Class 12: Sleep

How to Study and Measure Sleep

- **Sleep**: absence of overt behavior, and of consciousness
  - Measured indirectly
- Methods of Measuring sleep:
  - ElectroMyoGram (EMG): muscle activity (face, leg)
  - ElectroEnephaloGram (EEG): brain activity
  - ElectroOculogram (EOG): eye movement
  - Air Flow Measure: breathing
  - Heart Rate

EEG Measures Sleep

- Sleep has different stages characterized by different EEG waveforms (frequency content)
  - Brain rhythms detected using EEG

Stages and Rhythms

- Stage 1: drowsiness, heavy eyes Alpha waves (10 minutes)
- Stage 2: sensory disconnection, sleep spindles and K complexes (15 minutes)
- Stage 3 and 4: loss of consciousness, Delta waves (Last ~60 minutes)
Also called: Slow Wave Sleep
  - Also called: Paradoxical Sleep

EEG and Single Neurons
- During slow wave sleep neurons undergo up/down states
  - Periods of activity/silence
  - 1 period/second
  - Up State: neurons firing, memory consolidation
  - Down State: rest

Sleep is a Cycle:
- Free running sleep/wake cycle
- Experiment: Room or cave without windows, free food, entertainment, but no clocks
  - Measure the amount of time awake/sleeping
  - Results: sleep/wake cycle is not the same as day/night cycle
- Free running awake/sleep cycle: 25 hours
- R.E.M. and N.R.E.M. cycles every 90 minutes
  - Controlled by internal clock
- R.E.M. sleep has a refractory period of ~1 hour
  - Increase metabolic activity in CNS
  - Decreased PNS activity
  - Active sexual organs
  - Dynamic dreams

Why do we sleep?
- Sleep as a “behavior” (adaptive response)
  - All animals have slow wave sleep, but only bird/mammals have R.E.M. sleep
  - Sleep as a “Protective Response”
    - Night is dangerous
- Sleep as a “restorative” process
  - Resting of the brain (but not related to body activity)
  - Evidence: metabolic and blood flow decreases by 25% (Slow wave sleep)
    - Highest activity when awake
      - Highest delta waves + lowest activity (during slow wave sleep)
    - Sleep needs vary with development
      - Genetic basis
      - Different species have very different sleeping needs

Sleep Duration in Humans
- Sleep needs vary among humans (4-10 hours)
- Sleep starts in Utero (womb)
- Sleep needs vary along life span
Mauricio

- Need less as we age

**Deprivation Results**
- 24 hours of sleep deprivation: no “rebound” in sleep duration
- Record: 264 hours (11 days), by 17 year old high school student
  - 2 day “rebound” only

**Slow Wave Sleep**
- Deprivation Studies: no significant physical consequences (humans)
  - Loss of weight/death (rats)
  - Not a proportional function of recuperation
- Slow wave sleep need related to physical activity
- Brain metabolic activity decreases (by 25%)
  - Delta waves occur in the regions that were the most active in the awake stage
- Related to mental activity and “declarative memory” consolidation
  - Nap after learning
- Related to body temperature
  - Aspirin/Ibuprofen decrease temperature which prevents slow wave sleep
  - Citokines (immune response) increase temperature which increase slow wave sleep
- Dreams: static images

**R.E.M. Sleep**
- Deprivation Studies: significant consequences on cognitive performance
  - R.E.M. shows rebound phenomenon
- Brain metabolic activity increases
  - In infants: R.E.M. = 70% of sleep (developmental?)
  - Adults: R.E.M. = 15% (learning/memory consolidation, forgetting?)
- Dynamic dreams

**Sleep Disorders**
- Insomnia: problem falling asleep
  - Maybe due to stress
  - Psychological factors
  - Drug rebounds: after benzodiazepines (valium) or barbituates (anxiolytics)
- Sleep needs vary (4-10 hours)
  - Depends on environmental and health factors, day activity, mood, and genetics
  - Insomnia criteria depends on the individual
- Quantity of sleep vs quality of sleep (sleep apnea)

**R.E.M. Sleep Disorders**
- Narcolepsy: genetic and hormonal (orexin) bases
  - Sleep Attack: low arousal, few minutes of sleep
  - Cataplexy: high arousal, no loss of conscious
Sleep Paralysis (awake atonia): just before/after sleep

Hypnagogic Hallucinations: awake, dreaming, usually nightmares

R.E.M. without atonia: also known as R.E.M. sleep behavior disorder
- Act out dreams

Slow Wave Sleep Disorders

- Sleep walking: 15% children ages 5-12, at least once
  - Eyes open, no arms stretched, state of “half-consciousness”
  - Usually no walking
  - Sleep-related eating disorder
- Sleep taking: hypnosis, truth serum
- Night Terror: fear of losing consciousness
  - No memory of the event
- Fatal Familial Insomnia: damage to thalamus
  - Insomnia paranoia, hallucination, dementia
  - Death
  - Related to “mad cow” disease
  - No cure/genetic
- Bed-Wetting: primarily in children
  - Partly genetic/partly environmental