Learning and Memory

Informatics 1 Cognitive Science

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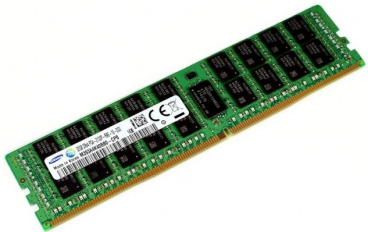
Topics

- What is memory?
- Memory systems
- Short-term and long-term memory

What is memory?



- Storage and retrieval of information
- Includes not only facts (hard to learn), but abilities, skills, and experiences
- Lifelong learning and forgetting
- Imperfect but robust (unlike computer memory)
- Comes in different qualities (unlike computer memory)

Computer memory versus cognitive memory

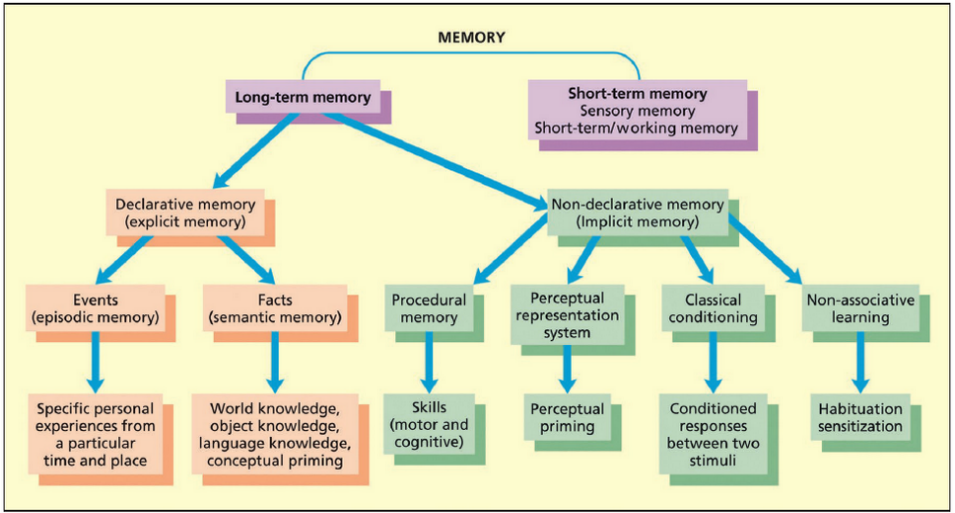
In computers:

- Memory and algorithmic processing are separated
- Address-based access for recall

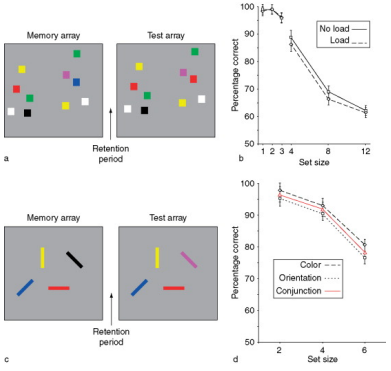
In the brain:

- Memory is a cognitive ability and inseparable from processing (the software is the hardware)
- Recall uses content-addressable access

Memory Systems

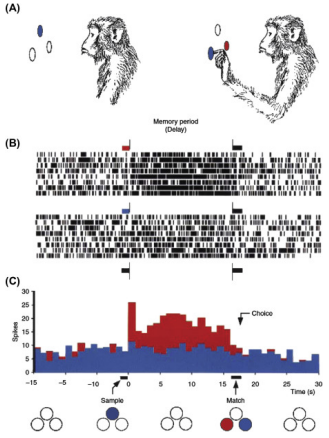


Short-Term / Working Memory



- Retaining information for short time periods, seconds to minutes
- (a) change detection paradigm using color (load: participant speaks); (c) change detection paradigm using color and orientation
- Capacity limited (about 4 items, not George Miller's Magical Number 7 ± 2)

Working Memory as reverberating neural activity



- A delayed match to sample (DMTS) task
- Suggests information maintained through reverberating neural activity (PFC)

Working Memory is more than a temporary store

TABLE 2
CORRELATIONS BETWEEN SPANS AND READING COMPREHENSION IN EXPERIMENT 1

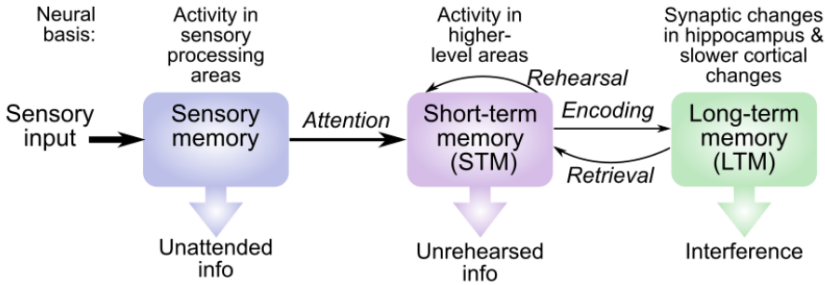
	Reading comprehension measures		
	Fact questions	Pronoun reference questions	Verbal SAT
Reading span test	.72*	.90*	.59*
Word span test	.37	.33	.35

* $r(18), p < .01$.

- Participants read sentences (e.g. "When at last his eyes opened, there was no gleam of triumph, no shade of anger. The taxi turned up Michigan Avenue where they had a clear view of the lake.")
  - Reading span test: Recall the last word of each sentence
  - Word span test: Word recall from a list of words read to participants
  - Reading comprehension tests: Recall of the meaning of the sentences
  - SAT: Verbal Scholastic Aptitude Test (measures comprehension)
- Individual performance is correlated: WM capacity is related to comprehension

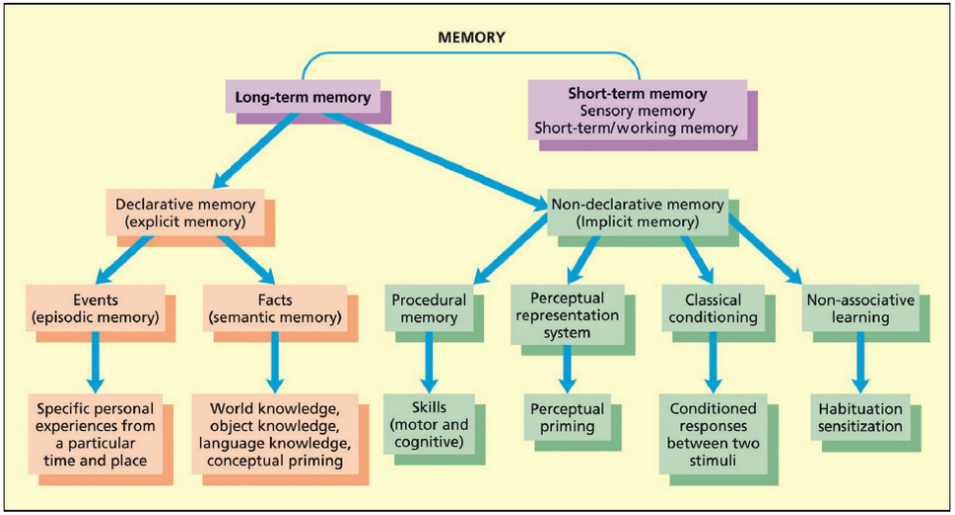
Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. Journal of verbal learning and verbal behavior, 19(4), 450-466.

Short-Term to Long Term Memory



- Neural activity maintains short term memory
- Attention selects information for STM
- STM content that is encode in STM can enter long term memory

Long Term Memory



Implicit Memory

- Does not require active recollection, typically unconscious
- Skill learning (procedural), conditioning and habituation
- Examples: motor skill learning like tying shoe laces, driving a bike or car, climbing difficult routes on rock

Explicit Memory

Also known as *Declarative Memory*. Divided into:

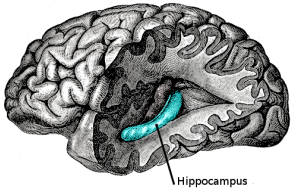
Semantic memory Factual knowledge about the world, such as: "What is the capital of Australia?". Involves multiple cortical regions. Information is retained for long times.

Episodic memory Personal events memory. Examples: "Name the route Adam Ondra climbed?", "What did you have for dinner last night?". Involves the medial temporal lobe, which includes the hippocampus. Selective and forgetful.

Often episodic memories are slowly stored away as semantic memories through consolidation.

A famous case study: Patient HM

- Bilateral hippocampal removal to cure epilepsy in 1953.
- Couldn't form memories of events after the lesion (anterograde amnesia)
- but was able to learn new procedures, and some short-term memory.
- This showed:
  - different mechanisms/sites for declarative and non-declarative memory
  - different mechanisms/sites for short and long-term memory



Henry Gustav Molaison (1926–2008)

Summary

- Memory is the storage and retrieval of information
- Memory comes in different forms: short-term, long-term, implicit, explicit
- Different memory systems are associated with different brain regions