

**XI International Conference  
of Lithuanian Neuroscience Association**

**BEHAVIOURAL MEDICINE  
AND NEUROPLASTICITY**

29 November 2019

Vytautas Magnus University  
Kaunas  
Lithuania



**2019**

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# PROGRAM

## Venue:

Vytautas Magnus University  
Small Conference Hall (2nd floor), S. Daukanto st. 28  
Kaunas, Lithuania

8.30–9.30 **Registration. Coffee / Tea**

9.30–9.40 **Opening and welcome**

Prof. Osvaldas Rukšėnas, President of the Lithuanian Neuroscience Association  
Representatives from Vytautas Magnus University

## **I session. Cognitive Neuroscience and Behavioural Medicine**

Chair – dr. Julius Burkauskas, Lithuanian University of Health Sciences, Palanga, Lithuania  
Co-chair – dr. Aistė Pranckevičienė, Lithuanian University of Health Sciences, Kaunas, Lithuania

9.40–10.15 **Keynote lecture**

### **How Cognitive Behavioural Therapy Impacts the Activity of the Brain: Emergent Understandings from the Field of Neuroscience and Beyond**

Prof. Sarah Corrie, The Central London CBT Training Centre, Central and North West London NHS Foundation Trust; Middlesex University London, UK

10.15–10.40 **The Intellect Structure of Ischemic Heart Disease Patients in the Middle and Late Adulthood**

Dr. Jurga Misiūnienė, Vytautas Magnus University, Kaunas, Lithuania

10.40–11.20 **Coffee / Tea. Poster session**

11.20–11.45 **Changes of Cognitive Function in Cardiovascular and Stress Related Disorders**

Dr. Julius Burkauskas, Neuroscience Institute, Lithuanian University of Health Sciences, Palanga, Lithuania

11.45–12.10 **Effectiveness of Biofeedback-Assisted Relaxation in Reducing Stress Among Students**

Dr. Gabija Jarašiūnaitė-Fedosejeva, Vytautas Magnus University, Kaunas, Lithuania

12.10–12.30 **Introduction to Human Brain Tour**

Dr. Corrado Calì, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia

12.30–14.00 **Lunch. Poster session**

**14.00–14.20 Meeting of members of the Lithuanian Neuroscience Association**

**II session. Neuroplasticity and Neurotechnologies**

Chair – prof. Saulius Šatkauskas, Vytautas Magnus University, Kaunas, Lithuania

Co-chair – dr. Aušra Saudargienė, Lithuanian University of Health Sciences, Kaunas, Lithuania

**14.20–14.55 Keynote lecture**

**The Complex Nature of Seizure Genesis**

Prof. Premysl Jiruska, Charles University, Prague, Czechia

**14.55–15.20 A Short Story about Working Memory – a Puzzle of Recent Theoretical, Computational and Experimental Advances**

Prof. Pawel Herman, Royal Institute of Technology, Stockholm, Sweden

**15.20–16.00 Coffee / Tea. Poster session**

**16.00–16.25 Transcranial Direct Current Stimulation (tDCS) and Memory Enhancement**

Dr. Jovana Bjekic, University of Belgrade, Belgrade, Serbia

**16.25–16.45 Post-sauna Residual Consequences on Brain Neural Network Arousal, Information Processing and Cognitive Performance**

Dr. Margarita Černych, Lithuanian Sports University, Kaunas, Lithuania

**16.45–17.00 Concluding remarks, discussions, awards**

**17.30–19.00 Farewell Party**

## Satellite Workshop

### Poster area

**13.00–16.45 Live Demo: Virtual Reality Tour into the Human Brain**

Dr. Corrado Cali, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia

Daniya J. Boges, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia

Kare, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia



Satellite Workshop



# **g.tec's BRAIN-COMPUTER INTERFACE WORKSHOP FOR CONTROL, ASSESSMENT AND REHABILITATION**

28 November 2019

Lithuanian University of Health Sciences  
Kaunas, Lithuania





# PROGRAM

**Venue:**

Auditorium A009  
Centre for the Advanced Pharmaceutical and Health Technologies  
Lithuanian University of Health Sciences  
Sukilėlių av. 13  
Kaunas, Lithuania

10.30–11.15 **Adaptive Neurotechnologies: Revolutionizing Treatments and Minds**

Dr. Milena Korostenskaja

11.20–12.00 **Non-invasive/invasive brain-computer interface systems, including current and future applications**

Woosang Cho

12.00–13.00 **Lunch break**

13.00–13.50 **Hands on sessions: BCI live experiments for motor rehabilitation and cognitive assessment (Part I)**

14.00–16.00 **Hands on sessions: BCI live experiments for speller, spherio, and painting (Part II)**

16.00–17.00 **Discussion and questions**

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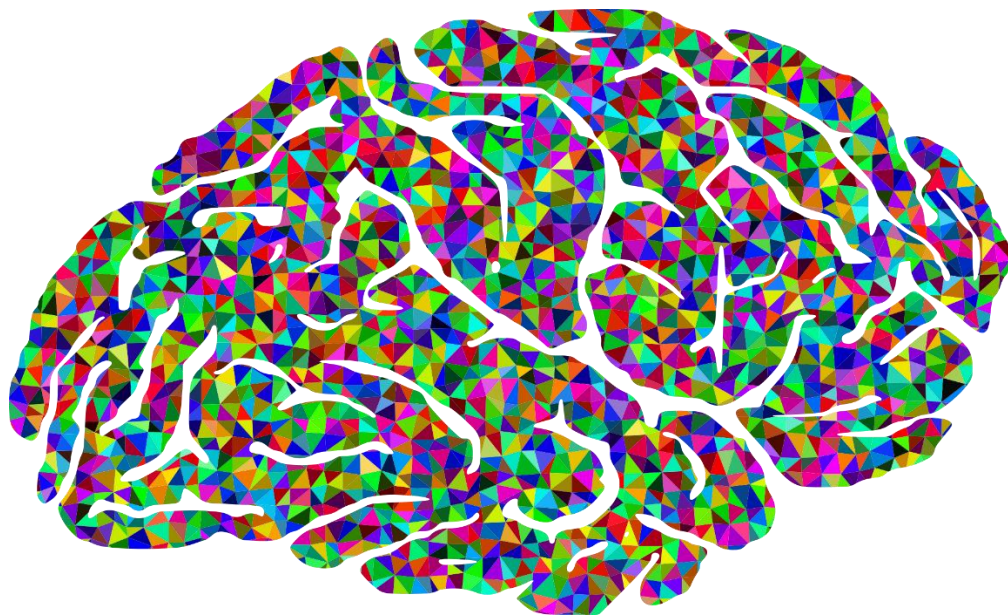
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## ORAL PRESENTATIONS



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# HOW COGNITIVE BEHAVIOURAL THERAPY IMPACTS THE ACTIVITY OF THE BRAIN: EMERGENT UNDERSTANDINGS FROM THE FIELD OF NEUROSCIENCE AND BEYOND

**S. Corrie**

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In recent decades, the cognitive-behavioural therapies have gained ascendancy as an evidence-based response to both the mental and physical health needs of the human population. As a psychological intervention, the cognitive-behavioural therapies are underpinned by the assumption that making changes at the level of cognition and behaviour provide a reliable gateway to improved emotional well-being and physiological change. But to what extent does the available evidence support this claim? What is truly known about the connection between cognitive-behavioural interventions and changes in the activity of the brain and what might we infer from this about the pathways that mediate the route to psychological healing? Drawing upon contributions from a range of disciplines, this keynote address examines what lessons we might learn in order to better support the estimated 450 million people who are living with a mental health condition.

# THE INTELLECT STRUCTURE OF ISCHEMIC HEART DISEASE PATIENTS IN THE MIDDLE AND LATE ADULTHOOD

J. Misiūnienė, L. Šinkariova, R. Petrolienė, L. Zajančkauskaitė-Staškevičienė, L. Alčiauskaitė

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## *Background and aim:*

There is a lack of research on the intellectual abilities of the older Lithuanian population (Salialione, Pacesiunaite-Raneberg, 2013), especially in the sample of IHD patients (Burkauskas et al., 2016). The aim of this work was to describe the intellect structure of ischemic heart disease patients in the middle and late adulthood.

## *Materials and methods:*

118 IHD patients (90 males, 28 females) aged between 41 and 70 yrs. ( $M = 57.49$ ,  $SD = 7.408$ ) participated in intelligence testing using the Intelligence Structure Test (I-S-T 2000R, Amthauer et al., 2007). Cronbach's alpha coefficients of the I-S-T 2000R showed good internal consistency (0.676–0.874). According to the age participants were divided into 2 groups: younger (incl. younger than 51 yrs.,  $N = 22$ ) and older (incl. 51 yrs. and older,  $N = 96$ ).

## *Results:*

Younger age was associated with higher not age-standardized intellect test scores (from  $r = -.192$  to  $r = -.31$ ,  $p < .05$ ). Analysis of I-S-T 2000R scales showed that high Numerical Signs scores stand out in the younger participants' intellect profile. High Sentence Completion, Calculations, and Numerical Signs scores, as well as low Number Series, Figure Selection, and Matrices scores stand out in the older participants' intellect profile. Data of older participant were suitable for Exploratory Factor Analysis (EFA):  $KMO = .894$ ; communalities ranged from .375 to .69, Bartlett's Test of Sphericity was 358.801,  $p < .05$ . EFA with Principal Component Extraction and Promax Rotation results two factor intellect structure. These factors were labeled as Verbal-Numerical Intelligence and Figurative Intelligence. Two factors were extracted with 51.5% of the variance explained.

## *Conclusions:*

The Intellect profile of IHD patients aged between 41 and 50 yrs. is more even than aged between 51 and 70 yrs. Two factors describe the intellect structure of IHD patients in the middle and late adulthood.

Acknowledgements: The study was funded by the Research Council of Lithuania (Grant No. MIP-081/2014).

# CHANGES OF COGNITIVE FUNCTION IN CARDIOVASCULAR AND STRESS RELATED DISORDERS

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## *Background and aim:*

Cognitive impairment predicts poor outcomes in patients with coronary artery disease (CAD) and in patients with anxiety and mood disorders (AMD), but much remains to be learned about these patients' cognitive function.

## *Materials and methods:*

The presentation will provide a selective overview of key issues concepts, themes and empirical findings of the literature on cognitive functions in patients with CAD and AMD.

## *Results:*

Cognitive impairment is a common complaint in patients with CAD. Impaired adult cognition predicts mortality [1] and dependency on others to carry out activities of daily living [2]. Accelerated cognitive decline has been linked to dementia [3] and reduced quality of life [4]. Five factors affecting cognitive function in patients with CAD: coronary artery bypass grafting (CABG) surgery, apolipoprotein E4 (APOE4) genotype, left ventricular ejection fraction (LVEF), medication use, and various hormones and biomarkers. Cognitively impaired patients with AMD exhibit poorer adherence to psychotherapy and may derive limited gains in health related quality of life as a result. Literature on cognitive impairment in patients with AMD mostly focuses on disorder specific executive cognitive dysfunctions.

## *Conclusions:*

Studies of cognitive function of patients with CAD and AMD are encouraged in order to better identify individuals at high risk for cognitive decline and impaired psychosocial functioning.

## *References:*

1. Fried LP, Kronmal RA, Newman AB, et al. Risk factors for 5-year mortality in older adults: the Cardiovascular Health Study. JAMA 1998; 279: 585–592.
2. Freiheit EA, Hogan DB, Eliasziw M, et al. Development of a frailty index for patients with coronary artery disease. J Am Geriatr Soc 2010; 58: 1526–1531.
3. Satizabal C, Beiser AS and Seshadri S. Incidence of Dementia over Three Decades in the Framingham Heart Study. N Engl j med 2016; 375: 93–94.
4. Duijndam S, Denollet J, Nyklicek I, et al. Perceived Cognition after Percutaneous Coronary Intervention: Association with Quality of Life, Mood and Fatigue in the THORESCI Study. Int j behav med 2017; 24: 552–562.



# EFFECTIVENESS OF BIOFEEDBACK-ASSISTED RELAXATION IN REDUCING STRESS AMONG STUDENTS

**G. Jarašiūnaitė-Fedosejeva, I. Pečiulienė, A. Perminas**

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## *Background and aim:*

The aim of the study was to assess the efficacy of biofeedback-assisted relaxation (BAR) in increasing student's ability to relax (i.e. the ability of a person to achieve the mode of relaxation).

## *Materials and methods:*

The ability to relax was assessed by skin conductance - SC, skin temperature - TMP, heart rate - HR and subjectively perceived stress. In a randomized controlled trial design, 83 university students with heightened levels of academic stress scores on the Academic Stress Scale, were chosen and randomly assigned into two groups. One group participated in a four BAR sessions programme and another was a control group, who had not received relaxation training. BAR was conducted using the device NeXus-10 (MindMedia, The Netherlands).

## *Results:*

BAR group reported a significant increase in ability to relax assessed by skin conductance and heart rate and significant decrease in their subjectively perceived stress from pre- to post intervention programme assessment when compared to the untreated control group.

## *Conclusions:*

In general, the inclusion of a stress management programme based on BAR in educational contexts could improve the students' ability to relax and may help to promote overall psychological health.

## THE FANTASTIC VIRTUAL REALITY VOYAGE: A JOURNEY INSIDE THE BRAIN ENERGY METABOLISM

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### *Background and aim:*

With the powerful aid of Virtual Reality we will take users into a journey within a tiny piece of brain, to explain, how glucose and lactate are sustaining brain physiology during tasks like learning, or memory.

### *Materials and methods:*

Neurons are connected to each other through synapses, and form new networks that are responsible for learning. The formation, establishment and functioning of synapses is energetically expensive. Astrocytes, the most abundant glial cells in the brain, are able to extract glucose from the blood flow, store it as “glycogen”; when synapses are working heavily, glycogen stores can be released to finally produce lactic acid, a molecule that can be shuttled to neurons and generate the energy necessary to sustain synaptic activity. This latter hypothesis is the basis of the ANLS (astrocyte-neuron lactate shuttle), a theory proposed by Pierre Magistretti in 1994, and supported to date by more than 20 years of experimental evidence.

### *Results:*

The animation will be based on real data from KAUST, Saudi Arabia, combined with simulations from the BlueBrainProject, Geneva, Switzerland. The lab of prof. Pierre Magistretti in KAUST is a world leader in the NeuroEnergetic field; dr. Corrado Cali is leading a collaborating project with Henry Markram’s BlueBrainProject in Geneva, to create biologically accurate simulations of the brain energy consumption from the neurons.

### *Conclusions:*

Virtual Reality is a powerful tool to unlock the mysteries and complexity of the brain.

## DECREASE IN NEURONAL NETWORK RESILIENCE PRECEDES SEIZURES AT MULTIPLE TEMPORAL SCALES

P. Jiruska (1, 2), J. Kudlacek (1, 2), W.-C. Chang (3), J. Chvojka (1, 2), M. I. Maturana (4), P. J. Karoly (4), M. J. Cook (4), J. Otahal (2), J. G. R. Jefferys (1), J. Hlinka (5)

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### *Background and aim:*

How seizures emerge from the abnormal dynamics of neural networks within the epileptogenic tissue remains an enigma. Recent studies demonstrate that to advance our understanding of ictogenesis requires detailed information about the epilepsy dynamics at multiple temporal scales. In our work, we have explored the trajectory of the brain dynamics at multiple temporal and spatial scales to provide compelling theory about seizure genesis.

### *Materials and methods:*

We have analyzed the electrographic activity in in vitro model of acute seizures induced by perfusing the hippocampal slices with artificial cerebro-spinal fluid containing high potassium or low-calcium. Long-term seizure dynamics was explored in a chronic model of temporal lobe epilepsy induced by the intra-hippocampal injection of a minute dose of tetanus toxin. Experimental observations about the short-term and long-term dynamics of transition to seizure were also evaluated in patients with epilepsy implanted with chronic seizure prediction device.

### *Results:*

Analysis of electrographic data in vitro, in vivo and in humans showed that the transition to seizure is not a sudden phenomenon, but a slow process characterized by the progressive loss of neuronal network resilience. From a dynamical perspective, the slow transition and long-term fluctuations in seizure probability are governed by the principles of critical slowing, a robust natural phenomenon observable in systems characterized by transitions between contrasting dynamical regimes.

### *Conclusions:*

Seizure onset represents the product of the interaction between the process of a transition to seizure, long-term fluctuations in seizure susceptibility, epileptogenesis and disease progression. Approaching the ictogenesis from the complex perspective is a crucial prerequisite for the identification of the causal mechanisms and ideal targets to effectively control the seizure emergence.

# A SHORT STORY ABOUT WORKING MEMORY – A PUZZLE OF RECENT THEORETICAL, COMPUTATIONAL AND EXPERIMENTAL ADVANCES

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## *Background and aim:*

Working memory (WM) is a key component of the brain's cognitive function as it supports the temporary storage and flexible manipulation of information crucial for decision making, planning and organising behaviour in time to achieve specific goals. Experimental studies of neural correlates of WM in a broad range of delayed match-to-sample tasks using a wide palette of brain imaging and electrophysiological methods have produced a large body of biological data, which have spawned a few conceptual frameworks aimed at revealing principles behind WM phenomena. Despite the inherent value of the generated hypotheses, without a more nuanced quantitative model it is hard to generate testable predictions and systematically validate the proposed ideas.

## *Materials and methods:*

For this reason, the cognitive neuroscience community has recently demonstrated growing interest in computational modelling and simulations of a WM system with the expectation for integrating experimental findings into a computational theory of WM. In this talk, a synergistic combination of theoretical, computational and experimental approaches dedicated to unravelling a mystery of neural mechanisms underlying fundamental processes of WM maintenance, encoding and retrieval will be discussed.

## *Results:*

An emerging theory of synaptic WM along with the accompanying simulations of our attractor memory neural network model will be presented in relation to our recent experimental findings about dynamical neural correlates of multi-item WM phenomena. In particular, the interplay between beta and gamma oscillations and their correlations with neuronal spiking activity that carries information about sequentially ordered memoranda will be given special attention.

## *Conclusions:*

In a broader perspective, we will argue for the unprecedented potential of large-scale mesoscopic spiking neural network models as a framework enabling to link different levels and types of biological findings, and thus enhancing multi-scale understanding of the cortical function and its neural substrate.

# THE PROSPECTS OF NON-INVASIVE BRAIN STIMULATION IN MEMORY RESEARCH AND FUTURE OF ITS THERAPEUTICS

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## *Background and aim:*

The memory is one of the key cognitive functions for everyday functioning as it enables us to remember information about people and places, recall past events, learn new facts and skills, etc. Unfortunately, memory is one of the most vulnerable cognitive functions as it declines with normal aging as well as due to various pathological states and conditions (e.g. different forms of dementia or psychiatric disorders). Different non-invasive brain stimulation techniques have shown a great promise in tackling the issue of memory function decline, and performance enhancement in normal functioning individuals. The series of experiments were conducted to explore the effects of transcranial direct current stimulation (tDCS) on memory function.

## *Materials and methods:*

Three cross-over sham controlled experiments assessing the effects of single session tDCS (20 min anodal, 1.5mA over parietal cortical target i.e. P3/P4 of 10–20 international EEG system) on associative memory (AM) were conducted. In each experiment the participants (young healthy adults age 21–35), completed one of the AM tasks (face-word and object-location task), and were assessed for cued recall accuracy immediately following the stimulation, but also 1 and 5 days later.

## *Results:*

In each experiment, AM performance was higher following active stimulation in comparison to sham ( $p = .05$ ). Furthermore, participants showed normal forgetting curve following both active and sham stimulation. Finally, the relative increase in performance was higher in initially lower performing participants which is of great importance for potential future therapeutic use.

## *Conclusions:*

These findings complement the current state of knowledge by suggesting that noninvasive brain modulation has a potential to improve performance on tasks requiring associative memory engagement. The effect of tDCS may prove to be beneficial for cognitive enhancement in normal aging and neurorehabilitation use.

# POST-SAUNA RESIDUAL CONSEQUENCES ON BRAIN NEURAL NETWORK AROUSAL, INFORMATION PROCESSING AND COGNITIVE PERFORMANCE

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## *Background and aim:*

The aim of this study was to induce whole-body moderate hyperthermia (rectal temperature 38.5°C) and simultaneously stress the brain (0.3°C warmer than arterial blood entering the brain) in subjects using a traditional sauna and to investigate the post-sauna residual consequences on brain neural network arousal, information processing, and cognitive performance.

## *Materials and methods:*

Sixteen male subjects (24±4 yr.) participated in the study. Whole-body hyperthermia was induced with Finnish sauna bathing. Before and 90 min after the sauna, resting electroencephalography (EEG) for spectral analysis and EEG event-related potentials (ERPs) during oddball tasks by two modalities (auditory and visual) were recorded.

## *Results:*

Finnish sauna exposure induced moderate to severe whole-body hyperthermia (rectal temperature, 38.5–39.6°C). At 90 min after the sauna, rectal temperature had recovered to the preheating level (preheating 37.11±0.33°C vs postheating 37.00±0.29°C,  $p > 0.05$ ). At 90 min after the sauna, an increase was found in alpha power following sauna recovery. In the visual task modality, post-sauna recovery led to enhancement in the N2 amplitude with centroparietal distribution and decreases in P3 amplitude with distribution along the frontoparietal axis for executive motor-cognitive processing. In the auditory task modality, post-sauna recovery led to a decrease in P3 amplitude with a frontoparietal distribution and this change was accompanied by auditory N2 amplitude enhancement along the centroparietal distribution for non-target cognitive processing. No significant differences in task performance were found.

## *Conclusions:*

Recovery to normothermia after a sauna leads to a greater resting neural network relaxation followed by increases in cognitive processing economy for a given oddball task.

# POSTER PRESENTATIONS



[pixabay image](#)



## P1. COMPETITION FOR ATTENTION OF SPATIAL MODULATIONS OF LOCAL VISUAL FEATURES

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### *Background and aim:*

The targets of visual attention are the most informative areas of the image. The parts of the scene that stand out in some modulation dimensions like contrast (CM), orientation (OM), or spatial frequency (FM) modulations attract the gaze to a greater extent. This raises the question of how different modulations compete for attention. The aim is to determine priorities for visual attention among spatial modulations of different dimensions and spatial frequencies (SF) when solving the visual recognition task.

### *Materials and methods:*

First, we created amplitude maps of CM, OM, and FM for the 100 original objects. Then, all information was deleted from the images, except for the areas around the local amplitude maxima. As a result, each object was represented thrice by the images consisting of CM, OM, or FM.

During a trial, the target was first shown to the subject, then an image consisting of three objects was presented; one of them corresponded to the target. The focus of attention was determined by eye tracking. In experiment 1, images having the same SF but formed from modulations of different dimensions competed for attention. In experiment 2, images were formed from modulations of the same dimension, but were differing in SF.

### *Results:*

In experiment 1, the first gaze shift after appearance of the stimulus was more often directed to an image formed from CM. Less commonly, an image consisting of OM became the target. Much less often, the gaze was shifted to an image composed of FM. When images of the same modulation dimension competed for attention (exp. 2), the ability to attract attention significantly decreased with increasing SF. Such a pattern was observed for any modulation dimension.

### *Conclusions:*

Calculations showed that the modulation amplitude is significantly higher for CM and OM than for FM; SF increase is also accompanied by a decrease of the amplitude. This may be an explanation of the result.

Acknowledgements: Supported by RFBR grant No. 17-06-50141-OFH/19.

## P2. THE ILLUSION OF OBJECT SIZE WITH THE INFLUENCE OF THE MÜLLER-LYER EFFECT

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### *Background and aim:*

The size illusion determinants are the target of the present study. The contours of any visual object cause distortions of perceived size. The effect is named the Object size illusion. Many objects look larger than they really are. A rectangle can be 10-30% longer than its physical length. As the length of the stimulus increases, so does the absolute value of the illusion but reaches its maximum and may begin to decrease afterwards.

### *Materials and methods:*

In contrast, a rhombus-shaped stimulus may appear shorter than it actually is. Observers underestimate rather than overestimate the length of the rhombus, which can lead to the opposite negative illusion. When the rhombus lengthens, the underestimation of the stimulus remains evident or even increases. Similarly, another visual object, a fish, may be shorter than its physical length. The longer the fish, the lower the value of the illusion, which can also sink to the scale of the negative numbers. The data may be interpreted in terms of the algebraic integration of two opposite effects: Object expansion and Distance contraction. The rhombus outline and the fish body contours play the role of the inward Müller-Lyer wings due to which the distance between two apexes shrinks. The degree of Contraction exceeds the grade of the Expansion in these experiments.

### *Results:*

The experiments with compound stimuli: diamonds in boxes and fishes in aquariums provide the positive Size illusion values and may show functions close to those of the empty rectangles. Now, the Expansion effect dominates over the Contraction effect.

### *Conclusions:*

The present psychological study supports the idea that the outer contours of a simple or compound stimulus serve as the main contributors to the Object size illusion. Inner inclusions and contours if present show weighty but less significant influence on the perceived distortion of extent.

### P3. PERCEPTION OF OBJECT LENGTH

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#### *Background and aim:*

The aim of the present study was to provide a support for the assumption that most visual objects appear somewhat larger than their occupied area.

#### *Materials and methods:*

Eighteen participants, the University students and teachers (thirteen female) attended in psychophysical experiments. The subjects were adjusting the blank range of the stimulus to equal the test object length, 200 arc min: of a line segment, triangle, rhombus, oval, rectangle, or a block with blurry contours. The vertex of the triangles was directed either to the stimulus central or lateral terminal. The geometric figures were empty or had a uniform filling. A certain rectangles were filled with achromatic birch rind pattern or some colored views: a column of bricks, stained glass window, or part of a bridge. The judgment errors of the subjects indicated the strength of the object size illusion.

#### *Results:*

All stimuli were perceived to be longer than they actually were. The triangles with vertexes pointing toward the stimulus center were the most powerful shape to induce the illusion of extent (about 16% of the stimulus length). The triangles with vertexes of the lateral orientation were two-three times less effective (5–7%) than those directed centrally. The diamond shape was the weakest stimulus type (4–5%). The line segment and stimulus with the blurry contours produced a little stronger (6%) illusion. The rectangles and ovals were about of the middle strength. The difference between the empty and filled shapes was insignificant. The filled rectangles, both chromatic and gray, created illusions of similar strength, 8–9%, probably because the objects were the same in size and shape.

#### *Conclusions:*

The experimental data obtained lead to a conclusion that estimating the size of an object relies mainly on the edges that define the object's shape.

## P4. CONTRIBUTION OF LUMINANCE AND COLOR TO THE ILLUSION OF OBJECT SIZE

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### *Background and aim:*

Object size expansion effect was studied.

### *Materials and methods:*

Performing psychophysical experiments, adult observers ER, IE, ES, and OG were adjusting the empty stimulus interval length to be equal with that of a rectangle object possessing a smooth uniform surface. The magnitudes of the object size illusion were measured. Three series of experiments were carried out.

### *Results:*

1. Luminance of the test objects varied and the background luminance was constant. The expansion effect was found to be an increasing function of the absolute luminance contrast. 2. The background luminance varied and that of the test object remained constant. Like in experiment 1, the illusion appeared also growing with increase of contrast of both dark and light objects. 3. The test object color was varying and luminance was not changing. The illusion magnitude was found about the same for all colors used including the achromatic grey.

### *Conclusions:*

Experimental data can be summarized as follows. Increasing luminance contrast, both positive and negative, caused the illusion strength growth, irrespective the contrast variations were conditioned by the object or background luminance changes. For bright objects, the size illusion growth was significantly steeper than for dark objects. At equal absolute values of luminance contrast, illusion for the light objects was stronger than for the dark ones. The object size illusion strength appeared independent on the surface color.

## P5. STANDARDIZATION OF THE WORKFLOW FOR MODELING IN SYSTEMS BIOLOGY AND COMPUTATIONAL NEUROSCIENCE

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### *Background and aim:*

A variety of different programming languages and platforms is used to build, validate and simulate computational models of biochemical and electrophysiological processes of neuronal circuits in Systems Biology and Computational Neuroscience fields. The goal of the study is to design a standardized workflow for building, validation, optimization, sensitivity and stability analysis, simulation of computational neuroscience models and automated conversion of codes into different programming languages.

### *Materials and methods:*

The standardized workflow is based on the model definition in SBtab format (Systems Biology Syntax rules), conversion to the Vector Field File generator (VFgen) compatible XML file and generation of programming code in a preferred programming language including C, Python, NEURON. Stability and sensitivity analysis of models is done using MCMC\_lib program.

### *Results:*

We applied a standardized workflow to translate a complex computational model of synaptic learning in hippocampal CA1 pyramidal neurons (Saudargiene and Graham, 2015) from C++ code to NEURON file using SBtab and VFgen formats. It enabled performing stability and sensitivity analysis of the model and running simulations in NEURON simulator used by the Human Brain Project Brain Simulation Platform.

### *Conclusions:*

A standardized workflow has been proposed and implemented to enhance computational model analysis, sharing, and reproducibility. Standardization of the modeling process is important in Systems Biology and Computational Neuroscience as models are becoming increasingly complex, more detailed and multiscaled.

Acknowledgements: This project was supported by the Human Brain Project Voucher Programme 2019–2020.

## P6. INTERNET DELIVERED MINDFULNESS PROGRAM REDUCES STUDENTS' ANXIETY AND DEPRESSION SYMPTOM SEVERITY: PILOT STUDY

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### *Background and aim:*

Mindfulness based Cognitive Therapy (MBCT) remains one of the leading treatment options for stress disorders such as anxiety and depression. We hypothesized that students who use mobile internet application "Ramus Protas" ("Quiet Mind"), based on the principals of MBCT, will report significantly lower depressive, anxiety and general fatigue symptoms.

### *Materials and methods:*

The "Quiet Mind" was designed and implemented using the Node.js framework, MySQL database. The internet application contained video materials on MBCT and meditation audio recordings for 8 weekly meditation sessions. In sum, 34 psychology students from Lithuanian University of Health Sciences (28 female, mean age  $26 \pm 10$ ) participated in the study. Two modules of Patient Health Questionnaire (PHQ) were employed to evaluate depressive and anxiety symptoms before and after the intervention. The Multidimensional Fatigue Inventory-20 was used to measure general fatigue. The Lithuanian Biomedical Research Ethics Committee approved the study protocol (No. BEC-VDU-66) and each study participant gave informed consent before inclusion into the study.

### *Results:*

During the first evaluation, students showed a mild depressive (mean  $6.8 \pm 3.5$ ) and anxiety (mean  $20.8 \pm 6.5$ ) symptoms as well as moderate level of fatigue (mean  $4.5 \pm 3.0$ ). After 8 weeks of internet-based MBCT the symptoms of depression significantly reduced (mean  $4.0 \pm 2.1$ , Wilcoxon signed-rank  $p=.03$ ; Student's  $t$  test  $p=.02$ ). Anxiety symptoms showed a tendency of decrease (mean  $13.4 \pm 11.0$ , Wilcoxon signed-rank  $p=.077$ ; Student's  $t$  test  $p=.10$ ). Fatigue also had a trend of decrease (mean  $1.8 \pm 1.9$ , Wilcoxon signed-rank  $p=.12$ ; Student's  $t$  test  $p=0.10$ ).

### *Conclusions:*

This is the first study to investigate the internet-based MBCT program in Lithuania. The results suggest that on-line MBCT, not only face-to face group MBCT, could be effective in reducing the symptoms of depression, anxiety and general fatigue.

Acknowledgements. This research was partially funded by the European Social Fund under the No. 09.3.3-LMT-K-712 "Development of Competences of Scientists, other Researchers and Students through Practical Research Activities" measure, received by Laurynas-Linas Dainauskas.

## **P7. STUDY OF EEG FREQUENCIES CHARACTERISTICS OF CHILDREN WITH EPILEPSY: STANDARD DIAGNOSTIC AND MOZART SONATA SUPPLEMENTED EEG RECORD ANALYSIS**

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### *Background and aim:*

There is growing evidence that brain activity of people with epilepsy is characterized not only by abnormal electrical discharges, but also by changes of the total background of brain activity. Analyzing brain electrical activity, frequencies characteristics can be a useful tool to help us understand epilepsy and its causes. The purpose of this study was to investigate the influence of Mozart k. 448 sonata on the EEG frequencies characteristics of children with idiopathic focal and generalized epilepsy.

### *Materials and methods:*

In the study 60 EEG records of children with generalized and focal epilepsy were analyzed. Control group: 16 children with generalized and 14 with focal epilepsy. Experimental group: 15 children with generalized and 14 with focal epilepsy. The procedure was supplemented with Mozart k. 448 sonata listening in the experimental group. The subjects underwent diagnostic EEG procedure, which included several stages: hyperventilation, sleep, photostimulation. Four frequencies (delta, theta, alpha, and beta) were analyzed in three resting states: R1, R2 and R3. The relative power of four frequencies was calculated in three electrodes Cz, Fz and Pz.

### *Results:*

The results of the study revealed that: 1. In the generalized epilepsy group participants' age was negatively related to theta power and positively to alpha and beta powers. In the focal epilepsy group age was negatively related to delta power in the fronto-center regions. 2. Gender had no significant effect on EEG frequency characteristics 3. The power of low frequencies (delta, theta) was more pronounced in the focal epilepsy group, which shows that this type of epilepsy is more severe. 4. The power of delta, alpha varied in the standard and experimental EEG procedure in the three assessed resting states. Considering the procedure these power variations were caused by changes of consciousness. 5. None of the investigated EEG frequency characteristics significantly differed among children who were and were not exposed by Mozart k. 448 sonata during the procedure.

### *Conclusions:*

Single experience of listening to Mozart k. 448 sonata has no effect on EEG frequencies characteristics among children with generalized and focal epilepsy.



## **P8. HEALTH RELATED QUALITY OF LIFE IS ASSOCIATED WITH CARDIOVASCULAR REACTIVITY DURING MENTAL STRESS CHALLENGE IN PATIENTS AFTER ACUTE CORONARY SYNDROME**

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### *Background and aim:*

Health Related Quality of Life (HRQoL) in patients after acute coronary syndrome (ACS) is known to be impaired (2, 3) and is worse than in the general population (4). The importance of psychological stress in the development and course of heart diseases is well established (5) (6). However, to our knowledge, there has been very few studies examining objective psychophysiological responses to stress in relationship to overall HRQoL in ACS patients. The aim of our study was to investigate the association of cardiovascular stress reactions with HRQoL in patients with ACS during cardiac rehabilitation.

### *Materials and methods:*

In sum, this cross-sectional study included 136 patients (84.6% men, age 52±8) within 2–3 weeks after ACS during cardiac rehabilitation. Patients were evaluated for HRQoL (Short SF-36 scale), symptoms of anxiety and depression (Hospital Anxiety and Depression Scale) and Type D personality (Type-D Scale). Trier social stress test (TSST) was employed to evaluate cardiovascular reactivity (systolic and diastolic blood pressure [BP], and heart rate [HR]) to psychosocial stress. Multiple linear regression analyses were performed to test for possible associations between cardiovascular stress reactivity and HRQoL.

### *Results:*

After controlling for baseline levels of HR, gender, age, NYHA functional class, AH, Type D personality, symptoms of anxiety and depression, use of beta-blockers, and history of smoking, the SF-36 Social functioning scale ( $\beta=-.182$ ;  $p=.03$ ) and SF-36 Vitality scale ( $\beta=-.203$ ;  $p=.03$ ) was associated with prolonged HR recovery following stress evoking tasks. No associations were found between HRQoL and BP measures during the TSST.

### *Conclusions:*

In patients who have experienced ACS, HRQoL was associated with prolonged HR recovery after mental stress, even after controlling for potential confounder. Future studies should investigate the possible role of mediating factors involved in the mechanisms relating cardiovascular stress response and HRQoL.

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### *Background and aim:*

This work deals with neural network modeling of second-order visual mechanisms that analyze texture information. Currently, there is growing evidence that these mechanisms play an important role in attention control. While spatial brightness changes are detected by the simple striate neurons, the neuronal mechanism for demodulation of spatial changes in contrast, orientation and spatial frequency (second-order features) is more complex. The well-known “filtration—rectification—filtration” scheme describing the organizational principles of second-order vision is too abstract for use in real world applications.

Our main aim is to train autoencoders to detect spatial modulations. These models can be useful tools for finding salient areas in an image. However, studying the representations generated by the convolutional network may be of particular interest.

### *Materials and methods:*

We trained both autoencoders specific to modulations of a certain local feature (either contrast, or orientation, or spatial frequency), and non-specific encoders-decoders of all these spatial modulations. The training and validation sets were formed from modulated artificial textures with widely varied properties such as brightness, contrast, etc. The training was conducted on the Nvidia Tesla V100 using the Keras and Tensorflow libraries.

### *Results:*

Models consisting of symmetrically organized encoder and decoder with 3 convolutional layers of 32–64 3x3, 3x3, 5x5 filters, 3 pooling / upsampling 2x2 layers, and output / input convolutional layer of 1 5x5 filter, showed good trainability. The quality of training for specific autoencoders is noticeably higher than for non-specific ones, but it greatly decreases with an increase of low-modulated images proportion in the training set.

### *Conclusions:*

The results can be used to create saliency maps which take into account the spatial distribution of second-order features in the scene.

Acknowledgements: Supported by RFBR, project No. 18-29-22001.

## P10. HYPOXIA – INITIATOR OF MICROGLIAL CELLS ACTIVATION?

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### *Background and aim:*

There are many studies claiming that brain ischemia induces cell death via multiple mechanisms. It is assumed that activation of microglia plays an important role in these processes. Nevertheless, so far little is known about the mechanisms and consequences of microglial activation during ischemia. It is considered that mitochondria not only plays a key role but is also are thought to be affected by ischemia. Still, there is lack of information about the link between mitochondrial dysfunction and inflammatory responses mediated by the activated microglia.

The aim of this study was to investigate effects of simulated ischemia and antidiabetic drug – potential effectors of mitochondrial oxidative phosphorylation system – phenformin and metformin on primary rat microglial cell cultures

### *Materials and methods:*

In this study we used primary microglial cultures (85% microglia) prepared from cerebral cortices of 5–7-day-old Wistar rats pups (both genders). Microglia cells were incubated under hypoxic conditions (2% O<sub>2</sub>) in the absence/presence of deoxyglucose (2DG) for 24 hours. The viability and number of microglia was assessed by fluorescence microscopy.

### *Results:*

We found that in the absence of 2DG, hypoxia stimulated proliferation of microglia, which was inhibited in the presence of 2DG. Phenformin and metformin in the absence of 2DG stimulated microglia proliferation and tended to increase microglial proliferation in presence of 2DG in hypoxic conditions comparing with 2DG –treated cells. Morphological changes, such as ameboidic phenotype with processes, round and flat shape with thick bundles underneath the membrane, were observed in microglial cells during hypoxia.

### *Conclusions:*

These data indicate that microglia cell activation during hypoxia might be triggered in a glycolysis dependent manner while phenformin and metformin-stimulated microglial proliferation is less sensitive to glycolytic activity of the cells.

**Acknowledgements:** This work was supported by the Research Council of Lithuania (global grant project LMT-K-712-01-013).

## P11. THE ROLE OF PHOSPHOLIPID SCRAMBLASE XKR8 IN THE DEVELOPING BRAIN

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### *Background and aim:*

During synaptic pruning synapses are eliminated from the neuronal network. This process needs to be strictly controlled, since underpruning and overpruning are associated with various neurodevelopmental diseases, such as autism spectrum disorder or schizophrenia. Nowadays there is an increasing number of published studies showing that developmental synaptic pruning is mediated by brain macrophages – microglia. One of the “eat me” signals in microglia-neuron interaction is phosphatidylserine (PtdSer). Exposure of PtdSer on the cell surface involves phospholipid scramblases, which non-specifically and bidirectionally transport PtdSer across the plasma membrane down its concentration gradient. Neniskyte et al. showed that Xkr8-dependent PtdSer scrambling is required for axon pruning during development. Here we investigated the expression of Xkr8 scramblase in the brain and the effect of Xkr8 conditional knock-out on the development of neuronal network.

### *Materials and methods:*

To assess Xkr8 expression we used qPCR, in situ hybridization and immunohistochemistry in various brain regions of C57BL6/J Xkr8 wild type (Xkr8-WT) and Xkr8 conditional knock out (Xkr8-cKO) mice. To determine whether PtdSer scrambling was required for the development of cortical neuronal network, we investigated cortical cell death and pruning of corticospinal tracts.

### *Results:*

We found that Xkr8 is indeed expressed in the brains of C57BL6/J Xkr8-WT. It was successfully deleted from the pyramidal neurons of in Xkr8-cKO mice. Although Emx1::Cre driver is expressed from the embryonic day 10.5, loss of Xkr8 during embryogenesis did not affect developmental cortical cell death, since total cortical cell density did not differ between Xkr8-WT and Xkr8-cKO mice during development. This indicates that increased synaptic density in Xkr8-cKO was due to aberrant synaptic pruning rather than superfluous neurons.

### *Conclusions:*

Here we show that the effects of conditional Xkr8 scramblase knock-out reported by Neniskyte et al. were not due to impaired developmental cell death. Furthermore, altogether our data argue that Xkr8-dependent PtdSer scrambling may indeed be a specific signal for developmental axonal synaptic pruning.

## **P12. COMPARISON OF NEUROPSYCHOLOGICAL AND ELECTROPHYSIOLOGICAL MEASUREMENTS OF COGNITIVE FUNCTIONS IN HEALTHY SUBJECTS AND MENTAL DISORDERS GROUPS**

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### *Background and aim:*

Both neuropsychological tests and electrophysiological methods (cognitive event-related brain potentials) are used for cognitive research. However, there are only few studies concerning relationship between these methods.

The aim of the study was to compare neuropsychological and electrophysiological measurements of cognitive functions in mental disorders and control groups. We investigated the relationship between physiological and psychometric cognitive assessment methods in an attempt to determine whether they were identical or there were specific differences in information which they bring. The final objective was to select the most informative methods.

### *Materials and methods:*

The study involved two groups of subjects. Control group consisted of 22 healthy subjects, mental disorder group – 22 patients with different diagnosis, who received treatment in Republican Vilnius Psychiatric Hospital. The mean age of participants was 41 year (from 20 to 60 years). Auditory P300 potentials were recorded for both groups. In addition to this, neuropsychological tests (Kraepelin's test, symbol coding, digital span test, memorizing of 10 words and Shulte's tables) were given to investigate cognitive functions.

### *Results:*

The study showed that groups made according to N2 and P3 latency values, as well as these made according to Schulte tables, Kraepelin's test, 10-word test, and Digit Symbol test results coincided with the actual control and mental disorders groups. In addition, electrophysiological and neuropsychological tests differed by factors. We also found out that electrophysiological studies are more sensitive to the influence of age than neuropsychological methods.

### *Conclusions:*

Healthy subjects and patients groups differed by both electrophysiological and neuropsychological tests results. Nevertheless, factor analysis showed that these methods help to obtain different information. Since there are more factors of neuropsychological test results than of electrophysiological test results, it was assumed that they provide broader information about the cognitive functions.

### **P13. EPISTATIC EFFECT OF DRD2 rs1800497 AND COMT rs4680 POLYMORPHISMS ON RISK FOR ALCOHOL USE DISORDER**

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#### *Background and aim:*

Genetic polymorphisms of brain dopaminergic system are common target for research of genetic predisposition for addiction disorders, however, studies usually report small effect size. A single genetic variation is not expected to have a strong impact on a multi-etiological disorder, such as addiction. Thus, genetic predisposition of vulnerability may be more explicit by exploring gene-gene interaction. We evaluated effect on risk for alcohol use disorder of two genetic variants: DRD2 rs1800497 and COMT rs4680. We have selected functional variants of dopaminergic pathway to investigate possible additive effect of genotypes.

#### *Materials and methods:*

Study included 329 participants (202 females and 127 males, mean age 32.35 (SD=9.93), that were recruited from local community. Risk of alcohol use disorder was evaluated by the Alcohol Use Disorder Identification Test (AUDIT). Polymorphisms of COMT rs4680 and DRD2 rs1800497 were determined by real time PCR. Non parametric tests were used to examine differences of AUDIT scores among groups of genotypes. Effect sizes of genotypes were evaluated by multivariate logistic regression analysis.

#### *Results:*

DRD2 rs1800497 genotype was significantly associated with AUDIT test scores, but not with the risk of alcohol use disorder. COMT rs4680 GG genotype was associated with risk of alcohol use disorder, however, effect size was small (OR = 2.152; 95% CI = 1.072-4.323, P=0.031). The study revealed that interaction of COMT rs4680 x DRD2 rs1800497 contribute significantly to the risk of alcohol use disorder. Combination of COMT rs4680 x DRD2 rs1800497 genotypes GGxCT/TT increase the risk for alcohol use disorder (OR = 5.121; 95% CI= 1.658 – 15.818, P=0.005).

#### *Conclusions:*

We demonstrated an increased risk for alcohol use disorder for carriers of COMT rs4680 GG who also were carriers of DRD2 rs1800497 T allele. The epistatic effect of genes may be linked to their functional effect on dopaminergic activity in the brain.

## **P14. COLOR VISION IN SCHOOL AGE CHILDREN WITH AND WITHOUT LEARNING DIFFICULTIES IN LATVIA**

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### *Background and aim:*

Children with color vision deficiency may perform poorly on test that employ color-coded materials. If their parents and teachers are unaware of this fact, those children may have learning problems. It is important to find color vision problems (also other vision disorders) for children as soon as possible. In Latvia (as in many other countries), no official guidelines exist for vision screening in school-age children; only visual acuity at far is evaluated in some of the Latvian schools.

The aim of our study was to find out how many children have color vision impairments in Latvian schools and wanted to find out, is amount of children with color vision deficiency the same in standard schools and schools for children with learning problems.

### *Materials and methods:*

Visual screening for 11033 (49% of them were boys and 51% were girls) children from age 7 till 18 years was performed in standard schools and in special schools with learning difficulties. Vision complaints and basic vision functions as far and near visual acuity, binocular vision, stereoacuity, accommodation and vergence functions, and color vision was evaluated during screening. Visual screening for 11033 (49% of them were boys and 51% were girls) children from age 7 till 18 years was performed in standard schools and in special schools with learning difficulties. The visual screening carried out optometrists and students from the Master's program in optometry. Vision complaints and basic vision functions as far and near visual acuity, binocular vision, stereoacuity, accommodation and vergence functions, and color vision was evaluated during screening. Color vision was assessed using the HRR and Rabkin pseudoisochromatic plates. If a child failed the screening section of the HRR or Rabkin, his/her color vision was tested with the full HRR set.

### *Results:*

Color vision deficits (CVD) were found for ~4.0% of boys and ~0.1% of girls. The percentage of males with color vision deficiency was significantly higher (12 boys of 160 (7.5%)) in the special schools compared to standard schools (193 boys of 5151 (3.76%)). There was no significant correlation between color vision deficiency and other vision problems. There are larger proportion of boys in specialized schools (75% from all children). Additional research such be done to find out, is there any connection between color vision problems and learning difficulties.

### *Conclusions:*

Our results show that the prevalence of color vision deficiency (CVD) among school age children in Latvia is less than reported levels for European Caucasian populations, for both male and female individuals (8% and 0.4%, respectively). Other tests are required to classify the type of color vision defect for these children.



## **P15. ISCHEMIA INDUCED DAMAGES TO CEREBRAL CORTEX AND CEREBELLUM REGIONS**

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### *Background and aim:*

Ischemic brain injury is the leading cause of disability and mortality worldwide and the severity of damage is dependent on ischemia duration. Accumulated evidence indicate that mitochondria play a critical role in ischemic injury. The pharmaceutical agents often fail to deliver clinical value as females react differently to treatment. Also, taking in consideration that cortex and cerebellum has a different composition of neuronal and glial cells, the aim of this work was to evaluate the activity of cerebral cortex and cerebellum mitochondria respiration, calcium retention capacity and the infarct zone size to evaluate 90 min and 120 min ischemia induced damages.

### *Materials and methods:*

Experiments were performed on brain isolated from 3 months old Wistar rats and distributed into three groups: control, 90 min ischemia and 120 min ischemia. Ischemia was induced in hypoxic chamber and the cortex and cerebellum mitochondria were isolated by differential centrifugation. The total mitochondrial protein was determined by the Biuret method. Mitochondrial respiration was measured with a 2k-Oxygraph "OROBOROS" and calcium retention capacity was determined fluorimetrically using Calcium Green 5N, which indicated extramitochondrial  $\text{Ca}^{2+}$  and the opening of permeability transition pore. Cerebral hemispheres and cerebellum infarct zone size was determined using 2,3,5-triphenyltetrazolium chloride (TTC) stain by computer image analysis.

### *Results:*

Results have shown that 90 min and 120 min ischemia primarily reduce respiration complex I activity in cerebral cortex mitochondria by 73% and 90 %, respectively, and in cerebellum mitochondria by 76% and 84%, compared to control group. Respiration complex II activity during 90 min and 120 min ischemia in cerebral cortex is reduced by 56% and 66%, respectively, and in cerebellum mitochondria by 57% and 52%, compared to control group. Results obtained by measuring calcium retention capacity in cortex and cerebellum mitochondria permeability transition evaluation show no statistically significant difference between control and ischemia groups. Finally, 90 min and 120 min ischemia increases cerebral hemispheres infarct zone size by 26% and 44%, respectively, and cerebellum infarct zone size by 30% and 41%, compared to control group.

### *Conclusions:*

Based on the results, although 90 min and 120 min ischemia increase cerebral hemispheres and cerebellum infarct zone size and reduce mitochondria respiration complex I and II activity, it has no effect on mitochondria calcium retention capacity.

## P16. EXPRESSING THE ORGANIZER OF AN ORGANISM'S BEHAVIOR: AN EPISTEMOLOGICAL OVERVIEW OF NEUROSCIENCE

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### *Background and aim:*

Neuroscience, as a discipline, makes many assumptions, as noted by Zavala, Pérez, Muñoz, and Herrera [1999–2000]. We make them explicit by cataloguing the methods by which neuroscientists arrive at conclusions.

### *Materials and methods:*

We collect and systematize the ways that neuroscientists have figured things out as discussed in Wikipedia articles, the Brain Science Podcast, and related books.

### *Results:*

We outline a system of 24 ways of figuring things out. In establishing a neural structure, neuroscientists document its activity at rest, at constant voltage or current, the correlates of activity (such as blood flow), and the functional components (such as neurons). Neuroscientists distinguish ever finer structures, identify species in which they function robustly, destroy that functionality, and trace structural evolution. The experimental goal is temporal precision in associating neural processes with experience and behavior. Neuroscientists then interpret "errors" at different levels of awareness: phantoms (false information), illusions (imperfect models), novelties (incorrect predictions), thoughts (mental fictions). We present these and the remaining ways of figuring things out as a comprehensive epistemological system.

### *Conclusions:*

In practice, neuroscience views the brain as the organizer of an organism's behavior. Implicitly, the methods of neuroscience assume and engage the attributes of an organizer whose internal logic interacts with its external environment at various levels of abstraction. The fundamental challenge of neuroscience is to match the physiological activity within brains with the framework of social conceptions by which we interpret not only our internal experience but also our external behavior. For example, we may conceive of walking as a step-by-step process, but our cerebellums do not. Neuroscience develops words and concepts by which we grow aware of how our brains function.

## **P17. ELECTROMYOGRAPHIC AND STABILOMETRIC ASSESSMENT OF POSTURAL RESPONSES TO BALANCE PERTURBATIONS ON AN ACTIVE PLATFORM AND IN QUIET STANCE**

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### *Background and aim:*

Antigravity posture in humans is based upon the inverted pendulum arrangement, which allows fast movements of the whole body mass with a minimum of energy expenditure. This comes at the price of continuous small muscle interventions to maintain balance both in quiet standing and in movement. The actual mechanisms of such muscle activity are not yet fully known, with a current view that stretch reflexes may play a relevant role. This report investigates how leg muscle activity relates to sways of the body on a platform.

### *Materials and methods:*

Young healthy subjects were placed on a digitally controlled platform that tilted 10° backwards. Surface electromyography, stabilometric and statokinesic data were acquired in quiet stance and immediately after tilt. Recordings were performed from the following muscles: tibialis anterior, soleus, vastus medialis and biceps femoris muscles.

### *Results:*

During quiet standing, bursts of electromyographic activity could be recorded from soleus and biceps femoris only, which compensated the passive forward oscillations of the body. When the platform was tilted backwards, a short latency response from the soleus could be recorded, followed by a series of alternated bursts of the tibialis anterior and the soleus itself. Little activity could be recorded from the thigh muscles, confirming that in young people it is the action upon the ankle joint which plays a major role for balance.

### *Conclusions:*

It may be concluded that stretch reflexes are of little relevance for standing balance, which instead is maintained by a feed forward mechanism regulating burst duration and frequency in the lower leg muscles.

## **P18. PSYCHOPHYSICAL STUDY OF AN EFFECT OF FILLED-SPACE ILLUSION CAUSED BY A SINGLE-DOT DISTRACTOR**

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### *Background and aim:*

The filled-space illusion (perceptual overestimation of the length of the filled stimulus part) has been systematically studied for more than one-and-half century, however, at present there is yet no consensus about the origin of this visual phenomenon. The aim of present study was to develop a quantitative model of the filled-space illusion and examine its capability to account for the effects induced by stimuli with the most elementary dot distractor.

### *Materials and methods:*

In the three series of experiment, we investigated the illusory effect as a function of distance between the distracting dot and lateral terminator of the reference spatial interval of the three-dot stimulus. It was shown that the model calculations properly predict all the illusion magnitude changes for stimuli with a distracting dot placed either within or outside the interval as well as for stimulus with two dots arranged symmetrically relative to the lateral terminator.

### *Results:*

The dependencies established were used for development of quantitative model, which was successfully applied also to fit the experimental results obtained earlier for conventional Oppel-Kundt stimuli.

### *Conclusions:*

A good correspondence between the experimental and theoretical results supports the suggestion that perceptual positional biases induced by the context-evoked increase in neural excitation can be considered as one of the main causes of the filled-space illusion.

## P19. EEG-BASED EVALUATION OF COGNITIVE WORKLOAD INDUCED BY REPETITIVE 3D VISUAL SEARCH TASKS ON A VOLUMETRIC DISPLAY

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### *Background and aim:*

Recent advances in three-dimensional (3D) visualization systems have contributed to the growing demand for the investigation of cognitive workload using electroencephalography. The analysis of brain activity leads to the better understanding of cognitive requirements when working with a new display. The aim of this study was to assess the short-term changes in brain activity induced by repetitive 3D visual search tasks on the innovative volumetric display.

### *Materials and methods:*

The visual stimuli were demonstrated on the volumetric multi-plane display x1405 produced by LightSpace Technologies. The search items (four constant angular size circles) were projected on sequential physically-separated display planes. In each trial, one of the circles was displayed closer to the individual comparing to three others. The individual's task was to find the closest circle and submit the answer about its relative location by pressing the corresponding key on the computer keyboard. Each individual accomplished three sessions. One session consisted of 50 search trials. To record electrical activity of the brain, we employed electroencephalography. The electrodes were placed in accord with the international 10-20 electrode position system. Afterwards, the analysis of event-related potential (ERP) and frequency band was applied.

### *Results:*

The significant changes were evident for the alpha band activity only in the central parietal area (Pz) and in the left parietal area (P3). Specifically, most individuals demonstrated a considerable increase in the alpha band power when comparing the first task session and the last one. Moreover, there was a slight increase in the beta band power. However, the data analysis of ERP components showed no considerable changes when comparing the brain activity during three sessions of repetitive visual search tasks.

### *Conclusions:*

In general, the neural activity remained stable during several sessions of repetitive visual tasks on the volumetric display. However, the variability of neural activity in the alpha band could reflect the changes in the working memory and visual attention, possibly related to the repetitiveness of the task. To differentiate the effect of volumetric representation of information, the cognitive workload should be further investigated for the stereoscopic visualization system.

## P20. A CASE STUDY OF CHROMESTHESIA: PREDICTION OF THE VOICE SIGNAL-EVOKED COLOR USING ARTIFICIAL NEURAL NETWORKS

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### *Background and aim:*

Chromesthesia is a type of synesthesia in which heard sounds evoke color sensation. In this case study we have investigated synesthesia effect in a female with a partial visual deficiency. The specificity of the synesthesia is described by the perception of another person as a shadow that gains a person-specific color shortly after some conversation. The study aims to predict the voice signal-evoked color using artificial neural networks.

### *Materials and methods:*

The study was performed by interviewing 39 participants (19 male, 49%) and registering the color, evoked by the voice-signal in the chromesthesia research subject. Participants' voices were recorded with 44100 Hz sampling rate and 68 voice features were extracted using pyAudioAnalysis Python module: averages and standard deviations of Zero crossing rate, Energy, Entropy of Energy, Spectral Centroid, Spectral Spread, Spectral Entropy, Spectral Flux, Spectral Rolloff, 13 Mel Frequency Cepstral Coefficients, 12 Chroma Vectors, Chroma Deviation. For color classification, we designed a multilayer perceptron (MLP) artificial neural network (ANN) with 4 hidden layers using Keras Python module. The ANN was trained using error backpropagation algorithm and employing data of 2 voice-evoked color classes: 6 pink-colored and 5 white-colored females.

### *Results:*

The dominant registered colors of study participants were white (5) and pink (6) for females and blue (7) and black (3) for males. There were also 12 multi-color samples and the rest were 1–2 samples per color. Training was done with 389 white-colored and 595 pink-colored samples. The classification accuracy of the white and pink females was 94 %. F1 scores were 0.91 for white-colored and 0.95 for pink-colored females.

### *Conclusions:*

Our study suggests that the evoked color depends on the features extracted from recorded voice clips.

## P21. PHOSPHATIDYLSERINE SCRAMBLING IS REQUIRED FOR DEVELOPMENTAL SYNAPTIC PRUNING

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### *Background and aim:*

Mature brain connectome emerges through synaptic pruning of superfluous connections in developing brain. Microglia have central role in this process: they refine neuronal circuitry by phagocytosis and trophocytosis of synaptic structures. While a range of microglial receptors and soluble molecules have been identified to mediate synaptic pruning, up until now there has been limited data on neuronal „eat-me“ molecules that would label unnecessary synapses for microglial elimination. Here we investigated the role of phosphatidylserine (PtdSer) scrambling in synaptic pruning.

### *Materials and methods:*

We used immunohistochemical detection of phosphatidylserine-specific opsonin MFG-E8 to identify the extent and the localization of PtdSer in developing brain. We further used conditional pyramidal neuron knock-out of Xkr8 phospholipid scramblase to define the role of PtdSer scrambling for synapse elimination. We used region-specific IHC labelling for cortical and thalamic projections to assess pruning specificity in Xkr8 cKO brains. Morphological findings were confirmed by electrophysiology of acute hippocampal slices and fMRI analysis of the whole brain connectome.

### *Results:*

We found that PtdSer is preferentially exposed on synaptic structures and promotes microglia-synapse interaction. PtdSer exposure was developmentally upregulated and required the activity of Xkr8 phospholipid scramblase. Conditional Xkr8 knock-out in excitatory neurons led to diminished axonal bouton trophocytosis and insufficient elimination of excitatory synapses. These morphological aberrations were followed by abnormal electrophysiological profiles of Xkr8-deficient neurons that exhibited increased spontaneous activity and the failure of functional synaptic maturation. Finally, Xkr8 deficiency led to increased global connectivity that was maintained into adulthood.

### *Conclusions:*

We provide the first evidence that mammalian synaptic pruning requires developmental PtdSer exposure via scramblase activity, identifying the first „eat-me“ signal that is exposed on unnecessary synapses for their developmental removal.



## P22. TAU PROTEIN EXERTS ISOFORM-DEPENDENT NEUROTOXICITY IN NEURONAL-GLIAL CO-CULTURES

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### *Background and aim:*

Tauopathies are the group of neurodegenerative diseases related to tau (tubulin associated unit) protein pathology in which both intracellular and extracellular compartments are critical. One of the pathology hallmarks is elevated level of tau in CSF. There are six different isoforms of tau varying in number of N-terminal inserts (N) and C-terminal repeats (R). Extracellular tau can be toxic to neurons, but whether neurotoxicity depends on tau isoform is unclear. In this study we aimed to investigate the neurotoxic effect of tau 2N4R and 1N4R isoforms.

### *Materials and methods:*

Neuronal-glial co-cultures (CGC) were prepared from P5-P7 Wistar rat cerebellum. Cultures were treated with 3  $\mu$ M of recombinant human tau protein at different aggregation state (2N4R isoform (441 amino acids); 1N4R isoform (412 amino acids) or 4R fragment (Leu243 – Glu372; 129 amino acids)) for 48 hours. Freshly prepared recombinant tau protein was considered as monomeric. To induce tau aggregation, protein samples (1 mg/ml) were incubated with/without A $\beta$ 1-42 oligomers (1:140) at the room temperature (RT) for 24 h prior the cell culture treatment. Neuronal viability and density were assessed by propidium iodide and Hoechst33342 staining. Microglial cells were identified by isolectin GS-IB4 -AlexaFluor488 staining.

### *Results:*

Our results show that monomeric and oligomeric tau2N4R causes significant loss of neurons up to 60%, without any increase in apoptosis or necrosis, and microglial proliferation. Monomeric tau1N4R has no effect on neuronal viability and cell number. But tau1N4R species obtained by pre-incubation at RT without A $\beta$ 1-42 oligomers are highly neurotoxic: after treatment number of necrotic and apoptotic cells increases by 56% and 27% respectively. Further we found that tau1N4R pre-incubated with A $\beta$ 1-42 oligomers significantly reduces number of viable neurons up to 40 % without apoptosis or necrosis. We also found that 4R fragment lacking N-terminus regardless of how was prepared has no effect on neuronal viability and number as well as on microglial proliferation, implying that N inserts determine tau neurotoxicity.

### *Conclusions:*

Our results suggest that extracellular tau exerts isoform dependent neurotoxicity in neuronal-glial co-cultures. Acknowledgements: This work was supported by the Research Council of Lithuania, Bilateral Exchange Project Joint Research grant S-LJB-18-2 INFLAMTAU.

## P23. 40-HZ AUDITORY STEADY-STATE EARLY LATENCY RESPONSE IS RELATED TO THE STROOP TASK PERFORMANCE

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### *Background and aim:*

Auditory steady-state response (ASSR) is an oscillatory response to the repeatedly presented auditory stimuli. Gamma-range ASSR is utilized in clinical practice to observe the dysfunctions of the entrainment of the brain activity in neuropsychiatric disorders with cognitive symptoms. Previous studies showed that the late-latency (200–500 ms) ASSR is significantly correlated to the information processing speed. However, early-latency (0–100 ms) part is a distinct response that has different characteristic and arises from different neural substrates. The Stroop task is a classical tool to evaluate fast processes and fast decision making. The present study aims to explore the possible relationship between the Stroop test and the early onset-related part of 40-Hz ASSRs in a uniform sample of young healthy subjects.

### *Materials and methods:*

The subjects were 29 males (mean age  $\pm$  SD 25.8 $\pm$ 3.3). The 40-Hz click trains were presented 150 times in a pseudo-randomized order with an inter-train interval set at 700-1000 ms. EEG responses were recorded according to 10/20 electrode placement system and analyses were performed on the left, central and right regions. The phase-locking index (PLI) and event-related power perturbation (ERSP) were calculated for the early-latency (0–100 ms). The Stroop test from the Psychology Experiment Building Language (PEBL) battery was used. Pearson's correlation coefficients were calculated to access the relationships; no multiple-test correction was applied as the tests were explorative in nature.

### *Results:*

The PLIs of the early-latency (0–100 ms) gamma over the central and right regions negatively correlated with the mean reaction times in the congruent condition of the Stroop test ( $r = -0.47$ ,  $p < 0.01$ ;  $r = -0.51$ ,  $p < 0.01$ ). The negative correlation was observed between the PLIs over the right region and the errors in the incongruent condition of the Stroop test ( $r = -0.38$ ,  $p = 0.05$ ).

### *Conclusions:*

The performance on the Stroop task resembles fast processes and fast decision making. This fits the purpose of the early-latency gamma response – a fast reaction to the sensory event. The negative correlation between parameters of Stroop task and the measures of the early-latency gamma reflects the more efficient processing of fast-response requiring executive tasks.

## **P24. BOTH GLOBAL AND LOCAL EFFECTS ARE DETECTED IN ADAPTATION TO LIGHT IN THE RAT SUPERIOR COLLICULUS NEURONS**

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### *Background and aim:*

Adaptation to light reduces retinal gain in bright light and thus helps us to detect images under very different light conditions. For instance, we can detect differences in illumination levels of less than 10% of the background even if light intensity changes from 0.1 lx to 10,000 lx. A number of features of adaptation to light enable to meet such challenges. We have shown recently that in rats one such a feature is a limited spatial spread of adaptation to small stimuli. Here we explored how this limited spread of adaptation affects responses to stimuli that differ in size.

### *Materials and methods:*

Experiments were performed in urethane-anaesthetized rats by employing single unit recordings with tetrodes. Images, bright spots on a dark grey background, were presented on a computer monitor located in front of the left eye of a rat placed at 22 cm distances. Both the adaptor and the control stimulus lasted for 0.6 s while the pause between them was 0.3 s.

### *Results:*

We found that for small adaptor stimulus, when the spot size was 1.8 and 6.2 spatial degrees, the adaptation effect was limited to the test stimulus sizes that were the same or smaller than the adaptor stimulus. However, large adaptor stimulus caused large reduction (adaptation) of responses to all stimulus sizes tested (up to 70 degrees).

### *Conclusions:*

Under our experimental conditions most size effects on the degree of adaptation to a small adaptor stimulus could be explained by a limited spread of adaptation. However, our data suggest that large stimuli (20 degrees in diameter) were inducing global adaptation.

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## P25. ODDS OF REPEATING AN ACTION ARE AFFECTED BY ITS PREVIOUS OUTCOME AND ELAPSED TIME

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### *Background and aim:*

Reinforcement learning makes an action that yields a positive outcome more likely to be taken in the future. Our main interest is how the outcome affects the delay before the action is repeated, and whether the delay itself correlates with repeating the same choice or selecting an alternative.

### *Materials and methods:*

As the experimental model we used groups of C57BL6/J and genetically modified NR1Tph2CreERT2 mice housed in cages that automatically recorded their activity. Animals had unlimited access to water and chow as well as probabilistic access to a reward (a solution of saccharin or alcohol). The probability of receiving the reward in two of the cage corners varied between 0.9 and 0.3 every 48 h over a period of several weeks.

### *Results:*

In most animals, the odds of choosing the same corner again were increased if that choice was previously rewarded. Interestingly, in many cases, the time elapsed from the previous choice also increased the probability of repeating the choice, irrespective of the previous outcome. Loss of NMDA receptors on serotonergic neurons increased the interval between choices. Behavioral data were fitted with a series of reinforcement learning, with modifications introducing the effects of decay of the expected value or increased the probability of repeating the same choice at longer intervals. We found that introducing an interval-dependent adjustment to the odds of repeating the same choice allowed for the best prediction of the observed behavior.

### *Conclusions:*

Interval between choices affects the probability of repeating the previous decision.

## P26. A COMPARISON OF AFFECTIVE REACTIVITY TO ARTIFICIAL FACIAL EMOTIONS BETWEEN MEN AND WOMEN: AN ERP STUDY

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### *Background and aim:*

Emotion is an affective state accompanied by cognition and consciousness, and plays a vital role in social interactions. Much of our understanding of human expressions has come from research using exaggerated, unambiguous emotional expressions presented via photographs. However, our daily encounters with subtle expressions suggest that we are adept in reading subtle emotions. Studies using artificial human face models have shown that virtual faces are recognized relatively well compared to natural faces. Moreover, the use of artificial face models makes it possible to manipulate intensity of the expression.

We aimed to compare affective reactivity to different artificial facial expressions between men and women utilizing an ERP method.

### *Materials and methods:*

42 females and 33 males performed emotion recognition task using faces that portray different emotions (anger, fear, disgust, happiness, sadness, surprise and neutral emotion) while multichannel EEG was recorded. The effect of sex and emotion was evaluated comparing an emotion recognition accuracy, a response time, a stimuli evoked global brain activity and a distribution of electrical activity across the scalp.

### *Results:*

Women recognized emotions more accurately and faster compared to men. All participants were more accurate in identifying happiness and fear compared to sadness and surprise. Women global brain activity was significantly higher than men in the time window between 370–485 ms, irrespective of emotions. No differences in activation topographies was found between sexes. However, differences in distribution of electrical activity evoked by different emotions occurred from approximately 330 ms after the stimulus onset.

### *Conclusions:*

We suggest that better recognition of emotions in women may be related to higher global brain activity evoked by various emotional expressions. Whereas differences in activation of specific brain areas may at least partially be explained by different recognition of a particular emotion.

## P27. NEUROSCIENCE READINESS TO IMPACT ON XXI CENTURY INDIVIDUAL PSYCHOLOGY AND BEHAVIOUR

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### *Background and aim:*

The aim of this work was to survey the readiness of neuroscience to impact on XXI century individual psychology and behavior.

### *Materials and methods:*

The review of the latest literature. Meta-analysis.

### *Results:*

1. Studies reveal that the subtleties of subconscious mind could be understood by means of some psychedelics (psilocybin, psilocin, LSD, ayahuaska, peyote, etc.) even more successfully than in Freudianism by analysis of dreams. Most importantly, psychedelic drugs can impact on receptor 5-HT<sub>2A</sub>, one of the subtypes in a serotonin receptors family. Taking it into consideration, some psychedelic centres presumably will be established in a not distant future. Their activity would be like visiting gym or spa, however, equipped with their own special programs together with trained therapists and guides.
2. Expectations of people to live happier life are not calming down. It is fascinating thing to know that modern biochemical systems may affect certain brain points by chemical and electrical signals and result individual experience of happiness. Thus neuroscience along with multiple possibilities possesses an important determinant of social welfare as well.
3. Endless innovations of teaching process to enhance student achievement are still inadequate. It is understood at last that the situation could be changed by reforming the school work principles in parallel with purposeful biopsychological management of the students. Enough to mention the fact that children in the world are increasingly using metilphenidate, a stimulant of central nervous system. It affects chemicals in the brain and nerves and is used to treat attention deficit disorder (ADD), attention deficit hyperactivity disorder (ADHD), and narcolepsy. This stimulant even may help to enhance achievement and make better behavior for such students who have no significant disorder.

### *Conclusions:*

Aforementioned activities which to be performed by different representatives of neuroscience in the various cultural and social domains consist a strong potential to strengthen mental health of our society members as well as enlarge the field of palliative care.

## P28. EVIDENCE OF NEUROPLASTICITY IN THE CONDITIONS OF MICROGRAVITATION

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### *Background and aim:*

The magnocellular and parvocellular visual systems are neural basis of global and local image analysis. They interact at different levels of information processing and provide a holistic perception (Shoshina, Shelepin, 2016). The mismatch of the magno- and parvocellular systems interaction, respectively, leads to persistent sensory impairments that observed in e. g. schizophrenia (Shoshina, Shelepin, 2015; Shoshina et al., 2014). The study of the functional state of these systems in chronic stress has shown the increase in the sensitivity of the magnocellular system (Shoshina et al., 2017; 2018). Previously obtained data suggested that the pattern of interaction between these systems may change due to increasing the magnocellular system sensitivity in extreme conditions. The aim of this work was to study the functional state and the nature of the interactions of the magno- and parvocellular visual systems during the «dry» immersion.

### *Materials and methods:*

«Dry» immersion is the model of the physiological effects of weightlessness. The study involved 8 volunteers. The contrast sensitivity was recorded for different spatial frequencies, based on the idea that the magnocellular system is sensitive to low spatial frequencies and the parvocellular system to high ones.

### *Results:*

We showed the increase of contrast sensitivity to low spatial frequencies on the third day of being in immersion and one day after the end of experiment, compared to background values. During the rest of the time spent in immersion, subjects demonstrated the same contrast sensitivity as before the experiment. Sensitivity to high spatial frequencies did not change in the experiment.

### *Conclusions:*

The microgravity conditions changes the sensitivity of the magnocellular neural system. The results indicate that it is possible to consider the functional state of the magnocellular system as a marker of adaptation.

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## **P29. THE EFFECTS OF MOTOR-COGNITIVE TRAINING IN DEVELOPMENT AND STRENGTHENING OF MENTAL NUMBER LINE IN CHILDREN WITH THE USE OF COMPUTER MATH GAME "KALKULILO"**

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### *Background and aim:*

Various neuroimaging, behavioral and clinical studies, pointed at parietal cortex as a crucial region involved in creating and maintaining abstract representations of numbers. Cognitive disorder defined as developmental dyscalculia eventuates from dysfunction of frontoparietal control network. Many studies confirm the benefits of a cognitive training using computer games and the modern technology in math education and therapy of dyscalculia. The effects of such stimulation are observed on behavioral as well as neuronal level. The aim of our study was to examine the effect of cognitive and cognitive-motor training with computer math game "Kalkulilo" on the development of basic mathematical skills - comparing the numbers presented in different formats (Arabic numerals, sets of dots) and the number line estimation.

### *Materials and methods:*

Eighty-eight children (aged 7–10) participated in the study. They were divided into 3 groups: 1st group were training with "Kalkulilo" game on laptop, 2nd group were training with "Kalkulilo" and Kinect sensor control of movement and the 3rd group was the passive control. Training took 5 hours and was divided into 10 sessions. Before and after training we measured the level of basic mathematical using the computer test "Prokalkulia 6-9".

### *Results:*

The results indicated the effect of training on spatial representations of numbers development because it improved the accuracy of number line estimation. The effect is particularly pronounced in the group of cognitive-motor training (with Kinect), which further suggests that this type of training is more effective than standard one (using only a computer).

### *Conclusions:*

It could be concluded that the use of mathematical game training may be therefore a valuable tool not only in math education but also it could be helpful e.g. in overcoming the cognitive deficits observed in dyscalculia.

## **P30. SYSTEMIC EFFECTS OF ALUMINIUM ON MICE AND BRAIN ALUMINIUM CONCENTRATION AFTER LONG-TERM EXPOSURE TO ALUMINIUM CHLORIDE**

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### *Background and aim:*

Aluminium (Al) causes toxic effects on various body organs and tissues, especially nervous tissue. Studies on animal models demonstrated changes in cognitive functions and morphological features of the central nervous system after consumption of water containing elevated concentrations of aluminium. This study was aimed to evaluate long-term effects of Al on mice body weight and brain mass and to determine concentrations of Al in mice brain and blood.

### *Materials and methods:*

Experiments were done on 4–6-weeks old Balb C mice. Animals were divided into three groups: control group, low dose Al group (Al 50; 50 mg Al<sup>3+</sup>/kg bw/day), high dose Al group (Al 100; 100 mg Al<sup>3+</sup>/kg bw/day). Control mice were given tap water, whereas Al treated mice received AlCl<sub>3</sub> in drinking water for 8 weeks. Systemic effect of AlCl<sub>3</sub> was evaluated according to the changes in mice body weight and relative brain mass index. Al concentration was determined by inductively coupled plasma mass spectrometry (using NexION 300 D).

### *Results:*

Exposure to low and high Al doses showed loss of mice weight during experimental period as compared to control. The body weight gain in Al 50 treated mice decreased by 1.9% after the first week and by 8.7% after 8 weeks. The body weight gain in Al 100 treated mice was even lower; it decreased by 3.5% after the first week and by 13% at the end of the experiment. The body weight of control mice increased gradually throughout experimental period with a slight slowdown in growth at 7–8 weeks. In Al 100 treated mice relative brain mass index increased by 19% ( $p < 0.05$ ) as compared to control. Treatment with low dose Al did not show any statistically significant change of this index. After 8 weeks of Al 100 administration, concentration of Al<sup>3+</sup> in the blood increased twofold (from 64.03 to 135.62 µg/L,  $P < 0.05$ ). The exposure to Al 50 caused no change in Al<sup>3+</sup> concentration in the mice blood. There were no changes in Al<sup>3+</sup> concentrations in the brain of mice exposed to both doses of Al.

### *Conclusions:*

Exposure to both doses of Al resulted in statistically significant decrease of mice body weight; meanwhile, only a high dose Al caused statistically significant increase in brain mass. The exposure to both Al doses did not cause changes in brain Al<sup>3+</sup> concentrations, whereas high dose Al caused an increase in Al<sup>3+</sup> concentration in the mice blood.

## P31. THE EFFECT OF OPTOMETRIC TREATMENT ON POSTURE

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### *Background and aim:*

Posture is the position of a body while standing or sitting. To maintain posture and stability in various conditions and activities, good balance system is required that is controlled by a complex set of sensorimotor control systems with the sensory input from vision, proprioception, and the vestibular system; integration of that sensory input; and motor output to the eyes and body muscles. With age and in case of specific pathological conditions, the loss of correct posture management can have serious consequences for the person causing falls and difficulty in walking. The aim of this work was to assess the efficacy of optometric treatment in the change of the posture.

### *Materials and methods:*

Posture and balance were tested in eleven patients (26–56 y.o.) with postural and gnathological problems, and no structural abnormalities (shorter arm or leg etc.). The stabilometric computerized platform was used before and after optometric treatment that consisted of refractive correction with glasses or contact lenses, optometric visual training, and advices about ergonomical and behaviour aspects.

### *Results:*

With the eyes opened, the weight distribution become more balanced in anterior-posterior direction, the centre of pressure (COP) moved closer to the theoretical centre and the COP sway velocity, area and length become smaller after optometric treatment. If the eyes were closed, no statistically significant changes were observed before and after optometric treatment.

### *Conclusions:*

The results of the study demonstrate that improvement of visual quality can directly affect the posture and balance of the patient. Therefore, the treatment of the patients with postural problems should be a teamwork involving various types of specialists including optometrists.

## **P32. HISTOLOGICAL CHARACTERIZATION OF THE ROLE OF THE VENTRAL TEGMENTAL AREA AND THE VENTRAL GIGANTOCELLULAR RETICULAR NUCLEI ON LOCOMOTION AFTER SPINAL CORD INJURY**

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### *Background and aim:*

Research on spontaneous recovery after spinal cord injury (SCI) has revealed naturally occurring corticospinal reorganization processes. However, there is a lack of research on the role of the brain in this recovery process. The objective of the study was to histologically examine the role of the ventral tegmental area (VTA) and the ventral gigantocellular reticular nuclei (vGi) in locomotion after SCI.

### *Materials and methods:*

Nine mice underwent treadmill training, then spinal cord hemisections (except the control group) and later received rabies injection below the injury site. The final locomotive task was performed on the uninjured mice four days after the rabies injection, acutely after SCI on one group and chronically on another one. The brain slices were stained using immunohistochemistry techniques, imaged with a confocal microscopy and then analysed using ImageJ.

### *Results:*

Both the VTA and vGi demonstrated c-Fos emission during the locomotion task. Cells expressing GABA and glutamate were found to be active during the locomotion in the VTA and vGi. The overall activity of the VTA and the signal of GABA and glutamate, were higher in the chronic group compared to the acute ( $p < 0.05$ ), while in the vGi it did not differ significantly. Some active spinal cord projecting cells were found in the vGi.

### *Conclusions:*

Our findings here suggest that the VTA is involved in a spontaneous recovery and its activity may be based on a motivation. Moreover, we assume that the vGi has an impact on a locomotion control after SCI but may not be influencing spontaneous corticospinal plasticity. Hence, the VTA and other structures of the reward system could be important regions to stimulate in neurorehabilitation, while the vGi impact on the corticospinal plasticity needs further investigation.

### **P33. HOW THE MENTAL REPRESENTATION OF NUMBERS CAN BE TRAINED ON TABLET WITH THE MOBILE APPLICATION "NUMBALA"?**

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#### *Background and aim:*

Research on the brain basis of mathematical abilities shows the key role of fronto-parietal networks in the formation of mental representations of number, e.g. mental number line. Damages in this brain areas result in the symptoms of developmental dyscalculia. Computer-supported methods, e.g. cognitive training with games, can provide many benefits to both therapy of this deficit and to mathematical education. The aim of the study was to examine the effect of training with mathematical game "Numbala" on such skills as numbers comparison, numerosity estimation and number line estimation.

#### *Materials and methods:*

Forty nine children aged from 7 to 8 participated in the study. Some of them (N=25) trained with the "Nubala" game on the tablet. It is based on the number line processing as well as performance of the simple arithmetic operations. Each training procedure was divided into 10 sessions which lasted about half an hour with 1-3 days intervals between them. Before (pre-test) and after (post-test) the training, the level of children's basic mathematical abilities were measured with the use of computer test "Prokalkulia 6-9": number comparisons, numerosity estimation, numerical stroop and number line estimation. The remaining (N=24) children constituted a control group – with no training. They performed "Prokalkulia 6-9" task twice (within the same time interval as the experimental group).

#### *Results:*

The results indicate that training with "Numbala" brings pronounced benefits. The improvement of the results in the training group was observed in the preprecision index of the number line estimation task for the symbolic (Arabic digits) and non-symbolic (set of dots) format of numbers. After training the estimation error decreased, especially the underestimation of the number location.

#### *Conclusions:*

Thus, it could be concluded that "Numbala" game may develop and strengthen the spatial representation of numbers, what means that can be great educational and therapeutic tool.

## **P34. NEUROPLASTIC EFFECTS OF PSYCHOTHERAPY AND PHARMACOTHERAPY IN THE TREATMENT OF DEPRESSION**

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### *Background and aim:*

The aim of this study was to advance an integrative model of psychotherapy and psychopharmacotherapy for depression. A hypothesis has also been put forward about two sources of neuroplastic changes resulting from the use of this treatment model.

### *Materials and methods:*

22 clinical interviews were conducted with depressed patients undergoing therapy in the framework of this integrative model.

### *Results:*

We compared the results of studies of Boeker 2005; Spitzer 2000, Boeker, 2017, Stassen et al. 2007; Szegedi et al. 2009 and the results of our clinical and interviews concluded that the hypothesis of two sources (psychotherapy and psychopharmacotherapy) of neuroplastic changes in depressed patients brains is relevant as part of this integrative treatment model.

### *Conclusions:*

Psychopharmacological drugs alter the functional capabilities of the brain by increasing the production and depletion of astrocytic growth factors, which in themselves serve as triggers of neuroplastic reactions. Psychotherapy (both CBT and psychodynamic paradigms) in patients with depression invents new models for using the neuronal structure and networks that are established and that brain neuroplasticity can be activated using psychotherapy. We can conclude that the processes of initiation and reorganization are induced and stabilized at the level of those neural networks that were previously involved in the thinking, feelings and actions of the corresponding patient. Through additional drug treatment, brain neuroplasticity can be maintained and reactivated additionally. Through early and adequate psychotherapeutic interventions, it is more likely that specific priming processes during a psychiatric disorder can be reduced and that the reduction in neuroplasticity and the ability to reorganize the neural networks of the patient concerned can be overcome.

### **P35. ASSOCIATIONS BETWEEN SERUM FREE TRIIODOTHYRONINE LEVELS AND SYMPTOMS OF DEPRESSION AFTER ISCHEMIC STROKE IN PATIENTS WITH NORMAL THYROID FUNCTION**

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#### *Background and aim:*

Depressive disorders often follow an acute ischemic stroke (AIS), affecting approximately one third of stroke survivors. Thyroid axis hormones have been reported to influence depression symptoms in clinically euthyroid subjects with and without adjacent somatic pathology. This study aimed to determine associations between serum thyroid axis hormone levels and depression in patients with normal thyroid function who experienced AIS.

#### *Materials and methods:*

In total, 144 patients (58% men, 42% women, age median 68 [60–75] years) participated in the study. Serum thyroid stimulating hormone, free tetraiodothyronine (FT4) and free triiodothyronine (FT3) levels were assayed on admission to the hospital. Patients with overt and subclinical thyroid dysfunction were excluded. Depression symptoms were evaluated using the Hospital Anxiety and Depression Scale (HADS-D) at discharge from the hospital. We used univariate regression to investigate the association between thyroid axis hormone serum levels and depression symptoms. Next, we applied logistic regression, adjusting for possible confounders.

#### *Results:*

The majority of patients (60.4%) showed symptoms of depression (HADS-D score > 3). In univariate model, only higher serum FT3 levels, but not FT4 and TSH levels, on admission were significantly associated with lower odds for depression (OR=0.51; 95% CI: 0.30–0.87, p=0.013). However, after also adjusting for left carotid artery territory stroke, increased social risk for depression due to unemployment or retirement before AIS, age and neurological severity on admission according to National Institutes of Health Stroke Scale, this association disappeared (OR=0.60; 95% CI: 0.34–1.06, p = 0.079).

#### *Conclusions:*

FT3 serum levels on admission are not confirmed to be independently associated with post-stroke depression symptoms after AIS in patients with normal thyroid function. Further studies on larger samples are needed.

### **P36. CHI3L1 AND OPN COMBINED PROGNOSTIC VALUE IN ASTROCYTOMA PATIENT SERUM**

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#### *Background and aim:*

Gliomas account for approximately 70% of primary brain tumors in adults. Of all Gliomas, grade IV Astrocytoma, also called Glioblastoma (GBM) has the poorest overall survival, with <5% of patients surviving 5 years after diagnosis. Due to aggressiveness, lethal nature and impaired surgical accessibility of the tumor it is important early and noninvasive prediction of the tumor, and patients' survival time. We hypothesize that combining several disease specific serum biomarkers could be a good choice to achieve higher specificity and sensitivity in predicting patient outcome. The aim of this study was to investigate the potential of five secretory proteins – GFAP, MMP-2, CHI3L1, OPN and AREG to predict Astrocytoma patient overall survival.

#### *Materials and methods:*

Study group consisted of 70 Astrocytoma patients and 31 healthy controls. For protein expression in blood serum commercial ELISA was used. Kaplan-Meier analysis was performed to evaluate patient's survival dependencies on investigated protein's expression and Cox analysis - to choose most promising variables.

#### *Results:*

CHI3L1 and OPN proteins serum levels were able to distinguish high grade Astrocytoma patient's group from healthy controls. We showed that integrating tumor IDH1 mutational status, serum CHI3L1 and OPN proteins expressions into one parameter patient's 24 months survival could be predicted with 86.8 % accuracy.

#### *Conclusions:*

Individual CHI3L1 and OPN protein concentrations in serum could help to distinguish between GBM and healthy and prognosticate survival. Combined values of these proteins and tumor IDH1 status could prognosticate patient 24 months survival with 86.8 % accuracy.



## P37. MT1 GENE CLUSTER METHYLATION ANALYSIS IN ASTROCYTIC GLIOMAS

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### *Background and aim:*

Astrocytic gliomas are the most common brain tumors characterized by high molecular heterogeneity, resistance to therapy and rapid progression. Despite advances in therapy, the most malignant form of astrocytic glioma, glioblastoma still determine poor survival rate, approximately 3–9 months. Thus, molecular markers for diagnosis and prognosis are urgently required. Metallothioneins (MTs) are group of cysteine-rich, metal-binding proteins encoded by a set of genes located on chromosome 16q12.2 – q13. It was shown that in cancerous cells DNA methylation can span in long stretches or gene clusters of the genome, contributing to gene expression. MT1 gene cluster is known for DNA methylation in several cancers which could serve as patient outcome biomarker. There is no data for MT1 cluster methylation level in astrocytic gliomas and its contribution to patient outcome.

### *Materials and methods:*

Methylation of 10 CpG islands (CGIs) at MT1 cluster in 68 post-operative tissues of patients with different grade astrocytic gliomas was determined by MS-PCR. Methylation levels were estimated and associations with patient clinical characteristics were analyzed. CGI methylation score was calculated for survival prognosis using Kaplan-Meier method. Significance level chosen for analysis was  $p < 0.05$ .

### *Results:*

Lower MT1 methylation level was associated with higher astrocytoma malignancy for MT1A, -E, -G, -M, -F, -L and -FG CGIs ( $p < 0.05$ ). Kaplan-Meier analysis have shown that five CGIs at MT1 locus: MT1A, -F, -G, -M and -FG were significantly associated with patient survival ( $p < 0.05$ ). Gene cluster DNA methylation calculation showed that methylation status of cluster differs between astrocytic glioma grades ( $p < 0.05$ ) and patients with high MT1 cluster methylation level had better prognosis (Log-rank test,  $p < 0.05$ ).

### *Conclusions:*

DNA hypomethylation at MT1 gene cluster contributes to glioma progression and could be potential prognostic marker for astrocytic gliomas.

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## **P38. ELECTROPHYSIOLOGICAL EVALUATION OF SEX-DEPENDENT DEVELOPMENT OF LOCAL CIRCUITRY IN HIPPOCAMPUS**

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### *Background and aim:*

During early postnatal development, a process of vigorous synaptogenesis followed by subsequent selective elimination of superfluous synapses, also known as synaptic pruning, underlies the normal reorganization and refinement of characteristic neural pathways in the brain. Aberrant pruning is often associated with various neurodevelopmental disorders, including autism spectrum disorder and schizophrenia. Recent morphological and immunohistochemical research in mice indicates sex-dependent differences in synaptic pruning: females are shown to undergo an earlier peak activity of synaptic elimination than males. However, it is still unknown how sex-related timing of synaptic elimination is reflected in the development of functional synaptic connectivity in both males and females. A number of factors, including number of synaptic contacts between neurons, number and functional state of receptors in synapse and neurotransmitter release probability, influences functional synaptic connectivity. These factors can only be evaluated by direct recordings of synaptic currents in living neurons. The aim of this study is to employ patch-clamp method for investigation of sex-dependent variation in electrophysiological profiles during early postnatal development.

### *Materials and methods:*

The whole cell recordings will be obtained from CA1 hippocampal pyramidal neurons in acute slices from both male and female wild type mice of varying postnatal ages.

### *Results:*

At the current stage of our research we are adjusting brain slice preparation and recording techniques in order to record induced, spontaneous and miniature excitatory postsynaptic currents that will estimate the degree of connectivity and maturity of neuronal circuitry.

### *Conclusions:*

As most of the knowledge on physiological neuronal development is based on single-sex research, our results will reveal valuable information about the sex-dependency of mechanisms underlying normal brain development and pathology.

## **P39. BARRATT IMPULSIVITY SCALE 11TH VERSION (BIS-11): SOME PSYCHOMETRIC DATA FOR A LITHUANIAN SAMPLE**

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### *Background and aim:*

The aim of the present study was the psychometric evaluation of the Barratt Impulsivity Scale 11th version (BIS-11).

### *Materials and methods:*

We analyzed data from 298 adolescents aged 18 to 70. Psychometric properties of the BIS-11 were analyzed using internal consistency confirmatory factor analysis, exploratory factor analysis, test-retest reliability.

### *Results:*

Multiple regression analysis showed that younger age related with higher impulsivity. Internal consistency analysis resulted negative inter-item correlation of two (3rd and 15th) questions and these were reversed. After four questions (No 15, 20, 23, and 29) removal (because of poor item-total correlation) internal consistency was good (Chronbach's alpha – 0.851). Even confirmatory factor analysis failed to fit observed data, The hypothesized three-factor structure based on all 26 items resulted in acceptable fit to empirical data. The discriminant and convergent validity showed good results. Test-retest reliability is moderate (varied from poor to good).

### *Conclusions:*

To sum up, the present study suggests that the Lithuanian version of the BIS-11 has sufficient psychometric properties for measuring impulsiveness in nonclinical sample. For further use of the scale it is advisable to refuse 3 questions (No 15, 23, 29) which lack of specificity for impulsivity assessment. Also according to the results we recommend review and paraphrase 20th question in the more appropriate way for Lithuanian sample. Lithuanian version of BIS-11 is reliable and valid instrument for impulsivity assessment.

