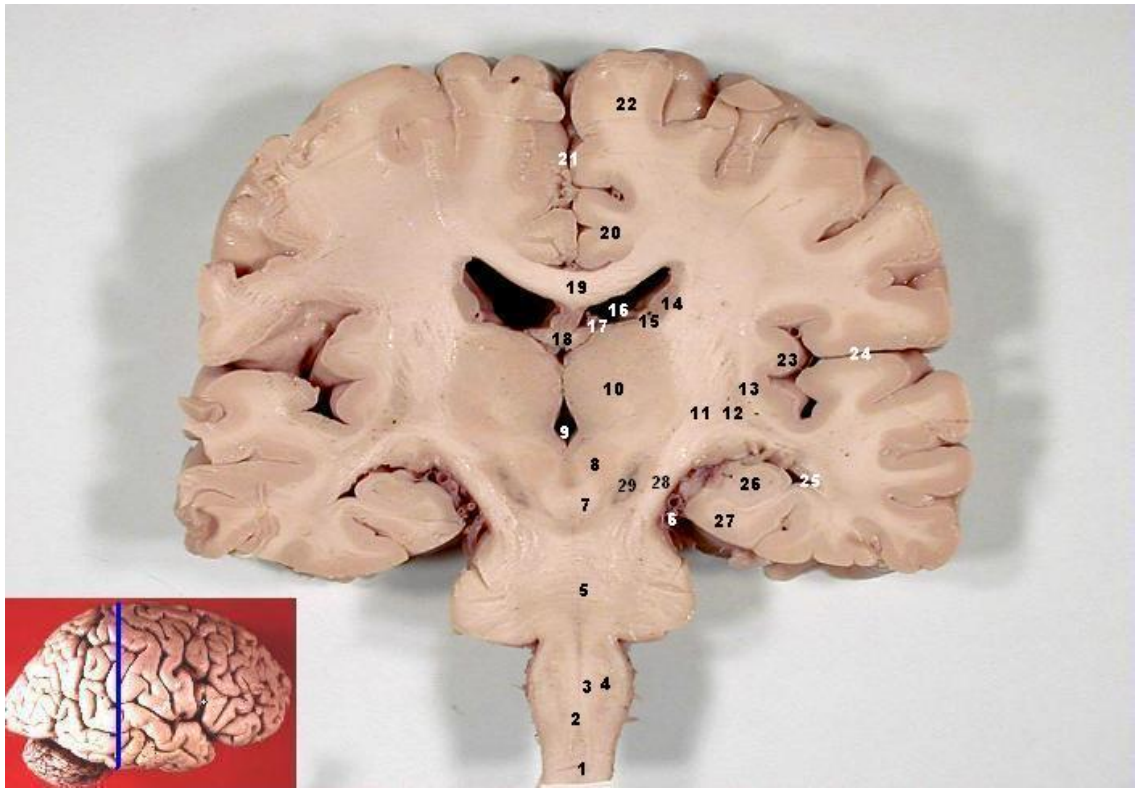
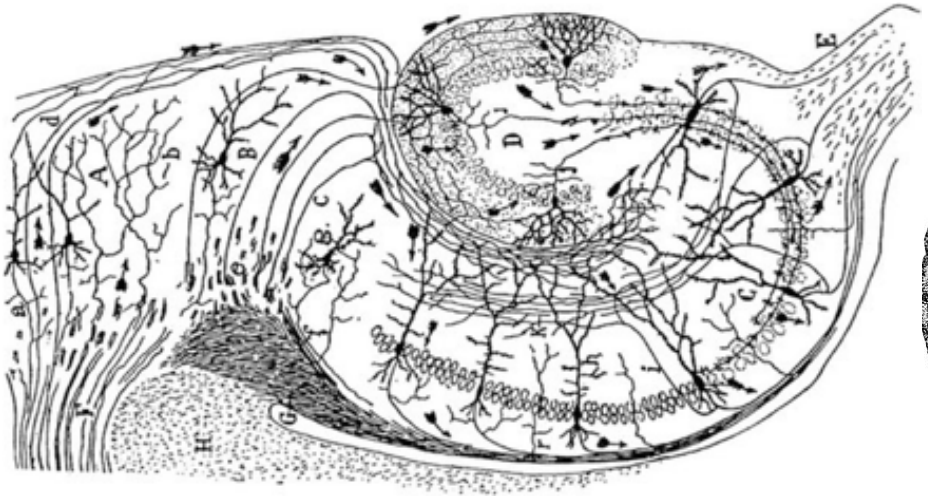
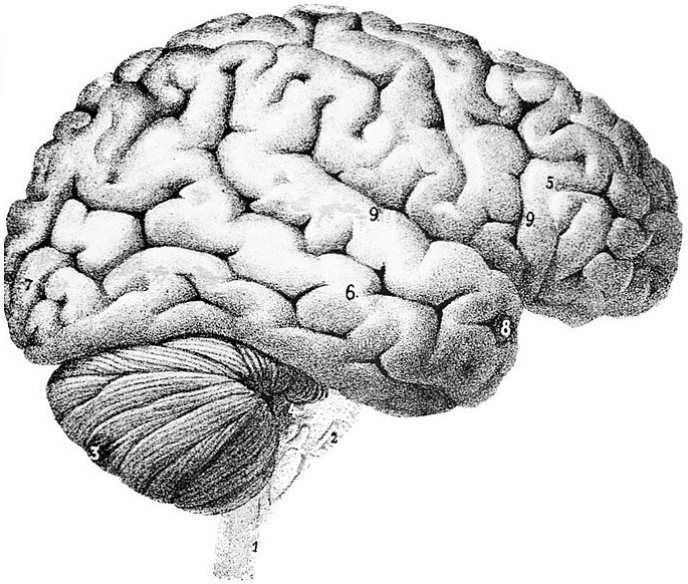
Memory and the Brain



Psychology, Portland State University
Behavioral Neuroscience, OHSU
nwnoggin.org

What is memory?

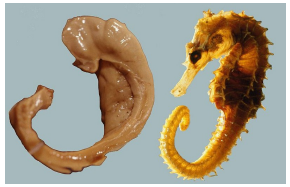




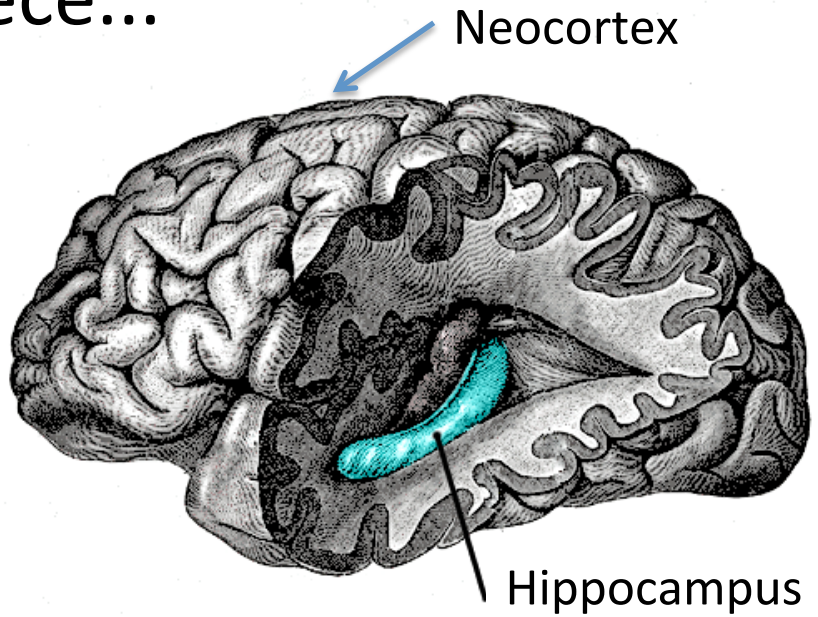
- Memory is physical
- Remembering an event is a creative act
- There are different forms of memory, each dependent on specific areas of the brain…
- Biological systems can grow - and decay

You remember events

- When you heard a song that has meaning…
- Details of episodes from own your life, like when you first picked up your instrument, or practiced a specific piece...



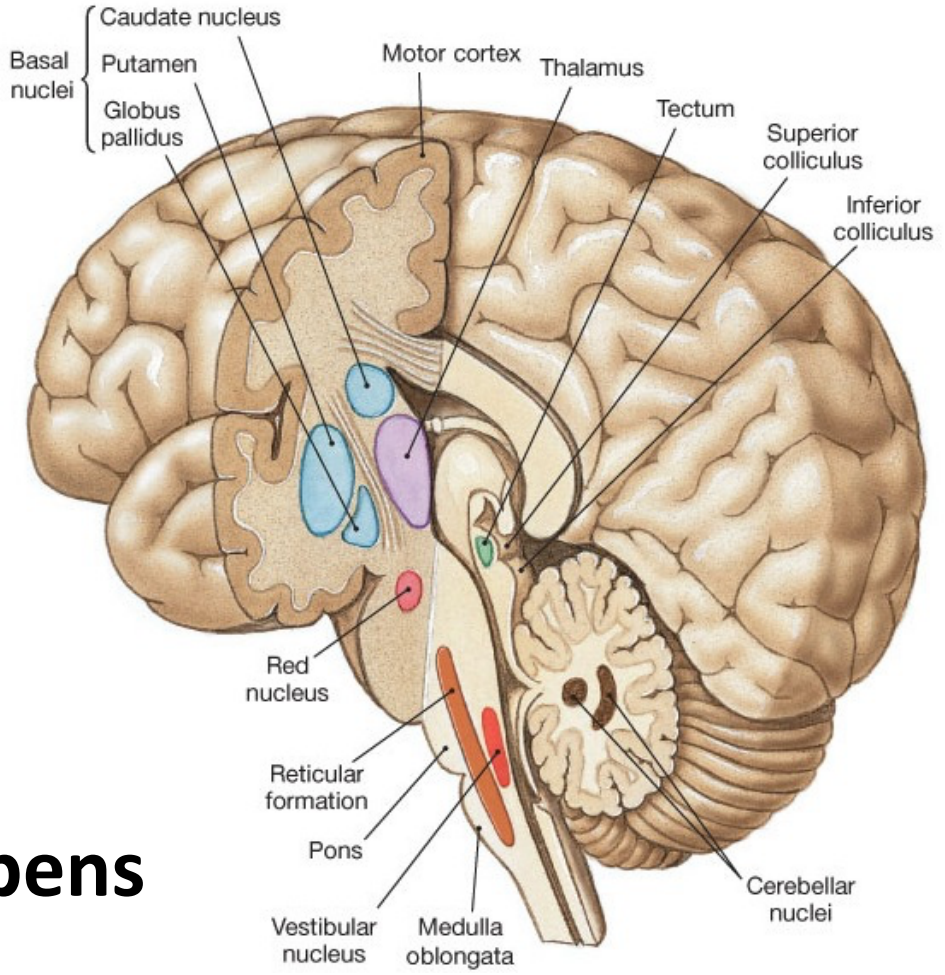
Depends on neural networks in the **hippocampus**, and other areas of **cortex**



You remember skills…
And music also *moves* you…

Literally…

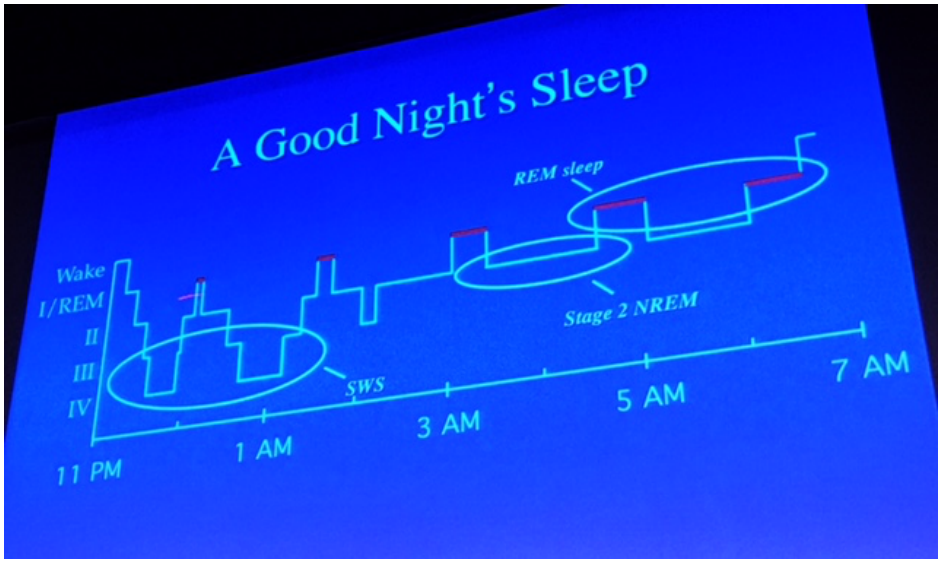
- **Basal ganglia**
  - Involuntary mvmt
  - Timing of mvmt
- **Cerebellum**
  - Balance
  - Coordination
  - Repetitive mvmts
- **Amygdala/Accumbens**
  - *Emotional* mvmts

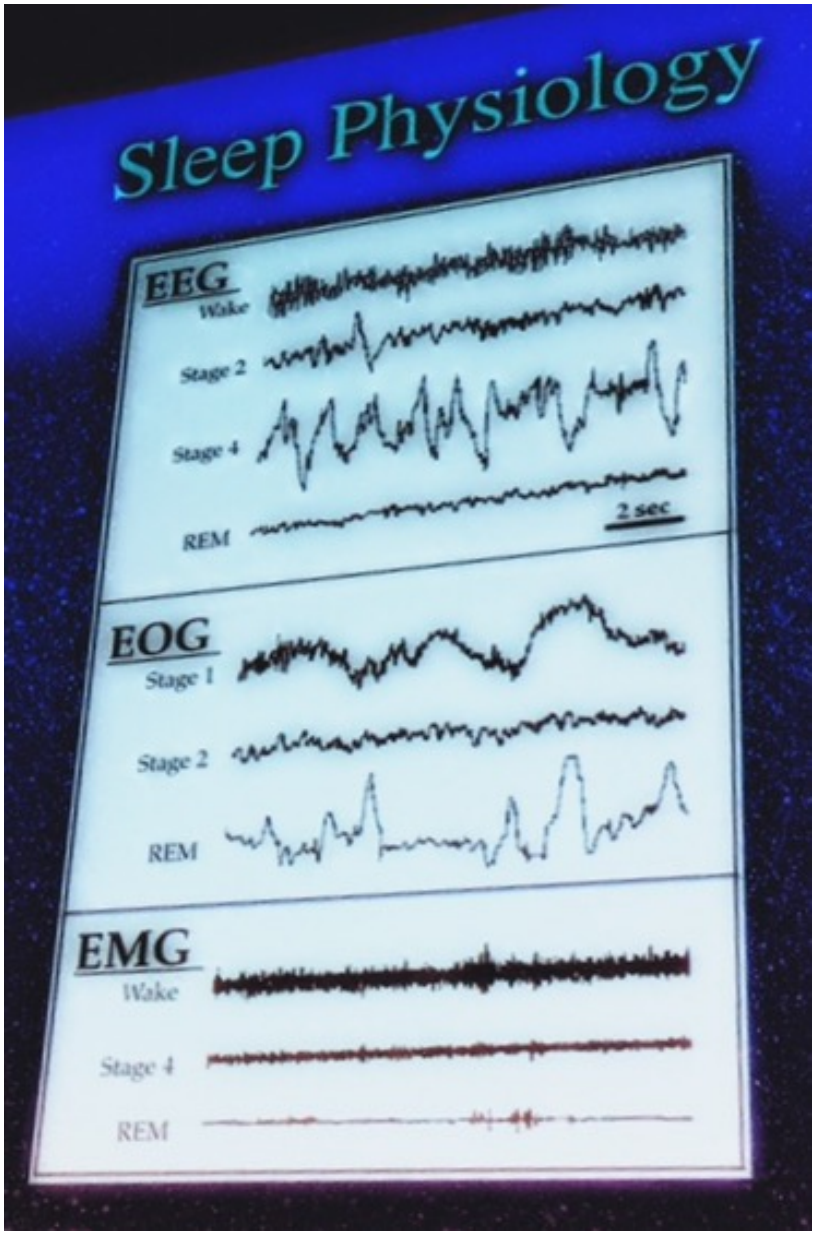


SLEEP

EEG: Sleep Stages
NREM and REM

Neuromodulation
Dopamine
Norepinephrine
Serotonin
Acetylcholine



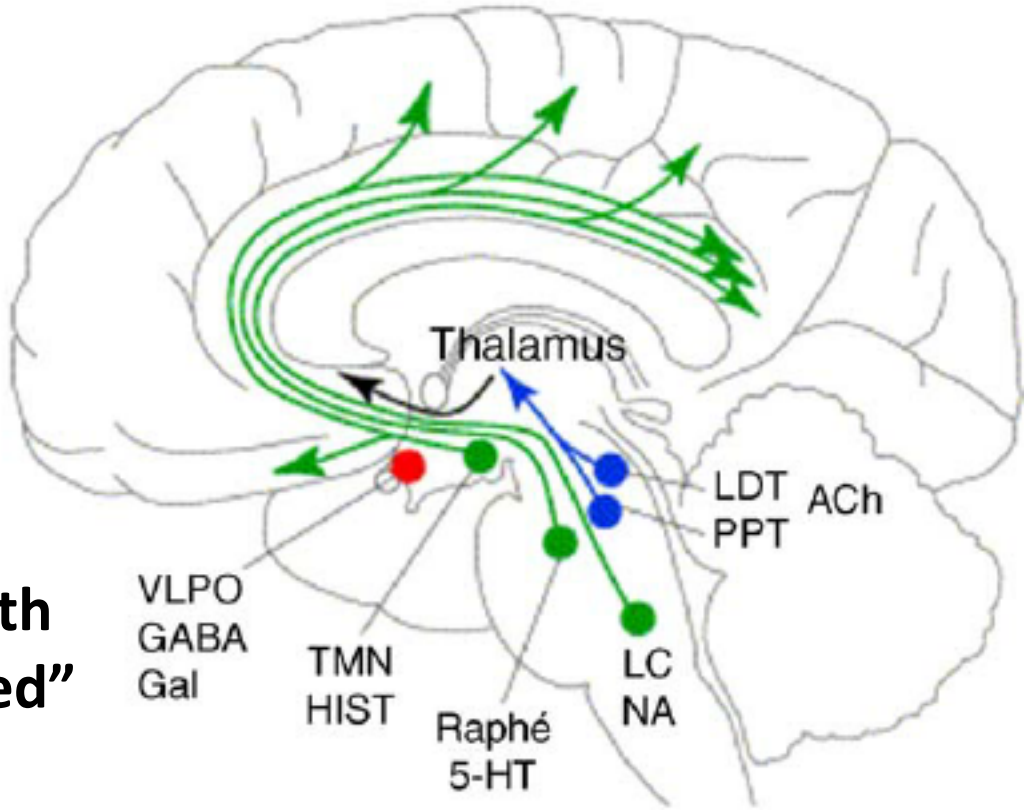


SLEEP: Changes in REM

Amygdala

Anterior cingulate

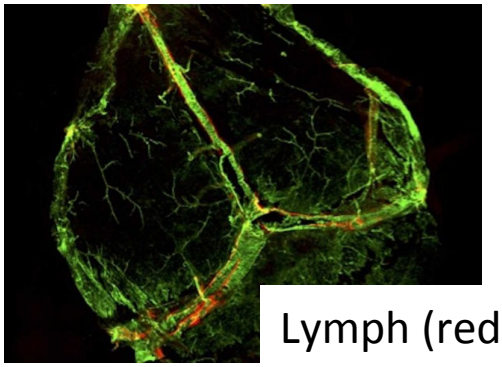
DLPFC



Dreams can be "hyper-emotional and bizarre, with logical constraints removed"
-Robert Stickgold (2017)

Sleep-wake and Other Biological Rhythms: Functional Neuroanatomy (2005)

Sleep and the glymphatic system



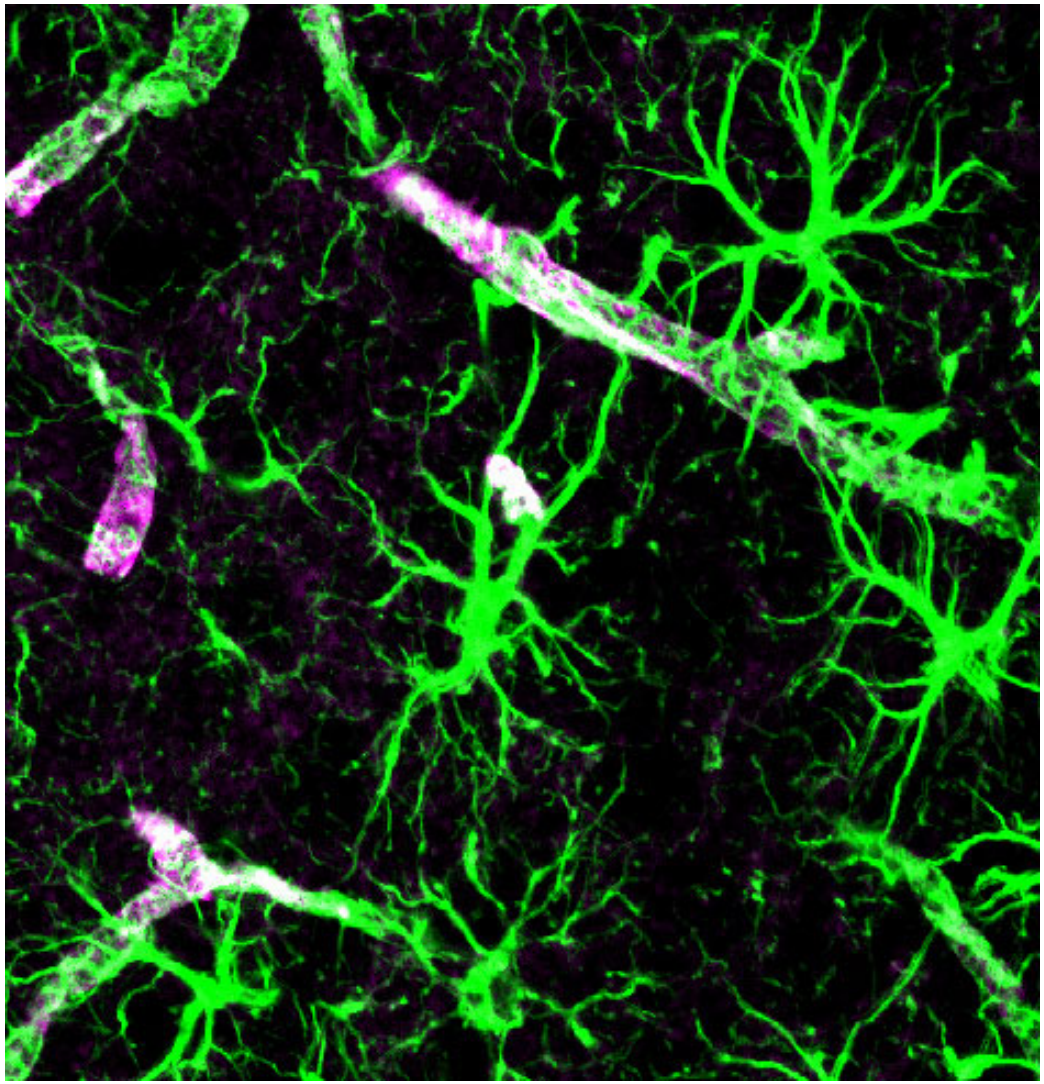
Lymph (red)

Jeffery Iliff, OHSU

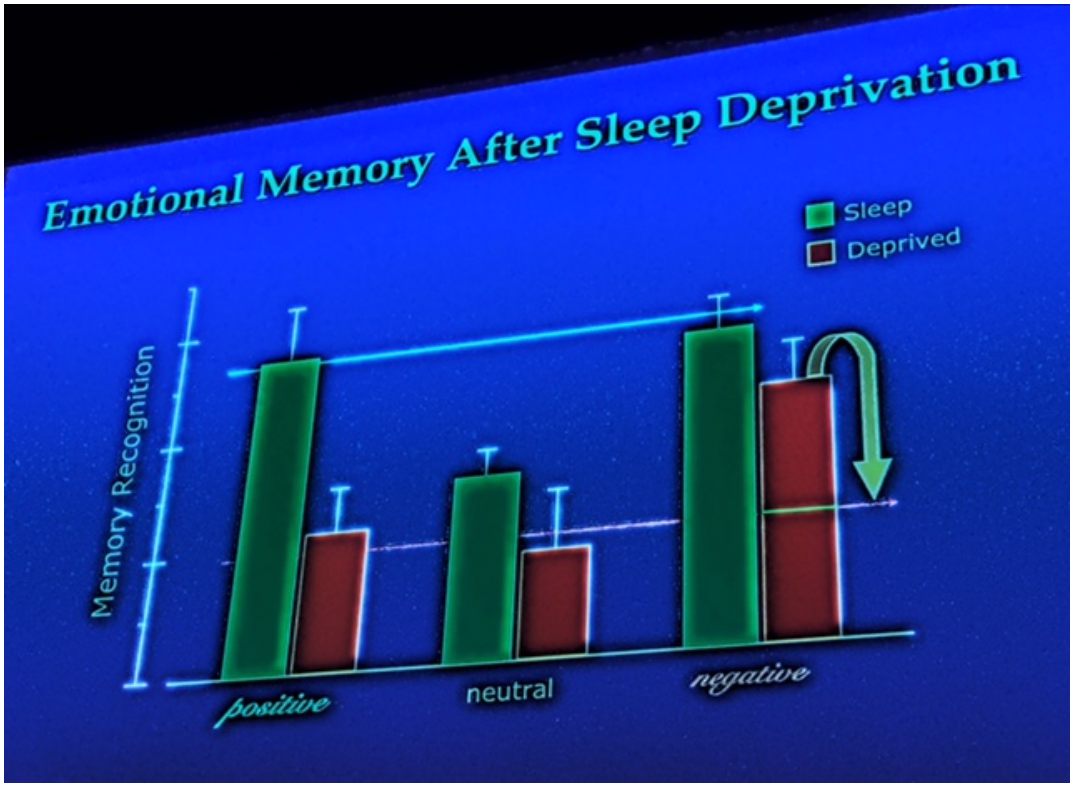
Limited lymphatic system in the brain

How is waste cleared from the CNS?

Lack of sleep, lack of clearance, increased risk of disease?

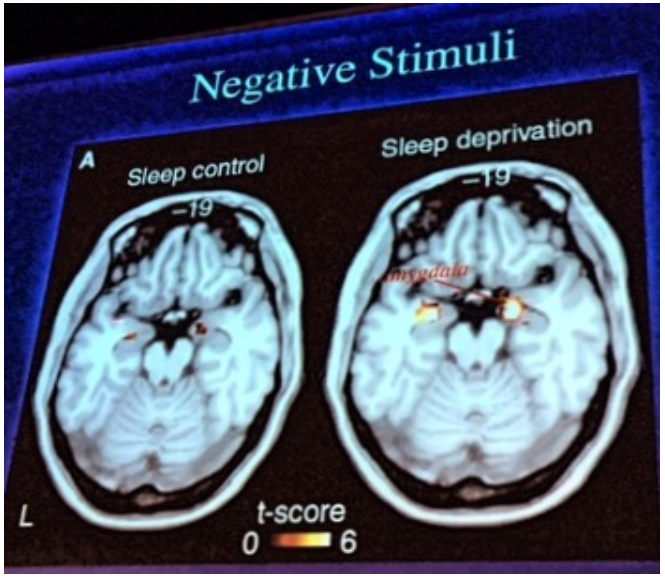


Lack of sleep makes you negative



Yoo et al (2007), Curr Biol

Sleep deprived subjects selectively better able to recall negative words than neutral or positive words they'd studied earlier



ALSO: greater amygdala response to negative words than their more alert subjects; and less functional connectivity with medial OFC…

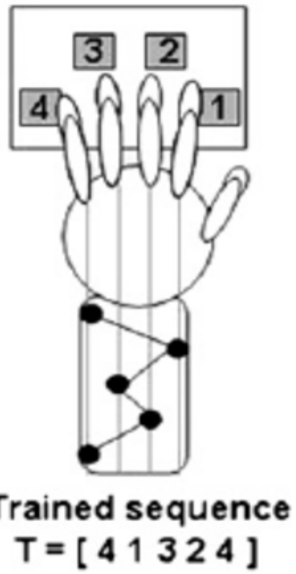
PREFRONTAL – AMYGDALA DISCONNECT:
Stronger negative emotional response, and less inhibitory control

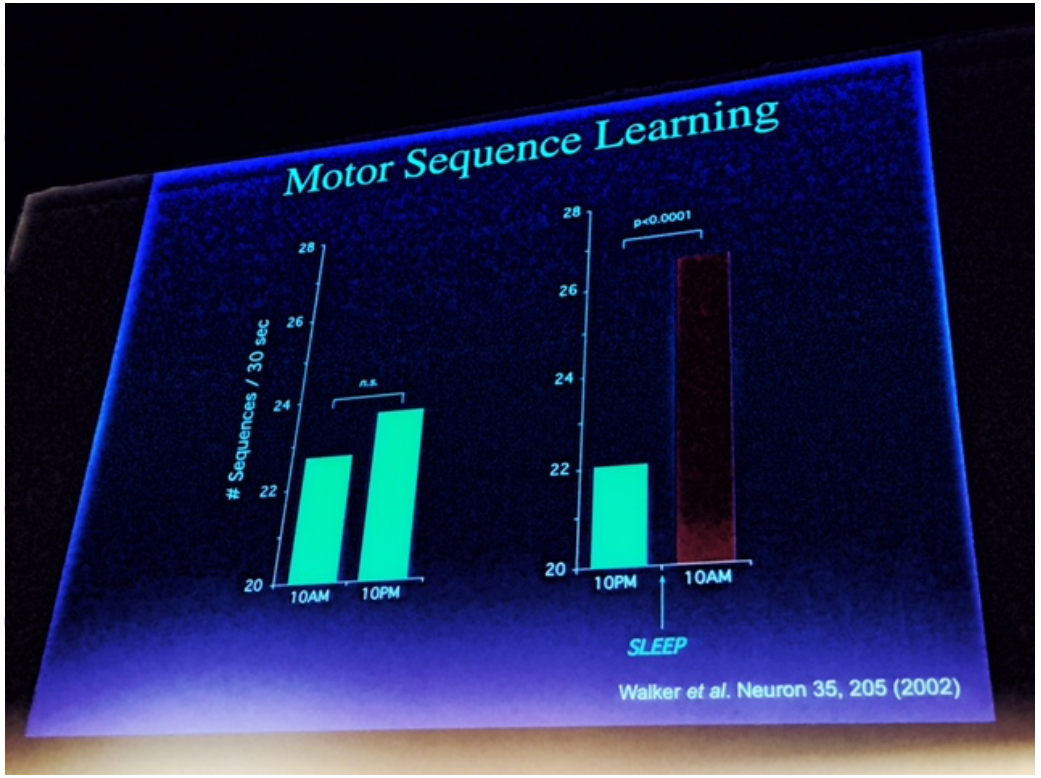
Lack of sleep impairs memory

Sleep enhances procedural memories

Subjects trained on a **sequential finger tapping task** did better if allowed to sleep after training, instead of spending the same amount of post-training time awake…

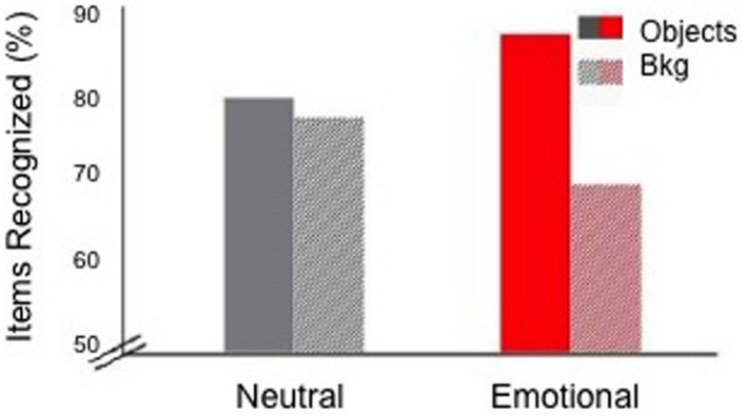
Walker et al (Neuron (2002))





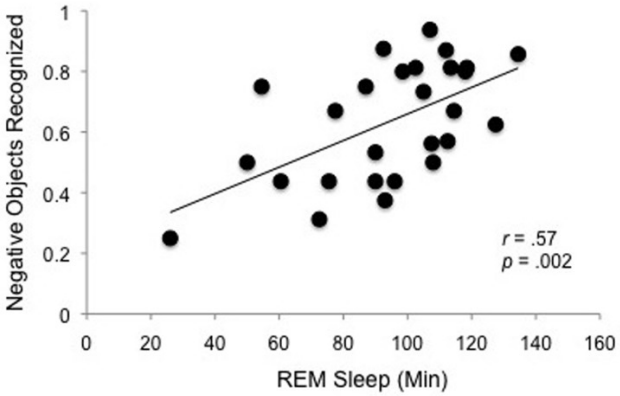
Sleep: get "gist," drop details

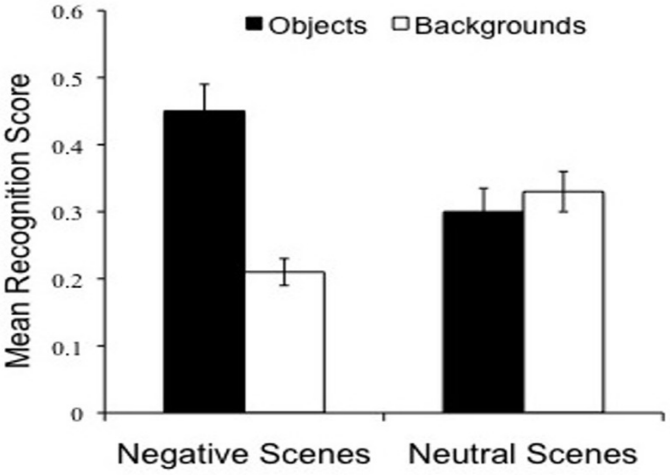
Sleep promotes lasting changes in selective memory for emotional scenes, Payne et al (2012)



Increase in memory for emotional objects
Decrease in memory for neutral backgrounds

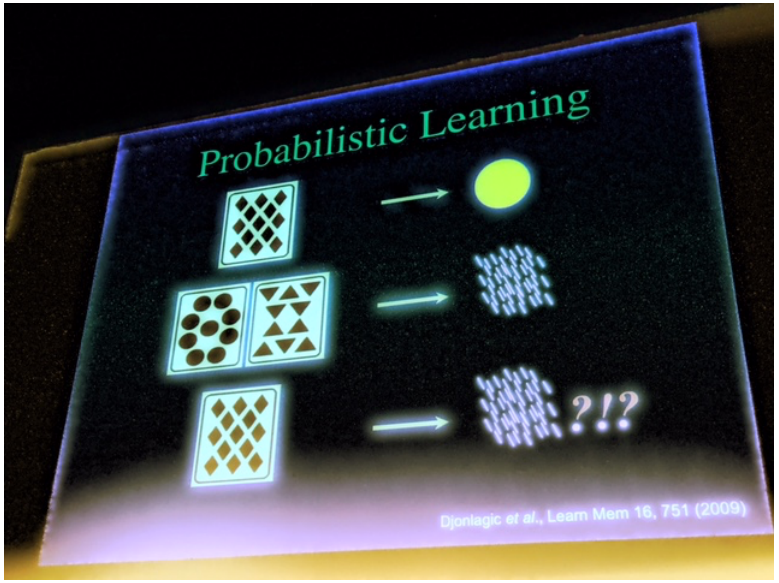
Positive association between REM and selective consolidation of central, negative aspects of complex scenes





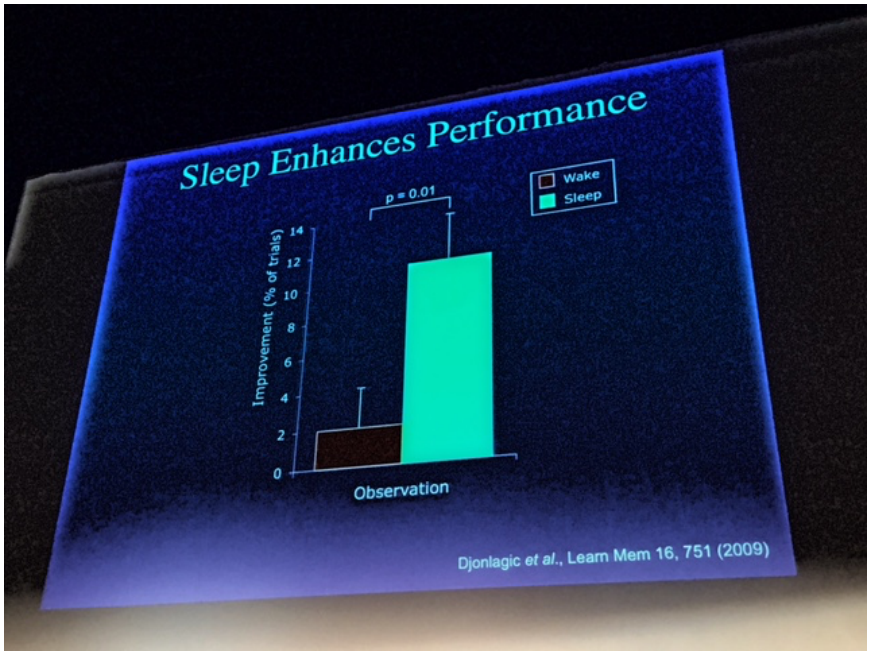
Sleep improves insight

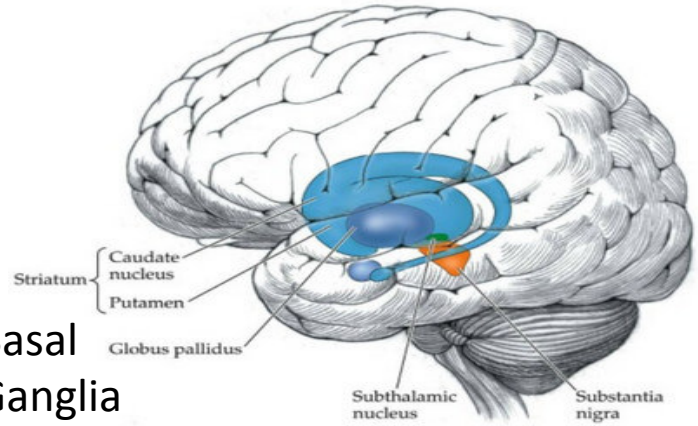
Djonlagic et al (2009)



Weather prediction task

Subjects presented with cards, each probabilistically linked to a particular outcome ("rain," "sun"). Better w/sleep…



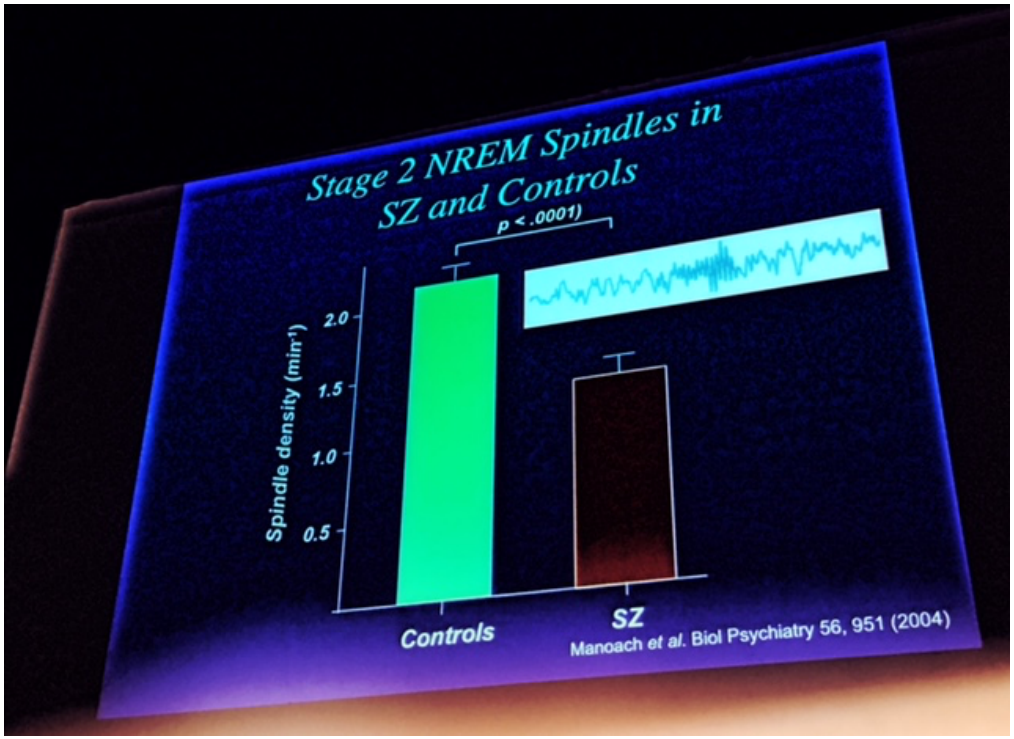


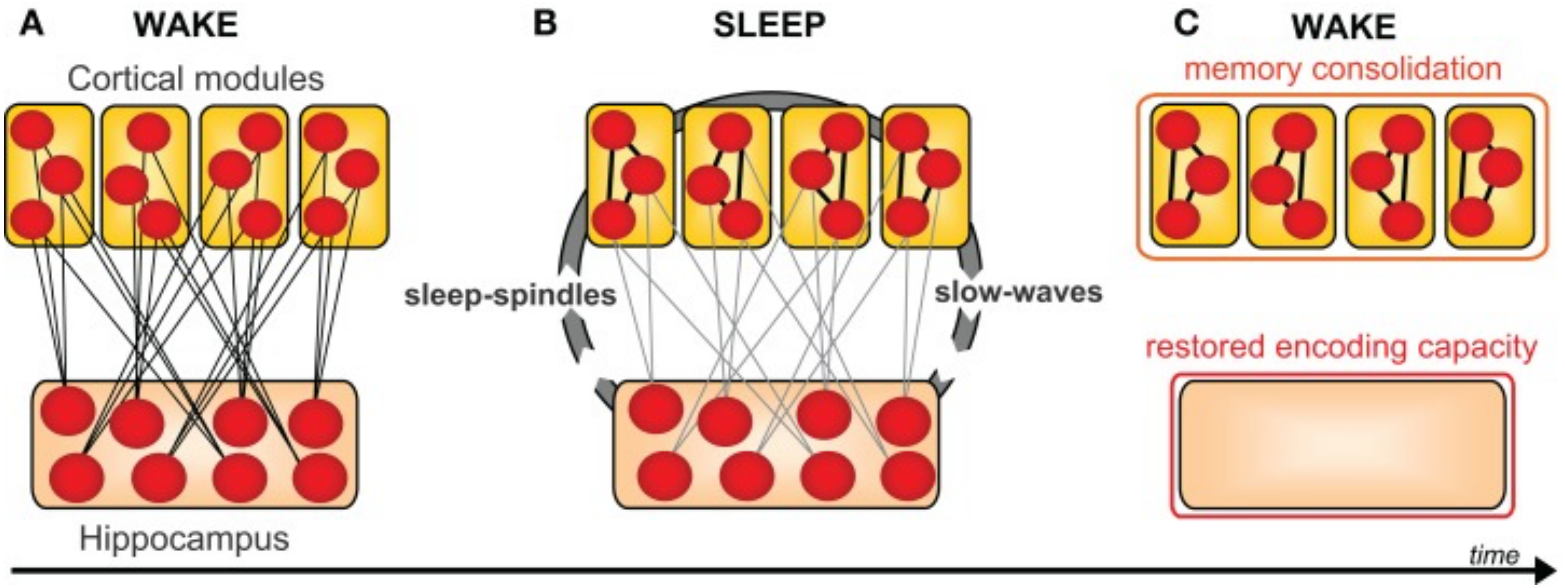
Basal Ganglia

Sleep and schizophrenia

Do NOT improve on finger tapping task

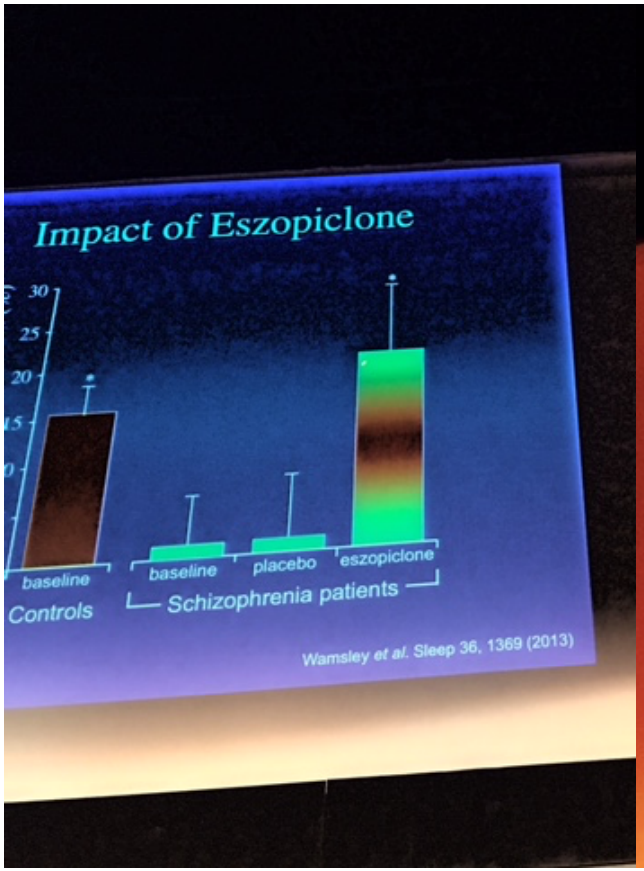
BUT: Much worse sleep
Fewer **sleep spindles**

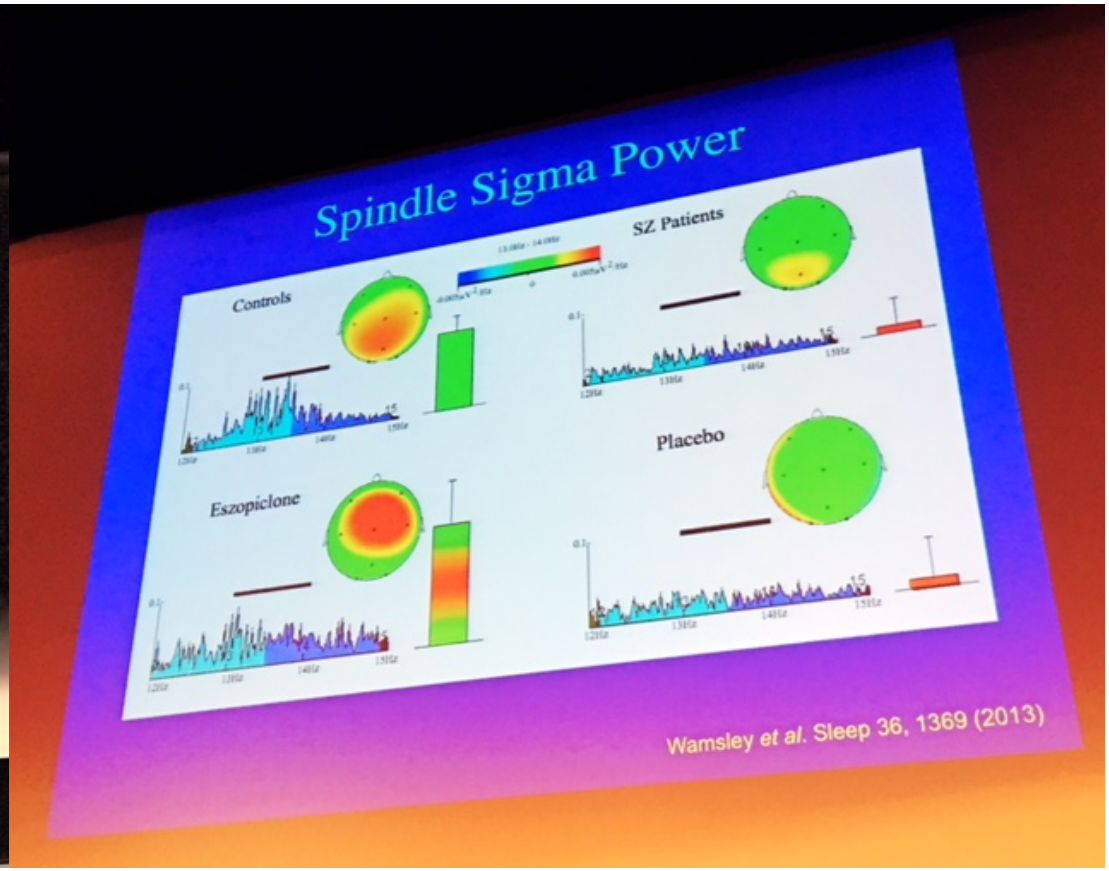




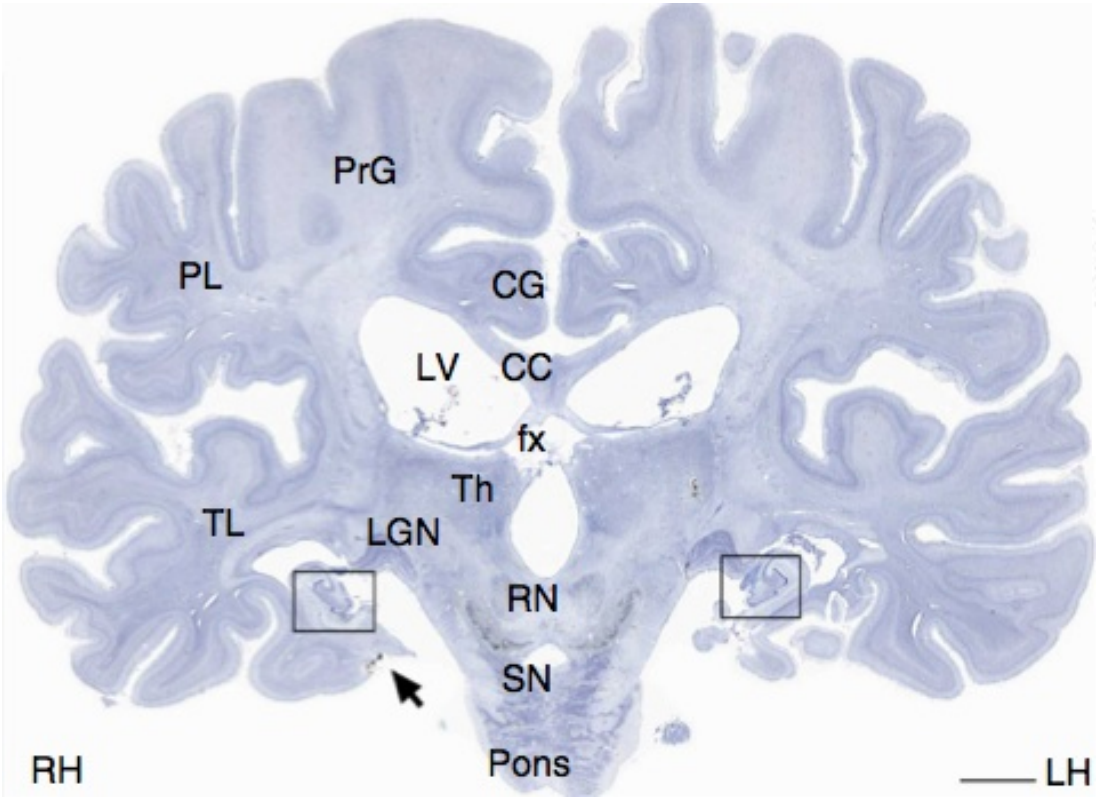
Better sleep = better memory

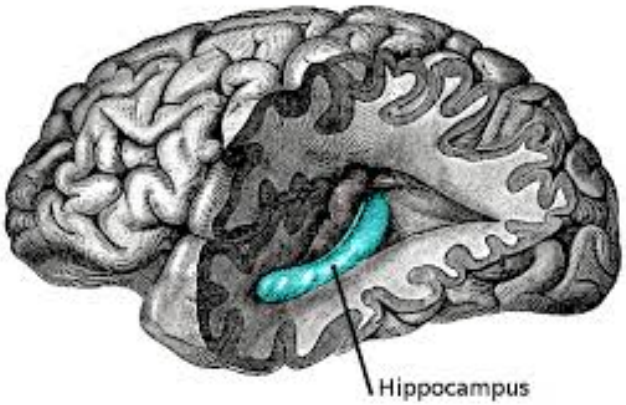
Eszopiclone improved sleep in schizophrenics, increasing the incidence of sleep spindles. This also restored the memory benefits of sleep! (Cenk Tec et al (2014))

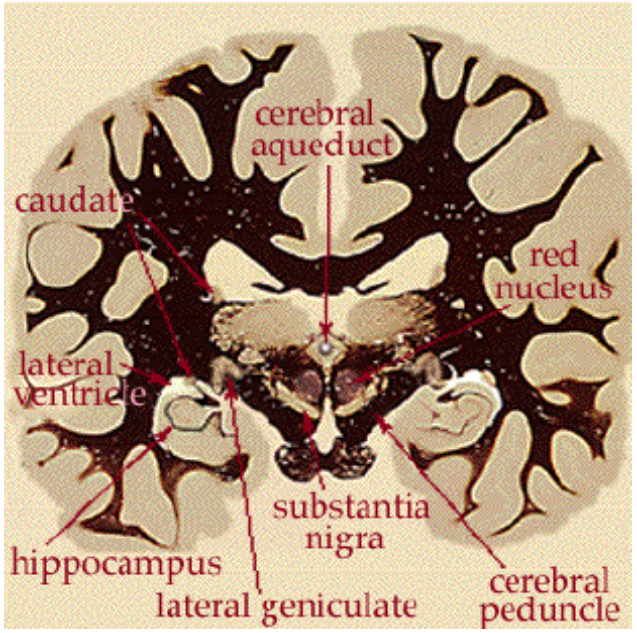




Patient H.M.



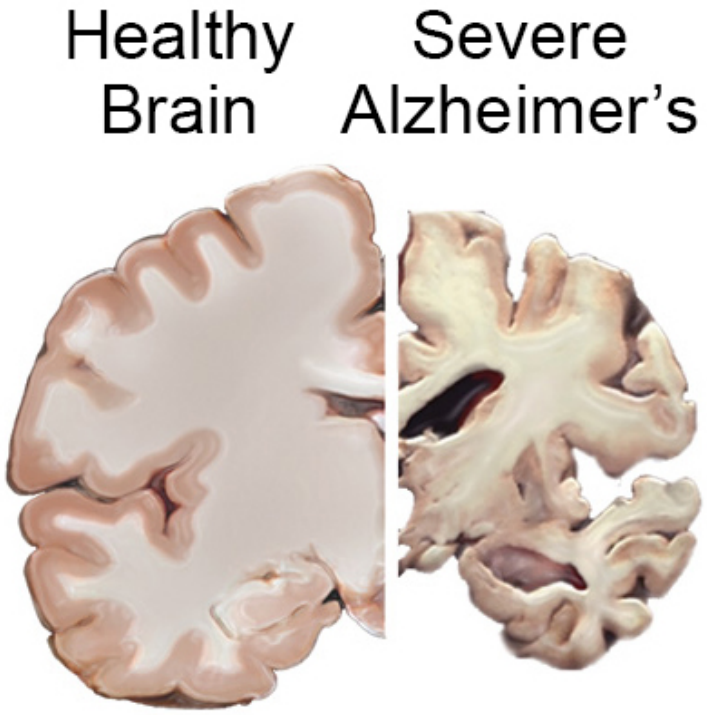




- Henry Molaison (1926 – 2008)
- Intractable epilepsy
- Surgery at age 27
- Bilateral temporal lobectomy

Alzheimer's disease

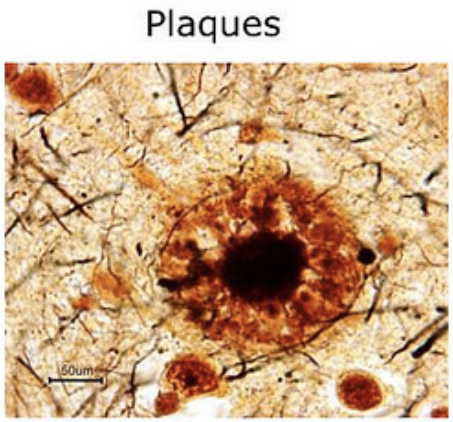
A "disconnection syndrome"



- Alois Alzheimer (1906)
- 6th leading cause of death (in US)
- Most common form of dementia
- Affects 5 million Americans

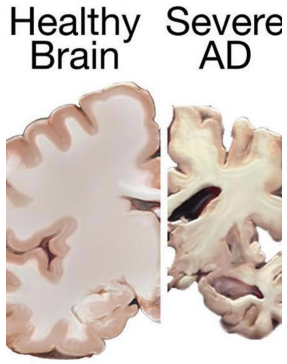
- Beta-amyloid plaques
- Tau protein tangles

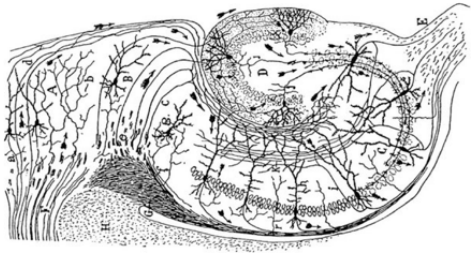
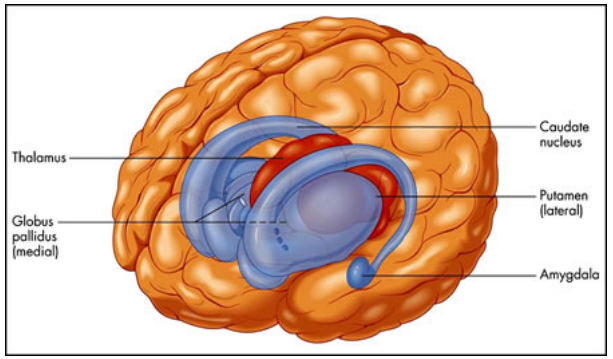
- Aging, inflammation, genetics
- Late vs. early onset forms



Henry

Dementia involves damage to neocortex and hippocampus





BUT: preservation of subcortical structures critical for involuntary movements, skills, emotions…