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Attention and working memory comparison in males and females using non-linear dynamical analysis

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Non-linear dynamical (NLD) approach was used to understand the behavior of neuronal excitability at the level of cells and microcircuits. The NLD analysis necessitated mathematical models, computation, and simulation. Reduced models of action potentials were used to improve computational efficiency. At higher levels of the brain organization, derivation and validation of mathematical models is non-trivial. Instead of focusing on empirical models, we performed data-driven NLD analysis to visualize the behavior of complex systems like the brain. In the present study, we used visual P300 time series of EEG recordings from Cz and Pz electrodes to evaluate the differential dynamics of males and females during attention and working memory tasks. The study was conducted with ethical approval at St John's Research Institute, Bengaluru, Karnataka, India (n=25; males=13, females=12) in healthy normal adults. The data were acquired with a Neuroscan 64-channel EEG system (NATUS), using its in-built visual stimulation (STIM2) and data acquisition (CURRY8) systems. Data pre-processing was done using EEGLAB, and visual P300 components for attention and working memory were calculated using ERPLAB. Vector fields were plotted using MATLAB on a phase plane for Cz and Pz channels for NLD analysis. The mean differences between visual P300 were compared using the Mann-Whitney U test at each time point. NLD analysis was focused on the regions showing statistically significant differences between males and females. The results are very preliminary. Researchers tried to analyze the vector fields qualitatively as well as quantitatively. Considering the two-dimensional phase plane, the points where trajectories intersect might be saddle points and orbits corresponding to limit cycle oscillations. However, the original system is of higher-order and characterized by chaos on strange attractors, where trajectories intersect on two dimensional phase space. Further search for metrics has been continuing, including measurement of Liapunov exponent and fractal dimensions. Conclusion: In this study, researchers analyzed differential NLD parameters in males and females. However, the patterns and metrics derived from NLD analysis might help in the diagnosis and classification of neurological diseases. As the study capture trajectory of one event, researchers cannot analyze phase portraits, nullclines, bifurcations.

Biography

Amit Tak Amit Tak, MD, Mathematical and Computational Physiologist, was born in Ajmer, India. He did his Bachelor in Medicine and Surgery in 2005 from JLN Medical College, Ajmer, MD (Physiology) -2019 from SMS Medical College, Jaipur, India, and PG Diploma in Statistical Techniques – 2019 from IGNOU, India. He served as a Commissioned Officer in Indian Amry for seven years. Then he taught nonlinear dynamical systems and Computational Neuroscience at the Centre for Converging Technologies, University of Rajasthan, Jaipur, India. Also worked in software development as a Medical Scientist at ICMR, Bengaluru, India. Presently he is an Assistant Professor in the Department of Physiol at RVRS Medical College, Bhilwara, India, and involved in a multicentric project aimed at developing Brain Function Index apparatus to neurologically evaluate cognition in collaboration with the Indian Institute of Science, Bengaluru.

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