Sleep Lecture 10/6/2022
Reading for next class: Chapter 8 until the end
Midterms returned next class. Key will be posted on the web

How to study and measure sleep
Sleep: absence of overt behavior, absence of consciousness. Measures are indirect
Methods to measure sleep:
1. ElectroMyoGram (EMG): muscle activity (face) legs
2. ElectroEncephaloGram (EEG): brain activity
3. ElectroOculoGram (EOG): eye movements
4. Air flow measurements: breathing
5. Heart Rate

EEG Measurements of sleep
6 Characteristics of sleep:
1. Awake
2. Stage 1 sleep: characterized by theta activity
3. Stage 2 sleep: characterized by sleep spindle (fast and short periods of activity) and big complexions called K complex
4. Stage 3 sleep: slow wave sleep
5. Stage 4 sleep: slow wave sleep
6. REM sleep: Theta activity and betta activity

REM Sleep: ‘Paradoxical’ sleep

Brain rhythms detected using EEG

Delta(below 4 hz), Thea, Alpha, Spindles (between 12 and 13 hz), Beta, Gamma

Sleep stages and rhythms:
Stage 1: drowsiness, heavy eyes. Last 10 minutes
Stage 2: Sensory disconnect. Sleep spindles and K. Complexes. Lasts 15 minutes
Stage 3 & 4: Loss of consciousness. Delta stage. Last about an hour. Also called slow wave sleep
R.E.M: dreaming, loss of muscle tonus, Rapid eye movement, activity in sexual organs, theta and beta stages, desynchronized, lasts 25 minutes. Also called paradoxical sleep.

Awake during alpha and beta.

**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 and memory consolidation.

Day/night cycle is 24 hours.
Sleep is a cycle: free running sleep/wake cycle
Experiment: room/cave without windows, entertainment, connection to the outside world.
Measure: amount of time awake/sleep
Result: sleep/wake cycle is not the same as day/night cycle.
Humans have internal alarm clocks. The days spent in the cave found a 25 hour a day schedule causing our body to advance against the clock 1 hour a day. We are always sleep deprived.

REM/non REM cycles every 90 minutes. Controlled by internal clock
REM sleep has a refractory period of 1 hour. Increase of metabolic activity in CNNS, decrease of activity in PNS. Sexual organs active during REM sleep and dynamic dreams occur.

REM Sleep is the furthest away from the awake stage and the most disconnected you will be from muscles and the outside world.

**Why do we sleep?**
1st theory: Sleep is a behavior (adaptive response): all animals have a slow wave sleep, but only mammals and birds have REM. Sleep as a "protective behavior". It is dangerous to move at night.
Evidence: dolphins have two hemispheres and sleep one half of their brains at a time.
2nd theory: sleep as a restorative process. Resting of the brain (but not related to activity).
Evidence: Cortex: metabolic activity and blood flow decrease by 25% during SWS. Sleep needs vary with development. Visual cortex is resting the most during sleep.

Sleep in need (genetic basis): Different species have very different sleep needs.
Bat: sleeps 19 hours (82% of time)
Giraffe: sleeps 1.9 hours (7% of the time)

**Sleep duration in humans**
- Sleep needs vary among humans (4-10 hours)
- Sleep starts in utero (in the womb ~5 months)
- Sleep needs vary along life span. Need less and less sleep as we age.
Sleep Deprivation Results:
24 hour sleep deprivation: no “rebound” in sleep duration
Record of sleep deprivation: 264 hours (11 days) but a 17 year old high school student and only ~2 days rebound sleep (slept longer for 2 days and was fully recovered after 2nd day)

Sleep: Slow Wave Sleep
Deprivation studies:
- No significant physical consequences (human)
- Loss of weight + death (bats)
- 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 most active in the awake state.
- Related to mental activity and “declarative memory” consolidation. (Napping after learning is good)
- Related to body temperature (aspirin/ibuprofen lowers temp and decreases and shortens slow wave sleep). Cytokines (immune response) raises temp and increases slow wave sleep
- Dreams in Slow Wave Sleep are static images
- SWS: declarative memory

Sleep: REM
- Deprivation studies: significant consequences on cognitive performance. REM sleep shows rebound phenomenon after deprivation.
- Brain metabolic activity increases: in infants: REM 70% of sleep (developmental role) and in adults REM 15% (learning, memory, consolidation and forgetting)
- Dreams in REM are dynamic
- REM sleep: non declarative memory

Sleep Disorders:
1. Insomnia
   - Sleep needs are variable (4-8 hours). Depends on genetic environmental facts (health, day, activity, mood) → insomnia criteria depends on the individual
   - Insomnia is a problem falling asleep. May be due to stress, psychological factors, drug rebounds
   - Quantity of sleep vs.s quality of sleep (sleep apnea)
   - Sleep apnea blocks respiration while sleeping causing the person to wake up and cause tiredness
2. REM sleep disorders
   - Sleep attack (person is bored and falls into a few minutes of REM sleep)
   - Cataplexy (person fully awake and aware of what’s happening, no loss of consciousness but go immediately to REM sleep and lose muscle tone )
- Sleep paralysis (awake atonia): just before/after sleep
- Hypnagogic hallucinations (also called awake dreaming and are usually nightmares. This occurs during the awake cycle)
- REM without atonia (also called REM sleep behavior disorder). “Act out dreams” and muscles are moving
- Narcolepsy: genetic and hormonal (orexin) bases that cover all these disorders listed in the REM sleep disorders.

3. Slow Wave Sleep Disorders
- Sleep walking (15% of children aged 5-12 do it at least once). Eyes open, no arms stretched, state of half consciousness. Usually no walking.
- Sleep-related eating disorder: when subjects become hungry and feel compelled to go eat during sleep. Starts with a SWS trigger
- Night terror: there is usually no memory of the event
- Sleep talking (equivalent to hypnosis/truth serums)
- Fatal Familial Insomnia: damage to thalamus. Symptoms include: insomnia, paranoia, hallucinations, dementia, death. Related to mad cow disease. No cure and is genetic

Quiz questions:
Our natural sleep/wake cycle is always 24 hours: False
The brain is much less active in REM sleep than in SWS: False
You dream full dynamic stories during _____ sleep. Sleep attacks may occur during _____ sleep:
1. REM 2. REM
Research shows that REM sleep dysfunction is involved in:
   a. Patients suffering from cataplexy
   b. Sleep walking
   c. In slow wave sleep
   d. All of the above

Answer: A. patients suffering from cataplexy