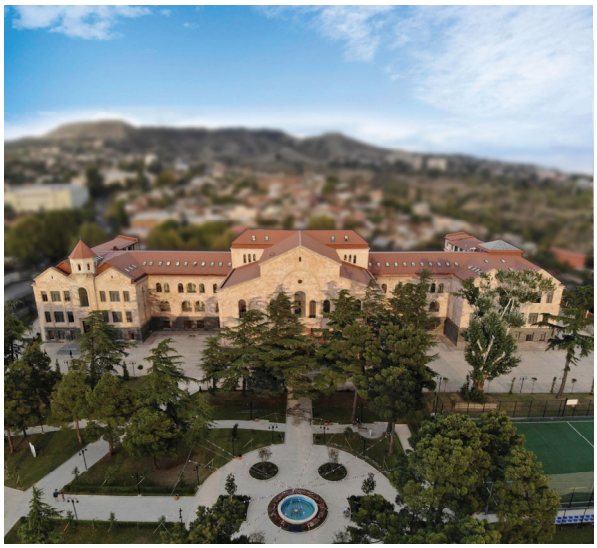
International Symposium on Neurocomputing Advances in Brain Research

15-16 July, Caucasus University
Tbilisi, Georgia



Program and Abstract book

Speakers:

Mariam Alaverdashvili, Nargiz Nachkebia, Malkhaz Makashvili, Irma Khachidze, Teona Gubianuri, Tetiana Kachynska, Illia Kuznietsov, Oleksiy Shpenkov, Pawel Herman

Organising and program committee:

Irma Khachidze (local host)

Pawel Herman (Swedish Research Links coordinator)

Sponsors

Vetenskapsrådet

VR Swedish Research Links program

International Symposium on
Neurocomputing Advances in Brain Research

PROGRAM

15-16 July 2019, Tbilisi, Georgia

15 July, 2019

10:30 – 11:00 Registration

11:00 – 11:15 Opening ceremony (Irma Khachidze; Pawel Herman)

11:15 – 11:50 **Pawel Herman** KTH Royal Institute of Technology, Stockholm, Sweden

"Computational simulations of cortical function and dynamics"

11:50 – 12:20 **Irma Khachidze** Georgian Society for Psychophysiological Research and Caucasus University, Beritashvili Centre of Experimental Biomedicine, Tbilisi, Georgia

"Quantitative and qualitative assessment of EEG in epileptic patients"

12:20 – 13:00 **Ilia Kuznietsov** Lesya Ukrainka Eastern European National University, Lutsk, Ukraine

"In search of decision making correlates: ERP components related to anticipation and reward processing"

13:00 – 13:30 *Coffee break*

13:30 – 14:00 **Nargiz Nachkebia** Beritashvili Centre of Experimental Biomedicine, Tbilisi, Georgia

"Fundamental sleep mechanisms as the necessary base for the adequate therapy of major depressive disease"

14:00 – 14:45 **Ilia Kuznietsov** Lesya Ukrainka Eastern European National University, Lutsk, Ukraine

"EEG and ERP microstate analysis using eLoreta: a practical approach"

15:00 – 16:00 *Lunch*

16:00 – 18:00 *Guided tour in Tbilisi*

18:00 *Dinner*

16 July, 2019

11:00 – 11:30 **Malkhaz Makashvili,** Ilia State University, Tbilisi, Georgia

"Gomez-Lopez-Hernandez Syndrome: 2 case reports from Georgia"

11:30 – 12:00 **Tatiana Kachynska** Lesya Ukrainka Eastern European National University

"Neurofeedback training for lowering aggression level in adolescents"

12:00 – 12:30 **Oleksiy Shpenkov** Taras Shevchenko National University of Kyiv, Ukraine

"How musical experience influences auditory brain wave entrainment"

12:30 – 13:00 *Coffee break*

13:00 – 13:45 **Mariam Alaverdashvili** Department of Psychiatry, University of Saskatchewan, Canada

"Brain functioning in health and after stroke"

13:45 – 14:30 **Teona Gubianuri** Caucasus University, Tbilisi, Georgia

"Implementation of technologies in the frame of CRL and GRENA projects"

Nino Zhamureli St. Andrew Georgian University, Tbilisi, Georgia

"EEGHUB.GE"

14:30 – 15:30 *Lunch*

15:30 – 16:00 **Pawel Herman**, KTH Royal Institute of Technology, Stockholm, Sweden

"Computational approaches to brain research: current trends and beyond"

16:00 – 16:45 Round table discussion and closing ceremony

16:45 – 19:30 Social event for junior participants

20:00 *Banquet*

ABSTRACTS

Assessment of the Fundamental Sleep Mechanisms by the Computer-based Polysomnography as the Necessary Base for the Adequate Therapy of some Psychiatric Disease

Nargiz Nachkebia, Laboratory Neurobiology of sleep-wakefulness cycle, I. Beritashvili Center of experimental biomedicine, Tbilisi, Georgia

Computer-based researches are considered for today as the necessary condition for many observations in humans and experimental researches in animal models. Computer-based polysomnography represents modern approach to the problem of more comprehensive assessment of neurophysiological and neurochemical mechanisms of sleep-wakefulness cycle and pathophysiology of some diseases characterized by sleep disorders.

In other words, Computer-based Polysomnography, also called a sleep study, is a test used for the complex registration of brain EEG, tone of skeletal muscles, eye and leg movements as well as the oxygen level in the blood, heart rate and breathing, during the study. Polysomnography is also for the diagnoses of sleep disorders. Method gives us possibility to identify more precisely the character of sleep disorders during various psychiatric, neurodegenerative and neurological diseases.

In addition to helping diagnose sleep disorders, polysomnography may be used to help adjust treatment plan in the case of diagnosed sleep disorder.

Polysomnography allows continuous 24 h registration of cyclic alteration of sleep stages to identify if or when normal sleep patterns are disrupted and why.

The normal process of falling asleep begins with a sleep stage called non-rapid eye movement (NREM) sleep with its three stages. During NREM sleep, brain waves, as recorded by electroencephalography (EEG), slow down considerably from high-voltage low amplitude to low-voltage high amplitude range. The deepening of NREM sleep and elevation in the percentage of slow waves in delta range increases accordingly to the progressing of NREM sleep stages, from 1 to 3 stages. In norm NREM sleep lasts continuously for 90-120 min and it is the deepest NREM sleep episodes during the all night sleep.

After an hour or two of NREM sleep, brain activity picks up again, and rapid eye movement (REM) sleep begins. Most dreaming occurs during REM sleep.

Humans (with monophasic type of sleep) normally go through multiple sleep cycles a night, with cycling between NREM stages and REM sleep after 90-120 minutes of continuous NREM sleep episode. Animals (with poly-phasic type of sleep) go with multiple cycling between wakefulness, light NREM, deep NREM and REM sleep. Sleep architecture in both cases is built up according to the strongly defined rules. Abnormality of the rules regulating normal intrinsic structure of sleep-wakefulness cycle undoubtedly leads to the disturbances of the normal course of sleep process and finally it is manifested in various form of sleep disorders. It happens during: sleep apnea or another sleep-related breathing disorder, when breathing repeatedly stops and starts during sleep; periodic limb movement disorder, characterized by involuntarily flex and extend your legs while sleeping. This condition is

sometimes associated with restless legs syndrome; narcolepsy, characterized by overwhelming daytime drowsiness and sudden attacks of sleep episodes at the face of wakefulness; REM sleep behavior disorder that involves acting out dreams as you sleep; unusual behaviors during sleep such as walking, moving around a lot or rhythmic movements; unexplained chronic insomnia and in other cases too.

If one of such condition takes consistent character and it is trouble falling asleep or staying asleep, computer-based polysomnography is the necessary tool for the assessment of the character of sleep disturbance.

Special attention requires assessment of the character of sleep disorders during major depressive disease, because it is one of the most widely spreading illnesses in the world and is characterized by serious sleep disorders. Direct linkage between the sleep mechanisms and depression therapy will be underlined in the oral report that will be presented on the symposium.

Quantitative and qualitative assessment of EEG in epileptic patients

Irma Khachidze[ab], Manana Gugushvili[b], Kate Inasaridze[b]

[a] Georgian Society for Psychophysiological Research and Caucasus University, Beritashvili Centre of Experimental Biomedicine, Tbilisi, Georgia

[b] Beritashvili Centre of Experimental Biomedicine, Tbilisi, Georgia

Introduction: We hypothesize that the comprehensive EEG evaluation can determine AED efficacy in epileptic children. Thus, this study aimed to investigate the alteration of quantitative and qualitative characteristics of EEG during anticonvulsant treatment.

Methods: Forty-three children aged 3-9 were investigated. EEGs were recorded three times: priortreatment, and twice under therapy (at three and six/eight months). Baseline EEG was analyzed for quantitative characteristics of interictal EEG such as absolute values of the power (AVP) spectra and EEG topography/Brain Mapping. The study involved epileptiform EEG and clinical condition assessments.

Results: Treatment decreased AVP spectra in a low-frequency range, suppressed spontaneous epileptic discharge, and spike-wave complex 3/s, partially decreased spikes-polyspikes, sharp waves, and generalized paroxysmal bursts during functional trials. Conclusions: The efficacy of treatment can be revealed via reduction of low-frequency waves and suppression of epileptiform EEG elements parallel to clinical improvement. Thus, optimal treatment strategies can be tailored based on the evaluation of background EEG characteristics using spectral analysis, EEG mapping and the quantitative EEG approach.

Computational simulations of cortical function and dynamics

Pawel Herman, KTH Royal Institute of Technology, Stockholm, Sweden

Cognitive neuroscience has for generations been driven by experimental evidence. Despite massive amount of experimental data there is still lack of understanding of key mechanistic principles that govern fundamental cognitive processes critical to our daily lives such as memory, attention, perception, decision making, goal-directed planning etc. Recently, computational neural modelling has attracted growing attention as a complementary methodology with the expectation to facilitate the integration of available data into brain theories and provide scaffolding for better understanding of the cognitive phenomena. In this talk I am going to briefly outline our computational modelling philosophy and summarise our progress with clear focus on what we have learned so far about the working memory function and its neural manifestations. In particular, some representative examples of simulations of our attractor memory neural network models will be used to showcase the potential of a computational approach to studying brain function and dynamics.

In search of decision making correlates: ERP components related to anticipation and reward processing

Illia Kuznietsov, Lesya Ukrainka Eastern European National University, Lutsk, Ukraine

Current state of EEG-based decision-making studies is characterized by wide rage of ERP components and paradigms, considered for decision-making process. ERP components may be divided into two major groups: those, related to reward-anticipation and those, related to reward-processing. Reward-anticipation components, in turn, may be classified as of cue-evaluation, motor preparation and feedback anticipation. Each component has specific temporal, spatial, behavioral and frequency features. Concurrent neuroimaging and behavioral methods (i.e. fMRI, MEG, eye-tracking) allow to characterize each component even in more detailed way. However, more information about specific process usually sets a question on distinguishing even between more components, which were previously considered as the one. On the other side, some components may show even more common in terms of new information, as thought earlier. The rapid development of new paradigms, like neuroeconomics and using strong formalisms like game theory allow give a new look on known and recently discovered types of evoked activity, challenging the previous knowledge of its behavioral and temporal organization. These results in high need of summarizing existing information on neuroimaging results and experimental approaches in studying of decision-making EEG correlates.

Gomez-Lopez-Hernandez Syndrome: 2 case reports from Georgia

Malkhaz Makashvili[a], Kotetishvili Bakur[b], Okujava Michael[a,c], Kotetishvili Alexander[b]

[a] Ilia State University, Tbilisi, Georgia
[b] Psycho-Neurological Clinic,
[c] I.Beritashvili Center of Experimental Biomedicine

Gomez-Lopez-Hernandez syndrome (GHLs) is a rare disease, described in about 50 patients to date. We report on 2 cases in the aim to stress the problems in diagnosing GHLs and to discuss the role of morphological anomalies, concomitant to GLHs, in behavioral changes of GLHs sufferers. In particular, we confirm the suggestion that rombencephallosynapsis and alopecia, not trigeminal numbness, are obligatory symptoms to diagnose the GLHs while callosal pathology is suggested to play a role especially in behavioral problems in GLS sufferers.

Neurofeedback training for lowering aggression level in adolescents

Tetiana Kachynska, Lesya Ukrainka Eastern European National University, Lutsk, Ukraine

Neurofeedback is a perspective method in correction of human psychological states. A hot point of its application is the regulation of emotional states in teenagers. Adolescence is characterized by maturation of self-controlling mechanisms, thus making neurofeedback training an appropriate tool for their strengthening. Moreover, teenagers' brain goes through the critical period of social functions reorganization, resulting in expressed emotional reactions and deviations in social behavior. Usage of neurofeedback as a non-invasive, cheap and captivating tool for the regulation of aggressive behavior may play a great role for subject's successful social adaptation. In our study we conducted alpha-neurofeedback training for lowering the aggression level in teenage schoolgirls. It was shown that neurofeedback training decreases aggression level. Concurrent psycho-motor tests showed the improvement of self-control mechanisms functioning. EEG microstate analysis allows to suggest the increased efficiency of controlling brain networks as the result of neurofeedback training.

How musical experience influences auditory brain wave entrainment

Oleksiy Shpenkov, Taras Shevchenko National University of Kyiv, Ukraine

Brainwave entrainment is a feature of the nervous system which is widely used in the diagnostic of epilepsy via photostimulation. Neural rhythms are also synchronized with acoustic periodic stimuli, like speech and music. It was hypothesized that neural synchronization with periodic stimuli generates expectancies for future events. Brainwave entrainment is more prominent to low-pitch sounds and it was also shown via MMN superior time perception for lower pitch than for high pitch. Moreover, there is evidence that musical experience enhances entrainment. We hypothesize that musical experience at certain instruments would affect brain entrainment to the pitches within the frequency range of the instrument.

Implementation of technologies in the frame of CRL and GRENA projects

Teona Gubianuri, Caucasus University, Tbilisi

The collaborative framework of the Swedish Research Links (VR-SRL) program run by Swedish Research Council (Vetenskapsrådet) includes besides the coordinating KTH Royal Institute of Technology, Stockholm, Sweden other international partners such as Lesya Ukrainka Eastern European National University, Lutsk, Ukraine and Georgian Society for Psychophysiological Research, Tbilisi, Georgia.

The aim of the collaborative project is to disseminate scientific findings and share knowledge as well as competence in the broad area of neuroinformatics. Above all, the ambition is to strengthen connections between the neuroinformatics communities of the participating countries.

In the frame of the VR-SRL grant joint meetings have been held in Sweden, Ukraine and Georgia. Due to the aim of the project, not only the coordinators of the project are involved in the activities, but other participants, part of which are Bachelor, Master and PhD students.

In the process of scientific exchange and knowledge sharing, Dr. Khachidze, representing the Georgian side, has implemented modern theoretical and practical methods in Georgia with the support of international collaborators such as Dr. Kachynska, Dr. Kuznietsov (both based in Ukraine) and Dr. Herman (Sweden). Dr. Khachidze has taken care of disseminating this knowledge and competence among students. It is worth pointing out that all this effort has been performed on a voluntary basis.

Another important achievement is securing another grant by Dr. Khachidze. Due to the constraints imposed by the VR-SRL grant, the project has received additional support and engagement by the Georgian Research and Educational Networking Association (GRENA) within the framework of the "EaPEC 2018 to enlarge Eastern Partnership". In the frame of the "EaPEC" project, GRENA has helped in establishing an EEG online database portal EEGHUB.GE.