Exploring EEG Microstates——Microstate separation, statistics, & application to brain aging

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Abstract

The tremendous progress of brain imaging technology has clarified the dynamics of the brain, enabling closer study among researchers from a range of disciplines. Electroencephalography (EEG), one of the most important brain monitoring methods, directly records the changes of electronic potential induced by neurons beneath sensors on the scalp. This technology has shown the potential to interpret mental processes, diagnose brain disorders, and greatly expand our scope of knowledge of neural processes.

Recent studies suggest that the procedure of brain state transition is not continuous and gradual, but discrete and drastic. The brain keeps a quasi-stable state for several hundreds of milliseconds before abrupt state transitions, which are identifiable through EEG topography. These abrupt transitions are termed microstates. It is reasonable to assume that different microstates indicate different brain functions, as various electric potential landscapes are generated by various configurations of neural assemblies. Therefore, microstates render important statistical information concerning modulations in regards to strength, latency, and configuration. As yet, however, due to the incomplete understanding of microstates' physiological basis, researchers lack an explanation as to the underlying activities and functions.

EEG microstates yields a variety of exciting research opportunities; among these is how microstates change in the aging brain, particularly in regards to predicting Mild Cognitive Impairment (MCI), Alzheimer's Disease (AD), Parkinson's Disease, etc. Extracted microstate variables show a complex and orderly evolution with age, fitting the pattern of developmental stages alleged by developmental psychologists. One potential research direction is the exploration and interpretation of microstate changes in the aging brain under experimental conditions. Ultimately, microstates might be used as biomarkers for early assessment of neurodegenerative diseases.