arousal and sleep

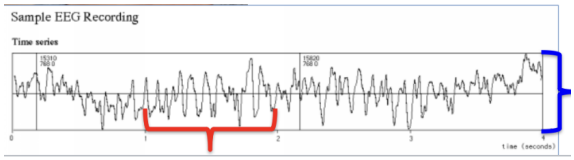
arousal in the brain

- reticular activating system
  - stimulated by sensory input
  - initiated, maintained endogenously
- reticular formation
  - sends Ach and glutamate throughout brain
- basal forebrain
  - delivers Ach throughout cortex
- locus coeruleus (dark blue place)
  - releases NE for vigilance
  - alerts memory
- lateral hypothalamus
  - releases orexin
  - maintain arousal in other systems based on body conditions

how does caffeine wake you up

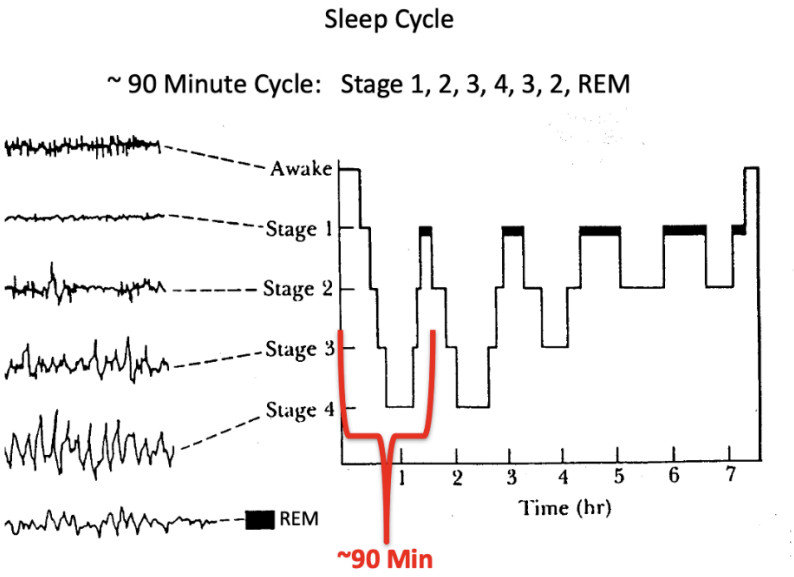
- Ach ←→ GABA opponent systems
  - adenosine (metabolic byproduct)
    - builds up in cells during the day
    - inhibits ACh and allow GABA to dominate → sleep
- caffeine crosses blood brain barrier
  - mimics adenosine and blocks adenosine receptor sites
    - doesn't inhibit ACh
  - suppresses GABA system while ACh is still active

EEG - electroencephalogram

- gross average change in electrical potentials in area under electrode
- amplitude = voltage
- frequency (Hz) = cycles/second
- 

EEG in sleep cycle

- awake → beta waves (18-24 Hz)
    - distractions from thinking and performing many things simultaneously
    - noise from multiple activity
- alert and relaxed → alpha waves (8-12 Hz)
    - brain in efficient peak
    - more coherence
- stage 1 sleep → theta (4-7 Hz)
- stage 2 sleep → theta w/ spindles and k-complexes
- stage 3&4 (slow wave sleep) → delta
    - stage 3 50%
    - stage 4 50%
- REM sleep → variable (12-28 Hz)
- awake to slow wave sleep: desynchronized → synchronized
    - REM sleep goes back to desynchronization



sleep cycle

- 90 minute cycle: stage 1-4-2, REM
- as night progresses
    - less slow wave sleep
    - duration of REM increases
- sleep deprivation slow more slow wave sleep
    - lethargy, poor concentration, irritability
    - decreased resistance to infection

REM (rapid eye movement) sleep

- paradoxical sleep
    - EEG desynchronized: high frequency, low voltage
    - heart and breathing rates highly variable
    - eyes move, genitals active but muscles paralyzed “atonia”
        - preventing motor signals from going through
    - highly correlated with dreaming

REM deprivation

- recording EEG of cat on pedestal in tank
    - when enter REM atonia causes cat to fall in → wake up (selectively depriving REM)
    - REM deprived cat displays irritability, poor concentration, hallucinations, death
- REM deprived→ REM rebound
    - REM periods lengthen

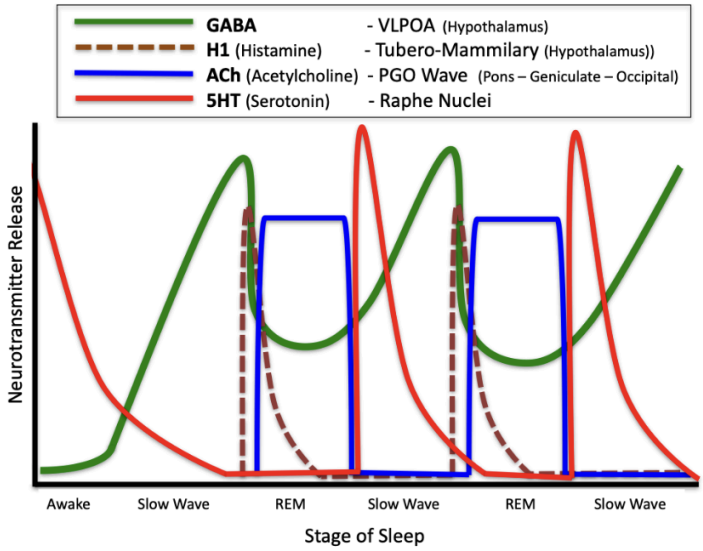
functions of sleep and REM

- controversial
- sleep is restorative
    - engage in critical metabolic processes, process waste, etc
    - different animals require different lengths of sleep
- REM may have cognitive/psychological advantages
    - REM deprivation→ poorer memory for previous day’s learning
    - dreams may be involved in helping resolve psychological conflicts
- slow wave / REM cycle may involve temperature regulation
    - brain operates within very narrow range of temperatures
    - brain cools down during slow wave sleep
    - REM warms brain
        - possibly why hypothalamus triggers PGO wave

regulating sleep cycle

- hypothalamus
    - VLPOA (ventro-lateral preoptic area) → basal forebrain
    - tuberomammillary
- raphe nuclei in medial pons
- PGO wave (pons geniculate occipital)
    - initiates REM sleep: Pons activity → lateral Geniculate of thalamus → Occipital cortex

neurotransmitters involved



circadian rhythm

- suprachiasmatic nucleus (SCN) of hypothalamus
    - clock maintains 24 +/- 1 hr rhythm of activity, impossible to disrupt
    - genetically controlled
    - interacts with pineal gland
- in absence of day/night cues subject maintains the 24 +/-1 hr rhythm but cycle tends to drift
    - flexibility → adapt to seasonal changes
- zeitgeber (time giver) = pineal gland
    - “third eye”, responds to visual input about daylight/darkness
    - releases melatonin - promotes sleep

retino-hypothalamic path

- specialized visual receptors
    - ancient ganglion cells with photopigment melanopsin
    - react to ambient light levels
    - send axon to SCN → informs pineal gland (daylight decreases / nightfall increases melatonin secretion) → melatonin inhibit SCN, regulating active/inactive cycle
- take melatonin for jet lag promotes pineal production of melatonin, resets clock