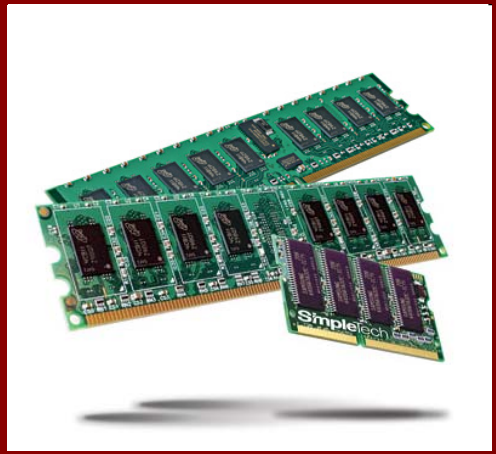
Memory in the brain



Kamil Vlček

Dpt. neurophysiology of memory, Institute of Physiology, ASCR

Outline of the lecture

- What is memory, memory classifications
- Memory by type of retrieaval
  - Non-declarative memory
  - Declarative memory
- Memory by time of storage
  - sensory memory
  - short-term memory
  - long-term memory
- Brain areas
- Memory processes
  - Encoding, consolidation and retrieval
- Memory by time temporal direction
  - retrograde, anterograde memory

What is memory?

- A **change in behaviour** resulting from individual's behavioural experience
- the **ability** to store, retain and retrieve learned information
  - a hypothetical **store** of information
  - a **content** of that store
- a subjective **experience** of remembering

What are various kinds of memory?

- to **remember** something
- to **know** something
- to have some **skill** or ability
- to react to something
  - in a specific way
  - emotionally
  - more or less than before

Memory classification

- by the type of retrieval
  - declarative (explicit), non-declarative (implicit)
- by the duration of the memory trace
  - sensory, short term, long term
- by temporal direction
  - retrograde, anterograde
- by function
  - working, reference

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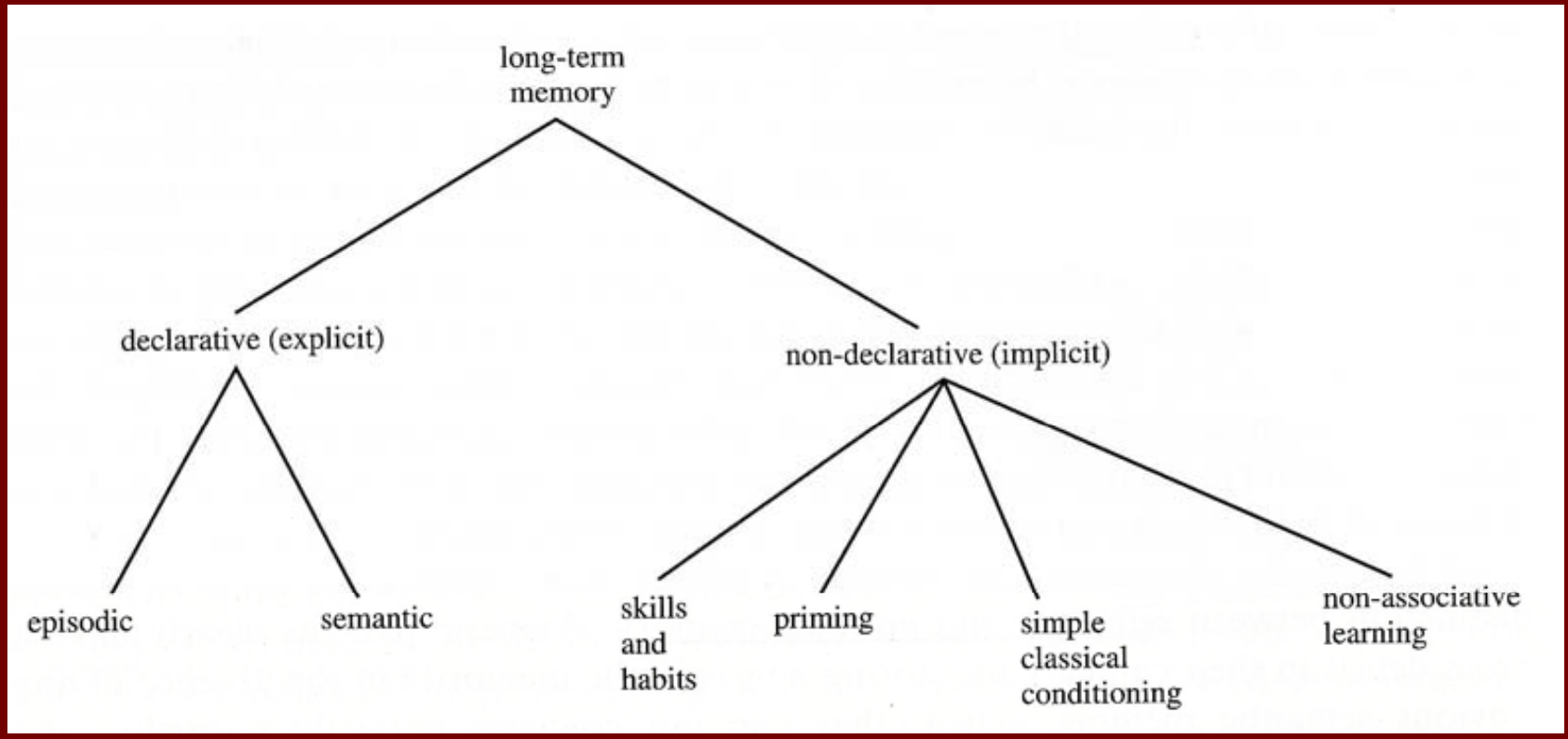
Classification by retrieval type

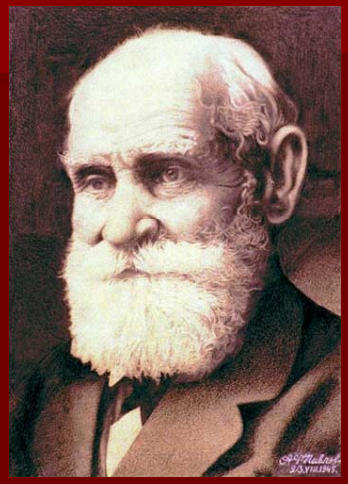


Non-associative learning

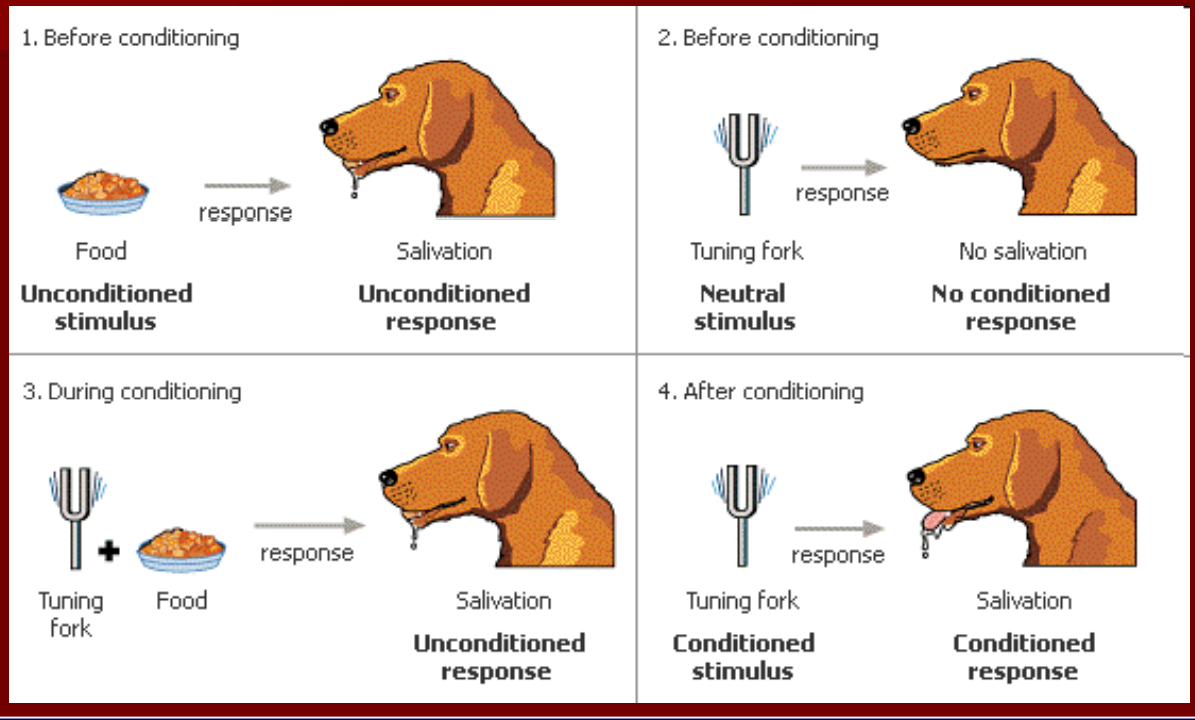
- Habituation
  - **decrease** in response to repeated stimulus
- Sensitization
  - **increase** in response to repeated stimulus

Hydra

Classical conditioning



I.P.Pavlov
1849 - 1936



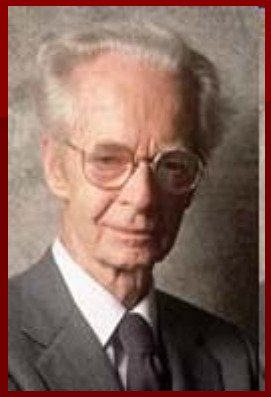
Conditioned Stimulus = Sound

Unconditioned Stimulus = Food

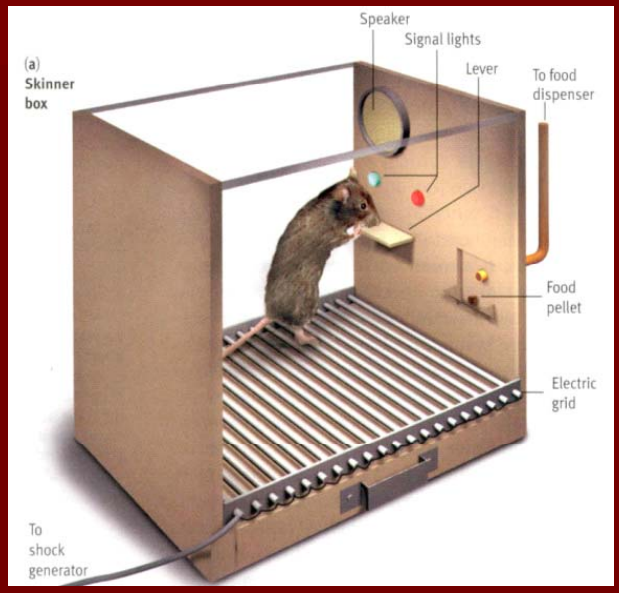
Unconditioned Response = Salivation

Conditioned Response

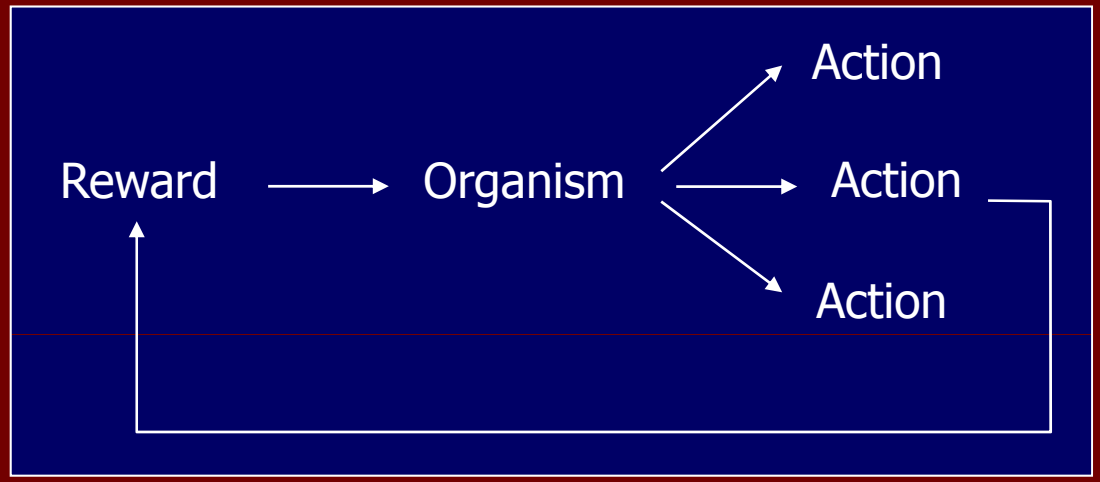
Operant conditioning



B. Skinner
1904 - 1990

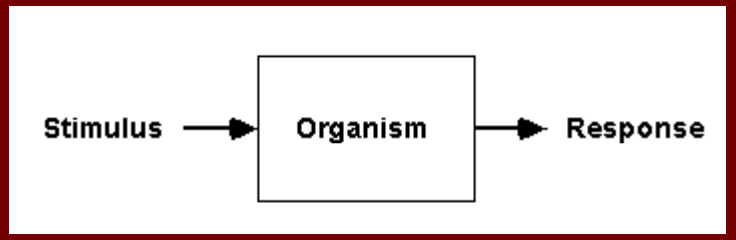


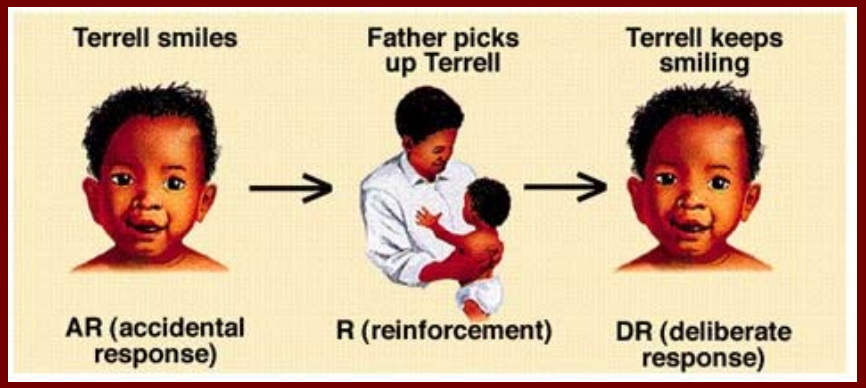
Skinner box



Behaviorism

- 1920s – 1950s
- Stimulus response model
- Organism as a black box
- All behaviour is just conditioned response to a stimulus (in both human and animals)
- Learning of social behaviour, language … everything

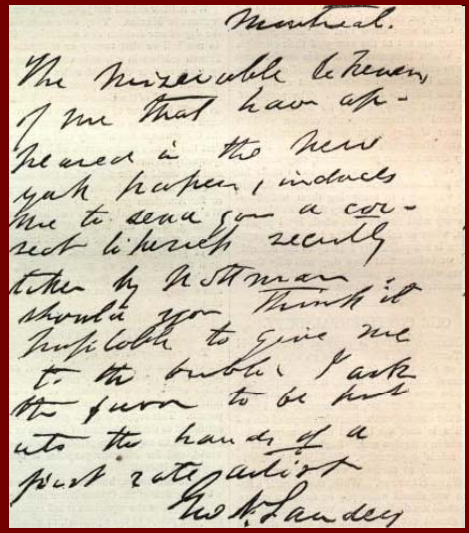




Skill and Habits

- walking
- writing
- driving
- swimming
- playing piano

- **No conscious recall required**

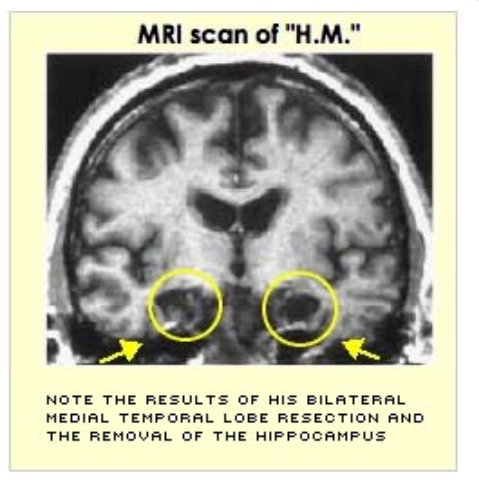


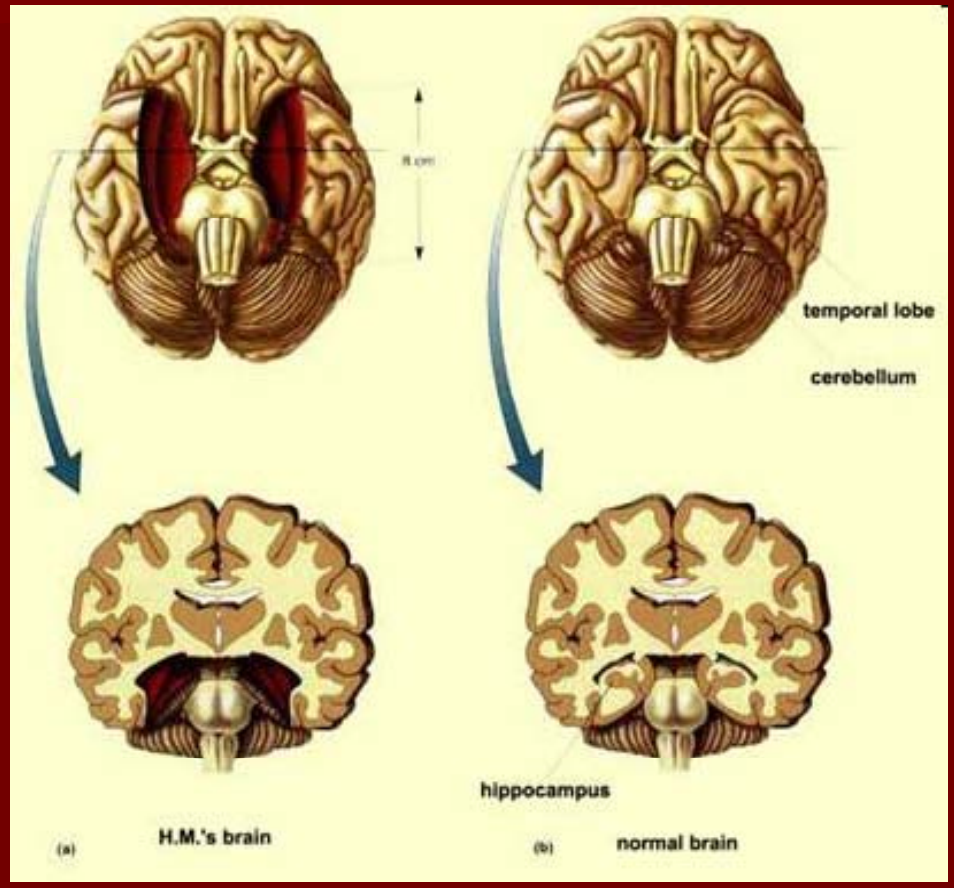
Emotional memory

- Learned emotional reactions
- Unconscious connections in the brain
- ? phobias ….

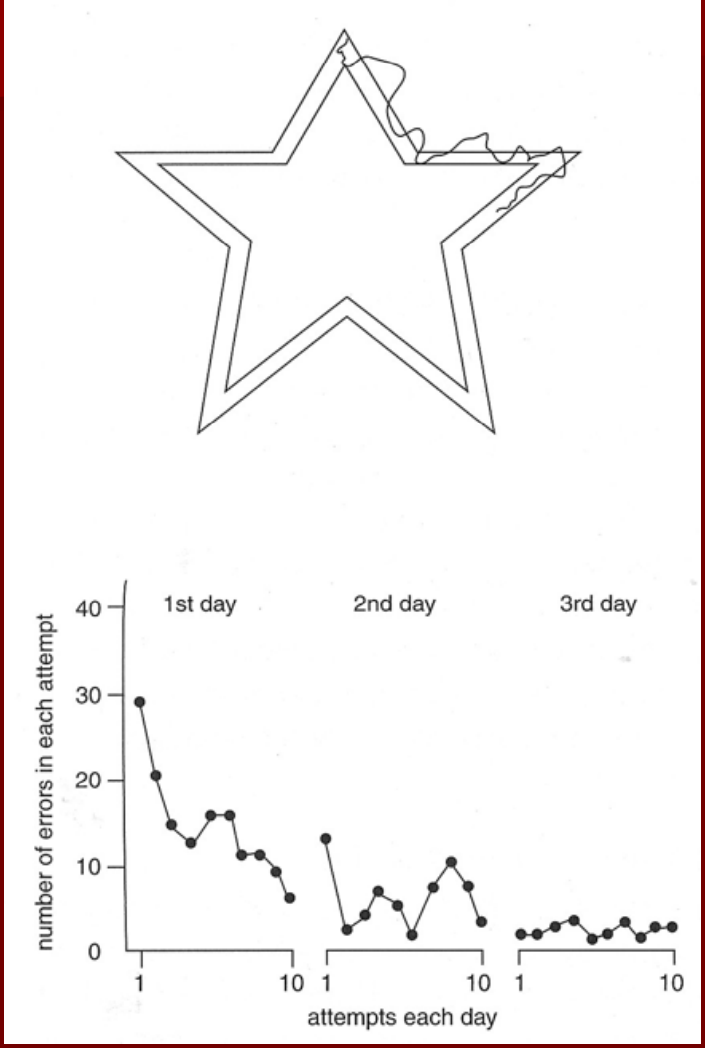
Declarative memory - patient H.M.

- In 1953 his hippocampus and Medial temporal lobe were bilaterally resected for untreatable epilepsy
- **global amnesia**
- he could not recall any new events, any names ..



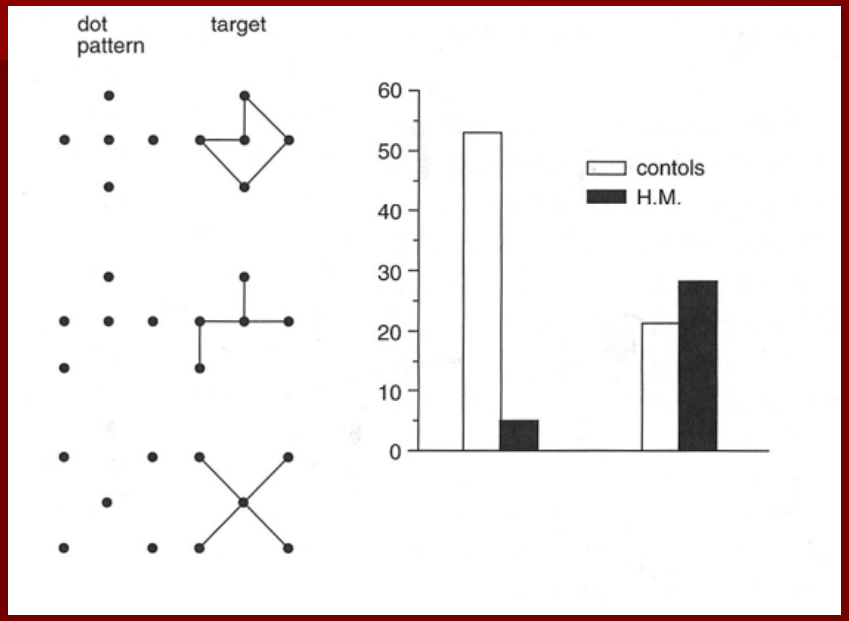


Skill learning in H.M.

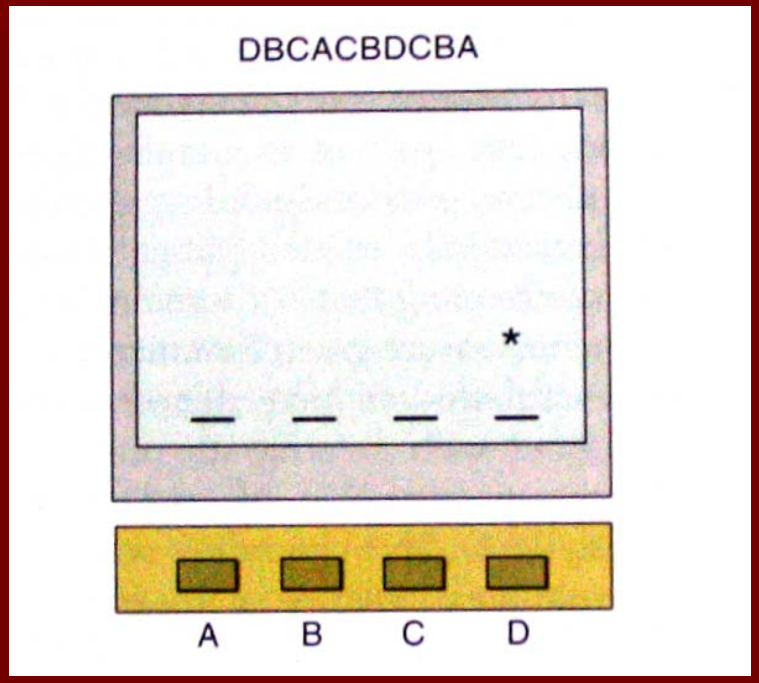


- The patients could learn skills like mirror drawing
- He could not remember learning it

Skills learning in H.M.



Priming for dot pattern



Learning of sequence

Implications of H.M.

- Two types of memory
  - sensitive to amnesia = declarative memory
  - insensitive to amnesia = non-declarative
- Evidence against the behaviorist schema of Stimulus -> Response

Declarative vs. Non-declarative

The criterium of consciousness and internal representation

- HOW? = Non-declarative = implicit
  - Habitution, senzitization, classical and operant conditioning, skills, emotional memory
- WHAT? = Declarativ (explicit)
  - semantic and episodic memory

Declarative memory

Facts = semantic memory

Events = episodic memory

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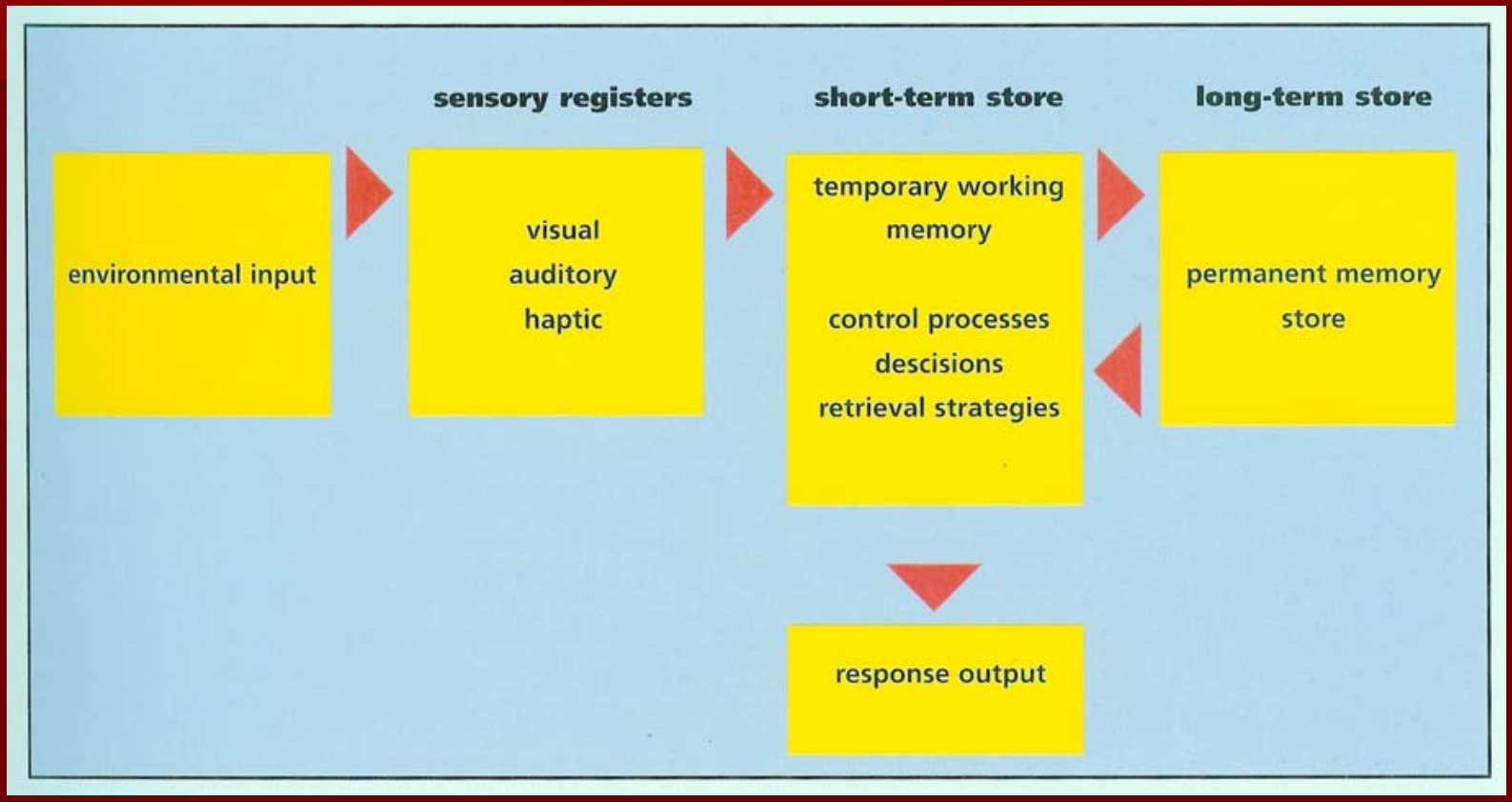
Memory by time of storage

- Short-term and long-term memory?
- What is the evidence?

Memory by time of storage



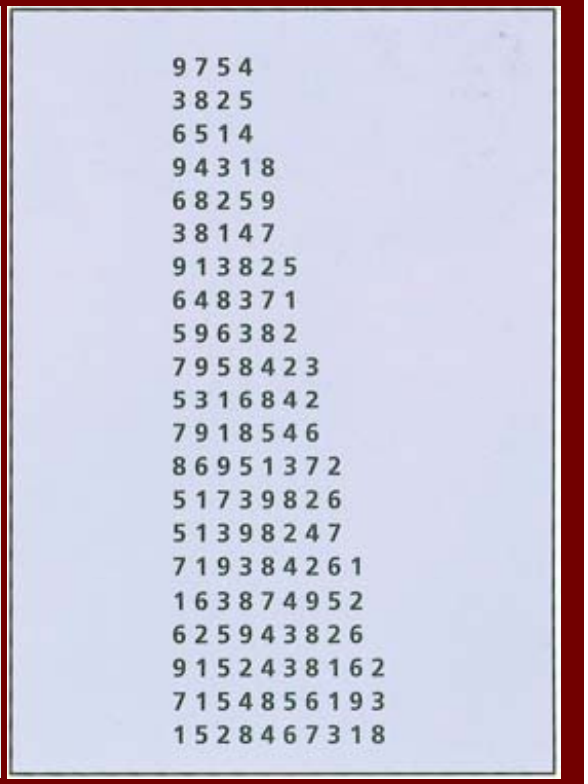
- Atkinson-Shiffrin memory model 1968

Sensory memory

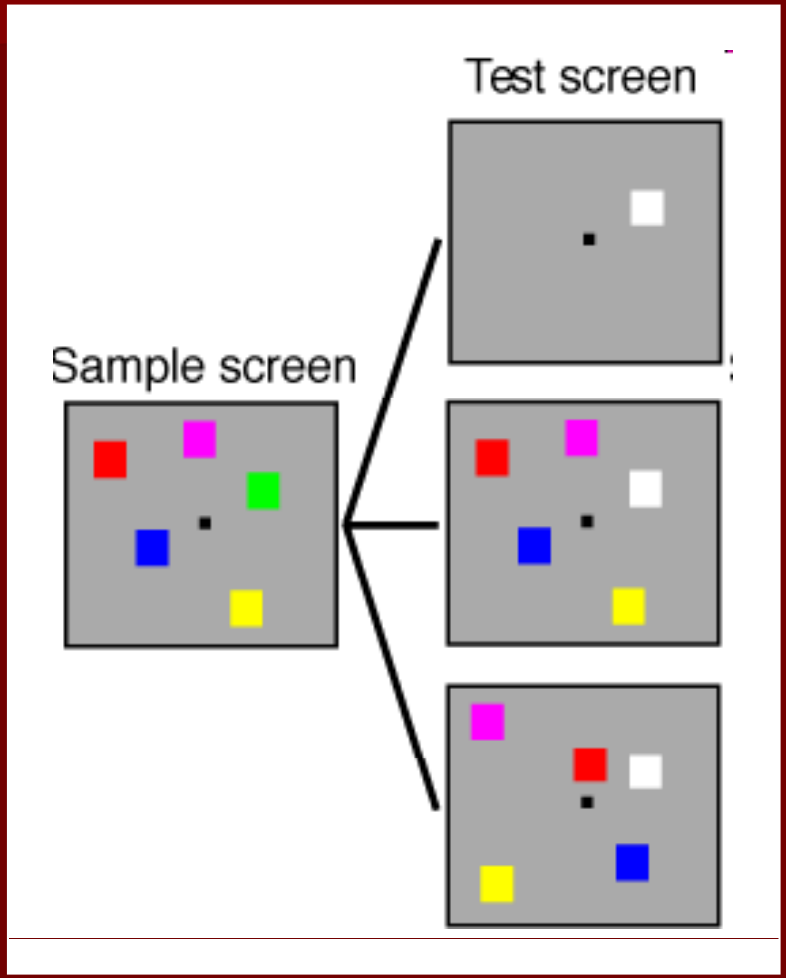
- Visual, auditory, haptic
  - when you close your eyes ..
- Helps to move the sensory information into short-term memory

Short-term memory

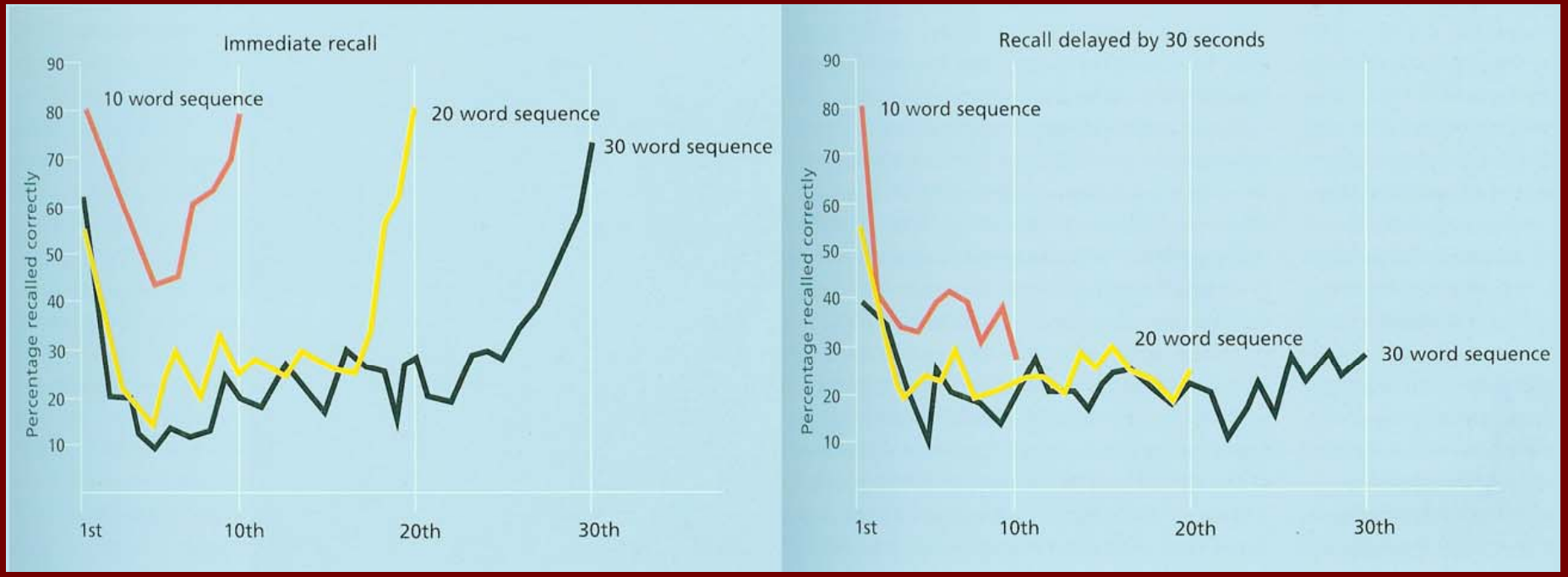
- Average number of remembered digits is 6 to 7
- visual and verbal memory



Visual short-term memory

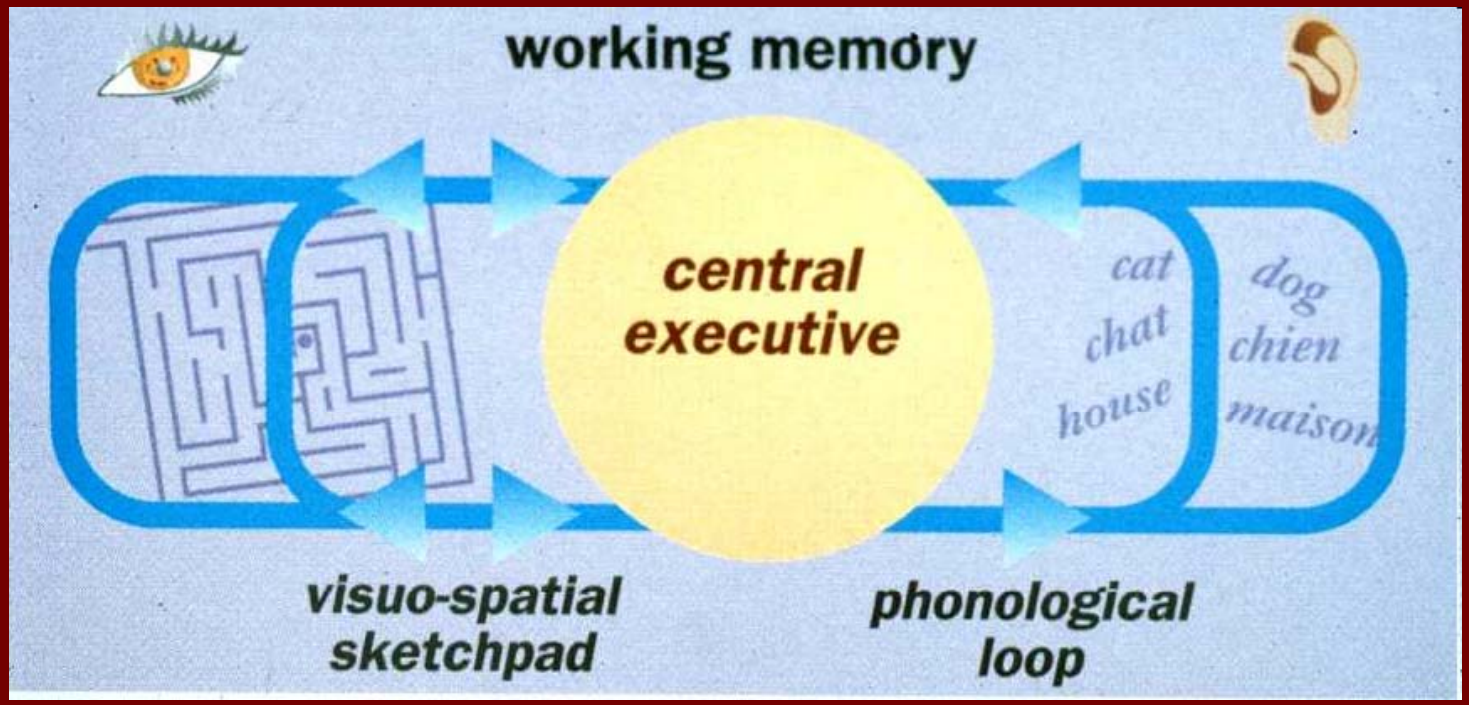


Is short-term different from long-term memory?



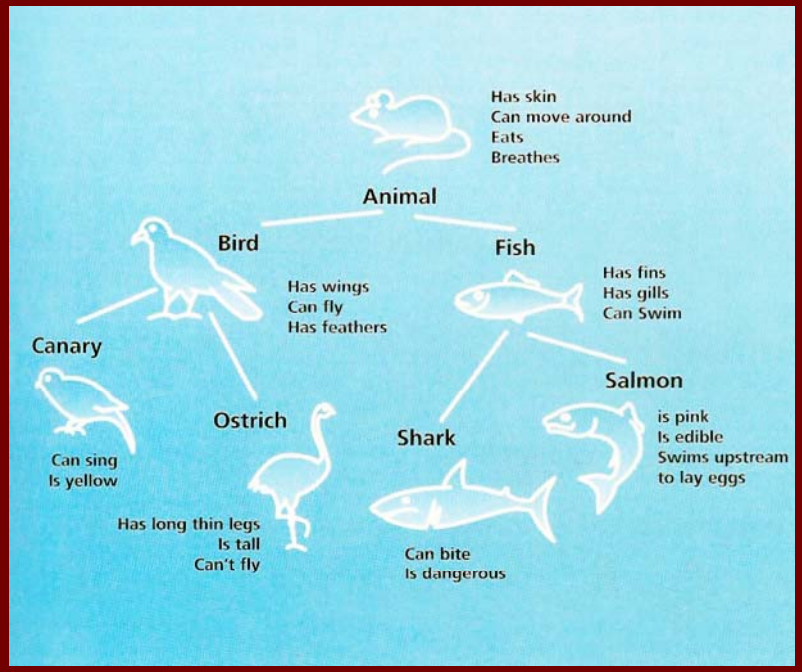
Working memory

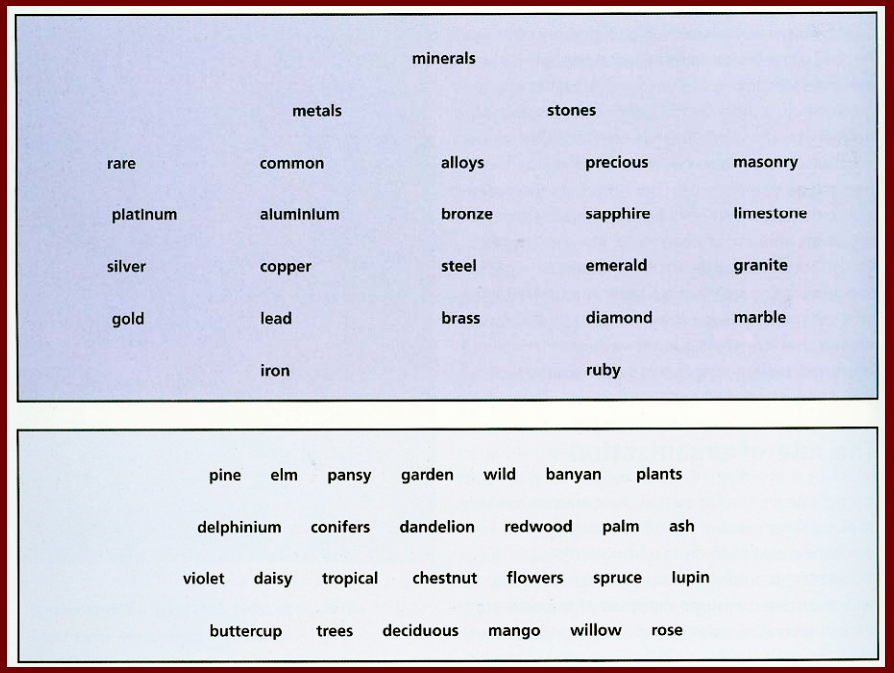
- In 1974 suggested by Baddeley and Hitch
- To the visual and verbal short-term memory they added the central executive



Long-term memory

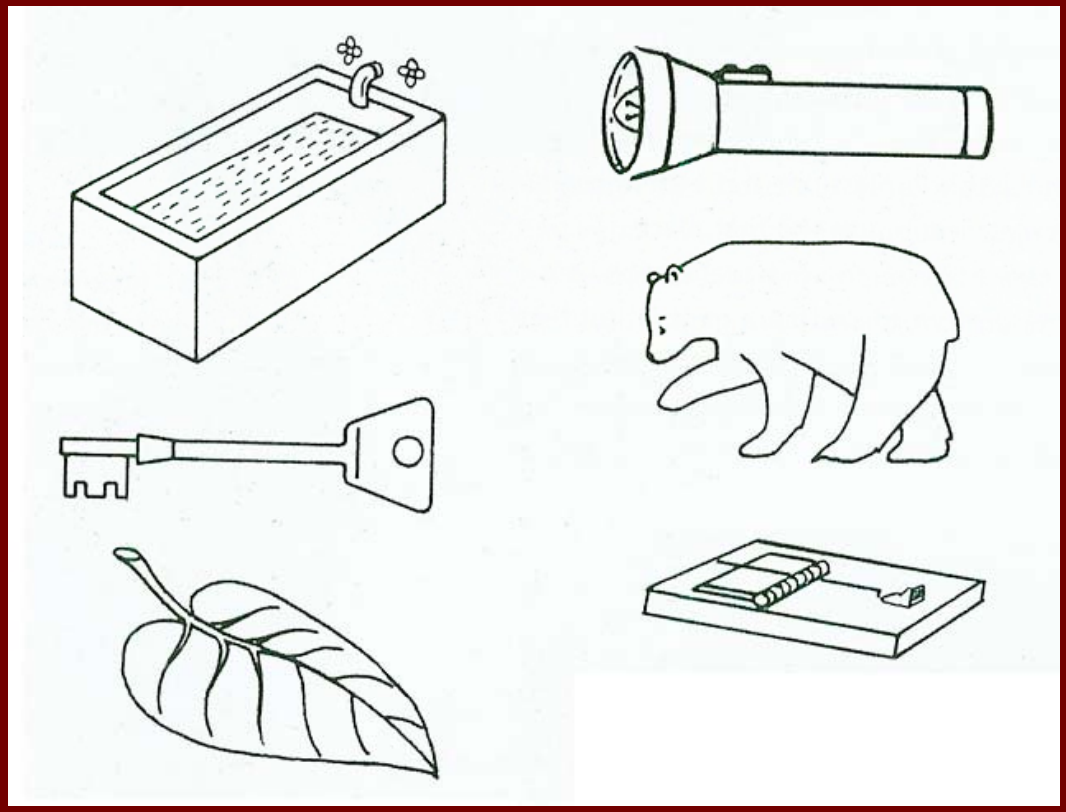
- The long-term memory is based on semantic relations
- Learning of semantically organized material is much easier than of unorganized





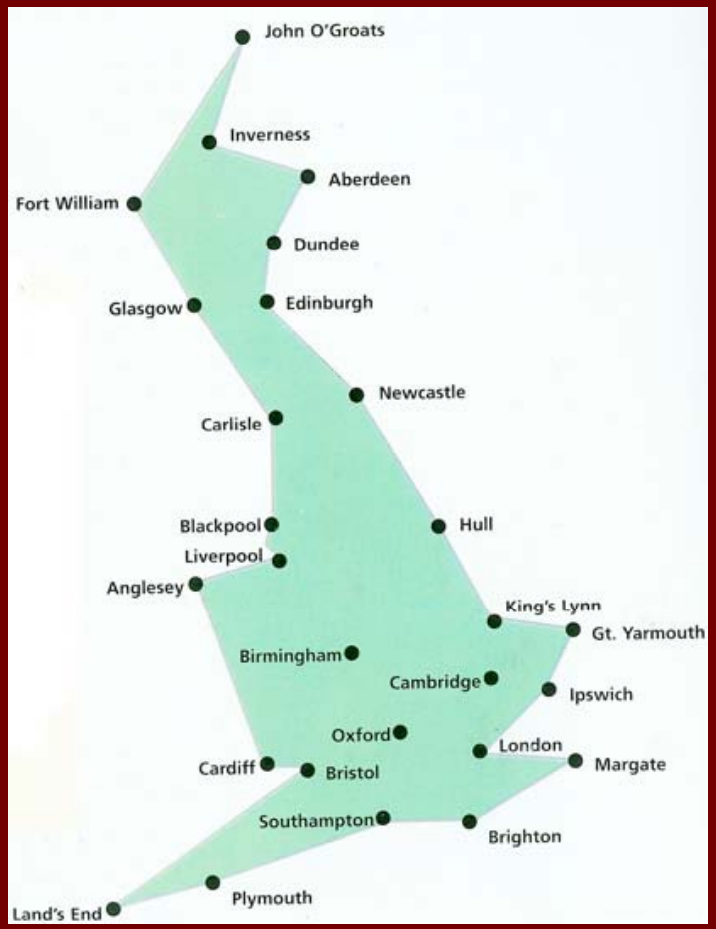
Long-term memory

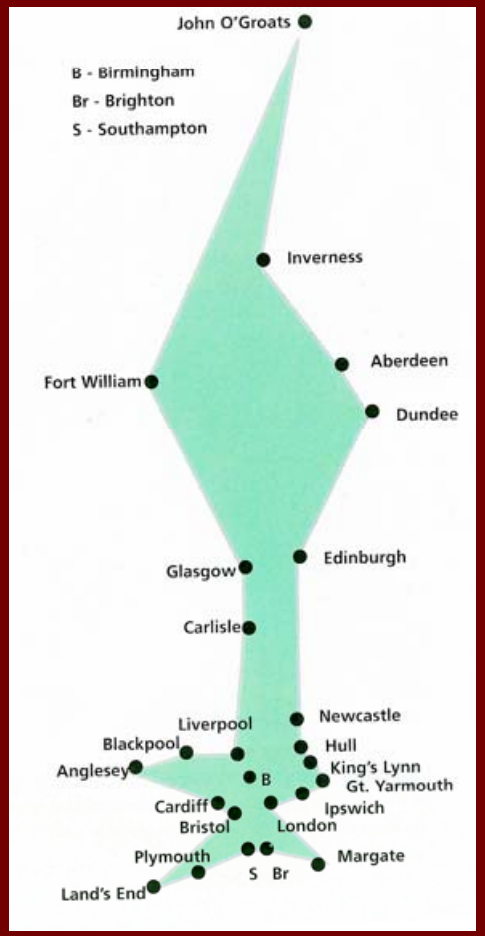
- The material is stored both verbally and visually



Long-term memory

- … is not stored exactly





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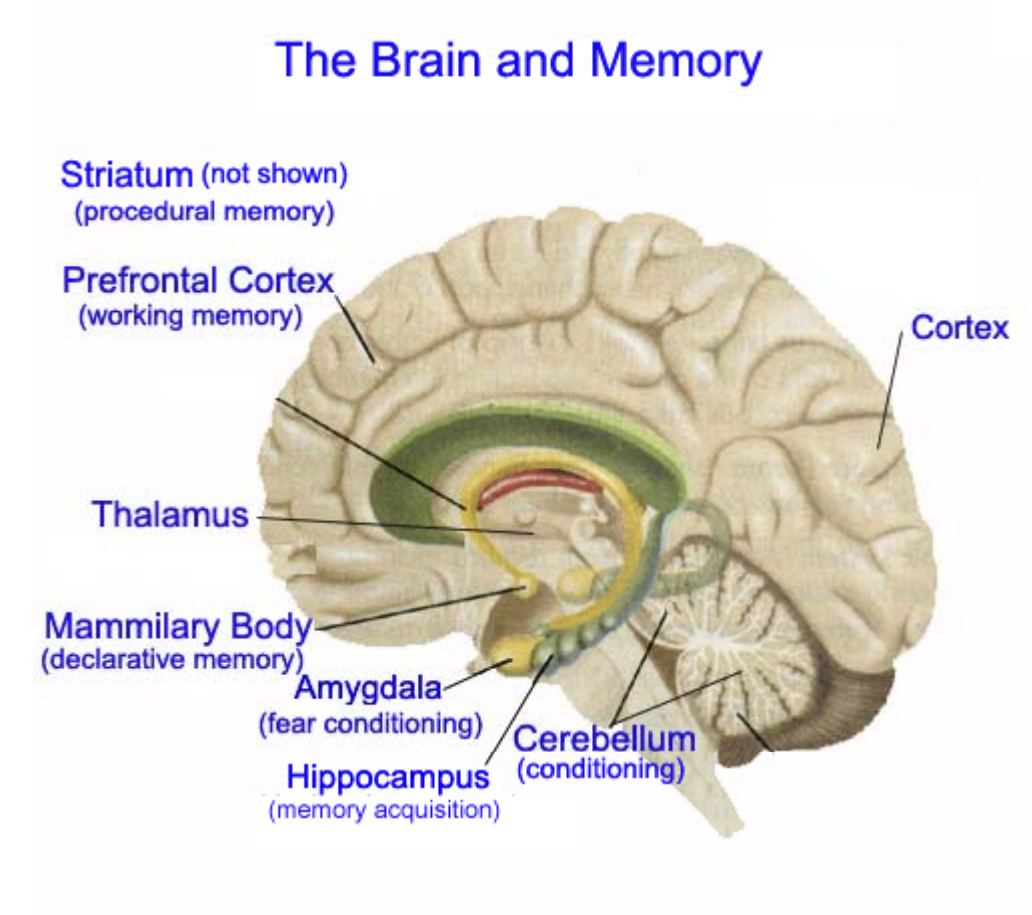
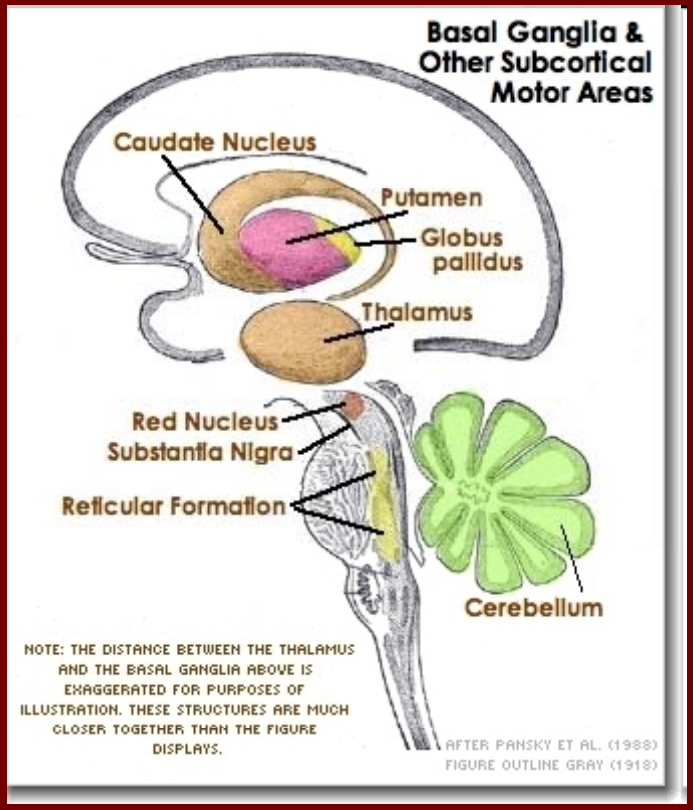
Brain areas involved in memory



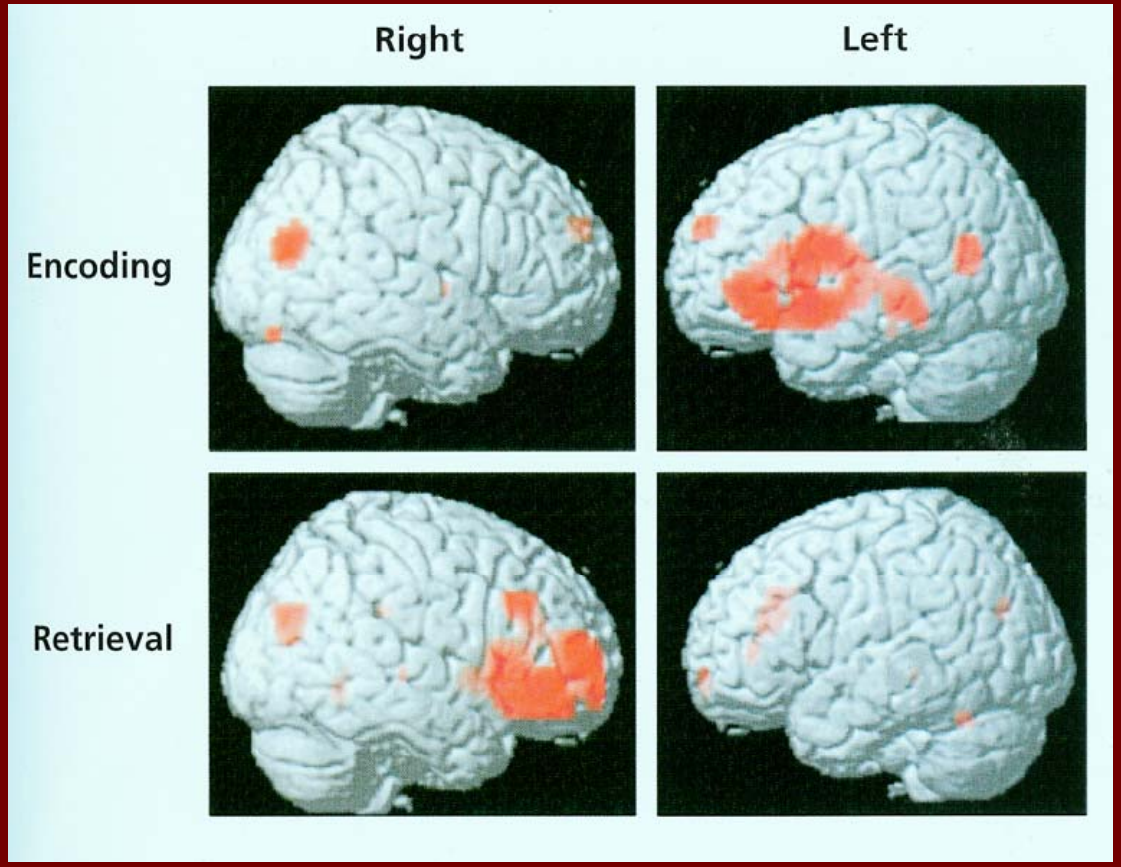


Memory processes

- Encoding
  - the information is stored in the brain, transferred from short-term to long-term memory
  - medial temporal lobe and hippocampus seem to be essential (anterograde amnesia)
- Consolidation
  - during several days (months?) after the encoding the memory is vulnerable to electric shock or photosynthesis inhibitors
  - retrograde amnesia
- Retrieval
  - consolidate memory is no longer dependent on the hippocampus
  - frontal lobes seem to be essential (aging, frontal lobe disorders)

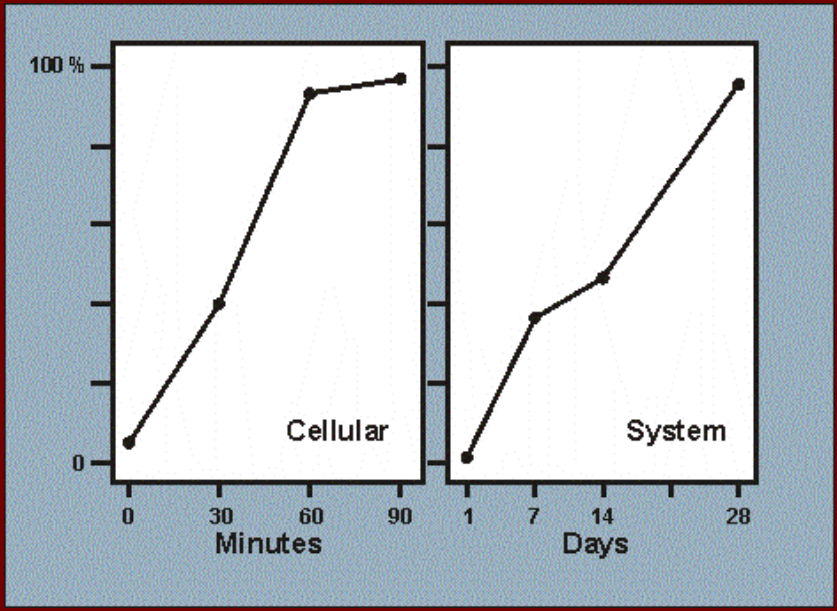
Learning and retrieval

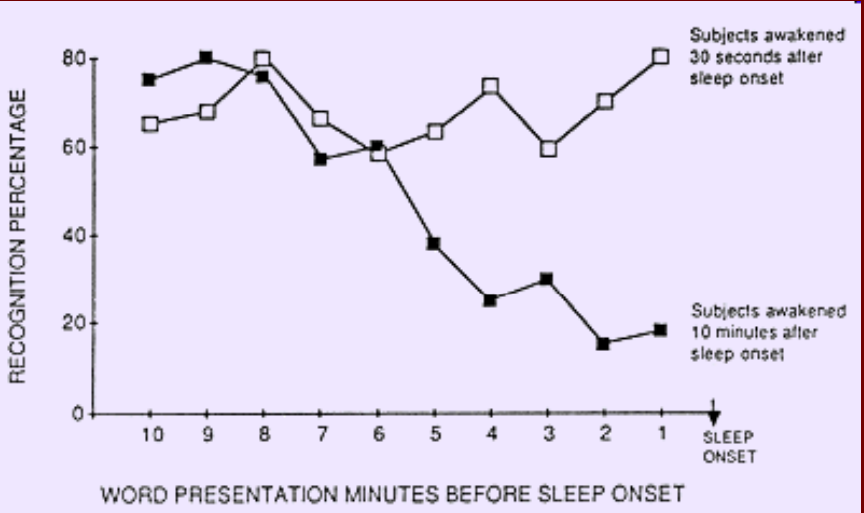
- The encoding and retrieval are different processes
- HERA – Hemispheric Encoding/Retrieval Asymmetry



Consolidation

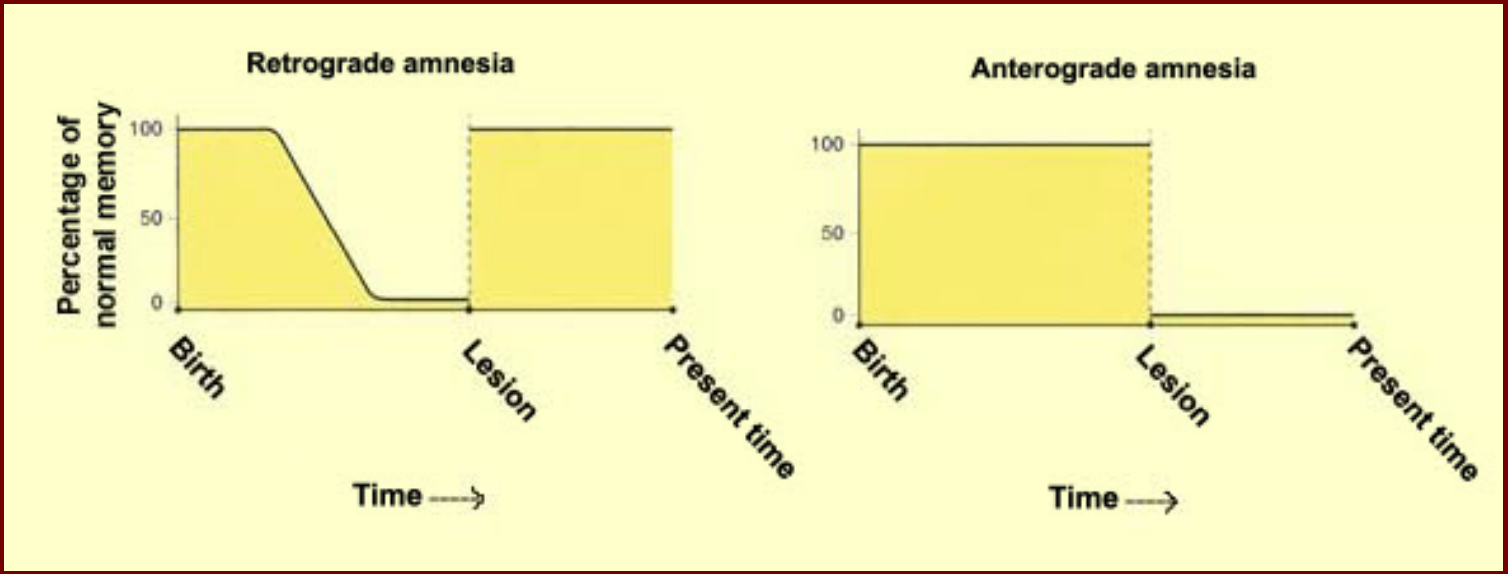
- Consolidation can be observed both on a cellular and system level
- Sleep deprivation impairs system consolidation





Memory by temporal direction

- Retrograde memory – before present time
- Anterograde memory – after present time



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Thank you for your attention