**Memory**

“Memory is the process of maintaining information over time.” (Matlin, 2005)

“Memory is the means by which we draw on our past experiences in order to use this information in the present’ (Sternberg, 1999).

Memory is the term given to the [structures](https://www.simplypsychology.org/multi-store.html) and [processes](https://www.simplypsychology.org/levelsofprocessing.html) involved in the storage and subsequent retrieval of information.

Memory is essential to all our lives. Without a memory of the past we cannot operate in the present or think about the future. We would not be able to remember what we did yesterday, what we have done today or what we plan to do tomorrow.  Without memory we could not learn anything.

Memory is involved in processing vast amounts of information. This information takes many different forms, e.g. images, sounds or meaning.

For psychologists the term memory covers three important aspects of information processing:

**Stages of Memory**

**1. Memory Encoding**

When information comes into our memory system (from sensory input), it needs to be changed into a form that the system can cope with, so that it can be stored.  Think of this as similar to changing your money into a different currency when you travel from one country to another.  For example, a word which is seen (in a book) may be stored if it is changed (encoded) into a sound or a meaning (i.e. semantic processing).

There are three main ways in which information can be encoded (changed):

**1. Visual (picture)**

**2. Acoustic (sound)**

**3. Semantic (meaning)**

For example, how do you remember a telephone number you have looked up in the phone book?  If you can see it then you are using visual coding, but if you are repeating it to yourself you are using acoustic coding (by sound).

Evidence suggests that this is the principle coding system in short term memory (STM) is acoustic coding.  When a person is presented with a list of numbers and letters, they will try to hold them in STM by rehearsing them (verbally).  Rehearsal is a verbal process regardless of whether the list of items is presented acoustically (someone reads them out), or visually (on a sheet of paper).

The principle encoding system in long term memory (LTM) appears to be semantic coding (by meaning).  However, information in LTM can also be coded both visually and acoustically.

**2. Memory Storage**

This concerns the nature of memory stores, i.e. where the information is stored, how long the memory lasts for (duration), how much can be stored at any time (capacity) and what kind of information is held.  The way we store information affects the way we retrieve it.  There has been a significant amount of research regarding the differences between Short Term Memory (STM ) and Long Term Memory (LTM).

Most adults can store between 5 and 9 items in their short-term memory.  Miller (1956) put this idea forward and he called it the magic number 7.  He though that short-term memory capacity was 7 (plus or minus 2) items because it only had a certain number of “slots” in which items could be stored.

However, Miller didn’t specify the amount of information that can be held in each slot.  Indeed, if we can “chunk” information together we can store a lot more information in our short-term memory.  In contrast the capacity of LTM is thought to be unlimited.

Information can only be stored for a brief duration in STM (0-30 seconds), but LTM can last a lifetime.

**3. Memory Retrieval**

This refers to getting information out storage.  If we can’t remember something, it may be because we are unable to retrieve it.  When we are asked to retrieve something from memory, the differences between STM and LTM become very clear.

STM is stored and retrieved sequentially.  For example, if a group of participants are given a list of words to remember, and then asked to recall the fourth word on the list, participants go through the list in the order they heard it in order to retrieve the information.

LTM is stored and retrieved by association.  This is why you can remember what you went upstairs for if you go back to the room where you first thought about it.

Organizing information can help aid retrieval.  You can organize information in sequences (such as alphabetically, by size or by time).  Imagine a patient being discharged from hospital whose treatment involved taking various pills at various times, changing their dressing and doing exercises.  If the doctor gives these instructions in the order which they must be carried out throughout the day (i.e. in sequence of time), this will help the patient remember them.

**Types of Memory**

What we usually think of as “memory” in day-to-day usage is actually  Long Term Memory (LTM). But there are important Short Term Memory (STM ) and sensory memory processes, which must be worked through before a long-term memory can be established. The **different types of memory** each have their own particular mode of operation, but they all cooperate in the process of memorization, and can be seen as **three necessary steps** in forming a lasting memory.

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| *Types of Human Memory: Diagram by Luke Mastin Types of Human Memory: Diagram by Luke Mastin* |

**Sensory memory** is the shortest-term element of memory. It is the ability to retain impressions of sensory information after the original stimuli have ended. It acts as a kind of **buffer** for stimuli received through the **five senses** of sight, hearing, smell, taste and touch, which are retained accurately, but very briefly. For example, the ability to look at something and remember what it looked like with just a second of observation is an example of sensory memory.

The stimuli detected by our senses can be either deliberately **ignored**, in which case they disappear almost instantaneously, or**perceived**, in which case they enter our sensory memory. This does not require any conscious attention and, indeed, is usually considered to be totally outside of conscious control. The brain is designed to only process information that will be useful at a later date, and to allow the rest to pass by unnoted. As information is perceived, it is therefore stored in sensory memory **automatically** and unbidden. Unlike other types of memory, the sensory memory cannot be prolonged via **rehearsal**.

**Short-term memory** acts as a kind of**“scratch-pad”** for temporary recall of the information which is being processed at any point in time, and has been refered to as "the brain 's Post-it note". It can be thought of as the ability to **remember** and **process information** at the same time. It holds a small amount of information (typically around 7 items or even less) in mind in an active,**readily-available** state for a short period of time (typically from 10 to 15 seconds, or sometimes up to a minute).

For example, in order to understand this sentence, the beginning of the sentence needs to be held in mind while the rest is read, a task which is carried out by the short-term memory. Other common examples of short-term memory in action are the holding on to a piece of information temporarily in order to complete a task (e.g. “carrying over” a number in a subtraction sum, or remembering a persuasive argument until another person finishes talking), and simultaneous translation (where the interpreter must store information in one language while orally translating it into another). What is actually held in short-term memory, though, is not complete concepts,but rather links or pointers (such as words, for example) which the brain can flesh out from it's other accumulated knowledge.

**Long-term memory** is, obviously enough, intended for storage of information over a long period of time. Despite our everyday impressions of **forgetting**, it seems likely that long-term memory actually decays very little over time, and can store a seemingly **unlimited** amount of information **almost indefinitely**. Indeed, there is some debate as to whether we actually ever “forget” anything at all, or whether it just becomes increasingly difficult to access or retrieve certain items from memory.

Short Term Memory  can become long-term memory through the process ofconsolidation, involving **rehearsal** and**meaningful association**. Unlike Short Term Memory  (which relies mostly on an **acoustic**, and to a lesser extent a **visual**, code for storing information), long-term memory encodes information for storage **semantically** (i.e. based on meaning and association). However, there is also some evidence that long-term memory does also encode to some extent by **sound**. For example, when we cannot quite remember a word but it is “on the **tip of the tongue**”, this is usually based on the sound of a word, not its meaning.

Long Term Memory  is often divided into two further main types: **explicit** (or **declarative**) memory and **implicit** (or **procedural**) memory.

**Declarative memory** (“knowing what”) is memory of facts and events, and refers to those memories that can be **consciously**recalled (or "declared"). It is sometimes called **explicit memory**, since it consists of information that is explicitly stored and retrieved, although it is more properly a subset of explicit memory. Declarative memory can be further sub-divided into episodic memory and semantic memory.

**Procedural memory** (“knowing how”) is the **unconscious** memory of skills and how to do things, particularly the use of objects or movements of the body, such as tying a shoelace, playing a guitar or riding a bike. These memories are typically acquired through repetition and practice, and are composed of automatic sensorimotor behaviours that are so deeply embedded that we are no longer aware of them. Once learned, these "body memories" allow us to carry out ordinary motor actions more or less automatically. Procedural memory is sometimes referred to as **implicit memory**, because previous experiences aid in the performance of a task without explicit and conscious awareness of these previous experiences, although it is more properly a subset of implicit memory.

**Declarative memory**  can be further sub-divided into **episodic memory** and**semantic memory**.

**Episodic memory** represents our memory of **experiences** and specific **events** in time in a serial form, from which we can reconstruct the actual events that took place at any given point in our lives. It is the memory of **autobiographical events**(times, places, associated emotions and other contextual knowledge) that can be explicitly stated. Individuals tend to see themselves as actors in these events, and the **emotional charge** and the entire**context** surrounding an event is usually part of the memory, not just the bare facts of the event itself.

**Semantic memory**, on the other hand, is a more structured record of **facts**, **meanings**, **concepts** and **knowledge about the external world** that we have acquired. It refers to general factual knowledge, shared with others and **independent of personal experience** and of the **spatial/temporal context** in which it was acquired. Semantic memories may once have had a personal context, but now stand alone as simple knowledge. It therefore includes such things as types of food, capital cities, social customs, functions of objects, vocabulary, understanding of mathematics, etc. Much of semantic memory is abstract and relational and is associated with the meaning of **verbal symbols**.

An important **alternative classification** of Long Term Memory  used by some researchers is based on the **temporal direction** of the memories.

**Retrospective memory** is where the content to be remembered (people, words, events, etc) is in the **past**, i.e. the recollection of past episodes. It includes semantic, episodic and autobiographical memory, and declarative in general, although it can be either explicit  or implicit.

**Prospective memory** is where the content is to be remembered in the **future**, and may be defined as **“remembering to remember”** or remembering to perform an intended action. It may be either event-based or time-based, often triggered by a **cue**, such as going to the doctor (action) at 4pm (cue), or remembering to post a letter (action) after seeing a mailbox (cue).

**Forgetting** 

**Forgetting** or **disremembering** is the apparent loss or modification of information already encoded and stored in an individual's [long-term memory](https://en.wikipedia.org/wiki/Long-term_memory). It is a spontaneous or gradual process in which old [memories](https://en.wikipedia.org/wiki/Memory) are unable to be recalled from memory storage. Forgetting also helps to reconcile the storage of new information with old knowledge First, the memory has disappeared - it is no longer available.  Second, the memory is still stored in the memory system but, for some reason, it cannot be retrieved.

These two answers summaries the main theories of forgetting developed by psychologists.  The first answer is more likely to be applied to forgetting in short term memory, the second to forgetting in long term memory.

Forgetting information from [short term memory](https://www.simplypsychology.org/short-term-memory.html) (STM) can be explained using the theories of trace decay and displacement.

Forgetting from [long term memory](https://www.simplypsychology.org/long-term-memory.html) (LTM) can be explained using the theories of interference and lack of consolidation.

**Theories of Forgetting**

**Decay theory**

An organic/physical explanation of forgetting based on the assumption that when something new is learned, a memory trace or neural imprint of the experience (that contains the stored information) is formed in the brain; the trace gradually fades over time through disuse unless it is reactivated by being used.

**Interference theory**

an explanation that proposes that forgetting in long-term memory occurs because other memories interfere with retrieval of what you are trying to recall, particularly if the other memories are similar to the one you are trying to remember.

**Motivated forgetting**

when forgetting in long-term memory arises from a strong motive or desire to forget, usually because the experience is too disturbing or upsetting to remember

**Retrieval**

the process of locating and recovering stored information from memory so that we are consciously aware of it.

**Retrieval failure theory**

an explanation of forgetting due to lack of or failure to use the right cue to retrieve information stored in memory; the information is not lost forever but it simply cannot be retrieved at that moment

**Retroactive interference**

when new information interferes with the ability to remember old information

**Suppression**

a type of motivated forgetting in which an individual actively keep a memory out of conscious awareness by choosing not to attend to or think about it

**Tip-of -the-tongue phenomenon (TOT)**

the feeling of being aware of knowing something and being confident that it will be remembered, but unable to be retrieve the information at that point in time. Demonstrates retrieval failure theory

**Proactive interference**

when information learned previously interferes with the ability to remember new information.

**Repression**

an unconscious process ( defence mechanism) through which an individual blocks a memory of an event or experience from entering conscious awareness because of the anxiety associated with recall; said to be a type of motivated forgetting

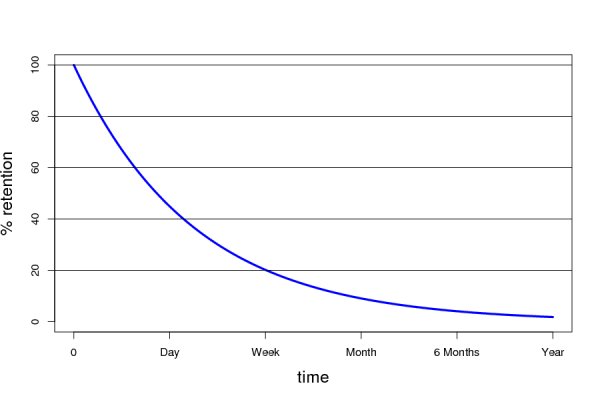
### Ebbinghaus forgetting curve

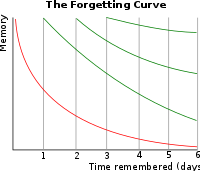
The forgetting curve shows how information or knowledge stored within the brain is lost over time if the individual makes no attempt to retain it. A related concept is the strength of memory, which refers to the durability that memory traces in the brain; the stronger the memory, the longer a person call recall it for.

With newly acquired information or knowledge, the curve shows that humans tend to halve their memory in a matter of days or weeks unless they consciously review the learned material. The speed of forgetting depends on a number of factors too, such as the difficulty of learned material, how meaningful it is, its representation, and physiological factors like stress and sleep.

Even though Ebbinghaus tried to eliminate meaning with his experiments, it was later determined that humans impose meaning even on nonsense syllables. For instance, the nonsense syllable PED (the first three letters of several common words) is actually less nonsensical than a syllable such as KOJ and others that differ in association value.

Having said that, the basal forgetting rate doesn’t differ much between individuals, whereas performance rates can be explained by mnemonic representation skills.





### How to overcome the forgetting curve

While some aspects that contribute to the speed of forgetting cannot be changed, Ebbinghaus said basic training in mnemonic techniques could help overcome differences in performance. He asserted that the best methods for increasing memory strength were:

**Better memory representation (e.g. mnemonic techniques)** - Coming up with a song is perhaps the most commonly used mnemonic technique. An example of which is how children remember their ABCs. However, other types include names, expressions, models, odes, note organisation, images, connections, and spellings.

**Repetition based on active recall (especially spaced repetition)** - When reviewing learned information, spacing out sessions over time makes items easier to remember. This is achieved through spaced presentation rather than repeat studying in a short span of time, also known as massed presentation.

**Criticism of Forgetting curve**

What’s more, some memories remain free from the effects of interference and don’t always follow the typical forgetting curve. For this reason, there is debate among supporters of Ebbinghaus about the shape of the curve for events and facts significant to the subject.

Memories of shocking events like the Kennedy Assassination or 9/11 are vividly imprinted in memory according to the flashbulb theory, while considerable variations in written recollections are possible when memory incorporates after-acquired information.

But when it comes to purposefully learning information or acquiring new knowledge, Ebbinghaus and his forgetting curve theory promote positive outcomes through better memory representation and repetition based on active recall.