Notes on Memory

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.

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**.

Sensory memory is an ultra-short-term memory and **decays** or degrades very quickly, typically in the region of 200 - 500 milliseconds (1/5 - 1/2 second) after the perception of an item, and certainly less than a second (although echoic memory is now thought to last a little longer, up to perhaps three or four seconds). Indeed, it lasts for such a short time that it is often considered part of the process of **perception**, but it nevertheless represents an essential step for storing information in short-term memory.

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 referred 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).

However, this information will quickly disappear forever unless we make a **conscious effort** to retain it, and short-term memory is a necessary step toward the next stage of retention, long-term memory. The transfer of information to long-term memory for more permanent storage can be facilitated or improved by mental **repetition** of the information or, even more effectively, by giving it a **meaning** and **associating** it with other previously acquired knowledge. **Motivation** is also a consideration, in that information relating to a subject of strong interest to a person is more likely to be retained in long-term memory.

The **central executive** part of the **prefrontal cortex** at the front of the brain appears to play a fundamental role in short-term and working memory. It both serves as a temporary store for short-term memory, where information is kept available while it is needed for current reasoning processes, but it also "calls up" information from elsewhere in the brain. The central executive controls two **neural loops**, one for visual data (which activates areas near the **visual cortex** of the brain and acts as a visual scratch pad), and one for language (the **"phonological loop"**, which uses **Broca's area** as a kind of "inner voice" that repeats word sounds to keep them in mind). These two scratch pads temporarily hold data until it is erased by the next job.

The **forgetting** of short-term memories involves a different process to the forgetting of long-term memories. When something in short-term memory is forgotten, it means that a nerve impulse has merely ceased being transmitted through a particular **neural network**. In general, unless an impulse is reactivated, it stops flowing through a network after just a few seconds.

Unlike with short-term memory, **forgetting** occurs in long-term memory when the formerly strengthened synaptic connections among the neurons in a neural network become weakened, or when the activation of a new network is superimposed over an older one, thus causing **interference** in the older memory.

Long Term Memory Types

Non-declarative or 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 playing a guitar or riding a bike. It is composed of automatic sensorimotor behaviours that are so deeply embedded that we are no longer aware of them, and, once learned, these "body memories" allow us to carry out ordinary motor actions 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 (“knowing what”) is memory of facts and events, and refers to those memories that can be **consciously** recalled. 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.

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**.

Both episodic memory and semantic memory require a similar encoding process. However, semantic memory mainly activates the **frontal and temporal cortexes**, whereas episodic memory activity is concentrated in the **hippocampus**, at least initially. Once processed in the hippocampus, episodic memories are then consolidated and stored in the **neocortex**. Our **spatial memory** in particular appears to be much more confined to the hippocampus, particularly the right hippocampus, which seems to be able to create a mental map of space, thanks to certain cells called **"place cells"**. Episodic memory does also trigger activity in the **temporal lobe**, but mainly in order to ensure that these personal memories are not mistaken for real life. This difference in the neurological processing of episodic and semantic memory is illustrated by cases of anterograde amnesia cases (a good example being a case known as **“C.L.”**) in which episodic memory is almost completely lost while semantic memory is retained.