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Train of Thought Derailed: How an Accident Can Affect Your Brain

A survivor of last week's deadly train derailment in Spain illustrates how disaster can alter your mind

By Lucas Laursen | Wednesday, July 31, 2013 | 4 comments

Image: Flickr/elentir (Contando Estrelas)

My cousin Guillermo Cassinello Toscano was on the train that derailed in Santiago de Compostela, Spain, last week when it went around a bend at twice the speed limit. Cassinello heard a loud vibration and then a powerful bump and then found himself surrounded by bloody bodies in wagon number nine. Shaking, he escaped the wreckage through either a door or a hole in the train—he cannot recall—then sat amid the smoke and debris next to the track and began to cry. Seventy-nine passengers died.

Cassinello doesn't remember everything that happened to him. The same mechanisms that kept his brain sharp enough to escape immediate danger may also make it harder for him both to recall the accident, and to put the trauma behind him. "The normal thing is that the person doesn't remember the moment of the accident or right after," says clinical psychologist Javier Rodriguez Escobar of trauma therapy team Grupo Isis in Seville, who helped treat and study victims of the 2004 Madrid train bombings. That's because the mind and the body enter a more alert but also more stressed state, with trade-offs that can save your life, but harm your mind's memory-making abilities.

As the train fell over, several changes would have swept through Cassinello's body. His adrenal glands, near his kidneys, would have released adrenaline (also known as epinephrine) into his bloodstream. The adrenaline would have directed blood to the powerful muscles of his arms and legs, where it would help him escape the wreckage faster. The hormone would have raised his heart and breathing rates. It also would have stimulated his vagus nerve, which runs from his spine to his brain. Although adrenaline cannot cross the blood–brain barrier, the vagus can promote noradrenaline production in the brain. That hormone activates the amygdala, which helps form memories.

Just the right amount of noradrenaline, researchers have found, can boost memory storage; too much can destroy it. Figuring out the balance could allow researchers to harness the hormone. Neuroscientist Christa McIntyre at the University of Texas at Dallas and colleagues have been studying how the chemical shapes memory-making in rats (her team is planning a human trial). When the team stimulated rats' vagus nerves the animals' memories improved. McIntyre has to keep the dose low, however, because other experiments have shown that too much noradrenaline appears to impede memory-making. Researchers are still trying to determine whether the excess noradrenaline directly causes the memory lapses or if the hormone is associated with high stress levels that cause some other chemical system to interfere. "That's the part we don't really understand: if there's too much [noradrenaline] or if there's another system that kicks in and puts a brake on it," McIntyre says.

Cassinello's memory lapses may be due to a noradrenaline overflow. But there may be other explanations for the gaps in his memory. His brain may have narrowed his attention at the time of the crash to only those things that matter for survival, such as escaping the train, leading him to ignore things that do not, such as whether the path out of the train passed through a door or a hole. Researchers have shown that humans report selective hearing during stressful events and that stressed people pay attention to different things than do unstressed people (pdf).

Cassinello's uncle picked him up from the accident scene and drove him to a hospital for a checkup. Apart from a few minor scratches, he was fine. But Cassinello says he has flashbacks to the disaster. "The images of shattered people in my cabin and outside are in my head," he says. Flashbacks are a normal part of the stress response. If Cassinello is lucky, the flashbacks will fade within weeks as he learns to suppress the bad memories cued up by triggers such as the sound of a train.

That process is called fear extinction. McIntyre and colleagues want to be able to influence it, so as to better help victims of post-traumatic stress disorder (PTSD). Scientists could activate a trauma victim's vagus nerve, amplifying the memory-writing process while the patient practiced healthy responses to a fear-inducing stimulus. If the process works, it could speed up recovery. Other researchers are working on drug-enhanced fear extinction using chemicals such as zeta inhibitory peptide (ZIP) or D-cycloserine. Another approach, called fear reversal, aims to provoke fear-inducing memories into a malleable state, such as all memories enter when we access them, and then changing them with the help of a different drug, propranolol, which interferes with protein formation, or even with precisely timed talk therapy aimed at blocking the reconsolidation of bad memories.

One thing that is almost certain is that his memories of the event will change with time. Studies after the September 11, 2001, attacks on the World Trade Center found that New Yorkers' reports of their experience of the attack changed over the years.

For now, survivors of traumatic experiences such as Cassinello can lean on the trauma therapists who rushed to Santiago after the crash. Some 70 to 80 percent of car accident survivors get away without PTSD, McIntyre reckons. As Rodriguez points out, however, most of those therapists are volunteers in town for a few days. It may take a few weeks or even months of therapy for patients to get past the worst of their experiences.