Individual Differences in Resting-state and Noise-induced Nonlinear Human Brain Dynamics

Keiichi Kitajo

Rhythm-based Brain Information Processing Unit, RIKEN BSI – TOYOTA Collaboration Center,

RIKEN Brain Science Institute, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan

E-mail: kkitajo@brain.riken.jp

The human brain can be regarded a nonlinear dynamical system and exhibits nonlinear dynamical characteristics. In this talk, I will report our recent findings on individual difference in resting-state and noise-induced human brain dynamics which were extracted by using statistical machine-learning methods.

First, I will show that the resting-state large-scale EEG (electroencephalography) synchrony is associated with functional recovery in stroke patients [1]. We found that fluctuations in instantaneous brain states were correlated with motor-related clinical scores in stroke patients. The results suggest that the dynamic repertoire of spontaneous large-scale phase synchronization networks mediates functional networking and accounts for the stroke recovery.

Second, I will demonstrate our experimental evidence that noise-induced macroscopic human brain responses exhibit highly consistent temporal patterns to an identical noisy visual input across trials. It is known that spikes of a single neuron responding to a repeatedly presented noisy input show highly consistent temporal patterns across trials [2]. From a nonlinear dynamical systems viewpoint, this nonlinear phenomenon is called “consistency”, which is defined as the reproducibility of response waveforms of a nonlinear dynamical system driven by the same input signal, starting from different initial conditions of the system, as has been observed in laser systems [3]. I experimentally demonstrated that EEG responses to noisy visual inputs showed a signature of consistency and the EEG responses differed across individuals. I speculated that differences in nonlinear dynamical features between the individual brains should be associated with distinct patterns of resting-state and noise-induced neural responses across individuals. I also discuss trait-like features of individual EEG responses.

References

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