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Novel EEG Network Neuroscience Features for Dementia and Awareness Level Estimation in Passive BCI Framework

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Introduction: We report pilot study results of novel EEG features utilizing the latest tools from network neuroscience [1] with possible application to early onset dementia neuro-biomarkers within a digital non-pharmacological therapy (NPT). Network analysis of EEG time-series allows for awareness level estimation [1] from a resulting network graph of node and edge numbers. We present statistically significant (see Figure 1) differing network node and edge number distributions between two groups of healthy aging and MCI evaluated (MoCA$\leq$ 25) conducting passive BCI experiments using FastBall paradigm [2]. The results reported in Figure 1 indicate different awareness levels in MCI elderly participants [1]. The pilot study was conducted using a Unicorn EEG headset at the Nicolaus Copernicus University in Torun, Poland. The Institute of Psychology UNC Ethical Committee for Experiments with Human Subjects has approved the study.

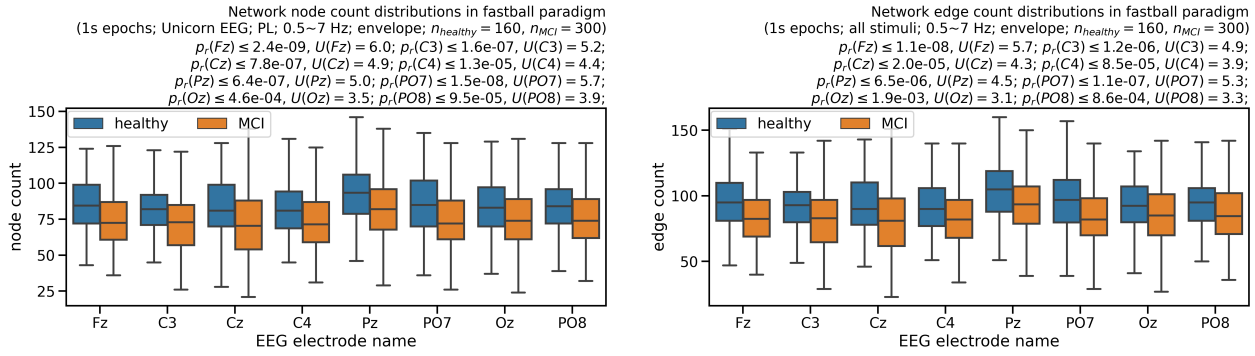

Figure 1: Boxplots with marked median, quartile ranges, and whiskers extending to show the remainder of the distributions of the network signal analysis resulting in node and edge counts for MCI versus healthy aging cognition subjects for all EEG electrodes analyzed separately (Unicorn EEG headset) during FastBall paradigm [2] with 5 Hz carrier/RSVP frequency. All electrodes resulted in significantly smaller node and edge numbers' distributions for the MCI-evaluated elderly participants ($p_r \ll 0.01$).

Discussion and Significance: The reported novel network science application to EEG time series introduces a candidate for an objective digital neuro-biomarker development within a passive BCI framework. A wearable EEG application shall allow for a plausible replacement of biased "paper & pencil" tests for a mild cognitive impairment (MCI) evaluation. Subsequent machine-learning model development and appropriate ethical supervision shall follow.

References:

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