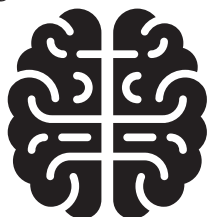


The human brain may remain active and coordinated as a person dies, shows a study that has recorded a dying brain for the first time.

In 2016, an 87-year-old man was admitted to the Vancouver General Hospital in Canada after a fall and diagnosed with a subdural haematoma. A healthy patient in good condition, surgery to remove the blood clot followed and he appeared to be recovering and interacting with clinical staff. But three days after the surgery, he began having seizures. Surgeons used continuous electroencephalography (EEG) to detect their cause, but during the recordings the patient entered cardiac arrest and passed away.

The recordings measured 900 seconds of brain activity around the time of death including 30 seconds before and 30 seconds after the patient's heart stopped beating. "Just before and after the heart stopped working, we saw changes in a specific band of neural oscillations, so-called gamma oscillations, but also in others such as delta, theta, alpha and beta oscillations," says Dr Ajmal Zemmar, a neurosurgeon at the US University of Louisville Hospital who co-authored the study.

Gamma oscillations are involved in high-cognitive functions, such as concentrating, dreaming, meditation, memory retrieval, information processing and conscious perception. "Through generating brain oscillations involved in memory retrieval, the brain may be playing a last recall of important life events just before we die, similar to the ones reported in near-death experiences," Zemmar speculates.



LIFE FLASHING BEFORE YOUR EYES

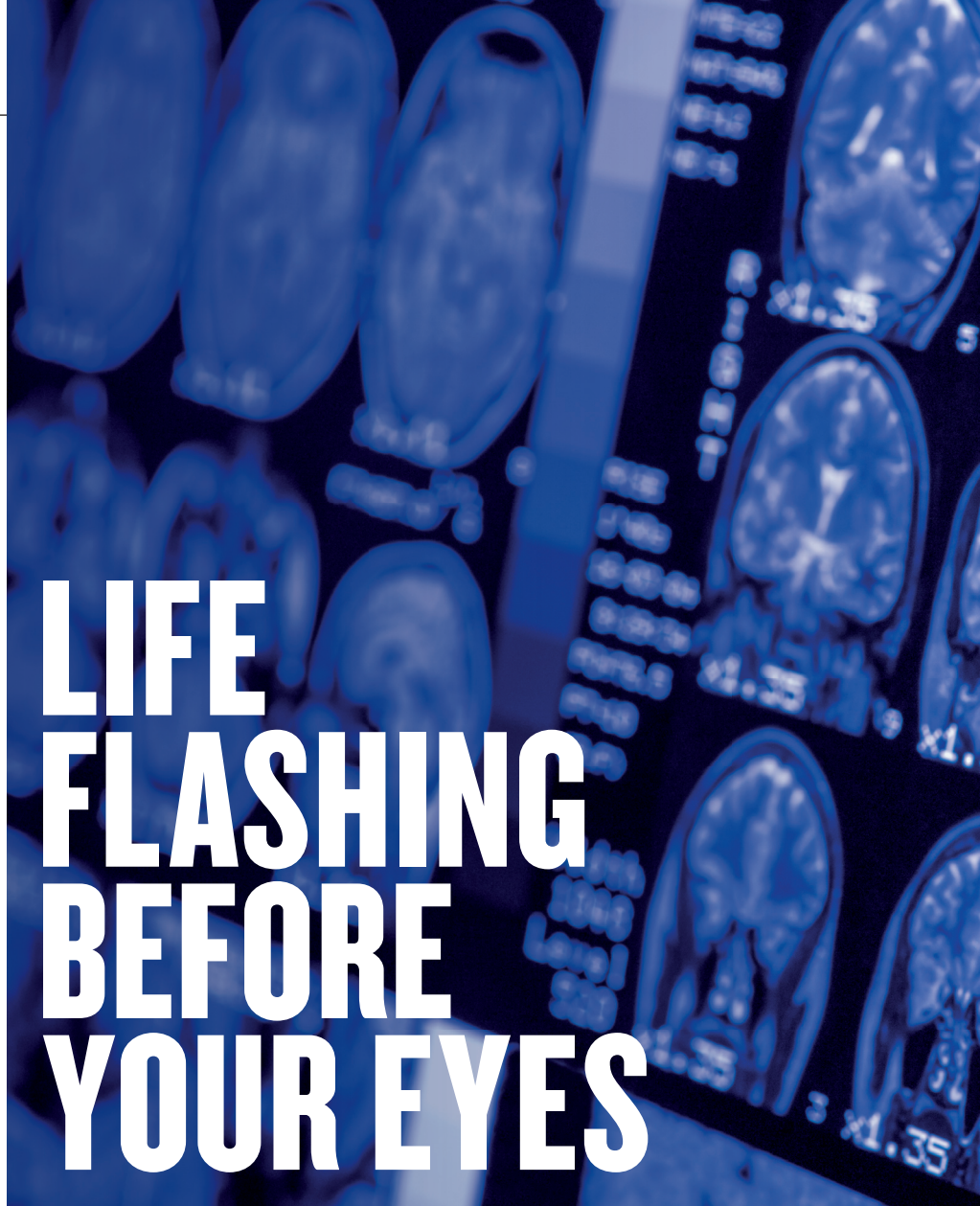
Current understanding

That the research team was able to record the activity of a dying human brain for the first time ever wasn't realised immediately. "I was just focused on treating the patient," Zemmar, who was in his residency at the time, says. "I had barely any time to process anything." But a few weeks later he and the other researchers – clinicians and academics from hospitals in Canada, China, Estonia and the US – began undertaking literature searches to establish whether recordings of a dying human brain had been taken before.

They found that EEG data gathered from humans – awake and healthy – who are meditating, remembering things and having out-of-body experiences show an "interplay" of oscillations of different

brainwave bands, especially gamma oscillations, "when they see pictures of their loved ones, when they remember the birth of their child", Zemmar explains. "The key descriptions are always consistent – out-of-body experiences, flashbacks of memory, dreaming states – that was fairly consistent in the whole."

The team also found previous studies using healthy young rats showed that when they underwent cardiac arrest, the same brainwave patterns happened before the rats died. "This was when we realised the magnitude of it – it evolved over time. Scientists live for these moments," Zemmar says, adding that the researchers spent the years before publishing reaching out to colleagues and scientists "hoping to get more datasets like this". "We waited for a long time, and finally we said we might just have to [publish] because we can't keep this forever."





Research difficulties

The researchers are hoping media attention will bring forward any similar findings from other researchers, and looking into ways the University of Louisville Hospital and a multi-centre trial in the US can reach out to other centres and colleagues that would be interested in the work to try and do further research. “Maybe truly nobody has these sets, maybe they are very difficult and unique to obtain,” Zemmar says.

The difficulty is it’s very hard to predict the timing of someone’s death, even if they have undergone a serious trauma. “One avenue is when we have patients in palliative care. But that is very difficult because they don’t have nutrition or fluids and they are getting drugs just to get comfortable to die, and it’s their last moments with their families.”

The research team is also speaking to

tech companies to see if there are more advanced technologies that can be used to record these brain signals. “We’re certainly continuing the research and we are actively looking right now as to what to do and how to do it, but we are facing these difficulties,” Zemmar adds.

Implications

He says the research can be categorised in three different ways. “Scientifically, it’s very difficult to interpret the data because the brain had suffered bleeding, seizures, swelling – and then it’s just one case. So we can’t make very big assumptions and claims based on this case. On the metaphysical side, it is intriguing to speculate to say that these brain activity patterns that occur when we have memory recall and dreaming and meditative states they recall just before we go to die,” he says.

AJMAL ZEMMAR

- ✓ Neurosurgeon at the University of Louisville with a special interest in movement disorders, neuro-robotics, surgical treatment of epilepsy and neuro-recovery
- ✓ Assistant Professor, Department of Neurosurgery, University of Louisville
- ✓ Fellowship at Toronto Western Hospital, University of Toronto
- ✓ Residency at University Hospital Zurich, Switzerland, and Vancouver General Hospital, Canada
- ✓ PhD in Neuroscience at the Brain Research Institute, ETH Zurich & University of Zurich, Switzerland
- ✓ MD from Johann Wolfgang Goethe University Frankfurt am Main, Germany.



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“On the spiritual side, I think it is somewhat calming. I face this at times when you have patients that pass away and you talk with their families; you have to be the bearer of bad news. Right now, we don’t know anything about what happens to their loved one’s brain when they’re dying.”

Zemmar himself was inspired to enter medicine because it offered a chance to help people and was a job he could do anywhere – he and his family fled Afghanistan in 1989 when the Russian army invaded, and went to live in Germany. “My parents always told me that people can take the material things away from you very quickly, but if you manage to have an education, nobody can take that away from you.” Specialism in functional neurosurgery followed – “throughout medical school I found the brain was the most fascinating organ, it’s just the unknown” – and now he specialises in functional neurosurgery.

“Neurosurgery is a specialty that takes time but that you can learn. You can learn how you operate, you can learn the skills. The biggest challenge is to me the moment when you can’t help somebody,” he adds. “I think if we know that there is something happening in their brain, that they are remembering nice moments, we can tell these families and it builds a feeling of warmth that in that moment when they are falling, this can help a little bit to catch them.” **BMS**