INFORMATION CONTENT IN SYNCHRONIZED NETWORKS IN NORMAL AND PATHOLOGICAL BRAIN STATES

A TALK BY

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It is said that complexity lies between order and disorder. In physiology, complexity issues are being considered with increased emphasis. Of crucial importance in the medical setting, pathological activity has been associated with low variability/complexity. In the case of the nervous system, it is well known that excessive synchronization is connected with pathologies such as epilepsy and Parkinson disease. However, brain rhythms and neural synchronization are also crucial for perception and cognition, so it is clear that either too much or not enough synchronization can lead to dysfunctional brain states. Here, we investigate the connection between synchronization and complexity in brain dynamics. We have first shown *in vivo* in a rat model of absence seizures, that the epileptic thalamocortical system can be considered as a self-sustained macroscopic oscillator, and also modeled it as a system of two Kuramoto oscillators. This confirms that large-scale low-complexity dynamics can emerge in pathological brain states. We have then investigated global synchronization in human brain dynamics following a statistical mechanics approach, to identify features of brain organization that are optimal for sensory processing, and that may guide the emergence of cognition. We applied this method to datasets comprising electrophysiological recordings of epileptic patients and also normal subjects during different sleep stages. We found that the information content of functional networks correlates with the state of consciousness/functionality: normal wakeful states are characterized by the greatest number of possible configurations of interactions between brain networks, representing highest entropy and intermediate synchrony values. These findings help to guide in a more formal sense inquiry into how conscious awareness arises from brain dynamics and it has important consequences for the control and monitoring of pathological synchronization.

RAMON GUEVARA is a physicist at the Department of Physics of the University of Padova. His main interest lies in the interface between biophysics and neuroscience. He has been a research fellow at several institutions, universities and hospitals around the world, including the University Paris Descartes, the Hospital for Sick Children in Toronto, the University of British Columbia in Vancouver and the neuroimage center Neurospin, at Saclay, France. His research focuses on the coordination of neural activity, both in the normal and the pathological brain, and in particular on the search of principles underlying synchronization phenomena in the brain, and their physiological and cognitive implications.

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