NeurotechEU Summer School of Quantitative Electroencephalography (QEEG)

– Course Plan –

1. Description

1.1. Title

NeurotechEU Summer School of Quantitative Electroencephalography (QEEG)

1.2. Target audience [with mention to the moment in the life cycle of the student or professional working life the course is applicable], E.g., bachelor, master, doctorate, post-doctoral

Bachelor's degree in medicine, psychology, bioengineering, biotechnology or biological sciences

1.3. Dates and duration

July, 17th - 21st 2023; 5 days

1.4. Program fees

- No fee for applicants emerging from NeurotechEU University alliance and NeurotechEU partner institutions
- 350 Euro for each participant outside of NeurotechEU consortium

1.5. Contact (for pre-course administrative issues)

research@ssnn.ro

2. Curriculum contents and learning outcomes

The Summer School will provide an introduction to the fundamentals of QEEG for individuals interested in neurotechnology. The program is designed to include morning lectures, followed by interactive hands-on sessions in the afternoon, over a five-day period.

QEEG involves the use of algorithms to transform brain waves into numerical data, which can be analyzed to gain insight into signal complexity, brain connectivity, and neural networks. The method has numerous clinical applications, including the study of neuropsychiatric disorders, epilepsy, stroke, dementia, and traumatic brain injury. During the program, participants will become familiar with various QEEG analysis tools, such as Brain Vision Analyzer 2 and some MATLAB toolboxes (e.g. EEGLAB, Brainstorm, Network Based Statistic) and engage in team-oriented activities that promote a multidisciplinary approach.

2.1. Curriculum contents:

- Electroencephalography (EEG) Basics
- Theoretical Foundations of Quantitative Electroencephalography (QEEG)
- QEEG Analyses
- QEEG and Other Technologies
- Group Projects on QEEG

On successful completion of the course, students will be able to:

Knowledge:
- describe the basic concepts of EEG (*Montage selection* – the arrangement of electrodes on the scalp to record EEG signals; *Acquiring EEG signals* – proper electrode placement, amplifying and filtering the signals to obtain accurate data; *Identifying patterns* – recognizing different patterns, such as alpha, beta, theta, and delta waves, or epileptic discharges; *Types of activity* – alertness, resting state, drowsiness, sleep or seizure; *Artifacts* – electrode pop, electrode bridge, physiological artifacts (blink, lateral eye movement, ocular flutter, eyelid fluttering, electrocardiographic, sweat, electromyographic, glosokinetic, photomyogenic), electrical interference; *Clinical applications* – epilepsy, sleep disorders, brain tumors, traumatic brain injury, stroke, encephalopathies of different etiologies)
- outline significant fundamentals of QEEG: *data preprocessing*, *artifacts removal* – by applying Independent Component Analysis (ICA) & Principal Component Analysis (PCA), *feature extraction* (via Brain Vision Analyzer 2 & Brainstorm)
- demonstrate knowledge of the uses of algorithms to transform brains waves into numerical data (using Brain Vision Analyzer 2, EEGLAB, Brainstorm, Network Based Statistic)
- create and interpret different parameters in *Frequency and Time-Frequency Domain Analysis* (Fast Fourier Transform/FFT, Spectral Analysis, Brain Maps), *Time-domain Connectivity* (Correlation, Mutual Information, Cross-Correlation, Granger Causality Transfer Entropy), *Frequency-domain Connectivity* (Coherence, Phase Locking Value, Phase Slope Index, Parametric and Non-Parametric Granger Causality)
- critically evaluate clinical applications of QEEG
- correlate QEEG with other brain exploration or therapeutical methods as Functional Magnetic Resonance Imaging (fMRI), Functional Near-Infrared Spectroscopy (fNIRS), Transcranial Direct Current Stimulation/ Transcranial Alternating Current Stimulation (tDCS/tACS), Magnetoencephalography (MEG), Transcranial Magnetic Stimulation (TMS), Eye Tracking (ET)

Skills:
- perform and interpret routine EEG recordings at a basic level;
- use QEEG analysis tools: Brain Vision Analyzer 2 and MATLAB toolboxes (EEGLAB, Brainstorm, Network Based Statistic)

Application of knowledge and skills:
- analyze data to understand signal complexity, brain connectivity, and neural networks;
- apply knowledge and skills in group work – research project proposal;
- prepare for other research settings (such as neurofeedback and brain-computer interfaces).

Transversal competencies:
- critical thinking, decision-making, problem-solving, teamwork, creativity.

3. Programme Coordinators

3.1. Name

- Professor Dafin Mureșanu, MD, PhD, MBA
- Lecturer Livia Popa, MD, PhD

3.2. Short reference to the suitability of the director profile to the main knowledge area addressed in the Summer Course

Professor Dafin Mureșanu, MD, PhD, MBA, is a highly accomplished neurologist and neuroscientist, currently serving as Professor of Neurology and Chairman of the Neurosciences Department at the "Iuliu Hatieganu" University of Medicine and Pharmacy Cluj-Napoca, Past President of the Romanian Society of Neurology, President of the Society for the Study of Neuroprotection and Neuroplasticity (SSNN), Chairman "RoNeuro" Institute for Neurological Research and Diagnostic, Corresponding Member of the Romanian Academy, Member of the Academy of Medical Sciences, Romania and secretary of its Cluj Branch. He holds key leadership positions in prominent organizations such as the European Federation of Neurorehabilitation Societies (EFNR), Secretary General AMN (Academy for Multidisciplinary Neurotraumatology), Chairman Communication Committee of the European Academy of Neurology (EAN) and has made significant contributions to the field. His research focuses on neuroprotection, neuroregeneration, and neurorehabilitation, and he has published extensively in scientific journals. Prof. Muresanu's dedication to advancing knowledge and education is evident through his involvement in international programs, educational projects, and scientific events. He has received numerous honors and awards for his contributions to medicine and was the principal organizer of the European Summer School of Quantitative Electroencephalography (QEEG) – first edition (Cluj-Napoca, July 11th - 15th 2022).

Lecturer Livia Popa, MD, PhD, is a Senior Neurologist at the Emergency County Hospital of Cluj-Napoca, lecturer at the "Iuliu Hatieganu" University of Medicine and Pharmacy Cluj-Napoca and researcher at "RoNeuro" Institute for Neurological Research and Diagnostic in Romania. Her research focuses on QEEG, and she played a key role in organizing the first edition of the European Summer School of Quantitative Electroencephalography (QEEG) held in Cluj-Napoca in July 2022. She obtained her PhD in Neurology in 2013 with a bursary, conducting research on the role of functional electrical stimulation and transcranial magnetic stimulation in Parkinson's disease. During her specialization, she was trained in Psychiatry and Neurology in Belgium for 3 years. She completed multiple courses in the field of Neurophysiology, the latest being: *International League Against Epilepsy (ILAE) – VIREPA "EEG in the diagnosis & management of epilepsy – Advanced Course"* 7th Edition (October 2020 – May 2021); *International League Against Epilepsy (ILAE) – VIREPA "Epilepsy and Sleep Course"* 4th Edition (October 2019 – April 2020).

Selected Publications

1. **Livinț Popa L**, Chira D, Dăbală V, Hapca E, Popescu BO, Dina C, Chereche R, Strilciuc , **Mureşanu DF.** Quantitative EEG as a Biomarker in Evaluating Post-Stroke Depression. Diagnostics (Basel). 2022;13(1):49, ISI Impact Factor 3.99, quartile Q2. DOI: 10.3390/diagnostics13010049. https://pubmed.ncbi.nlm.nih.gov/36611341/

2. **Livint Popa L**, Mihaela Iancu M, Livint G, Balea M, Dina C, Vacaras V, Vladescu C, Balanescu L, Buzoianu AD, Stefan Strilciuc S, **Muresanu D.** N-Pep-12 supplementation after ischemic stroke positively impacts frequency domain QEEG. *Neurol Sci* 2022; 43(2):1115-1125, ISI Impact Factor 3.83, quartile Q2. DOI: 10.1007/s10072-021-05406-9. https://pubmed.ncbi.nlm.nih.gov/34173086/

3. **Livinț Popa L**, Dragoş HM, Strilciuc , Pantelemon C, Mureşanu I, Dina C, Văcăra V, **Mureşanu D**. Added value of QEEG for the differential diagnosis of common forms of dementia. *Clin EEG Neurosci* 2021; 52(3):201-210; ISSN: 15500594, eISSN: 21695202; ISI Impact factor 1.765, quartile Q3. DOI: 10.1177/1550059420971122. https://doi.org/10.1177/1550059420971122

4. **Livinț Popa L**, Dragoş H, Verişezan Roşu O, Pantelemon C, Strilciuc . The role of quantitative EEG in the diagnosis of neuropsychiatric disorders. J Med Life 2020; 13(1): 8-15; print ISSN: 1844-122x, online ISSN: 1844-3117, online ISSN: 1844-3109; PubMed-MEDLINE, Index Copernicus, EBSCO Publishing, Proquest indexed scientific journal, CNCSIS B+ quotation. DOI: 10.25122/jml-2019-0085. https://pubmed.ncbi.nlm.nih.gov/32341694/

3.3. Hosting partner: HE Institution to which the director belongs and whose Internal Quality System will manage all the internal quality assurance procedures.

- "Iuliu Haţieganu" University of Medicine and Pharmacy Cluj-Napoca and RoNeuro Institute for Neurological Research and Diagnostic Cluj-Napoca

4. Lecturers/Trainers

4.1. List of lecturers

Lecturer Livia Popa, Dr. Hanna Dragoş, Dr. Victor Dăbală, Dr. Diana Chertic, Stud. Vlad Chelaru, Dr. Irina Vlad, Dr. Anca Demea, Dr. Emanuel Ştefănescu, MSc. Diana Chira

4.2. Short reference to each of their suitability to their role in the course.

Dr. Hanna Maria Dragoş, MD, MSc, PhD student, is a fourth-year Resident in Neurology at the Emergency County Hospital of Cluj-Napoca and QEEG junior researcher at "RoNeuro" Institute for Neurological Research and Diagnostic for three years. She is a first-year PhD student investigating cognitive reserve, functional connectivity and MRI radiomics in patients with vascular cognitive disorders under the supervision of Prof. dr. Dafin Fior Muresanu. She has master's degrees in Clinical Pharmacology and Public Health. She has attended multiple courses in her field of interest: EAN Spring School 2022, International Summer School of Neurology 2022, ESO Stroke Winter School 2023, Analyzing Neural Time Series Summer School 2023. She has published seven articles on cerebrovascular diseases and/or QEEG with a h-index of 2.

Dr. Victor-Horea Dăbală, MD, is a three-year Resident in Neurology at the Emergency County Hospital of Cluj-Napoca, 2nd Clinical Neurology Ward. In addition, he is a volunteer and early-stage researcher at the "RoNeuro" Institute for Neurological Research and Diagnostic, Cluj-Napoca. Currently, he is an intern at Radboud University's SPECS - Synthetic, Perceptive, Emotive, and Cognitive Systems Lab, where he is involved in implementing speech-related rehabilitation methods for patients with disorders of consciousness. His expertise includes Clinical and Theoretical Neurophysiology, with practical experience in Electroencephalography and Quantitative Electroence-phalography, as well as the study of consciousness. From a practical standpoint, he has experience analyzing neural data with software like BrainVision Analyser (BVA), and MATLAB (Brainstorm and EEGLAB).

Dr. Diana Chertic, MD, is an early-stage researcher passionate about investigating the pathophysiology of patients with various neurological disorders. She is currently a two-year Resident in Neurology at the Emergency County Hospital Cluj-Napoca, affiliated with the Department of Neuroscience of the University of Medicine and Pharmacy "Iuliu Hatieganu", where she applies EEG, QEEG and eye tracking to uncover new insights into the underlying causes of these conditions. From May to July 2023, Dr. Diana Chertic is a trainee at the SPECS Lab of the Donders Institute for Brain, Cognition and Behavior, where she is developing a cutting-edge neurorehabilitation tool for patients with disorders of consciousness. Her scientific interests include vision, decision-making, circadian rhythms and neuroplasticity.

Stud. Vlad-Florin Chelaru is a 5th-year medical student and a volunteer statistics instructor for 1st and 2nd-year medical students at the "Iuliu Hațieganu" University of Medicine and Pharmacy Cluj-Napoca. Drawing on his experience as CTO and technical advisor for two conferences, HEART and MEDICALIS, as well as being a co-author for articles across multiple domains, he offers extensive technical expertise to assist and guide participants in learning how to use the QEEG software proposed by the group.

Dr. Irina Maria Vlad, MD, is a young specialist in Neurology and currently a teaching assistant in Neurology at the Department of Neurosciences, "Iuliu Hațieganu" University of Medicine and Pharmacy in Cluj-Napoca, Romania. Her professional interests primarily revolve around translational and clinical research in the field of neurosciences. She has actively pursued opportunities to enhance her knowledge by regularly attending courses. Currently, she is furthering her academic pursuits as a PhD student.

Dr. Anca-Diana Demea, MD, is a third-year Resident in Neurology, currently working in the 2nd Clinical Neurology Ward, Emergency County Hospital Cluj-Napoca. She graduated in 2020 from the "Iuliu Haţieganu" University of Medicine and Pharmacy in Cluj-Napoca, with a history of internships during university years in hospitals around the world, such as Hong Kong, Mexico-Toluca, Jakarta-Indonesia and as an Erasmus student for one year in Leipzig, Germany. As a brain junior doctor, her main interests are movement disorders, headache and neuroophthalmology. She is member of the European Academy of Neurology, International Parkinson and Movement disorder Society and Romanian Society against Epilepsy.

Dr. Emanuel Ştefănescu, MD, has a five year training in Child Neurology performed at the Child Clinical Neurology Ward from Emergency County Hospital Cluj-Napoca. In January 2023 he started the second specialization in Neurorehabilitation. He is a member of EAN Scientific Panel Child Neurology since 2021. Beside performing his job as medical doctor and develop his PhD thesis in Neurolgy, he is junior researcher at the "RoNeuro" Institute for Neurological Research and Diagnostic (Eye Tracking Lab), having special interests on Research and Innovation in medicine and healtcare, Eye Tracking Technologies, Neuroscience, Neurorehabilitation, Rare Diseases and Artificial Intelligence.

Diana Chira, MSc., is a young researcher with a background in Public Health and a master's degree in Research Design and Data Analysis. She is an integral part of the clinical trials team at the "RoNeuro" Institute for Neurological Research and Diagnostic. Over the past two years, she has actively collaborated with the QEEG team, leading to her involvement in research in this field. Her scientific interests lie in neurorehabilitation, particularly in the utilization of Brain-Computer Interface (BCI) technology and virtual reality (VR) applications. With her academic proficiency and hands-on experience, she is particularly interested in fostering multidisciplinary international collaborations aimed at advancing and improving the field of neurosciences.

5. Academic structure

5.1. Total workload (in ECTS or hours)

3 ECTS

5.2. Structure of the program (schedule and workload per any distinct academic sections included in the course).

- Day 1: Brain technology & EEG basics ~ 7 hours
- Day 2: Brain mapping using EEG. Hands-on sessions ~ 6 ½ hours
- Day 3: Brain connectivity. Hands-on session ~ 6 hours
- Day 4: QEEG and other technologies. Teamwork ~ 7 hours
- Day 5: Projects presentation & Final evaluation ~ 3 hours

5.3. Resources made available (e.g., facilities, …)

Complete equipment for recording EEG on 21-channels (Neurosoft – LIAMED) and on 32 channels (NicoletOne™ EEG system - Natus Medical, Brain Vision Analyzer signal processing devices with BrainVision Analyzer Educational license offered with the courtesy of Brain Products GmbH)

5.4. Type of certificate that can be obtained

- Certificate of Participation

5.5. Assessment procedure (procedure to assess that the learning outcomes have been achieved).

The attendees will be evaluated after working in predefined teams of four or five, attempting to develop a project idea that involves QEEG assessment of subjects. We will imagine it as a contest for a grant application. They may be up against four competing projects on the same topic. Therefore, providing a solid rationale for the methodological approach is crucial for the team's success.

5.6. Student learning outcomes evaluation

At the end of the course, the participants will be kindly asked to fill out an evaluation questionnaire by scanning the QR code below. The questionnaire assesses students' learning outcomes and their level of satisfaction with the entire event.
https://forms.office.com/e/rQBAGjAExg