MEDICINE

SEIZED BY CHAOS

The Mandelbrot set: order hiding withir chaos.

The seemingly random storms of electrical anarchy inside the human brain can actually flag a warning of impending epileptic seizure. American researchers have used the mathematics of chaos theory to predict some types of epileptic attack minutes to hours before they begin. One day these signals may be monitored by implants which, given enough notice, could take steps to prevent the onrushing fit.

The team, from the University of Florida (UF) Brain Institute and the Malcom Randall Veterans Affairs (VA) Medical Center in Gainesville, have been working on decoding the brain's random electrical bursts for more than a decade now.

"We had determined some years ago that there was a theoretical potential for predicting seizures," said team member Dr. J. Chris Sackellares, a VA neurologist and a UF professor of neurology, neuroscience and biomedical engineering. "But it has only been in the past year that we have really been able to demonstrate that we can do so reliably. And it has only been recently that we realized that the state of transition to a seizure could last for many hours."

The researchers began to suspect in 1988 that the blossoming field of chaos science would be able to shed light on epilepsy. In a nutshell, chaos theory offers a mathematical approach for seeing a kind of order in events that previously had appeared to be random. Looking for

intel inside showcase
Try it on a Pentium III processor

IN ASSOCIATION WITH
amazon.com
Search:
All Products
enter keywords:
GO!

had appeared to be random. Looking for repeating patterns inside complex systems enables scientists to predict future manifestations of the same routines. Early in the 1990s, the approach enabled Sackellares and his colleague Leonidas D. Iasemidis to be the first to identify the existence of a pre-seizure transition period.

All our body systems exhibit a certain amount of randomness in their daily operation. Our heartbeat, breathing, circulation and digestion all fluctuate from minute to minute as they encounter and adapt to outside influences. Likewise, our brains emit random discharges of electrical energy during their normal function. The body requires all this unruliness and in fact, fixed, inflexible rhythms are a sign that something is wrong.

The researchers' technique involves using sophisticated mathematical formulas to sort through the brain's complex electrical signals, which can be recorded by electroencephalograms (EEG's). The scientists theorize that a seizure's function is to correct a neural system gone awry; one that is in danger of becoming locked into a rigid pattern. A buildup of such organised, harmonious signals needs to be fixed to return the brain to its naturally chaotic state. The intense burst of an epileptic seizure could be the brain's way of erasing problems and 're-booting' itself.

To predict seizures, Iasemidis and Sackellares look for signs of communication between the site where a patient's seizure begins and elsewhere in the brain. When an increasing number of electrode pairs begin oscillating together during an EEG, it signals a seizure is on its way.

In their early research, the scientists were looking for such transitions to occur seconds to minutes before a seizure began. But in the past year, by analysing electrical activity in the brain recorded for a 10-day period, they have identified a warning stage, developing anywhere from minutes to many hours ahead of time.

"We may not be able to pinpoint the exact time, but we can determine whether you are in danger," Sackellares said.

Lasemidis noted that their goal is to be able to identify a window of opportunity for preventing seizures.

"Predicting exactly when a seizure will occur is not the main question," he said. "We're interested to see if we can knock the system out of its route to the seizure. We'd like to see if we can intervene with either electricity or medication to try to get the system to reset itself right at the beginning of the buildup of the pre-seizure transition

Their work, now the basis of a U.S. patent application, opens the door to the creation of implantable devices that can detect signs a seizure is approaching and deliver medication, or electrical or magnetic stimulation to try to prevent it.

Both scientists say it is realistic to think that implantable devices can be developed to detect the pre-seizure state and automatically act to thwart it. They noted that such devices have been developed for other conditions, including diabetes.

Epilepsy is the name given to a variety of seizure disorders, which are estimated to afflict more than 40 million people around the world, according to the World Health Organisation. In 70 percent of the cases, there is no known cause; head trauma, tumors, strokes, infections and poisons are implicated in the others.