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Automatic Control and Systems Engineering

The Department of Automatic Control & Systems Engineering
is pleased to announce the following seminar:

"Neuroelectric Biomarkers of Network Dysfunction in Motor Neuron Disease"

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Thursday, 27 June 2019 at 14:00
LT2, The Sir Henry Stephenson Building

Abstract

The quantification of phenotypes, progression and outcome in the clinical trials for Motor Neuron Disease (MND)/Amyotrophic Lateral Sclerosis (ALS) remains a challenge; which can be can be attributed to major shortcomings of the existing biomarkers including: focus on focal structural degeneration rather than functional changes in motor/cognitive networks (emerging from the pathobiology), invasiveness and cost. Our team in Trinity College Dublin have used new advanced signal analysis and statistical techniques to develop high-density EEG measures for quantify the functional neuroelectric activity in specific brain networks that are engaged in several experimental paradigms, i.e. during resting-state and cognitive/motor tasks. Crossectional and longitudinal "resting-state" EEG showed characteristic patterns of increased connectivity. When we source-localised the activity to the underlying brain source, we observed a frequency-specific pattern of change in spectral power, synchrony and co-modulation. We found increased average co-modulation of neural oscillations with other brain regions in the central and posterior regions of the brain (δ-, θ- and γ_l-band) and frontal regions (δ- and γ_l-band). Furthermore, the average synchrony to other brain regions was decreased in the temporal and frontal lobes (δ-, θ- and α-band) and in the motor cortex (β-band), with decreased region-to-region connectivity in frontal (δ-band) and motor (β-band) network. Auditory mismatch negativity and sustained attention to response task (SART) as "cognitive tasks", further revealed the network dysfunction: increased activity in the left posterior parietal, central and dorsolateral prefrontal cortices and a decrease in the inferior frontal and left superior temporal gyri. The cortico-muscular (EEG-EMG) coherence during isometric pincher grip "motor tasks" interrogated the motor networks: The Primary Lateral Sclerosis (PLS) and Post-Polio Syndrome patients showed α-, β- and γ-band increases over frontal, parietal, and ipsilateral motor regions, while the abnormal coherence patterns in the ALS was widespread. The correlations of the EEG changes with structural degeneration (MRI) and functional scores, revealed the motor/cognitive and direct/compensatory nature of these network impairments. The afforded discriminatory powers (AUC=0.79), exceeded the levels in (f)MRI studies. The EEG measures had minimal overlap with the traditional phenotypes (site of onset and genotype), but rather formed new clusters of patients suggesting the discovery of new network-based phenotypes. Our findings demonstrate that the quantitative EEG measure of neural activity and connectivity elucidate the network pathology in MND/ALS and can serve as prognostic biomarkers and outcome measures for clinical trials.

Biography

Received the B.Sc. degree in mechanical engineering from Iran University of Science and Technology, Tehran, Iran, in 2003, and the M.Sc. degree in biomechanical engineering from Sharif University of Technology, Tehran, Iran, in 2006. He received his Ph.D. degree in biomedical engineering from University of Strathclyde, Glasgow, Scotland, UK, in 2013.

He was with the Department of Biology, Northeastern University, Boston, MA, USA, as a Research Associate (2012) and a Postdoctoral Research Associate (2013-2014). He joined Academic Unit of Neurology in Trinity College Dublin, the University of Dublin, Dublin, Ireland as a Research Fellow in 2014, and is now a Senior Research Fellow, Principal Investigator, and the Research Strand Leader of the neural signal analysis and neurophysiological biomarkers in the Motor Neuron Disease research group at Trinity College Dublin. His research area includes neural control of human

movement, EEG/EMG and electrophysiological correlates of neuro-motor activity, diagnostic and prognostic biomarkers in Motor Neuron Disease (MND), and neural engineering. He has received more than €430,000 competitive research funding as Principal Investigator from Irish Research Council (IRC), Health Research Board (HRB) and Research Motor Neurone (RMN) of Ireland; and more than €980,000 as co-investigator or collaborator. He is the author of 16 articles (5 as the first author, 5 as the last author) in international peer-reviewed journals.
Dr Nasseroleslami is a member of IEEE, IEEE EMBS, Society for Neuroscience (SfN), International Society of Electrophysiology & Kinesiology (ISEK), Organisation for Human Brain Mapping (OHBM), Federation of European Neuroscience Societies (FENS) and Neuroscience Ireland. He was a recipient of a 3-year Ph.D. scholarship award from Scottish Funding Council (SFC) in 2008 and Government of Ireland 2-year Postdoctoral Research Fellowship from IRC in 2015. His research paper in Journal of Biomechanical Engineering was selected as an editors' choice paper in 2014.