

Memory

Memory

Memory is the capacity to retain information over time (in both living organisms and computers).

It enables us to learn from experience (e.g., trial-and-error).

There is no single memory system in our brain but several, functionally distinct systems.

They differ in

- the type of information that they store,
- the duration for which it is stored, and
- the maximum amount of information that can be stored (capacity).

Sensory Memory

Sensory memory is a “short-term storage facility” for incoming sensory information.

Holds information only long enough for higher-level cognitive processes to operate on it, e.g., object recognition.

There is one separate form of sensory memory for each of the five senses, for example:

- **Iconic memory:** visual sensory memory holding a “snapshot” of recent (200-300 ms) visual input.
- **Echoic memory:** auditory sensory memory “echoing” recent (several seconds) auditory input.

Iconic Memory Experiment

Sperling (1963):

4×3 array of randomly chosen English letters

• **Whole-report condition:**

- After brief presentation, letters disappear
- Subjects have to report which letters were shown

• **Partial-report condition:**

- After brief presentation, letters disappear
- The pitch of a played tone indicates whether to report the letters in the first, second, or third row.

Iconic Memory Experiment

Whole-Report Condition

Your task: Memorize as many letters as possible in the following display and report them after the display has disappeared.

Iconic Memory Experiment

Iconic Memory Experiment

H B X V
M F Z T
P G W Q

Iconic Memory Experiment

Iconic Memory Experiment

How many letters did you remember?

Typically, people can report only 4 or 5 of them correctly.

Iconic Memory Experiment

Partial-Report Condition

Your task: Memorize as many letters as possible in the following display.

Right after the display has disappeared, an arrow will point to one of the previously shown rows.

Report as many letters as possible that were shown in that row.

Iconic Memory Experiment

Iconic Memory Experiment

E Y H N
G X K F
M Q Z T

Iconic Memory Experiment



Iconic Memory Experiment

Iconic Memory Experiment

How many letters did you remember
this time?

Often, people can report all four letters.

Iconic Memory Experiment

Partial-Report Condition

Let us do the partial-report condition one more
time, in case you were not prepared the first time.

Iconic Memory Experiment

Iconic Memory Experiment

K C R Q
P V Z G
L H X S

Iconic Memory Experiment



Iconic Memory Experiment

Iconic Memory Experiment

You did not know where the arrow was going to appear; therefore, you must have memorized all 12 letters in order to get all four relevant letters right.

The Sperling experiment thus shows that iconic memory can hold at least 12 letters.

Other research shows that in fact iconic memory can hold much more information – a quite detailed “snapshot” of the visual scene.

However, this information fades very quickly (fast decay).

Working Memory

Working memory is also known as short-term memory.

It can hold information for longer durations than sensory memory.

However, its capacity is severely limited.

Working memory can hold multimodal information, i.e., acoustic and visual information.

It is like a workbench holding all items that we (certain cognitive processes) need to complete a specific task.

Example: Dialing a phone number that somebody has just told us.

Working Memory

Do you remember our memory task example when we discussed experimental design?

If subjects memorize numerical data and report them after a certain time interval, there is hardly any decay even for long intervals.

However, if they have to an interfering task (e.g., counting backwards) during the interval, there is increasing decay with longer intervals.

Some studies found that in such situations the amount of stored information has a half-life of about 3 to 5 seconds.

Working Memory

In a famous (infamous?) paper, Miller (1956) studied the capacity of working memory.

He found that people can hold about seven plus/minus two items in working memory.

The problem is: How do you define “item?”

For example, expert chess players can store entire game configurations in working memory.

Chess novices can memorize the positions of at most a few pieces.

What is the reason for this? Differences in working memory?

Working Memory

No, the reason is **chunking**, i.e., the grouping of items into meaningful units.

For example, the expert chess players recognize entire common constellations of several pieces as units.

These units then constitute their memorized "items."

A similar example is the memorization of letters.

You can memorize a much longer sequence of letters if they form an English sentence than when they are randomly chosen.

Long-Term Memory

You can still remember events that happened a long time ago, for example, when you were a child.

Long-term memory is able to store large amounts of information over very long durations.

There are several distinct types of long-term memory:

- Procedural memory
- Declarative memory:
 - Semantic memory
 - Episodic memory

Procedural Memory

- Also called implicit memory
- Memory for skill
- Demonstrated only by doing
- Arises without conscious recall
- Examples: Riding a bike, playing tennis, playing the piano.

Declarative Memory

- Also called explicit memory
- Memory for facts and events
- Demonstrated by speaking
- Arises with conscious recall
- **Semantic memory:**
 - Knowledge of facts
 - For example, things that you learn in this course
- **Episodic memory:**
 - Contains personally experienced events
 - E.g., what you did on your birthday last year.