Medical Xpress

Modeling the restless brain

June 4 2007

Indiana University neuroscientists Olaf Sporns and Christopher Honey find the 98 percent of brain activity that other researchers consider just background noise to be fascinating and important.

Brains are always active, even when people are at rest. In this "resting state," waves of neural activity ripple through the brain, creating fluctuating and ever-changing patterns. Sporns and Honey's work on modeling this brain activity sheds new light on how and when these mysterious fluctuations occur and offers insights into what the brain does while idle.

"Some people see the brain in terms of inputs and outputs, like a computer. If you provide an input, you'll get a particular output," said Honey, a doctoral student in IU Bloomington's Department of Psychological and Brain Sciences. "We take a different view. We believe that even in the absence of an external stimulus, there are very important processes going on in the brain which affect the stimulus-responses that the brain will produce. We believe that ongoing spontaneous activity should be studied in itself. Other researchers consider this to be unimportant 'noise' that should be filtered out."

Honey and Sporns, associate professor in the Department of Psychological and Brain Sciences, took a close look at the spontaneous activity of the brain at rest. With their computational approach -- which involved creating a large-scale computer model of the brain of a macaque monkey -- they demonstrated that the shape and pattern of the fluctuations are determined by the brain's wiring diagram, its neuroanatomy.

Their model also can show how slow 5- to 10-second fluctuations of activity emerge naturally from much faster, chaotic neural interactions that typically last only a few milliseconds.

"Our model suggests that the cortical resting state is not time-invariant, but instead contains rich and interrelated temporal structure at multiple time scales that is shaped by the underlying structural topology," Sporns and Honey wrote in an article appearing this week in the *Proceedings of the National Academy of Sciences* early edition online.

The article, which will be available at http://www.pnas.org/cgi/doi/10.1073/pnas.0701519104, includes a link to a movie that visualizes what spontaneous fluctuations in the monkey's brain would look like. Coauthors of the article are Rolf Kötter, a neuroanatomist at Radboud University in Nijmegen in the Netherlands, and Michael Breakspear, a cognitive neuroscientist at the University of New South Wales in Australia.

When a person reads a book or talks with a friend, task-related neural activity occurs in different regions of the brain, but this activity only accounts for around 2 to 5 percent of the total activity of the brain. Fluctuations of similar magnitude -- the ones studied by Sporns and Honey -- occur when a person is at rest, doing nothing.

The nature of these "resting state fluctuations" is an active topic of research in cognitive neuroscience, with their mysterious origin prompting one prominent researcher to label them the "brain's dark energy," Sporns said. As yet, no one knows why these fluctuations occur or what their function might be.

Sporns and Honey suggest that a closer look at brain structure might provide a new perspective.

Despite the huge amount of work being done by neuroscientists, relatively little is known about how the human brain is structured -- how, for example the hundreds (the number is unknown) of regions in the human brain are connected. The computer model created by Sporns and Honey suggests that this very pattern of connectivity is crucial to generating and shaping brain activity in the resting and active brain.

Empirical work on the human brain is challenging due to the fact that the brain's intricacies cannot simply be manipulated and observed. Sporns and Honey compare studying the brain to studying other complex systems such as cellular metabolism, the economy or global climate change. Models must be used to test theories and generate new insights into how the system works as a whole.

And while technologies such as functional MRI allow scientists to measure some kinds of neural connectivity, neuroinformatics approaches, which use extensive anatomical and physiological data sets to describe the macacque's brain, allowed Sporns and Honey to collect data on all the activity that occurred during their simulations.

Sporns said he wants to create a similar large-scale computer model of the human brain that will allow them to study larger networks and connectivity, once the necessary data sets of how human neural networks are structured are available.

A computational model of the human brain would help researchers better understand where the observed resting state fluctuations come from. It also would let them tie neural activity to cognitive and behavioral performance and ask questions about differences in the brains of individual persons.

Sporns said this research could lead to clinical applications, offering new diagnostic tools for brain disorders such as Alzheimer's disease that are known to affect the brain's connections. It also could help explain why humans do not think alike.

"If fluctuations in brain activity are shaped by anatomy," Sporns said, "then individual differences in the way people think and what they think about could be rooted in differences in the way their brains are connected."

Source: Indiana University

Citation: Modeling the restless brain (2007, June 4) retrieved 10 April 2024 from https://medicalxpress.com/news/2007-06-restless-brain.html