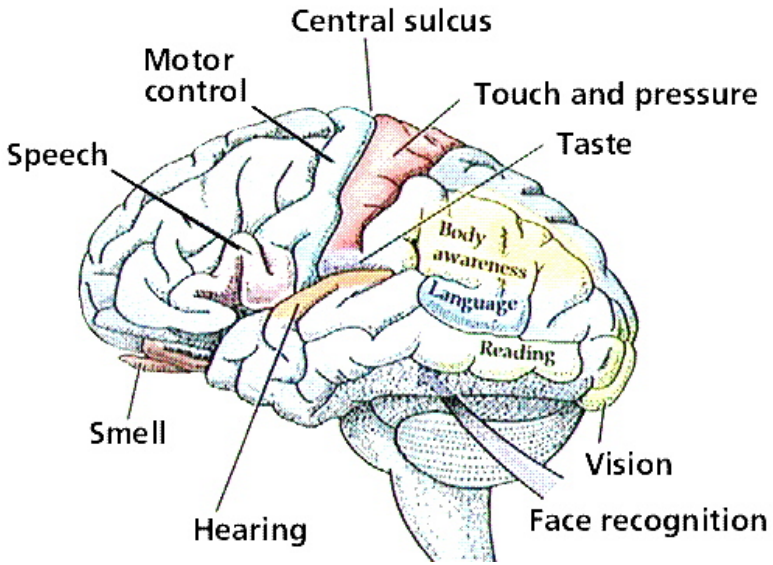
Sensation (Somatosensory system):
the nerve system that detects

- touch or pressure
- temperature (warm or cold),
- pain (itch and tickle),
- proprioception (muscle movement and joint position)
- visceral (information from within the body, e.g. stomach ache)
- facial expression.

Biometric measures – a matter of brain, pulse, skin,



Brain – Sensation, attention, perception, sleep



Network of billions of neurons (Andreassi , 2000)

5 basic brain waves:

Delta (1–4 Hz)

associated with the deepest stages of sleep

Theta (4–8 Hz),

manifested during some short term memory tasks

Alpha (8 – 12 Hz)

associated with a state of relaxation

Beta (13 – 30 Hz)

associated with mental or physical activity

Gamma (30–70 Hz)

Event-related potentialsis any measured brain response that is directly the result of a thought or perception.

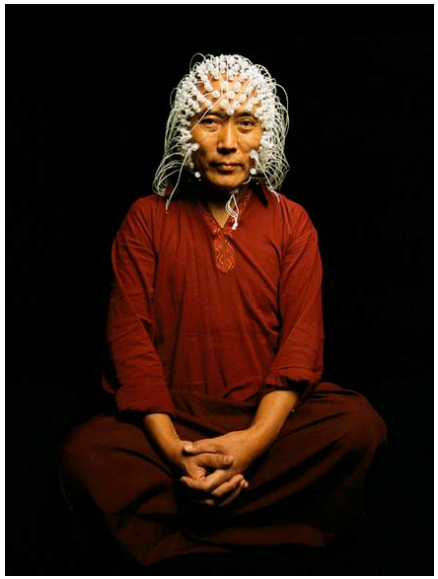
Brain – EEG records II

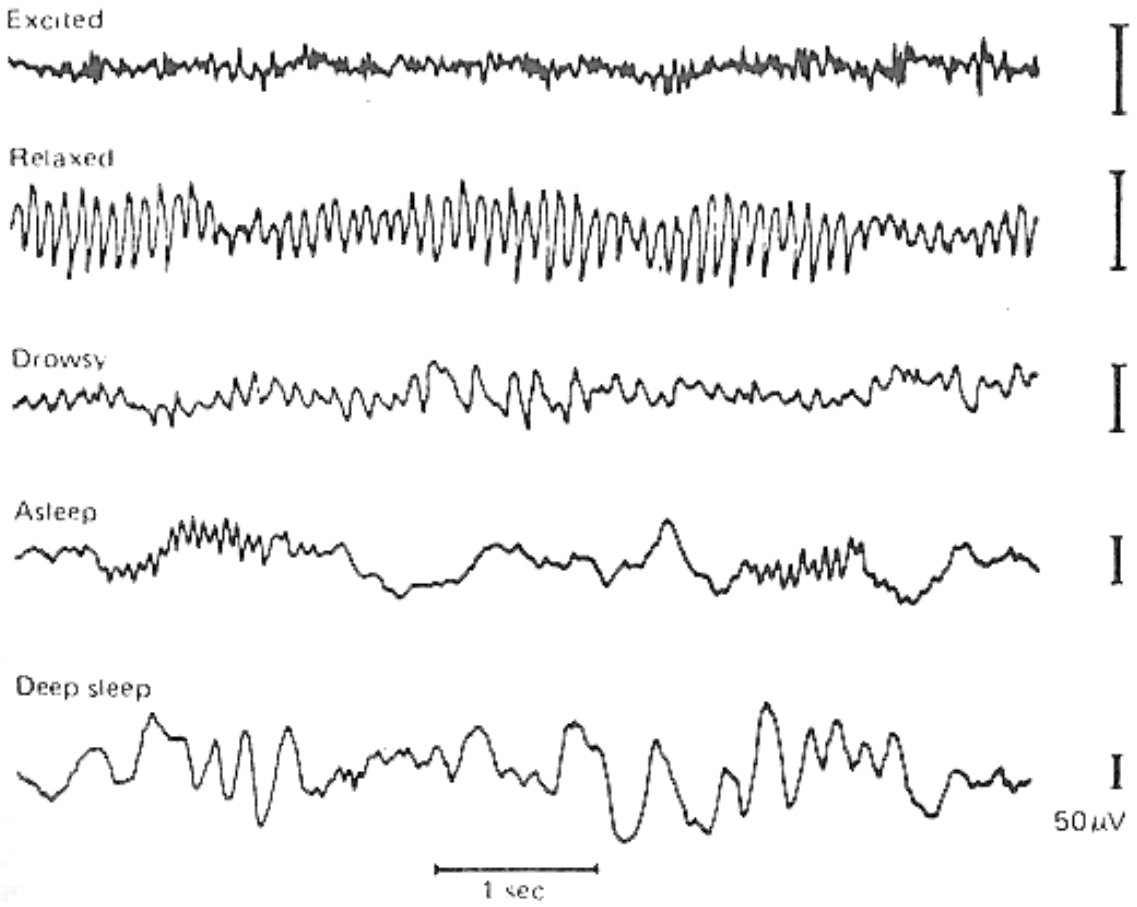
TABLE 5.1
Psychological States and Their EEG, Conscious and Behavioral Correlates

Behavioral Continuum	*Electroencephalogram Characteristics*	*State of Awareness*	*Efficiency*
Strong, excited emotion; fear, rage, anxiety	Desynchronized: low to moderate amplitude; fast mixed frequencies	Restricted awareness; divided attention; diffuse, hazy; 'confusion'	Poor: lack of control, freezing up, disorganized
Alert attentiveness	Partially synchronized: mainly fast low-amplitude waves	Selective attention, but may vary of shift; 'concentration' anticipation; 'set'	Good: efficient, selective, quick reactions; organized for serial responses
Relaxed wakefulness	Synchronized: optimal alpha rhythm	Attention wanders—not forced; favors free association	Good: routine reactions and creative thought
Drowsiness	Reduced alpha and occasional low-amplitude slow waves	Borderline partial awareness; imagery and reverie; 'dreamlike' states	Poor: uncoordinated, sporadic, lacking sequential timing
Light sleep	Spindle bursts and slow waves (larger); loss of alphas	Markedly reduced consciousness (loss of consciousness); dream state	Absent
Deep sleep	Large and very slow waves (synchrony but on slow time bases); random irregular patterns	Complete loss of awareness (no memory for stimulation or for dreams)	Absent
Coma	Isoelectric to irregular large slow waves	Complete loss of consciousness; little or no response to stimulation; amnesia	Absent
Death	Isoelectric: gradual and permanent disappearance of all electrical activity	Complete loss of awareness as death ensues	Absent

Note. From Lindsley, D. B. (1960). Attention, consciousness, sleep & wakefulness. In J. Field, H. W. Magoun, & V. E. Hall (Eds.), *Handbook of physiology, Section I, Neurophysiology* (Vol. III, pp. 1553–1593). Washington, DC: American Physiological Society (p. 1554).

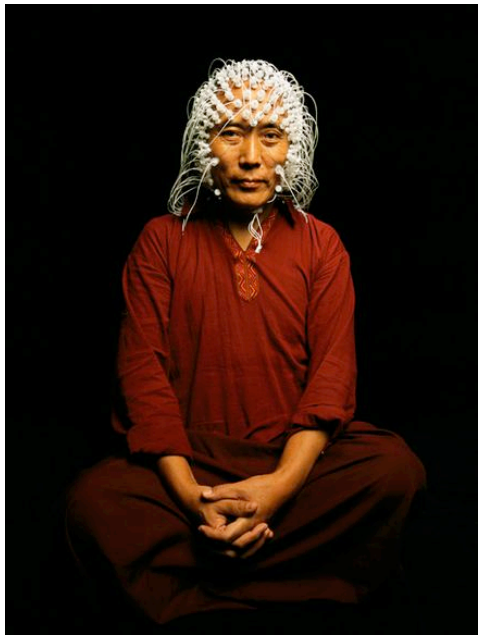
Brain – Sleep





Taken from Andreassi (2000, p. 57)

Biometric measures – Sleep



NREM stage 1

This is a stage between sleep and wakefulness. The muscles are active, and the eyes roll slowly, opening and closing moderately.

NREM stage 2

In this stage the alpha waves of the previous stage are interrupted by abrupt activity

NREM stage 3

The sleeper is less responsive to the environment; many environmental stimuli no longer produce any reactions.

REM

The sleeper now enters rapid eye movement (REM) where most muscles are paralyzed. This level is also referred to as *paradoxical sleep* because the sleeper, although exhibiting EEG waves similar to a waking state, is harder to arouse than at any other sleep stage. Vital signs indicate arousal and oxygen consumption by the brain is higher than when the sleeper is awake

Biometric measures – Central Nervous System

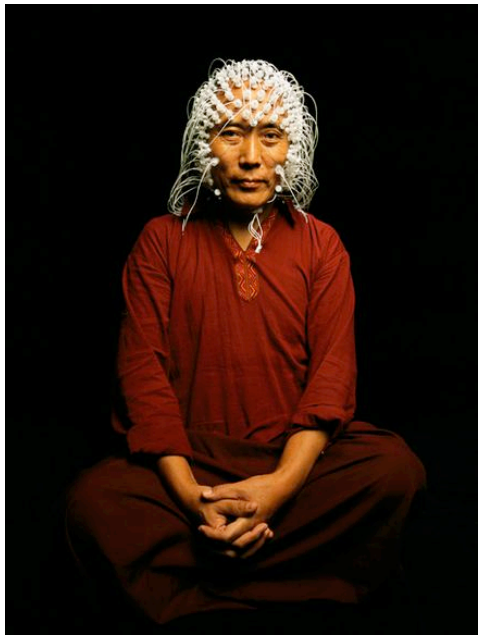


TABLE 5.2
Classification of Sleep EEG

Stage W (waking)	Alpha activity and/or low-voltage, mixed frequency EEG
Stage 1	Low-voltage, mixed-frequency EEG with much 2–7 Hz activity (no rapid eye movements, REM)
Stage 2	Presence of sleep spindles (12–14 Hz) and/or K-complexes (high-voltage, negative-positive spikes) on background of low-voltage, mixed-frequency EEG
Stage 3	20% to 50% of epoch with high-amplitude delta waves (2 Hz or less)
Stage 4	Delta waves in more than 50% of epoch[a]
Stage REM	Low-voltage, mixed-frequency EEG activity and episodic rapid eye movements
Stage NREM	Stages 1, 2, 3, and 4 combined, i.e., those stages with no rapid eye movements

Note. From *A Manual of Standardized Terminology, Techniques and Scoring Systems for Sleep Stages of Human Subjects* by A. Rechtschaffen and A. Kales (Eds.). Washington, D.C.: U.S. Public Health Service, U.S. Government Printing Office, 1968.

[a]Measurement epochs are 20–30 seconds.

Taken from Andreassi (2000, p. 109)

Brain – EEG records

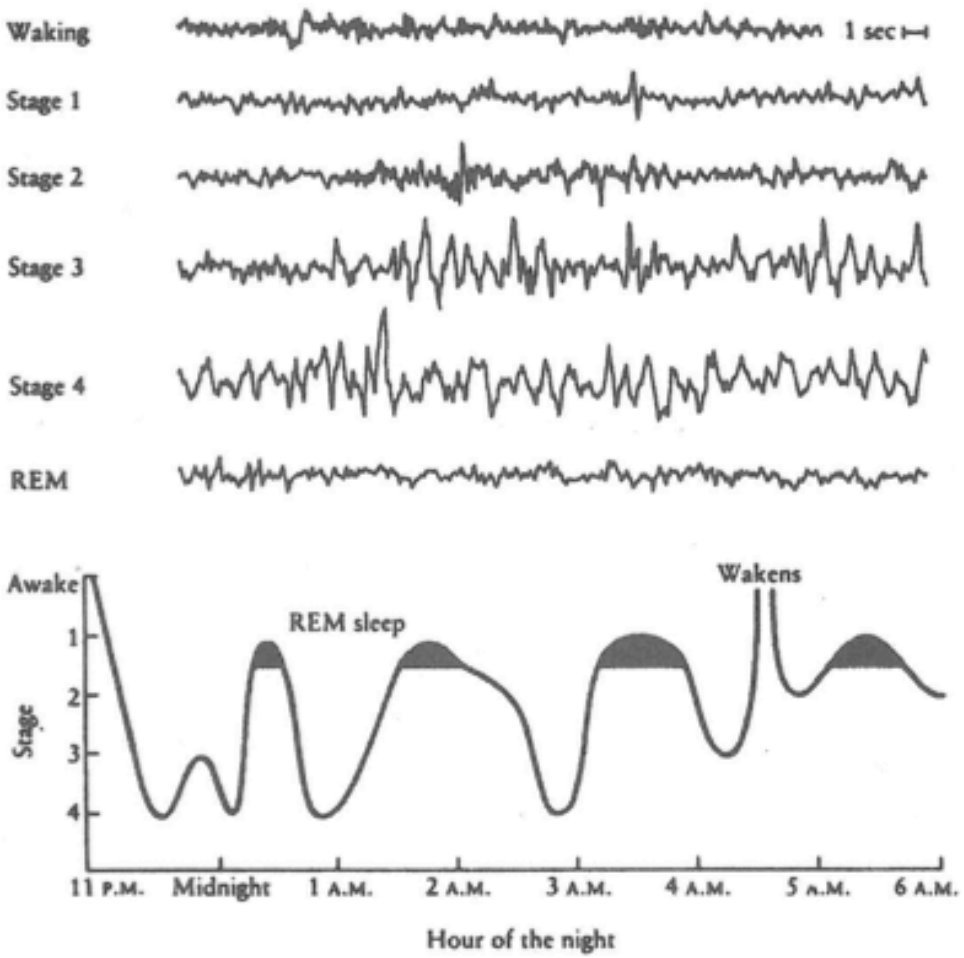
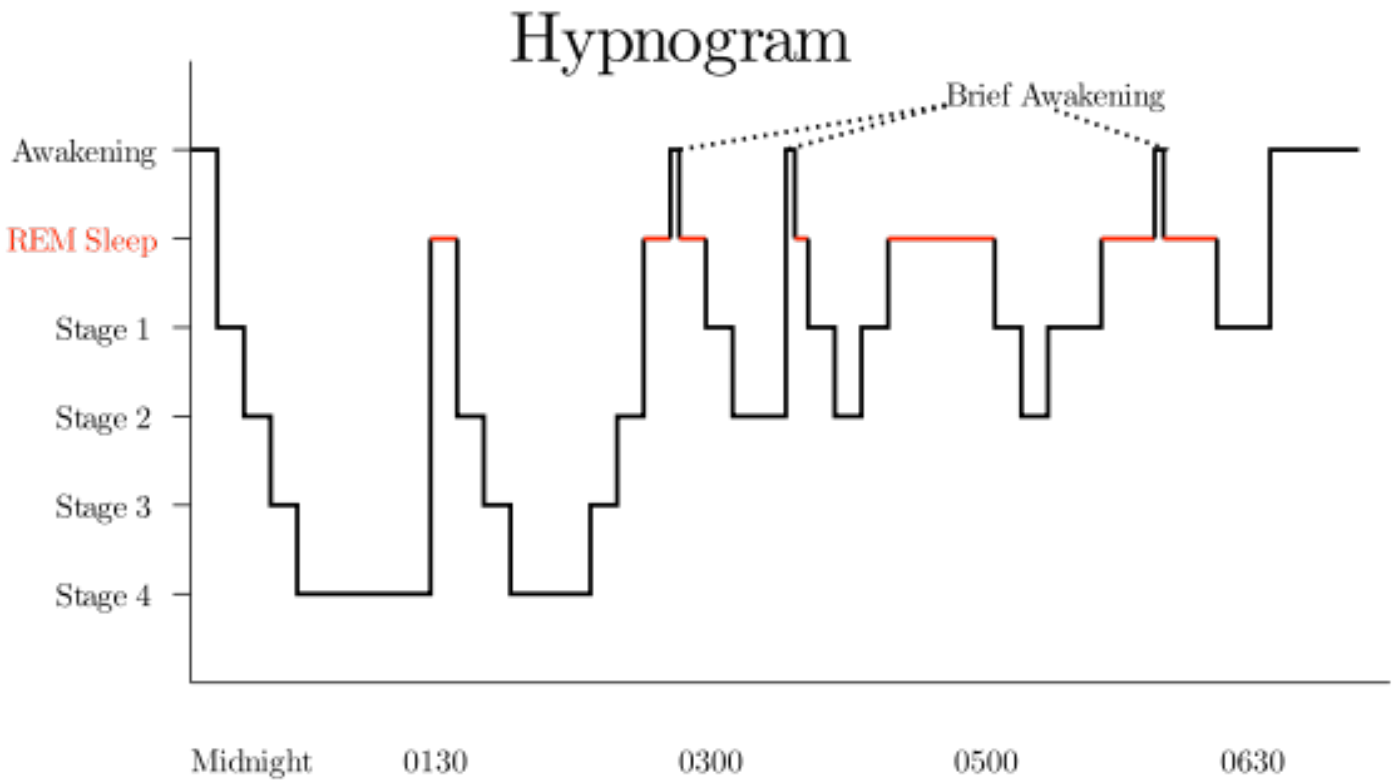


FIG. 5.3. EEG patterns during REM sleep resemble those of waking EEGs (top). Sleep increases and decreases in depth, and periods of REM sleep get longer as the night progresses. From Bloom and Lazerson (1988). Copyright 1985, 1988 by the Educational Broadcasting Corporation. Reprinted by permission of W. H. Freeman and Company.

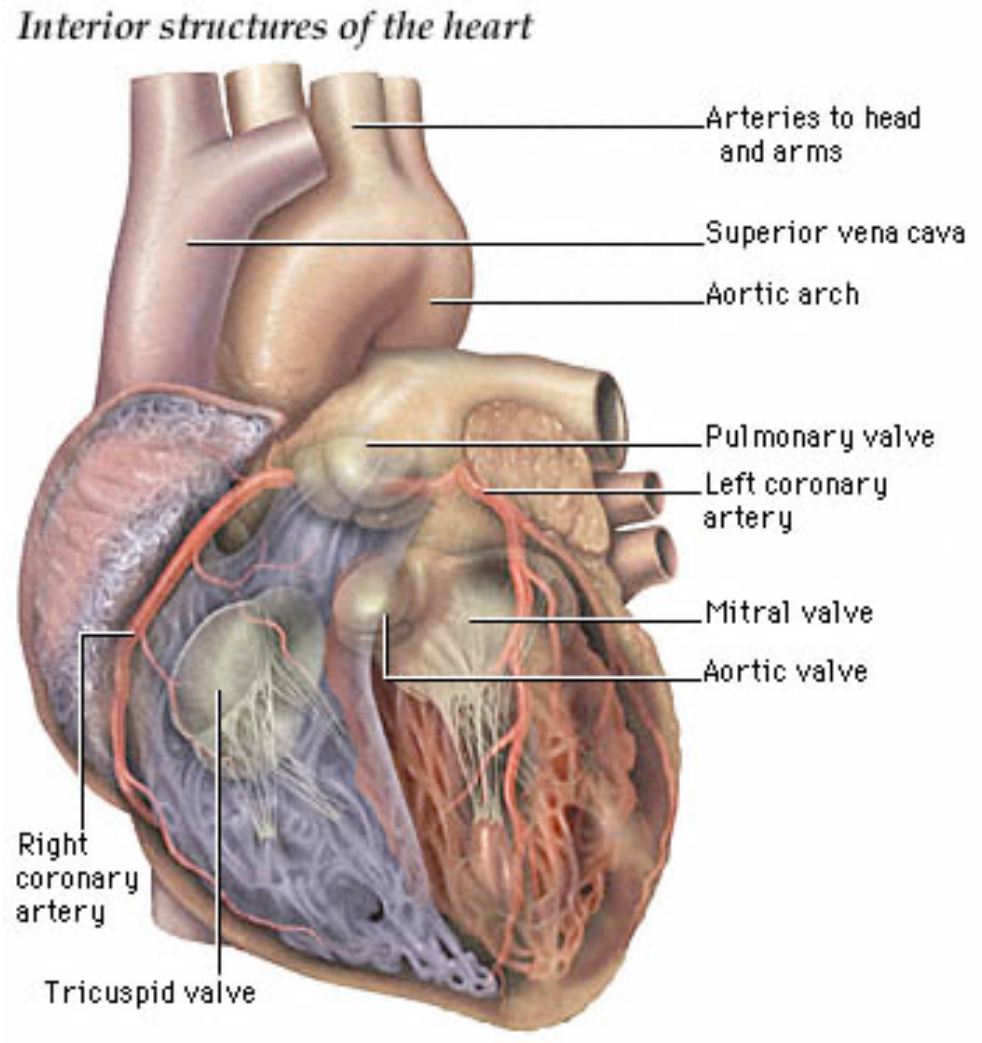
Taken from Andreassi (2000, p. 110)

Brain – EEG records



https://en.wikipedia.org/wiki/Rapid_eye_movement_sleep#/media/File:Sleep_Hypnogram.svg

Heart – Activity, attention, stress emotions

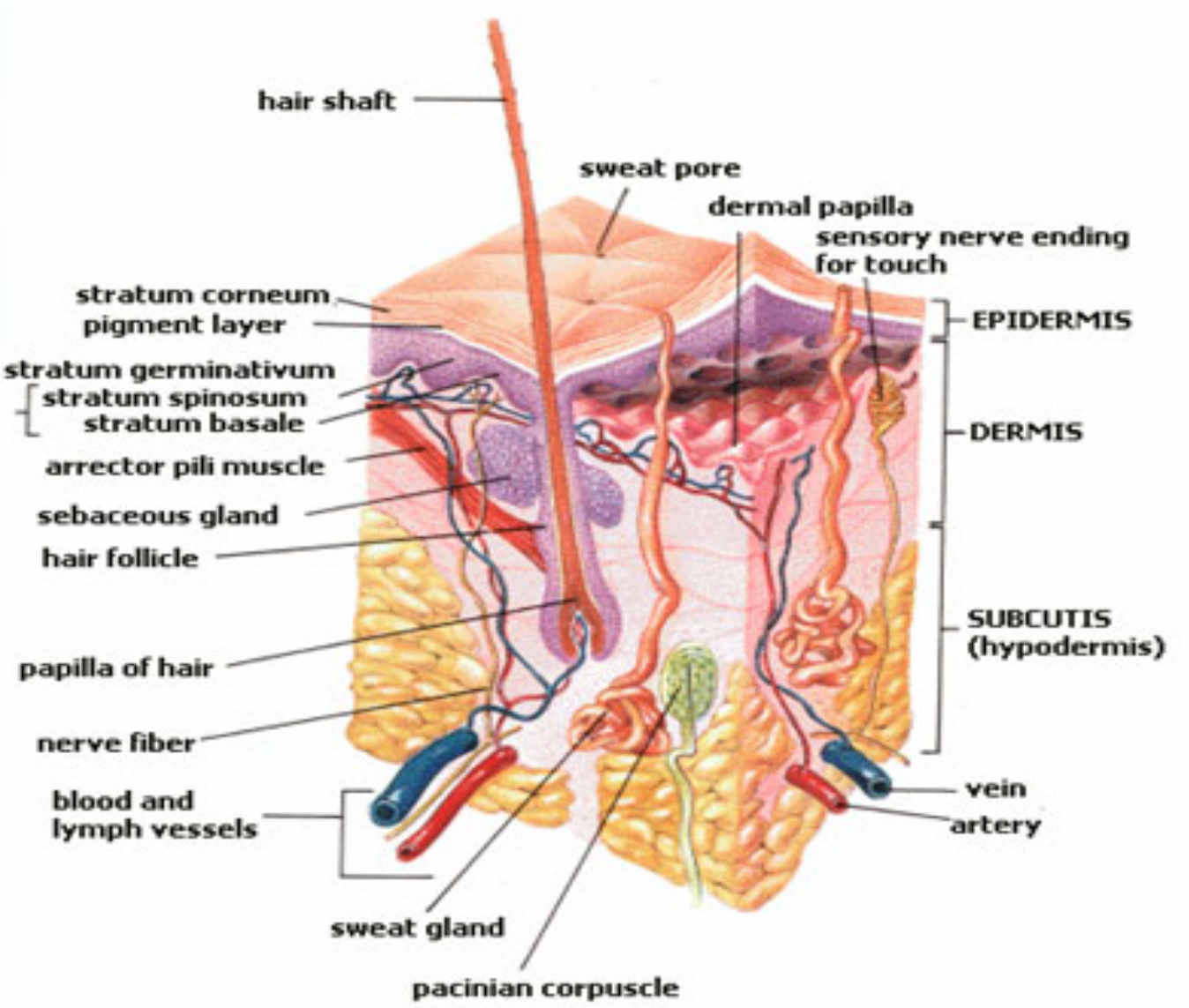


72 beats per minute (rest)

- Physical performance and heart activity
  reaction time, complex motor function
- Mental performance and heart activity
- Stress
- Emotional response
- Social context

See Also
http://ajpheart.physiology.org/content/288/1/H424

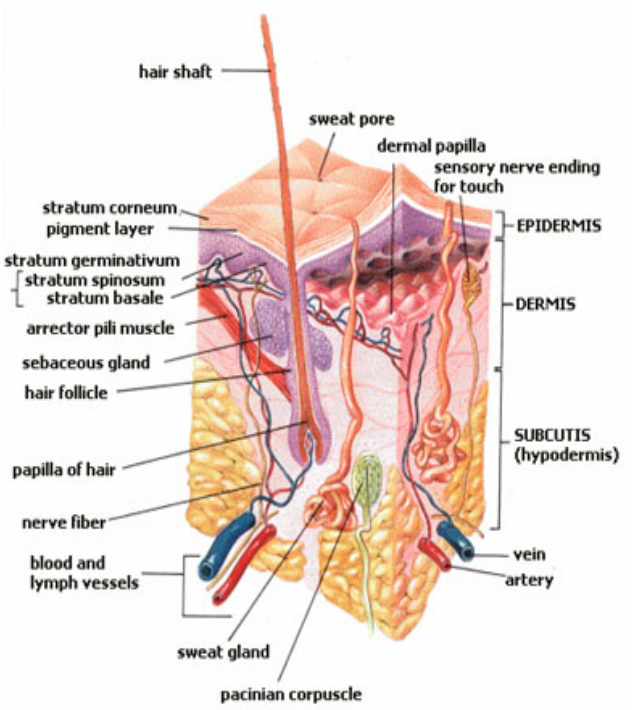
Haptic – a matter of skin



Largest organ

- Protection
- Isolation
- Sensation

Haptic – a matter of skin



Sensation:

- Relevant are the eccrine sweat glances

- receptors that detect light against heavy pressure
- brief against sustained pressure
- and endocrinal receptors that cause the feeling of "tension”

- level of arousal (conductance)
- level of positive/negative emotion (changes in conductance)

Haptic – a matter of skin .... but more than touch

Touch:

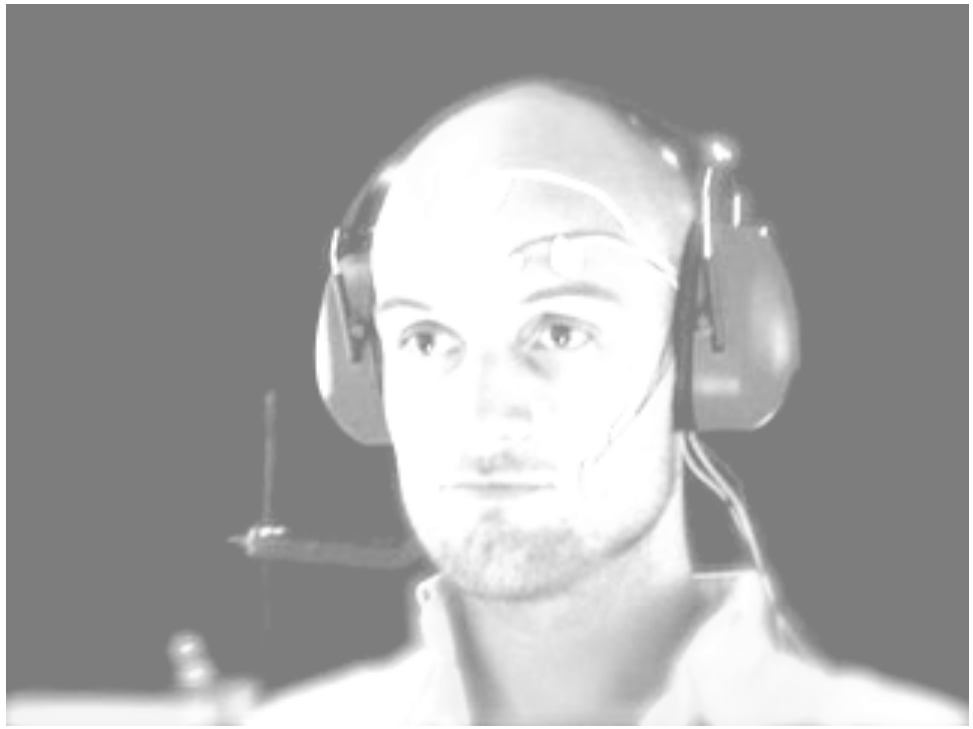
- the perception of pressure
- shape,
- softness,
- texture,
- vibration
- relative temperature
- emotional quality

Haptic – a matter of skin .... but more than touch

Loss of haptic ability

- Loss of the capability to sense limb movement and position
- Major impairment in skilled performance, even with full vision and hearing. This is worsened as visual information degrades.
- Abnormal movements and the inability to walk following the loss of somesthesis.
- Major loss of precision and speed of movement, particularly in the hands.
- Major difficulty performing tasks that combine significant cognitive loads and fine motor skills such as writing minutes during meetings.
- Major difficulty learning new motor tasks, relearning lost ones, or using previous experience to guide these processes.
- Loss of the unconscious ability to communicate through body language.

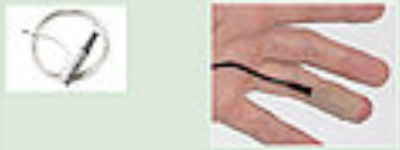
Haptic – Sensors



Sensors

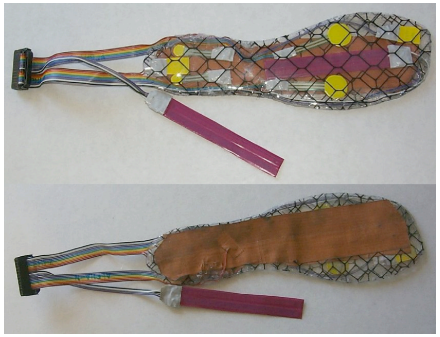
A sensor is a device which measures a physical quantity and converts it into a signal which can be interpreted by an instrument.

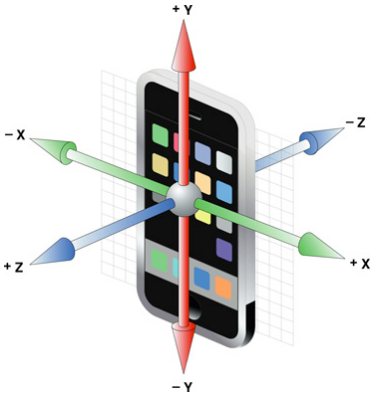
Sensors - Body measurement

Modality	Acronym	Measures	Sensor
electrocardiograph	ECG/EKG	cardiac conduction, heart rate, HRV	
electrodermograph	EDA, GSR, SC, SP	eccrine sweat gland activity	
electroencephalograph	EEG	cortical postsynaptic potentials	
electromyograph	SEMG	muscle action potentials	
feedback thermometer	TEMP	peripheral blood flow	
photoplethysmograph	PPG	peripheral blood flow, heart rate, HRV	
pneumograph	RESP	abdominal/ chest movement, respiration rate	

(Andreassi, 2000)

Sensors - Body measurement





Additional sensors

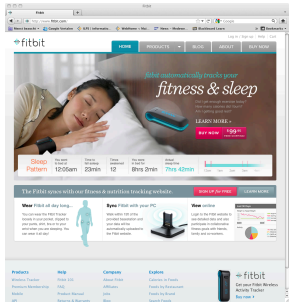
- breath bands
- pulse meter
- FSR pads (force sensitive resistors that measure continuous pressure) (Paradiso et al.)
- PVDF strips (polyvinylidine fluoride that measures dynamic pressure) (Paradiso et al.)
- FTIR (Acryl) (Baudisch 2011)
- gyroscopes
- accelerometer

The Multitoe project by Patrik Baudisch at Haso Plattner Institut
http://www.hpi.uni-potsdam.de/baudisch/projects/multitoe.html

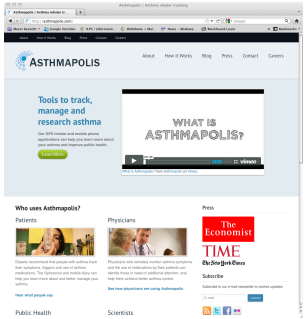
Sensors - Body measurement

Constant measurement

Nike+ Micoach



Fitbit DirectLife



RunKeeper Asthmapolis

Haptic – Sensors and Emotion

Emotion and Measurement

Identification of the personal emotion based on physiological measurements to achieve affective computing

Rosalind Piccard

Haptic – Sensors for skin response

Galvanic skin response (GSR),
Electrodermal response (EDR),
Psychogalvanic reflex (PGR),
Skin conductance response (SCR),

Skin is a reliable physiological measurement

A method of measuring the electrical resistance of the skin

Method;
Attach two leads to the skin
Acquire a base measure
As the activity being studied is performed, recordings are made from the leads.

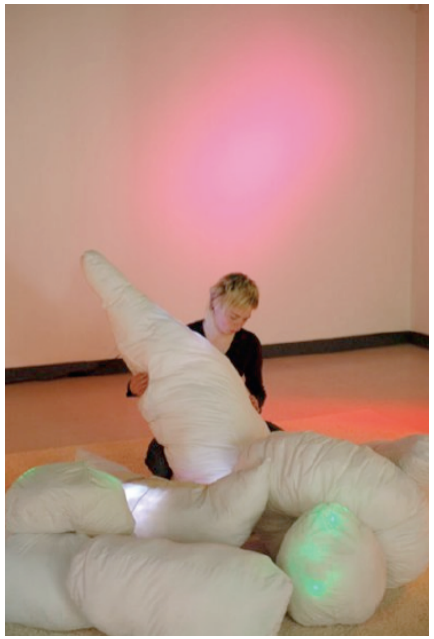
Haptic – Sensors for skin response

Galvanic skin response (GSR),
Electrodermal response (EDR),
Psychogalvanic reflex (PGR),
Skin conductance response (SCR),

Idea: Relation between sympathetic activity and emotional arousal, although one cannot identify the specific emotion being elicited.

GSR is highly sensitive to emotions in some people. Phobia, anger, startle response, orienting response and sexual feelings are all among the emotions which may produce similar GSR responses.

Haptic – Sensors for skin response



Whisper: http://www.youtube.com/watch?v=GEofDFj8WFY

Soft(n): http://v2.nl/lab/projects/soft-n

Interactive textile Thecla Schiphorst

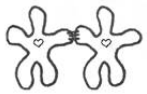
Medium:

- breath bands
- vibrators
- Silk organza
- Pulse meter

Translation of heartbeat and touch (position + intensity) from biological semantics into communication semantics.

e.g. a motion (pressure + direction) => order (move).

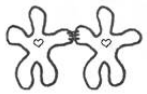
Sensors – Interpretation Touch (Schiphorst et al.)



Tactile efforts quality

touch-effort	Description
tap	A soft, short, small, touch, usually rendered with a single finger.
pat	A bigger version of “tap” and a soft version of “slap”. Usually rendered with an open hand or palm.
hold	A lingering, soft, big, touch. A “hold” has an encompassing feel.
touch	“Touch” is a small version of “hold”. It is an indication of comfort and is rendered with the fingers, hand, or palm.
stroke	A traveling touch, soft but directional, rendered with fingers, hand or palm.
glide	A traveling, meandering, touch. Soft and directionless and rendered with the fingers, hand, or palm.
jab	A hard, short, small, touch. A hard poke by a finger or blunted object. Also known as “poke”.
knock	A medium-sized, fist against, rapping hard. In our scheme, it is different than “jab” and “slap” in size only.
slap	An open-handed, hard, short, touch. In our scheme, a large version of “jab” and “knock”.
press	This is a long, hard, touch.
rub	This is a moving, hard, touch.
knead	Kneading involves many fingers moving hard and in a slightly wandering fashion.
other touch- efforts not attempted in this system:	
punch	This is like a “knock”, but is different in intensity and slightly different in timing.
flick	This is like a “jab”, but is slightly different in shape over time. A “flick” travels slightly in relation to a “jab”, which is more stationary.

Sensors – Interpretation Touch (Schiphorst et al.)



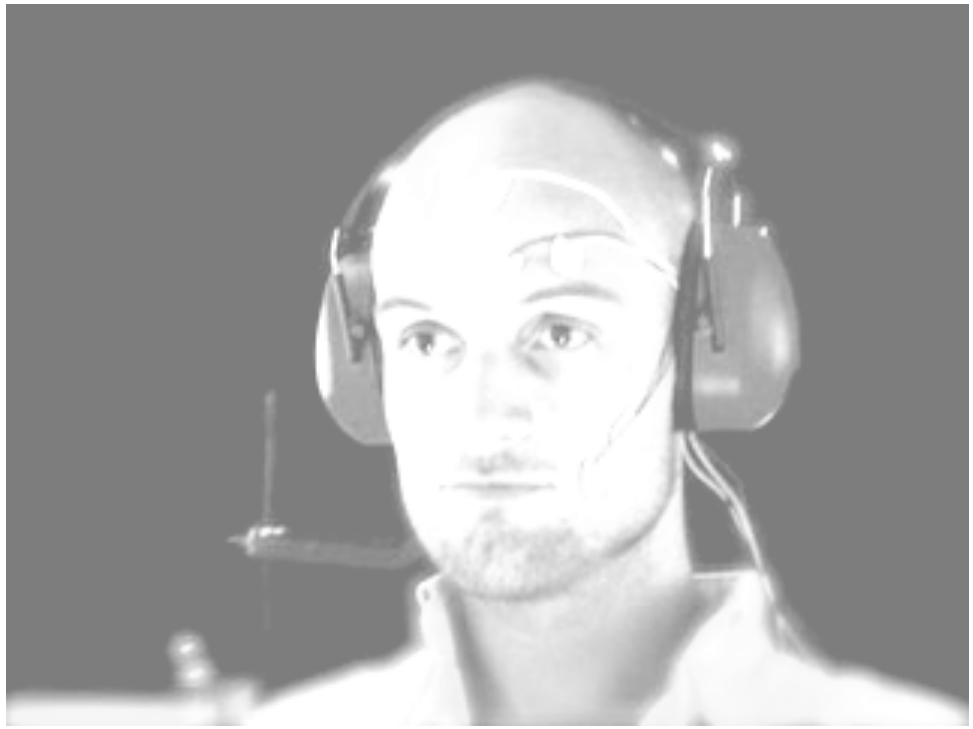
Parameter extraction

Parameter:		Description
pressure	soft-hard	The intensity of the touch.
time	short-long	The length of time a gesture takes.
size	small-medium-big	The size of the part of the interaction object that touches the pad.
number	one-many	The distinction between one finger or object and many fingers.
speed	none, slow-fast	The speed of a touch-effort. This is the overall velocity of movement. This parameter is not used directly to distinguish efforts, but is used to determine space.
direction	none, left, right, up, down, and four diagonals	The direction of movement. This parameter is not directly used to distinguish efforts, but is used to determine space and path.
Secondary:		
space (speed)	stationary-traveling	A function of speed. If speed is zero then the gesture is stationary, otherwise it's traveling.
path (direction)	straight-wandering	If the speed is not zero, and there is only one direction registered, the gesture is straight.
disposition (pressure)	constant-varying	If the pressure maintains a single value after an initial acceleration the gesture is constant, otherwise it's varying.
pattern (gesture)	continuous-repetitive	If a gesture is unique in relation to the gesture immediately before and after, it is continuous. Any repeated action or gesture is classified as repetitive.

Haptic – summary

- Haptic allows the creation of feedback mechanisms.
- Modelling of physical phenomenon, such as pressure and object collision are required.
- GSR provides the means to detect emotional pattern
- Correlation between GSR pattern and emotion needs to be defined, as GSR represents similar emotions alike.

Haptic – References



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