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# of Lithuanian Neuroscience Association

Program and Abstracts

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PROGRAM

9.15–10.00 **Registration. Coffee/Tea.**

10.00–10.10 **Opening. Prof. Osvaldas Rukšėnas**, president of LNA.

I session *(Chair – Prof. Osvaldas Rukšėnas)*

10.10–10.40 **Prof. Janina Tutkuvienė**, Department of Anatomy, Histology and Anthropology, Vilnius University, Lithuania. *"Perception of females' body attractiveness: from healthy to unrealistic proportions, from matured to infantile females' body image"*

10.40–11.10 **Dr. Giuseppina Porciello**, Department of Psychology, Sapienza University of Rome, Italy. *"The power of others gaze: ideological and physical similarity matters!"*

11.10–11.40 **Dr. Sergii Tukaiev**, National Taras Shevchenko University of Kyiv, Ukraine. *"Neurophysiological aspects of Media reception: the effect of emotional valence"*

11.40–12.10 **Prof. Daniel Wojcik**, Nencki Institute of Experimental Biology, Poland. *"Source reconstruction from extracellular potentials, from single cells to the whole brains"*

12.10–13.30 **Lunch. Coffee/Tea.**

II session *(Chair – Dr. Kastytis Dapšys)*

13.30–14.30 **Plenary lecture. Dr. Tomas Palenicek**, National Institute of Mental Health, Czech Republic. *"The neurobiology of psychedelics and implications for treatment"*

14.30–15.00 **Dr. Robertas Badaras,** Vilnius University Faculty of Medicine, Centre of Toxicology in Clinic of Anaesthesiology and Intensive Care, Lithuania. *"Neurotoxicity of psychoactive substances"*

15.00–15.30 **Nijolė Goštautaitė Midttun**, Mental Health Initiative, Lithuania. *"Psychosis labyrinth and open psychiatry"*

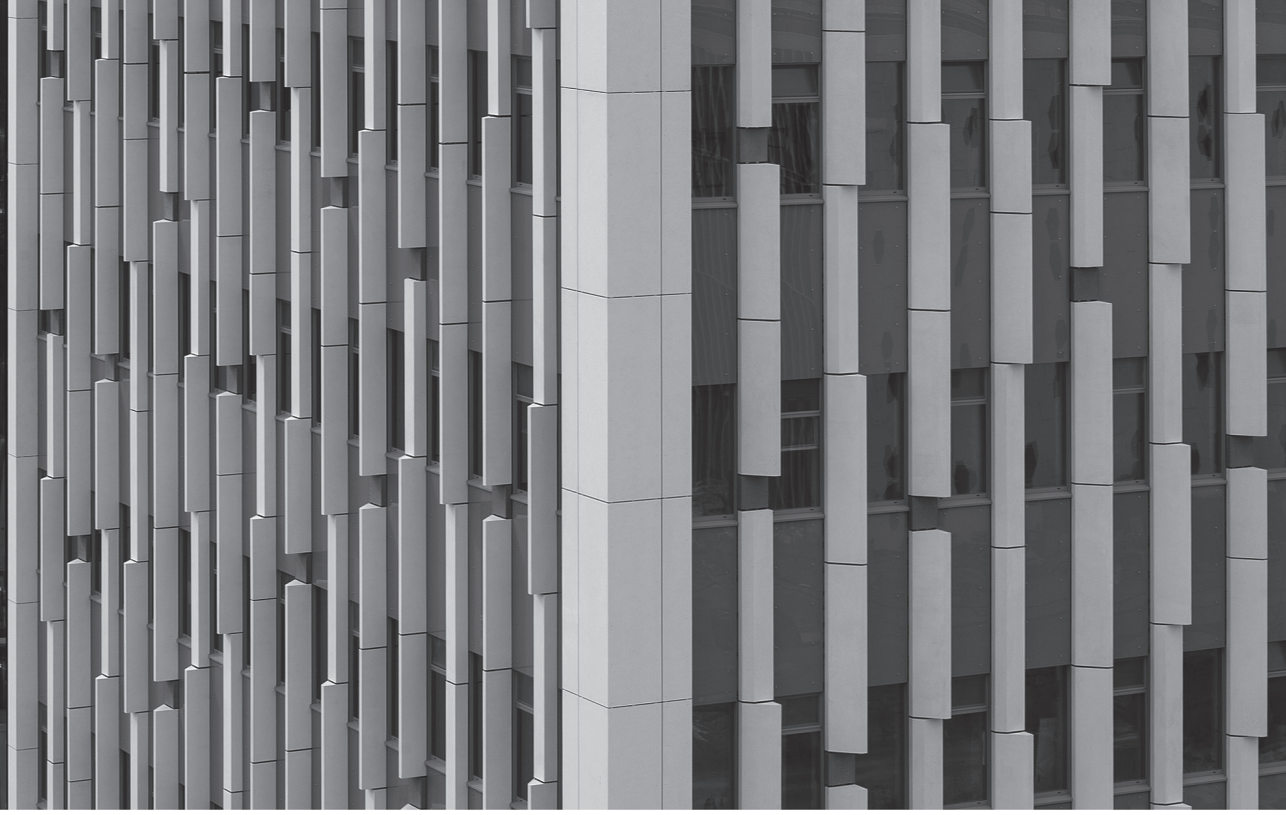
15.30–16.00 **LNA members meeting. Coffee/Tea.**

III Poster session *(Chair – Prof. Aidas Alaburda)*

16.00–17.30

17.30–17.45 **Concluding remarks. Awards.**

17.45–19.00 **Party.**



Oral presentations

PERCEPTION OF FEMALES' BODY ATTRACTIVENESS: FROM HEALTHY TO UNREALISTIC PROPORTIONS, FROM MATURED TO INFANTILE FEMALES' BODY IMAGE

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Sex-related body shapes evolved as important markers for mate selection, and conveyed gene quality, health and fertility. According to the evolutionary theory, men and women should prefer bodies that signal reproductive success. However, a perception of mate quality may vary depending on the environment. Preferences for body size and shape were changing over times and varied considerably within and among populations. There is a question if preferable body image of females (or males) at particular times and environments reflected maximum fecundity, "average" tendency in body size and shape, or the other psycho-socio-cultural attitudes. In ancient societies, females' attractiveness was mostly related to biological functions – fertility, feeding of the offspring (Venuses). Over times, females' body image became increasingly socialized: the emancipation of women and the economic freedom was related to promotion of slender bodies. At the beginning of 20th century, the "ideal" woman became noticeably slimmer, and was extremely shaped several times – such an extreme shaping of females' body might be related to body care industry also (body as a part of the economic market). During human evolution, our bodies had been shaped by fluctuating habitat, nutritional, reproductive, and other health-related factors – it is possible that in favourable environment, male preferences shifted away from signals of high fecundity towards more androgenic females' body size and shape. This phenomenon might be considered as an adaptive strategy for smaller family size and greater involvement of females into resource acquisition (career orientation and less reproduction ambitions).

THE POWER OF OTHERS' GAZE: IDEOLOGICAL AND PHYSICAL SIMILARITY MATTERS!

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In daily life, we constantly read and interpret a variety of signals sent by others, a process that implicitly or explicitly mediates successful interpersonal interactions. Among others' body related cues, gaze direction is one of the crucial signals used for directing the attention of conspecifics in both human and non-human primates. In particular gaze-following, namely the tendency to follow others' gaze movements, is a pivotal social behavior that arises early in life and predicts sophisticated social abilities, such as joint attention and theory of mind. Albeit automatic, gaze-following is permeable to high-order variables (e.g. social status, ethnical membership etc.). Our research group, for example, showed that political affiliation influences gazefollowing. We found that the tendency to follow others' gaze is stronger when right-wing participants faced their in-group political leader (vs. the out-group's), Silvio Berlusconi (SB) who dominated the Italian political landscape and had a massive popularity at the time of data collection. Interestingly, this effect paralleled the perceived-similarity between the voters' and SB's personality and disappeared when the leader resigned from office after sex and political scandals. Indeed, the leaders' fall in popularity paralleled the reduction of his gaze's attracting power, as well as the decrease in similarity perceived by his voters. The less similar rightwing voters felt to their leader, the less they followed his gaze. Besides voter-leader perceived similarity, in a separate series of studies, we showed that physical similarity (self vs. friend face) influences gaze-following behavior. We found that participants were maximally interfered when they observed their own gaze-shifts and that this effect was reduced after a simple interpersonal multisensory (i.e. visuo-tactile) stimulation. After 2 minutes of synchronous touches felt on one's own and seen on the face of others, participants not only experienced the illusory sensation of including others in one's own face (Enfacement), but they also followed less their own gaze in a gaze-following task. This effect, that we called Engazement, depends on a positive interpersonal perception of the pair partner. Together, the present experimental findings suggest that gazefollowing is a plastic behavior that can be modulated by complex situational and dispositional factors, in which ideological and physical similarity plays a crucial role.

NEUROPHYSIOLOGICAL ASPECTS OF MEDIA RECEPTION: THE EFFECT OF EMOTIONAL VALENCE

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Media effects are a complex research subject. An issue of great importance is to detect unique traits in reactions to emotionally accented Mass Media in the conditions similar to the natural setting of TV news program. The aim of this study was to investigate the neurodynamics of human brain while watching negative TV news (4 plots each 1-1,5 minutes long) interrupted by a pause for three 30 seconds-long TV commercials (food and drink). 86 healthy volunteers (women and men) aged 17 to 26 years participated in this study. We estimated the spectral power density of all frequencies from 0.2 to 45 Hz. All participants characterized the TV news as unpleasant and activating, the ads – as rather pleasant and relaxing. The viewing of TV news and TV ads caused activation changes in the information-analytical cognitive processes of neural networks. They increased actualization of attention (depression alpha2 rhythm), short-term memory with an emotional component (increase in theta1,2 in the central-posterior and right frontal areas only for negative TV news), as well as semantic-cognitive and emotional processes (depression alpha3 and exaltation of beta1,2 bands). Increase of the number of viewed TV news plots with ads interruption despite their negative emotional content led to the development of intellectual processes of adaptation (no changes in the reactivity of the theta-rhythm and activity reduction of cognitive beta1,2 and alpha3 neural networks). Depression of alpha1,2-bands (external attentional system) indicated activation of the descending control systems. We demonstrate inhibitory effect of ads viewing on the activation of cognitive neural networks in response to watching TV news despite their negative emotional orientation. Our results suggest that violence and ads in TV videos exert significant influence on the psychological condition of the participants. The general trends show that violent video cause more significant emotional impact on mental state.

SOURCE RECONSTRUCTION FROM EXTRACELLULAR POTENTIALS, FROM SINGLE CELLS TO THE WHOLE BRAINS

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Extracellular recordings of electric potential remain a popular tool for investigations of brain activity on all scales in animals and humans, from single cells (spikes) to systems studied with depth electrodes (LFP, SEEG), subdural recordings (ECoG), and on the scalp (EEG). They are relatively easy to record but difficult to interpret: since electric field is long range one can observe neural activity several millimeters from its source. As a consequence, every recording reflects activity of many cells, populations and regions, depending on which level we focus. One way to overcome this problem is to reconstruct the distribution of current sources (CSD) underlying the measurement.

We recently proposed a kernel-based method of CSD estimation from multiple extracellular recordings from arbitrarily placed probes (i.e. not necessarily on a grid) which we called kernel Current Source Density method (kCSD). In my presentation, I will present this method and explain why it works. I will also show two recent developments, skCSD (single cell kCSD) and kESI (kernel Electrophysiological Source Imaging). skCSD assumes that we know which part of the recorded signal comes from a given cell and we have access to the morphology of the cell. This could be achieved by patching a cell, driving it externally while recording the potential on a multielectrode array, injecting a dye, and reconstructing the morphology. In this case we know that the sources must be located on the cell and this information can be successfully used in source estimation. In kESI we consider simultaneous recordings with subdural ECoG (strip and grid electrodes) and with depth electrodes (SEEG). Such recordings are taken on some epileptic patients prepared for surgical removal of epileptogenic zone. When MR scan of the patient head is taken and the positions of the electrodes are known as well as the brain's shape, the idea of kCSD can be applied to constrain the possible distribution of sources facilitating localization of the foci.

THE NEUROBIOLOGY OF PSYCHEDELICS AND IMPLICATIONS FOR TREATMENT

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Psychedelics, also known as hallucinogens by the broader public, are a heterogenic class of mind-altering drugs. They have seen a resurgence in popularity amongst scientists as well as the general public as a research tool and therapeutic agent. The term "psychedelics" formed from the Greek words *psyche* and *delein* can be translated as "soul-manifesting". The notoriously known examples of so-called classic serotonergic psychedelics are LSD, psilocybin and mescaline and a hallucinogenic brew Ayahuasca (containing DMT). These drugs are partial agonists at serotonin 5-HT2A/C and 5-HT1A receptors with the 5-HT2A agonism being responsible for their "hallucinogenic" activity. From a wider perspective, other drugs also share the psychedelic activity albeit through different receptor / neurotransmitter mechanisms: dissociative anaesthetics, (e.g. ketamine, phencyclidine), cannabinoids, salvinorin A, and anticholinergics (e.g. atropine, scopolamine). After 50 years of these drugs not being used scientifically in humans at all, they have started to be reinvestigated both in US as well as in Europe over the last five years. From one perspective, they are used as tools for understanding the neurobiology of psychoses, due to their psychotomimetic effects. At the same time, using modern neuroimaging methods they enable us to study in detail the neurobiology of introspective processes, perception, emotions, and cognition etc. Last but not least, several studies show their effectivity in the treatment of anxiety, depression and also addiction. This presentation will focus on the overall neurobiology of psychedelics and their potential for use in treatment. Recently gathered data from our trials with psilocybin, ketamine and cannabis in humans (volunteers as well as patients) will be discussed in relation to the current state of the art.

This study was supported by the projects IGA MHCR NT/13897, ED2.1.00/03.0078, LO1611/NPU I, MH CZ - DRO (NIMH-CZ, 00023752) and PRVOUK P34.

NEUROTOXICITY OF PSYCHOACTIVE SUBSTANCES

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Neurotoxicity refers to any form of substance-induced dysfunction of the nervous system. Chronic psychoactive substances intake has determinant neurotoxic and neuroadaptive consequences on neurotransmitter systems and brain circuitries. Neuroadaptive alterations within these systems can contribute to addiction development and maintenance. A better understanding of neural processes directly associated with the development and maintenance of addiction can help to improve prevention programs as well as therapeutic interventions in the treatment of addicted patients. All drugs of abuse have in common that their intake leads to increased dopaminergic neurotransmission in the ventral striatum and the nucleus accumbens (Di Chiara and Imperato 1988). As natural or primary (like food, sex, or sleep) and secondary reinforcers (like money) also elicit dopaminergic release, it was initially suggested that dopamine mediates reward and causes hedonic feelings (Wise 1982). Thus, the mesocorticolimbic circuit has often been termed as the neural "reward system." It was therefore suggested that dopamine mediates motivational behavior towards reward instead of consummatory pleasure – therefore functions as a neural correlate of "wanting" instead of "liking" (Berridge 2009). It is generally assumed that "liking" (experience of pleasure) on the neurobiological level is associated with the opioidergic neurotransmitter system. Stress response is activated during withdrawal from chronic administration of all major drugs with abuse potential, with a common response of elevated adrenocorticotropic hormone, corticosterone (Koob 2008). New methods of opioid withdrawal management can reduce the symptoms and severity of withdrawal (Badaras 2016).

PSYCHOSIS LABYRINTH AND OPEN PSYCHIATRY

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The stigma of mental illness and psychiatry is highly prevalent and persistent in society. It acts as a barrier for accessing treatment, adopting effective methods, alleviating suffering and costs. Evidence from different fields of neuroscience does not easily reach populations in need, might be difficult to comprehend and therefore requires new avenues of expression. Art projects are more frequently used as bridging multidisciplinary practices, assisting in translation of research knowledge into better clinical practice, lower stigma, changes in attitude and behavior.

In this presentation experiences from the *Open Psychiatry Month, 2016* will be shared, focusing on psychiatric simulation art projects: Labyrinth psychotica and virtual psychosis simulator by Jennifer Canary (Netherlands). Safe, yet firsthand experience of psychosis-like phenomenon does provide novel insights to clinicians, service providers, caregivers, police and other professionals, as well as patients themselves. Implications, risks and benefits of such projects will be discussed.

Open psychiatry month is an annual psychiatry destigmatization initiative, which advocates evidence based practice and improved access to psychiatric treatment for all persons with mental health care needs.

Posters

P1. 3D GAIT ANALYSIS OF RAT WALKING FOR MONITORIZATION OF THE SCIATIC NERVE REGENERATION

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Analyzes used to evaluate the sciatic nerve regeneration have been documented in the literature. Among these analyzes sciatic function index is widely known analysis method. Although it is cheap and robust it has been considered by many investigators that it is not effective. In the present study videos taken from two different sides (side and back) were used to analyze joint movements of ankle, knee, and hip in the time frame of gait. For this purpose, a total number of 30 rats were divided into three groups (control, sham-operated, sciatic nerve injury group). After their video recordings were done by using a video camera with 240 fps, video based motion analysis was performed. Analysis of the data revealed that videos taken from back side was advantageous. Additionally, we think that exorotation angle could be used in monetarization of the sciatic nerve regeneration.

P2. ULTRASTRUCTURAL CHANGES IN PATIENTS WITH DIVERTICULAR DISEASE

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Diverticular disease (DD) is characterised by herniation of colonic mucosa and submucosa through points of weakness in circular muscle. Current understanding of the disease suggests that disrupted neural control of normal colonic motility is important. However, no studies have been done to examine the fine structure of the enteric nervous system. The aim of this study was to study the ultrastructural changes of the myenteric and submucosal subplexuses that occur in DD.

Samples of the sigmoid colon were collected from 10 patients (2 controls and 8 patients with DD). Diverticular sigmoid colon samples were collected from patients who had undergone elective surgery. Specimens of healthy (control) sigmoid colon were collected from non-obstructing colon tumours. Samples of the myenteric and submucosal plexuses with the surrounding tissue were observed with a transmission electron microscope.

Patients with DD exhibit remodelling as well as damage of the myenteric plexus. We found patches of fragmented axons, as well as a higher percentage of swollen axons in DD-affected samples (controls 4.11%, DD 9.52%, 95% CI [2.09, 8.70], $p = 0.006$). The mean area of healthy axon profiles was higher in controls (controls 0.429 μm^2, DD 0.231 μm^2, $t = 9.75$, $p < 0.0001$). The morphology of the submucosal plexus remained unchanged: the percentage of swollen axons (controls 4.49%, DD 4.35%, 95% CI [-3.9, 3.6], $p = 1$) as well as the size of the axons (controls 0.415 μm^2, DD 0.390 μm^2, $t = 1.037$, $p = 0.299$) did not change.

Patients with DD show substantial structural alterations of the ENS characterized by axon remodelling and axon swelling. The morphometric data give evidence that the disease is associated with ultrastructural alterations and further findings might prove important in understanding the disease. This study was supported by the grant from the Research Council of Lithuania (SEN-15023).

P3. TRACING THE SOURCE OF nNOS POSITIVE FIBERS IN THE HEART: A PILOT STUDY

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Nitric oxide (NO) is an intracellular molecule that can modulate blood flow, neuronal activity and immune system. In nervous system NO is synthesized by neuronal nitric oxide synthase (nNOS). Both extrinsic and intrinsic nNOS positive (nNOS-p) neurons and fibers are found in the heart. This suggests that NO is involved in neurogenic heart regulation. However the source of extrinsic nNOS-p nerve fibers is undetermined. nNOS-p neurons were found in dorsal root ganglion, ganglion nodosum, ganglion stellatum. Also neurons that contain nNOS have been located in the dorsal motor nucleus of the vagus (DMVN) and nucleus ambiguus (NA). But it hasn't been demonstrated whether these extracardial nNOS neurons innervate the heart. This study's aim was to evaluate the possibility that source of extrinsic intracardiac nNOS-p nerve fibers are cardiac vagal preganglionic neurons. We chose to primarily evaluate NA given that proportion of DMVN neurons projecting to the heart is believed to be low and that heart rate decreases triggered by activation of the DMVN is small when compared to activation of NA.

Vagus nerve (Vn), ganglion nodosum (GN) and brain sections at Vn root entry point were obtained from two 4 weeks old rats. Sections of Vn were taken at the heart, neck and GN level. Using immunofluorescent technique, sections were double labelled for nNOS and choline acetyltransferase and analyzed using confocal microscopy.

nNOS-p neurons were found in NA and next to it. In Vn root small amount of nNOS-p fibers were also found. Various nNOS-p neurons and fibers were observed at GN. nNOS-p fibers were also located at the neck and heart levels in the Vn.

These findings suggests that Vn is one of the sources of nNOS positive fibers in the heart. Though a further tracing and immunohistochemical studies are needed to determine whether these fibers are from preganglionic parasympathetic neurons or are they afferent fibers. As our findings suggests that the both sources are possible.

P4. MORPHOLOGY AND AGE-RELATED ANALYSIS OF RABBIT STELLATE GANGLION

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Aim. The aim of our exploration was investigated the rabbit stellate ganglions morphology in the different age groups. After this study, we will plan to continue to physiological research and these results will be used to the clinic.

Material and methods. The stellate ganglions were studied in 10 rabbit ganglions, five rabbits were young ages (6 months) and five rabbits were the middle ages (over 2 years). The stellate ganglion consist of the caudal cervical (ganglion cervical caudal) and the first thoracic vertebral ganglions. The caudal cardiac nerve comes from the stellate ganglion. The tissue was fixed with 4% phosphate buffered formaldehyde and was processed for 4 μm thick paraffin sections. Tissue sections were stained with eosin and Carazzi's hematoxylin. Statistical analysis was performed using SPSS version 19.

Results. The stellate ganglions were surrounded by connective tissue and extends from the connective tissue fibers forming the partitions inside the ganglions. The connective tissue was found in the all rabbit ganglions. The ganglions were irregular shape and edge. The stellate ganglion neuron density was higher in the periphery of ganglion, than the centre of ganglion. Neurons were different size and shape (oval, round and irregular). The mononuclear and two nuclear neurons were in the rabbit stellate ganglions. The mainly nucleus were localized eccentrically in the neurons. The young rabbit ganglions had different neuron size. The older rabbits had less neurons, but they were marginally higher.

Conclusions. The age of the rabbit had not influence the rabbit stellate ganglions area and shape. We were found that the neuron bodies and nuclei were marginally higher in the older rabbits. The ganglions area and shape were not difference.

P5. OPTUINO – THE OPEN SOURCE MICROCONTROLLER SOFTWARE FOR OPTOGENETICS

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Optogenetics is nowadays one of the most widely used tool in neuroscience. It allows for precise regulation of neuronal activity in a freely – moving animal and it is relatively simple to use. Though, software and hardware used in ontogenetic is relatively expensive and open – source tools in this field are lacking. We developed Arduino – based microcontroller for the laser and simple and user – friendly graphical user interface (GUI) using Processing. It allows for adjusting laser pulse length and frequency, creating optogenetics protocols and controlling the laser using TTL. Our software and hardware scheme will be accessible freely in the Internet. Our tool can be also used for precise anduser – friendly control of any device that can be triggered with TTL output.

P6. BARBITURATE ANESTHESIA DECREASES ISCHEMIA-INDUCED INJURY IN RAT BRAINS VIA BLOCKADE OF MITOCHONDRIAL PERMEABILITY TRANSITION PORE

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Ischemic brain diseases are among leading causes of human deaths and disabilities. Mitochondria mediate development of brain cell death during ischemia due to opening of the mitochondrial permeability transition pore (mPTP), therefore, regulation of mPTP opening might be as potential target for a disease-modifying treatment strategy in ischemic brain pathologies. Recent studies have demonstrated that suppression of mPTP opening by rotenone, an irreversible inhibitor of the mitochondrial electron transport chain complex I, was highly effective and escaped cells from death in heart and cell cultures. In this study we aimed to investigate the effects of complex I reversible modifying barbiturates used as intraperitoneal pentobarbital/ketamine anesthesia on rat brain cell viability and mitochondrial functions in brain regions cortex and cerebellum after 2 hours of total brain ischemia.

Our results showed that ischemia-induced mPTP opening was fully blocked in cortex and cerebellum mitochondria isolated after pentobarbital/ketamine anesthesia and ischemia. We also found that barbiturate anesthesia–induced neuroprotective effects were related with mild inhibition of NAD-dependent respiration and complex I activity in cortex and cerebellum mitochondria. Moreover, pentobarbital added directly increased the resistance of isolated normal cortex mitochondria to Ca^{2+}- induced activation of mPTP simultaneously with inhibition of respiration of NAD-substrates and mitochondrial complex I activity. Importantly, pentobarbital/ketamine anesthesia and ischemia- received animals showed significantly decreased level of necrosis in coronal slices from cortex and cerebellum. In summary, our study suggests that mild inhibition of mitochondrial complex I during barbiturate anesthesia may play an important role in mPTP regulation and cell viability in ischemic rat brains and that complex I modulators may be effective pharmacological agents for stroke treatment.

P7. MITOCHONDRIA-DERIVED SUPEROXIDE MEDIATES $A\beta_{1-42}$ OLIGOMER-INDUCED NEUROTOXICITY IN PRIMARY BRAIN CELL CULTURES

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Alzheimer disease (AD) is the most common dementia disorder in the elderly. One of the hallmarks of AD is the accumulation of beta-amyloid (Aβ) in the brain. Aβ is protein fragment that in a healthy brain is broken down and eliminated. In AD, these Aβ fragments accumulate to form soluble oligomers, bigger protofibrils and insoluble fibrils, however, the mechanism by which the Aβ induce cell death remains elusive. Recent research demonstrates importance of oxidative processes in AD pathogenesis. Mitochondria may produce reactive oxygen species (ROS) leading to mitochondrial dysfunction and neuronal death, however, the role of mitochondrial ROS in Aβ-induced neuronal death is not entirely understood. The aim of our study was to investigate whether various $A\beta_{1-42}$ aggregates, small Aβ1-42 oligomers (1-3 nm), large Aβ1-42 oligomers (>5 nm) and insoluble Aβ1-42 fibrils are capable to induce mitochondrial ROS generation and whether the mitochondrial ROS might mediate cell death in rat primary neuronal-glial cultures. Results with MitoSOX Red, a mitochondrial superoxide indicator, showed that only small $A\beta_{1-42}$ oligomers induced rapid mitochondrial superoxide production in neurons, astrocytes and microglial cells. Larger $A\beta_{1-42}$ oligomers (>5 nm) and $A\beta_{1-42}$ fibrils did not cause mitochondrial ROS production. MitoTEMPO, a scavenger of mitochondrial superoxide, significantly decreased superoxide level in all, neurons, astrocytes and microglia, after 1 hour incubation with small $A\beta_{1-42}$ oligomers. Importantly, small $A\beta_{1-42}$ oligomer-induced neuronal death and loss was significantly decreased by MitoTEMPO after 24 hours. Our findings suggest that small Aβ oligomers can be taken up by neurons, astrocytes and microglia and cause production of mitochondrial superoxide leading to neuronal.

P8. CENTRAL AMYGDALA MEDIATES EMOTIONAL CONTAGION

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Emotional contagion, i.e., sharing emotional states between individuals, is considered to be the simplest form of empathy. Even though this phenomenon was reported in several species in behavioural experiments, the neuronal circuits necessary for sharing emotions are poorly understood. In order to study this phenomenon, we used an experimental model in which one rat (observer) is watching a cage-mate (demonstrator) undergoing contextual fear conditioning. This kind of stimulation promotes ultrasonic vocalizations in 22-kHz, which are known to occur in aversive situations. What is more, observer rats mimic the behaviour of demonstrators and display freezing.

We hypothesized that social transmission of fear depends on central nucleus of the amygdala (CeA), a brain structure which is well known to be engaged in fear and anxiety regulaton in individual animals. To check this hypothesis, we injected a viral vector carrying channelorhodopsin 2 (ChR2) sequence into CeA. To ensure that the ChR2 would be expressed only in the subpopulation of CeA cells which are activated by the observational fear, it was placed under the c-fos gene promoter. Two weeks after the surgery the rats underwent observational transfer of fear; the control group was exposed to the experimental cage for the same amount of time. 24 hours later the rats were put into modified version of open field and the cells which had expressed c-fos on the previous day were activated with blue light.

The stimulation resulted in robust increase in avoidance behaviours in the experimental group, indicating that CeA cells which are activated by observational fear regulate anxiety. Using transgenic Venus-PSD95 rats in combination with PHA-L anterograde tracer, we also gathered some preliminary data suggesting that that within many brain structures, the cells which were activated by observational fear were getting projections from CeA. The results show that the CeA neural circuits activated by observational fear are involved in control of defensive behaviors.

P9. EVALUATION OF THE INFLUENCE OF 9-METHYL-2[-3-(4-M-CHLOROPHENYL-1-PIPERAZINYLPROPYL)]-1,2,3,4-TETRA HYDRO--CARBOLIN-1-ONE ON NOREPINEPHRINE LEVELS IN PREGNANT WISTAR RAT BRAINS AND DEVELOPMENT FETUSES

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The aim of this study was to investigate the influence of 9-methyl-2[-3-(4-m-chlorophenyl-1-piperazinylpropyl)]-1,2,3,4-tetrahydro-b-carbolin-1-one on norepinephrine levels in pregnant females rat brains and development rat fetuses of Wistar strain.

The chemical compound 9-methyl-2[-3-(4-m-chlorophenyl-1-piperazinylpropyl)]-1,2,3,4-tetrahydro-b-carbolin-1-one has an action similar to atypical antidepressant drug. This chemical compound has been synthesized at the Institute of Pharmacology, Polish Academy of Sciences in Cracow. The studies were performed as recommended by WHO.

Macroscopic external evaluation of fetuses, both sectional and skeletal according to Dawson's and Peter's methods were employed. The evaluation of birth defects of internal organs was carried out according to Wilson's technique in Barrow's and Taylor's modification.

Pregnant females (10-12 rats in each group) were treated with 1/50, 1/100, 1/250, 1/500, 1/1000 of DL_{50} (2000 mg/kg body mass) of 9-methyl-2[-3-(4-m-chlorophenyl-1-piperazinylpropyl)]-1,2,3,4-tetrahydro-b-carbolin-1-one by gavage on each day 7-14 of gestation. Four groups of pregnant females were controls: UC – untreated, TCa – treated with H_2O by gavage in equal volume, TCb- treated with carboxymethylocellulose by gavage in equal volume and ST- standard teratogen / chlormethine hydrochloride /. Females were euthanized and caesarean section were performed on last day of gestation. Malformations of fetuses were determinate by gross examination and Alcian Blue with Alizarin Red double skeletal staining. Obtained brains of pregnant females were fixed in liquid nitrogen homogenised and tested.

A significant differences of norepinephrine levels in pregnant females brains after 1/50 of DL_{50} of 9-methyl-2[-3-(4-m-chlorophenyl-1-piperazinylpropyl)]-1,2,3,4-tetrahydro-b-carbolin-1-one was noted.

On the basis of these studies it has been found out that 9-methyl-2[-3-(4-m-chlorophenyl-1-piperazinylpropyl)]-1,2,3,4-tetrahydro-b-carbolin-1-one in all doses has teratogenic effects. The highest incidents of malformed fetuses occurred after treated with 1/250 of DL_{50} of 9-methyl-2[-3-(4-m-chlorophenyl-1-piperazinylpropyl)]-1,2,3,4-tetrahydro-b-carbolin-1-one was noted.

P10. ACTIVATION OF MACROPHAGE WITH β-AMYLOID OLIGOMERS AND THEIR IMMUNE COMPLEXES

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Macrophages are a part of organism defense system. They remove pathogenic micro-organism and other biohazardous materials, give an activation signal to the immune system cells. However, in many cases it is unknown how macrophages are activated with potentially pathogenic proteins. For example, detailed mechanism of macrophage/microglia activation with β-amyloid (Aβ) during Alzheimer's disease is unclear.

The aim of the current research was to investigate the influence of Aβ oligomers and their immune complexes (IC) on macrophage phenotype. The research models were murine macrophage cell line J774, microglia cell line BV2 and primary spleen cell culture from BALB/c mice. We generated macrophage from splenic monocytes and used this culture in our research. The variations in the levels of cell markers – inflammatory macrophage M1 markers and anti-inflammatory macrophage M2 markers – were investigated by flow cytometry and ELISA.

Our results showed generation of both inflammatory and anti-inflammatory phenotype after splenic macrophages treatment with Aβ oligomers and their IC. The IC induced higher expression of M2-related marker IL-10 compared to Aβ oligomers alone. Higher levels of IL-10 may indicate a negative impact of IC on the phagocytic degradation of Aβ oligomers. J774 treatment with Aβ oligomers and their IC induced the inflammatory phenotype of macrophage. However, there was no change in expression of cell activation markers after BV2 treatment with Aβ oligomers. This shows that microglia is less sensitive to the same strength of activation signal. In conclusion, the activation of macrophages with oligomeric proteins and their IC can induce different signals and lead either to the inflammatory or anti-inflammatory phenotype depending on oligomeric proteins and the type of cells.

P11. NEURON-MICROGLIA INTERACTION: THE ROLE OF PHOSPHATIDYLSERINE IN SYNAPTIC PRUNING

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Nervous system development is associated with the generation of excess neuronal synapses that is followed by their tightly controlled removal, a process known as synaptic pruning. Microglia are involved in scavenging synapses and their pruning activity has been well reported in various parts of the brain. Altered neuron-microglia interactions during development may lead to defective maturation of neuronal connectivity. However, the neuronal "eat-me" signals that mediate phagocytosis recognition and engulfment of synapses remain to be identified.

One of the key "eat-me" signals for synaptic pruning during development might be the cell surface exposure of the lipid phosphatidylserine (PtdSer). PtdSer is located in the inner leaflet of plasma membrane and scramblase non-specifically translocate phospholipids across the lipid bilayer in both directions. One of phospholipid scramblases – Xk-related protein 8 (Xkr8) – may promote caspase-3-dependent PtdSer exposure on neurons' surface. To understand how PtdSer exposure contributes to the discrimination of synapses to be eliminated or maintained in developing hippocampus, we developed a mouse line that enables us to investigate morphological and electrophysiological properties of neurons with aberrant PtdSer scrambling.

Using acute and fixed brain slices from these Xkr8 knock-out mice we determined the effects on electrophysiological profile of hippocampal circuitry and morphological consequences for hippocampal synapses under scramblase deficiency.

P12. ANTIOXIDANT ENZYMES ACTIVITIES IN MICE BRAIN UNDER SELENIUM AND/OR ALIUMINIUM IONS TREATMENT

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The present study was conducted to determine how Al and Se ions alone and in combination could affect superoxide dismutases and catalase activities as well as distribution of these elements in the blood and the brain of mice.

Estimation of the element distribution in brain showed that concentrations did not differ from control. While in blood after 24 h exposure levels of Se increased in Se and Se+Al group. Levels of Al increased in Al and Se+Al group. After 14 d. IP injections increased only Al concentrations.

It was evaluated the effect of Al and Se ions alone and in combination on SOD and CAT activities in brain after single Al injection. The results showed that SOD activity was the same value in control and experimental groups. After a single Se dose injection SOD activity decreased by 33.0%. Subsequently, were evaluated changes in SOD activity following a single Se+Al injections and was observed a significant decrease. The results showed that 24 h after injection of Al, Se or their mixed, CAT activity in mouse brain was the same in the control and the experimental groups.

There were evaluated the effects of Al and/or Se on antioxidant enzymes activities after 14 d. IP injections. The results showed that injections of these elements alone did not cause changes of SOD activity. The data of the effect of both elements showed that SOD activity decreased by 29.4%. Meanwhile after 14 d. daily injections the obtained results showed that Al caused a statistically significant increase of brain CAT activity and the injections of Se and Se+Al solutions did not affect CAT activity.

Our studies revealed that Se and Al total effect in the mice brain reduce the SOD activity after 24 h and 14 d. repeated exposure; in the brain Se ions could counteract the effect of Al on the activity of CAT after 14 d. of intoxication.

P13. THE ANALYSIS OF STEROID HORMONES IN SALIVA AND BLOOD FROM GREY SEAL (*HALICHOERUS GRYPUS*) PUPS

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Grey seals (*Halichoerus grypus*) are large marine mammals. They are top predators and their population size often reflects the status of the environment they are living in. Once almost extinct, the population of grey seals is now rapidly growing and has a large impact on marine economy of Northern Atlantic and Baltic countries. A special attention is brought towards physiological aspects that control the size and the growth of their population. Steroids are important to neural development, sexual maturity and immune system of mammals. However, levels and effects of steroids, especially androgens and estrogens, have been very little studied in young grey seals, thus it is unknown what impact they have on early development of grey seals. Moreover, there are different methods that could be applied and used for collection and analysis of steroids in marine mammals.

In this study we analyzed the suitability of saliva use for analysis of steroid hormones – estradiol (E), testosterone (T) and cortisol (C) – of grey seal pups during their early development – lactation and post-weaning periods. We looked at a) sample collection, b) sample preparation and analysis, and c) compatibility of steroids in saliva and plasma samples.

Saliva (N = 37) and EDTA plasma (N = 32) samples were collected during the breeding season of grey seals in the Isle of May, 2012. Saliva was collected using synthetic swabs (Salimetrix Europe Ltd.). Saliva samples were heated at 60^0C and plasma samples were extracted with diethyl ether prior to analysis. Commercial ELISA kits (IBL-International GmbH.) were used for analysis and were validated for grey seal plasma and saliva assays for all studied steroids separately. Correlations were found between levels of saliva and plasma C ($r = 0.68$, $p < 0.001$) and E ($r = 0.65$, $p < 0.01$), but not T ($r = -0.07$, $p = 0.77$). The means of concentrations found in saliva (E: 11.77 ± 1.44 pg/ml; T: 130.53 ± 14.23 pg/ml, C: 0.21 ± 0.02 ug/dl) are comparable with those reported previously in other pinniped species.

Saliva collection cannot replace blood sampling in the wild due to highly contaminated and changeable environment of breeding grey seals and the need for fairly long restrain periods or sedation of animals during sampling procedure comparing with blood collection, but could be used in captivity as an alternative to blood sampling. Saliva sample preparation for analysis is faster than blood preparation and does not require sample extraction. Saliva could replace E and C steroid analysis in plasma. However, more work should be done on compatibility of T levels in blood and saliva in the future.

P14. OPTIMIZATION OF BIOLOGICAL MATERIAL PREPARATION METHOD FOR TRACE ELEMENTS ANALYSIS FOR INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY

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The monitoring of trace elements in human urine and blood plays an important role and gives better understanding of possible environmental and occupational contamination. Inductively coupled plasma mass spectrometry (ICP-MS) is a most suitable technique for the purpose because it exhibits a good precision, excellent sensitivity, and multielemental capability, so that majority of trace elements can be reliably monitored simultaneously in the same sample.

Biological material preparation is very important segment of ICP-MS analysis. The aim of the study was to find out which preparation method (mineralization or direct dilution) of biological material (blood and urine) is more reliable and gives the required preciseness to analyse cadmium (Cd) and lead (Pb) in biological material using ICP-MS. For that we used certified reference materials: Seronorm™ Trace Elements Urine Blank, Seronorm™ Trace Elements Whole Blood L-II (SERO AS, Norway), Clin Check® Trace Elements Whole Blood L-II (RECIPE, Germany). Microwave sample preparation system "Multiwave 3000" (Anton Paar, Austria) with closed quartz vessel XQ80 was used to prepare biological samples for mineralization method. And dilution with pure water up to appropriate volume was used as direct dilution technique. Total Cd and Pb concentrations in reference biological materials were determined by NexION™ 300 D ICP-MS (PerkinElmer, USA) and using Standard mode with argon gas. Each element in each biomaterial was analysed at least 3 times, analyses were repeated after 1 and 5 months.

We concluded that for ICP-MS analysis of Cd in urine appropriate preparation was mineralization method, of Pb in urine – direct dilution method. The examination of Pb and Cd in blood samples showed that both preparation methods were appropriate and reliable. Reliability and preciseness of results under proper samples storage conditions are at least 5 months.

P15. THE ANALYSIS OF SELENIUM AND MANGANESE USING INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY (ICP-MS) UNDER OPTIMAL CONDITIONS

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The aim of the study was to find the most reliable analysis mode of inductively coupled plasma mass spectrometry (ICP-MS) capable of giving the most accurate reading of selenium (Se) and manganese (Mn) in blood and urine. Furthermore, the accuracy and preciseness of analysis were investigated while monitoring the stability of sample to establish how long the sample may be stored and yield correct results.

The research was conducted using the NexION 300 ICP-MS (PerkinElmer, USA) equipped with nickel cones and quartz cyclonic spray chamber as a sample introduction system and applying three different modes: Standard Mode, Collision Mode KED (with kinetic energy discrimination) and Reaction Mode DRC (with a scanning quadruple), and following manufacturer recommendations. Se and Mn analysis were performed in certified reference materials: Seronorm™ Trace Elements Urine Blank, Seronorm™ Trace Elements Whole Blood L-II (SERO AS, Norway), Clin Check® Trace Elements Whole Blood L-II (RECIPE, Germany). Three trials of each sample were performed, where mode reliability and sample result accuracy were recorded, analyses were repeated after 1 and 5 months.

The results of the study showed that Standard mode is the only appropriate choice to analyze selenium in blood and urine. It was also established that both KED and DRC modes for Mn in blood, and DRC mode for Mn in urine were suitable for accurate and reliable analysis. Finally it was noted that if kept properly, reliability and preciseness of results are at least 5 months.

P16. THE STUDIES ON THE ROLE OF BRCA1 IN ALZHEIMER'S DISEASE USING PATIENT-DERIVED NEURONS

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Our knowledge and understanding of the molecular bases of Alzheimer's Disease is still limited by the imperfections of the existing *in vitro* or *in vivo* models. Therefore derivation of neural cell lines by reprogramming skin fibroblasts derived from Alzheimer's disease patients into neural stem cells can substantially fill this gap.

Alzheimer's disease patient derived fibroblasts have been reprogramed into induced pluripotent stem cells (iPS cells) using Yamanaka's factors. Next iPS cells heve been subjected to neural induction into neuro-epithelial like stem cells (NES cells). Finally, using a composition of suitable growth factors including NGF and BDNF, we have obtained neurons. Next, using molecular biology methods (qPCR), we tested mRNA expression profile of selected markers of neural precursors, maturing and mature neurons, and different types of neurons and glial cells. We concluded that we have obtained neurons representing the maturing population of glutaminergic neurons with some GABAergic. The level of expression of glial cells markers indicated a residual amout of these cells. Then, using immunocytochemical staining and Western blotting we verified neurons in terms of protein content and localisation of neurofilament L, VGLUT1, MAP2 and GFAP, respectively for neural and glial markers. According to our findings with the use of AD fibroblasts (Wężyk etv al. submitted), neural cells were further subjected to oxidative stress using doxorubicin. Comparision of fibroblasts with neurons showed that AD neurons are characterized by similar to AD fibroblasts pathology, manifested by increased content of BRCA1 and H2AX proteins and similar expression pattern of genes involved in DNA damage stress response. This study opens new and exciting research line on the role BRCA1 in AD neurons.

P17. MULTIPLE PULMONARY METASTASES FROM ASYMPTOMATIC BENIGN INTRACRANIAL MENINGIOMA: CASE REPORT

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Background. This case presents unexpected association between diseases and symptoms. We believe that it should compel clinicians to rethink the known behaviors of the benign tumors, in particular meningioma which can gain independent metastatic potential. This report aims to increase the awareness of clinicians toward patients with this unusual and clinically isolated pattern, because metastases can remain misdiagnosed for a long period of time. This case contributes to medical knowledge, diagnostic and prognostic approaches. This is also the first case of metastatic meningioma reported in Lithuania.

Case presentation. We report a 66 - year-old woman who presented with persistant productive cough, dyspnea, fever and weakness during physical activity. Chest radiographs revealed multiple small round shaped pulmonary nodules. Thoracoscopic resection and histopathology showed a benign meningioma. Magnetic resonance imaging scan of the brain demonstrated a small dural based mass in the left pontocerebellar angle connected with deep dilated cerebral venous network and superior petrosal sinus. Morphological findings of the session were consistent with a World Health Organization grade I fibrous meningioma.

Conclusion. Meningiomas are usually non-invasive tumors and do not metastasize and hence, are perceived as benign tumors. Patients with this uncommon and clinically isolated pattern of metastases can remain misdiagnosed for a long period of time, due to unexpected behavior of this particular tumor. This case report denies most of the criteria of possible risk factors for the development of metastases from a meningioma what allows to consider it as tumor with unpredictable behavior.

P18. IMPACT OF DEPRESSION AND PSYCHOLOGICAL DISTRESS ON PREOPERATIVE COGNITIVE PERFORMANCE OF BRAIN TUMOR PATIENTS

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Background. Decreased cognitive functioning is a common complication in brain tumor (BT) patients, leading to decreased quality of life and functional limitations. BT diagnosis is also frequently accompanied by increased levels of psychological distress and depression. This study aimed to evaluate cognitive performance of BT patients with clinical depression and increased levels of psychological distress.

Methods. 63 patients (18 [28.6%] glioma, 32 [50.8%] meningioma, 13 [20.6%] other types of BT), admitted for elective BT surgery were assessed using Trail Making Test (TMT), Rey Auditory Verbal Learning Test (RAVLT), and phonemic and semantic fluency tasks. Presence of depression was evaluated using The Mini-International Neuropsychiatric Interview; subjective level of psychological distress was assessed using Hospital Anxiety and Depression Scale (HADS).

Results and conclusions. 22 (35%) patients met diagnostic criteria for current Major Depressive Disorder (MDD), and 14 (22%) reported episodes of depression in the past. 22.7% of patients reported significantly increased levels of anxiety and 10.3% reported increased levels of depression. 58% of patients with current MDD and 71% of patients with past MDD were diagnosed with meningioma. No significant differences were observed in cognitive performance of patients with different types of tumors. Partial correlation analysis controlling for age revealed that current MDD was related to lower verbal fluency ($r=-0.33$, $p<0.05$). MDD episodes in the past were related to decreased psychomotor speed and executive functioning (TMT, Part A, $rho=0.47$, $p<0.01$; Part B, $rho=0.51$, $p<0.01$), and recognition errors (RAVLT, $rho=0.36$, $p<0.05$). Study results imply that current and recurrent depression might be related to decreased cognitive functioning in BT patients, making neuropsychological evaluation more complicated.

P19. INCIDENCE OF PRIMARY MALIGNANT CENTRAL NERVOUS SYSTEM TUMOURS IN LITHUANIA DURING 2007–2014

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Primary malignant brain tumours are rare but represent a serious health burden due to their poor prognosis.

This study describes the incidence rate (IR) of primary malignant central nervous system (PM CNS) tumours in Lithuania during 2007–2014 and the changes of the IR.

Data of the patients who were diagnosed with tumours during 2007–2014 was analysed. Data was obtained from the Lithuanian Cancer Registry and the Neurooncology Sector of the Hospital of Lithuanian University of Health Sciences Kaunas Clinics Neurosurgery clinic. $\chi 2$ test was applied to compare qualitative data, linear regression analysis of log transformed IR – to evaluate the changes. Statistical significance level $\alpha=0.05$.

Total 1704 new cases of PM CNS tumours were registered during 2007-2014. 85.5 % of new cases were gliomas (most common were glioblastomas (68.4 %) and astrocystomas (18.4 %), $p<0.001$), embryonal tumours – 1.8 %, meningeal – 0.9 %, neuronal – 1.0 % ($p=0.016$). 89.1 % had supratentorial location, 4.7 % – subtentorial, 3.9 % – brain stem, 2.3 % – spinal cord ($p<0.001$).

The total IR was 6.75/100000 (men 7.06/100000, women 6.49/100000). IR was highest at the age of 65-74. The IR of supratentorial tumours was 5.84/100000, subtentorial – 0.31/100000, brain stem – 0.25/100000, spinal cord – 0.15/100000. IR of subtentorial tumours increased by 8 %, brain stem tumours decreased by 15 % ($p<0.05$). IR of gliomas was 5.86/100000, meningeal tumours – 0.06/100000, neuronal – 0.07/100000, embryonal – 0.13/100000. IR of glioblastomas was 4.01/100000, astrocystomas – 1.08/100000, oligodendrogliomas – 0.27/100000.

In conclusion, the IR was higher for men. The IR was highest at the 65–74 years of age. No significant changes of IR during 2007-2014 were found in different age, sex and histological type groups. Changes of IR of supratentorial and the spinal cord tumours were not significant. IR of subtentorial tumours has significantly increased, brain stem tumours – decreased.

P20. QUANTITATIVE PROFILES OF A SET OF CANCER-ASSOCIATED PROTEINS IN SERA OF PATIENTS DIAGNOSED WITH GLIOMA

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Glioma is one of the most common and highly malignant brain tumors with most patients having poor prognosis. The treatment of glioma is complicated by the absence of reliable tools, which would allow to monitor essential aspects of tumorigenesis such as cell invasiveness and angiogenesis. To improve early and noninvasive diagnostic it is important to create highly sensitive, glioma-specific detection methods based on circulating molecular markers in sera of glioma patients. Although, single biomarkers of gliomas are detected in the blood, there are no widely accepted biomarkers in sera for detection, follow-up and prognostication of glioma.

To achieve that, 10 proteins playing key role in the angiogenesis and invasion of tumor were selected. We performed multiplex screening of sera proteins in 29 patients with different malignancy grades of glioma and 23 healthy controls using antibody-pair-based assay containing AREG, MMP2, PAI-I, NCAM-1, TGF beta1, OPN, IGF-1, ANG-1, IP-10 and TIMP-1. Semi-quantitative comparison of protein levels were measured in the preoperative and postoperative patient sera. Gene expression at the mRNA level in tumor tissue of the same patients was investigated using RT-PCR.

Comparison of protein levels in blood serum samples before and after operation showed that there was the relationship among protein levels. We found slight increase in the level of postoperative sera AREG and OPN as compared to pre-operative sera. Compared to normal controls and patients with astrocytoma grade II glioblastoma patients exhibited significantly lower levels of several sera proteins, such as PAI-I, NCAM-1 and TGF beta1. PAI-I, NCAM-1 and TGF beta1 protein level in serum may be related with glioblastoma. The significance of these proteins needs to be further characterized.

P21. THE FIRST DETERMINATION OF MAXIMAL NORMAL CORTICAL MOTOR CONDUCTION TIME IN A HEALTHY LITHUANIAN POPULATION AND THE RELATION BETWEEN SLEEPING HABITS AND CORTICAL MOTOR THRESHOLD

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Purpose. To measure the central motor conduction time (CMCT) in healthy individuals as well as to determine the relation between cortical motor threshold (CMT) and sleeping habits in healthy individuals.

Method. We have investigated 50 healthy adult volunteers (12 males and 38 females; age=23±0.6 years) using TMS. The peripheral motor latency (PML) was estimated using the F-wave method using motor-evoked potentials (MEPs) from the *m.abuductor pollicis brevis*. With a round coil we estimated CMT at rest. A single-pulse stimulation at a suprathreshold intensity was performed and 5 MEP's from the target muscle were recorded. CMCT was obtained by subtracting PML from the total latency. A second T MS investigation was performed on 23 subjects in order to compare the results of the first and the second trials. 27 of our subjects completed the Epworth Sleepiness Scale (ESS) questionnaire and answered questions on their sleeping habits.

Results. The mean CMCT was 6.95 ms, SD 0,59 ms (n=144). Maximal normal interhemispheric difference was 1,99 ms. In CMT significant difference was found between men and women (45.11% vs. 39.95%, p=0.033). No correlation was found between the ESS Score and motor thresholds (p=0.673) in neither the dominating (p=0.785) or the non-dominating (p=0.982) hemispheres. Subjects who slept less than 7 hours per day demonstrated a tendency to have lower mean CMT (39.42% in the dominating hemisphere, 38.69% in the non-dominating hemisphere) than those who slept longer than 7 hours per day (43.15% in the dominating hemisphere and 42.50% in the non-dominating hemisphere), but statistical significance was not reached (p=0.088).

Conclusions. The maximal normal CMCT (8,43 ms) and interhemispheric difference in CMCT (1,99 ms) in a healthy Lithuanian population were evaluated.

No correlation was found between the ESS score and motor thresholds.

A tendency for CMT to be lower in individuals who sleep fewer hours per day than recommened was observed.

P22. EVALUATION OF CEREBRAL BLOOD FLOW VELOCITY DURING LANGUAGE PROCESSING USING TRANSCRANIAL DOPPLER SONOGRAPHY

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Background. Transcranial Doppler sonography (TCD) enables the detection of cerebral blood flow velocity (BFV) changes induced by language processing.

Aim. The aim of this study was to evaluate cerebral blood flow velocity changes during phonological and semantic fluency tasks requiring both overt and covert word generation.

Methods. Simultaneous bilateral TCD monitoring of BFV in the middle cerebral arteries (MCAs) was performed in 10 healthy volunteers during 4 separate groups of tasks: phonological-covert, phonological-overt, semantic-covert and semantic-overt. All subjects were right-handed, as measured by the Edinburgh Handedness Inventory.

Results. Total of 6 females and 4 males, aged 23-27 (mean ± SD age 24,2 ± 1,23) were examined. Phonological-covert, semantic-covert and semantic-overt tasks induced bilateral relative BFV decrease in the MCAs compared with the preceding rest periods. However, mean BFV in the left MCA remained greater than the mean BFV in the right MCA (-0.98% *vs.* -2.52%, p=0.092; -1.82% *vs.* -3.69%, p<0.05; -1.54% *vs.* -3.89%, p<0.05, respectively). Only overt-phonologic word generation task demonstrated a 1.6% increase of mean BFV in the left MCA (p<0.05). We did not observe any signifficant correlations of mean interhemispheric BFV changes across each of the four conditions, although the correlation coefficient of -0.370 (p=0,293) between semantic-covert and fonetic-overt tasks was observed.

Conclusions. A greater mean BFV in the left MCA was detected throughout all language tasks, but only phonologic-overt word generation induced an increase of mean BFV compared to a resting baseline.

P23. ASSESSMENT OF RESTING-STATE EXPERIENCE IN SCHIZOPHRENIA

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Resting state (RS) is the functional state of the brain during a no-task or low-demanding task, viewed as ones inner mentation. Changes of brain functioning during the RS were found in schizophrenia (Sz). Most of the RS research focuses on objective methods to evaluate RS (EEG, fMRI), although more easily applicable subjective methods, such as Amsterdam Resting-State questionnaire (ARSQ), could have a potential application in RS studies. Our aim was to evaluate RS using ARSQ in subjects with Sz.

Thirty Sz patients (age 37.9 SD 13) completed a 5-minute eyes-closed resting session following a paper version of ARSQ. Fifty items were self-rated in a 5-point Likert scale. Items were clustered into 7 dimensions: Discontinuity of Mind, Theory of Mind (ToM), Self, Planning, Sleepiness (Sleep), Comfort and Somatic Awareness. Some of the items depicted motivation to participate, ability to remember thoughts and feelings, ability to rate the items and had their eyes closed during the whole session. The data was compared with normative data taken from Diaz et al. (2013).

Before applying exclusion criteria, subjects with Sz scored higher on Sleep, ToM and Planning dimension but lower on Comfort. The results could be related to higher sleepiness in Sz patients, as some studies found that transition to first sleep stage correlated to Tom, Sleep and Planning experience. When exclusion items were taken in consideration, only 3 out of 30 questionnaires met the criteria (as opposed to 60% in healthy group by Diaz et al.). The main problems were as following: inability to rate the items, items rated several times, inability to stay with closed eyes through the session, all items rated in extremes, low motivation, inability to remember thoughts or feelings. It took longer for Sz subjects to finish the ARSQ and a few subjects were afraid of staying with eyes closed. Thus, the ARSQ (at least the self-reported paper version of it) does not seem to be a valuable tool for clinical RS research in Sz.

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P24. AUDITORY STEADY-STATE RESPONSES TO STIMULATION OF DIFFERENT PRESENTATION ORDER AND DURATION

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The brain electroencephalographic (EEG) oscillatory activity within gamma range (30–80 Hz) frequencies is known to be important for a number of perceptual and cognitive processes. EEG oscillatory activity has also been shown to synchronize with fast repetitive external stimuli. The auditory steady-state responses (ASSRs) follow the frequency of stimulation and have the greatest magnitude when stimuli are presented at 40 Hz. 40 Hz ASSR power and phase precision are decreased in schizophrenia and bipolar disorder and therefore 40 Hz ASSR is increasingly used as a biomarker for neuropsychiatric disorders. However, the impact of basic stimulus properties for obtaining the reliable ASSR is far less frequently studied.

The aim of this study was to investigate whether auditory stimulus-train presentation order and duration has impact on 40 Hz ASSR. To achieve the aim, ASSRs recorded with EEG in 14 healthy participants were analysed. Stimuli were bursts of white noise with train frequency of 40 Hz. Stimuli were different in duration (500, 1000, 1500 and 2000 ms). In addition, same duration stimuli were presented both in regular and random orders. The mean power of the ASSR at Fz and FCz electrodes were estimated in the time window of 0–500 ms.

The results indicate that 40 Hz ASSR power is significantly lower to stimuli presented in random order compared to regular order. None of differences between ASSR to stimuli of various duration were statistically significant. These results may have been due to attentional processing. However, further studies, which take these variables into account will need to be undertaken.

P25. RESTING STATE EEG ALPHA IN SUBJECTS WITH NORMAL AND ABNORMAL BODY WEIGHT

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Up to date only two studies examined effect of body weight on the resting state EEG parameters. In both studies changes in alpha power were observed. We aimed to examine the hypothesis that alpha power differs in abnormal body weight subjects compared with normal-weight subjects.

Resting EEG data were recorded from 16 electrodes in 19 underweight subjects, 19 normal-weight subjects, and 23 overweight/obese subjects under both eyes-closed and eyes-open conditions. Power in alpha (8-12 Hz) band was analyzed in three electrodes (Fz, Cz, Pz).

Analyses of variance among the factor group (underweight, normal-weight, overweight/obese) showed no significant differences of alpha ($p>0.05$) among either in eyes-closed or in eyes-open conditions. Although results were not significant, a trend for alpha power to fit to the pattern normal-weight>underweight, overweight/obese could be observed.

Abnormal weight is not related to abnormal resting state alpha compared to normal-weight subjects and more studies are necessary to examine the relation between body weight and abnormal neural synchronization of resting state alpha rhythms.

P26. PLEASANTNESS ASSESSMENT OF 40HZ AUDITORY CLICK STIMULATION TRAILS: DURATION EFFECT

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40 Hz auditory steady-state responses (ASSR) are used to test the ability of local cortical networks to generate gamma frequency activity in patients with psychiatric disorders. However subjective reports of participants indicate that click stimulation is not pleasant. To date, no research has explored how duration of click trains fused or elicitation of 40Hz ASSR influence subjective responses.

Twenty six healthy participants took part in the experiment (age range 20–40; 13 females). Subjects were presented 40 Hz click trains of 500 ms, 1000 ms, 1500, ms and 2000 ms. For subjective evaluation, 20 stimuli of each type were presented. Sounds were presented in a randomized order. The experiment was programmed and presented using Psychopy software. Subjects were asked to evaluate how arousing the sound was (arousal) and how pleasant the sound was (valence). Arousal scale was ranging from 1 as "not arousing" to 9 as "very arousing"; valence scale was from 1 as "very unpleasant" to 9 as "very pleasant". Effect of stimulus train duration and subject's gender was evaluated in repeated measures ANOVA.

Arousal of the stimuli was rated similarly by both males and females – shorter stimuli were rated as less arousing. Significant interaction between gender and duration occurred for valence: short duration stimuli were rated as more pleasant by females, whereas longer duration stimuli were rated as more pleasant by males.

The pleasantness of click trains is differently rated by males and females. The arousing effect of click trains depends on train duration.

P27. SEX DIFFERENCES IN THE HUMAN BRAIN ACTIVITY AT TESTING OF THE WORKING MEMORY FOR VERBAL AND NONVERBAL STIMULUS

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At presence of general working memory structure, women and men use different strategy of the verbal and nonverbal information memorization. The EEG spectral and coherent analyses, which was registered during working memory testing, have shown that in the processes of storing simple geometrical figures men and women formed integrated memory neural network in which men were involved in almost all areas of the brain, and which consisted the interaction of the visual stimuli remembering and logical-semantic analysis of their features. While women nonverbal information processing took place more locally, neural network of logical-semantic analysis involving imagination of previously seen stimuli formed. Under conditions of the task complexity increasing – in the test on remembering geometrical figures with two signs in which we modeled an information overload, both men's and women's interhemispheric synchronization was destroyed, and men rather remembered what they have seen, and the women – what they thought about what they have seen. The time of women reaction was significantly higher than for men, but the significant difference in a percent of errors between men and women wasn't found.

Under conditions of the memorizing verbal information – a set of letters and association by similarity and association by adjacency in time and in space, for women in addition to the front area was still active posterior associative cortex. For men, increased activity was observed in the frontal areas of the brain, more in the left hemisphere. It wasn't found significant differences between men and women in numbers of errors, but in memorizing association by adjacency in time women lost significantly more time, this was the most difficult task for them. These results show that men and women realized different strategies in working memory, but that lead to almost identical results.

P28. GENDER DIFFERENCES IN FRONTAL LOBE HEMODYNAMIC RESPONSE DURING COGNITIVE TASK PERFORMANCE

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Aim of this study: Executive functioning is one of the main traits of higher-level cognition in humans. For over four decades the Wisconsin Card Sorting Test (WCST) has been one of the most distinctive tests of prefrontal function, but clinical research and recent brain imaging data have brought into question the validity and specificity of this test because of an unexplained variability of neuroimaging results across studies[1]. The aim of this work was to investigate possible gender differences in hemodynamic response obtained during computerized WCST which in turn could explain this variability by the ratio of gender in subjects' cohort.

Subjects: We analyzed 30 healthy 21.6 ± 2.6 year-old right-handers (50% females) without diagnosed mental or cardiovascular disorders.

Device: CW-type 16 optode fNIR400 device, Biopac.

Test: We used the modified version of freely accessible computerized Wisconsin Card Sorting Test (WCST)[2].

Results: No significant differences between males and females in WCST performance were obtained: the average correct sorting rate was 79.90 % and 79.11 % (99 % CI), and 14.1 ± 7.4 and 14.5 ± 5.9 of perseveration errors.

Time-series z-score group level analysis show quantitative ($p<0.05$) and qualitative differences between genders. No significant hemispheric differences were found. Time-series group level analysis using normalization by max value, show quantitative differences ($p<0.05$). However, it does not apply for all optodes. No significant qualitative and hemispheric differences were found. Calculations of Laterality index show that oxygenized, deoxygenized, and total hemoglobin – all are lateralized in the right side of the prefrontal cortex, but oxygenation ([Hbo]-[Hbr]) show strong lateralization to the left side for both male and female groups, especially for rostral prefrontal cortex.

Conclusion: gender ratio in cohort solely may only partially explain some of the disagreements on the activated brain areas during WCST[1]. However, an impact of hormone levels and handedness was not investigated.

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P29. CUE VALENCE MODULATES EVENT PRECEDING BRAIN ACTIVITY

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Neural activity elicited by an emotional event depends on its valence (positive, neutral or negative). However, it is barely known how a cue, indicating upcoming valence, affects anticipatory brain activity and does this activity relate to later stimuli recollection.

In this study of event related potentials (ERP) we presented emotional words which emotional valence was indicated by cue (☺, 😐 or ☹) preceding each word (for example *laugh, door, crash*). During the first part of the task participants (21 female of 23±3 years old) were asked to indicate emotional valence of given words. In the second part, performed an hour later, the retrieval of previously presented words was tested.

Comparison of the prestimulus (cue evoked) brain activity revealed significant effect of the cue valence in time interval from about 250 to 400 ms after the cue onset. The cue indicating the negative valence evoked significantly higher positivity over the right centroparietal scalp area as compared to the cue indicating the positive valence. This means that cue valence modulates anticipatory brain activity and may have significant effect on the further processing of the emotional information.

In addition, we observed that in the whole time window after the cue onset Global Field Power (which represents the global strength of scalp fields) was significantly higher ($p<0.02$) for forgotten words as compared to remembered words (retrospectively evaluated). This may indicate quantitatively higher level of brain activity before the words which were forgotten. However, the mean accuracy of the retrieval of words was 67,8%. Consequently, the amount of data used for comparison was unequal for remembered (~68%) *vs* forgotten (~32%) conditions. Therefore, the results from this part of the study should be treated with care.

P30. TENDENCY TO WORRY ABOUT UNPLEASANT BODY SENSATIONS IS ASSOCIATED WITH NEUROTICISM, BUT ONLY WORRY IS REFLECTED IN HEARTBEAT EVOKED POTENTIALS

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Anxiety may be considered a consequence of noisily amplified self-referential interoceptive predictive states of belief. Neuroticism – one of the anxiety phenotypes – refers to relatively stable tendencies to experience psychological distress and negative emotions. Various interoceptive aspects are known to be reflected in Heartbeat Evoked Potentials (HEPs).

To examine whether worry and/or neuroticism are interrelated and reflected in HEPs, 40 healthy subjects (50% males, aged 19–30 years) were recruited to fill in the Multidimensional Assessment of Interoceptive Awareness (MAIA) and NEO Personality Inventory (NEO PI-R) questionnaires. To measure HEPs, EEG and EKG were recorded during the resting state.

MAIA scores on Not-Worrying scale had a weak correlation with scores on NEO PI-R Neuroticism scale ($r = -0.32$, $p = 0.04$) in whole sample, and a moderate correlation in female subsample ($r = -0.52$, $p = 0.02$). A moderate positive correlation between mean HEP amplitudes in 455–550 ms window at vertex and MAIA Not-Worrying scale was found ($r = 0.58$, $p < 0.001$ in the whole sample; $r = 0.70$, $p = 0.002$ in females subsample), suggesting that the less subject worry or experience emotional distress with sensations of pain or discomfort, the more positive HEP amplitude is; this association remained even after controlling for neuroticism level ($r = 0.54$, $p = 0.003$ in the whole sample; $r = 0.67$, $p = 0.004$ in females subsample). NEO PI-R scores on Neuroticism scale were not associated with HEP amplitudes.

Neural activity evaluated by HEPs was shown to be related to the ability not to worry about unpleasant body sensations, but not to personality trait of neuroticism.

P31. EXTRACTION OF RESONANCE FREQUENCY FROM ITPC AND POWER MEASURES

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The individual preference for gamma band (30-80 Hz) frequencies has been shown. It was described as the maximal response frequency to periodic stimulation eliciting auditory steady-state responses (ASSRs) – resonance frequency. Experimental studies reveal that individual frequency is associated with person's time resolution in sound processing and language processing. The results were based on power measure. However, it is known that inter-trial phase coherence (ITPC) is a more reproducible and reliable parameter, but it is unknown if results obtained with ITPC resemble those obtained with power.

The ASSR data to stimulation frequencies ranging from 35 Hz to 55 Hz in a 1 Hz step were collected in a sample of 39 healthy subjects. The maximum resonance frequency was extracted separately for each measurement – power and ITPC - in three locations at Fz, FCz, Cz.

Neither parameter (power vs ITPC; $F(1, 38) = 3.51$, $p > .05$) nor electrode (Fz vs FCz vs Cz; $F(1.6, 61.4) = 3.2$, $p > .05$) effect was found on maximum resonance frequency. Spearman correlation analysis revealed that frequencies identified both with power and ITPC are positively correlated in-between at all locations (Fz=.48; FCz =.42; Cz=.55).

We conclude that ITPC-extracted maximum resonance frequency is similar to power-extracted, suggesting that it can be evaluated from ITPCs in further studies.

P32. THE MAGNETIC AUDITORY STEADY STATE RESPONSES (MEG-ASSRS) DO NOT DIFFER BETWEEN EYES-CLOSED AND EYES-OPEN CONDITIONS

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Auditory steady-state response (ASSR) is an electromagnetic brain signal recorded in response to periodically presented auditory stimuli. The frequency of the ASSR is close to the frequency of stimulation and reflects the ability of neural networks to synchronize. Some previously reported electroencephalographic ASSR (EEG-ASSR) data suggest that ASSRs are larger in eyes closed condition compared with the eyes open one. By utilizing a whole-head, 306-channel magnetoencephalography (MEG) system in 12 healthy subjects, we aimed to determine whether this finding holds true for MEG-ASSRs.

We have evaluated MEG-ASSRs elicited by 20 Hz and 40 Hz click trains during eyes closed and eyes open conditions. The phase-locking factor, dipole moments and source locations of the ASSR have been estimated.

Consistently with the results of previous studies, both dipole moments and phase-locking factors of MEG-ASSRs were significantly larger in the right hemisphere. However, contrary to published EEG-ASSR studies, we found no significant differences between MEG-ASSRs in eyes closed and eyes open conditions. Moreover, dipole analysis of 20 and 40 Hz MEG-ASSRs did not reveal significant differences.

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P33. RELATIONSHIP OF MENTAL ILLNESS WITH SIMPLE AND COMPLEX INFORMATION PROCESSING SPEED, MEMORY AND SET-SHIFTING ABILITIES

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While, without a doubt, mental disorders are very heterogeneous in clinical manifestations and etiology, almost without exception they are related to decrease in information processing speed (IPS). This association is explained by neurobiological changes due to mental illness. Psychosocial aspects of mental illness are also major area of contemporary scientific interest. However, less attention has been paid to the fact that simple and complex IPS impairment might be analyzed separately. The overall purpose was to analyze the role of simple and complex IPS in cognitive functioning among people suffering from mental disorders. General clinical sample (N = 104) was compared to healthy controls (N = 381). General clinical sample of mental illness was composed of persons with self-reported history of mental disorder(s), persons being treated for mild-moderate (F10-F99, except F20-F29) mental disorder, and persons who were being treated for severe (F20-F29) mental disorder. Neuropsychological battery of eleven computer administered tasks was used in order to measure simple IPS, complex IPS, memory, and set-shifting. Additionally, demographic information was collected. People with mental illness obtained lower performance scores on simple IPS, complex IPS, memory and mental set-shifting tasks compared to healthy controls. Mental illness was directly and indirectly related to cognitive domains. Based on estimation of direct and indirect effects simple IPS is the strongest mediator of mental illness relations with other cognitive domains. Therefore, we can assume that mental illness leads to decrease in both simple and complex IPS, whereas slower IPS leads to decline in performance on memory and mental set-shifting tasks. Due to limited sample of subjects with mental illness, disease-specific analysis of interrelations between various cognitive domains was not conducted, yet future research in this area might provide addition insight into manifestation of mental illness.

P34. A NEW METHOD FOR CONSUMERS' SOCIABILITY RESEARCH IN SOCIAL MEDIA: FROM A NEUROMARKETING PERSPECTIVE

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Nowadays the increased use of social media technologies has created new opportunities for consumers and companies to promote social interactions online. These social interactions are diverse from traditional social interactions in terms of quantity, quality. However, consumers' sociability refers to the social interaction between two or more users, includes "a sense of being together" (or "social presence") and occurs in social media. The academic literature has revealed different approaches to measure consumers' sociability in the virtual environment. These approaches involve unidimensional and multidimensional conceptualisations of consumers' sociability, regarding the social presence theory. Furthermore, the latter conceptualisation explains the nature of "consumers' sociability" comprehensively but promotes methodological challenges. Special attention has been paid to the unidimensional approach for the measurement of "consumers' sociability" in the marketing literature. In contrast, other studies of the literature on information systems (IS) literature have relied on the multidimensional approach and have highlighted some methodological complexities. Since little is known with regard to the integration of neuromarketing techniques in the "consumers' sociability" research domain, it highlights the improvements that neuromarketing techniques might provide in studying consumers' sociability. The purpose of this paper is to provide a new method for measuring consumers' sociability in social media from the neuromarketing perspective. The study has employed a systematic review and comparative analysis of existing studies measuring consumers' sociability from diverse disciplines. The importance of various neuromarketing techniques such as electroencephalography (EEG), galvanic skin conductance (GSR) and others has been analysed. The current paper advocates a new methodological approach by using these techniques which can be used to assess consumers' sociability in social media. Future implications for researchers are included.

P35. LINK TO THE OPPEL-KUNDT ILLUSION REASONS

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Geometrical optical illusions help in lighting the way to interesting new neuroscience approach. For further studies of the Oppel-Kundt illusion, three filled/unfilled horizontal patterns are taken for separate and superposed presentations in psychophysical experiments: (1) a regular sequence of seven vertical stripes, (2) contour rectangle, and (3) uniformly filled rectangle forming a solid block. The empty test interval is terminated by a stripe identical with the filling stripes and vertical edges of rectangles in height and luminance. Two combined filling structures are raised by the basic stimuli superposition: (4) stripes within the outlined rectangle, and (5) stripes on the uniformly filled block. A possible effect of summation of the perceived distortions is under consideration. Subjects adjust the length of the test interval to that of the referential one, and the matching errors if occurring are considered as the illusion magnitude. The three original versions of the filling pattern (1, 2, and 3) produce illusory distortions about equal in magnitude. The combined stimuli (4 and 5) show readily the same values without any increase or decrease of the perceived distortions. Obviously, neither stripes nor solid filling contribute to the illusion. A single feature common to all five stimuli, the horizontal contours, both real and interpolated, may cause the overestimation of the filled interval length. The contours produce excitation continuities in the neural networks. The spatiotemporal integration along a continuous excitation pathway results into the perceived distance increase if compared to the percept of the empty interval extent.

P36. INFLUENCE OF FILLING DISCONTINUITY ON THE STRENGTH OF THE OPPEL-KUNDT ILLUSION

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In present study, we examined the filled/unfilled illusion strength as a function of degree of contextual filling (by the horizontal line segment) of the referential interval of the three-dot stimulus. In experiments, two variants of filling discontinuity were checked. In the first one, the length of the line segment (placed in the centre of the referential interval) varied from zero to complete filling of the interval. In the second, the length of the segment was constant but the extension of the referential interval varied (the positions of the terminal spots of the referential interval moved aside from the line segment ends symmetrically, thus, forming the empty gaps and producing discontinuities in the filling). Subjects adjusted the length of the empty test interval to that of the reference, and the matching errors were considered as the illusion magnitude. The data obtained from twenty-nine subjects showed increasing overestimation of the referential interval with growing length of the context, and continues decreasing of the illusion strength with the growing of the interval length. The dependencies established were used to develop a new semi-empirical mathematical model functions of which were successfully applied to fit the experimental curves of the present study and those obtained earlier for conventional Oppel-Kundt stimuli with regularly distributed subdividing elements in the filled part.

P37. INFLUENCE OF GABA SYNAPTIC PROPERTIES AND POISSON INPUT FREQUENCY ON OSCILLATION PATTERN IN A MODEL OF SPIKING NEURAL NETWORK

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In this study we use a model of spiking neural network to investigate the effect of increased GABA synaptic conductance decay time constant and varied frequency of Poisson noise input on the resting state oscillations. The model consists of 1000 leaky integrate-and-fire neurons with realistics connectivity patterns and poportions of neuronal populations of 800 pyramidal neurons (PCs), 150 regular-spiking interneurons (RSIs) and 50 fast-spiking interneurons (FSIs) (Spencer in Frontiers in Human Neuroscience 3, 2009). All cells are randomly interconnected and have recurrent connections between each other. Poisson noise input to network cells represents background activity in the cortex and is set to 4Hz, 25Hz and 100Hz.

Synchronous oscillations of g frequency are obtained for all frequencies of Poisson noise inputs, but AMPA, NMDA and GABA synaptic weights of the network have to be readjusted. Network activity is also dependent on the alterations in properties of GABA synaptic conductance. Increased GABA synaptic conductance decay time constant leads to the reduced frequency of the network resting state oscillations.

Activity of the spiking neural network is influenced by synaptic weights, properties of GABA synapses and Poisson noise input. Such non-linear complex dynamical systems can be investigated using computational modelling techniques, contributing to understand intrinsic mechanisms of oscillations in healthy and pathological conditions of the brain.

P38. MULTIDIMENSIONALITY OF SYNAPTIC PLASTICITY: INTERACTIONS BETWEEN SPIKE TIMING, FREQUENCY AND NEUROMODULATIONS

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Synaptic plasticity, the ability of synapses to change their strength over time in response to different levels of neural activity, is influenced by a myriad of factors. The specific brain region, age and mental state of the subject and existing pathological conditions may result in different cellular, neurochemical and electrophysiological mechanisms, giving shape to rules that govern synaptic plasticity. In this study we focus on three factors and their interactions in shaping plasticity rules of a model CA1 hippocampal pyramidal cell Schaffer collateral synapse: spiking frequency, spike timing and neurotransmitter by acetylcholine (ACh). Both spike frequency and timing have received significant attention in the empirical literature, however data on their interaction with neurotransmitters is scarce. Existing literature shows that ACh increases cellular excitability via different mechanisms: inhibition of various types of potassium channels [1] and mixed effects on different subtypes of voltage gated Ca^{2+} channels [5]. What is more, it has been shown that ACh has direct potentiating effects on synaptic plasticity [2]. These two observations lead to a question: whether and under what conditions do potentiating ACh effects saturate and become irrelevant? Using Neuron 7.4 simulation environment, we combine models of Ca^{2+} based NMDA glutamate receptor dependent plasticity [3] and of a detailed CA1 pyramidal cell [4] to study synaptic plasticity, pairing single spikes at low and high frequencies. Preliminary results show that ACh differentially affects plasticity rules depending both on pairing frequency and spike timing.

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Program and Abstracts

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