



Memory

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- Memory is the glue that binds our mental life, the scaffolding for our personal history.

Definition

Memory is intrinsically linked to learning and involves:

- Acquisition of skills and associations.
- Storage of information.
- Learning of new information (anterograde memory).
- Recall of previously learnt information (retrograde memory).

MEMORY PROCESS

- Registration of information
- Storage of information
- Retrieval of information.

So, The memory process

- Registration can be thought of as a necessary condition for storage to take place, but not everything that registers on the senses is stored.
 - Similarly, storage is a necessary, but not sufficient, condition for retrieval: we cannot recover information that has not been stored, but the fact that we know the information is no guarantee that we will remember it on any particular occasion.
 - This is the crucial distinction between :
 - *availability* (whether or not the information has been stored)
- and
- *accessibility* (whether or not the information can be retrieved).

Memory

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graph TD; Memory[Memory] --> Registration[Registration (encoding)]; Memory --> Storage[Storage]; Memory --> Retrieval[Retrieval];
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Registration (encoding)

Refers to input to the memory system.
Closely related to selective attention.
Relates to the questions:
How is sensory information processed in
a way that allows it to be stored?
or
How are things remembered?

Storage

Refers to the process by which sensory
information is retained in memory.
Relates to the questions:
Where are our memories 'kept'?
and
Is there more than one kind of memory?

Retrieval

Refers to the process by which stored
information is recovered.
Relates to the questions:
Are there different kinds of
remembering?
What do we remember?
and
Why do we forget?

The three processes of memory

1. Registration (or encoding)

- The transformation of sensory input (e.g. a sound or visual image) into a form that allows it to be entered into (or registered in) memory.
- With a computer, for example, information can be encoded only if it is presented in a format that the computer recognizes.

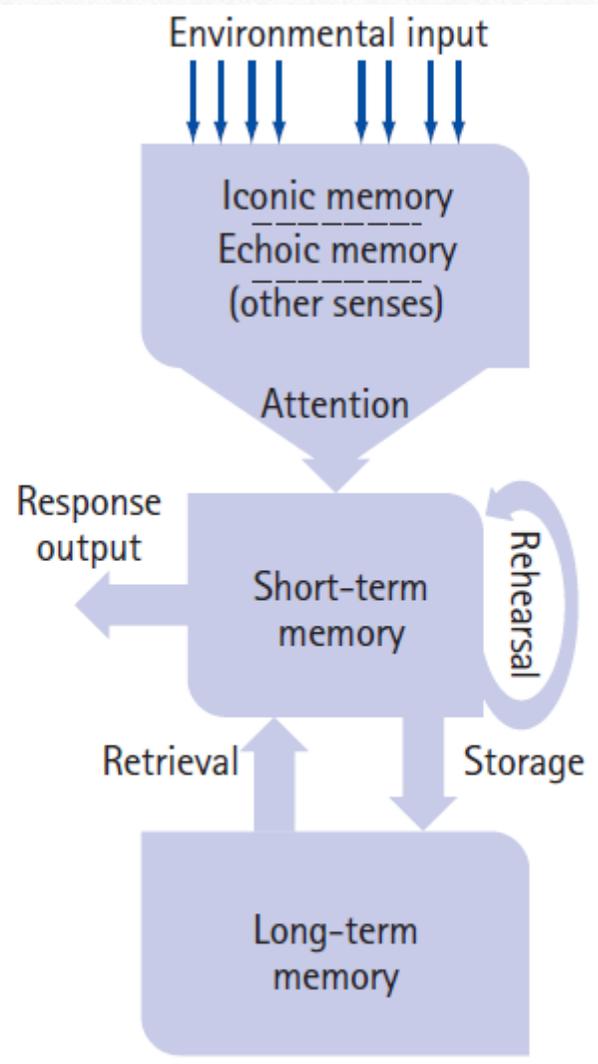
2. Storage

- The operation of holding or retaining information in memory.
- Computers store information by means of changes in the system's electrical circuitry. In humans, the changes occurring in the brain allow information to be stored, though exactly what these changes involve is unclear.

Storage of information:

Multi-store model (Atkinson and Shiffrin's model)

- Atkinson and Shiffrin's MSM (sometimes called the *dual memory model* because of the emphasis on STM and LTM)
- was an attempt to explain how information flows from one storage system to another .The model sees sensory memory, STM and LTM as permanent structural components of the memory system (built-in features of the human information-processing system). In addition to these structural components, the memory system comprises more transient control processes.
- Rehearsal is a key control process serving two main functions:
 1. to act as a *buffer* between sensory memory and LTM by maintaining incoming information within STM;
 2. to transfer information to LTM.



Multi-store (dual-memory) model of memory

Storage of information

According to Multi-store model (Atkinson and Shiffrin's model):

They classified memory storage into : Sensory, short- and long-term systems.

A. Sensory memory:

- Gives us an accurate account of the environment as experienced by the sensory system. We retain a literal copy of the stimulus long enough for us to decide whether it is worthy of further processing. Any information that we do not attend to or process further is forgotten.

A. Sensory memory

1. Large capacity but information is unanalyzed, unconscious and of very short duration.
2. Sense(modality) -specific: Additional information entering the same sensory channel immediately disrupts the storage. For example, if two visual stimuli are presented within quick succession, memory of the first stimulus may be lost; but if the second stimulus is a sound or smell, it will not interfere with memory of the visual stimulus.
3. Types: *echoic* – auditory (up to 2 s), *iconic* – visual (0.5 s) and *haptic* – touch.

B. Short-term memory (STM) (primary/working memory)

- one-hundredth of all the sensory information that impinges on the human senses every second reaches consciousness.
- Of this, only about 5 per cent is stored permanently.
- Clearly, if we possessed only sensory memory, then our capacity for retaining information about the world would be extremely limited.
- According to models of memory such as MSM some information from sensory memory is successfully passed on to STM.

B. Short-term memory

- Short-term (and long-term) memory can be analyzed in terms of the following:
 1. *Capacity*: how much information can be stored.
 2. *Duration*: how long the information can be held in storage
 3. *Coding*: how sensory input is represented by the memory system.

1. Capacity of STM

‘The magical number seven, plus or minus two’

- *chunking* can be used to expand the limited capacity of STM by using already established memory stores to categorize or encode new information



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Chunking

- Chunking is involved whenever we reduce a larger amount of information to a smaller amount.
- This (i) increases the capacity of STM and (ii) represents a form of encoding information, by imposing a meaning on otherwise meaningless material.

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2. Duration of STM:

- In the absence of rehearsal(repeating), then, the duration of short-term memory is very short (within 20 to 30 s), even with very small amounts of information.
- If a more difficult distractor task is used, the duration can be made even shorter.

3. Coding of STM

- STM must code information according to its *sound*.
- Even when information is presented visually, it must somehow be transformed into its acoustic code
- *semantic coding* (coding for meaning) had taken place in STM.

C. Long-term memory (LTM) (secondary memory)

1. Capacity :It is generally accepted that LTM has unlimited capacity.

Some of the kinds of information contained in LTM include:

- I. a spatial model of the world around us;
- II. knowledge of the physical world, physical laws and properties of objects;
- III. beliefs about people, ourselves, social norms, values and goals;
- IV. motor skills, problem-solving skills, and plans for achieving various things;
- V. perceptual skills in understanding language, interpreting music and so on.

2. Duration of LTM

- Information can be held for between a few minutes and several years (and may in fact span the individual's entire lifetime).

3. Coding of LTM

- With verbal material, coding in LTM appears to be *mainly semantic*.
- Our ability to picture a place we visited on holiday indicates that at least some information is stored or coded *visually*.
- Some types of information in LTM (e.g. songs) are coded *acoustically*.
- *Smells and tastes* are also stored in LTM.

	Capacity	Duration	Coding
STM	Seven bits of (unrelated) information; can be increased through <i>chunking</i>	15–30 s (unaided); can be increased by (maintenance) <i>rehearsal</i>	Mainly acoustic; some semantic; visual also possible
LTM	Unlimited	From a few seconds to several years (perhaps permanently)	Semantic, visual, acoustic; also olfactory and gustatory; very flexible

Forms of long-term memory

1. **Declarative** (expressed through language and sub-divided into episodic and semantic)

Declarative memories are experienced explicitly (recalled completely with subjective temporal awareness).

- a) Episodic* An autobiographical memory for events and places.
- b) Semantic (knowledge)* Vocabulary, meanings, significance.

2. **Procedural** (expressed through action).

- Procedural memory is ***IMP***licit (no conscious recollection or temporal awareness) and concerns skills (***I***ntuition, ***M***otor, ***P***erception).

Memory Systems and Associated Neuroanatomy

Type of System	Type of Memory	Associated Anatomy	Length of Recall	Memory Used to Remember
Declarative (explicit or conscious)	Episodic	Temporal lobes (medial), anterior thalamic nuclei, fornix, hippocampus, mammillary bodies, prefrontal cortex	Long term	Personally experienced events, e.g., what you ate yesterday
	Semantic	Inferolateral temporal lobes	Long term	General knowledge about the world, e.g., the capital of New Jersey
Nondeclarative (implicit or unconscious)	Procedural	Cerebellum, basal ganglia, supplementary motor area	Long term	Things you do automatically, e.g., how to tie your shoes
	Working	Prefrontal cortex, language and visual association areas	Short term	Recent information, e.g., the phone number just obtained from a new acquaintance

3. RETRIEVAL

- The recall of information from memory (LTM→STM).
- Emotion influences retrieval:
 1. facilitated by positive emotion because of increased rehearsal and organization
 2. impaired with negative emotions/anxiety
 3. facilitated by reproducing original emotional context (**state-dependent learning**).
- ***Primacy and recency effects*** Accurate recollection of an item is more likely if it is one of the first or last items to be learnt. Primacy occurs because initial items receive most consolidation and recency because immediate information is still in STM.
- Forgetting is more often a failure to access information than to retain it.

Forgetting

- Under the multimodal model of memory, forgetting from long-term memory could be caused by **interference** or **trace decay**.

1. Interference theory

- forgetting by interference is item dependent.

There are two main types:

- *Proactive interference/inhibition*—previous learning is likely to impair subsequent learning.
- *Retroactive interference/inhibition*—new learning is likely to impair previous learning.

2. Decay theory

- Memories fade with time.
- The longer the item remains in the memory system, the weaker is its strength.
- New material has a high trace strength, while older has a low trace strength.
- Forgetting by decay is time dependent.

