Where Memory Lives...

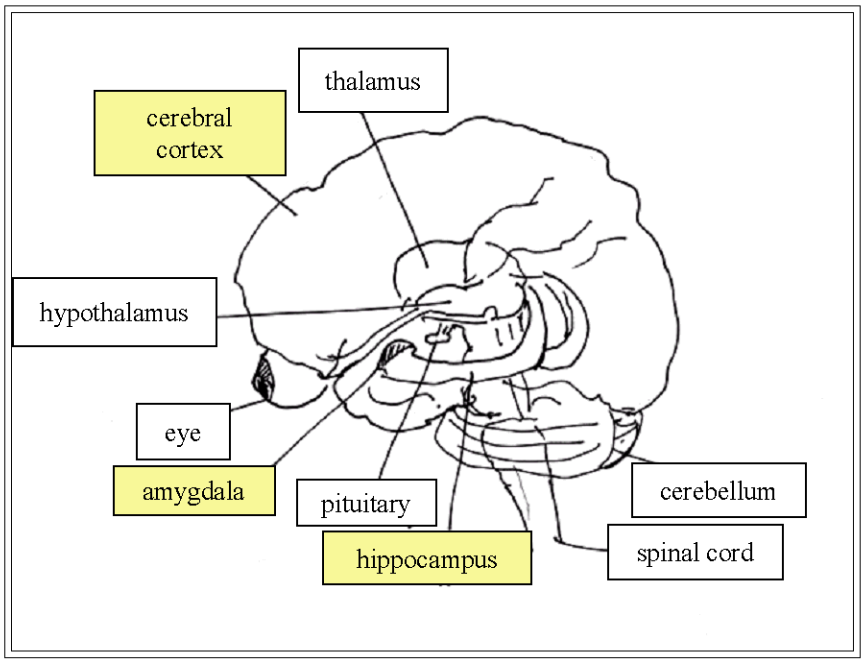
Think for a moment – what's the earliest event you can remember?

Now memorize these three words: hippocampus, amygdala, neocortex. Look away and see if you can recall them.

OK – now what part of your brain did you just use? Did you use the same part to recall your earliest memory as you did to recall the three words? To answer these questions, you'd need to know where memories are stored and if any different parts of the brain are used when the memories are retrieved. Also, you'd need to know if the same parts of the brain store new memories and very old ones.

Several regions of the brain have been shown to be important for memory. Take a look at these three:

- Hippocampus
- Cerebral cortex
- Amygdala



Hippocampus

In humans, the **hippocampus** is the key region responsible for the formation of short term memories. The hippocampus also prepares those memories for long-term storage. There is a hippocampal region in each half or hemisphere of the brain. The name describes the shape, which is supposed to be like the tail of dolphin.

Comparison of biochemical pathways at work in the nervous systems of flies, slugs, mice and humans has shown that similar pathways are important for memory in all organisms.

When rats are placed in different positions in the environment, their brains can detect these changes. By measuring electrical activity in the brain, scientists have found that the "position sensing" occurs in the hippocampus. This region appears to be involved in a kind of memory known as spatial memory. Spatial memory in rats has many similarities with factual (declarative) memory in humans.

Cerebral Cortex

The outermost layer of the brain is the **cerebral cortex**, also called the **neocortex**. Even though the cerebral cortex is only a few millimeters thick, its convoluted shape gives it a big surface area. Perhaps its texture is why in Latin the word "cortex" refers to bark. The neocortex is a key region in the long-term storage of many facts. It contains about 10% of all the nerves in a brain – over 10 billion nerve cells!

After about 45 days, a new memory cannot survive in short-term memory storage of the **hippocampus**. A memory is either lost or transferred to long-term memory in the **neocortex.**

Amygdala

Forming "how to" type memories, called procedural memories, occurs in the **amygdala.** The name means almond and refers to its nut-like shape. It is located near the hippocampus.

The amygdala is also involved in fear responses. People who have had the amygdala removed as a treatment of severe epilepsy no longer react with a normal fearful response to unpleasant situations. Some of the early studies of amygdala were done by observing cats – so the nickname of the amygdala is the "hiss and spit" center of the brain. For both humans and other animals, the amygdala is important for the regulation of emotional responses and in turn with memories that are strengthened by emotion.

Working Together

The different regions of the brain are not isolated but instead "talk" to one another. What happens when an old memory is retrieved from long-term storage in the neocortex? Recent studies suggest that the hippocampus may be involved. However, this question is still being hotly debated. Some of the questions that are being asked by researchers include:

- What happens to a memory when it is retrieved – does the old copy remain safe?
- If the temporary version of a memory stored in the hippocampus is lost or damaged, is the memory itself lost?
- Does a memory have to undergo the consolidation process again (transfer from short-term to long-term memory) after it is retrieved?

These and other questions are being answered as research moves forward.

Modern Methods in Brain Research

Early studies of the brain relied on patients with brain injuries, and autopsies of bodies donated for education. In both cases, a complete look at the active brain was impossible. However, modern technologies have extended our ability to look into a brain in a living person. You may have heard of some of these technologies because they are used in medicine as well as in scientific research.

CAT or CT scan (Computerized Axial Tomogram) This technique uses radiation to produce images of tissues in body. Each image appears as a "brain slice" taken from one plane of focus. CT is a standard technique to diagnose brain injuries, headaches or some changes in mental activity.

MRI (Magnetic Resonance Imaging) This technique uses a VERY powerful magnet to create an image from 3 planes. MRI images of the brain are excellent and detailed. MRI is used to diagnose brain diseases such as brain cancer.

fMRI (Functional MRI) This technique makes repeated scans of the brain. The increased oxygen flow to active areas helps produce an image corresponding to brain activity. fMRI is used to study the brain during activities.

PET scan (Positron Emission Tomography) This technique requires injection of a radioactive dye to monitor brain function. PET scan is the best imaging technique to assist in the diagnosis of subtle brain injury because it is very sensitive.

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