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RESEARCH AREA

In our study we investigate the effects of aging on neurodynamics and various aspects of cognitive functioning. Our research focuses on the identification of neurophysiological biomarkers that can potentially predict age-related changes in cognition and help better understand their biological origin. Our project has two fundamental aspects. First, we develop new analythical and computational methods that can effectively capture nontrivial features of neural dynamics. These include, but are not limited to methods for assessing the fractal properties of dynamic functional connectivity among distinct brain regions, a subfield that only recently became the focus of interest in the field of neuroscience. Second, we collect and analyze data from our population of interest, specifically healthy (i.e., no history of any neuropsychiatric disorder or any severe general medical condition), elderly individuals. Results from the elderly group are contrasted with those obtained from healthy, young (age < 40 years) adults. We record cortical activity usin electroencephalography (EEG). Measurements are first performed in resting-state (i.e., not engaging in any specific mental activity), then EEG is recorded while subjects perform three different cognitive tasks. These all put different mental skills to test, such as pattern recognition, working memory or spatial orientation and learning. Following the EEG recordings, participants are further evaluated using the standardized and validated Cambridge Neuropsychological Test Automated Battery (CANTAB). This session includes seven further tasks, each testing various aspects of cognition that are most commonly affected in conditions related to age and pathologies eventually leading to dementia. Our research therefore not only focuses on how resting-state neural activity might predict performance related to different aspects of cognition, it is also equivalently important, how the brain adapts to increased mental challange/workload, and how this adaptation might be affected at a later age.

TECHNIQUES AVAILABLE IN THE LAB

Introduction to electroencephalography (EEG) and its neurophysiological origins, experience in conducting measurements with EEG
Introduction to analytical and evaluation methods frequently applied in cognitive neuroscience
Introduction to postgraduate level mathematics
Programming skills in Matlab and Python languages, introduction to the Matlab and Jupyter Notebook environments
Machine learning skills
Skills commonly applied in the fields of statistics and data science
Scientific writing skills
Presentation skills

SELECTED PUBLICATIONS

Mukli, P., Csipo, T., Lipecz, A., Stylianou, O., **Racz, F.S.**, Owens, C.D., Perry, J.W., Tarantini, S., Sorond, F.A., Kellawan, J.M. and Purebl, G., (2021) Sleep deprivation alters task-related changes in functional connectivity of the frontal cortex: A near-infrared spectroscopy study. **Brain and Behavior 11:** p.e02135.

Racz, F.S., Farkas, K., Stylianou, O., Kaposzta, Z., Czoch, A., Mukli, P., Csukly, G. and Eke, A. (2021) Separating scale-free and oscillatory components of neural activity in schizophrenia. **Brain and Behavior 11:** p.e02047.

Kaposzta, Z., Stylianou, O., Mukli, P., Eke, A. and **Racz, F.S.** (2021) Decreased connection density and modularity of functional brain networks during n-back working memory paradigm. **Brain and Behavior 11:** p.e01932.

Racz, F.S., Mukli, P., Nagy, Z. and Eke, A., (2018) Multifractal dynamics of resting-state functional connectivity in the prefrontal cortex. **Physiological measurement 39:** p.024003.

Racz, F.S., Mukli, P., Nagy, Z. and Eke, A. (2017) Increased prefrontal cortex connectivity during cognitive challenge assessed by fNIRS imaging. **Biomedical optics express 8:** 3842-3855.