

Measuring the phase synchronization in the ADHD brain networks while observing facial emotions

*Sheida Ansarinassab¹, Fatemeh Parastesh², Fahimeh Nazarimehr³, Farnaz Ghassemi⁴, Sajad Jafari⁵

¹ Biomedical Engineering Department, Amirkabir University of Technology, Tehran, Iran

² Biomedical Engineering Department, Amirkabir University of Technology, Tehran, Iran

³ Biomedical Engineering Department, Amirkabir University of Technology, Tehran, Iran

⁴ Biomedical Engineering Department, Amirkabir University of Technology, Tehran, Iran

⁵ Biomedical Engineering Department, Amirkabir University of Technology, Tehran, Iran

*sh.ansarinassab@aut.ac.ir

Abstract— Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common psychological disorders among children, which in addition to lack of attention, hyperactivity, and impulsive movements, has faced these children with major problems in the proper facial emotions processing of others resulting in establishing inappropriate social relationships. In this study, for the first time, the nonlinear Correlation between the Probability of Recurrences of signals (CPR) method is used to measure the phase synchronization in the brain networks of 22 ADHD children and 22 healthy ones while observing four types of emotional-visual stimulations. After constructing the brain networks of all individuals and extracting the topological graph features such as clustering coefficient and the shortest path length, appropriate statistical tests are applied to examine significant differences (significance level 0.05) between groups. This study results indicate the higher mean phase synchronization and clustering coefficient and the lower mean shortest path length (P-Value <0.05) in the ADHD subnetworks consisting of frontal-frontal, occipital-frontal, and occipital-occipital brain connectivity than healthy ones. The frontal and occipital brain lobes are the human emotional and visual processing centers, respectively. These findings can represent a deficit in these lobes' function of the ADHD brain networks in processing emotional-visual stimuli.

Keywords—Attention Deficit Hyperactivity Disorder, Phase synchronization, Facial emotions, Nonlinear method, Topological graph features.