

**XIII International Conference  
of the Lithuanian Neuroscience Association**

# CONSCIOUSNESS

**26 November 2021, Kaunas, Lithuania**

Virtual Conference on MS Teams platform

Time zone: UTC/GMT +2:00 hours



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# PROGRAM

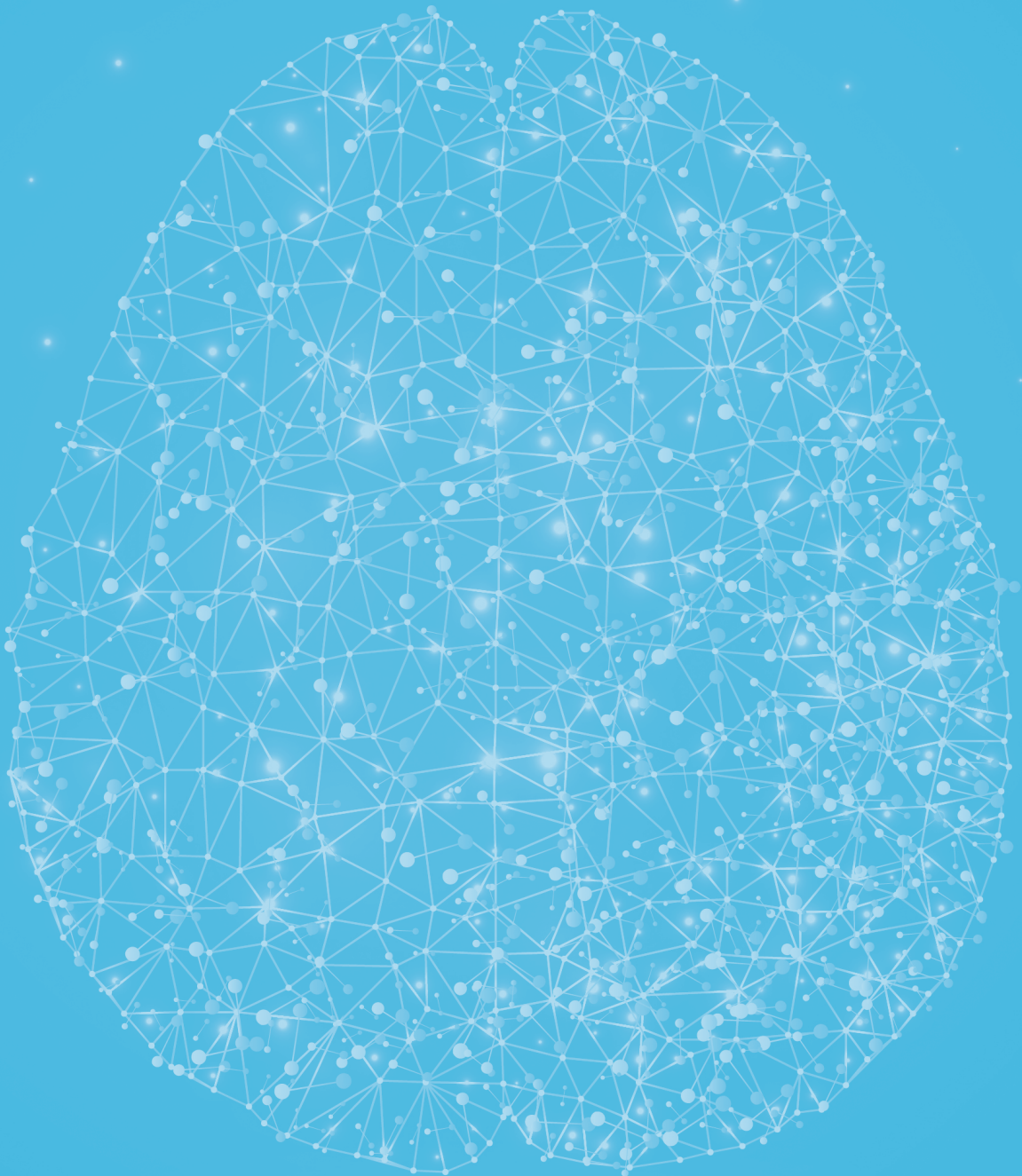
26 November 2021  
Virtual Conference on MS Teams platform

9.00-9.15	<b>Opening and Welcome</b> Prof. Osvaldas Ruksenas, President of the Lithuanian Neuroscience Association Prof. Vaiva Lesauskaite, Vice-Rector for Research, Lithuanian University of Health Sciences, Kaunas, Lithuania Prof. Arimantas Tamasauskas, Director, Neuroscience Institute, Lithuanian University of Health Sciences, Kaunas, Lithuania
	<b>I session. Cognitive Neuroscience and Consciousness</b> Chair – prof. Saulius Satkauskas, Vytautas Magnus University, Kaunas, Lithuania
9.15-10.15	<b>KEYNOTE LECTURE</b> <b>The Embedded Consciousness: The Self-organization of the Serotonergic Matrix</b> Prof. Skirmantas Janusonis, Department of Psychological and Brain Sciences, University of California, Santa Barbara, USA
10.15-11.00	<b>Embodied Brains for Interactive Robots</b> Prof. Jörg Conradt, KTH Stockholm, The Royal Institute of Technology, Computational Science and Technology, Stockholm, Sweden
11.00-11.15	<b>Coffee/Tea</b>
11.15-11.45	<b>Who Knows how to Distinguish Between Conscious and Unconscious Processing?</b> Prof. Assoc. Renate Rutiku, Institute of Psychology, Jagiellonian University, Krakow, Poland
11.45-12.00	<b>Psilocin Induces Perceptual Alterations in Rats: Visual Discrimination Study</b> Čestmír Vejmla, PhD student, National Institute of Mental Health, Klecany, and Third Faculty of Medicine, Charles University, Prague, Czechia
12.00-13.30	<b>Lunch. Poster session</b>
13.30-13.45	<b>Meeting of LNA members</b>
	<b>II session. COVID-19 and the Brain</b> Chair – Prof. Vesta Steibliene, Lithuanian University of Health Sciences, Kaunas, Lithuania
13.45-14.45	<b>KEYNOTE LECTURE</b> <b>Lifestyle and Online Behaviours during the Covid-19 Pandemic</b> Prof. Ornella Corazza, Department of Clinical, Pharmaceutical and Biological Sciences, University of Hertfordshire, UK

14.45-15.00	<b>Coffee/Tea</b>
15.00-15.30	<b>Neuropsychological Consequences of COVID-19</b> Dr. Aiste Pranckeviciene, Lithuanian University of Health Sciences, Kaunas, Lithuania
<b>Short plenary lectures</b>	
15.30-15.45	<b>Rate Yourself! Platform to Know Your Problematic Usage of the Internet: Risks, Mental Distress and Quality of Life</b> Dr. Vilma Liaugaudaite, Lithuanian University of Health Sciences, Kaunas, Lithuania
15.45-16.00	<b>Problematic Internet Use, Mental Distress and Impulsivity Symptoms in Students</b> Juliija Gecaite-Stonciene, PhD student, Lithuanian University of Health Sciences, Kaunas, Lithuania
16.00-16.15	<b>Pilot Studies on Association with Spontaneous eye Blinking Rate and Alterations in Brain Activity: an Overview</b> Dovile Simkute, PhD student, Vilnius University, Vilnius, Lithuania
16.30-17.30	<b>Publishing Workshop of European Journal of Neuroscience (EJN) Handling, Review and Publication of EJN Manuscripts</b> Chair – prof. John Foxe, EJN Editor-in-Chief, University of Rochester, Rochester, USA  <b>Introduction</b> Prof. John Foxe, EJN Editor-in-Chief, University of Rochester, Rochester, USA  <b>Handling of Manuscripts submitted to EJN</b> Prof. Assoc. Antoine Adamantidis, EJN Senior Editor, University of Bern, Bern, Switzerland  <b>Rigor in Presentation and Statistical Analyses of Data presented in EJN Manuscripts</b> Dr. Guillaume Rousselet, EJN Section Editor, University of Glasgow, Glasgow, UK  <b>Review Process of Manuscripts submitted to EJN</b> Prof. Paola Bovolenta, EJN Senior Editor, University of Madrid, Madrid, Spain  <b>Ethics of Peer-review Evaluation of Manuscripts submitted to EJN</b> Prof. Yolanda Smith, EJN Senior Editor, Emory University, Atlanta, USA  <b>Q&amp;A and Concluding Remarks</b> Prof. John Foxe, EJN Editor-in-Chief, University of Rochester, Rochester, USA
17.30-18.00	<b>Concluding Remarks, Discussions, Awards</b>



# Oral presentations



# The Embedded Consciousness: The Self-organization of the Serotonergic Matrix

Skirmantas Janusonis

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All neural processes in the brain are physically embedded in a dense matrix of thin axons (fibers) that release serotonin (5-hydroxytryptamine), a major signaling molecule. This matrix is present in all vertebrate brains, from ancient fish to mammals. More generally, serotonergic fibers appear to be a fundamental component of virtually all extant neural architectures on this planet. In mammals, the serotonergic matrix supports perception, cognition, and natural transitions among major states of consciousness (e.g., wakefulness and sleep). Not surprisingly, it has been associated with a number of mental disorders and conditions, including depression, autism, and the effects of psychoactive drugs. We have recently proposed that the serotonergic fibers are quintessential “stochastic axons,” a conceptually novel class of axons that cannot be captured in the connectomics framework. Theoretical self-organization models based on random walks and anomalous diffusion will be discussed. Some of these models require supercomputing and may contribute to other fields, including many-particle physics and machine learning. Several experimental platforms will be presented, including transgenic mouse models, holotomography, and hydrogel-based systems. Since serotonergic axons are nearly unique in their ability to regenerate in the adult brain, this fundamental research may stimulate new approaches to the functional restoration of injured brain tissue.

## Embodied Brains for Interactive Robots

Jörg Conradt

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The last decade has shown an explosion of neuronal inspired (“neuromorphic”) hardware and algorithms for sensing and computation. Such systems allow fault tolerant and low latency information processing on a small power budget. In this presentation, I will first discuss fundamental processing differences between the human brain and today’s computers; and will continue presenting two examples of such “neuromorphic computing” systems: (1) Event Vision Sensors, which perceive and report information as the human eye in spike-signals instead of image frames; and (2) Spiking Neuronal Networks (SNN) in software and hardware, which promise to control complex future robotic systems, such as neuro-prosthetic devices. Throughout the talk I will emphasize applications of available neuromorphic computing platforms connected to real-time real-world robotic scenarios.

## Who Knows how to Distinguish Between Conscious and Unconscious Processing?

Renate Rutiku

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Being conscious means that some of the activity in your brain must be directly related to your subjective experience. Delimiting this activity is notoriously difficult, however, because there exist a myriad of other brain processes that may only be indirectly related to consciousness. The standard practice of simply contrasting experimental conditions with and without specific conscious contents is therefore unsuited. It will yield direct as well as indirect correlates of consciousness and there currently exist no consensus on how to separate them.

We propose a new approach for distinguishing between conscious and unconscious processing that goes beyond the mere comparison of contents. The new approach capitalizes on the temporal properties of conscious experience and how they relate to the evolution of stimulus-related activity. In a series of experiments, we demonstrate that by asking observers for more detailed information on what they see in the first moments of becoming aware, a direct link between the onset of subjective experience and EEG activity can be established. The results indicate that EEG activity in the P2/N2 range is most reliably correlated with the temporal properties of consciousness. Future research must focus this time window in greater detail and narrow down the specific neural processes that occur at the onset of subjective experience.



## Psilocin Induces Perceptual Alterations in Rats: Visual Discrimination Study

Čestmír Vejmola<sup>1,2</sup>, Kateřina Syrová<sup>1,2</sup>, Klára Šíchová<sup>1</sup>,  
Vlastimil Koudelka<sup>1</sup>, Michael Tesař<sup>1</sup>, Kelemen Eduard<sup>1,3</sup>,  
Tomáš Páleníček<sup>1,2</sup>

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Visual hallucinations induced via the 5-HT<sub>2A</sub> receptor are not only a hallmark of the action of psychedelics, but also a significant symptom of schizophrenia and Parkinsonism. Despite recently increasing research interest, the phenomenon of visual hallucinations remains poorly understood, partly due to the limits of current rodent models.

The aim of the present study was to probe the existence of psilocin-induced visual alterations in rats. We developed and utilized a food rewarded two-choice visual discrimination task controlled for other possible deficiencies to assess visual effects designed according to human reports on hallucinations nature.

Rats were trained to discriminate between two kinds of visual cues. First, luminance-based - black and white scene - and second pattern-based - stationary scene of vertical grating and hallucinatory-like dynamic scene of vertical grating distorted under 6 various visual effects. Rats were subsequently tested in both set-ups.

Psilocin significantly impaired rats' performance in the pattern-based task, however, did not impair performance in the luminance-based task. Weaker performance was given in effects curving the vertical grating along the planes. Psilocin showed to induce difficulties in discriminating visual scenes reminiscent of hallucinations according to human descriptions.

Our observations thus shed light on the phenomenology of the 5-HT<sub>2A</sub> receptor-induced hallucinations in rats, having translational implications in the effect of psychedelics and understanding schizophrenia or Parkinsonism.

## Lifestyle and Online Behaviours during the COVID-19 Pandemic

Ornella Corazza

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The current COVID-19 pandemic and resulting prolonged period of self-isolation have affected the self-perception of individuals as well as their practice of physical exercise and patterns in the consumption of image and performance enhancing drugs (IPEDs) in the attempt to boost appearance. During this presentation, Professor Corazza will present the results of various cross-sectional studies that are part of an overarching global project aimed to study fitness habits during the COVID-19 lockdown which was carried out in eight countries (UK, Lithuania, Portugal, Spain, Italy, Hungary, Brazil and Japan). These studies focus on: (1) Assessing the perception of body image and related habits during self-isolation (e.g., using fitness apps or spending more time in social media); (2) Understanding whether exercise can help to cope with self-isolation; and (3) Exploring any potential use of IPEDs during self-isolation as a way to boost physical appearance. Findings have contributed to a better understanding of the effects of self-isolation on body image and the identification of related risky behaviours, while contributing to the development of practices targeting mental and physical wellbeing during a challenging time for humanity. This work has been supported by the Cost Action (CA) 16207 <https://www.cost.eu/actions/CA16207/>

## Neuropsychological Consequences of COVID-19

Aiste Pranckeviciene<sup>1,2</sup>, Giedre Gefenaite<sup>3,4</sup>, Inesa Buneviciene<sup>5</sup>,  
Jurgita Kapociute-Dzikiene<sup>5</sup>, Ausra Saudargiene<sup>1</sup>,  
Laura Salciunaite-Nikonove<sup>2</sup>, Bendiktas Kaminskas<sup>2</sup>, Agne Stanyte<sup>6</sup>,  
Kristina Mozuraityte<sup>1</sup>, Valdas Koncius<sup>5</sup>, Indre Jonikaite<sup>7</sup>, Ieva Kubiliute<sup>8,9</sup>,  
Karolina Lubyte<sup>9</sup>, Monika Lukoseviciene<sup>7</sup>, Akvile Rudenaite<sup>9</sup>,  
Ramunas Jokubka<sup>1</sup>, Liveta Burksaite<sup>5</sup>, Vilma Liaugaudaite<sup>1</sup>,  
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**Background and aim:** This presentation will provide an overview of the results from the “Monitoring of psychological health and neuropsychological functioning of COVID-19 survivors” (Research Council of Lithuanian, No. P-DNR-20-5) project. The study aims to explore long-term psychological, neurocognitive, and social consequences of COVID-19.

**Material and methods:** A multi-stage applied study was implemented between May 2021 and November 2021 in Lithuania. People who were hospitalized because of COVID-19 as well as those who had only mild COVID-19 forms and were treated at home were assessed using a set of questionnaires complimented with telephone-based short neuropsychological testing. Special attention was given to health complaints, psychological well-being, and neurocognitive functioning. To investigate the broader social context in which recovery from COVID-19 takes place, an artificial intelligence (AI)-based sentiment analysis model for the Lithuanian language was created and used to analyze the prevailing attitudes in public media towards COVID-19 disease, health care workers, and COVID-19 survivors during the pandemic period.

**Results and conclusions:** More than 1/3 of subjects after discharge from the hospital reported symptoms that lasted  $\geq 5$  weeks. Neurocognitive complaints were also prevalent.

Almost 1/4 of the hospitalized COVID-19 survivors reported severe long-lasting problems with orientation, concentration, memory, and difficulties while performing cognitively challenging tasks. COVID-19 was also related to increased mental distress: 57.5% of COVID-19 cases reported severe anxiety, 30% depressive symptoms and 39% increased irritability during acute COVID-19 phase.

Media sentiment analysis revealed that while coronavirus keyword coverage was dominated by neutral framing (negative coverage of 16%), other COVID-19 related issues, such as health-care workers, sick people, or hospitals, were covered in more emotionally negative way - negative coverage of 32%, 32% and 31%, respectively. The deeper analysis allows us to conclude that during 2021 the percentage of negative communication was decreasing for hospital, health care workers, patient, vaccine keywords, but not coronavirus. Recommendations for communication of COVID-19 and other related risk/crisis issues are therefore formulated for policy makers, journalists, and general society with the focus on media literacy and public education.

## Rate Yourself! Platform to Know Your Problematic Usage of the Internet: Risks, Mental Distress and Quality of Life

Vilma Liaugaudaite<sup>1</sup>, Ausra Saudargiene<sup>2</sup>,  
Julija Gecaite-Stonciene<sup>1</sup>, Aiste Pranckeviciene<sup>3</sup>,  
Inga Griskova-Bulanova<sup>4</sup>, Dovile Simkute<sup>4</sup>,  
Rima Naginiene<sup>5</sup>, Laurynas-Linas Dainauskas<sup>6</sup>,  
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**Introduction.** Engagement in Problematic Internet Use (PIU) for coping with mental distress caused by COVID-19 pandemic may pose a long-lasting threat to develop anxiety and depressive disorders. Despite dedicated research and breakthroughs in the scientific understanding of relevant neurobiological and psychosocial factors, the risk factors for PIU in relation to mental distress remain largely unknown. This lack of certainty hinders accurate diagnosis, prediction of prognosis, and development of effective interventional approaches. Thus, we aimed to create an internet platform (IP) for individual self-assessment of depressive symptoms, anxiety levels, PIU and quality of life.

**Methods and Results.** Our IP was developed through project “Determinants of Quality of Life in Lithuanian Students: Problematic Use of the Internet (PUI) and Neuropsychological Profile” funded by the Lithuanian Research Council. IP currently contains four questionnaires: the Patient Health Questionnaire; the Generalized Anxiety Disorder Questionnaire; the Problematic Internet Use Questionnaire; and the Quality of Life Questionnaire. Therefore, through an online assessment IP provides feedback on participant’s anxiety, depression, PIU and quality of life.

**Conclusions.** The IP is user friendly, cost-effective instrument to self-assess psychological and health related characteristics, such as mental distress, PIU and quality of life. The



IP can be administered remotely via computer or mobile device and provides auspicious results for interventional approaches.

**Acknowledgements.** We are grateful for the students who took their time to complete our survey, which served as a basis in the development of internet platform (IP). We thank the COST Action CA16207 “European Network for Problematic Usage of the Internet”, supported by COST (European Cooperation in Science and Technology: [www.cost.eu](http://www.cost.eu)) for the inspiration to explore this topic. We are especially grateful to the Lithuanian Research Council that funded this project, No. S-GEV-20-5.

## Problematic Internet Use, Mental Distress, and Impulsivity Symptoms in Students

Julija Gecaite-Stonciene<sup>1</sup>, Ausra Saudargiene<sup>2,3</sup>, Aiste Pranckeviciene<sup>1</sup>, Vilma Liaugaudaite<sup>1</sup>, Inga Griskova-Bulanova<sup>4</sup>, Dovile Simkute<sup>4</sup>, Rima Naginiene<sup>5</sup>, Laurynas-Linas Dainauskas<sup>2</sup>, Gintare Ceidaite<sup>3</sup>, Julius Burkauskas<sup>1\*</sup>

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**Introduction.** Over the last decade, research into the negative effects of problematic internet use (PIU) has greatly increased, especially during the Coronavirus disease (COVID-19) pandemic. Engagement in PIU as an impulsive coping with mental distress may pose a long-lasting threat to develop anxiety and depressive disorders. Students may be particularly vulnerable to PIU, as they have largely unfettered, unsupervised access to the internet and are responsible for their own time management. Thus, we aimed to examine the prevalence of PIU and mental distress symptoms during the COVID-19 pandemic among university students in Lithuania and to test the hypothesis that PIU affects anxiety and depressive symptoms through the mediating role of impulsivity.

**Methods.** In this cross-sectional, 619 university students (92.9 % females, mean age of 22±3 years) participated in an online survey from May to November, 2020. The following scales were completed: the Problematic Internet Use Questionnaire-9, the Generalized Anxiety Disorder Questionnaire-7, the Patient Health Questionnaire-9, and the Barrat Impulsiveness Scale-11. K-means cluster analysis and one-way multivariate analysis of variance were used for group comparison in terms of internet use time and habit change during COVID-19 pandemic. Structural equation modelling was employed to examine the mediating effect of impulsivity in association between PIU and mental distress, while controlling for age.

**Results.** Overall, 45.1 % of investigated participants reported significant PIU, and 38.1 % had markedly expressed symptoms of anxiety, while 43.6 % of the students reported significant depressive symptoms. During the COVID-19 pandemic 76 % of the students reported at least moderate increase in their internet use time. During the COVID-19 pandemic anxi-

ety and depressive symptoms were significantly higher in the group of frequent internet users. The results of the structural equation modelling analysis showed a statistically significant effect of PIU on subjective anxiety symptoms and the statistically significant effect of PIU on subjective depression symptoms, both mediated via impulsivity.

**Conclusions.** Almost half of the university students experienced significantly expressed PIU, anxiety or depression symptoms during the COVID-19 pandemic. Findings also suggest that the links between PIU, anxiety and depressive symptoms are partially mediated via impulsivity symptoms. The current study was one of the first examining the prevalence of PIU among university students during COVID-19 pandemic as well as its interplay with mental distress and impulsivity.

## Pilot Studies on Association with Spontaneous Eye Blinking Rate and Alterations in Brain Activity: An Overview

Dovile Simkute<sup>1</sup>, Povilas Tarailis<sup>1</sup>, Igor Nagula<sup>1</sup>, Agne Raciute<sup>1</sup>, Julius Burkauskas<sup>2</sup>, Inga Griskova-Bulanova<sup>1</sup>

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**Introduction.** Problematic Internet Use (PIU) is often described as an umbrella term, covering a variety of different activities available due to the internet access. For some individuals, these activities have a potential to lead to an inability to control one's use despite the negative consequences in daily life, what coincides with the definition of addiction. In this study we aim to evaluate the PIU relationship with mental health state and to investigate the response inhibition reflected by N2 and P3 components during Go/NoGo task and dopaminergic transmission indicated by Spontaneous Eye Blink Rate (sEBRs) during Resting State in a sample of non-clinical Internet Users.

**Methods.** Subjects were divided into two groups (PIU Group and Control Group) based on the results of short version of Problematic Internet Use Questionnaire (PIUQ-9). A set of tests was used to monitor the presence of comorbidities: Barratt Impulsiveness Scale (BIS-II), Beck Depression Inventory (BDI-II), Beck Anxiety Inventory (BAI) and Clark-Beck Obsessive-Compulsive Inventory (CBOCI). EEG data were recorded during the auditory equiprobable Go/NoGo task and three electrodes (Fz, Cz, Pz) were selected for further investigation of N2 and P3 components. The sEBRs were assessed with an electrooculogram recorded from above and below the left eye and from the right and left outer canthi.

**Results.** Problematic Internet Users (PIU) group demonstrated higher scores on Impulsiveness Scale and Obsessive-Compulsive Inventory compared to Control Group. P3 amplitude were higher in PIU group at Cz ( $p=0.032$ ) and Pz ( $p=0.012$ ) electrodes sites during Go condition. P3 amplitudes were also higher in PIU group during NoGo condition at Cz ( $p=0.032$ ) and Fz ( $p=0.009$ ) electrode sites. Lower N2 amplitudes were observed in PIU group during NoGo condition at Fz electrode site ( $p=0.022$ ). In the group with PIU, impulsivity levels were inversely related to sEBR, and a trend of negative association of sEBR with compulsive behavior was observed.

**Conclusions.** The preliminary Go/NoGo experiment data is consistent with the results from previous reports, where lower N2 and higher P3 amplitudes in addicted populations were observed. Future research should enroll subjects with high PIU and strongly expressed psychopathology levels to further address the utility of sEBR as a potential biomarker of dopaminergic transmission.

## Publishing Workshop of European Journal of Neuroscience (EJN): Handling, Review and Publication of EJN Manuscripts

John Foxe<sup>1</sup>, Antoine Adamantidis<sup>2</sup>, Guillaume Rousselet<sup>3</sup>,  
Paola Bovolenta<sup>4</sup>, Yoland Smith<sup>5</sup>

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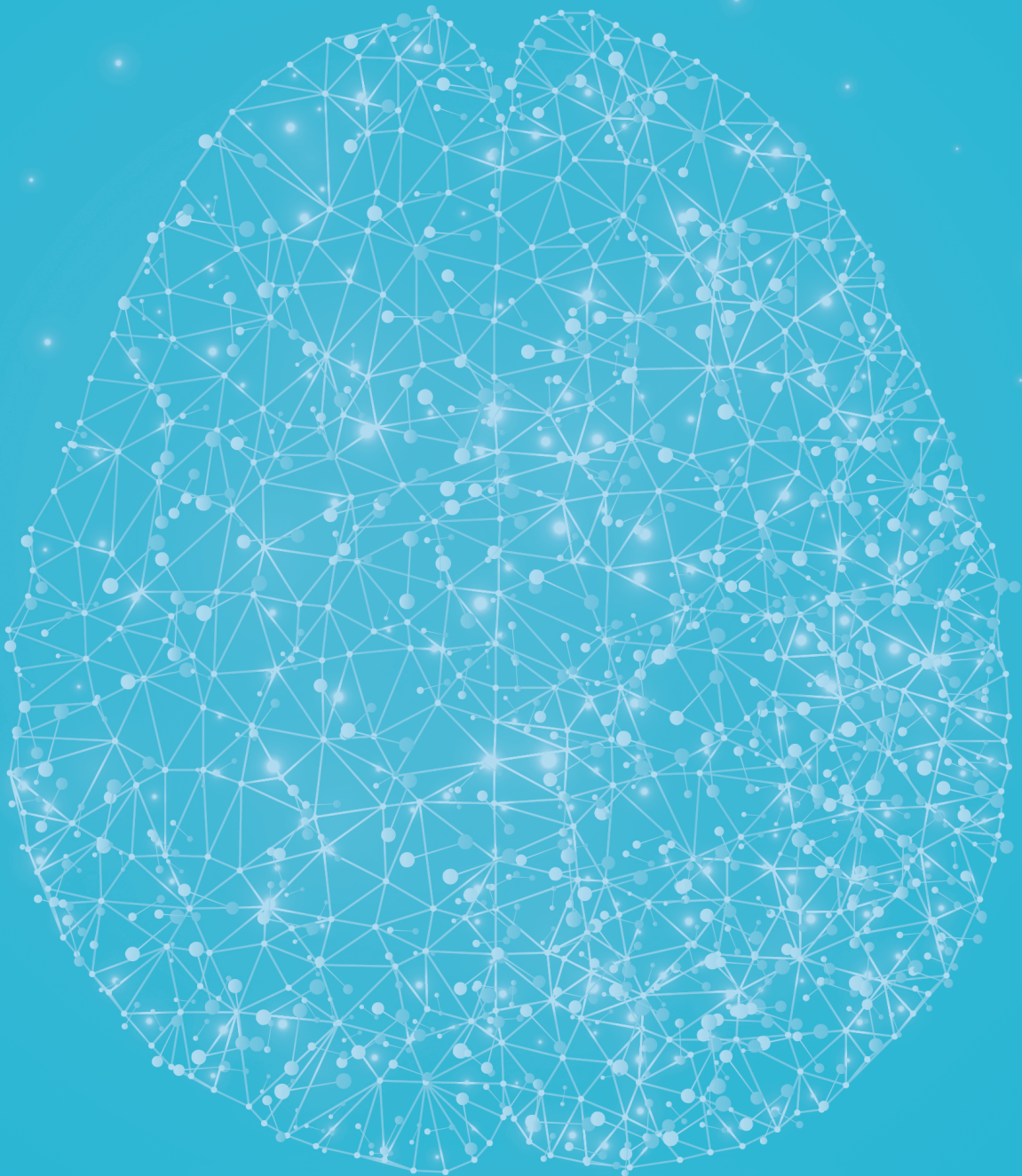
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During this workshop, Editors from the European Journal of Neuroscience will discuss various topics related to submission, handling and peer-review of scientific articles published in European Journal of Neuroscience (EJN). John Foxe, editor-in-chief of EJN will provide a general overview of the publication process, highlight the critical role of EJN as the official journal of the Federation of European of Neuroscience Society (FENS) and discuss the main goals of this joint presentation. His presentation will be followed by that of Antoine Adamantidis, EJN Senior Editor, who will explain the process associated with the handling, review and publication of EJN manuscripts. Guillaume Rousselet, EJN Section Editor, will then discuss the requirements about presentations and statistical analyses of quantitative data presented in EJN manuscripts. Paola Bovolenta, EJN Senior Editor, will follow with a discussion of the expectations of EJN manuscript reviewers and discuss what editors look for in good peer-reviews. To conclude, Yoland Smith, EJN Senior Editor, will discuss ethical issues related to rigor, reproducibility and peer-review of EJN manuscripts. The session will conclude with a live Q&A and concluding remarks monitored by John Foxe.



# Poster presentations



# PAS Multi-Source Interference Task without Semantic Component: A Pilot Study

Ingrida Antonova<sup>1</sup>, Olga Stefańska<sup>1, 2</sup>, Ewa Kublik<sup>1</sup>

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Multi-Source Interference Task (MSIT) combines elements of spatial (Simon), flanker and semantic (numerical Stroop) interference and is used to investigate cognitive control. Effect of spatial and flanker interference in MSIT has been evaluated in different studies; however, it is not clear to what extent behaviour and event-related potential (ERPs) are modulated by semantic interference. We aimed to exclude the effect of semantic interference in MSIT by using color stimuli instead of digits.

We conducted a pilot study and recorded EEG from 64 channels in eight young adults while they performed two versions of the task: standard MSIT with digit stimuli (MSIT-D) and modified MSIT with color stimuli (MSIT-C). In MSIT-D, stimuli are sets of three digits, two of which are identical and the target digit is different. In control condition, target digit position is compatible with its value and two flankers are zeros and do not require a response, while in the interference condition, target digit position never matches its value and is surrounded by two flankers that could also require a response. In MSIT-C, we used sets of three colored double-circles to represent stimuli used in MSIT-D.

In both task versions, participants showed higher accuracy and faster responses in control than in interference condition. Comparison between MSIT-D and MSIT-C revealed no differences in accuracy, and one difference in reaction times: response to control stimuli in MSIT-C took significantly longer than in MSIT-D but did not differ for interference stimuli.

As expected from previous studies, ERP-microstate analysis revealed that in MSIT-D later P3 (represented by a separate microstate, MS4) had larger amplitude in control than interference condition. Visual MS1-P1 component had larger amplitude and MS2-N1 lasted longer in MSIT-D than MSIT-C task. In contrast, the early P3 part (MS3) was shorter and had lower amplitude in MSIT-D than in MSIT-C. Despite differences in behavioural data, no ERP-microstates differences were observed between control and interference conditions in MSIT-C task.

To conclude, temporal dynamics of earlier processing of color stimuli differed compared to processing of digit stimuli. The absence of semantic interference does not affect interference condition but makes control condition more difficult due to missing automatic cueing information about the correct digit response.

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## Dependence of the Eye Fixations Duration on the Visual Complexity of Stimuli During the Recognition of Kanji Logograms by Russian-Speaking Observers

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Several authors have shown that as the complexity of kanji logograms increases, the time for their reading by the native Japanese speakers increases too. It was also found that the reading speed decreases when the kanji's printed-frequency increases, yet frequent kanji of middle complexity may be read faster than those of low complexity and low printed frequency. Meanwhile, the time that is required to read rare kanji of medium complexity is significantly longer comparing to simple ones. Using logograms as meaningless visual stimuli for native Russian speakers, we discovered nevertheless the similar effect. We suppose that it can be described physiologically.

We used slightly modified set of 72 kanji from work of Tamaoka, Kiyama (2013). This set is divided into 3 groups depending on the amount of strokes (2-6, 8-12, and 14-20). Every group consists of the equal number of characters having high and low printed frequency in Japanese. The observer's task was to choose the kanji among the 4 samples displayed at the bottom of the screen that would be the same to the target kanji at the top of the screen. The procedure repeated for every kanji from the set. The eye movements were recorded by the SMI RED-m tracker. The observers were 50 native Russian speakers.

For each trial, the total time of eye fixations was calculated. As expected, the fixation time increased with the growth of the target complexity ( $F(1.466, 71.842) = 183.415, p < 0.0001$ ). Surprisingly, the growth patterns were different for rare and high-frequency kanji ( $F(1.773, 86.883) = 19.393, p = 0.032$ ). Moreover, for simple and complex kanji, the fixation durations was the same (the mean difference  $< 10$  ms), but high-frequency kanji of medium complexity were detected by Russian speakers much faster (1.39 s) than rare ones (1.62 s) ( $t = -7.563, p < 0.0001$ ). Using a computational model of second-order visual mechanisms, we estimated the amount of information that an observer reads when perceiving each of the kanji used. It turned out that for medium and rare kanji it is the highest.

There were no differences in recognition time for simple and complex kanji stimuli. Yet there were significant differences for kanji of medium complexity. This can probably be explained by the significantly larger number of visual features read by the observer, to which bottom-up attention was directed.

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## Machine Learning Application for a Case Study of Synesthesia

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Synaesthesia is a neurological condition in which one type of sensory stimulus triggers another type of sensory sensation. In this study, we investigated a case of sound-to-color synesthesia using two methodologies: the classical method of synesthesia authenticity diagnosis using the test of genuineness (TOG), and multilayer feed-forward neural network application for the classification of voice-induced colors.

The research subject SB is a 22 years old female with partial blindness. She can only see grey silhouettes but claims that after communication with a person, their grey silhouette develops a person-specific color. To investigate SB case interviews were conducted with 39 participants (19 males and 20 females). SB was talking with each participant until their silhouette developed a color. Voices of the participants were recorded using two-channel audio equipment with a 44,1kHz sampling rate.

To test the genuineness of the case TOG was applied. SB was presented with the same stimuli (participant voice recordings) a year later, without having been previously warned about a retest and similar age and education female was used as a control group. The control was instructed to assign random colors to the audio recordings and was told to memorise them, to be retested in two weeks. The TOG confirmed the genuineness of SB synaesthesia.

To further investigate SB synesthesia, a multilayer feed-forward neural network was designed to classify synesthetically evoked colours. We raised a hypothesis that if SB synesthesia is sound-to-colour synesthesia, then the neural network should be able to classify different voice signals by colours. Also, a random forest machine-learning algorithm was used to select relevant features. Training of the neural network was done with the group with most data - white and pink colour assigned females. 68 audio features were extracted from the recordings. The trained neural network successfully classified (94% accuracy) before unseen voice samples, confirming SB colour synaesthesia is sound evoked. The results were further improved by selecting the most relevant features - 98% accuracy was achieved with 34 most relevant features.



## Evaluation of the Antioxidant Effects of Green Tea Extract in Brain of Mice Affected by Cd, Ni and Pb

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**Introduction.** Green tea is one of the most favorite beverages around the world, and is now known as medicinal plant; therefore its therapeutic properties have been studied extensively. Green tea is produced from the leaf of *Camellia Sinensis*, of the Theaceae family and has anti-inflammatory, anti-mutagenic, anti-proliferative, anti-cancer, anti-diabetic and anti-hypertensive effects.

Toxic metals are widely found in our environment. It is known that the higher levels of Cd affect the central and peripheral nervous systems, haematopoietic system, cardio-vascular system, kidneys, liver and reproductive system. Pb can damage various systems of the body including the renal, hepatic, hematological, and skeletal systems with the central nervous system being its primary target. Meanwhile Ni is considered to be an essential element in microorganisms, plants and animals, and is a constituent of several enzymes and other proteins, but it is also considered to be potentially hazardous to living organisms, because of its genotoxicity, immunotoxicity, mutagenicity and cancerogenicity.

One of possibilities to reduce deleterious effects of these toxic metals is to focus to natural products, because plants react to heavy metal toxicity through immobilization, chelating and compartmentalization of the metal ions.

**Objective.** The present investigation was undertaken to evaluate the antioxidant effects of green tea extract (GTE) in mice brain affected by Cd, Ni and Pb.

**Methods.** Experiments were done on outbred white laboratory mice using intraperitoneal injections of CdCl<sub>2</sub>, NiCl<sub>2</sub>, Pb(CH<sub>3</sub>COO)<sub>2</sub> and/or GTE solutions. The exposure-time was 14 days. The concentration of antioxidant GSH was measured by reaction with DTNB to give a compound that absorbs 412 nm light wavelength. Lipid peroxides were estimated by measuring TBR reactive substances and were expressed as malondyaldehyde.

**Results.** Our experiments showed that the content of GSH in mice brain decreased in all experimental groups, with the exception of GTE treated mice group (it was at the control level). The content of malondyaldehyde in mice brain was decreased in four experimental groups: mice affected by GTE, Cd+GTE, Ni+GTE and Pb+GTE, but increased in Cd, Ni and Pb treated mice groups as compared to control.

**Conclusions.** Our studies showed that GTE protected lipids from peroxidation in mice brain affected by Cd, Ni and Pb, but didn't protect GSH from oxidation.



## Perceived Size of Triangles and Rectangles

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The aim of the study was the influence of the configuration of the stimulus contour on the illusion of the stimulus size. Horizontally oriented isosceles triangles, rectangles and hybrid stimuli (irregular pentagons) were presented on the monitor screen as empty contour shapes. All stimuli were equal in length and height (180×72 arc min). The triangle apex angle was 23°. The angle of the peak apexes of the hybrid stimuli was changing by steps in the 23°–180° range. As the angles increased in presentations, the diagonal edges of the irregular pentagons became shorter and the horizontal segments grew longer. The subjects adjusted the empty interval of the bipartite stimulus so that it was perceptually equal to the length of the figures, and the mistakes made were considered the values of the illusion of the size of the object. The data obtained showed: i/ the rectangles caused the strongest illusion (9.3%); ii/ the illusion for the triangles was less strong: those the vertices of which were situated at the center of the stimulus caused the 8.5% distortions and the others with vertices at the outer end of the stimulus provided the 3.2% illusion strength; iii/ the illusion of the hybrid stimuli was the weakest (0.7 – 6.3 %). We assume that the global shape, the spatial combination of line segments forming angles and, finally, a closed contour was the main factor of the perceived distortions of the size of the visual stimuli. The positional shifts in the pattern of excitation of an integral contour determined the resulting percept of an object size rather than the sum of shifts in excitations of the separate contour components. The displacements in the excitation pattern might occurred at the level of the grouped associative fields forming the intermediate-level mechanisms of integration of excitations of closed contours. It is well known that the intermediate mechanisms show strong attentional modulation. Attention fields of the Gaussian type select receptive fields throughout the visual cortex, enhance their reactions and lead to a relative increase in weight and to a shift in the positions within the excitation patterns. The displacements of the excitation sites turned into an incorrect assessment of the spatial distance ratios when performing the task of sizing in the present experiments. The sharp angle component in the stimulus shape suppressed the stimulus-size-expansion effect.

## Cross-Section of 3D Objects: Which Factors Influence Our Ability to Perform This in Mind?

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**Introduction:** Spatial abilities are an important part of human intelligence. It is known that these abilities can be influenced by sex and sex hormones. However, biological factors are not the only source of influence. Socio-cultural, cognitive, and individual differences play a role as well. In this study we aimed to evaluate the influence of biological and non-biological factors on participants' spatial abilities assessed using Cross Section Task (CST).

**Methods:** We recruited 112 women ( $26.9 \pm 4.6$  years) and 28 men ( $26.9 \pm 3.9$  years). Women were divided into four groups according to their hormonal status: oral contraceptives users (OC,  $n = 25$ ), hormonal intrauterine device users (IUD,  $n = 20$ ), naturally cycling women in early follicular phase (NCF,  $n = 37$ ) and in mid-luteal phase (NCL,  $n = 30$ ). Saliva samples were taken to assess concentration of sex hormones. Participants performed paper-pencil Cross Section Task and Visual Working Memory task. Gender-Related Attributes Survey (GERAS) was used to evaluate participant's masculinity and femininity in personality, cognition, and interests' domains. Other individual characteristics were evaluated using Self-reported Cognitive Assessment Questionnaire.

**Results:** On CST task men outperformed naturally cycling women ( $p \leq 0.01$ ) and OC users ( $p = 0.011$ ) but not women using IUD ( $p > 0.05$ ). There were no statistically significant differences between women groups and no significant correlation between sex hormones and task performance. Higher GERAS cognition domain masculinity score was related positively with CST performance in whole sample ( $r = 0.27$ ,  $p = 0.001$ ) and in women ( $r = 0.24$ ,  $p = 0.015$ ). On the contrary, there was a negative correlation between femininity cognition score and correct responses in the whole sample ( $r = -0.23$ ,  $p = 0.007$ ) and the same direction trend in men ( $r = -0.34$ ,  $p = 0.09$ ). Higher self-assessed spatial and mathematical-logical abilities were linked positively with performance ( $r \geq 0.36$ ,  $p \leq 0.001$ ). No difference between groups was found in working memory task performance and no correlation between two tasks ( $p > 0.05$ ).

**Conclusion:** Study results suggest that social factors such as gender related cognitive attributes, self-report overall spatial and mathematical-logical abilities, as well as biological sex and exogenous hormones usage are linked with the Cross Section Task performance.

## Cognitive Functioning of Males with Coronary Artery Disease: The Role of Obstructive Sleep Apnoea and Inflammatory Biomarkers

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**Introduction:** Males are especially vulnerable to obstructive sleep apnoea (OSA) presenting as an independent risk factor for adverse cardiac outcomes and impaired cognitive functioning [1]. Increased concentrations of inflammatory biomarkers, such as N-terminal pro-B-type natriuretic peptide (NT-proBNP) and high-sensitivity C-reactive protein (hsCRP), are common in individuals with coronary artery disease (CAD) and have also been associated with impaired cognitive functioning [2] and unfavourable CAD prognosis [3]. Although proposed theoretically [4], the effect of an interaction between OSA and these biomarkers on cognitive function has not so far been thoroughly investigated in the clinical setting.

The aim of our exploratory study was to determine whether OSA interacting with NT-proBNP and hsCRP has an effect on specific aspects of cognitive functioning in males with CAD.

**Method:** In sum, 328 males (mean age 57±10 years), undergoing cardiac rehabilitation, were evaluated for socio-demographic and clinical risk factors as well as NT-proBNP and hsCRP serum levels. Cognitive functioning testing included the Digit Symbol Substitution Test (DSST), and Trail Making Test Part A (TMTA). Participants underwent full-night polysomnography and were classified in mild/non-OSA (n=253) and OSA (n=75) according to an apnoea-hypopnea index (AHI) ≥15 event/h (3% or arousal). Several analyses of variance (ANOVA) were performed on cognitive functioning for (OSA vs mild/non-OSA) group interaction with NT-proBNP (<157.0 vs ≥157.0 ng/L) and with hsCRP (<0.39 vs ≥0.39 mg/dL).

**Results:** Significant group (OSA, mild/non-OSA) × NT-proBNP (<157.0 vs. ≥157.0 ng/L) interactions were found only for the DSST raw score (F<sub>2,324</sub>=5.06, P=.002). There was a tendency for group (OSA, mild/non-OSA) × NT-proBNP (<157.0 vs ≥157.0 ng/L) interactions for the TMTA (F<sub>3,324</sub>=3.67, P=.013). Tendency was also observed for group

(OSA, mild/non-OSA)  $\times$  hsCRP ( $<0.39$  vs  $\geq 0.39$  mg/dL) interaction with the DSST raw score ( $F_{3,323}=3.81$ ,  $P=.010$ ). Decomposition of interactions showed that the DSST scores of the OSA group with NT-proBNP  $\geq 157.0$  ng/L ( $M=29.7$ ;  $SD=8.5$ ) were significantly lower,  $F_{1,30}=1.10$ ,  $p=.001$ , than those of the mild/non-OSA with NT-proBNP  $<157.0$  ng/L ( $M=36.1$ ;  $SD=10.2$ ).

**Conclusions:** Males with OSA and clinically elevated NT-proBNP levels experienced inferior motor speed, attention, and visuoperceptual executive functions compared to those without OSA or lesser NT-proBNP levels.

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## Wirelessly Programmable Deep Brain Stimulator Combined with an Invasive Blood Pressure Monitoring System in a Non-Tethered Rat Model

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**Background:** Control circuits of blood pressure have a significant nervous system regulation element and, thus, contribute to the pathogenesis of essential drug-resistant hypertension. Approaching the lower medullary region and targeting these mechanisms with an electric stimulation may conceivably have a potential value in combating drug-resistant hypertension. A novel device is indispensable for this purpose and further investigation.

**Aim:** To develop a wireless device combining several functions – a programmable deep brain stimulator with an invasive continuous blood pressure monitoring system in a non-tethered rat model. To track hemodynamic changes simultaneously applying stimuli transmitted via implanted electrodes to the vasomotor nucleus of the animal's brainstem. To focus on animal survivability, catheter patency rates and device data drift.

**Materials and methods:** The device consists of a wireless data transmission module (ESP8266 chip, integrated antenna, RF circuit and flash memory) and blood pressure measurement circuit (pressure sensor BPS130 and external ADC converter MCP3202) controlled by ARM Cortex-M0+ microcontroller LPC844. Polyethylene catheter (internal diameter 0.58 mm) was filled with lock solutions: 500 IU heparin/99,5% glycerol or 500 IU heparin/50% dextrose. Stainless steel wire (100 µm diameter) was used for electrodes. After



the catheter and electrode implantation procedure, the device was tested on 10 Wistar rats (aged 12-16 weeks). For data collection and visualization, custom software was developed.

**Results:** Nine out of ten rats survived the operation and two weeks testing period with no or temporary neurological compromise. Calculated patency duration of catheters filled with heparinized dextrose solution was 125,05 min (SD = 12,5 min), while catheters filled with heparinized glycerol solution lasted until daily catheter maintenance (>24 h) according to study the protocol. Blood pressure calibration analysis showed minimal sensitivity drift in 50-200 mmHg range.

**Conclusions:** Wirelessly programmable brain stimulator combined with an invasive blood pressure monitoring system can be successfully used in hemodynamic animal studies ensuring high animal survival rates after lower medullary implantation. Patency rates and blood pressure transduction characteristics of catheters filled with heparinized glycerol were exceedingly better. No significant zero or sensitivity drift of device pressure sensor was detected in vivo.

**Keywords:** Deep brain stimulation; Hypertension; Rat model.

## NMDA Receptor-Based Voltage Dependent Synaptic Plasticity Model of Learning at the Hippocampal CA3-CA1 Synapses

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Synaptic plasticity is believed to be a biological basis of learning and memory. Long-term potentiation (LTP) and long-term depression (LTD) are the most common forms of synaptic plasticity, induced by a pre- and postsynaptic neuronal activity, and refer to the strengthening and weakening of synaptic weight.

We develop a NMDA receptor-based voltage dependent synaptic plasticity model for synaptic modifications at Schaffer-collateral synapses onto hippocampal CA1 pyramidal neuron. The model incorporates the NMDA receptor-based function and is able to capture dynamics of the NMDA NR2A and NR2B receptor subunits without explicitly modeling dendritic spine intracellular calcium dynamics, a local trigger of synaptic plasticity. The model was embedded into a detailed compartmental model of a hippocampal CA1 pyramidal cell to investigate the dependence of synaptic modifications on the NMDA receptor functioning for spatially and temporally specific inputs.

The present study reproduces experimentally observed outcomes of LTP and LTD induction, as well as standard STDP protocol, analyzes the sensitivity of the model and predicts the influence of synaptic location on synaptic modifications and explains the impaired learning during theta cycles in the presence of the NMDA receptor hypofunction. During experiments it was observed that high frequency stimulation leads to LTP induction and EPSPs increase up to 180%, while low frequency stimulation induces LTD which leads to EPSP decrease up to 54%.

The developed NMDA receptor-dependent synaptic plasticity model can be used for experimentally testable predictions and be applied in large scale simulations for modeling hippocampal networks in health and disease.

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## 3D Mental Rotation and Eye Tracking: Relationship Between Parameters of Eye Movements and Task Performance

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Department of Neurobiology and Biophysics, Vilnius University, Vilnius, Lithuania One of the most popular paradigms to measure a person's mental rotation (MR) ability is a task with two 3D figures made of blocks introduced by Shepard & Metzler. During this task, two figures are shown together and one of them is rotated by a certain degree. Participants should decide if both figures are identical, or mirror images of each other. It has been shown that accuracy gets lower and response time gets longer with higher angular disparities. However, a decrease of performance accuracy in an approximately 80° angular disparity condition has been observed and interpreted as a change of performance strategy implemented by participants. In our study we investigated links between participants' behavioral metrics (accuracy and response times) and parameters of their eye movements (number and duration of fixations). We aimed to identify reasons for performance decrease in the specific angular disparity conditions.

37 volunteers (12 men) performed the MR task based on the Shepard & Metzler paradigm while their eye movements were tracked using EyeLink 1000 Plus. Participants' accuracy, response time, number and duration of fixations were measured for each trial. 240 stimuli pairs (160 identical, 80 mirrored) with angular disparities as 15°, 35°, 55°, 75°, 95°, 105°, 135°, or 155° were displayed. Each trial had a maximum duration of 4 s. Trials with identical pairs were analyzed.

Study results revealed that the number of fixations was related positively with response time ( $r = 0.96$ ,  $p < 0.001$ ) and negatively with accuracy ( $r = -0.54$ ,  $p < 0.001$ ). Angular disparity between figures in a pair had a significant effect ( $p < 0.001$ ) for all evaluated parameters. There was a significant effect of interaction between angular disparity and visual hemi-field (left and right figures) on average fixation duration ( $p < 0.05$ ). Starting from the angular disparity of 75°, the right (rotated) figure tended to attract longer fixations than the left (not rotated) with the largest difference in the 95° condition. This was related to the lowest performance accuracy. These results, together with heat maps of fixations' count, suggest that tendency for lower accuracy on 75° and 95° angular disparities could be explained by hiding cues of the 3D figures and not solely on participants' strategy adjustments.

# The Role of Immersive Virtual Reality in Cognitive Rehabilitation in Stroke Patients: A Systematic Review

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**Background.** Cognitive function impairments usually affect 20 – 80 % of stroke survivors. Convenient rehabilitation methods do not seem attractive, engaging and optimizing neuroplasticity processes in stroke patients. The problem of cognitive rehabilitation in stroke can be seen from two sides: lack of attention on cognitive rehabilitation in stroke patients, low patients' motivation to engage in rehabilitation activities. Most recently the focus has been on innovative computerized methods for cognitive function improvement in rehabilitation settings. The most promising immersive virtual reality (VR) methods.

**Aim.** The main purpose of the present systematic review was to collect the scientific evidence for the evaluation of the effectiveness of immersive VR in cognitive rehabilitation of memory in post-stroke patients.

**Methods.** Five electronic databases (PubMed, Web Of Science, ScienceDirect, MEDLINE, and PsycARTICLES) were searched for articles published in English and peer-reviewed journal from 2015 until April 2021.

**Results.** One study was included. It was found that the immersive VR is suitable for cognitive rehabilitation in stroke patients. As well as, immersive VR combined with computerized neurocognitive rehabilitation was more effective than neurocognitive rehabilitation program.

**Conclusions.** The present review was the first to specifically focus on immersive VR effectiveness in cognitive rehabilitation for stroke. It presents that immersive VR cognitive rehabilitation may be promising method for cognitive function improvement. Further research is needed.

**Keywords:** immersive virtual reality, cognitive rehabilitation, stroke.

## Auditory Steady-State Responses do not Depend on Sex Hormones in Mice

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**Background and aim:** Auditory Steady State Response (ASSR) is used as a method to assess brain's ability to synchronize. Due to the changes during schizophrenia, ASSR is increasingly used as a biomarker to diagnose or even predict schizophrenia (Thuné et al., 2016) stimulus parameters, and analysis and recording techniques. DATA SOURCES Searches were conducted in PubMed and reference lists of appropriate publications to identify relevant studies published from November 1999 to March 2016. Initial literature searches were performed with combinations of the following search terms: (1. Recent studies suggest that brain changes during schizophrenia may be highly dependent on gender and/or sex hormones (Mendrek & Mancini-Marie, 2016) the interest in differences between male and female patients has expanded to encompass brain morphology and neurocognitive function. Despite some variability and methodological shortcomings, a few patterns emerge from the available literature. Most studies of gross neuroanatomy show more enlarged ventricles and smaller frontal lobes in men than in women with schizophrenia; finding reflecting normal sexual dimorphism. In comparison, studies of brain asymmetry and specific corticolimbic structures, suggest a disturbance in normal sexual dimorphism. The neurocognitive findings are somewhat consistent with this picture. Studies of cognitive functions mediated by the lateral frontal network tend to show sex differences in patients which are in the same direction as those observed in the general population, whereas studies of processes mediated by the corticolimbic system more frequently reveal reversal of normal sexual dimorphisms. These trends are faint and future research would need to delineate neurocognitive differences between men and women with various subtypes of schizophrenia (e.g., early versus late onset. First, the incidence and severity of schizophrenia vary between men and women (Falkenburg & Tracy, 2014). Second, women have exacerbations of schizophrenia during the menstrual cycle (da Silva & Ravindran, 2015). Therefore, it is likely that sex hormones or other sex-related factors may affect the schizophrenia biomarker ASSR. The aim of this study was to evaluate ASSR dependence on sex hormones. This was done by quantifying ASSR sex differences and assessing ASSR changes during estrous cycle in females.

**Materials and methods:** The experiments were performed on mice (14 females and 12 males). ECoG electrodes were implanted for chronic ASSR registration. ASSR parameters (phase-locking index (PLI) and power ratio) were calculated after removing epochs associated with motion artefacts and selecting the data in the 35-45 Hz interval. Phase of estrous cycle was determined from cytological evaluation of vaginal smears.

**Results:** No difference between males and females (PLI  $p=0.432$ , power ratio  $p=0.403$ ; Mann-Whitney test). Furthermore, ASSR does not change during the estrous cycle in females (PLI  $p=0.366$ , power ratio  $p=0.194$ ; Friedman test).

**Conclusions:** The results of the study show that there is no sex difference in ASSR and ASSR does not change during estrous cycle. These results demonstrate that sex hormones has little or no impact in ASSR generation.

**Funding:** Study was supported by the Research Council of Lithuania (09.3.3.-LMT-K-712-24-0038 and 09.3.3.-LMT-K-712-25-0057), IBRO Return Home Fellowship, IBRO Early Career Award and MJJ (Marius Jakulis Jason) fellowship.

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## Validation of the Substance Use Risk Profile Scale in Lithuanian Population

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**Background.** The Substance Use Risk Profile Scale (SURPS) measures personality traits associated with the risk of addictive substance use and abuse: Hopelessness, Anxiety Sensitivity, Impulsivity and Sensation Seeking. The SURPS could be useful for selecting the targeted prevention groups and for personalized interventions. We examined psychometric properties of the SURPS in Lithuanian population. Moreover, we included patients with alcohol dependence in our study as only a few studies has previously examined psychometric properties of the SURPS in clinical samples.

**Materials and methods.** Translation and adaptation procedure of the SURPS scale was implemented according to the second edition of the International Test Commission for translating and adapting tests. The sample consisted of 247 participants, who were recruited from the local community and from an inpatient addiction treatment centre.

Internal consistency, stability, factor structure, content and discriminative validity and sensitivity of the SURPS were examined. Clinical diagnosis of alcohol dependence (by ICD-10 criteria) and the AUDIT results were used to establish the discriminative validity of the SURPS. Separate gender analyses for associations of personality traits with alcohol dependence and hazardous use of alcohol were performed.

**Results.** The SURPS scale demonstrated appropriate internal validity, good temporal stability, adequate criterion validity, and sensitivity. The construct validity of the scale was appropriate after removal of two items.

Alcohol dependence group scored higher than the control group on the Hopelessness, Anxiety Sensitivity and Impulsivity subscales of the SURPS. Stratification by gender revealed that scores of Hopelessness were higher in alcohol dependent males, but not in females. Hazardous alcohol use was associated with Sensation Seeking. This association was driven by females and an association of Impulsivity with hazardous use of alcohol was present in females, but not in males. The SURPS had a good sensitivity for alcohol dependence for both males and females. However, for the hazardous alcohol use the SURPS had poor sensitivity that was slightly better for females.



**Conclusions.** The SURPS demonstrated good sensitivity for discriminating on alcohol dependence and was more sensitive for discriminating on hazardous alcohol use for females. Also, the results suggest a possible different motivational mechanisms of hazardous use of alcohol for genders.

## Plant Extracts Impact on Lipid Peroxidation And GSH Level in Mice Brain

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**Introduction.** Blackcurrants (*Ribes nigrum*) are widely grown in most European countries and very popular in Lithuania. The biochemical constituents of their fruits are polyphenols, polyunsaturated fatty acids, organic and phenolic acids. Due to the high content of anthocyanins, black currants have high antioxidant, anti-inflammatory and antimicrobial properties.

Red oranges are popular worldwide and belong to the sweet orange species (*Citrus sinensis* X). They distinguish from oranges by the presence of pigmentation-causing anthocyanins in their flesh and sometimes in the peel of the fruit. Biologically active compounds such as: anthocyanins, ascorbic acid, hydroxycinnamic acids and flavonoids are found in them.

Reactive oxygen species (ROS) are highly reactive molecules and can damage cell structures such as carbohydrates, nucleic acids, lipids, and proteins and alter their functions. Aerobic organisms have integrated antioxidant systems, which include enzymatic and nonenzymatic antioxidants that are usually effective in blocking harmful effects of ROS. By the way, one of the possibilities to reinforce antioxidant system and reduce lipid peroxidation is plant extract food supplementations.

**Objective.** This study was performed to evaluate the antioxidant effects of red orange and blackcurrant extracts on the brain of laboratory mice.

**Methods.** Experiments were performed on outbred white laboratory mice by changing drinking water with red orange and blackcurrant extract solutions. Exposure time was 21 days. Lipid peroxidation level was estimated spectrophotometrically by measuring the concentration of malondialdehyde (MDA) produced by reaction with TBA at 535 nm and 520 nm light wavelengths. The concentration of antioxidant reduced glutathione (GSH) was measured spectrophotometrically by reaction with DTNB to give compound TNB, which absorbs light wavelength at 412 nm.

**Results.** Experiments showed that GSH concentration in mice brain significantly increased in all experimental groups (by 34% (blackcurrant extract) and 184% (red orange extract)) as compared to the control mice group. The amount of MDA in mice brain significantly decreased by 54% in blackcurrant extract group and 37% in red orange extract group as compared to control.

**Conclusion.** Our studies showed that blackcurrant and red orange extracts protected lipids from oxidation and increased antioxidant GSH concentration in mice brain.

## The Effect of Microgravity on Parameters of Visual Perception in a 7-Day “Dry” Immersion

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Visual perception plays a crucial role in providing the brain with information necessary for making decisions, building a picture of the world and adapting to changing conditions. The aim of the research is to study the peculiarities of visual perception in microgravity conditions.

The “dry” immersion (DI) method allows reproducing three main physiological effects of weightlessness: centralization of biological fluids, “unsupported” and hypokinesia.

The contrast sensitivity of the visual system in the detection task was recorded using the method of visocontrastometry (Shelepin et al., 1985). Gabor elements with spatial frequencies of 0.4, 0.8, 1.0, 3.0, 6.0, and 10.0 cycles/degree were used for measurement. In addition, we assessed interference immunity, through a comparison of the number (percentage) of contours required to recognize fragmented figures (75 figures) under noise conditions (Gollin test: Forman, 1991). Measurements were taken the day before the immersion, on days 1, 3, 5, and 7 of the DI, and the day after.

The visual system experiences the maximum stress during the transition from gravity to microgravity and reverse, the so-called period of acute adaptation and re-adaptation, respectively. Visocontrastometry shows an increase in sensitivity at low frequencies and a slight change at high frequencies, which we regard as evidence of a mismatch in the interaction between the magnocellular and parvocellular systems. Regarding the effect of immersion on the integration of contour fragments under interference, the percentage at which figure guessing occurs and the number of errors increases during the gravity/microgravity transition. The day after DI, the results of both contrast sensitivity and noise immunity return to those demonstrated before immersion.

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## Recognition of Biological Movements and Cognitive Functioning in Patients with Central Nervous System Tumours

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Humans have a remarkable ability to perceive, identify, recognize and interpret biological movements. Point-light displays (PLD) is the only method used to represent trajectories of human movements in visual material. Biological movement recognition might be disturbed in some disorders.

**Aim:** The aim of the study was to examine if people with central nervous system (CNS) tumors bear deficits in recognizing biological movement. In addition, authors of this study decided to examine whether these deficits are associated with cognitive functions (especially executive functions).

**Materials and methods:** The study was performed at Neurosurgical Department of the Institute of Psychiatry and Neurology in Warsaw, Poland. The patients who were admitted to Neurosurgical Department in the purpose of brain tumour removal were recruited to the study group. The control group consisted of healthy people. Neuropsychological tools (ACE-III, Rey figure, CTT, Ruff Figural Fluidity Test, WAIS-R Digit Span) and a program for biological motions recognition.

**Results:** In terms of age, education level and gender no statistical differences were observed between the control group and the research group. Our study revealed statistically significant differences in the recognition of biological movement in the control and study group. The correlation analysis between EF and biological movement recognition were found in the following domain of neurophysiological tests: RFFT unique combinations, M-ACE, ACE-III visual-spatial functions, CTT interference indicator.

**Conclusions:** People affected by brain tumours have impaired ability to recognize biological movements.

## Correlation Between Visuomotor Reaction Time and Thoracoabdominal Respiration Ratio

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**Background and aims:** Visuomotor Reaction Time (VMRT) is the time required to recognize and respond to sequentially appearing visual stimuli. Superior VMRT indicates a faster signal processing in the central nervous system. There are different ways of breathing – thoracic, abdominal, thoracoabdominal and there is experimental evidence that abdominal breathing is able to improve mental function (e.g. sustained attention). However, the relation between VMRT and thoracoabdominal ratio during spontaneous breathing is unclear. Therefore the present study aimed to make a preliminary investigation.

**Methods:** 71 healthy adults (30 men, age=25±2.7, BMI=25.6±5.2; 41 women, age=25.8±2.4, BMI=22.5±3.5) completed VMRT test on a simple visual reaction time tester (Xindonghuachen, Beijing, China) and two minutes respiration test using two respiration belts (Vernier, Beaverton, OR, USA). Two belts were tied at the height of the xiphoid and navel separately and ten continuous stable breathing cycles were selected for calculating the lower ribcage motion, abdominal motion and thoracoabdominal ratio (the ratio of lower ribcage motion to abdominal motion measured by respiration belts). A nonparametric partial correlation test (set age and BMI as the control variables) was applied for analysis on SPSS 26.

**Results:** All results are presented as median, first quartile and third quartile since the data is not normally distributed. Men's VMRT was 510ms (480-560), lower ribcage motion was 2.85N (2.51-4.15), abdominal motion was 1.57N (0.58-2.18), and the thoracoabdominal ratio was 2.62 (1.74-5.74). Women's VMRT was 550ms (520-600), lower ribcage motion was 2.18N (1.73-2.79), abdominal motion was 0.92N (0.71-1.25), and the thoracoabdominal ratio was 2.36 (1.30-3.60). For men, VMRT is negatively correlated with TAM ratio ( $r=-0.537$ ,  $p<0.01$ ), while no significant correlation between VMRT and thoracic motion, VMRT and abdominal motion was found. For women, there was no significant correlation between VMRT and all measured variables - thoracic motion, abdominal motion, and thoracoabdominal ratio.

**Conclusions:** The results show the higher thoracoabdominal motion ratio, the faster visuomotor reaction for men, and no correlation for women. Larger sample size is needed for further exploration.

## Psychophysical Study of The Area of Influence of Distractors on the Geometric Illusion of Extent

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**Aim:** The aim of the study was to further develop a quantitative model of the filled-space illusion and test it to account for the effects caused by stimuli containing distracting line-segments of along or perpendicular to the main stimulus axis.

**Methods:** Illusion was studied as a function of the distance between the distracting lines and the lateral terminator of the reference spatial interval of the three-dot stimulus. Data obtained in three different series were fitted with relevant functions of the model.

**Results:** It was shown that the model satisfactorily describes all changes in the illusion magnitude for various stimulus. For distractors shifted along the stimulus axis, the magnitude of the illusion increases to a certain maximum value with the increase of distractors displacement and smoothly decreases to zero thereafter. For distractors shifted orthogonally to the stimulus axis, the illusion magnitude monotonically decreases with the increase of distractors displacement. In the case of the distractor rotation, the greatest illusion magnitude refers to orientations of the distracting line segment along the stimulus axis and decreases to the minimum value for the orthogonal orientation.

**Conclusions:** A good correspondence between the experimental and theoretical results supports the suggestion that the two-dimensional profile of the AWS can be described as the absolute value function of the first derivative of a Gaussian along the radial direction in the visual field and the Gaussian function along the tangential direction.

## Size Illusion in Dependence of Stimulus Area

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We studied the manifestation of the size illusion for four filled geometric shapes: squares, circles, rhombuses and equilateral triangles. In psychophysical experiments, the subjects adjusted the empty interval of the two-part stimulus so that it was equal to the width of the figures the area of which varied within the 0.08 – 10.24 deg<sup>2</sup> interval. According to the averaged data for four subjects, the strength of the illusion gradually increased with an increase in the area of squares and triangles, but decreased with an increase in the area of circles and rhombuses. The data obtained can be explained by an interaction of two opposite physiological processes: i/ an increase in the size of an object and ii/ a reduction in distance between two terminal points. Presumably, the expansion of the perceived width occurred for all four figures due to positional shifts in the profiles of the neural excitations caused by the boundaries of the objects. The larger the object was, the greater the positions shifted. But the expansion effect was only apparent for the squares and triangles. In the rhombuses and circles, the lateral segments of the contours played the role of two pairs of inner Müller-Lyer wings, due to which the distance between the endpoints was reduced, therefore, the expansion effect was greatly decreased. The resulting misperception weakened or even became negative when the area of the rhombuses and circles increased. The reduction in distance was greater for rhombuses than for circles, assumingly due to the straight lines of the wings. There was only one pair of wings in the triangles, so the effect of shortening the distance was present but weaker than the effect of expansion. Conclusions: A. The shape of the contour of an object is the main factor determining the strength and sign of the distortions of the perceived size of visual objects. B. The effect of distance reduction may prevail the phenomenon of the size expansion in strength.



## The Gut Microbiota as a Source for Possible Biomarkers of Alzheimer's Disease

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Age-related neurodegenerative disorders such as Alzheimer's disease (AD) have become a critical public health issue due to the significantly extended human lifespan. Although AD research has made important breakthroughs, the pathogenesis of this disease remains unclear, and specific AD diagnostic biomarkers and therapeutic strategies are still lacking. Recent research has provided that the gut microbiota participates in pathogenesis in diseases such as AD, diabetes, obesity and has an impact on aging process. Moreover, the endocannabinoid system (ECS) and the gut microbiota are increasingly emerging as important players in maintaining the general homeostasis and the health status of the host. To understand the role of the gut microbiota and the ECS in AD, induced by diabetes mellitus type 2, we used C57BL/6J mice and female mice that were subjected to a different diets: control, control & prebiotics, high-fat and high-fat & prebiotics. Experiment took 15 months with diets and several tests were performed on particular time points: glucose tolerance test (3 and 9 months), behaviour tests, fecal microbiota analysis and additionally we have investigated gene in selected 11 different genus of bacteria (0, 1, 3, 6, 9, 12, 15 months). The components of the ECS were examined in different brain areas and parts of gastrointestinal tract.

We showed that specific high-fat diets triggered obesity, leading to diabetes mellitus type 2 and caused Alzheimer's disease, which is clinically diagnosed by observing declining cognitive functions and changes in different components of the ECS. In searching for a connection between gut microbiota and AD, we also noticed changes in the gut microbiota throughout the experimental period and observed a different detection of gene, encoding an enzyme involved in the metabolism of nucleotides in different diets and time points.

# Human Brain Reacts Differently to Real Three Dimension (3D) and Stereoscopic 3D: An Eeg Study

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**Introduction.** With the recent development of three-dimensional (3D) technology, the accurate assessment of human factors needs to evaluate the various effects of new 3D visualization on the human visual system and depth perception. One of the popular methods to study perceptual processing is analyzing the electroencephalography (EEG) signals because of good temporal resolution. Current estimates have evaluated the impact of stereoscopic 3D image viewing on the human visual system. However, there is a lack of investigation about the actual 3D perception (i.e., what we can see on the volumetric multiplanar displays) by the human brain. This research aimed to study the potential differences in event-related potentials (ERPs) between two fundamentally different conditions: stereoscopic visualization and volumetric multiplanar image visualization.

**Methods.** We used a visual search array of four constant angular size rings. Each trial consisted of a combination of 3D and 2D visual targets. In the 3D presentation mode, one of the rings was displayed closer to the subject compared to the others, while in the 2D presentation mode, all rings were shown in the same plane. The task was to find the closest ring by pressing the corresponding key on the computer keyboard. The same structure was applied for stereoscopic 3D visualization in the anaglyph method. We used electroencephalography to record the electrical activity of the brain during the task.

**Results.** The ERPs revealed higher activity in the P3 component in the 3D presentation between two conditions but not in the 2D presentation mode. Early component analysis showed no significant differences between the two conditions, neither 3D nor 2D.

**Conclusions.** In conclusion, based on previous studies, the P3 component has been associated with various cognitive processes like attention, working memory, decision-making, and executive function. In our study, a shorter time of task completion and the higher cognitive activity of the P3 component could represent a less challenging depth perception in volumetric 3D visualization than stereoscopic 3D.

Keywords: Electroencephalography (EEG), event-related potentials (ERPs), stereoscopic, volumetric multiplanar, depth perception.

## TLR4 Receptors and Caspase-1 Mediate Extracellular Tau-Induced Neurotoxicity in Neuronal-Glial Co-Cultures

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**Introduction.** Tauopathies are a group of neurodegenerative diseases which development is closely associated with pathological changes of tubulin-associated unit (tau) protein. Intracellular tau aggregates are considered to be a major feature of tauopathies, but extracellular tau found in cerebrospinal fluid also rises with disease progression. Increasing evidence suggests that tau pathology spreads within anatomically connected brain regions and that intact neurons can secrete and take up exogenous tau protein which in turn induces fibrillization of intracellular tau in prion-like manner. Recently, intra- and extracellular tau protein was demonstrated to directly activate microglial cells via NLRP3–ASC inflammasome which catalyses caspase-1 formation. We have previously shown that extracellular tau<sub>2N4R</sub> induces phagocytosis of viable neurons by activated microglia and in this study, we aimed to investigate whether caspase-1 and Toll-like 4 (TLR4) receptors mediating NLRP3–ASC/caspase-1 pathway activation are involved in tau<sub>2N4R</sub>-induced neuronal loss.

**Methods.** Primary neuron-glia cell co-cultures from rat (Wistar) cerebellum were treated with recombinant tau<sub>2N4R</sub> protein with or without pre-incubation with YVAD-CHO, VX-765 and anti-TLR4 antibody. Fluorescence and confocal microscopy were used to determine neuronal clearance signal transmission: cell viability was assessed by Hoeschst33342/propidium iodide staining, microglial cells were labelled with isolectin IB4-AlexaFluor488, caspase-1 activation was evaluated using FamFlica kit.

**Results.** Our results show that loss of neurons and microglial proliferation induced by tau<sub>2N4R</sub> protein in primary neuronal-glia co-cultures were completely prevented by caspase-1 inhibitors YVAD-CHO and VX-765. After treatment with tau<sub>2N4R</sub> active caspase-1 labelled by FamFlica localized within microglial cells, but not neurons. We also found that blockage of TLR4 receptors by antibody prevented caspase-1 activation in microglial cells. Moreover, anti-TLR4 also had neuroprotective effect against tau<sub>2N4R</sub>-induced neuronal loss in neuronal-glia co-cultures.

**Conclusions.** Taken together, the results suggest that the extracellular tau<sub>2N4R</sub> protein induces microglia cell-dependent neuronal loss via TLR4 receptors and caspase-1.

## Computer Games in Vision Care

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**Background and aim:** Video games are used in several fields, including physiotherapy and ergotherapy, video games as distractors for pain reduction, cognitive rehabilitation, therapeutic benefits for the elderly, social and communication skills development for people with learning disabilities, attention deficit disorder. Based on the popularity of video games, there are ways to use them for productive purposes, such as the use of video and computer games in healthcare. Video games have also grown in popularity in the visual field, due to their entertainment factor as well as their interesting and eye-catching design. For example, it is possible to train athletes' eye-hand coordination or other motor skills at home using specialized computer or video games. Or to improve and stabilize convergence, accommodative or vergence abilities, fusion reserves or stereovision, for example, through a game during vision training. Modern technology provides opportunities to develop and improve traditional methodological approaches, for example in the treatment of amblyopia. Lack of clarity in the choice of methodology and the parameters of the specialized game/stimulus hinders both the understanding of theoretical knowledge and the design of tests.

**Materials and methods:** Literature review on current global practices and effectiveness of computer-based vision training. To develop a cost-effective vision training methodology that will allow training of accommodation and vergence disorders.

**Results:** An analysis of the available literature shows that there is still no standardized protocol for computer-based vision training for children and adults.

**Conclusions:** The need for computer-based vision training, its methodology, the staff involved and its cost-effectiveness are still debated. Games used in vision training should be interesting, attractively designed, simple to implement and have enough easy instructions to keep the patient active and motivated during therapy.

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## The Anticonvulsant Lamotrigine Reduces Bout-Like Alcohol Drinking in Rats

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**Introduction.** Alcohol drinking patterns contribute to alcohol related problems, and alcohol-dependent individuals differ greatly in this respect (i.e. binge-like, episodic, sporadic, steady). This should be taken into account in the development of effective treatments. Our aim was to study the microstructure of voluntary baseline alcohol drinking behaviour in rats and to assess whether and how repeated administration of anticonvulsant lamotrigine impacts this drinking microstructure.

**Methods.** For this purpose, male Wistar rats were subjected to voluntary alcohol drinking procedure for approximately 2 months, and optical lickometers were used to register each lick of the water/alcohol sipper tube in a chronological order. From this data, the bout-like drinking pattern was identified and different characteristics of bout-like drinking have been analyzed. After the last day of baseline measurements, each animal was subjected to a total of 3 daily injections of either vehicle, 5 mg/kg of lamotrigine or 10 mg/kg of lamotrigine.

**Results.** Our data showed that under baseline conditions, animals drunk more water and had higher number of water bouts per day, however, the size of an alcohol bout was larger than a water bout. Lamotrigine treatment did not have a significant impact on the total daily alcohol intake, number of alcohol licks and number of alcohol bouts. However, 10 mg/kg of lamotrigine significantly reduced alcohol bout-like drinking preference, the size of bout and licking rate. Contrary to alcohol drinking, number of water licks and number of bouts were significantly increased by higher dose of lamotrigine, whereas water bout-like drinking preference, bout size and licking rate were not affected by this treatment.

**Conclusions.** The present study demonstrated that, similar to humans, voluntary alcohol drinking in animals differ by their drinking microstructure whereby some of them consume alcohol exclusively in a bout-like patterns. Anticonvulsants may be one treatment strategy that specifically affect this type of drinking.

## Arterial Hypertension Influences Heart Innervation in Aged Experimental Animals

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**Objective.** To detect changes of cardiac nerves in aged experimental animals due to arterial hypertension.

**Methods.** Aged (46-50 weeks) spontaneously hypertensive rats (SHR, n=3, systolic blood pressure >150 mmHg) and Wistar-Kyoto rats (WKY, n=3, systolic BP<150 mmHg) of similar weight (g)  $377\pm4$  vs.  $330\pm45$  were studied. The 2-dimensional echocardiography was performed to evaluate cardiac anatomy and showed an enlarged left ventricle chamber in the hypertension group.

Neural structures were stained immunohistochemically for general neuronal marker PGP 9.5. The diameter of the atrial and ventricular epicardial nerves was measured in whole-mount preparations. Also, ventricular myocardial innervation in the right and left ventricles and septum was measured using threshold function in transverse cryosections and expressed in percentages (%). Results were described as mean  $\pm$  standard error and compared by Student t or Mann-Whitney U test, p-value<0.05.

**Results.** In both groups of rats, epicardial nerves were abundant and showed highly replicable patterns of innervation in the left dorsal region of the atrium. The diameter of SHR and WKY atrial epicardial nerves in this specific region differed significantly ( $25\pm0.9$  vs.  $31\pm1.8$   $\mu\text{m}$ , p=0.001), and it was smaller in the SHR group.

Ventricular epicardial nerves access walls of cardiac ventricles throughout the arterial part of the heart hilum at the roots of ascending aorta and pulmonary trunk and on the dorsal side from the heart hilum venous portion in both groups equivalently. The diameter of nerves was greater in the hypertensive group (SHR  $33\pm15$  vs. WKY  $24\pm1.5$   $\mu\text{m}$ , p<0.001), probably because the left ventricle chamber was enlarged and needed more innervation.

The ventricular myocardial nerve fiber meshwork was different in all three segments. The innervation was denser in SHR in the right ventricle (SHR  $1.8\pm0.06\%$  vs. WKY  $1.14\pm0.04\%$ , p<0.000) and septum (SHR  $0.446\pm0.02\%$  vs. WKY  $0.38\pm0.02\%$ , p=0.034). However, it was similar in the left ventricle (SHR  $0.66\pm0.03\%$  vs. WKY  $0.73\pm0.03\%$ , p=0.067), maybe due to myocardial hypertrophy, which is usually more prominent in the left than the right ventricle.

**Conclusions.** Arterial hypertension affects the innervation of the heart, but the neural plexus of different parts of the heart is affected in a different manner.

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## Effect of Selenium Supplementation on Lipid Peroxidation and Selenium Concentrations in Mice Brain and Blood

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**Introduction.** Selenium (Se) is a trace element with a wide spectrum of biological action. Despite the low concentration in the body, Se performs various unique functions through antioxidant selenoproteins, that contributes to redox signaling, protein folding, neurochemical signaling. Nevertheless, Se is involved into the diverse functions of the brain including coordination, memory and cognition. However, higher Se doses act as prooxidant and disturb cellular redox balance. Thus, significant changes in Se concentration could be related to neuronal dysfunction and neurodegenerative diseases. This study was performed to evaluate the effect of different Se doses on lipid peroxidation in mice brain and blood.

**Materials and methods.** Experiments were performed on BALB/c mice. Animals were divided into three groups: control group, low-dose Se group (0.2 mg of Se/kg bw/day), high-dose Se group (0.4 mg of Se/kg bw/day). Control mice were given tap water, whereas Se treated mice received Na<sub>2</sub>SeO<sub>3</sub> in tap water for 8 weeks. Se concentration was determined by inductively coupled plasma mass spectrometry (using NexION 300 D). Lipid peroxidation was estimated by measuring thiobarbituric-acid-reactive substances and expressed as malondialdehyde (MDA), a marker of lipid peroxidation. License of the State Food and Veterinary Service for working with laboratory animals No. G2-80.

**Results.** The exposure to low-dose Se caused a 3.1-fold increase of Se concentration in mice blood in comparison with Se concentration value (271.23 µg/L, p<0.05) of control. Likewise high blood Se concentration (936.17 µg/L, p<0.05) was noted in mice after administration of high-dose Se. Treatment of mice with low- and high-dose Se, increased Se concentration in mice brain by 138 % (0.145 µg/g, p<0.05) and by 152 % (0.154 µg/g, p<0.05) respectively. It was shown that the decrease in MDA concentration by 41 % in mice blood and by 25 % in the brain after treatment with low-dose Se was statistically significant. Meanwhile, the exposure to high-dose Se caused a decrease of MDA concentration in the blood by 27 % (p<0.05) but did not change MDA concentration in the brain as compared to control.

**Conclusions.** The low- and high-dose Se increased Se concentration in mice blood and brain but decreased MDA concentration in the blood. The exposure to low-dose Se caused a decrease of MDA concentration in the brain, whereas the exposure to high-dose Se showed no effect.



## Pilot Study on Parameters of Eye Tremor in Healthy People and in Psychopathology

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**Introduction.** Tremor of eye movements along with drift characterizes the intersaccadian periods of fixation (Hee-kyoung Ko et al., 2016; Rucci, Victor, 2015). During fixation eye movements, most of the information is received and a detailed analysis of the image occurs. Eye tremor is a natural oculomotor activity that is out of the conscious control. The amplitude of tremor oscillations is normally 20-40 arc seconds, the average oscillation frequency is 87 Hz. The frequency of the eye tremor gets into the gamma range of fluctuations that provide neuronal synchronization in many areas of the brain. The working hypothesis of the study is that the indicators of tremor eye movements are objective and adequate indicators of the mental state.

**Method.** Study participants: 9 people without a history of neurological and psychiatric diagnoses, 7 patients with a diagnosis of schizophrenia and 3 patients with delusional disorder. The parameters of eye tremor were recorded using an optical system elaborated by the authors. Video recordings of eye micromovements were performed from the outer side of the sclera. The duration of the video was 0.3-1.5 seconds. 90 videos were suitable for digital analysis. The parameters of the amplitude and frequency of eye tremor were calculated using the author's program.

**Results.** Analysis of variance of the obtained data showed a significant difference between groups in certain ranges of frequency (ft) and amplitude (at) of tremor. The numbers indicate the average values of the analyzed range of frequency and amplitude of eye tremor. Differences were observed between patients with schizophrenia and delusional disorder in ft71 ( $p=0.02$ ), at67 ( $p=0.0009$ ), at71 ( $p=0.00001$ ), at110 ( $p=0.00006$ ). Differences between mentally healthy and schizophrenic patients were observed in the frequency of tremors in the ranges with an average frequency ft71 ( $p=0.02$ ) and ft110 ( $p=0.00001$ ). Healthy participants and patients with delusional disorder differed in tremor amplitude in the range at67 ( $p=0.001$ ), at71 ( $p=0.001$ ), and at110 ( $p=0.0001$ ).

**Conclusion.** Thus, both the frequency and the amplitude of tremor of the eye movements have the potential for assessing mental state.

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## The Importance of Variability in the Performance of the Number Line Estimation Tasks in Children with Dyscalculia Risk

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Dyscalculia is defined as a neurodevelopmental specific learning disorder leading to the impairment in mathematics. The aim of the study was to investigate number line estimation ability in children with diagnosis of dyscalculia risk. Fifty-two children (26 girls and 26 boys, mean age = 9.88) participated in the study. Thirty-two had diagnosis of dyscalculia risk (DR). They were compared to 20 typically developed children (TD). Participants performed two number-to-position tasks (they were asked to estimate the position of a given number on the empty number line, ranged 0-100 and 0-1000, respectively). Moreover, they performed two tasks (also with 0-100 and 0-1000 range), which required the verbal response determining an estimated number magnitude for the location that was indicated by an arrow on the line. The results of the verbal tasks showed the greater mean estimation error (EE) in DR group only in case of 0-1000 interval. In the number-to-position tasks the greater value of EEs in DR group both for 0-100 and 0-1000 interval were revealed. However, the most interesting result was found when focusing on values of variance within each group, not only in the context of variability descriptive statistics (SD and SEM) but also in the context of a variance showed in the scatter plots presenting individual data and the vast differences between EEs of particular participants. There was a considerable heterogeneity of EE values obtained in both groups and in each tasks, however in DR group this dispersion of individual results was clearly bigger. Thus, it could be concluded that Mean or even SD and SEM statistics do not manifest the real decrease of abilities in the case of some deficits, until we focus on individual data dispersion. It seems to be an important finding for example in regard to diagnosis of dyscalculia.

## Effect of Selenium on The Levels of Trace Elements in Mice Brain And Blood

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**Introduction.** The most important trace elements selenium (Se), iron (Fe), zinc (Zn) and copper (Cu) play a significant physiological role in brain development and function. These elements, which are involved in metabolic and redox processes in CNS, may affect cognitive functions. It is therefore important to maintain adequate levels of these elements in the brain. However, literature data on physiological concentrations of trace elements in humans and experimental animals brain are quite conflicting. There is even less data on how an excess of Se affects the balance of other elements. Therefore, the purpose of this study was to elucidate the changes in levels of Fe, Cu, Zn related to Se administration.

**Materials and methods.** Experiments were done on 4-6 week-old BALB/c mice. Control mice were given tap water, whereas Se treated mice - Na<sub>2</sub>SeO<sub>3</sub> (0.2 mg of Se/kg body weight) in tap water for 8 weeks. Trace elements concentrations was determined by inductively coupled plasma mass spectrometry (using NexION 300 D) in Toxicology laboratory of Neuroscience Institute. License of the State Food and Veterinary Service for working with laboratory animals No. G2-80.

**Results.** It was shown that after 8-week oral consumption of Na<sub>2</sub>SeO<sub>3</sub> solution, Se concentration in mice blood increased 3.1-fold (from 271.23 to 852.01 µg/L, P<0.05), meanwhile in brain increased 2.4-fold (P<0.05) in comparison with Se concentration value (0.061 µg/g, P<0.05) of control. The exposure to Na<sub>2</sub>SeO<sub>3</sub> caused a statistically significant increase in Cu level both in the mice blood and brain in regard to control. It was determined an increase in Cu concentration in mice blood and brain by 13 % (1.41 µg/g) and 32 % (4.91 µg/g) respectively. In contrast, administration of Na<sub>2</sub>SeO<sub>3</sub> decreased Fe concentration in mice blood by 8 % (833.35 mg/L, P<0.05), while Fe concentration in the brain increased by 19 % (from 27.27 to 32.40 µg/g, P<0.05) as compared to control. The exposure to Na<sub>2</sub>SeO<sub>3</sub> caused no changes in Zn concentration neither in mice blood nor brain.

**Conclusions.** It was determined that Se affects levels of trace elements in mice brain and blood. The exposure to Na<sub>2</sub>SeO<sub>3</sub> for 8 weeks increases Se concentration in mice blood resulting in higher accumulation of Se in the brain, which respectively increases Cu and Fe levels without influencing level of Zn. Meanwhile, the raised Se level in the blood is related to increased Cu, but decreased Fe concentrations.

## Antioxidant Defense Capability of Zinc to Mitigate Nickels Neurotoxicity in Mice

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**Introduction.** The nervous system is one of the major targets of nickel, as this metal crosses the blood-brain barrier and accumulates in the brain. Ni competes with redox active metals, reduces the activities of the enzymes of antioxidant system, thus causing oxidative stress.

Although redox inert zinc isn't an antioxidant in the true sense of the word, its deficiency is associated with increased free radical generation and weakened response to oxidative stress. The scientific data indicates the ability of Zn to reduce lipid peroxidation, enhance capacity of antioxidant system and suggests potential antagonism with Ni.

The aim of present study was to evaluate the antioxidant defense capabilities of Zn on Ni induced brain oxidative damage of mice. To assess oxidative status, contents of reduced glutathione (GSH) and metallothionein (MT) were measured.

**Methods.** Mice were randomly assigned into 3 metal exposure groups plus a control group which received i.p. injections of saline. Mice of Ni and Zn exposure groups received an i.p. injections (once a day) of corresponding amounts of  $\text{NiCl}_2$  and  $\text{ZnSO}_4$ . Mice of the Zn+Ni exposure group were i.p. injected with  $\text{ZnSO}_4$  and after 20 min with  $\text{NiCl}_2$  solutions in corresponding doses.

**Results.** Our results have showed that single and repeated  $\text{Ni}^{2+}$  administration significantly decreased contents of GSH in the brain of mice by 20 % and 30 % respectively.  $\text{ZnSO}_4$  administration didn't seem to affect content of GSH at neither period of exposure, however the injection of  $\text{Zn}^{2+}$  20 minutes prior to the  $\text{NiCl}_2$  administration has returned GSH concentration to the level of control at both periods of exposure ( $p < 0,05$ ).

Brain MT concentrations were increased by 30 % after a single exposure to  $\text{Ni}^{2+}$  just as after single  $\text{Zn}^{2+} + \text{Ni}^{2+}$  exposure ( $p < 0,05$ ), however MT concentration in the brain of once  $\text{Zn}^{2+}$ -treated group of mice remained at control level. Repeated  $\text{NiCl}_2$  administration increased brain MT content by 36 %; repeated exposure to  $\text{ZnSO}_4$  raised MT level by 121 %, while Zn pre-treatment 20 minutes prior to the  $\text{NiCl}_2$  administration increased MT concentration by 80 %, comparing to the control group ( $p < 0,05$ ).

**Conclusions.** The exposure to Ni has significantly reduced content of GSH and increased level of MT after both single and repeated  $\text{NiCl}_2$  administration.  $\text{Zn}^{2+}$  pretreatment has provided protective effect against  $\text{Ni}^{2+}$ -induced GSH depletion at both exposure periods, however MT levels after single and prolonged both metal administration remained increased.

## PsyExTool Project for Psychophysical Research of Sensory Systems

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A range of computer programming packages for psychophysical methods including open source are available at present. But there are not many convenient and enough flexible experiment control tools that incorporates these methods. The current MATLAB and GNU Octave environment-based project PsyExTool is aimed to create a tool that enables to couple the methods with visual or audio stimulus presentation modules. At present the program allows to use adjustment, constant stimulus and adaptive PSI psychophysical methods. The parameters of the stimulus and psychophysical method is adjusted in a single graphical user interface. The responses are collected using keyboard or mouse. The process of experiment is displayed graphically. At the end of the session, the data can be stored or exported for further analysis. The structure of the program may incorporate and combine additional methods for data collection and stimuli presentation in various sensory modalities. The open-source status of the code should ensure availability and flexibility of the tool.

## The Relationship Between Time and Numbers Processing in Children, the Effect of Music Education

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The processing of time and numbers has the shared neural basis and the cognitive mechanisms. Moreover, A Theory of Magnitude (ATOM) proposes that time, space, physical size, pitch and quantity are part of one general magnitude system.

The aim of the study was to investigate the relationship between the level of basic numerical abilities and the level of time perception as well as production (e.g. the reproduction of auditory stimuli duration) in children. Moreover, we calculated the correlation between the indices of both abilities in 2 group of participants: 1) children experienced in music education and 2) children from general population (control group).

A group of 65 children, aged from 7 to 10, participated in the study. Forty-five of them had no experience in music education (control group, C). They were compared to 20 children, who had access to music education (M). Each participant was examined with the use of two computerized tests to measure 1) the basic mathematical skills such as number comparison, numerosity assessment and number line estimation, and 2) time perception, production, and reproduction (also the rhythm processing).

The results of correlation analyses showed the several positive correlations between investigated abilities (e.g. between rhythm perception and number line estimation), that confirm the ATOM postulates, however only in the case of M group, while almost no expected correlation in the control group. Thus, it could be concluded, that music education may enhance the relationship between processing of numbers and time. It suggests that music education is beneficial for mathematical education in primary school.



## Cortical Midline Structures in the Psychotherapeutic Process

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Cortical Midline Structures (CMS) create broad connections to other regions in the brain, thus they have an impact on all the psychological functions involved in psychotherapeutic process. They form subjective space and time dimension. The patient's Self temporalizes and spatializes the brain (Nothoff, 2021). A basic subjectivity of the spatiotemporal structure of the Self in the neuronal activity of the brain performs psychological defences and transfer/countertransfer relationships in psychoanalytic psychotherapy. The short and critical consideration of the book "The Dynamic Self in Psychoanalysis Neuroscientific Foundations and Clinical Cases" by Rosa Spagnolo and Georg Northoff will be undertaken.

## EEG Theta Principal Component Correlates with Sleepiness Ratings

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The resting-state paradigm is frequently applied in EEG research; however, it is associated with the inability to control participant's thoughts. To quantify subjects' subjective experiences at rest, the Amsterdam Resting-State Questionnaire (ARSQ) was introduced covering ten dimensions of mind wandering. We aimed to estimate associations between subjective experiences and data-driven EEG components extracted using frequency Principal Components Analysis (f-PCA).

**Methods:** 5 minutes resting-state EEG data of 176 subjects were used to evaluate data-driven EEG components extracted with f-PCA. The Bayesian correlation approach was implemented to assess associations between ARSQ domains assessed after resting and f-PCA outcomes.

**Results:** Five alpha components, one beta, one theta, and one delta component were identified corresponding to previous reports on the resting state EEG. Only frontal mid-line theta component peaking at 4 Hz was positively associated with Sleepiness ( $r=0.264$ ,  $BF_{10}=47.423$ ). No other correlations emerged. The inverse model of eLORETA showed a trend-level activation of the voxels at subgenual cingulate gyrus, anterior cingulate, and limbic lobe.

**Conclusion:** The association observed between theta component and Sleepiness is in line with previously reported associations on EEG and fMRI signals, pointing to the relevance of assessments of spontaneous thoughts occurring during the resting state.

## Impact of Diet on Microglia Functions in Ageing Animals

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Microglia represent a specialized population of macrophages-like cells in the central nervous system (CNS) and considered immune sentinels that are capable of orchestrating a potent inflammatory response. Microglia dysfunction has major implications on neurodegenerative diseases. In recent years, research on gut microbiota has proved valuable in understanding systemic homeostasis and pathogenesis via the gut-brain axis. These evidences support the idea that microbiota not only plays a crucial role in the immune response led by microglia in the CNS but also in the development, proliferation and maturation. Gut microbiota modulation is possible through diet. To understand the impact of diet on microglia cells we used C57BL/6JRj mice for our research. The animals were divided into two groups (old and young) and subjected to a different diets (control, control & prebiotics, high-fat and high-fat & prebiotics). After 10-month diet (old group) and 1-month diet (young group), the animals were culled and microglial cells were isolated to perform phagocytosis, ROS and senescence experiments which directly correlate to microglial activation and functioning in the CNS of aged and young animals.

In our experiments, we observed a decline in microglia functions in aged animals when compared to young animals. Furthermore, microglia from high-fat diet animals showed a bigger decline even when compared with other diets.

## Regulating Negative Emotions: An Impact of Sex and Personality Traits

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Department of Neurobiology and Biophysics, Vilnius University, Vilnius, Lithuania Difficulties in emotion understanding and inability to effectively implement emotion regulation (ER) strategy might be related to depression, anxiety and worse psychological state. Previous studies demonstrated sex differences in emotional functioning, but it is not clear how it affects ER as a trait and a state. This study aims to evaluate sex differences in several ER parameters: subjective ratings of emotional stimuli, habitual ER strategy, emotional state and alexithymia.

90 healthy ( $27 \pm 4.4$  years) volunteers participated in an ER study: 34 women in the follicular, 30 women in the luteal phase of their menstrual cycle, and 26 men. During ER task participants were shown neutral ( $n = 24$ ) and negative (low and high intensity,  $n = 144$ ) images and were instructed to either simply view them or to up- or down- regulate their emotions applying reappraisal ER strategy. Participants rated perceived negativity after each stimulus. The emotion regulation questionnaire was used to evaluate which (reappraisal or suppression) ER strategy participants use in daily life. The Toronto alexithymia scale was used to evaluate ability to identify and describe emotions. Visual analog scale was applied to evaluate participants' emotional arousal level before, during and after the experiment.

Perceived negativity in the ER task was lower in down-regulation and higher in up-regulation compared to view condition in all groups. There were no significant differences in the ER trait or state parameters between women in the follicular and luteal phases. However, men scored lower in perceived negativity (highly negative pictures) than women. Questionnaires revealed higher alexithymia scores and more often usage of the suppression ER strategy in men as compared to women. There was a significant positive relationship between alexithymia scores and the use of suppression ER strategy in women ( $r = 0.31$ ,  $p = 0.01$ ) and men ( $r = 0.56$ ,  $p = 0.002$ ). Before, during and after the ER task, men evaluated their arousal level lower than women. Additionally, the level of emotional arousal during and after the ER task positively correlated with perceived negativity in men and women.

To summarize, lower perceived negativity and arousal level, more frequent use of the suppression ER strategy, and a higher alexithymia score in men suggest systematic differences in emotion regulation and processing between sexes.

## The Effect of Elsholtzia Ciliata Essential Oil on Catalase (CAT) Activity in Mice Brain

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**Background:** Recently data show that *Elsholtzia ciliata* (*E. ciliata*) essential oil has an antioxidant activity that is determined by different phenolic compounds. Flavonoids are the most predominant substances in the genus *Elsholtzia* and have an effect against oxidative stress which plays an important role in the development of various diseases. Catalase (CAT) belongs to the first line defence antioxidants and is able to reduce oxidative stress by degrading hydrogen peroxide to water and oxygen. The present study aimed to determine the possible antioxidative effect of *E. ciliata* essential oil on CAT activity in mice brain.

**Materials and methods:** The experiment was done on 4 - 6 weeks old white BALB/c laboratory mice weighing 20-30 g. 50 mice were divided into five groups: control, which received saline solution; olive oil; AlCl<sub>3</sub>; *E. ciliata* oil and AlCl<sub>3</sub>; *E. ciliata* essential oil. Oxidative stress was induced by injection of AlCl<sub>3</sub> solution. CAT activity in brain homogenates of mice was measured via hydrogen peroxide and ammonium molybdate reaction and light absorption of produced complex was assessed by spectrophotometry at 410 nm after 21 days of *E. ciliata* oil intragastric administration via a stomach tube.

**Results:** The results showed that in AlCl<sub>3</sub> group CAT activity was significantly decreased (by 62.76%,  $p < 0.05$ ) compared with control group. In mice treated with a combination of AlCl<sub>3</sub> and *E. ciliata* essential oil, the activity of CAT in brain was significantly higher (by 81.45 %,  $p < 0.05$ ), compared to AlCl<sub>3</sub> group. No significant difference was detected in the activity of CAT in the brain of mice between olive oil and control groups. The administration of *E. ciliata* essential oil increased the activity of catalase in brain by 26.94 % compared with control group, however the difference was not significant.

**Conclusions:** Our results demonstrated that *Elsholtzia ciliata* essential oil has antioxidant effect and increase the activity of catalase in the brain of mice after AlCl<sub>3</sub>-induced oxidative stress.

**Keywords:** *Elsholtzia ciliata*, antioxidant activity, catalase, mice

