(αSC). Machine learning algorithms using elastic net regularization were used to develop models that predicted clinical outcome. Performance of models using the three connectivity measures were compared, as well as models incorporating an early symptom change predictor.
All connectivity metrics showed significant changes and were significant predictors of outcome, with αSC showing the best model performance area under the curve [AUC] of 0.83. Early symptom change also significantly predicted outcome (AUC=0.79), and the combination of αSC and symptom change in the UL subgroup yielded the highest accuracy (AUC=0.91). Predictive models for coherence and envelope correlation incorporated primarily temporo-parietal connections, while those for αSC included primarily connections from the stimulation site to contralateral fronto-temporal locations.
Network connectivity significantly changed in the first rTMS treatment. αSC was the strongest predictor of clinical outcome that was both superior to and additive with early symptom change measurements. These findings suggest that early connectivity changes may be used to predict outcome and optimize rTMS treatment of MDD.
**Keywords:** Depression, repetitive transcranial magnetic stimulation, machine learning, electroencephalography (EEG)

### 844
### ROBOTIC TRANSCRANIAL MAGNETIC STIMULATION (TMS) MOTOR MAPPING IN CHILDREN

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**Introduction**:The developing brain is highly capable of reorganizing itself after exposure to environmental and internal influences, or brain injuries. Cortical motor maps are being increasingly used to study plasticity, with pediatric populations being ideal models. Motor maps are individualized representations of primary motor cortex (M1) measurable with single pulse TMS.Advances in MRI-guided robotic TMS may facilitate more rapid and accurate mapping. We aimed to characterize robotic TMS motor maps in children.
**Methods**: Healthy, right handed children (n=24, median age 15.5 years, range 12-18 years, 52% female) underwent neuronavigated robotic TMS (Brainsight2, Axilum) motor mapping. A 12x12, 7mm grid was placed over M1 with 4 stimulations per point generating motor evoked potentials (MEP) of four hand muscles. Primary outcome was motor map area (volume, center of gravity, and cortical excitability were secondary). Proportions of map area were compared at 25%, 50%, and 75% of maximum MEP amplitude. Clinical motor function was assessed using the Purdue Pegboard and Jebsen Taylor tests. One-way ANOVA, t-tests, and correlations compared subject characteristics with motor map metrics.
**Results**: Complete motor maps were obtained in 46/48 measurements with favourable tolerability and no adverse events. Measuring submaximal proportions of map area and volume resulted in significantly smaller variance (all $p < 0.05$). All measures of map area and volume were not associated with age but were significantly larger in males ($p<0.05$). Baseline motor map metrics were not associated with clinical motor function measures.
**Conclusion:**Robotic TMS motor maps are safe, feasible, and tolerable in adolescents. Gender but not age may be associated with map metrics. Proportions of map area and volume may be most accurate for measuring change in studies of motor map plasticity.
**Keywords:** Robotic Transcranial Magnetic Stimulation, Motor Maps, Children, Neuroplasticity

### 845
### GALVANIC VESTIBULAR STIMULATION (GVS) NORMALISES SUBNETWORK INTERACTIONS IN PARKINSON'S DISEASE

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Galvanic Vestibular Stimulation (GVS) has been reported to have beneficial behavioural effects in Parkinson's Disease (PD), including improving manual tracking performance, improving gait and balance, enhancing interhemispheric connectivity and overall connectivity to the pedunculopontine nucleus (PPN). In this study, we tested the effects of different GVS stimuli on fMRI brain subnetwork interactions in both health control (HC) and PD groups. Twenty-six PD subjects (on medication) and 15 age- and sex- matched controls were recruited in our study and their fMRI data were collected with sham stimulation (i.e., resting state), noisy GVS, 1 Hz sinusoidal GVS, and 70-200Hz multisine GVS conditions. In the subjects' native space, hippocampal, temporal/insular, basal ganglia, vision/cerebellar, frontal, sensorimotor and default-mode subnetworks were extracted. Subnetwork interaction coefficients were estimated by non-negative canonical correlation analysis (nCCA).
Without GVS, interactions of the vision-related/cerebellar subnetwork with the hippocampal, temporal/insular, basal ganglia, frontal and sensorimotor subnetworks were significantly decreased in the PD group. GVS stimuli did not have a significant effect on subnetwork interactions in the HC group. However, in the PD group, the interactions between the hippocampal and temporal/insular subnetworks, between the basal ganglia and sensorimotor subnetworks, and between the basal ganglia and default-mode subnetworks were significantly improved (i.e. made closer to them of HC group) by the sinusoidal GVS. With the multisine GVS, the interactions between the hippocampal and temporal/insular subnetworks were also significantly improved.
Our results suggest that GVS has widespread, system-level effects, and improves subnetwork interactions in PD in a stimulus-dependent manner. Given recent work demonstrating that Deep Brain Stimulation (DBS), a proven therapy for PD, also improves network interactions, our results suggest further investigation of GVS as a potential therapy in PD is warranted.
**Keywords:** Galvanic Vestibular Stimulation, fMRI, brain connectivity, Parkinson's Disease

### 846
### TRANSCRANIAL MAGNETIC STIMULATION OF THE MIDLINE CEREBELLUM IN A THETA-BURST PATTERN INDUCES CHANGES IN EEG GAMMA FREQUENCY COMPARED TO SHAM

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**Introduction:** Transcranial magnetic stimulation (TMS) is a technology capable of inducing an electrical field on the surface of the brain. When applied repetitively over a matter of minutes, this can induce long-lasting changes in brain activity. Theta burst TMS has demonstrated promise for inducing both neuroplasticity-related changes and behavioral changes in animal and human studies. Few studies have looked at EEG changes induced by repetitive TMS targeted at the cerebellum.
**Methods:** Eleven patients with various neuropsychiatric disorders (6 schizophrenia, 3 bipolar disorder, 2 autism spectrum disorder) completed one three-minute session of either active or sham theta burst stimulation targeted with neuronavigation at lobule VIIB of the midline cerebellum, as part of an ongoing trial. Resting EEG was recorded for 5 minutes immediately pre- and post-stimulation. EEG was also recorded during the stimulation. The theta burst protocol involved 200 total bursts delivered at 100% motor threshold. EEG results were analyzed to compare intra-stimulation and post-stimulation with pre-stimulation in the active and sham conditions.
**Results:** Active stimulation resulted in intrastimulation decreases in gamma frequency power and post-stimulation increases in gamma frequency power over the midline cerebellar lead compared to sham. These changes were not seen in a vertex location lead. The gamma frequency power changes were also present in the medial and lateral prefrontal regions post-stimulation. Magnitude-squared coherence values between the midline cerebellum and the medial prefrontal region demonstrated increased coherence in the theta and alpha range during active stimulation followed by increased coherence in the gamma range post-stimulation which was not present with sham stimulation.
**Conclusions:** Increased coherence between the medial prefrontal region and the midline cerebellum during and post-stimulation suggests a

functional connection between these two brain regions that is consistent with previous optogenetic stimulation work in animal studies.
**Keywords:** Neuromodulation, cerebellum, EEG, TMS

**847**

## A COMPETENCE BY DESIGN MODEL FOR INTEGRATING NEUROSTIMULATION MODALITIES INTO PSYCHIATRY RESIDENCY TRAINING

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**Background:** Competence By Design (CBD) is an initiative undertaken by the Royal College of Physicians and Surgeons of Canada to modernize specialty residency training. CBD places primary focus on achievement of specific skills, organized as Entrustable Professional Activities (EPAs), rather than time-based criteria for resident evaluation and promotion. Within psychiatry, neurostimulation modalities including electroconvulsive therapy (ECT) and repetitive transcranial magnetic stimulation (rTMS) provide ideal subjects for the CBD model, given the specific skills each entails. As neurostimulation applications in psychiatry become more widespread, it is critical for postgraduate training to evolve in order to equip residents with competencies required of modern psychiatrists. We aimed to develop recommendations for the integration of neurostimulation competencies into a CBD framework, which could be applied to postgraduate psychiatry training in Canada.
**Methods:** We established a working group including clinical and academic faculty, postgraduate educators, and residents within our Department of Psychiatry. Following a scoping process, including a literature review of CBD initiatives in psychiatry and neurostimulation, we determined that organizing EPA units based on modality was reflective of best practice within CBD-adopting training programs, particularly in procedural specialties.
**Results:** We developed EPA proposals for ECT and rTMS, consisting of seven and eight milestones respectively. Each milestone corresponded to a discrete component competency required for independent practice in each modality, including aspects of patient evaluation for appropriateness, treatment planning, stimulus delivery, and follow-up. Sub-milestones were defined corresponding to specific clinical skills and knowledge necessary for each component of each procedure. CANMEDs roles associated with each sub-milestone were identified.
**Discussion:** Our pilot CBD framework outlines a comprehensive and concrete process for establishing competency in ECT and rTMS at a level required for an independent practitioner. Our goal is to provide a platform for the integration of neurostimulation into modern psychiatric residency training in Canada and internationally.
**Keywords:** Neurostimulation, medical education, residency training, Competence By Design

**848**

## SAFETY AND TOLERABILITY OF NON-INVASIVE NEUROSTIMULATION IN CHILDREN

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**Background:** Non-invasive brain stimulation (NIBS) can interrogate neurophysiology and modulate brain function but children are underrepresented in the literature. Transcranial magnetic stimulation (TMS) and transcranial direct-current stimulation (tDCS) are increasingly applied to pediatric populations but safety data is lacking and a source of concern. We report a large, prospective experience of children undergoing brain stimulation to determine safety and tolerability across diverse modalities and populations.
**Methods:** Our academic pediatric center established a non-invasive brain stimulation laboratory for children in 2008. Multi-disciplinary neurophysiological studies included single- and paired-pulse TMS methods. Interventional trials used repetitive TMS (rTMS) and tDCS. Prospective, standardized safety and tolerability data was obtained on all subjects across multiple sessions including a pediatric-specific questionnaire as well as child and parental interviews.
**Results:** From 2008-2018, 381 children underwent brain stimulation (median 13.2 years, range 0.7–18.0). Most common were children with typical development (118), perinatal stroke/cerebral palsy (100) or mild traumatic brain injury (121). There were no serious adverse events. Headache occurred following rTMS in 20% initially but decreased to 13% in the second week, and to 0% by the third week in a depression study. All other longitudinal safety assessments also decreased by at least 28%. Similarly, following rTMS, headache occurrence decreased by 45% by the fourth week in participants with traumatic brain injury. Following single and paired-pulse neurophysiology TMS protocols, the occurrence of headache, neck pain or unpleasant tingling was >20% but dropped by 50% when assessed again one week later. Following motor cortex tDCS, occurrence of itching and tingling was >25% but decreased by >80% 1 week later.
**Conclusions:** NIBS is safe and well tolerated in children. Side effects are mild and marked tolerance develops quickly. NIBS may be considered minimal risk in children, encouraging further applications in the developing brain.
**Keywords:** TMS, tDCS, Safety, Children

**849**

## TISSUE ENGINEERING AND NEW APPROACHES FOR THE DISSOLVING OF SOME OBSTACLES IN LONG-TERM ELECTRODES

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Nowadays the medical electrodes used extensively in treatment and diagnosis in lots of disorders. For example in Seizure recognizing, treatments and prevention and also for heart pacemakers, brain pacemakers, Cochlear implant, Peripheral Nerve Stimulation Devices, this electrode have lots of use . Neural electrodes have been widely used for brain research. The use of these electrodes in the brain is limited due to their inability to record neural signals for a long time. But the main problem in these electrodes is the invasive Feature of them, so these electrodes make a wound in the place where they put, and the immune system comes to the wounded site and some of the immune cells like as Microglia and macrophages produce fibrosis. In this case, the metal and bioinert electrodes couldn`t work correctly because of the Insulation property in the fibrous tissue that produces with immune cells and connective tissue that stimulated with trauma. So tissue engineering has lots of solutions to eliminate these obstacles, for example, using biocompatible and biodegradable materials must be a good idea for this kind of devices. By the way, until today the scientists used some synthetic and natural materials as a conductor electrode ( like as chitosan) And it seems using some biological materials like as some decellularised tissue must be helpful in long-term electrodes some of the elements (Biomaterial) that the scientists used as suitablestuff for long-term materials are Polypyrrole (PPy), Polyaniline (PANI), Poly(3,4-ethylenedioxythiophene) ( PEDOT), Polythiophene (PTh), Polythiophene-vinylene (PTh-V), Poly(2,5-thienylenevinylene) (PTV), Poly(3-alkylthiophene) (PAT), Poly(p-phenylene) (PPP) and Etc. We hope that in the future medical engineering and tissue engineering will be able to solve all the problems of medical electrodes.
**Keywords:** Nervous system, medical electrodes, Tissue Engineering

**850**

## REPETITIVE TRANSMAGNETIC STIMULATION MAY REDUCE CUE-INDUCED CRAVING IN METHAMPHETAMINE USE DISORDER

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**Objective:** The primary aim of this project was to use a randomized single-blind sham-controlled study to investigate if high frequency (HF-)rTMS can modulate cue-induced craving in adult methamphetamine (METH) users.
**Background:** Methamphetamine Use Disorder (MUD) is a significant public health problem with 4.7% of the U.S. population having tried METH in their lifetime. METH is highly addictive and can result in significant psychiatric burden. Current treatments for MUD are not effective and new