Why we remember—or forget—details of alarming moments

17 December 2015, by Beth Newcomb

Alarming or exciting moments are known as “emotionally arousing” events.

When someone walks down the street and is startled by a car accident, what determines whether they clearly remember the details of what they were doing prior to the crash?

Paradoxically, such alarming or exciting moments—known as "emotionally arousing" events—can either impair or enhance memories of the moments surrounding them. With the car crash example, this can result in fuzzy memories for some witnesses and vivid recollections for others.

A new model of how chemicals in the brain work during these moments, proposed by a USC-led research team, makes sense of this paradox, illustrating that it all comes down to whether the witness is actively paying attention to something prior to the event.

In the car crash example, this means that the witness most likely to accurately remember the details of what they were doing prior to the crash would be the person actively paying attention to some train of thought, activity or part of their surroundings as they traveled down the street. Conversely, the person idly walking without paying any particular attention to anything might have little memory of what they were specifically thinking or doing prior to the accident.

Cells and synapses

When someone is focusing on a task or piece of information, neurons in the person's brain release the neurotransmitter glutamate, a chemical that passes across the gaps, or synapses, between neurons in order to transfer nerve impulses through the brain. Paying more attention to something means releasing more glutamate in the applicable region of the brain.

According to the proposed model, glutamate molecules interact with norepinephrine, a hormone that's the precursor to adrenaline and is released during emotionally arousing events. When released into the same region of the brain, norepinephrine and glutamate enter into a positive feedback loop, with each chemical increasing the release of the other.

This results in "hot spots" of improved processing and better memory of information being paid attention to. Conversely, less processing power is given to background information that's not being focused on, said Professor Mara Mather, who holds joint appointments at USC Dornife in psychology and USC Davis School of Gerontology. Mather is first author on the study.

What do they have to GANE?

The culmination of nearly a decade's work, the model is called Glutamate Amplifies Noradrenergic Effects, or GANE. It not only explains the paradox of why memory can be impaired or enhanced in emotionally arousing situations, but it also shines light on how a region of the brain called the locus coeruleus influences attention and memory.

The locus coeruleus region of the brainstem produces most of the brain's norepinephrine and plays a role in attention and memory as well as cognitive control and stress. It's also suspected of being involved in memory-robbing diseases such as Alzheimer's, Mather added.

"[The locus coeruleus] is like a mixing table at a recording studio that's increasing the volume on what matters, but turning other things down at the same time," Mather explained. "It's modulating how active something is; it can control what signal you get from each of the many things that are processed by the brain simultaneously."

Provided by University of Southern California