Carpe Diem – Seize the Day Blog

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In this week's blog Anastasia Brodovskaya, University of Virginia and Jaideep Kapur, University of Virginia examined how seizures can cause memory loss. Epilepsy is a disease marked by recurrent seizures, or sudden periods of abnormal, excessive, or synchronous neuronal activity in the brain. One in twenty-six people in the U.S. will develop epilepsy at some point in their life. While people with mild seizures might experience a brief loss of awareness and muscle twitches, more severe seizures could last for several minutes and lead to injury from falling and losing control of their limbs.

Many people with epilepsy also experience memory problems. Patients often experience retrograde amnesia, where they cannot remember what happened immediately before their seizure. Electroconvulsive therapy, a form of treatment for major depression that intentionally triggers small seizures, can also cause retrograde amnesia.

So why do seizures often cause memory loss? Anastasia Brodovskaya and Jaideep Kapur found from their brain-mapping study found that seizures affect the same circuits of the brain responsible for memory formation. One of the earliest descriptions of seizures was written on a Babylonian tablet over 3,000 years ago.

Why do seizures cause memory loss? Seizures can be caused by a number of factors, ranging from abnormalities in brain structure and genetic mutations to infections and autoimmune conditions. Often, the root cause of a seizure is not known.

The most common type of epilepsy involves seizures that originate in the brain region located behind the ears, the temporal lobe. Some patients with temporal lobe epilepsy experience retrograde amnesia and are unable to recall events immediately before their seizure.

This may be because these seizures affect the hippocampus, a region in the temporal lobe important for memory storage and processing. During sleep, the hippocampus transmits new information learned during the day to another part of the brain called the cerebral cortex in order to consolidate it into new memories. This process occurs through many brain pathways connecting the hippocampus to the cortex.

With this in mind, Anastasia Brodovskaya and Jaideep Kapur wondered if the electrical signals of seizures might also follow the same routes the brain uses for memory consolidation instead of creating their own separate path. They reasoned that disruption of this pathway might cause memory loss.

To figure this out, Anastasia Brodovskaya and Jaideep Kapur trained mice to navigate a T-shaped maze to find a reward of sweetened condensed milk. The mice had to learn how to

alternate between the left and the right arm of maze in a specific pattern to be given milk. When the mice were able to obtain the milk 80% of the time, we determined that the mice had successfully consolidated their memory of how to navigate the maze.

Fifteen minutes after the mice successfully learned how to navigate the maze, we injected them with a drug that causes seizures. The day following the seizure, we found that the mice performed poorly on the maze, as though they had not learned how to navigate it in the first place. This confirmed that a single seizure was enough for the mice to forget what they learned just before the seizure.

The next step for Anastasia Brodovskaya and Jaideep Kapur was to figure out why seizures caused the mice to forget what they learned. To identify which parts of the brain were active during the learning process and during seizures, they used genetically engineered mice whose neurons produce a red protein when activated. Anastasia Brodovskaya and Jaideep Kapur mapped the neurons of these mice as they were learning how to navigate the maze and during the induced seizures. In analyzing these maps, they found that learning and seizures activated the same brain circuits in the hippocampus and cortex. Because they use the same brain pathways, seizures can disrupt the memory consolidation process by taking over the circuit. This meant that seizures can hijack the memory pathways and cause amnesia.

Because memory is networked throughout the brain, memory impairments might not necessarily stem just from interference in the hippocampus alone. Anastasia Brodovskaya and Jaideep Kapur stated that future studies on other brain regions will further clarify how seizures cause memory loss. Now you know why seizures can impact memory.

Editor's Note: The Carpe Diem – Seize the Day Blog will be distributed and posted weekly.
Always remember – **CARPE DIEM – SEIZE THE DAY!**

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