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Measuring complexity and synchronization phenomena in the human epileptic brain[1]

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The framework of the theory of nonlinear dynamics provides new concepts and powerful algorithms to study complicated dynamics such as the human electroencephalogram (EEG). Although different influencing factors render the use of nonlinear measures (such as measures for complexity, synchronization, or interdependencies) in a strict sense problematic, converging evidence from various investigations now indicates that nonlinear EEG analysis provides a means to reliably characterize different states of normal and pathological brain function and thus, promises to be important for clinical practice. This talk will focus on applications of nonlinear EEG analysis in epileptology. Epilepsy affects more than 50 million individuals worldwide - approximately 1 % of the world's population. The disease is characterized by a recurrent and sudden malfunction of the brain that is termed seizure. Epileptic seizures are the clinical manifestation of an excessive and hypersynchronous activity of neurons in the brain. It is assumed that seizure activity will be induced when a critical mass of neurons is progressively involved in closely time-linked high frequency discharging. Recent investigations of intracranially recorded EEG involving nonlinear time series analysis techniques indicate that this build up of a critical mass can indeed be tracked over time scales lasting minutes to hours. Future real-time analysis devices may enable both investigations of basic mechanisms leading to seizure initiation in humans and the development of adequate seizure warning and prevention strategies.

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