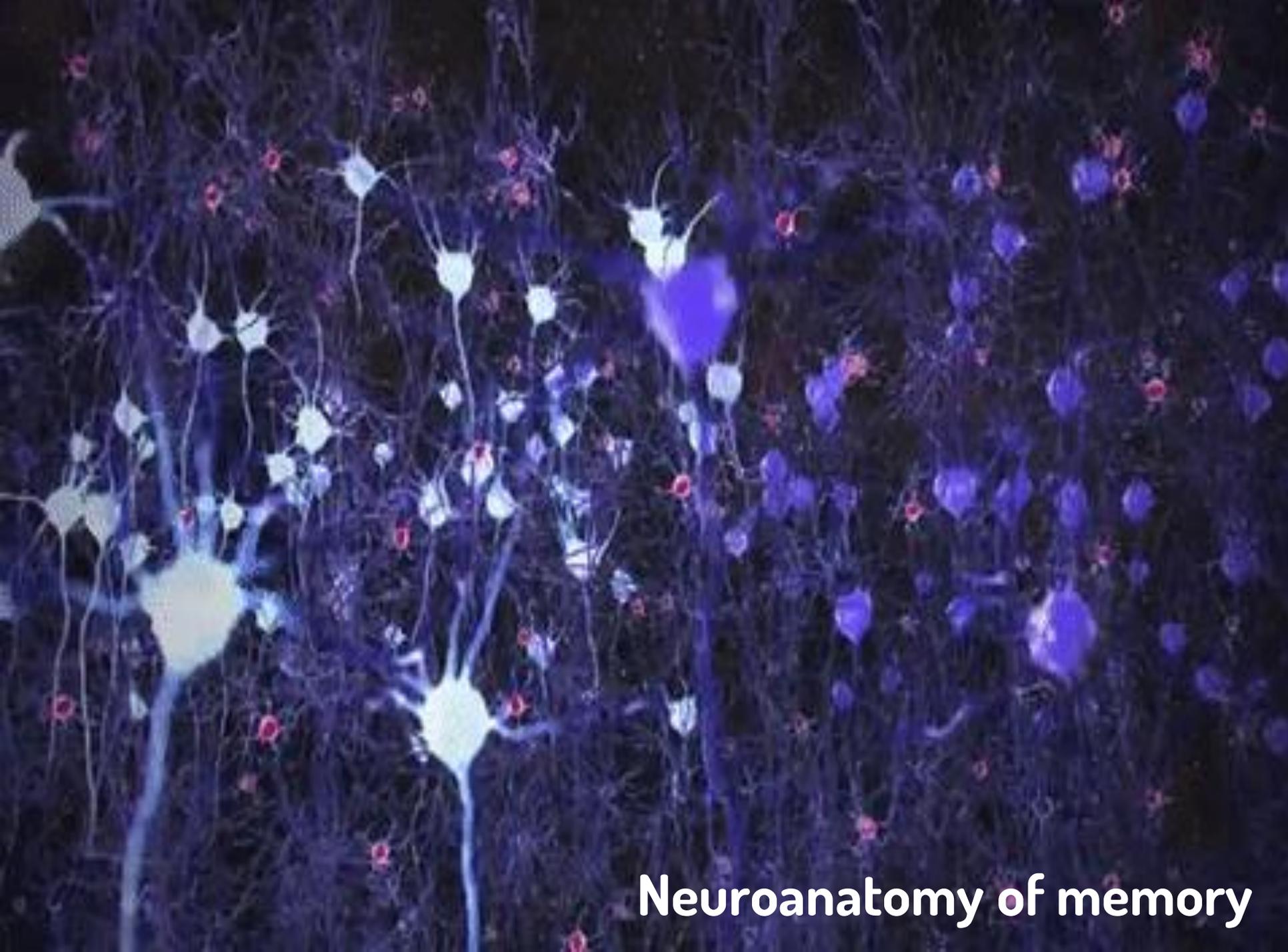


OKITI

HUNGARIAN BRAIN RESEARCH PROGRAM
NEMZETI AGYKUTATÁSI PROGRAM



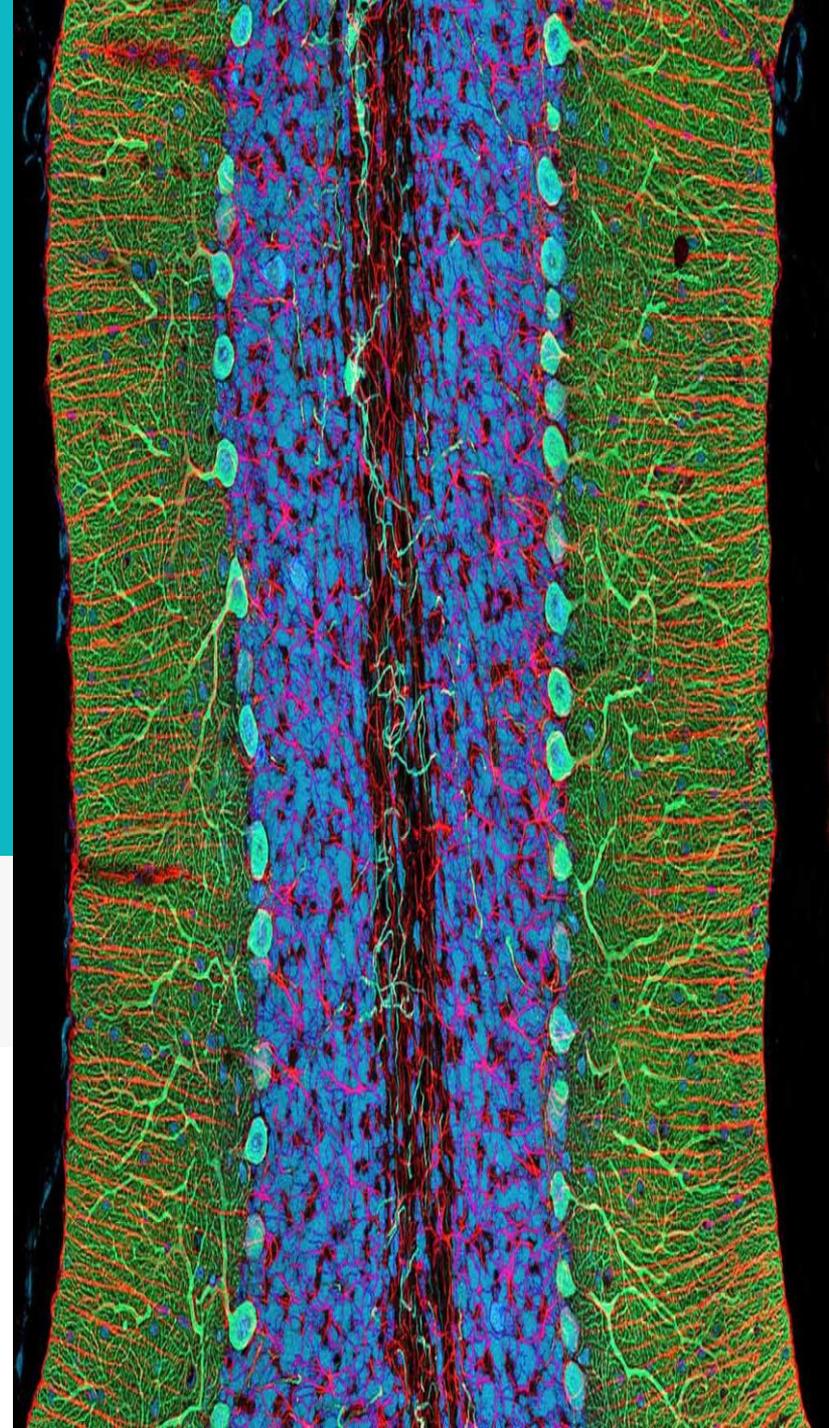
Andras A. Horvath, MD, PhD
Clinical Anatomy Course 2020



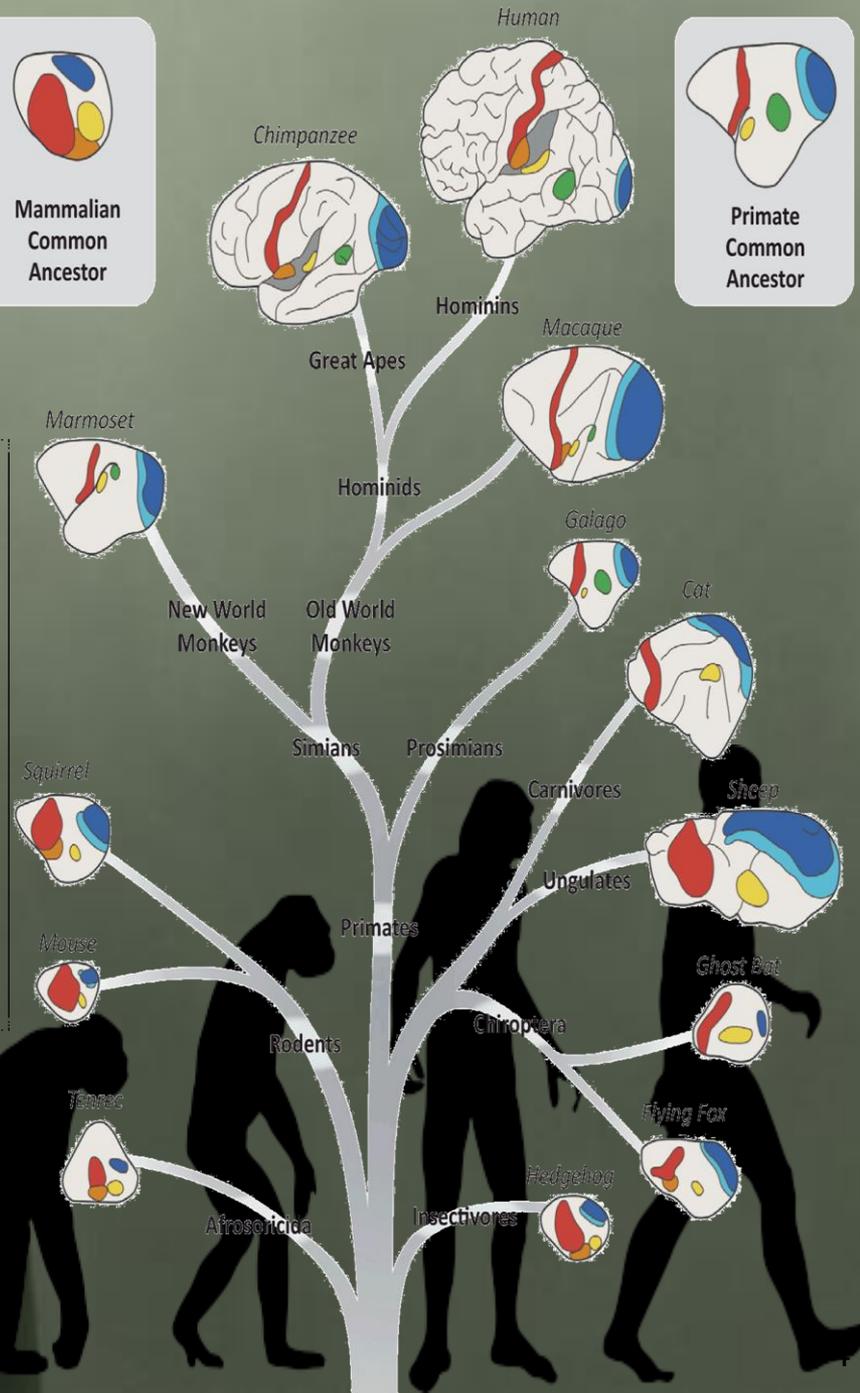
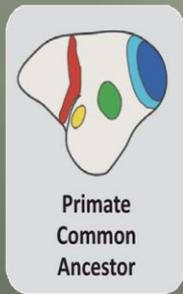
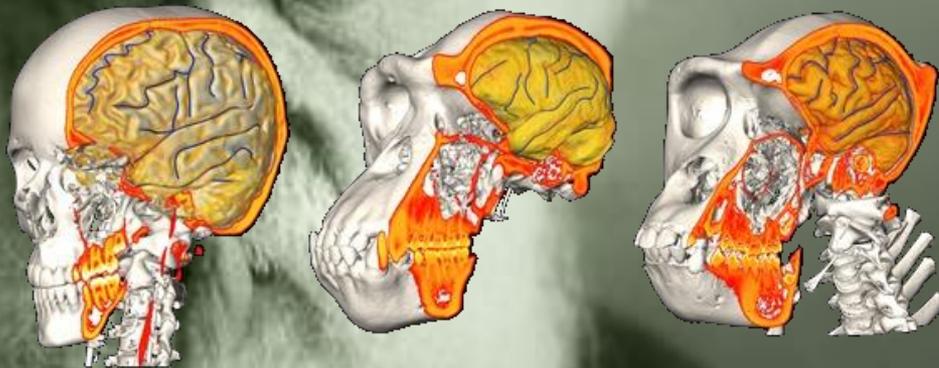
Neuroanatomy of memory

Agenda

- 🧠 **Theory of mind**
- 🧠 Episodic memory
- 🧠 Semantic memory
- 🧠 Procedural memory



Encephalisation



Memory= survival



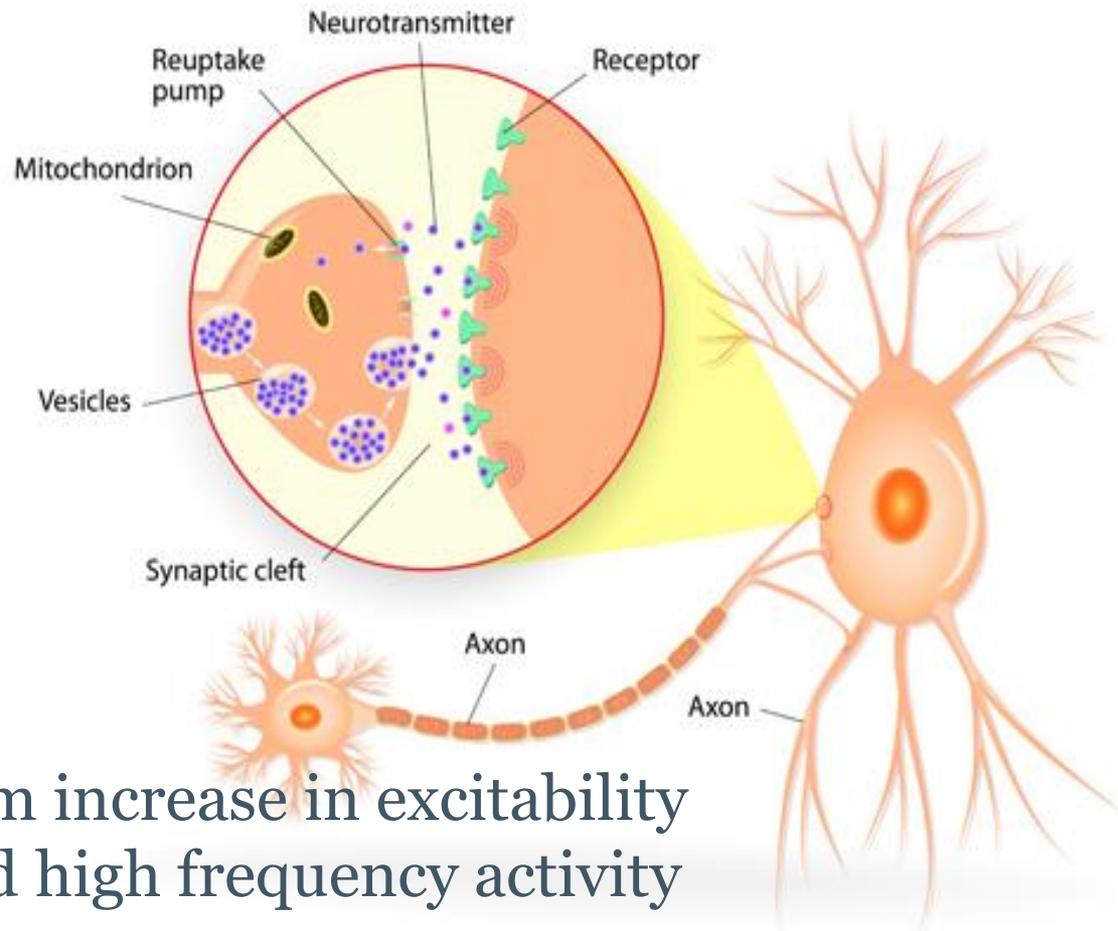
Memory fragments= history



Consequences

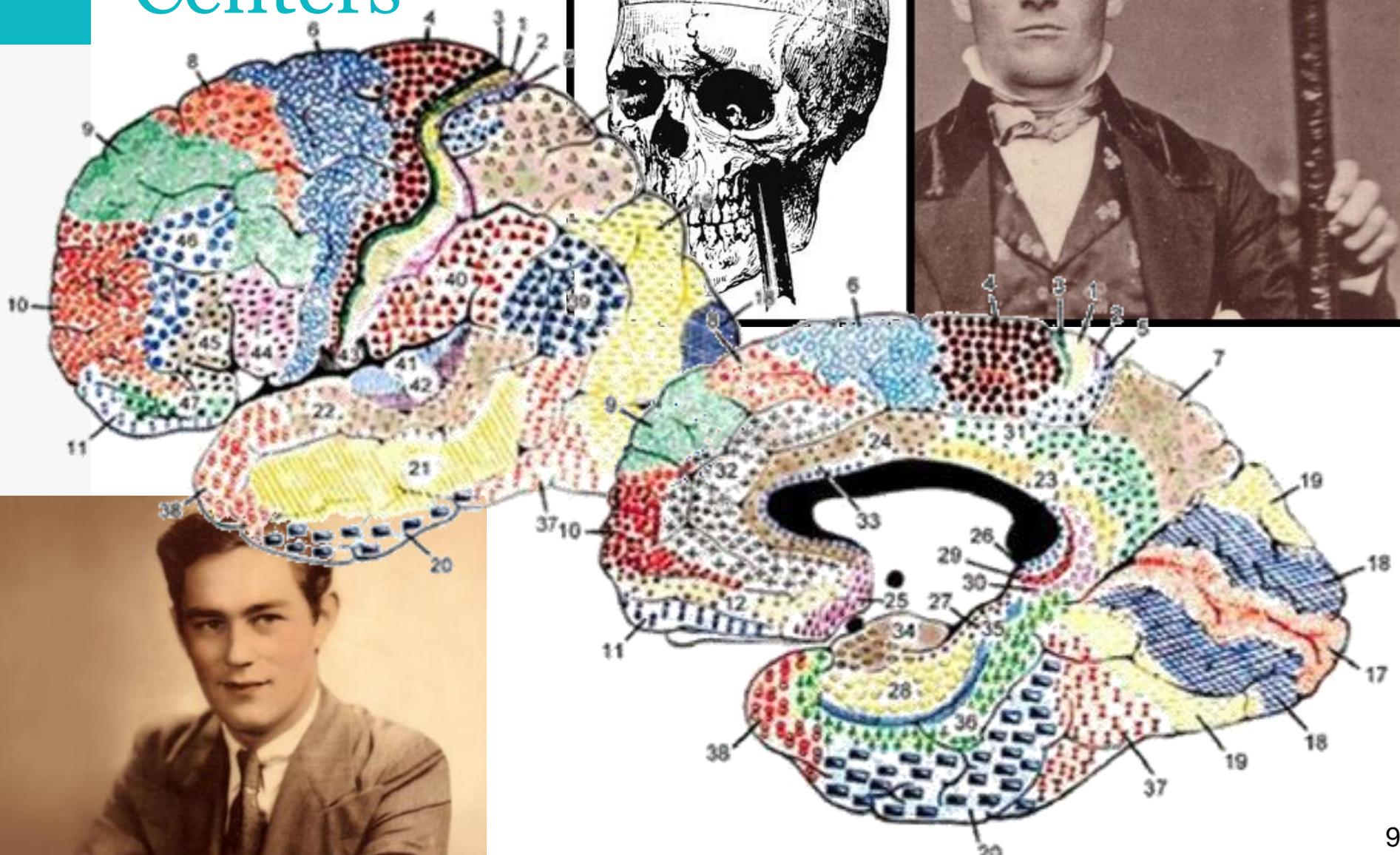


Synaptic plasticity= LTP/LTD

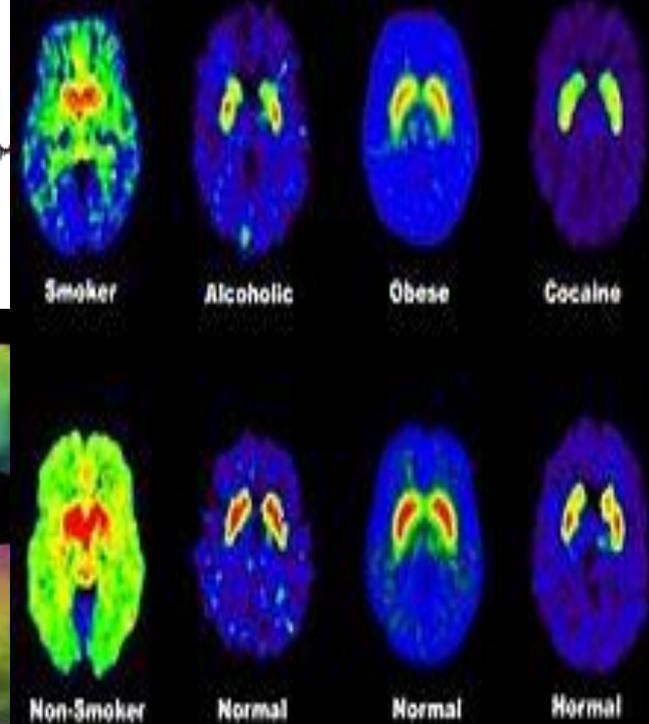
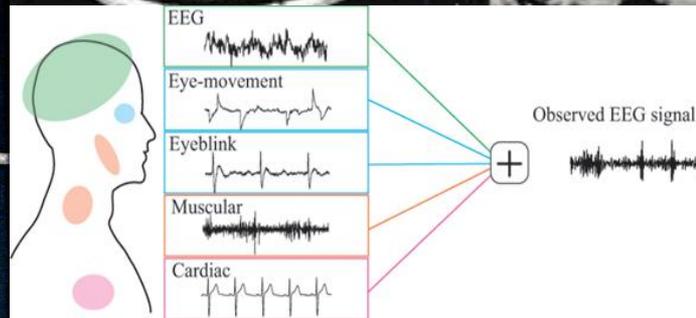
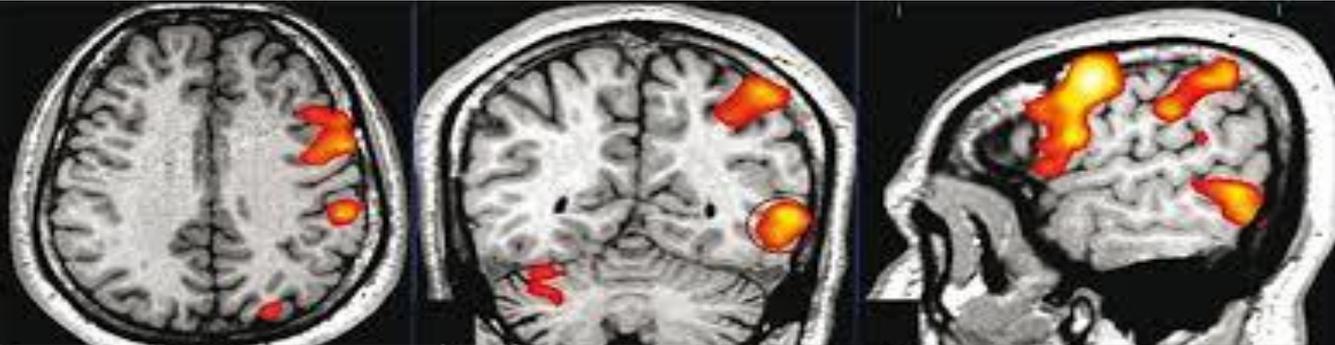
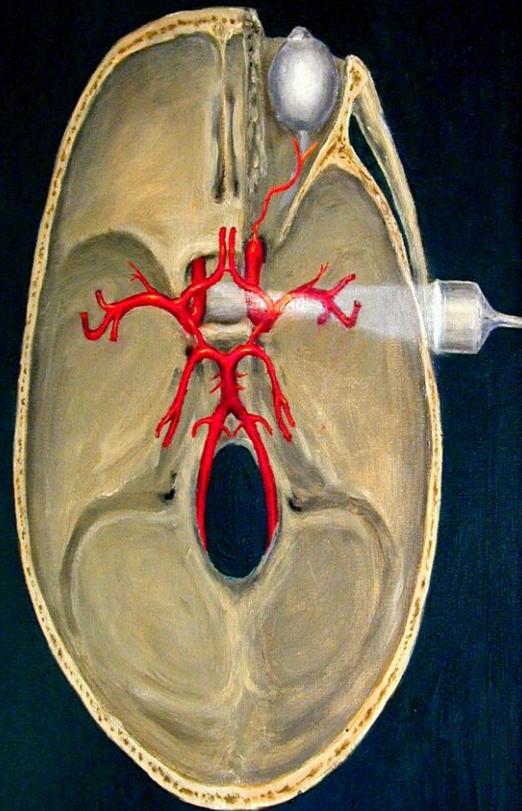


🧠 Long-term increase in excitability by repeated high frequency activity

Centers



In vivo imaging



Location of memory?

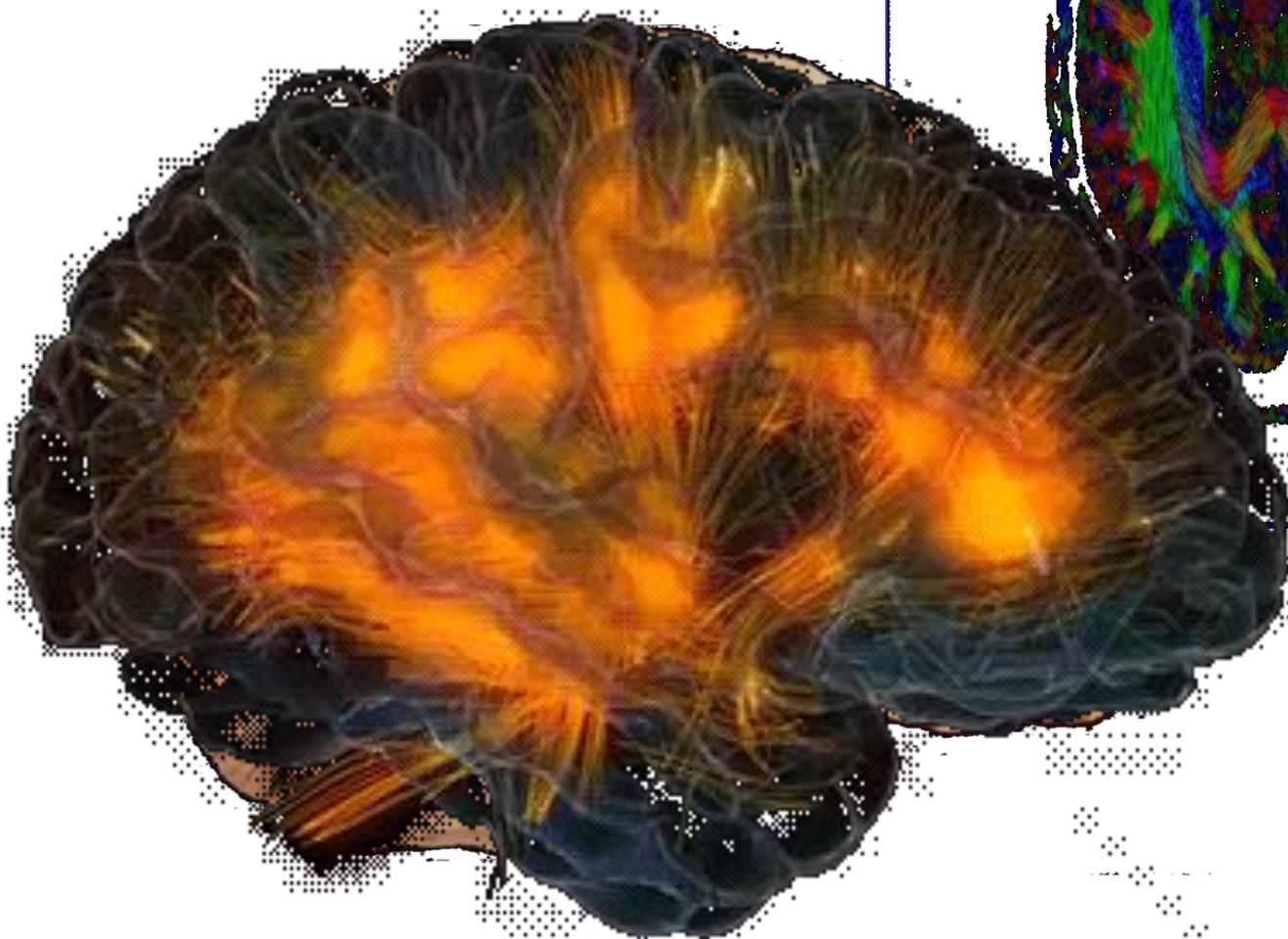


🧠 Edward Munch,
Scream, Oslo, 1893-
1910

Associations

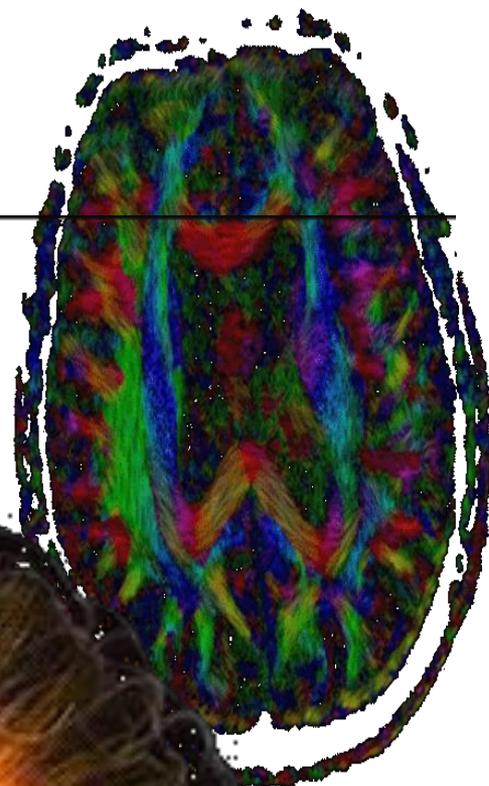


Networks

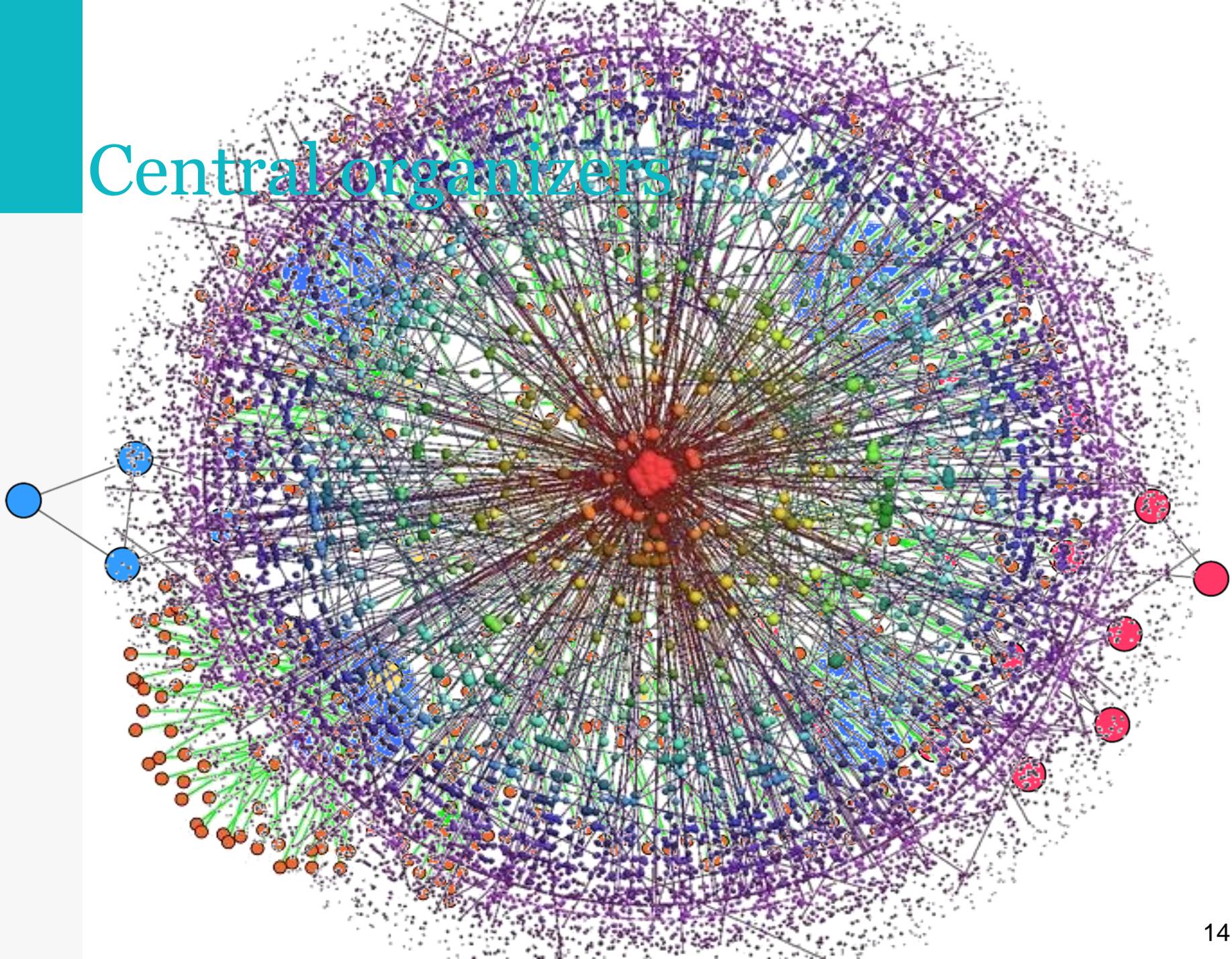


12/04/10/10

RAH



Central organizers



Process of memory

Attention

Encoding

Consolidation

Retrieval

Forgetting

-Targeting focus point and maintenance
-In prestudy and study phases

-Selection of insignificant
-Active erasement
-In resting phase

-Formation into memorable and retrievable form
-In study phase
-What is remembered is what is processed

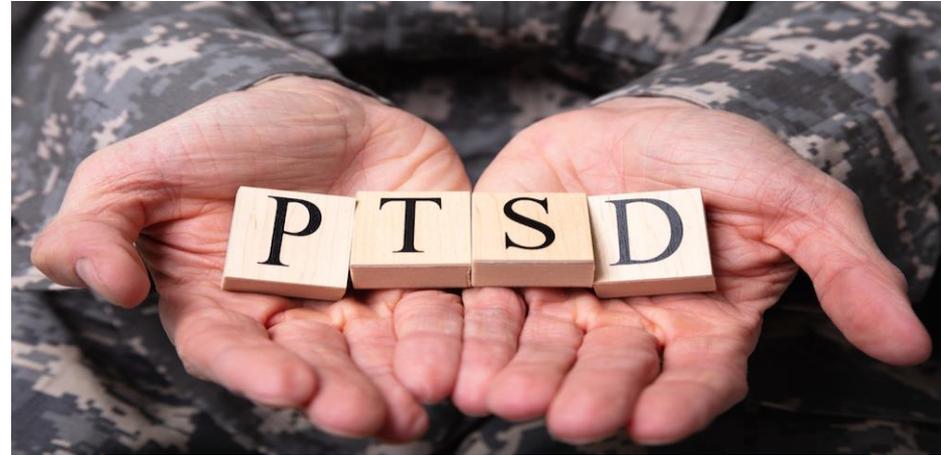
-Locating, selecting and activating memory items
-At the point of test

-Making new memories permanent
-In study- test interval
-Time need

Forgetting

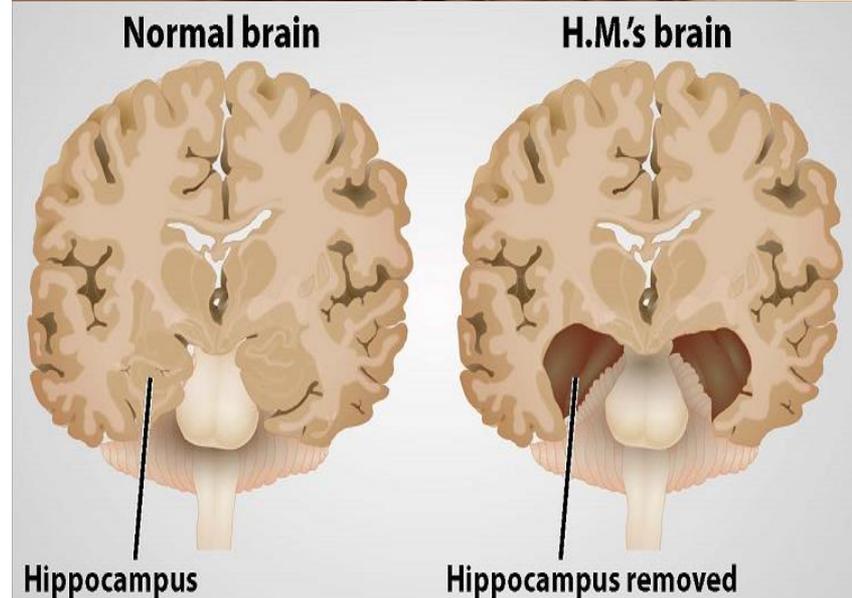
- Passive mechanism?
- Sleep depotentiation
- Forgetting neurons
- Rac1 protein
- Active neurogenesis

- Network preserves the susceptibility!

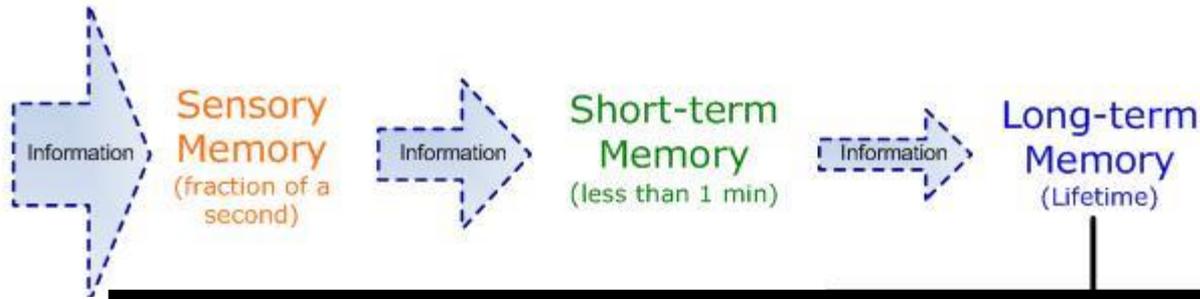


H.M.

- Severe epilepsy due to bicycle accident at the age of 9
- Bilateral temporal lobectomy
- Anterograde amnesia
- Short-term vs long-term memory
- Explicit vs implicit memory
- Episodic vs semantic



Forms of memory



Explicit memory
Requires conscious awareness

Implicit memory
Does not require conscious awareness

Semantic memory
Facts and general knowledge

Episodic memory
Personally experienced events

Procedural memory
Motor and cognitive skills

Priming
Enhanced identification of objects or words

Learning through classical conditioning

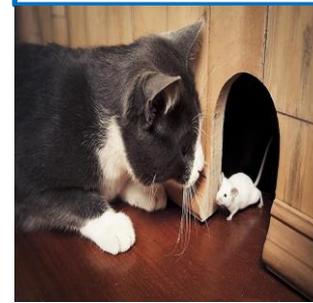
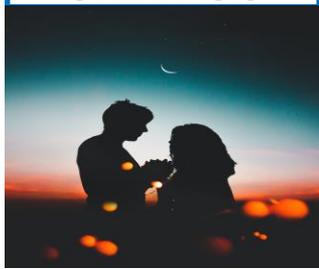
CORTEX

HIPPO-CAMPUS

BASAL GANGLIA, CEREBELLUM

CORTEX

AMYGDALA



Short-term?

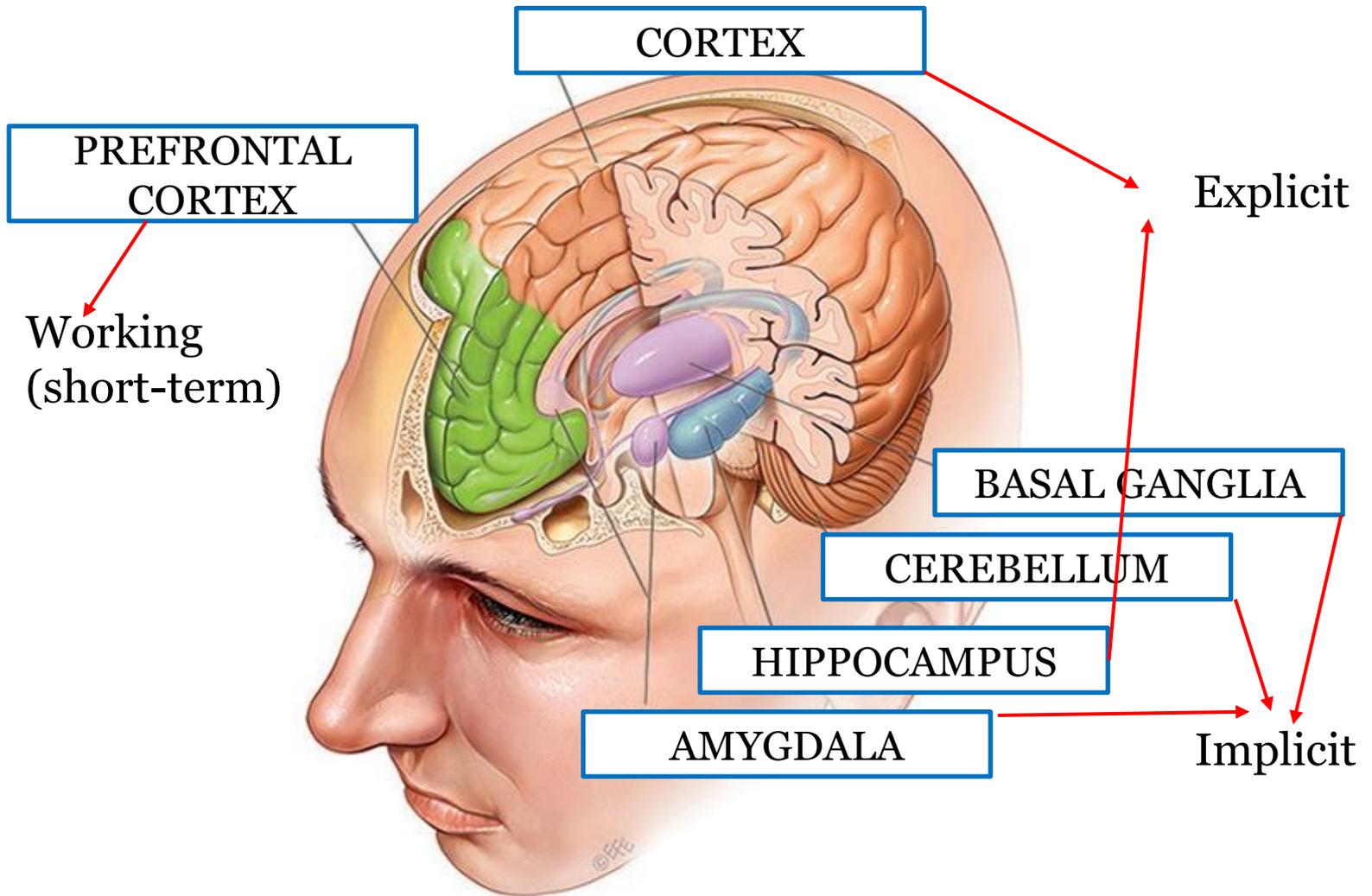


Short-term: HIPPOCAMPUS

Working: FRONTAL CORTEX

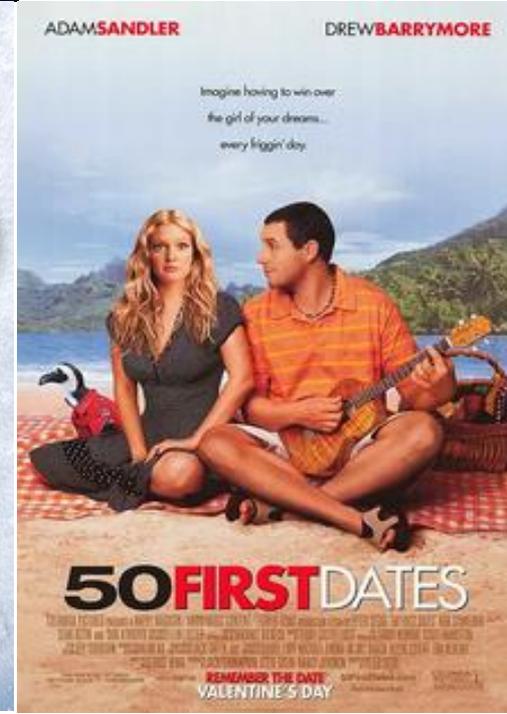


Distribution of memory structures



Amnesia

- 🧠 Deficit in memory caused by neuronal damage
- 🧠 Retrograde and anterograde
- 🧠 Cause: injury,
- 🧠 Special: childhood, psychogenic



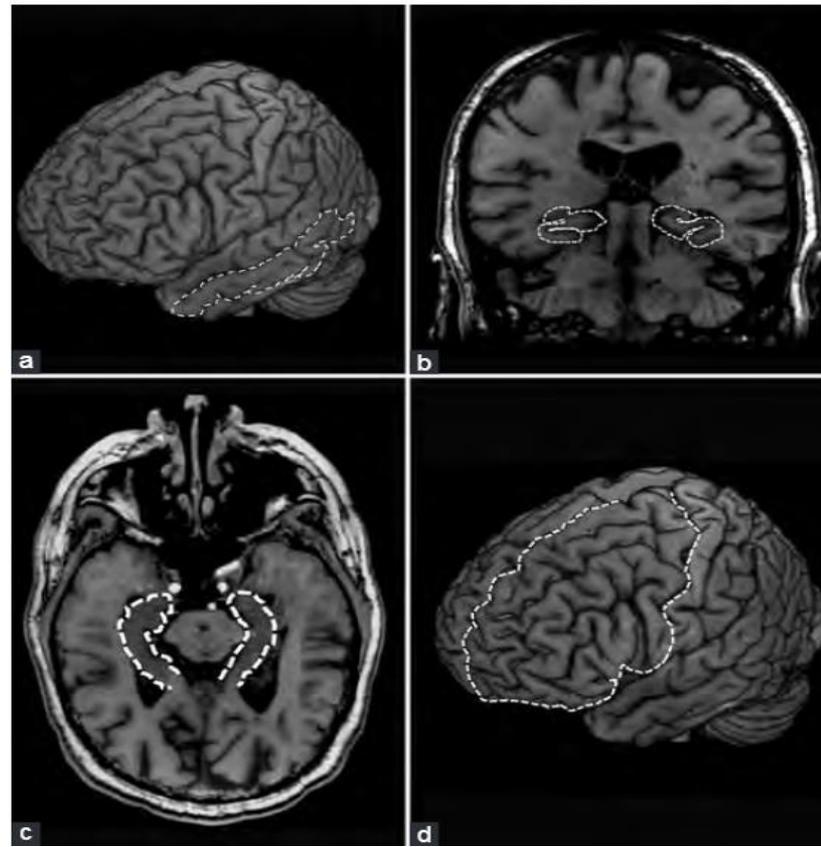
Agenda

- 🧠 Theory of mind
- 🧠 **Episodic memory**
- 🧠 Semantic memory
- 🧠 Procedural memory



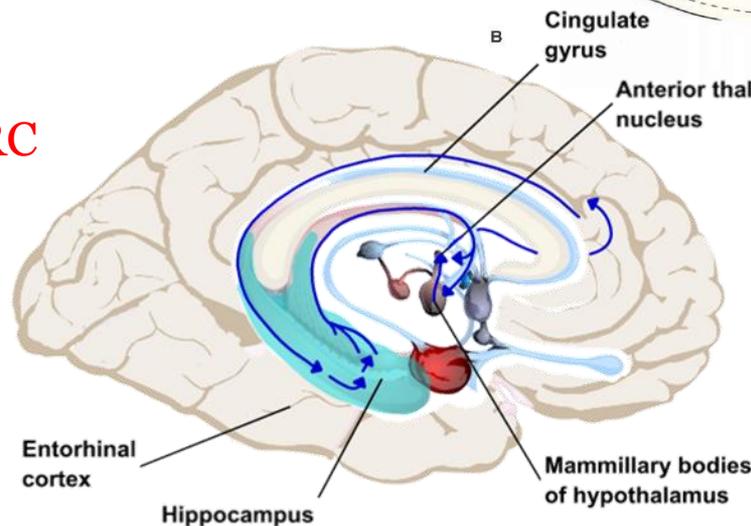
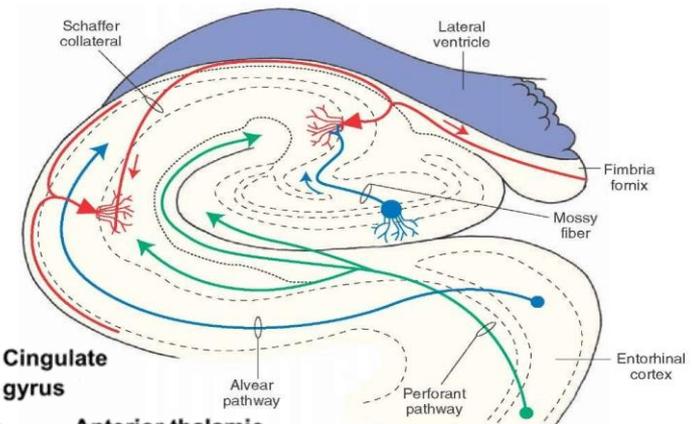
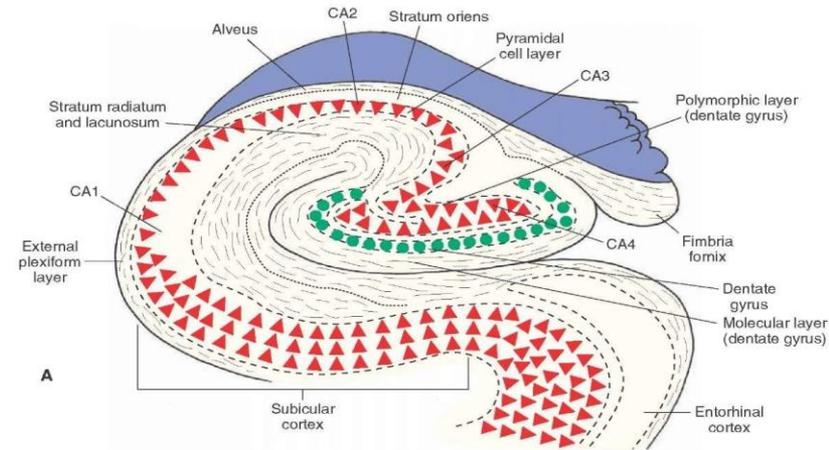
Episodic memory

- Personally experienced events
- Identity and individuality
- Cortical: Frontal-temporal cortex, entorhinal area
- Subcortical: hippocampus



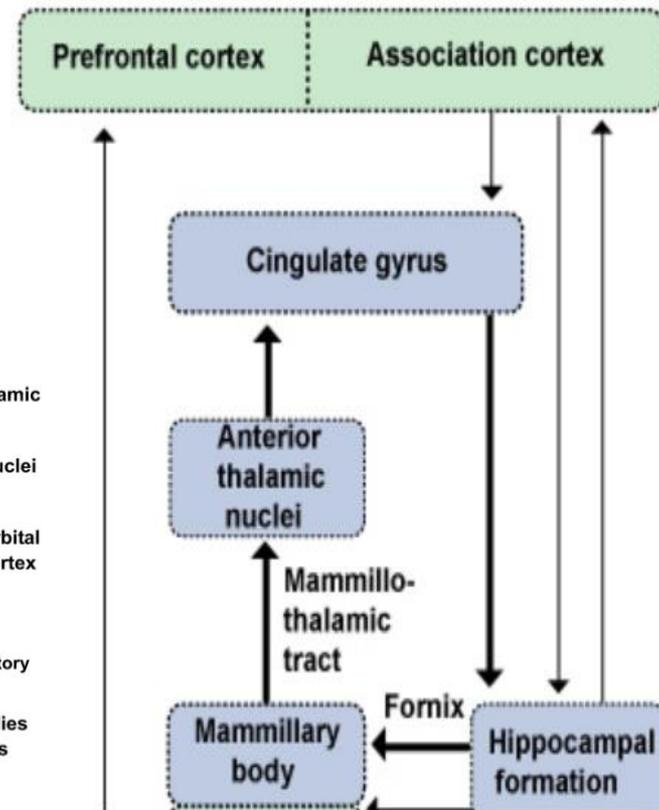
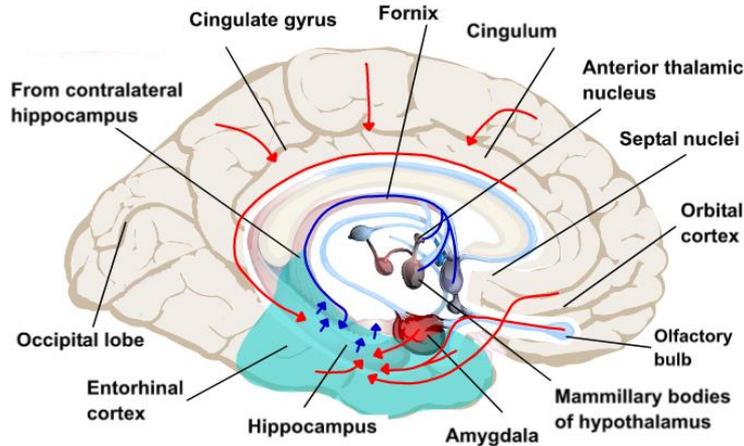
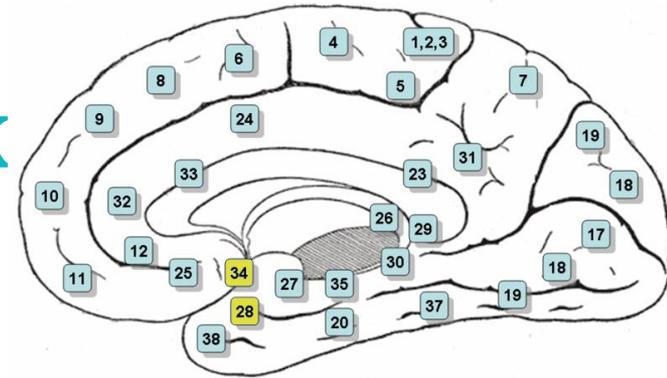
EM: hippocampus

- Input: entorhinal cortex (alvear and perforant path)
- Alvear path: ERC layer 3 to CA1
- Perforant path: ERC layer 2 to dentate g., CA3
- Internal connections: mossy fibers (granular cells to CA3); Schaffer-collaterals (CA3 to CA1)
- Output: fornix (to mammillary body); ERC



EM: entorhinal cortex

- Medial temporal lobe- MTL (ERC+ perirhinal cortex+ parahippocampal gyrus)
- ERC: medially amygdala, laterally PHG
- Br: 28, 34
- Function: association; grid cells (O'Keefe, MB Moser, E Moser 2014)

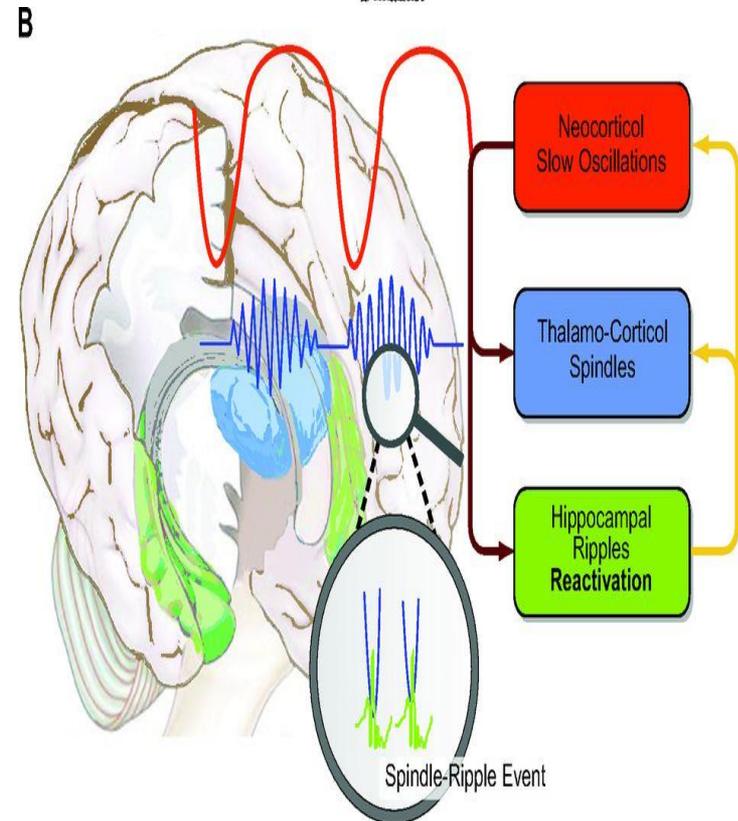
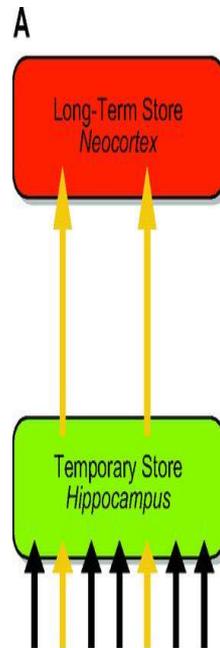
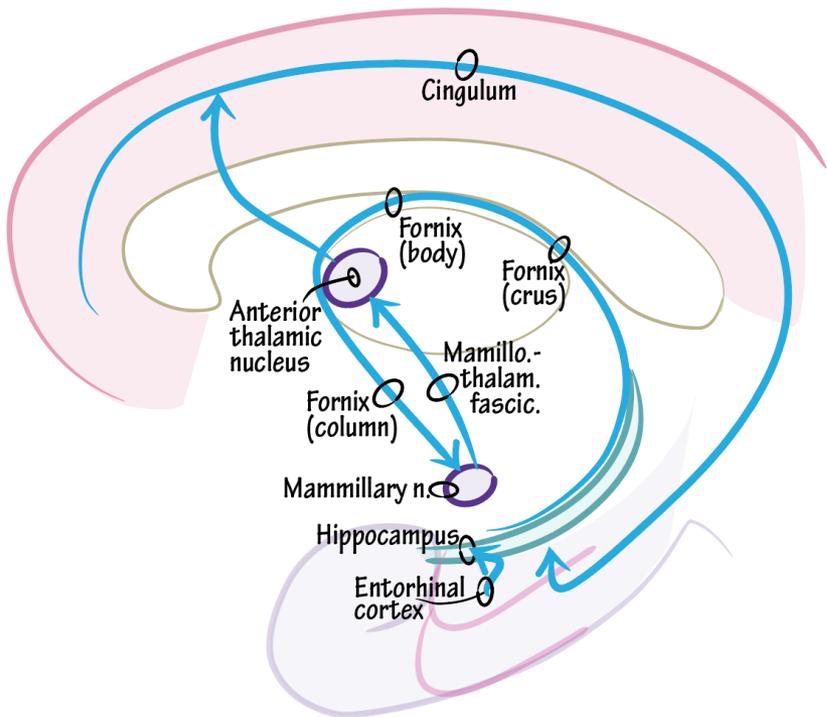


Memory consolidation - the price of sleep

ОПЫТЪ СИСТЕМЫ ЭЛЕМЕНТОВЪ.
ОСНОВАННОЙ НА ВЪХ АТОМНОМЪ ВЪЗДЪ И КОМПЛЕКСНОМЪ СИСТЕМЪ.

The Periodic Table of the Elements

Extra-Hippocampal Circuitry
The Papez Circuit



Slow-wave dependent consolidation process till full storage (7-9 years)

Cortico-hippocampal network

- Left loop~encoding; right loop-retrieval
- Left verbal memory; right visual and spatial memory
- Parahippocampal (posteromedial) and perirhinal networks (anterior temporal) networks: AT item processing, item to concept long-term transformation; PM context processing, context to situation long-term transformation

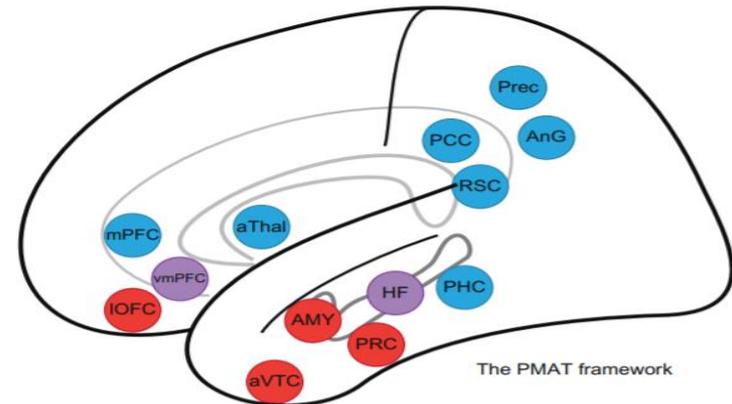
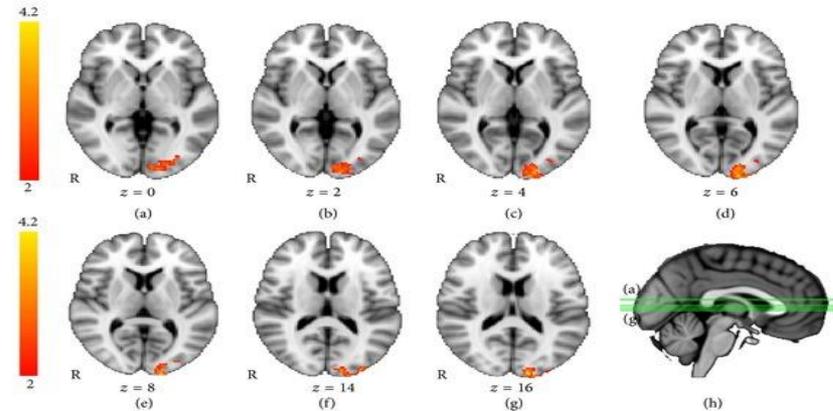
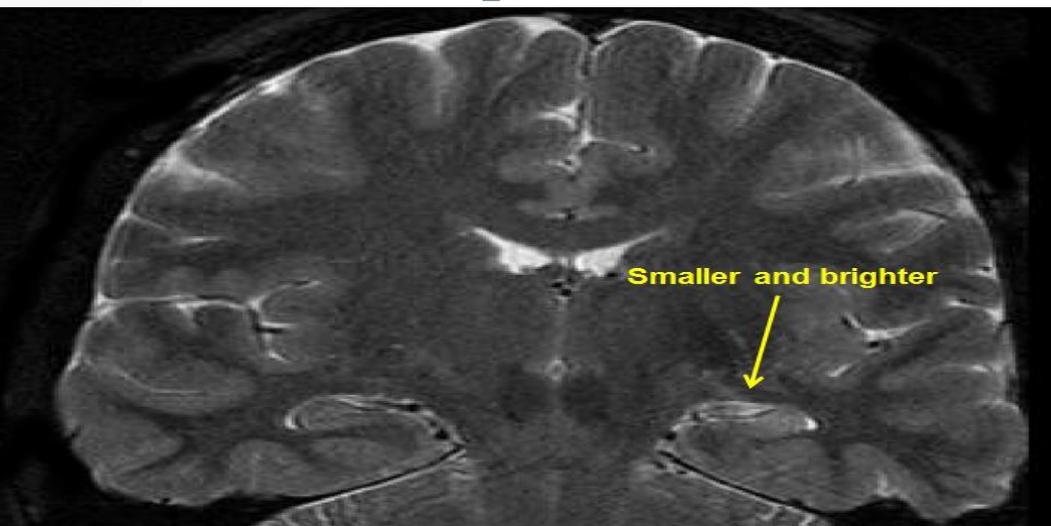
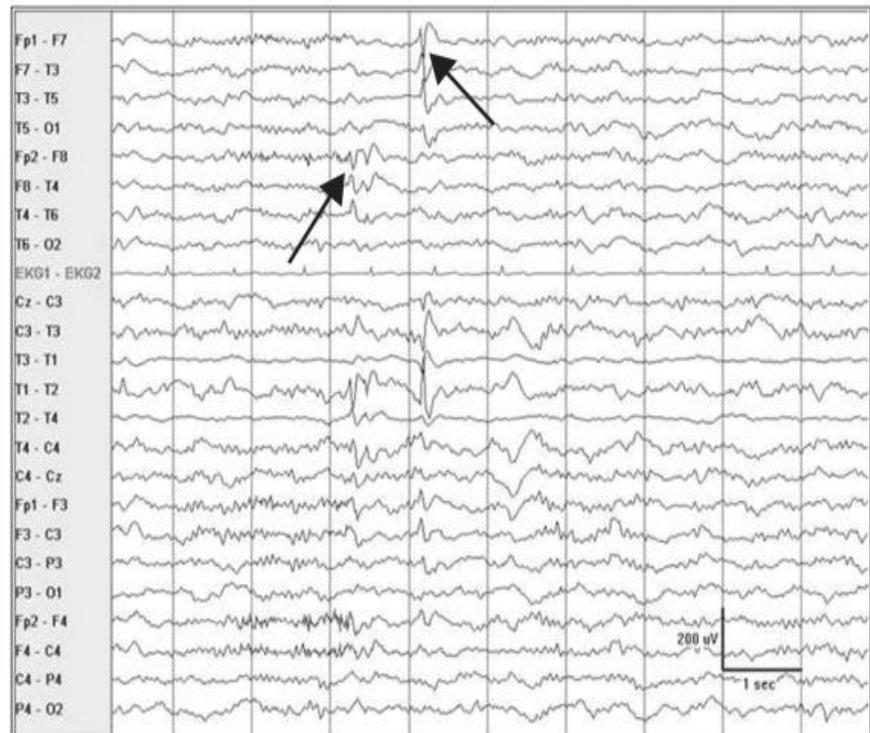
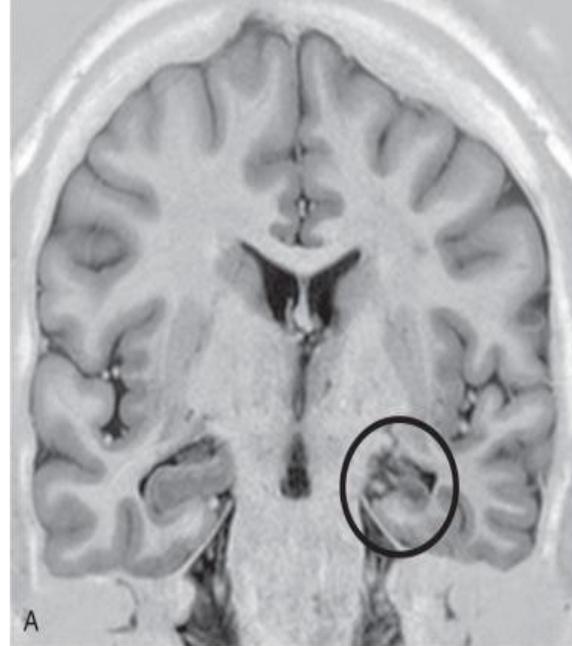


FIGURE 1

The PMAT framework. Regions of the PM system include the PHC, RSC, posterior cingulate (PCC), angular gyrus (AnG), precuneus (Prec), anterior thalamus and mammillary bodies (aThal), and medial prefrontal cortex (mPFC). Regions of the AT system include the PRC, anterior ventral temporal cortex (aVTC), amygdala (AMY), and lateral orbitofrontal cortex (IOFC). Possible sites of integration include the hippocampal formation (HF) and ventromedial prefrontal cortex (vmPFC).

MTLE

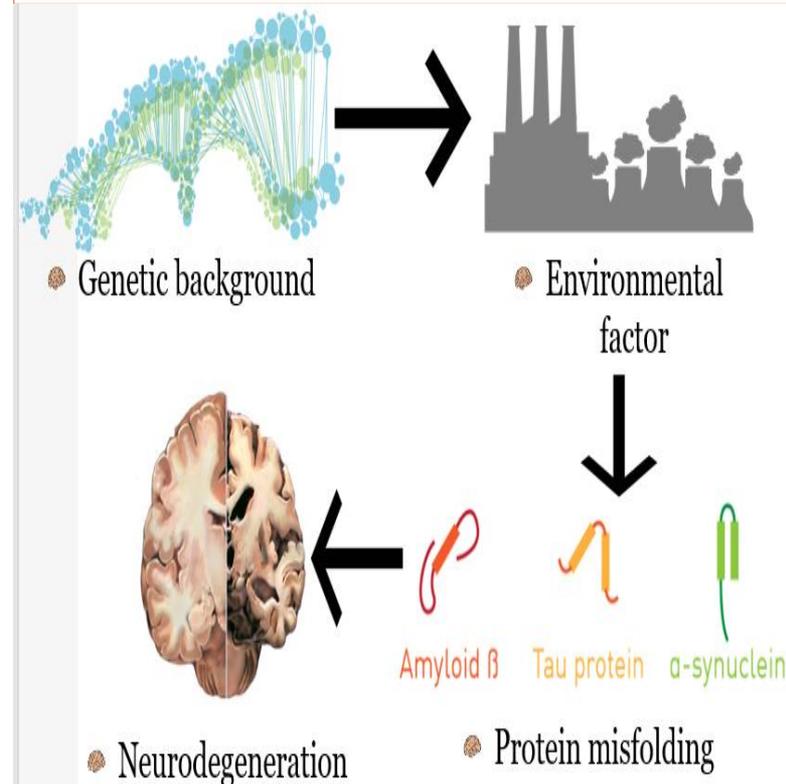
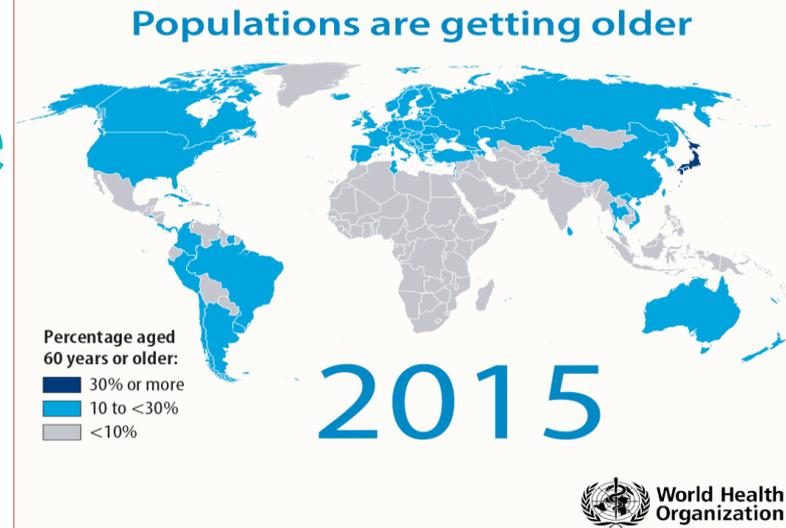
- MTLE: mesial temporal lobe epilepsy
- Focal seizure with impaired awareness
- Pathology: hippocampal or mesial temporal sclerosis



B

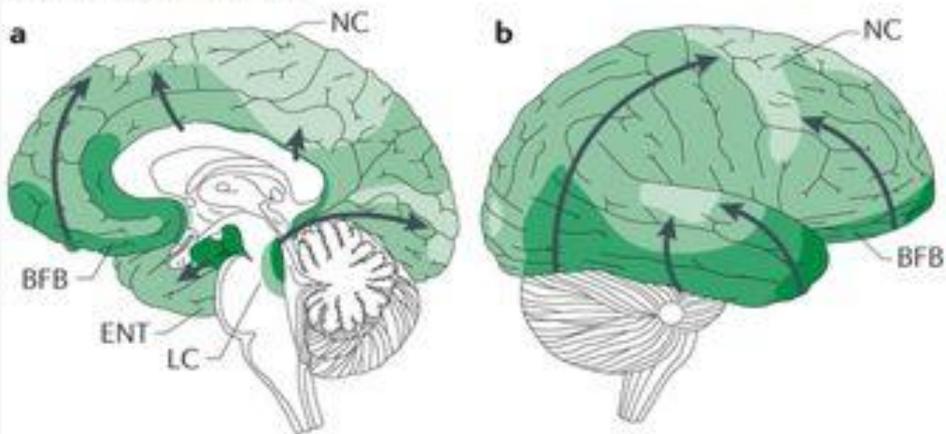
Alzheimer's disease

- 🧠 ~prevalance: 50 million
- 🧠 Onset: age 65-75
- 🧠 Symptoms: spatial disorientation, episodic memory impairment
- 🧠 Course: 6-8 years (loss of communication, social skills)
- 🧠 Risk: factors decreasing neuronal survival
- 🧠 Treatment: -

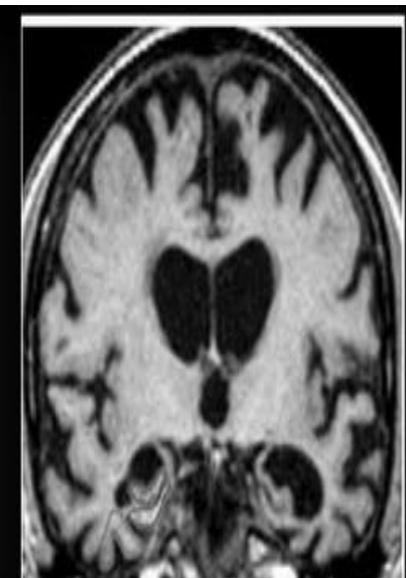
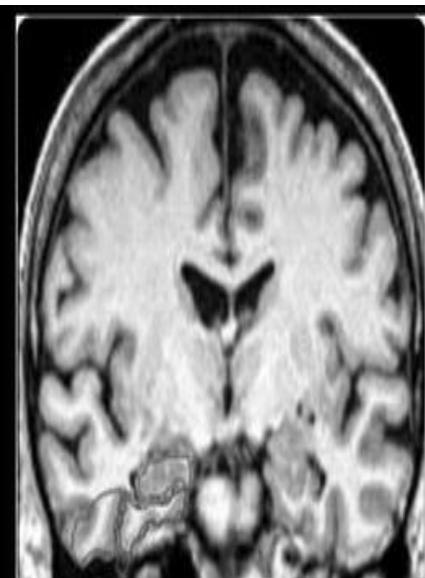
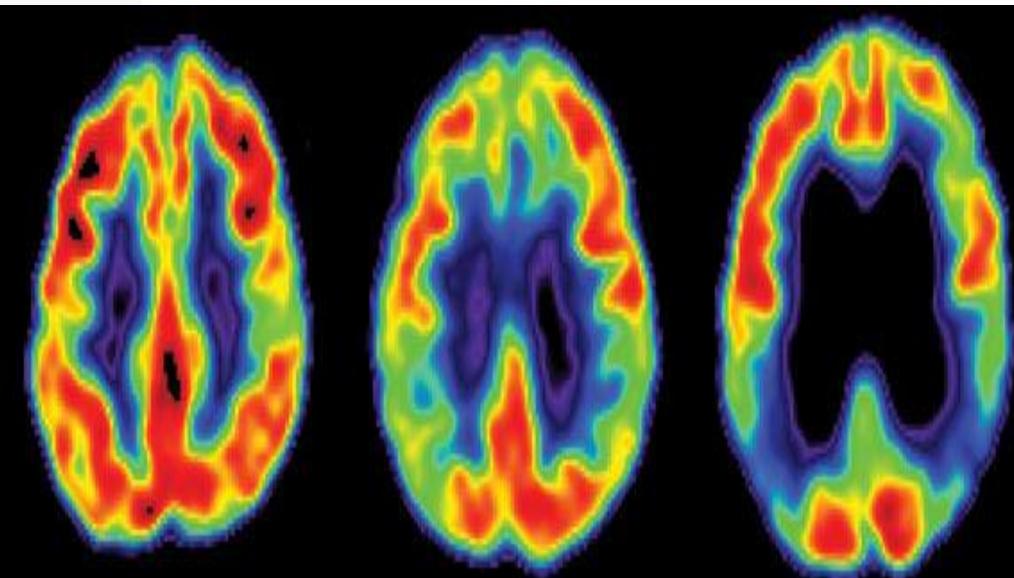
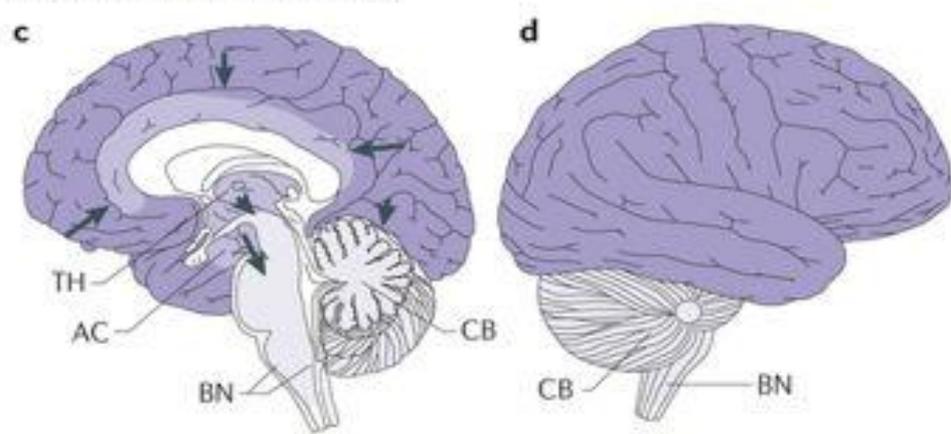


Spreading pattern

Alzheimer disease: tau



Alzheimer disease: amyloid- β



Korsakoff's syndrome

- Cause: alcoholism, toxins, malabsorption → B1 deficiency
- Pathology: degeneration of mammillary body
- Symptoms: episodic amnesia (**anterograde** and retrograde), confabulation
- Treatment: B1-vitamin supplementation

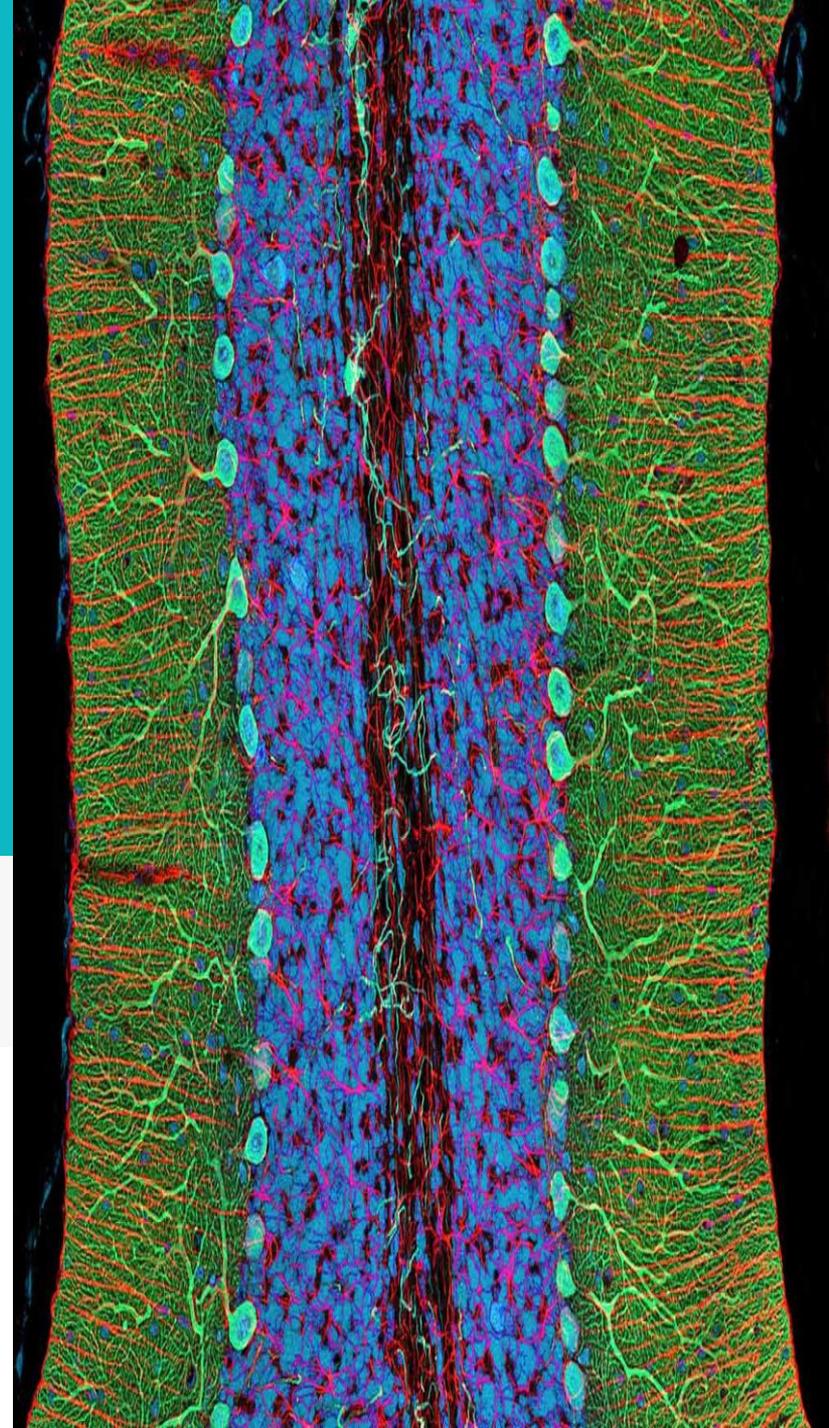


Münchhausen

O. Herrfurth pinx

Agenda

- 🧠 Theory of mind
- 🧠 Episodic memory
- 🧠 **Semantic memory**
- 🧠 Procedural memory



Semantic memory

- Definition of objects (shape, size, color, function, motion), people, places, facts
- Intelligence and education
- Cortical:
Occipital, all others
- Subcortical:
hippocampus, basal ganglia, cerebellum

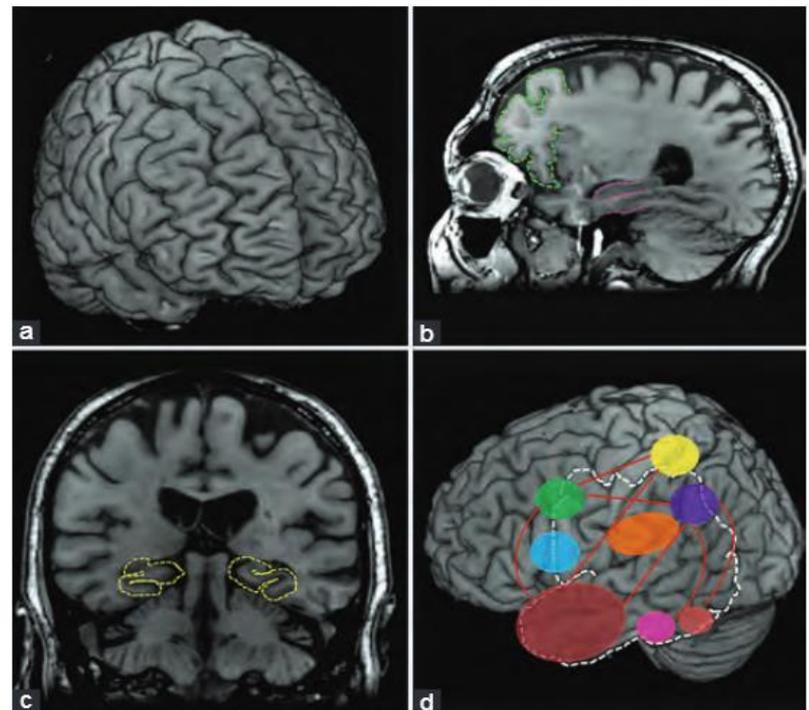


Figure 4: Brain structures involved in semantic memory: (a, b and c) frontal, temporal, and occipital lobes (neocortex); (d) proposed semantic memory network within the temporal lobe, modified from Patterson *et al.*^[44]

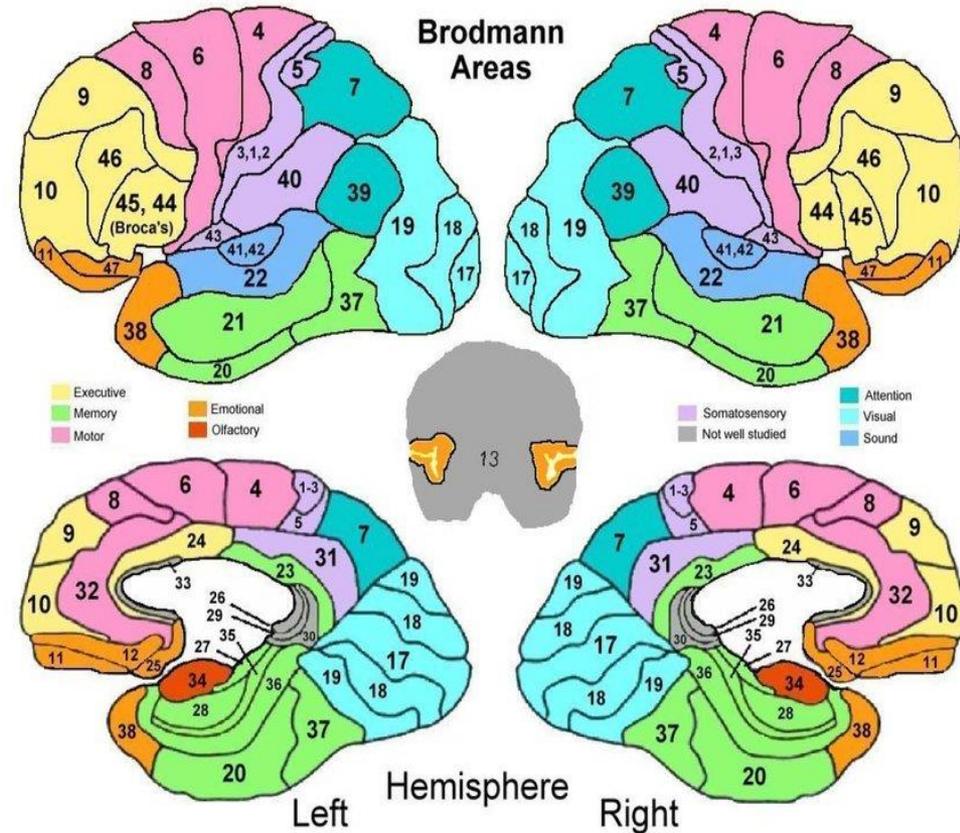
Encoding and retrieval

🧠 Encoding: core feature of facts:

- Hammer (motor)
- Thunder (auditory)
- Cat (visual)

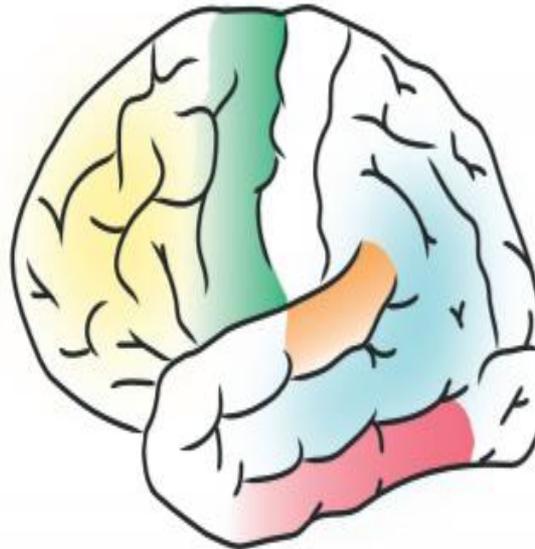
🧠 Retrieval: tool related:

- Inferior frontal cortex (word selection)
- Fusiform gyrus: naming



Perceptual- motor

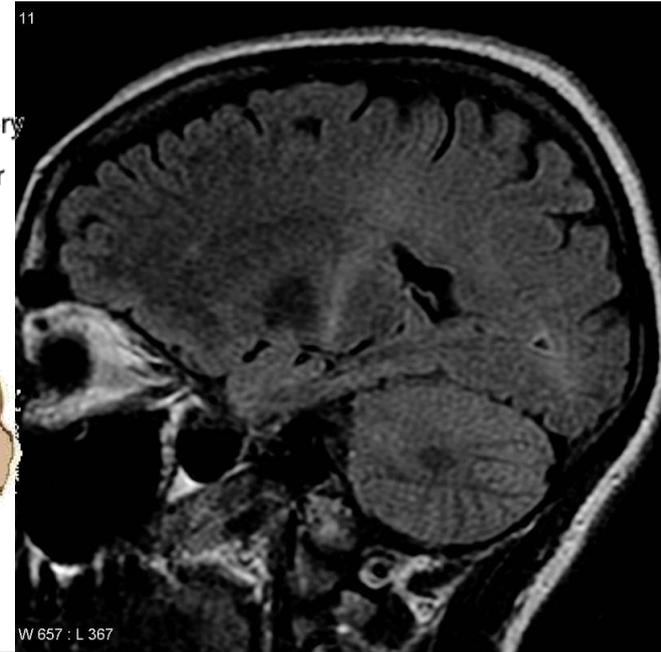
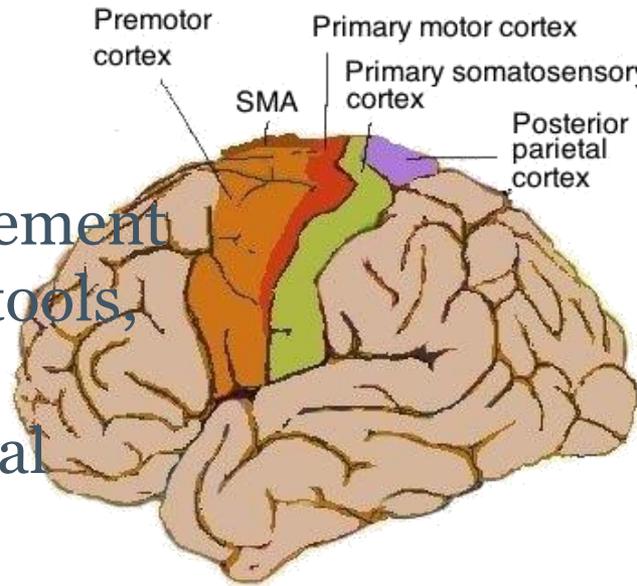
- Encoding and consolidation: area associating to sensory perception
- Primary role of occipital cortex in sensory context
- Motor context: frontal lobe
- Auditory context: temporal lobe



- Motor
- Sound
- Visual
- Heteromodal semantic representation
- Heteromodal executive processes

Neurodegenerative motor disorders

- Naming and understanding movement related facts (sport tools, handwork tools)
- Amyotrophic lateral sclerosis

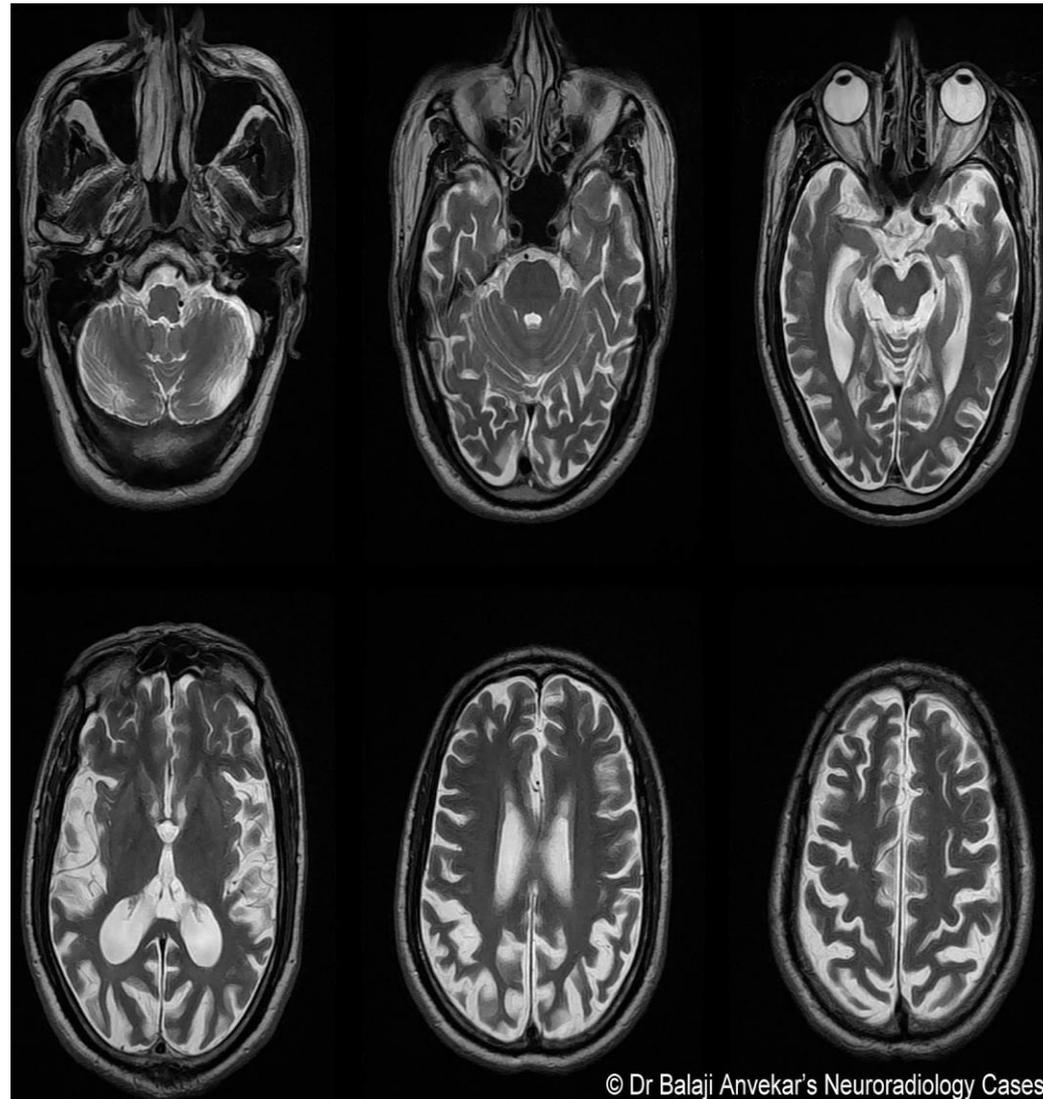


Grossmann 2008

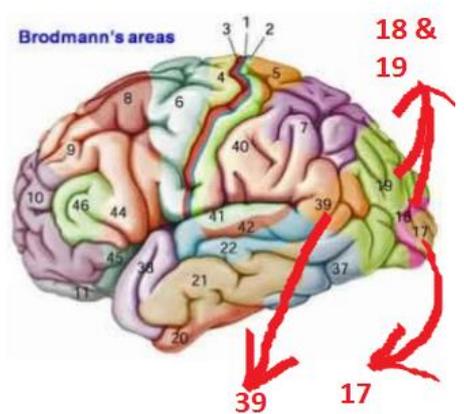
Neurodegenerative visual disorders

🧠 Naming and understanding visually processed facts (faces, animals)

🧠 Benson's syndrome (PCA)



1. Primary visual area (area 17)
2. Visual association area (area 18 & 19)
3. Higher visual association area (area 39)

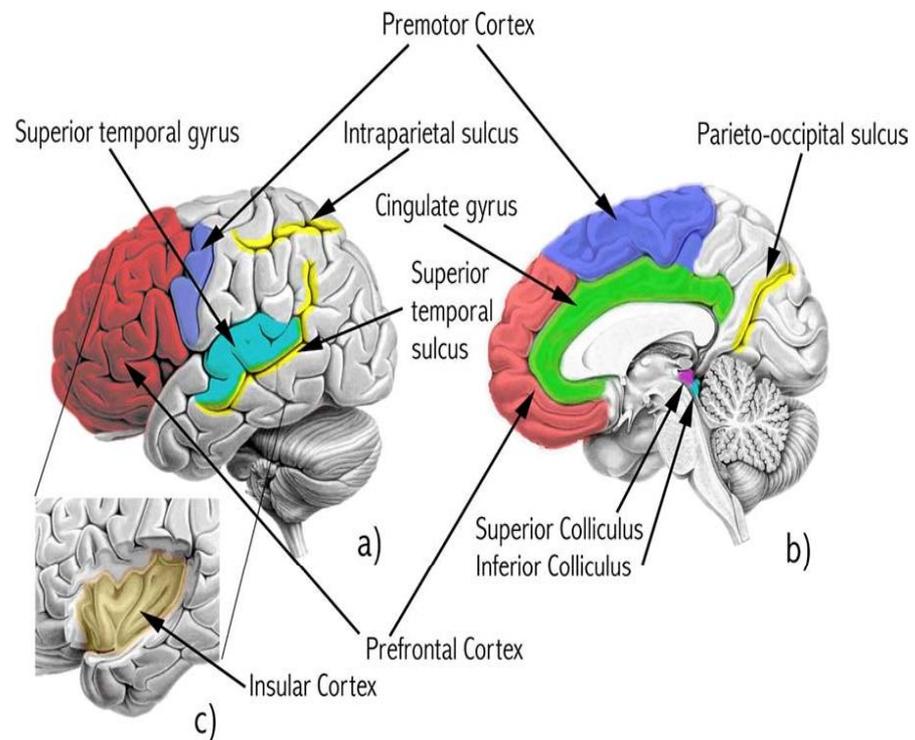


Million faces of world



Heteromodal brain regions

- 🧠 Convergence of multiple sensory and motor modalities (larger dendritic fields, lower neuron density)
- 🧠 Anterolateral temporal cortex, prefrontal cortex, inferior parietal cortex
- 🧠 Hub-and-spoke
- 🧠 Posterior: integration; anterior: selection



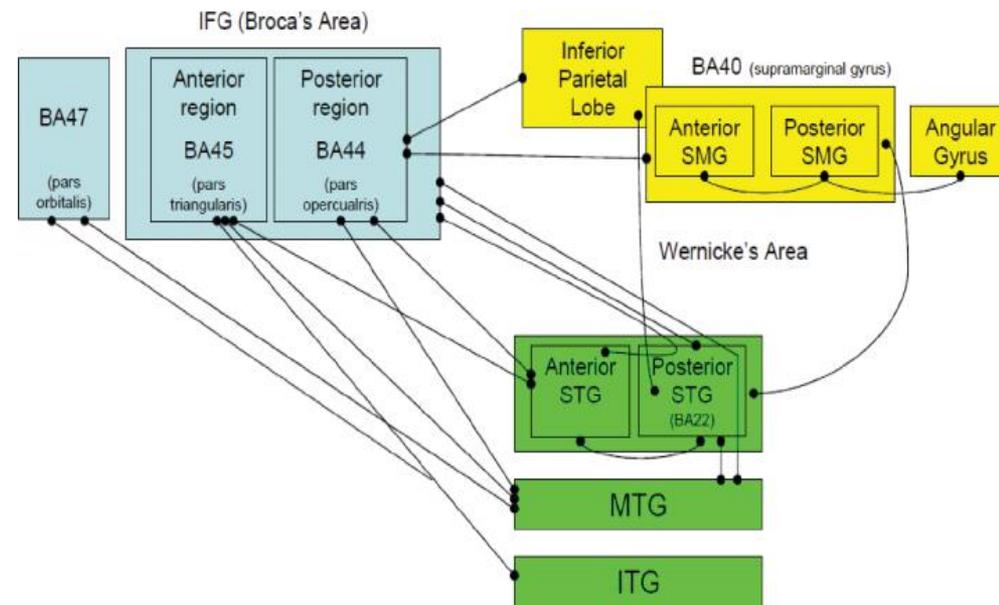
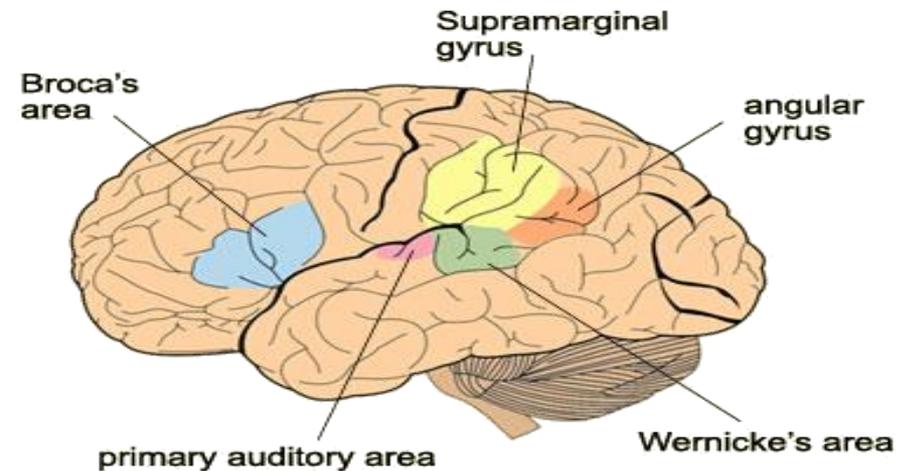
Angular gyrus (Br39)

- High level integration of motor and sensory information through language

- Integrate into representation

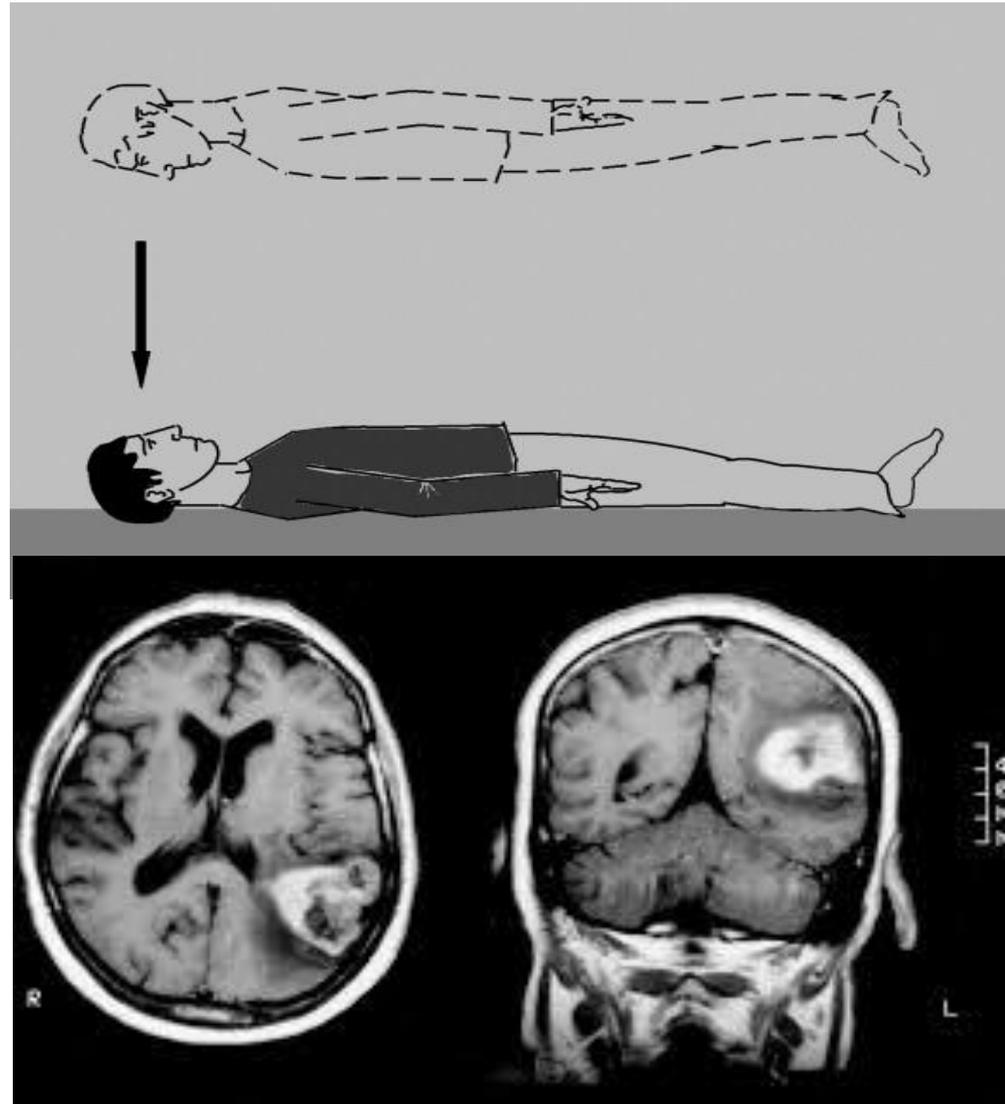
- Dominant hemisphere

- Metaphores, mental number line, self experience



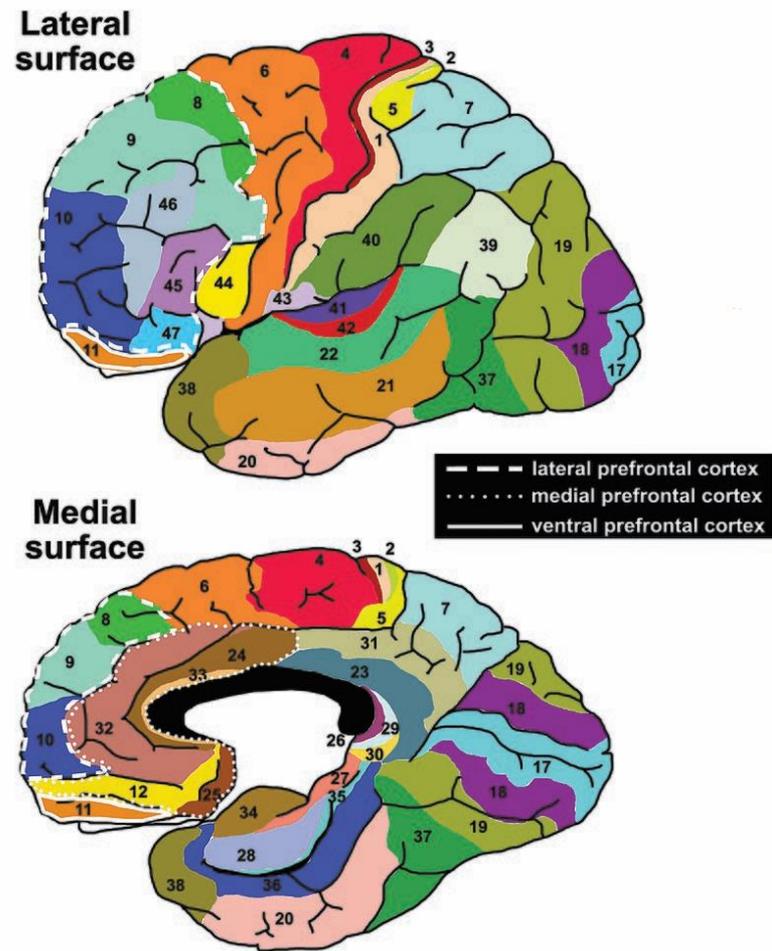
Angular gyrus (Br39)

- Angular seizures: out-of-body experience
- Gerstmann-syndrome: acalculia, agraphia, finger agnosia, left-right disorientation



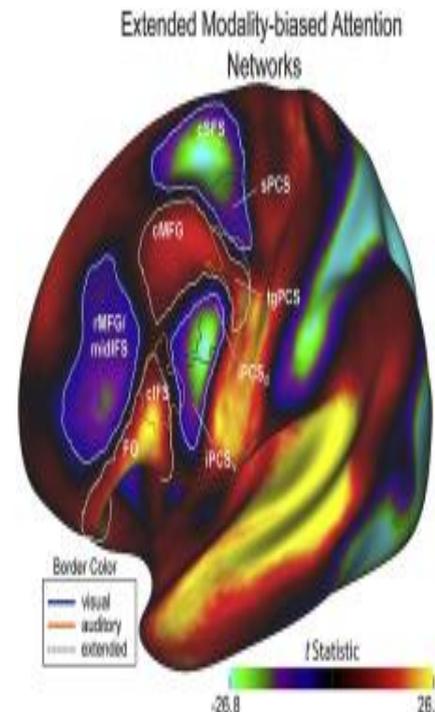
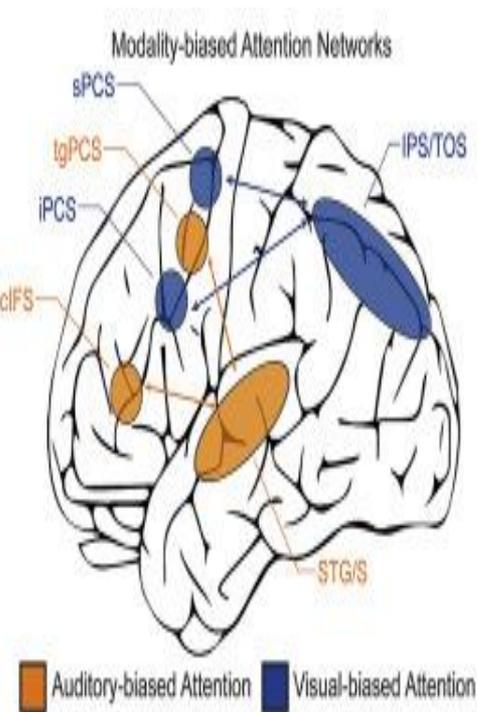
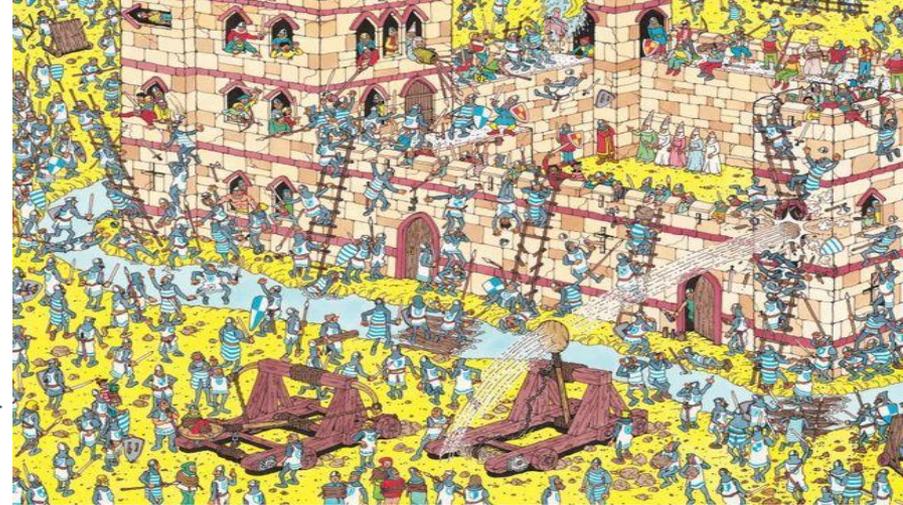
Prefrontal cortex

- Directed retrieval
- Mediates execution: logical and rule-based processes → planning, decision making, social behaviour
- Dynamic Filtering Theory: enhancing goal-direction; inhibition irrelevant



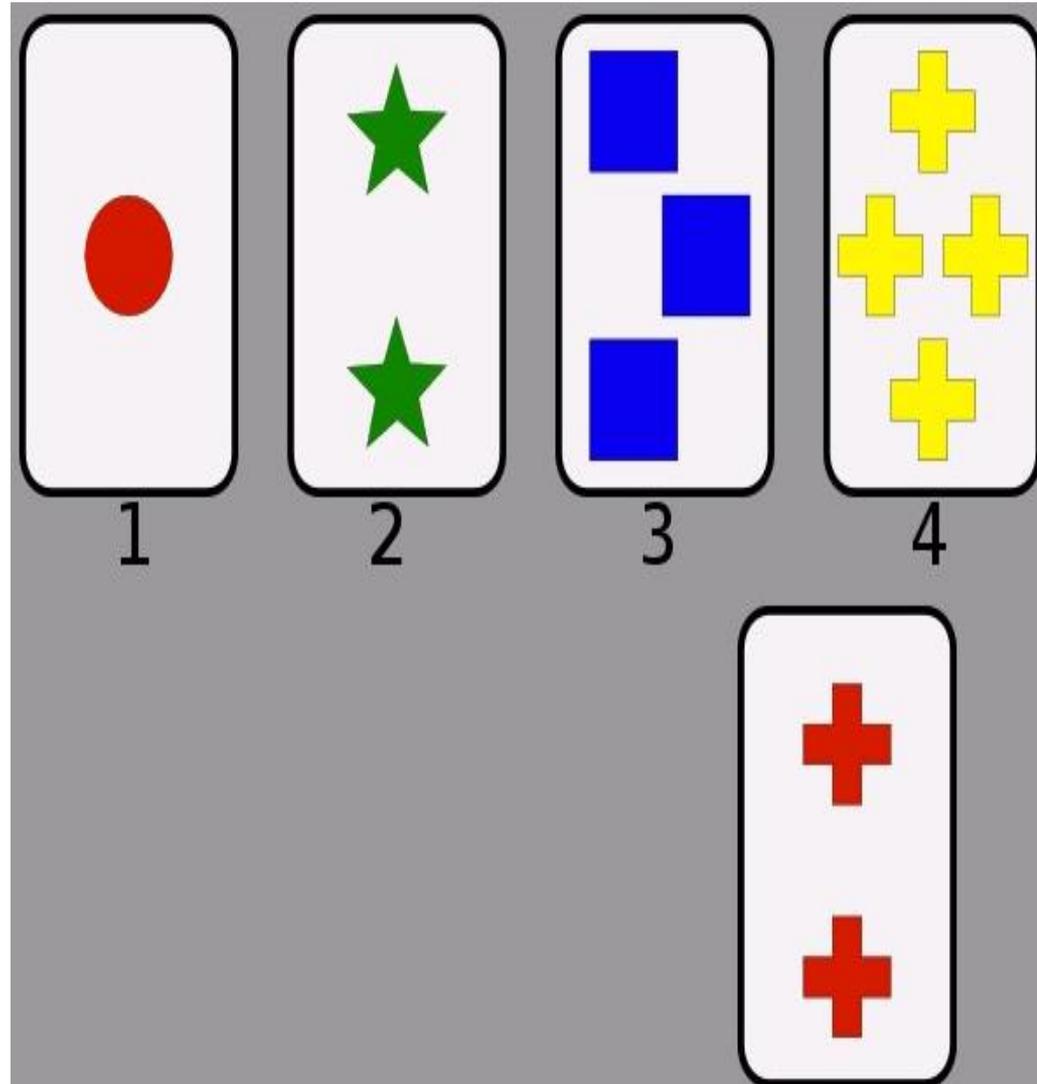
Attention

- Sample selection for survival
- Activation of short-term memory
- Based on semantic facts: previously important = possibly important
- Modality-based activation
- Episodic requires semantic, short-term requires long-term



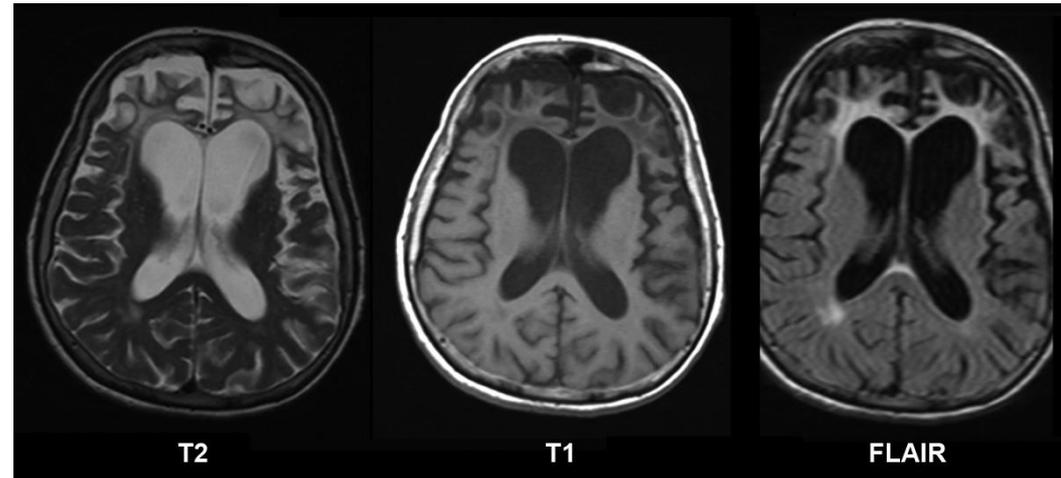
Prefrontal cortex- testing

- 🧠 Wisconsin Card Sorting Test
- 🧠 Strategic planning, organized searching, utilizing environmental feedback to shift cognitive sets, directing behavior toward achieving a goal, and modulating impulsive responding



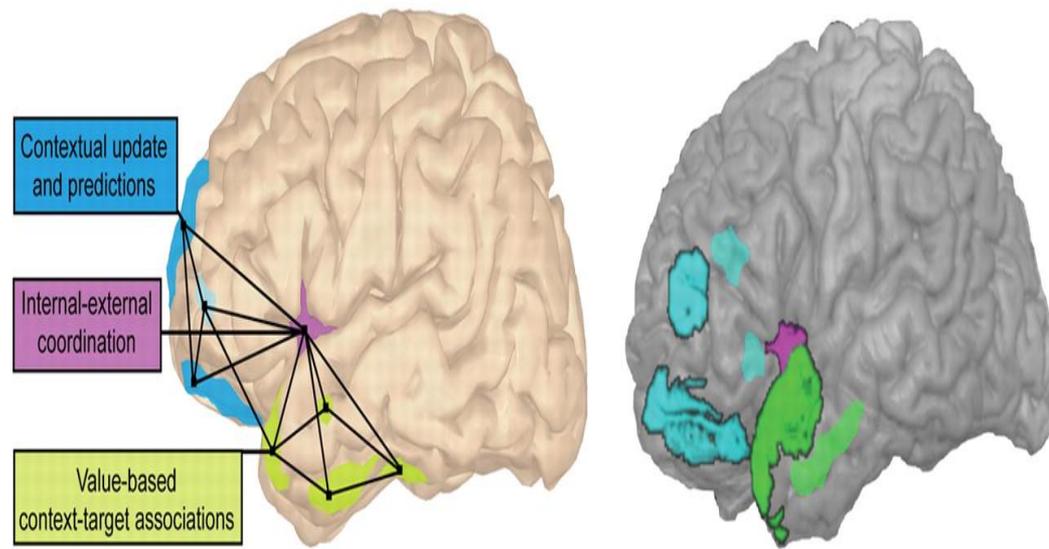
PFC neurodegeneration

- Frontotemporal lobar degeneration (FTD)
- Early onset
- Speech or behavior dominance (progressive aphasia or dementia)
- Behavior dominant associates to semantic impairment, executive function loss



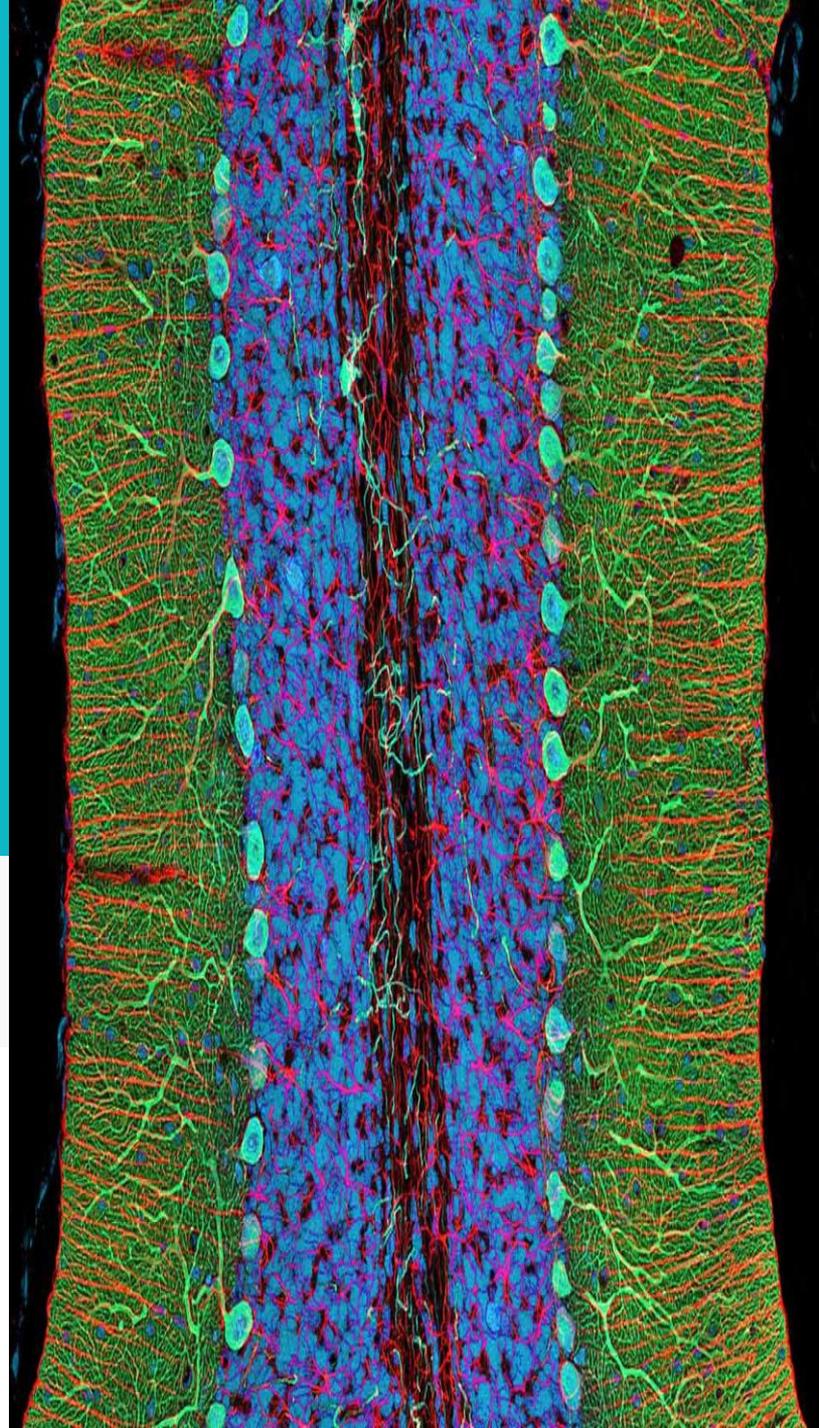
A Social context network model

B bvFTD atrophy pattern



Agenda

- Theory of mind
- Episodic memory
- Semantic memory
- **Procedural memory**



Procedural memory

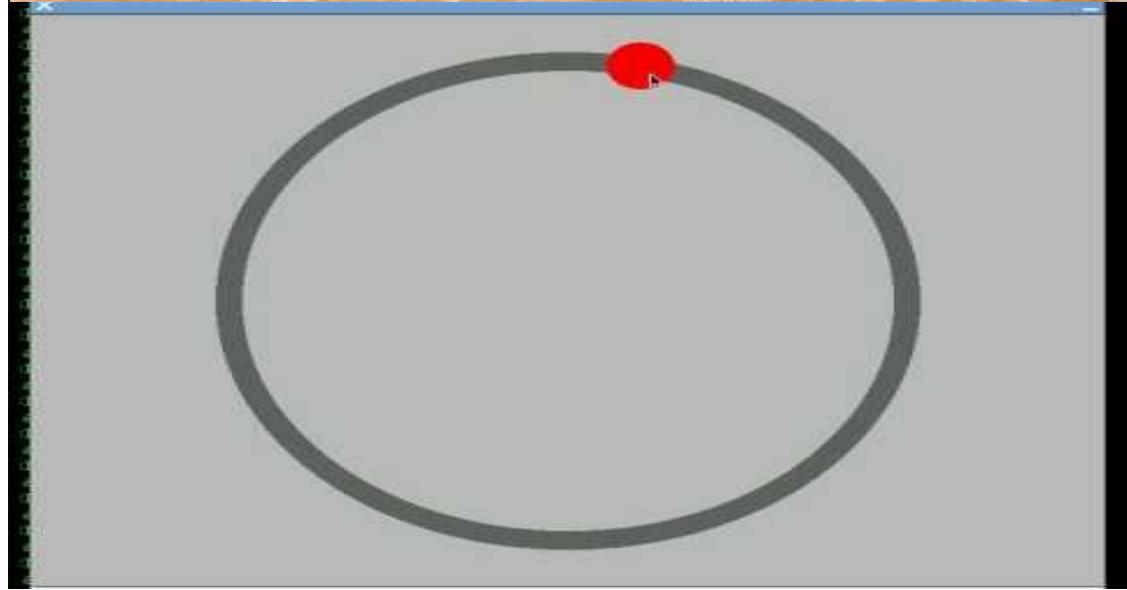
🧠 2 models:

-Acquisition:

Cognitive phase,
associative phase,
autonomous phase

-Prediction:

Attempt, fail,
analysis



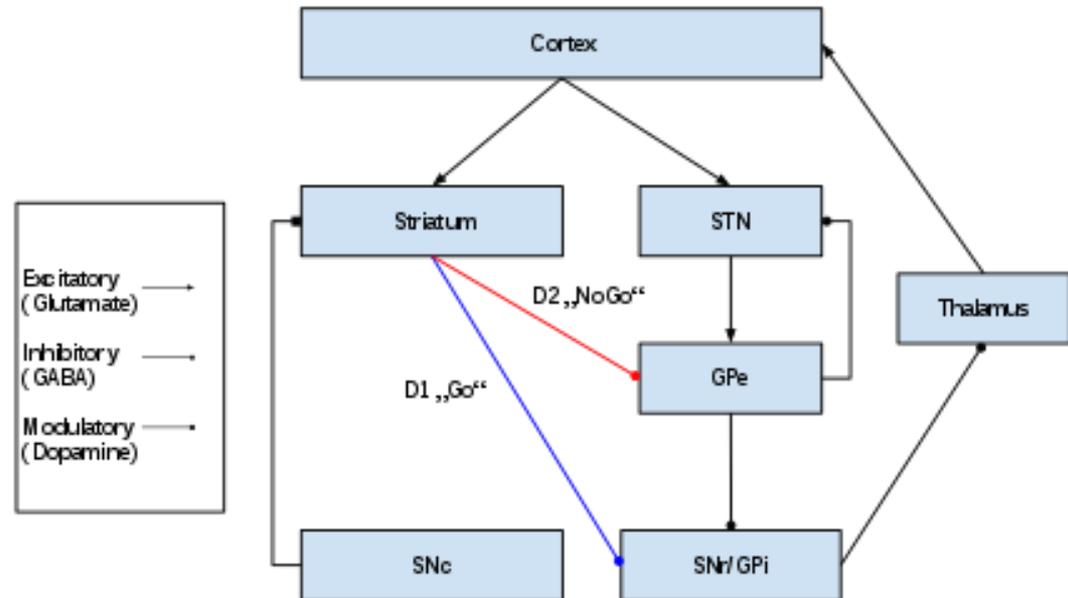
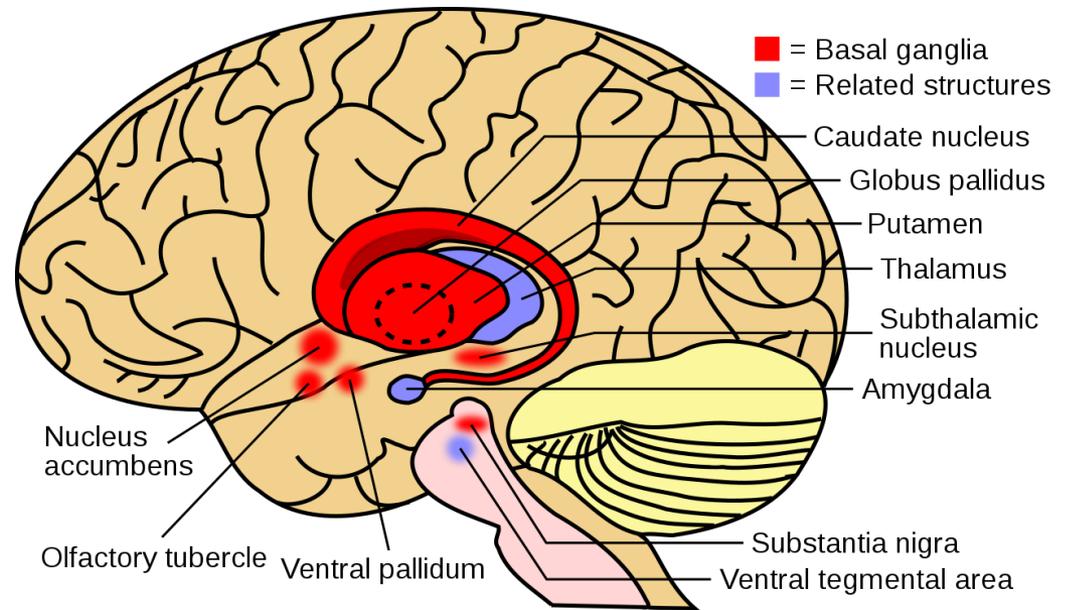
Anatomy

🧠 Crucial role: striatum

🧠 Feedback loops, positive-negative

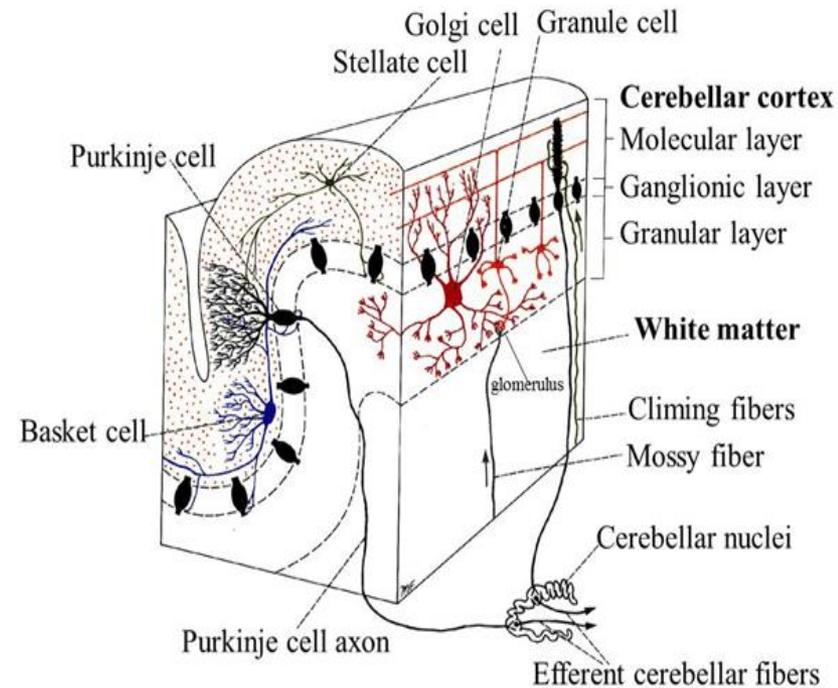
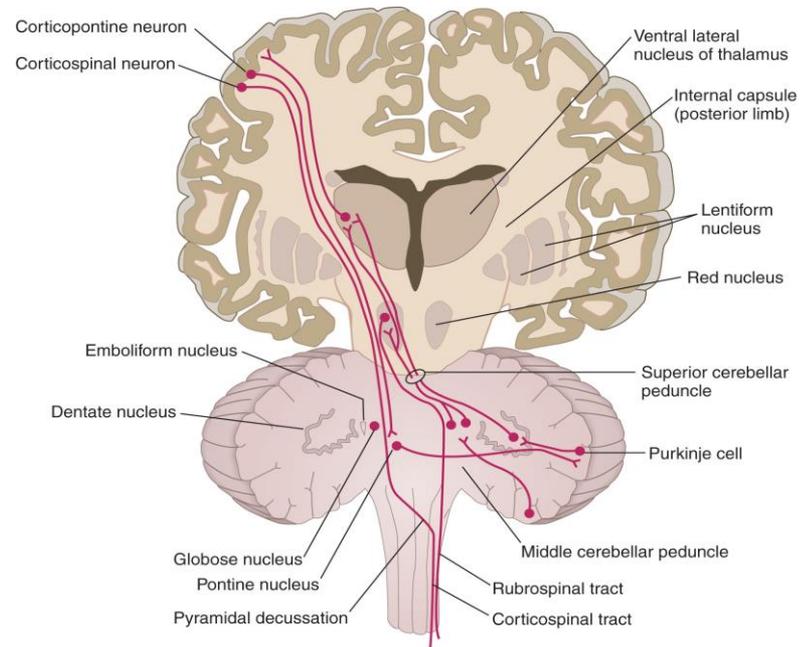
🧠 Input: limbic, brain stem, motor areas

🧠 GABAergic efferents



Anatomy

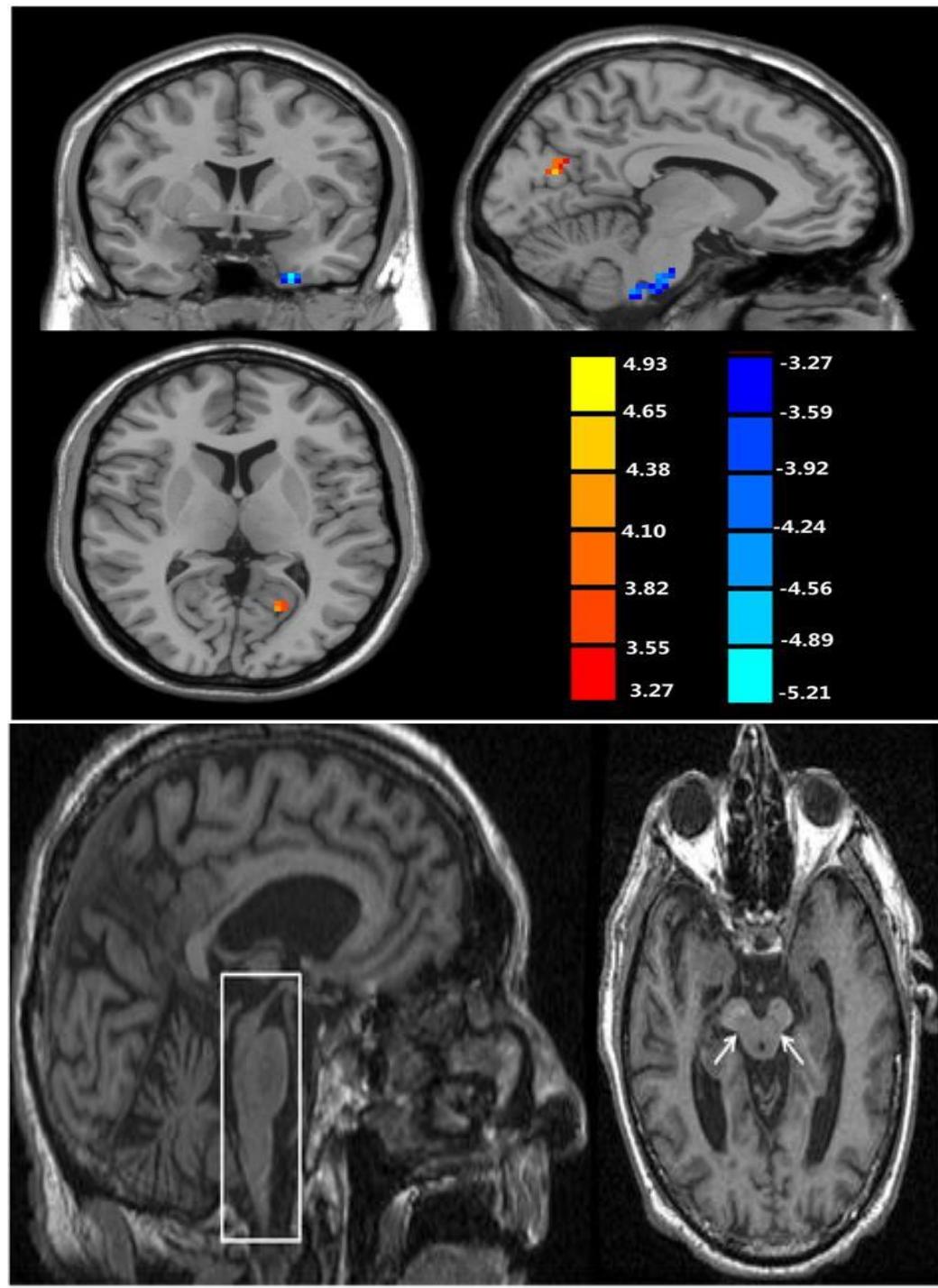
- 🧠 Crucial role: cerebellum
- 🧠 Feedback loops, positive-negative
- 🧠 Input: limbic, brain stem, motor areas
- 🧠 GABAergic efferents



Pathology

🧠 Enhanced learning:
Tourette-syndrome
(spontaneous activation)

🧠 Impaired: Parkinson-
disease („difficulty with
the sequence-specific
knowledge that is needed
in the acquisition step of
procedural memory”)





The best thing about
Memories
... is making them

Golfian.com

