How to study and Measure Sleep (8.1)

➔ Sleep: Absence of overt behavior, absence of consciousness
  ◆ -> Measure are ‘indirect’
➔ Methods to measure sleep
  ◆ ElectroMyoGram (EMG): muscle activity (face), legs
  ◆ ElectroEncephaloGram (EEG): Brain activity
  ◆ ElectroOculoGram (EOG): eye movements
  ◆ Air flow measurements: breathing
  ◆ Heart rate…

EEG measurements of sleep
Sleep has different stages characterized by different EEG waveforms (frequency content)

Sleep has stages
➔ Sleep stages and Rhythms
  ◆ Stage 1: Drowsiness, heavy on eyes, last 10 minutes
  ◆ Stage 2: sensory disconnect. Sleep spindles and K complexes, last 15 minutes
  ◆ Stage 3/4: loss of consciousness, last 60 minutes also called Slow wave sleep
  ◆ REM: dreaming, loss of muscle tonus, rapid eye movement, activity in sexual organs, desynchronized, last 25 minutes also called paradoxical sleep
EEG and single neurons

➔ During slow wave sleep neurons undergo up and down states: periods of activity/silence, 1 period/second
  ◆ Down state: rest
  ◆ Up state: neurons are firing. Memory consolidation.

Sleep is a cycle: free running sleep/wake cycle

➔ In class video
  ◆ Experiment: room/cave without windows, free food, entertainment, no clocks
  ◆ Measure: the amount of time awake and asleep
  ◆ Result: sleep and wake cycle is not the same as day and night cycle

Sleep has cycles

➔ Sleep is a cycle
  ◆ Free running awake/sleep cycle; 25 hours
  ◆ REM and non-REM cycles every 90 minutes. Controlled by internal clock
  ◆ REM sleep has a refractory period of 1 hour. Increase metabolic activity in CNS, decrease of activity in PNS. Sexual organs activity. Dynamic dreams.

Why do we sleep (8.6)

◆ Sleep as a behavior (adaptive response): all animals have SWS, but only mammals and birds have REM. Sleep as a 'protective behavior': it is dangerous to move at night
◆ Sleep as a restorative process. Resting of the brain (but not related to body activity)

➔ Evidence:
  ◆ Cortex: metabolic activity and blood flow decrease by 25% (during SWS)
  ◆ Highest activity (when awake)

➔ highest delta + lowest activity during sleep
◆ Sleep needs vary with development

Sleep is a need (genetic basis)

➔ Different species have different sleep needs
  ◆ -human infant ~16hrs asleep
  ◆ -human adult ~8hrs
  ◆ -human elder ~5.5hrs
  ◆ -owl monkey ~17hrs
  ◆ -rhesus monkey ~11.8hrs
  ◆ -baboon ~10.3hrs
  ◆ -squirrel monkey ~9.9hrs
  ◆ -chimpanzee ~9.7hrs

Sleep duration in humans

◆ Sleep needs vary among humans (4-10hrs)
◆ Sleep starts in utero (womb)
◆ Sleep needs vary along life span. Need less and less sleep as we age

➔ 24 hours sleep deprivation: no 'rebound' in sleep duration

Sleep: SWS (8.8)
Deprivation studies:
- No significant physical consequences (human)
- Loss of weight + death (rats)
- Not a proportional function of recuperation

SWS need is not related to physical exercise
- Brain metabolic activity decreases by 25%. Delta occurs in the regions that were the most active in the awake state
- Related to mental activity and 'declarative memory' consolidation

-> nap after learning…
- Related to body temperature

-> aspirin/ibuprofen lower temp -> prevents slow wave sleep.
-> cytokines (immune response) raise temp -> increases slow wave sleep
- Dreams: static images

Sleep: REM sleep (8.7)
Deprivation studies:
- Significant consequences on cognitive performance
- REM shows rebound phenomenon after deprivation

Brain metabolic activity increases
- In infants: REM= 70% of sleep, developmental role?
- In adults: REM= 15% of sleep, learning and memory, consolidation?
  Forgetting
- Dynamic dreams

Sleep disorders

Insomnia: problem falling asleep. May be due to stress, psychological factors or drug rebounds (valium or antibiotics)
- Sleep needs are variable (4-8hrs). Depends on genetic and environmental factors (health, day activity, mood). 'insomnia' criteria depends on individual
- Quantity of sleep vs. quality of sleep (sleep apnea)

REM sleep disorders
- Sleep attack (low arousal, few minutes, sleep)
- Cataplexy (high arousal, no loss of consciousness)
- Sleep paralysis (awake atonia): just before/after sleep.
- Hypnagogic: hallucinations (awake, dreaming, usually nightmares)
- REM without atonia (a.k.a REM sleep behavior disorder). Act out dreams

Narcolepsy: genetic and hormonal (orexin) bases
  - https://www.youtube.com/watch?v=MZeLca_2QPw

SWS sleep disorders
- Sleep walking (15% children age 5-12 do it at least once)
- Eyes open, no arms stretched, stage of half consciousness
- Usually no walking
- Sleep-related eating disorder
  - Sleep talking (hypnosis, truth serums)
  - Night terror (fear of losing consciousness? No memory for the event)
◆ Fatal familial insomnia, damage to thalamus. Insomnia, paranoia, hallucinations, dementia, related to mad cow disease. No cure. Genetic
◆ Bed wetting. Primarily in children. Partly genetic, partly environmental

What if you had a quiz
◆ (T/F) our natural sleep/wake cycle is always exactly 24 hours.
◆ (T/F) the brain is much less active in REM sleep then in SWS.
◆ You dream full dynamic stories during _____ sleep. Sleep attacks may occur during _____ sleep.
◆ Research shows that REM sleep is involved in:
  ● Patients suffering from cataplexy
  ● Sleep walking
  ● In Slow wave sleep
  ● All of the above

Answers:
◆ False
◆ True; opposite
◆ REM, REM
◆ A