UNIVERSIDADE FEDERAL DO RIO GRANDE DO NORTE

INSTITUTO DO CÉREBRO

Venue:
BRAIN INSTITUTE
UFRN CENTRAL CAMPUS

NATAL
November 17-18, 2022

GREETINGS

Dear all,

We are approaching another end of the year and with it comes the House Symposium, which this year will be on November 17th and 18th. This is the first in-person House Symposium after we moved into our long-awaited home, now at the UFRN main campus (location here).

There will be two days of various activities, including lectures, posters, round tables, film presentations, and cultural activities. The event is open to the entire community interested in learning more about the different lines of research at the Instituto do Cérebro (ICe-UFRN).

To be able to participate, you need to register here. The registration deadline is November 11th, 23:59 BRST.

In addition to registration, we encourage researchers at all levels (undergraduate, graduate, and postdocs) to present their work. Don't miss this opportunity to publicize, discuss and improve your research.

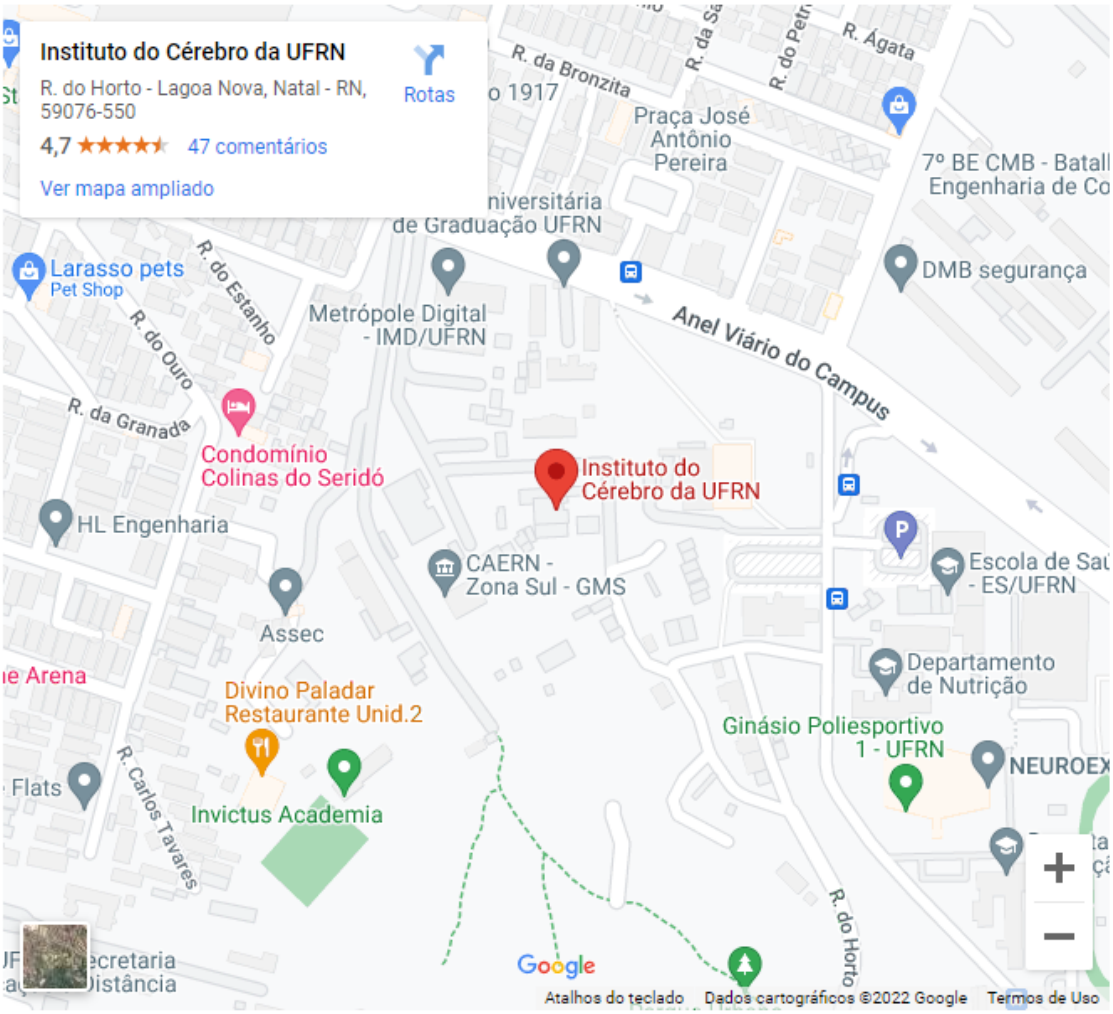
Abstracts for poster presentations can be submitted here. All poster presenters should submit 1 slide for the flash talk session. The submission deadline is November 11th, 23:59 BRST.

Come join us!

Sincerely,

Organization Committee

Venue: Brain Institute/UFRN, Auditorium, Natal – RN
https://www.neuro.ufrn.br/



Program at a glance

November 17th

14:00 – Opening words (Adriano Tort/Draulio Araujo)

14:15 – ICe directors address (Kerstin Schmidt/Maria Bernardete)

14:30 – "Porque a Terra é plana e você ainda não sabe: Entre a Ciência e o Obscurantismo." (Sergio Neuenschwander)

15:00 – Movie exhibition: "Eu sou uma arara", de Mariana Lacerda e Rivane Neuenschwander**,** 2022 (24 min)

15:30 – Students flash talks

16:00 – Coffee Break & Poster Session

17:30 – Capoeira with Sidarta Ribeiro

November 18th

9:30 – Coffee & Poster Session

Talk Session 1

Moderator: Fernanda Palhano

10:00 – "Dream content and slow EEG oscillations during human sleep predict prey adaptation in a predator-versus-prey videogame" (Daniel Brandão/Sidarta Lab)

10:30 – "How different hypotheses for the mechanism of zika virus entrance in the embryonic CNS help to explain the diversity of phenotypes found in human patients?" (Eduardo Sequerra)

11:00 – "Comparative physiology of adult neurogenesis, why and what for" (Rafael Lima/Richardson Leão Lab)

11:30 – "LSD as creativity booster?" (Isabel Wiessner/Draulio Lab)

12:00-13:30 – Lunch Break

Talk Session 2

Moderator: Daniel Takahashi

13:30 – "Emotional contagion by observation: is it affected in autism?" (Débora Hashiguchi/Rodrigo Pereira Lab)

14:00 – "Mechanisms and functions of respiration-driven gamma oscillations in the primary olfactory cortex" (Joaquin Gonzalez/Tort Lab)

14:30 – "High-frequency oscillations in epileptogenesis" (Antonio Jhones Rocha/Claudio Queiroz lab)

15:00 – "Loud noise modulates dorsal hippocampal theta oscillations during locomotion" (Katarina Leão)

15:30 – Coffee Break & Poster Session

Talk Session 3

Moderator: Rodrigo Pereira

16:30 – "Functional signatures of the visual interhemispheric circuit" (Kerstin Schmidt)

17:00 – "Delayed vocal development in autism: an experimental approach" (Tarciso Velho)

17:30 – "Integrative biology of marmoset vocal behavior" (Daniel Takahashi)

18:00 – Concluding Remarks/Happy Hour

ORAL PRESENTATIONS

O1 - DREAM CONTENT AND SLOW EEG OSCILLATIONS DURING HUMAN SLEEP PREDICT PREY ADAPTATION IN A PREDATOR-VERSUS-PREY VIDEOGAME

Daniel Brandão (Brain Institute, UFRN, daniel.soares.brandao@gmail.com)

Sleep is an important mental and bodily state for the consolidation of memories. It is very conserved across animal species, and likely had an early and sustained influence on the evolution of prey and predator behaviors. The Threat Simulation Theory states that dreaming was also important along evolution, due to the capacity of alerting about possible future threats. Methodological limitations complicate comparisons of sleep and dreams between preys and predators in non-human animals, but this can be addressed by inviting humans to play videogames. We set out to address the link between sleep, dreaming, and the prey vs. predator dichotomy in 13 pairs of adult volunteers that came to the laboratory and had their brain activity simultaneously recorded through electroencephalography (EEG), while they played a videogame against each other for 45 minutes, then slept for 2 hours, had their dream reports collected, and then played again for another 45 minutes. In the videogame, one participant was hunted by the other in a predator-versus-prey simulated confrontation. The results indicate that preys reported more dreams than predators, and that dreams related to the game contributed more to prey score. Preys also benefited from having a deeper sleep than predators, which was also positively correlated with prey score. Furthermore, preys showed greater EEG power in the delta frequency band (slow wave oscillations < 4Hz), which also favored their score. No effect was found for sleep spindles. The prey's performance was impaired by the number of occurrences of microstate C, a task-negative pattern of electrical activity. These results suggest that slow waves during sleep and game-related dream contents improve the post-sleep performance of individuals in the role of prey, while no benefits were detected for those in the role of predator. Altogether, the results show that both sleep and dreams are important for adapting to the very difficult situation of being preyed upon, but not so relevant in the context of being a predator, which does not represent a very stressful challenge.

Funding: FINEP; FAPERN.

O2 - HOW DIFFERENT HYPOTHESES FOR THE MECHANISM OF ZIKA VIRUS ENTRANCE IN THE EMBRYONIC CNS HELP TO EXPLAIN THE DIVERSITY OF PHENOTYPES FOUND IN HUMAN PATIENTS?

Eduardo Bouth Sequerra (Brain Institute, UFRN, ebsequerra@neuro.ufrn.br)

As a developmental neuroscientist, I was devastated and intrigued by the birth of thousands of children with microcephaly during the zika virus (ZIKV) outbreak in 2015. Since then, my group and a multi-professional crew at UFRN have been trying to understand the natural history of the virus while affecting the central nervous system (CNS) ontogenesis. We now know that the phenotypes generated by the congenital ZIKV infection form a spectrum with diverse phenotypes. These phenotypes vary from normocephalic children with mild CNS malformations and no clinical signs, to severe microcephalic children with arthrogryposis and epilepsy. We are testing two infection routes for modeling different modes of infection. We inject ZIKV in the amniotic fluid of mice for modeling the CNS entrance through neurons, after infecting the olfactory epithelium. Alternatively, we inject ZIKV in neonatal mice's cerebrospinal fluid to model CNS entrance through the ventricles and meninges. We observe that the two models generate different infection patterns, with the injection in the amniotic fluid infecting

first projection neurons. In contrast, the CSF injection first infects the ventricular zone and glia. In the second part of our investigations, we are interested in understanding how the ZIKV spreading through the CNS stops. Our hypothesis is that the maternal immune system activation recruits her cells to the embryonic CNS. To test that, we use transgenic female mice pregnant with wild-type embryos or vice-versa. Our results show a physiological passage of maternal cells to the embryonic brain that increases after the induction of inflammation by the injection of inactivated ZIKV in the amniotic fluid. To test if the mothers of children with microcephaly (MZIKV) have antibodies against embryonic CNS targets, we performed ELISA assays using the protein Engrailed1. This protein is a morphogen that patterns the anterior rhombencephalic field. The sera from MZIKV shows a higher affinity for Engrailed1 than those from control mothers. This data suggest that the mothers of ZIKV-derived microcephaly patients get exposed to antigens commonly expressed in the developing CNS. The results from our lab show that different routes of ZIKV entrance and spread are part of the explanation for the diversity of phenotypes found in the congenital ZIKV syndrome. Moreover, we show that ZIKV infection increases the placental permeability of maternal cells, which can lead to the production of antibodies against fetal CNS targets.

Funding: CAPES, CNPq, International Centre for Genetic Engineering and Biotechnology.

O3 - COMPARATIVE PHYSIOLOGY OF ADULT NEUROGENESIS, WHY AND WHAT FOR

Rafael Vitor Lima da Cruz (Brain Institute, UFRN, rafael.lima@neuro.ufrn.br)

It's been 60 years since Joseph Altman first demonstrate that new neurons are continuously produced in the hippocampus of mammals, despite that was only in the 1990's it was accepted by the majority of the scientific community as a relevant process to neurophysiology, quickly ascending to the status of knowledge that would enable repair of brain damage coming from injury and/or neurodegenerative diseases. Now we know how those neurons are produced, who are the neural stem cells, how they are regulated, how they migrate and in which circuits they integrate, yet, no effective therapy for replacement of damaged brain tissue has been developed, equally still eludes us what is the function of those cells, when we try to understand it comparing species, we find that the diversity of selective pressures shapes the process to the animal specific needs, in this species-specific scenario comparative physiology rise as the opportunity to explain adult neurogenesis by giving emphasis to similarities and differences not only to the bio-mechanisms by its own, but also to how it interact with the phenomenology of behavior. I intend to organize and summarize the available data on diverse taxa ranging from cnidaria with potential to regenerate the whole nervous system, to mammals with an anatomical restricted and strict regulated adult hippocampal neurogenesis.

Funding: CAPES.

O4 - LSD AS CREATIVITY BOOSTER?

Isabel Wießner (Brain Institute, UFRN, isabel.wiessner@gmail.com)

Background: Controversy surrounds psychedelics and their potential to boost creativity. To date, psychedelic studies lack a uniform conceptualization of creativity and methodologically rigorous designs.

Aims: This study aimed at addressing previous issues by examining the effects of lysergic acid diethylamide (LSD) on creativity using multimodal tasks and multidimensional approaches.

Methods: In a randomized, double-blind, placebo-controlled, crossover study, 24 healthy volunteers received 50 µg of LSD or inactive placebo. Near drug peak, a creativity task battery was applied, including pattern meaning task (PMT), alternate uses task (AUT), picture concept task (PCT), creative metaphors task (MET) and figural creativity task (FIG). Creativity was assessed by scoring creativity criteria (novelty, utility, surprise), calculating divergent thinking (fluency, originality, flexibility, elaboration) and convergent thinking, computing semantic distances (semantic spread, semantic steps) and searching for data-driven special features.

Results: LSD, compared to placebo, changed several creativity measurements pointing to three overall LSD-induced phenomena: (1) 'pattern break', reflected by increased novelty, surprise, originality and semantic distances; (2) decreased 'organization', reflected by decreased utility, convergent thinking and, marginally, elaboration; and (3) 'meaning', reflected by increased symbolic thinking and ambiguity in the data-driven results.

Conclusion: LSD changed creativity across modalities and measurement approaches. Three phenomena of pattern break, disorganization and meaning seemed to fundamentally influence creative cognition and behaviour pointing to a shift of cognitive resources 'away from normal' and 'towards the new'. LSD-induced symbolic thinking might provide a tool to support treatment efficiency in psychedelic-assisted therapy.

Funding: Beckley Foundation and CAPES – Finance Code 001.

O5 - EMOTIONAL CONTAGION BY OBSERVATION: IS IT AFFECTED IN AUTISM?

Debora Hashiguchi (Brain Institute, UFRN, d.hashiguchi@neuro.ufrn.br)

Emotional contagion can be defined as the transmission of emotional information from one individual to another. This phenomenon is conserved in mammals of different species, such as humans and rats. When the development of these skills is impaired, the individual cannot respond adequately to a given situation. It has long been realized that such competence is affected in autism, but it is still poorly understood. Rats prenatally exposed to valproic acid (VPA) are a well-established animal model of autism. In this way, we are investigating the behavioral responses of freezing and vocalization as well as neural activation responses in these animals when observing a familiar rat being exposed to an aversive stimulus (a foot shock). Our hypothesis is that VPA rats are more sensitive to the observation of conspecific fear experience compared to controls.

Funding: CNPQ, CAPES, FUNPEC.

O6 - MECHANISMS AND FUNCTIONS OF RESPIRATION-DRIVEN GAMMA OSCILLATIONS IN THE PRIMARY OLFACTORY CORTEX

Joaquín González (Brain Institute, UFRN & Departamento de Fisiología, Facultad de Medicina, Universidad de la República, joaqgonzar@gmail.com)

Gamma oscillations are believed to underlie cognitive processes by shaping the formation of transient neuronal partnerships on a millisecond scale. These oscillations are coupled to the phase of breathing cycles in several brain areas, possibly reflecting local computations driven by sensory inputs sampled at each breath. Here, we investigated the mechanisms and functions of gamma oscillations in the piriform (olfactory) cortex of awake mice to understand their dependence on breathing and how they relate to local spiking activity. Mechanistically, we find that respiration drives gamma oscillations in the piriform cortex, which correlate with local feedback inhibition and result from recurrent connections between local excitatory and inhibitory neuronal populations. Moreover, respiration-driven gamma oscillations are triggered by the activation of mitral/tufted

cells in the olfactory bulb and are abolished during ketamine/xylazine anesthesia. Functionally, we demonstrate that they locally segregate neuronal assemblies through a winner-take-all computation leading to sparse odor coding during each breathing cycle. Our results shed new light on the mechanisms of gamma oscillations, bridging computation, cognition and physiology.

Funding: CAP.

O7 - HIGH-FREQUENCY OSCILLATIONS IN EPILEPTOGENESIS

Antonio Jhones Rocha (Brain Institute, UFRN, jhoneslrocha@gmail.com)

High-frequency oscillations (HFOs) are spontaneous (80-500 Hz), transient and fast (20-100 ms) oscillations recorded mainly during slow-wave sleep (SWS) and quiet waking of mammals. Physiological HFOs (ripples) participate in sensorial perception and memory consolidation. In parallel, pathological HFOs occur in brain regions involved in the seizure initiation in individuals with epilepsy. Our hypothesis is that pathological HFOs result from a sustained depolarization of a neuronal population whose recurrent (feedback) inhibition is functional, contributing with synchronized firing of action potentials in a neuronal population. In this work, we used electrophysiological recordings and an animal model of status epilepticus (SE) to study the expression of HFOs associated with epileptogenesis in mice. Animals were implanted with deep electrodes, bilaterally, in the hippocampus and retrosplenial cortex. Animals received a single intrahippocampal dose of pilocarpine (560 µg/site in 800nL) for the induction of status epilepticus (SE) during video-electrophysiology recordings through a guided-cannula. We identified 1,689 ripples in 6 animals. We observed that ripple rate of occurrence decreased after SE ($F[4,20]=4.34$, $p=0.01$; ANOVA), as well as oscillation frequency (Hz) of ripples ($F[4,20]=5.39$, $p=0.003$; ANOVA). Interestingly, we observed a significant correlation between the reduction in frequency of ripples and the severity of the SE (SE+2, $R=-0.82$, $p=0.05$; Spearman), as well as between the rate of ripples and the severity of the SE (SE+2, $R=-0.94$, $p=0.01$; Spearman). Pathological HFOs were detected in the first seconds of the first seizure of the SE in all recorded animals (N=6), occurring coupled with high-amplitude ictal spikes. Our results show that ripple alterations are partially explained by SE severity. We also show that pathological HFOs occur in the first seconds after the beginning of SE, suggesting that these oscillations do not need structural reorganization for its expression. Currently we are evaluating the effect of Cannabis sp. extracts and powders in the properties of HFOs during SE in the same animal model.

Funding: CAPES and UFRN.

O8 - LOUD NOISE MODULATES DORSAL HIPPOCAMPAL THETA OSCILLATIONS DURING LOCOMOTION

Katarina Leão (Brain Institute, UFRN, katarina.leao@neuro.ufrn.br)

The hippocampus and the entorhinal cortex integrate multimodal sensory information from the environment during exploratory behaviors, which is essential for physical space representations and crucial for animal survival. Sound cues from the environment contributes to hippocampal coding of cognitive maps, and recently it was shown that loud noise can activate an ascendant auditory pathway that reaches the hippocampus via the medial septum/entorhinal cortex, complimentary to auditory pathways innervating the primary auditory cortex. Still, the role of the reticulo-limbic pathway in providing auditory information for hippocampal polysensorial integration is not clear. Here, we studied the dynamic modulation of the theta frequency of the hippocampus and medial prefrontal cortex, by systematically comparing the influence of silence or loud noise, before and during optogenetic or chemogenetic stimulation/inhibition of key anatomical

areas (dorsal cochlear nucleus, pontine reticular nucleus, medial and lateral entorhinal cortex, medial septum and primary auditory cortex) during locomotion. We found that mean locomotion-generated theta oscillation frequency is increased by loud broadband noise when the non-canonical sound pathway is activated, and this activity is independent of the activity of the primary auditory cortex. We speculate that the functional output of the increased theta frequency during running can make animals more alert and reactive to possible environmental dangers.

Funding: CAPES, American Tinnitus Association.

O9 - FUNCTIONAL SIGNATURES OF THE VISUAL INTERHEMISPHERIC CIRCUIT

Kerstin Schmidt (Brain Institute, UFRN, kschmidt@neuro.ufrn.br)

The brain builds active predictions that allow inferring causal relationships in received sensory signals. These predictions are derived from the history of sensorimotor interactions with the world. Our perception can be thus understood as the result of real-time comparisons of information transmitted in sensory input signals with activity patterns previously constructed in the brain, or priors. These patterns explain why the perceptual organization follows certain principles (Gestalt laws), as happens during the conjunctions made between elements, necessary for the segmentation of surfaces or objects. In our group, we study the visual circuits of rodents, carnivores and humans. We explore the hypothesis that simple visual expectations are constantly being created by the functional intra- and interhemispheric connectivity of the brain and updated upon visual stimulation. We aim to establish reliable feature-selective electrophysiological, hemodynamical and behavioral signatures of these visual connections, such as cortical maps of orientation selectivity, rate covariation, pairwise coherence and graph measures of ongoing and stimulus-evoked activity. Since the corpus callosum is a frequent and early target of a variety of neurodegenerative processes, reliable markers of the visual intra- and interhemispheric cortico-cortical microcircuitry might turn out to be useful for both animal models and long-term studies in humans.

Funding Capes, CNPq, DFG Priority Program 2205.

O10 - DELAYED VOCAL DEVELOPMENT IN AUTISM: AN EXPERIMENTAL APPROACH

Tarciso Velho (Brain Institute, UFRN, velhot@neuro.ufrn.br)

Autism spectrum disorder (ASD), a set of neurodevelopmental disorders characterized by severe disruptions in social behavior and communication skills, affects 1% of the world population, with an annual cost of ~300 billion dollars in the US alone, according to the US Centers for Disease Control and Prevention (CDC). In Brazil, an estimated 2 million people are affected, representing a major burden to a public health system (SUS) that provides care to ~71% of the population (Brazilian Institute of Geography and Statistics). Among environmental factors associated with ASD, embryonic exposure to the anti-epileptic drug valproic acid (VPA) increases ASD incidence, with affected children displaying pronounced verbal impairments. In spite of its risks, VPA is prescribed to reproductive age women to treat a range of neurological conditions, like epilepsy, bipolar disorders, and migraine. The mechanisms of detrimental VPA actions remain largely undefined, in part due to the lack of adequate model organisms. Innovative experimental studies are thus needed to better understand VPA mechanisms and the potential impact and risks of its usage. Songbirds are among the few organisms that evolved vocal learning and related brain pathways, zebra finches being the choice species for studying the neurobiology of learned vocal behavior. Vocal learning in finches and speech acquisition in humans share a critical period, babbling behavior, and the role of auditory and social cues for proper learning, as well as many features of their vocal circuitry, including

similar cortical projections, molecular markers, and genetic control mechanisms of vocal behavior. Here, we investigated the effects of embryonic VPA exposure on vocal and social behavior in zebra finches. Our results show that VPA exposure during embryonic development leads to delayed vocal development, similar to what has been observed in humans. Moreover, VPA exposed birds show signs of decreased social interactions, hypersensitive hearing, and altered locomotion. These results represent a significant step towards generating a tractable animal model to study the neurobiology of autism-related delayed vocal development. Moreover, this approach should contribute to a better understanding of factors and mechanisms associated with ASD, in particular those induced by exposure to VPA.

Funding: CAPES.

O11 - INTEGRATIVE BIOLOGY OF MARMOSET VOCAL BEHAVIOR

Daniel Takahashi (Brain Institute, UFRN, takahashiyd@neuro.ufrn.br)

Primates coordinate their social dynamics by exchanging vocalizations with each other. Given its relevance, it is natural to investigate how vocal behavior emerges during development. Here, we propose that vocal behavior develops through a sequence of continuous and discontinuous processes that allow the transition from non-vocal behavior to immature vocal behavior and to mature vocal behavior. Using marmosets, a non-human primate that exhibits vocal plasticity, we show that despite the first vocalization happening only after a monkey is born, oro-facial movements needed for vocalization develop in the womb. We also show that, once they are born, the transition from immature to mature vocalizations follows a non-linear phenomenon resembling punctuated equilibrium, albeit in development and not evolution.

Funding: Pew Latin American Fellowship, NIH-NINDS R01NS054898.

POSTER PRESENTATIONS

P1 - WAVEFORM-BASED CLASSIFICATION OF DENTATE SPIKES

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Dentate spikes (DSs) are short-duration and large-amplitude patterns of the hilar local field potential, most likely occurring in quiet behavioral states, such as slow-wave sleep and awake immobility. They result from strong excitatory discharges from the entorhinal cortex (EC) through the perforant path, producing the synchronous activation of the dentate gyrus (DG) network. Depending on whether they originate from the lateral or medial EC, DSs can be classified as type 1 or 2, respectively. The perfect classification is possible by current source density (CSD) analysis, requiring recordings of several electrodes across the DG laminae. Here we developed an unsupervised DS classification method based on their waveforms, thus requiring only one electrode. This approach allows the investigation of the functional role of each DS type in tetrode and single-wire recordings, which are abundant and typically yield a more significant number of cells than linear probes. The classification performance was verified in seven mice with DG laminar profiles, resulting in accuracies greater than 80% and inversely proportional to the relative amount of DS type 2. Also, the average CSDs, waveforms, and rates of the DS types classified by our method were preserved in relation to the ones classified via CSD. In addition to the applicability of the method in expanding the study of DSs, these findings show that DS types do have different waveforms, and thus different underlying network dynamics and roles in memory processing. Furthermore, applying our method to single-electrode LFPs from apoE3-KI and apoE4-KI mice, we observed that the latter, which are a model for late-onset Alzheimer's disease (AD), had wider DSs, especially when young. This result reflects pathophysiological alterations in the EC-DG network, which could become potential biomarkers for an early AD diagnosis. In any event, it showcases the applicability of our DS classification method to DG datasets collected with single or widely-spaced electrodes.

Funding: CNPq and CAPES (Finance Code 001), Brazil.

P2 - THE EFFECTS OF FEMALE SEX STEROIDS ON MOTOR COORDINATION

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According to findings in the literature, Female sex steroids (FSS) can modulate circuits involved in somatic motricity, influencing the cerebellum and the nigrostriatal system. This finding is perceived on the performance of motor coordination tasks, in which it was observed that women show better performance than men with an increase in FSS. The ¬use of tests that assess manual dexterity between the right and left hands provides parameters for assessing cortical asymmetry. Thus, the aim of the study was assess whether FSS interferes with electromyographic activity during the performance of coordinated finger motor activity of the fingers in 30 right-handed women, aged between 18 and 30 years, who had a regular menstrual cycle and were not using hormonal contraceptives. The assessment of motor coordination was performed using the Finger-Tapping Test (FTT) and the electromyographic activity was recorded using electrodes positioned adjacent to the common extensor muscle of the fingers. The FTT was performed in simple and sequential configurations. In the simple configuration, the subjects were asked to press a button as fast as possible for ten seconds with the index finger; in the sequential configuration, the subjects had to press keys on a keyboard with a specific sequence of fingers for ten seconds. The test was performed in three sessions, in the menstrual, follicular, and luteal phases of the menstrual cycle, with an onset phase

randomly determined for each participant. The statistic tests were conducted using SPSS software (version 20). The Analysis of Variance (ANOVA) was the parametric test used. In our results, there was no findings about the effect of FSS on electromyographic activity ($p = 0,204$ for simple configuration and $p < 0,005$ for sequential configuration). However, it was observed that the right and left hands presented a different pattern of muscle activation, with the intensity of muscle activation of the right hand being lower than that of the left hand ($p = 0,004$ for simple configuration and $p < 0,005$, for sequential), so considering that all participants were right-handed this suggest that the muscles of the non-dominant hand had a higher muscle recruitment for the control of the movements when realizing the task. Furthermore, it was seen that the muscle fibers were recruited differently to perform the FTT, so fibers with intermediate velocity of contraction had a greater intensity of muscular activation than the fibers that contract with slow and fast velocities ($p < 0,005$ for simple and sequential configurations). The absence of significant results on the influence of FSS on muscle activity corroborates the idea that the effect of FSS probable occurs at the level of the cerebral cortex, as already demonstrated in previous studies by our research group in the assessment of motor imagery. Subsequently, the electroencephalographic data obtained during the FTT will be analyzed, with the aim of evaluating the influence of FSS on the cortical activity of sensorimotor areas.

Funding: Federal University of Rio Grande do Norte through the Institutional Program for Scientific Initiation Scholarships (PIBIC) of the National Council for Scientific and Technological Development (CNPq) and Process No. 306942/2021-6 to MBCS/CNPq.

P3 - STUDYING THE ACTION OF VISUAL CALLOSAL CONNECTIONS WITH THE PERCEPTION OF ILLUSORY MOTION

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It is likely that visual tasks such as perceptual grouping according to simple Gestalt rules such as common shape and fate can, with the aid of top-down influences, be solved at an early level of cortical processing. This is attributed to the fact that already in primary visual cortex, horizontal circuits present feature-selectivity for orientation, direction of motion and colinearity. The callosal connection is believed to perpetuate these selective functions across the midline of the visual field and ensure the functional integrity of the visual image. Evidence for this hypothesis has been obtained from both anatomical and electrophysiological data in many mammalian species with frontal eyes. In the present study, we aimed to identify behavioural markers of the integrity of selective horizontal and callosal circuits which are applicable to humans. To this end, we examined the directions of apparent motion illusion created by the Motion Quartet, a stimulus designed to challenge callosal connectivity. In order to probe different circuits, we created different global objects by pairing the quartet's elements with colinear shapes of different orientations (a solid gray circle, or either a horizontally or vertically oriented grating stimulus convoluted with a Gabor function). We collected behavioral data on the perceived direction of movement (either vertical or horizontal) of 15 volunteers, while the visual stimuli changed their position either crossing or sparing the vertical midline. Experiments consisted of 5 repetitions of 120 presentations of each one of the 9 conditions, in which the participants were instructed to fixate on the screen and indicate the perceived direction of movement by button press. Overall, control data seem to confirm the expected bias for vertical direction of motion mirroring the known asymmetry of axon length to travel when processing either vertical (intrahemispheric) or horizontal (callosal) directions of motion at the visual field's vertical midline. As expected, pairing the motion quartet's elements with different orientations facilitated different kinds of perceived motion for horizontal and vertical Gabors. Surprisingly, in this preliminary dataset, all stimuli paired with iso-oriented Gabors seemed to bias perception towards

the (midline crossing) horizontal direction in comparison to the neutral control, irrespective of the Gabors orientation and the colinearity/non-colinearity of the global stimulus composition. In conclusion, pairing the motion illusion with an iso-orientation cue facilitates perceptual grouping across the midline, reflecting callosal connectivity between neurons of similar orientation preference in both hemispheres in humans."

Funding: G.P. received a stipend from CNPq and L.G. from CAPES.

P4 - RESPIRATION-COUPLED OSCILLATIONS AS MODULATORS OF FREEZING BEHAVIOR IN RATS

Duarte, E.H., Dias, A.A., Belo, J.A., Drieskens, D.C., Laplagne, D.A., Tort, A.B.
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We know that breathing is fundamental to life. However, breathing is responsible for much more than gas exchange, including being able to modulate our emotions. In 1942, Lord Adrian discovered an oscillatory rhythm that synchronizes with nasal respiration, in what nowadays became known as respiration-coupled oscillations (RCOs). Several lines of evidence suggest that these oscillations are initiated by the activation of neurons in the nasal epithelium. After reaching the olfactory bulb, RCOs are transmitted throughout the brain, in regions such as the amygdala, hippocampus, and prefrontal cortex, among others. Recent studies show that a strong 4-Hz oscillation appears during freezing, an expression of fear behavior in rodents. During freezing, rodents can emit ultrasonic vocalizations (USVs), which are coupled to the exhalation phase of the respiratory cycle. Here we propose to simultaneously record freezing behavior, USVs and electrophysiological signals from the medial prefrontal cortex and hippocampus in a cue-driven fear conditioning paradigm. Our main hypothesis is that RCOs occur during freezing and moreover are differentially expressed during the emission of USVs. Furthermore, we hypothesize that USV activity produces a natural disturbance in the sniffing cycle that is also observed in RCOs. Our experimental setup will include the synchronization of electrophysiology, sound, and video acquisition systems. To this end, a master clock will be programmed to emit binary pulses to the analog inputs of each component. Also, we will use the Kinect camera during the recording sessions as we plan to create an algorithm to extract freezing behavior through the depth data.

Funding: CNPq and CAPES.

P5 - RESPIRATORY BRAIN RHYTHMS AND THEIR RELATIONSHIP WITH ANXIETY

Dias, A.A., Duarte, E.H., Belo, J.A., Drieskens, D.C., Laplagne, D.A., Tort, A.B.
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Anxiety is characterized as a state of perception of threats that can lead to danger. It is considered an evolutionarily adaptive behavior that results in different physiological changes. The emotional response evoked by anxiety causes activation of brain areas and temporal coordination of neuromodulation. Over the past 20 years, studies have shown that changes in the activity of the hippocampus, amygdala, and prefrontal cortex (PFC) would be related to fear and anxiety responses. The connections between these areas are thought to be coordinated by the theta oscillations (~ 6 - 12 Hz). However, recent findings have shown that a possible larger network could be related to the modulation of anxiety, which would be orchestrated by the projections from the olfactory bulb (OB) to the PFC. Namely, both the OB and PFC exhibit neuronal oscillations that synchronize to the phase of the respiratory cycle and are named respiratory rhythms (RR) because of their co-variability in peak frequency with the breathing rate. These refer to actual LFP oscillations coupled with breathing and not the mechanical process of breathing itself. Lower LFP frequencies present themselves as a mechanism for long-range communication

through the synchronization of cortical brain regions during different behavioral states, which could be the case of RR. In this work, we wanted to understand how the changes in the respiratory cycle could influence the appearance of these oscillations and how they could be related to the behavioral state during anxiety. For that, we recorded respiration through intranasal pressure and LFPs from the medial PFC (anterior cingulate, prelimbic and medial orbital), OB and parietal cortex of 7 male Wistar rats as they freely behaved in the elevated plus maze (EPM). We found that the respiratory rate changes depending on the behavioral state (anxious vs non-anxious) and locomotor activity. Moreover, changes in the LFP power spectrum also depended on the behavioral state and seemed to mirror changes in respiratory activity. These preliminary results indicate that increases in respiratory rate during EPM exposition predict anxious states, which might be accompanied by an increase in RR activity.

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P6 - DIFFERENT VIRAL INOCULATION TECHNIQUES REVEAL DIFFERENT POSSIBLE ROUTES FOR ZIKA VIRUS INFECTION AND SPREAD THROUGH THE DEVELOPING CNS

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The congenital zika virus (ZIKV) syndrome represents a variety of phenotypes that expand from normocephalic children with no or mild symptoms to severely malformed microcephalic patients. In our lab, we are trying to understand if the route of infection and the pattern of ZIKV spread in the central nervous system (CNS) can contribute to this phenotype. To do this, we developed two models: 1- the injection of ZIKV in the amniotic fluid, where we believe ZIKV enters the CNS through cranial nerves and spreads mainly through neurites; and 2- the injection of ZIKV in the cerebrospinal (CSF) fluid, we believe that the spread through this liquid occurs in more severe cases when the virus affects the brain and spinal cord. To inject ZIKV into the amniotic fluid of 15th embryonic day (E15) mice, we anesthetize the female with an intraperitoneal injection of 87.5 mg/kg ketamine and 12.5 mg/kg xylazine. After finding the uterine horns, they are exposed and constantly bathed with saline at 37ºC to avoid drying out. Each embryo receives in its amniotic fluid 1µl of inactivated ZIKV solution (Mock, 30 minutes 60oC) and 1µl of ZIKV at a concentration of 105 PFUs. After injection, we return the uterine horns to their original position and suture the female. At the end of the experiment, we euthanize the female. Embryos are removed, decapitated, and placed in 4% paraformaldehyde overnight. For intraventricular injection postnatal, we use postnatal mice with one day of life (P1). At this stage, the mice are still completing neurogenesis, equivalent to the second trimester in humans. We anesthetize the animals with ice, and after the procedure, they are reanimated and warmed on a warm plate. Here, 0.5µl of saline, 0.5µl of inactivated ZIKV solution (Mock, 30 minutes 60oC), and 0.5µl of ZIKV (105 PFUs). We only inject the right lateral ventricle in our experiment. In the experiment with infection in the amniotic fluid, half of the animals had ZIKV in the OE at three days post-infection (dpi) and less in the olfactory bulb (OB) or the anterior and posterior regions of the brain. At 6dpi, we find ZIKV infection in the OE and the OB. The frequency of animals infected in the anterior and posterior areas of the brain increases. At 12dpi, the OE and the posterior brain region display no sign of infection. However, half of the animals had it in the prosencephalon and all in the OB. The histological analysis reveals that ZIKV in the 3dpi brain infects mainly the forming grey matter, where the neurons are. The 3dpi retina has the optic nerve and ganglion cell layer infected. The proliferative regions, the ventricular zone, and the outer neuroblastic layer of the retina do not have infected cells at this point. Intraventricular inoculation in postnatal animals is efficient in causing

infection. Clinical signs of the disease start at seven dpi. Infected animals have a maximum survival of 12 dpi. Some symptoms are dehydration, hind limb paralysis, tremors, lack of balance, weight loss, and ataxia. Histology data show that ZIKV infects the brain parenchyma from 3 dpi. The pattern of infection is very different from that found in the amniotic fluid injections. Here, infected neurons are less prevalent, multiple glial cells infected, like microglia, and the ventricular zone is heavily infected. Also, in three dpi, the ventricular region and brain parenchyma are infiltrated with leukocytes (CD45+). In animals with eight dpi, the presence of CD45+ cells becomes more evident, the lateral ventricles increase in size, and the cerebral cortex becomes thinner. In conclusion, our data show that the injections of ZIKV in the amniotic fluid or the CSF produce different patterns of ZIKV infection and spread. Future experiments will be necessary to characterize the neurological consequences of each of the two methods. We hope that the comparison of the results obtained here can help to elucidate the complexity of phenotypes found in CZVS.

Funding: CAPES; CNPq and International Centre for Genetic Engineering and Biotechnology.

P7 - STANDARDIZING A MURINE MODEL TO STUDY MATERNAL-FETAL MICROCHIMERISM INTERACTIONS IN HEALTH AND DISEASE

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Microchimerism is a natural phenomenon that harbors cells that originated from a different individual than its host. During pregnancy, immune cells physiologically migrate from the mother to the fetus. However, the functional role of these maternal microchimeric cells in the offspring is unknown. Likewise, fetal cells cross into the maternal circulation and graft on her tissues. These cells can both be beneficial while helping in tissue regeneration, or cause disease. There is a positive correlation between the number of fetal cells persisting in the mother and the development of autoimmune diseases. Another side of the microchimerism phenomenon is that we know little about how it changes in pathological conditions and if it influences embryonic development. Here, we propose a new method to study the exchange of cells through the placenta and to measure microchimerism. To do that, we use the two crossings combinations between □-actin-eGFP transgenic mice and wild-type partners. We are testing the effect of the inactivated zika virus (ZIKV; a test of inflammation) or the active virus (infection effect test) over the placental permeability. We perform this through intrauterine injections of the viral solutions (inactivated or not) in the amniotic fluid. After that, we quantify and identify the cellular populations involved in the maternal-fetal interface through flow cytometry. We planned three groups: 1- intrauterine injections with saline (control, no inflammation), 2- injections of the inactivated virus (inflammation), and 3- ZIKV injections (inflammation + infection). In each of these groups, we use different crossings combinations to evaluate maternal and fetal microchimerism separately. To analyze maternal microchimerism, a transgenic heterozygous □-actin-egfp female crosses with a C57Bl/6 wild-type male. This match contrasts the green fluorescence of maternal cells within wild-type embryos that did not inherit the transgene (half). We perform the surgery for injections on the 15th embryonic day (E15). Later, we dissociate the embryonic brain and liver to detect eGFP fluorescence in the flow cytometry. We are studying the fetal cells passing to the maternal blood by crossing C57Bl/6 wild-type females with a transgenic □-actin-egfp male. This combination contrasts the green fluorescence of embryonic cells within the non-fluorescent maternal cells. Then, we collect the maternal blood to examine the passage of embryonic cells. We take four blood samples from the pregnant female at different stages: E0 (control), E14 (before surgery),

E16 (24h after surgery), and E18 (48 hours). Later, all samples are submitted to flow cytometry, where we can see the total pool of green cells. For labeling leucocytes, we use the CD45 antibody. We established the difference in fluorescence profiles between samples from animals with no transgene or animals with the constitutive expression of eGFP. These comparisons have shown that in the embryonic liver and brain or the adult blood, eGFP+ cells display an order of magnitude higher fluorescence intensity. Therefore, eGFP expression is a valuable tool in cytometry experiments for distinguishing microchimeric cells from the autofluorescence of host cells. Our preliminary results show a physiological migration of green fluorescent maternal cells in the brain of embryos, a total number of 1748 cells in a pool of 100.000, found in the control group. The total number of cells increases in the group injected with the inactivated ZIKV two days erlier compared with the control (10.414 in 100.000). Moreover, the discrepancy between the control versus inactivated ZIKV groups is almost ten times higher in the embryonic liver – control (141 cells in 100.000) and inactivated ZIKV (2053 cells in 100.000). Hence, flow cytometry analysis shows that it is possible to quantify the total number of exchanged cells between the mother and embryo. Our preliminary results suggest that the migration of cells from the mother to the embryonic brain is a physiological process and increases under the induction of inflammation by ZIKV antigens.

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P8 - INTRA- AND INTERHEMISPHERIC INTERACTIONS IN PRIMARY VISUAL CORTEX

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Long-range selective horizontal connections might be decisive for the maintenance of a spontaneously active network that conditions “a priori” neuronal responses by facilitating likely conjunctions of forms, or of movement trajectories. Accordingly, fundamental principles of Gestalt, such as the grouping of elements according to orientation and colinear alignment, could be engineered by selective horizontal circuits, and ongoing functional interactions should reflect this architecture. In the primary visual cortex, these connections extend through the corpus callosum with the same selectivity for orientation, direction of movement and collinearity. Their position in the central visual field render possible to compare intra- with interhemispheric actions, representing trajectories and directions of movement crossing the vertical meridian of the visual field or not. To address possible neuronal signatures of those interactions we studied the activity of neurons representing midline crossing stimuli in the two visual cortices by recording simultaneously from 2 x 16 spatially separated electrodes, which were placed into homotopic parts of the visual cortex, i.e. the transition zone between area 17 and 18, in cats (n = 4). In order to implant electrodes into cortical sites that are directly or indirectly linked by the corpus callosum, we performed intrinsic signal imaging to precisely define the areal border. Subsequently, we obtained extracellular electrophysiological recordings of single unit spiking activity during grating and natural visual stimulation designed to study integration. As an efficient measure of functional interaction we used ongoing and stimulus-evoked coherence in the low gamma band (30-59 Hz) between pairs of firing rates, focusing on pairs of neurons with overlapping receptive fields. We compared this measure to joint rate changes as well as to changes of the joined Fano Factor. We observed significant ongoing and evoked coherence at least for one stimulus condition in the majority of intrahemispheric (n=447) and interhemispheric pairs (60%, n=266) of single units with overlapping RFs, with higher probability for intra- than interhemispheric pairs (73% versus 60%). On average, ongoing and evoked coherence between intra- was about 20% higher than between

interhemispheric pairs. This difference increased to almost 35% for cases where both ongoing and stimulus driven activity showed significant coherence. Both types of coherence showed orientation and direction selectivity, in both ongoing and stimulus-driven activity. Intrahemispherically, the pairwise coherence decayed with cortical distance between iso-oriented neurons to peak again at an interval of about 900μm in accordance with the clustering of horizontal connections. In conclusion, we confirm that both ongoing and stimulus-driven coherence within long-range intrinsic and interhemispheric networks reflect the selectivity of horizontal axons to link neurons of similar response properties over longer distances. The results are compatible with the interpretation that those connections serve to anticipate likely grouping operations between neurons representing the vertical meridian, such as those caused by crossing movements or objects.

Funding: CAPES.

P9 - GAMMA RESONANCES: INTERACTIONS BETWEEN INTRINSICALLY GENERATED OSCILLATIONS IN THE CORTEX AND PERIODIC VISUAL INPUTS

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Gamma rhythms have been associated with large-scale integration mechanisms, such as during visual perception and attention. Gamma activity in the visual cortex can be modulated by manipulating the global features of visual stimuli. Variations in attentional load are also associated with fluctuations in the frequency and strength of gamma oscillations. However, most of this evidence is correlational and remains controversial. In the present project, we aim to develop a causal approach to the study of gamma by using periodic visual signals generated by LEDs. It is known that cells of the primary visual cortex can accurately follow fast (100 Hz) periodic signals. Thus it is possible to make the cortex oscillate at frequencies close to the intrinsic gamma oscillation (resonance frequency). Initially, we will evaluate the gamma response characteristics induced by a visual stimulus devoid of any flicker (e.g., moving grids printed on sheets of paper illuminated by LED at constant voltage). Next, we will observe how different frequencies generated by LEDs affect the course of gamma responses. Recordings of spikes and local field potentials (LFP) with multiple electrode-multiplexes will be obtained in the retina, lateral geniculate nucleus, and visual cortex of the anesthetized and alert cat. Correlation and coherence analysis will be performed for responses of single cells and populations. Our study will allow us to tackle relevant questions about the mechanisms of gamma oscillations during anesthesia and alert states. We will know if the same cells that generate gamma are also those capable of following periodic external stimuli. We will also be able to elucidate whether periodic stimuli actually promote gamma processes in the brain, as recently speculated. We hope our study will contribute to the debate about the functional significance of gamma rhythms in visual processing.

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P10 - GAMMA RESPONSES IN MONKEY V1: AN OBJECT-ORIENTED APPROACH

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Experiments in monkeys offer a unique opportunity to explore neural mechanisms during perception. Despite countless efforts, not much is known under natural conditions. Data obtained in the primary visual cortex (V1) for free viewing of natural scenes in capuchin monkeys (Maldonado et al., 2008) and macaque monkeys (Brunet et al., 2015; Uran et

al., 2022) showed inconsistent results. These studies, however, were limited by passive viewing of static scenes without attentional engagement. Here, we propose an alternative paradigm centered on the concept of a visual object. We aim to evaluate the role of gamma synchronization (30 - 90 Hz) in V1, specifically during the visualization of sets of visual objects presented on a computer screen. First, behavioral studies will be done to make sure that monkeys are able to recognize two-dimensional representations of real objects correctly. For this, the monkeys will be tested in a matching-to-sample task that discriminates between objects resembling the real object (sample). Second, electrophysiological recordings will be made in V1. As a visual task, monkeys will either (1) freely observe sets of objects or (2) detect a specific object among distractors (visual search). Comparisons will be made between responses after saccades directed to salient objects (targets, attention condition) and neutral objects (distractors, no attention condition). Our analysis will focus on describing oscillatory responses for different spectral bands (in particular, the beta and gamma bands) and coherence analysis. We discuss the significance of this project in light of previous V1 data from our laboratory obtained during free viewing of natural scenes.

Funding: CAPES and CNPq.

P11 - PHYSIOTHERAPEUTIC TREATMENT ASSOCIATED WITH THE USE OF BOTULINUM TOXIN IN PATIENTS WITH SPASTIC CEREBRAL PALSY: AN INTEGRATIVE REVIEW

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Introduction: Cerebral palsy (CP) is characterized by brain damage in the early stages of development, and may be associated with spasticity. In view of the normalization of muscle tone, botulinum toxin (BT) is an alternative to provide greater relaxation of the muscles in patients with spasticity. Physiotherapy treatment associated with the use of toxin could enhance the treatment for spasticity. Objective: To review the literature on physical therapy treatment associated with the use of TB in patients with spastic cerebral palsy. Methods: A literature review was conducted in PubMed, LILACS, BVS and SciELO databases, from 2010 to 2020. The descriptors used were: cerebral palsy, spasticity, botulinum toxin and physical therapy. Results: 77 articles were found, however, 8 were excluded for being duplicates and 60 for not meeting the inclusion criteria, being included 9 articles in this review. In the reviewed studies, TB when associated with physical therapy treatments, promoted the relaxation of spastic muscles, reduced pain, favored the use of orthoses, increased the range of motion, improving the quality and life expectancy of these individuals. Final considerations: The use of TB associated with physical therapy provides improvement on spasticity and functionality in patients with spastic CP.

P12 - THE EFFECTS OF NUSINERSEN TREATMENT ON THE MOTOR AND RESPIRATORY FUNCTION OF INDIVIDUALS WITH TYPE 1 AME

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Introduction: Spinal muscular atrophy (AME) is a rare disease, characterized by muscle atrophy secondary to degeneration of motor neurons. Nusinersen is the first drug approved for the treatment of AME type 1 and the impacts on the motor and respiratory function of its use have not yet been fully described. Objective: To review the literature on the effects of Nusinersen treatment on the motor and respiratory function of individuals with Type 1 AME. Method: This is a literature review through a bibliographic

survey in the databases: PubMed, Scielo and Portal Regional from the Virtual Health Library. Using the descriptors in English and Portuguese: Spinraza, Nusinersen, Rehabilitation, Specialty in Physiotherapy, assessment of muscle strength, assessment of respiratory muscle strength and Spinal Muscular Atrophy. Results: 237 studies were identified, 8 of which are eligible for this review. In the studies reviewed, Nusinersen showed improvements in respiratory symptoms in some of the studies and in others the disease continued to progress, since the results on motor function were all positive and promising, especially with regard to the acquisition of motor milestones and gain in functionality. Conclusion: Treatment with Nusinesen obtained gains in the motor function of patients with type 1 AME, however, there are controversies regarding its effect on respiratory function.

P13 - BEHAVIORAL STUDY OF THE GO AND NO/GO RESPONSE DURING THE PHASES OF THE MENSTRUAL CYCLE

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Female sex steroids (FSS) exert effects on the central nervous system, being involved in aspects related to coordination and motor performance. It is also known that hormonal fluctuation throughout the menstrual cycle in women is associated with the quality of performance in manual and spatial motor tasks observed from behavioral tests. Inhibition of motor action and prevention of harmful events are important executive functions in human behavior, since inhibitory control of movement occurs regularly in our daily lives. This study sought to identify the effects of FSS on motor inhibitory control in 29 healthy women, aged between 18 and 30 years, right-handed, with a regular menstrual cycle and not using hormonal contraceptives, using the Go/No-Go Task as a tool. The objective of the study was to evidence, from peripheral muscle stimulation, the brain function in the contexts of response inhibition through reaction time and error processing. The Go/No-Go Task includes pairs of sound stimuli (S1= both events were pairs of sounds of the same nature, high or low; and S2= in the first event the sound was low and in the second it could be loud or low, randomly). The S1-centered task is characterized by decision-making after the first event and execution or inhibition after the second event, while in the S2-centered task the decision was made after the second event, after which the execution or motor inhibition occurred. The test was applied in three phases of the menstrual cycle (menstrual, follicular and luteal) and the initial phase in which the test was applied was previously defined for each volunteer. Electromyography was recorded to monitor the reaction time to the task and blood collection to monitor hormone levels in each phase of the cycle. Data analysis showed a significant difference in reaction time between the protocols centered on S1 and S2 ($F(1) = 12.957$, $p < 0.001$), but it was not possible to find a difference between the phases of the menstrual cycle ($F (1) = 0.493$, $p = 0.611$). Additionally, no interaction was found between the phases and the two protocols ($F(2) = 0.070$, $p = 0.933$). The analysis of incorrect test responses for protocols centered on S1 and S2 remained significant ($F (1) = 4.517$, $p = 0.035$), but did not show the effect of menstrual cycle phases ($F (2) = 0.460$, $p = 0.632$) nor in the interaction between menstrual cycle phases and protocols ($F(2) = 0.003$, $p = 0.997$). In view of these findings, a complementary analysis of the EEG and additional research on the subject are necessary to better evidence the participation of the FSS in the central regulation of inhibitory motor control.

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P14 - SLEEP AND LEARNING IN OCTOPUS INSULARIS

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Among invertebrate animals, the class of cephalopods, belonging to the phylum Mollusca, has stood out in research for its remarkable intelligence and learning ability. In particular, octopuses have shown complex behavior regarding the organization of their nervous system, including a lobe for learning. These animals also show, as already known in vertebrates, learning skills by touch and observation. In the literature, there are studies carried out with the species O. vulgaris in which it was verified that octopuses are able to change behavior based on the results of experiments, demonstrating that they can associate information and reproduce adaptive behavioral responses. Among the objectives of this study, we seek to relate the learning and intelligence of these animals with their sleep patterns. Sleep is a behavior that occurs in several taxa of the animal kingdom and has already been extensively studied in vertebrates, especially in mammals and birds. However, among invertebrates, in the case of octopuses, there are behavioral and electrophysiological records that point to the existence of at least two sleep phases. The objective of this work is to investigate and describe in detail, through a comprehensive behavioral quantification, the learning process of the species Octopus insularis. It is intended to investigate and describe O. insularis behaviors, characterize the learning processes and identify if there is a relationship with sleep. Using video recordings, the work aims to assess whether the young adults of this species are capable of learning a new task, called here "Russian dolls", which requires the animals (N=5) to sequentially open up to three different jars, one inside the other, one smaller than the other, with a reward (crab or shrimp) inside the smaller jar. It was observed that octopuses are able to open the 3 types of jars, opening it many times in different ways, which shows the cognitive ability and behavioral versatility of these animals.

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P15 - FRONTOPOLAR CORTEX OXYGENATION AND AFFECTIVE RESPONSE DURING A MAXIMAL INCREMENTAL TEST CYCLING IN ADULTS: A PRELIMINARY DESCRIPTIVE STUDY

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The pre-frontal cortex (PFC) has an important role in the control of interoceptive pathways during aerobic exercise and, consequently, on the affective response. This relationship is intensity-dependent and the different regions of the PFC seem to present

a different activation pattern. However, the activation pattern of the frontopolar cortex (FPC) is not known. In this sense, the aim of the current study was to describe the activation pattern of the FPC and affective response during a maximal incremental test cycling. Eleven adult men (24.5 ± 7.1 years older; BMI, 26.5 ± 2.9 kg/m2; VO2max, 38.9 ± 6.7 ml/L/min) were submitted to a maximal incremental test cycling until voluntary exhaustion (25W/min + 20W/min at 60 rpm). Systemic oxygen consumption was measured using (Quark CPET, COSMED, Italy) to identify the ventilator threshold (VT) and respiratory compensatory point (RCP). Oxyhemoglobin (Hbo) and deoxyhemoglobin (Hbb) concentrations in the FPC in both cortical hemispheres were measured using NIRS (Imagent, ISS Inc., Milford, USA). For analysis, Hbo and total hemoglobin (Htotal = Hbo + Hbb) were considered. The affective response to exercise was measured using the feeling scale (+5 to -5 u.a.) at the end of each stage of maximal incremental test. Repeated measures ANOVA was used to compare the hemodynamic and affective response of the FPC at different intensities (VT, RCP and end bout). Affective response decreases with increasing intensity (VT, 2.9 ± 1.4 vs. RCP, -1.4 ± 2.2 vs. end bout, -4.6 ± 0.7 u.a; $F(2, 20) = 95.358$, $p < 0,001$, power = 1.00). The Hbo concentration were not different for left (VT, 50.7 ± 11.2 vs. RCP, 50.8 ± 11.5 vs. end bout 50.8 ± 11.5 µmol; $F(2, 20) = 0,441$, $p = 0,650$; power = 0.112) and right hemispheres (VT, 55.9 ± 12.4 vs. RCP, 56.2 ± 12.6 vs. end bout 56.3 ± 12.7 µmol; $F(2, 20) = 3,0303$ $p = 0,072$; power = 0.517). Likewise, Htotal concentration were not different for left (VT, 74.6 ± 16.9 vs. RCP, 74.5 ± 17.0 vs. end bout 74.5 ± 16.9 µmol; $F(2, 20) = 0,527$, $p = 0,599$; power = 0.125) and right hemispheres (VT, 82.4 ± 20.5 vs. RCP, 82.5 ± 20.5 vs. end bout 82.6 ± 20.6 µmol; $F(1.137, 11.369) = 0,765$ $p = 0,478$; power = 0.162). In summary, our preliminary findings suggest that the negative affective response with increasing exercise intensity is not related to changes in FPC hemodynamic activity. In this sense, our findings are complementary to previous studies that found reduced hemodynamic activity in the dorsolateral PFC and increased hemodynamic activity in the ventromedial PFC according to the increased exercise intensity. Therefore, they suggest a region-dependent hemodynamic activity in the PFC during exercise.

P16 - SCIENCE WORKSHOP FOR TEACHERS OF PUBLIC HIGH SCHOOLS IN THE BRAZILIAN NORTHEAST

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The project sought to capacitate professors of high schools to the importance of practical classes that stimulate learning in students. The objectives of this project were to connect teachers of public high schools with "science-making" methods, creating a relationship between them and the researchers of Brain Institute, at UFRN; to spread hands-on activities, with accessible and low-cost equipments as a way of discussing scientific methods and help them teaching science with technical and pedagogical support; and to work with ideas and concepts associated with emotions, memory, perception, action, attention, learning and conscience. The workshops happened for over two consecutives days, each in two of the partner schools in small cities (Caicó and Currais Novos), with the workload totalling 16 hours each. The workshop at the Brain Institute occurred during one day with a workload of 8 hours. Specifically, the subjects involved: 1. comprehension of the brain as an electric organ (bioelectrogenesis); 2. the sensory system and the relation between perception and sensation; 3. mechanisms of memory and learning; and 4. control and expression of emotions. The materials used for the workshops were given by the project team and the schools. At the end of the events, the teachers demonstrated being able to comprehend the subjects that were presented during the meetings, with critical and reasoned thinking. However, when we asked in an online survey if they felt prepared to do these experiments in their classrooms, the majority of professors that responded to the forms said they could not (46,6%) and a 100% would recommend the workshop for a friend. We hope that teachers realized that science can be accessible to

those who are interested in doing so. We believe that our actions contributed with professional and personal transformation to the teachers, helping them in the hard task of educating citizens, especially with critical and independent thinking.

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P17 - EXPERIMENTAL MODEL OF MICROCEPHALY: STRUCTURAL AND NEUROMOTOR DEVELOPMENT IN SAFE OR NOT TO POLYPHENOL (EMPFEROL) IN THE NEONATAL PERIOD

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The increase in the number of microcephaly cases since 2015 has drawn the attention of the scientific community, especially in Brazil. The main clinical sign of Microcephaly is the decrease in head circumference, which can be associated with physical and intellectual disabilities. Busulfan is capable of inducing signs similar to those of microcephaly. Polyphenols, such as and Kaempferol, are substances found abundantly in vegetables and are strong candidates to be used as a possible strategy in the treatment of microcephaly, as they have neuroprotective action. Therefore, the present study aimed to investigate the late repercussions of neonatal treatment with polyphenol (Kaempferol) on murinometric and neuromotor development in rats submitted to pharmacological manipulation with Busulfan® in the gestational period to induce microcephaly. Eighteen litters of Wistar rats were used, originating from 18 adult rats and 9 adult rats that were placed for mating in the proportion of 2 females to 1 male. The rats were placed for mating and after confirmation of pregnancy, two groups of pregnant women were formed: the Control group and the group that was induced to microcephaly with Busulfan®. The rats were treated daily from the 12th to the 14th day of gestation. On the 1st postnatal day, 4 subgroups were formed: Control + Vehicle; Control + Kaempferol; Microcephaly + Vehicle; Microcephaly + Kaempferol. For statistics, analysis of variance (ANOVA) was used for parametric data. To analyze body weight, reflexes and locomotor activity, the Two Way ANOVA Test, Tukey Post Test was used. Statistical significance was considered assuming a critical level of 5%. There was no difference between the experimental groups in relation to the body weight of male offspring during lactation. Likewise, the treatments did not change the body weight of male offspring at 30 days. Pharmacological manipulation with Busulfan® in the gestational period caused repercussions among the male pups that made up the experimental groups. Groups M+V and M+K showed a delay in the disappearance of the handgrip reflex compared to groups C+V and C+K. There were no effects of manipulations with Busulfan® or with Kaempferol for the Vibrissae Placement, Recumbency, Aversion to Precipice, Free Fall, Startle Response, Negative Geotaxis and Bar Holding reflexes between the experimental groups. Regarding locomotor activity, the M+V group covered a greater distance than the C+V group in the 17th PND and the M+K group had a greater distance covered than the C+K group in the 21st PND. In terms of average speed, the M+K group was faster than the C+K group on the 21st day. The mean potency of the M+K group was higher than that of the C+K group at the 21st PND. The M+V group showed less downtime than the C+V group at the 17th PND. The polyphenol Kaempferol seems to delay the onset of hyperactivity in animals submitted to pharmacological manipulation with Busulfan®, however it was not able to reverse the damage in the other parameters observed. Gestational treatment with Busulfan® may be associated with changes in motor behavior, which was demonstrated by the presence of hyperactivity identified in the open

field test and which may be related to an impairment in the motor cortex. There was no difference between the experimental groups in relation to body weight. However, the polyphenol Kaempferol seems to delay/delay the onset of hyperactivity in animals submitted to pharmacological manipulation with Busulfan®. However, it was not able to reverse the damage in the other parameters observed. More studies should be carried out in order to understand whether both Kaempferol and Bulsufan® can morphologically modify brain regions.

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P18 - USE OF AUTOENCODER NETWORK FOR REPRESENTATION OF ULTRASONIC VOCALIZATION

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Advances in Deep Learning architectures now allow us to find structure in large datasets, including behavioral data. Our lab is interested in understanding how abnormal neurodevelopment affects neonatal vocal production in an animal model of autism, which could potentially benefit from these new tools for feature extraction. A specific architecture, called variational autoencoder, can be trained to represent multivariate (high-dimensional) input data in a compact format through the optimization of a reduced number of latent variables. Therefore, the aim of this scientific initiation project is to learn and explore this architecture for the characterization of neonatal rodent ultrasonic vocalizations. This work combines knowledge from a number of disciplines, including bioacoustic, systems neuroscience, and computational neurobiology, in order to explore new avenues and frameworks about vocal communication.

P19 - SPIKE WAVEFORMS AS IMAGES: USING DEEP LEARNING TO CLASSIFY NEURONS

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Brain activity can be investigated through its electrophysiological correlates, such as the product of microcurrents generated by excitatory and inhibitory neurons, in response to an external or internal stimulus. Those two classes of neurons differ in morphological, functional, and connectivity patterns among different structures and cellular layers, presumably leading to differential contributions to brain function. Electrophysiological recordings in the brain can be made at different scales, from macroscopic, where the electrical activity of a population of neurons is recorded, known as Local Field Potential (LFP), to the microscopic scale, where the activity of a single neuron can be recorded. These extracellular recordings allow the analysis of cellular firing patterns, correlated to cellular encoding. Although it is a rich source of information, the classification of cellular populations as excitatory and inhibitory neurons remains a notorious problem lying at the heart of neuroscience data analysis. Current techniques used to analyze and characterize cell types are faced with a tradeoff between accuracy and efficiency, especially when working with large-scale recordings, which grow increasingly popular due to advances in recording technology. In this work, we propose a novel approach for cell classification based on image recognition with deep learning. Using a publicly available dataset containing thousands of neurons, we transformed spike waveforms into images using Gramian Angular Fields. This method preserves the temporal information of time series data while making it possible to harness the capabilities of image recognition in deep learning models. Our preliminary results show that deep learning can be used to classify

neuronal cell types efficiently and accurately in large-scale recordings from the hippocampal formation. Future analyses can also test the generalization capabilities in other brain regions. Although presently limited by the putative nature of the current labeling data, this method can incorporate morphologically-derived label data as they become available in the future, using a paradigm known as continual learning. Furthermore, this approach can also lead to new insights into how information regarding the cell class is encoded in its spiking waveforms.

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P20 - MEASURING HIERARCHICAL INDEX IN A PROSOCIAL NON-HUMAN PRIMATE

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The capacity to frequently produce behaviors that benefit others, i.e., prosociality, is a trademark of human society. Among primates, besides humans, only marmosets are thought to be prosocial. Like humans, marmosets are cooperative breeders, where every member in a group takes care of the offspring. However, life in a group also carries inevitable conflict and competition, which structure the social hierarchy between the subjects in a group. Therefore, to understand the social dynamics, we must understand how prosocial tendency interacts with competitive behavior. In particular, understanding the interaction between prosociality and social hierarchy will help manage colonies and create new strategies to detect social instabilities early on, thus reducing aggression and promoting the colony's well-being. First, we established a procedure to measure social hierarchy using an observational study with two groups of marmosets during the daily husbandry period. Two observers were habituated and trained for focal sampling. We validated the observations by obtaining a > 80% compatibility level between observers. We followed the behavior of four focal animals for 30 minutes, three times a week, for two months. We classified the behaviors of the animal into three categories: dominant (bite, grabbing, chasing, and erh-erh vocalizations), submissive (avoidance, hiding, and crying vocalizations), and affiliative (grooming, auto grooming, being groomed, invited grooming, play). Our results suggest an age-related dominance hierarchy of non-breeding individuals, where older juvenile animals dominate younger ones. Consistent with the literature, breeding females from both colonies demonstrated dominance over all the other animals. These findings show that we can dynamically measure the social hierarchy of the individuals in a colony. Our next step is to find characteristics of the social interactions that predict changes in the hierarchy.

P21 - MECHANISMS AND FUNCTIONS OF RESPIRATION-DRIVEN GAMMA OSCILLATIONS IN THE PRIMARY OLFACTORY CORTEX

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Gamma oscillations are believed to underlie cognitive processes by shaping the formation of transient neuronal partnerships on a millisecond scale. These oscillations are coupled to the phase of breathing cycles in several brain areas, possibly reflecting local computations driven by sensory inputs sampled at each breath. Here, we investigated the mechanisms and functions of gamma oscillations in the piriform (olfactory) cortex of awake mice to understand their dependence on breathing and how they relate to local spiking activity. Mechanistically, we find that respiration drives gamma oscillations in the piriform cortex, which correlate with local feedback inhibition and result from recurrent connections between local excitatory and inhibitory neuronal populations. Moreover,

respiration-driven gamma oscillations are triggered by the activation of mitral/tufted cells in the olfactory bulb and are abolished during ketamine/xylazine anesthesia. Functionally, we demonstrate that they locally segregate neuronal assemblies through a winner-take-all computation leading to sparse odor coding during each breathing cycle. Our results shed new light on the mechanisms of gamma oscillations, bridging computation, cognition and physiology.

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P22 - DYNAMICAL SYSTEMS ANALYSIS OF THE ECOLOGICAL RELATIONSHIP BETWEEN LEAF-CUTTING ANTS AND FUNGI

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The ecological relationship between ants and fungi balances the entire planet's ecosystem. As the evolutionary process triggered the specialization of this relationship, leafcutter ants emerged by developing the behavior of cutting and collecting fresh leaves to grow the fungus that feeds them, i.e., ants farm fungi. Efficient farming requires a highly dynamic collective behavior that adapts as environmental and farming conditions change. Given its complexity, understanding which conditions are critical for the ant-fungi relationship requires tools from dynamical systems theory. Here, using a mathematical model previously used to study the ant-fungi relationship, we show that farming presents high sensitivity to the proportion of individuals allocated to different functions performed by the insects in the anthill. This modeling result corroborates the findings that the leafcutter ants redistribute the tasks among the subjects to manage the fungus culture.

P23 - EVALUATION OF ANTISEIZURE ACTIVITY OF CANNABINOL AND CANNABIGEROL IN PENTYLENETETRAZOLE-INDUCED SEIZURES IN MICE

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Phytocannabinoids modulate cell excitability and have been used in the treatment of seizure symptomatology. Among the molecules in this class, tetrahydrocannabinol (THC) and cannabidiol (CBD) are the most studied. The present project will evaluate the effects of THC and CBG on seizures produced by the gabaergic blocker pentylenetetrazol (PTZ). To this end, we will investigate the behavioral response to acute and chronic treatments of cannabinol (CBN) and cannabigerol (CBG) on seizures induced by the cited model. A dose-response relationship will be made to evaluate the dose of PTZ to be selected. As positive controls, we will use CBD and diazepam, drugs known to be effective in seizure control, with dosage to be defined. Preliminary results with the PTZ model (80mg/kg) showed a previously unknown spasmodic behavior in this model. Ongoing experiments include qualitative description of ictal behaviors in addition to quantification of induced seizure parameters, such as latency and duration, as well as behavioral changes produced by pharmacological interventions with CBN and CBD in the model. With this, we hope to contribute to expand the applicability of phytocannabinoids for the symptomatic treatment of epileptic seizures.

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P24 - SEVOFLURANE DECREASES THE FIRING FREQUENCY OF LAYER 5 PYRAMIDAL NEURONS BUT EFFECTS IN ACTIVE MEMBRANE PROPERTIES ARE CELL-TYPE DEPENDENT

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General anesthetics are ubiquitous in medical practice, but the cellular mechanisms that promote amnesia, analgesia, immobility and unconsciousness by affecting voltage and ligand-gated ion channels still need to be better understood. Recent studies show that different anesthetics differentially affect specific ion channels and that cortical pyramidal neurons are affected by lower concentrations than interneurons. This highlights that general anesthesia does not follow a "general" mechanism but depends on the choice of anesthetics and cell-type specific effects. Volatile anesthetics like sevoflurane are especially hard to study in in vitro preparations. Yet, biophysical models predict stabilization of the open-state of low-threshold voltage-gated K+ currents (Kv1.2 channels), yet to be confirmed by electrophysiology. Here we attempt a first step in identifying the electrophysiological profile of sevoflurane. We applied sevoflurane by passing the carbogen mixture through a vaporizer for volatile anesthetic thereby oxygenating and solubilizing sevoflurane in the recording artificial cerebral spinal fluid (aCSF) and performed whole-cell current clamp recordings of layer 5 pyramidal neurons (L5 PN) of the auditory cortex of adult mice. Concentrations of sevoflurane in the aCSF were quantified using gas chromatography-mass spectrometry. We subdivided L5 PN into type A and B cells based on active membrane properties in response to small depolarizing and hyperpolarizing current steps. Quantification of passive and active membrane properties before and after application of sevoflurane at 0.5% showed a decrease in the firing frequency for both cell types and a specific effect on depolarizing the action potential threshold of type A L5 PNs, (ΔAPthreshold=+18.63 mV; p=0.0249; n=5) and increasing the latency of action potential half-width of type B L5 PNs (ΔAPHalf-width=+1.08 ms; p=0.0486; n=4). Stable recordings after washout of sevoflurane restored partially initial maximum firing frequency, AP threshold for type A and AP half-width for type B L5 PNs.Our preliminary results conclude that sevoflurane decreases the firing frequency of both types of L5 PNs. However, membrane properties are differentially affected depending upon cell-type. Future studies will also examine how sevoflurane alters membrane properties of different types of cortical interneurons and contribute to our cellular understanding of volatile anesthetics mechanism of action.

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