EEG = electro ence phalography

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non - invasive, used for diagnosing epilepsy

EEG - means surface, but also other forms (internal)

intracranial EEG, grid of electrodes on brain (special)

normally on skull - measure voltage oscillation of brain ~µV range

mainly postsynaptic potentials (other mV range)

small range, bc of skull (resistance of bone) ~1,5cm thick

summed up activity of 1 million nerve cells, not all contribute equally → 80% pyramid neurons (aligned structure) cerebral cortex

bc of anatomy neocortex, pyramidal neurons form ele. dipole, all in same direction → don't cancel each other out (radial direction), similar in brainstem + hypothalamus

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Hans Berger invented (1873-1941) Berlin: first proof exist of brain

experiment: stop from traffic for 1 day (ele. interferences)

big challenge to measure µV

now EEG amplifier small box / cigarette package

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after invention → special scene on electrode placement: scene to compare (percent of distance)

despite headsize - comparable regions (only scaling problem)

up to 256 electrodes, no positioning scene required

medical EEG max 32 electrodes

10-20 electrode placement: 10-20% distance steps

nasion (between eyes) to inion (back of head) distance measured

same earlobe to earlobe (auricular points)

crossing points of grid

F: frontal lobe P: parietal lobe

T: temporal lobe O: occipital lobe

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now: EEG caps, electrodes prepositioned, lab has ~4 caps in diff. sizes

intracranial EEG: why?

- µV → mV (no skull), no role measuring techniques advanced enough
signal quality much improved (impedance = resistance depends on fqc.)
fqc. up to 150 Hz, high fqc. more attenuated
all fqc. over 80Hz too much attenuates for external EEG (skull is like lowpass filter)
bandwidth - limitation

EEG = de. biosignal from brain, bandwidth 1-80 Hz

intracranial 100 times higher amplitudes, lesser bandwidth limitations (up to 600Hz)

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sleep staging: slow oscillations important
usually high oscillation, little slow act (high pass filter 5 Hz)

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fqc. components in EEG (external)

5-80 Hz band → divided in subbands

- α 8-13 Hz (rest, ideal)
- β 15-30 Hz (default, standard)
- γ 30-40 Hz (study, attention, focus)
- low theta 4-7 Hz (sleep)
- delta 1-3,5 Hz (young infants)

physiologically relevant - diff. mental states

today fqc. analysis with spectrogram (EEG people: compressed spectral array)
time x-axis, fqc. y-axis, color gives intensity (blue: weak, red: strong)

alpha block: eyes closed (appears), eyes open (disappears)
often tested by doctor

Passive/active electrodes

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spatial representation EEG, spread of activities over skull

- passive: no electronics integrated in electrodes
- active: preamplifier integrated

silver - silver-chloride ions electrode | (Napf elektrode) to avoid contact voltages (µV range)
in body all electricity transported by ions
from ion conductance to cable
even temp changes increase noise
special clean. process → contact volt. canceled out, cheap, effective, have to be rechlorinated
also skin resistance has to be reduced for good EEG (< 10k Ω)
↳ cleaning procedure • peeling • alcohol (remove fat/oils)
• place electrode • measure resistance → repeat until skin resistance < 10k Ω

passive electrodes: spike electrodes (spike ~0,5mm), go into skin, have to be sterilized (good signal quality), also for dense hair

needle electrodes: painful, only for good signal quality, also anastesia monitoring,

active EEG electrodes used today, little amplifier (factor 10) close to source, more robust to noise, able to measure higher resistance (upto 500k Ω), no need for skin cleaning, but special electrode gel for electrical connection also for long hair, gel also good, for small movements to counteract

EEG based neuro-bio-feedback

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use:
EEG based Neuro-biofeedback

creating feedback loop EEG and patient, also as computer game,
depending on α-waves, "how to relax", often used with children

also commercially available

use:
diagnosing epilepsy most important application

early application, noble price in medicine

epilepsy: causes piece of tissue in brain, neurons defect (few mm), very strong synchronized AP,
spread like wave, neighboring regions also AP
even no symptoms → epileptic spikes, spikes only hint for epilepsy
symptoms: depends where located epileptic focus,
cramping, not conscious : motoric center
consciousness: suddenly does something, but can't remember,
absence attack, often done, can be measured,
damage potassium channels
help with medication mostly, also surgery, difficult to find tissue by external EEG
intercranial EEG, can calculate focus
open skull, apply grid, close skull again, permanent recording, trigger attack
(no sleep, stroboscope), remove electrodes, surgery, can even be healed

use:
diagnosing sleep disorder

sleep stages: 0 awake
1 light sleep
2 } deeper
3 }
4 deep sleep

REM (dream, rapid eye movements)
EEG same as awake, body paralyzed

construct hypnogram (sleep stages) in sleep lab
in sleep lab many instruments: muscle tension, ECG, EEG, breath
polysomnigraphy (measurement of, biological parameter during sleep)
specific

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today no more cables
→ hypnogram (sleep stages) → diagnose

use:
recording of reactions (event related)

repeat for example hearing tone → average (random components falls out)
→ components related to tone get amplified

used for hearing tests for babies: damage ear, nerve, brain?

- for speech research, characteristic curves
  repeat sentence at least 50 times → event related response
  → alter experiment a bit → difference in logical / unlogical sentences (odd ball experiment)
  no sense → N4 decreases → valuable research, speech research
  test if a person speaks a language

use:
brain computer interfaces
(locked-in-syndrome, learn to inc. α-waves → (language (old),
modern approach event related, P300 letters focus (slow),