From Cognitive Shift Theory to Closed-Loop Neurocognitive Control: An End-to-End EEG-Based System for Real-Time Attention Regulation

Wang, Junzhe (School: The High School Affiliated to Renmin University of China)

This study addresses the prevalent issues of ADHD(attention deficit hyperactivity disorder) and distracted focuses under daily routine; this study aims to bridge the gap between abstract psychological theories and clinical biomedical engineering. Grounded in the "Cognitive Shift" theory proposed by Professor Bruce Allyn of the Harvard Negotiation Project, this paper develops an end-to-end neurofeedback system integrating "real-time sensing, logical decision-making, and active intervention of individual attention." The study features a self-developed 16-channel high-spatiotemporal-resolution EEG hardware system designed to monitor the antagonistic balance between the Default Mode Network (DMN) and the Executive Attention Network (EAN), identifying the state transition from endogenous mind-wandering to exogenous task execution. By integrating an active acoustic intervention module based on voice interaction, the system achieves a dynamic reshaping of cognitive states. This research proves that underlying neuroscientific principles can be successfully transformed into accessible end-to-end applications. It provides a biomedical engineering paradigm for shifting psychological research from "descriptive analysis" to "predictive intervention," offering significant scientific and practical value for digital health and human-computer symbiosis.

Awards Won:
Second Award of $2,400