Brain study suggests consciousness a matter of optimal degree of connectedness in neural network

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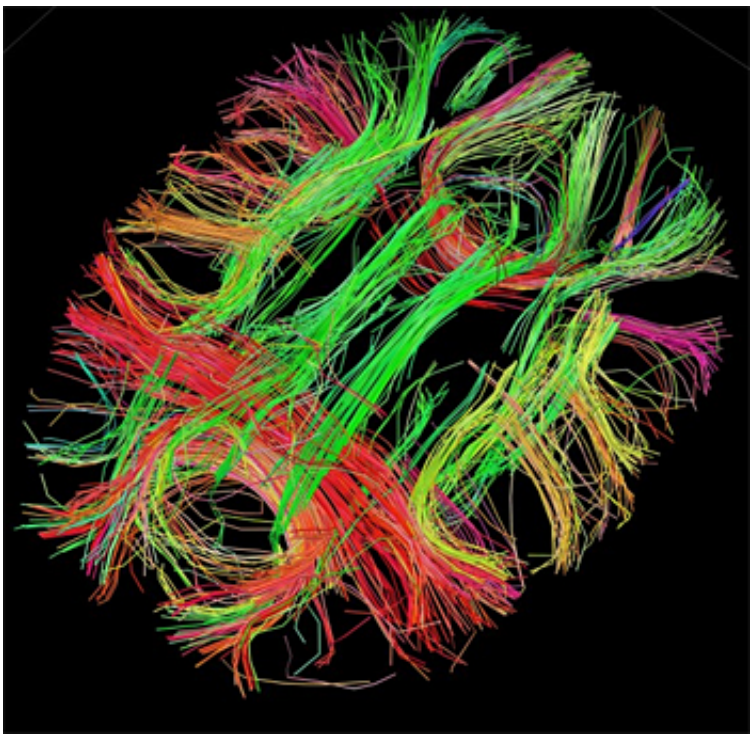

White matter fiber architecture of the brain. Credit: Human Connectome Project.

(Medical Xpress)—A team of European researchers has found evidence that suggests that human consciousness is a state where the neural network that makes up the brain operates at an optimal degree of connectedness. In their paper published in *Journal of the Royal Society*

Interface, the team describes their study of the human brain using volunteers undergoing fMRI scans while succumbing to the effects of an anesthetic that caused them to lose consciousness, and what was revealed in reviewing the scan data.

Human beings, when awake, exist in a state of consciousness that is uniquely difficult to define. Scientists try by agreeing that it is the ability to have subjective experiences and to enjoy a first-person perspective on the "reality" of the world. But that does not explain the voice that is our own self, nor the varying degrees of consciousness, such as the differences between being asleep, versus partially awake, versus being completely unconscious. In this new effort, the researchers sought to learn more about the state that exists in the mind when consciousness occurs by enlisting the assistance of 12 volunteers who agreed to be made unconscious by the drug propofol, normally used to put people under during surgical procedures (and notably, also the drug that led to the death of singer Michael Jackson) while undergoing fMRI scans.

Scientists (and surgeons) believe that propofol causes people to become completely unconscious, which by definition would mean to become incapable of processing thoughts. The brain should not be able to process pain signals, for example, thus making surgery a pain free experience. To gain a better perspective on the various states of consciousness, the team watched blood flow changes in the brains of the volunteers as they moved from a conscious state, to unconsciousness and then back to consciousness.

In studying the scans, the researchers found that when the volunteers were conscious, there was what they describe as "a flurry of ever-changing activity," with a lot of activity between the various neural networks. In contrast, they found that while unconscious, the brains of the volunteers were engaged in far less interconnectivity and were less variable over time.

These findings, the team suggests, show that consciousness in the brain is merely, in a physical sense, a state where there is an optimal level of neural network connectedness.

More information: Enzo Tagliazucchi et al. Large-scale signatures of unconsciousness are consistent with a departure from critical dynamics, *Journal of The Royal Society Interface* (2016). DOI: 10.1098/rsif.2015.1027

Abstract

Loss of cortical integration and changes in the dynamics of electrophysiological brain signals characterize the transition from wakefulness towards unconsciousness. In this study, we arrive at a basic model explaining these observations based on the theory of phase transitions in complex systems. We studied the link between spatial and temporal correlations of large-scale brain activity recorded with functional magnetic resonance imaging during wakefulness, propofol-induced sedation and loss of consciousness and during the subsequent recovery. We observed that during unconsciousness activity in frontothalamic regions exhibited a reduction of long-range temporal correlations and a departure of functional connectivity from anatomical constraints. A model of a system exhibiting a phase transition reproduced our findings, as well as the diminished sensitivity of the cortex to external perturbations during unconsciousness. This framework unifies different observations about brain activity during unconsciousness and predicts that the principles we identified are universal and independent from its causes.

https://medicalxpress.com/news/2016-01-brain-consciousness-optimal-degree-connectedness.html