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E-field shaping while being more efficient than circular coils. Furthermore, results show that 2–4 mm coil movements led to small errors in the E-field pattern (3% - 6%). Our computational multichannel TMS neuronavigation system allowed rendering the E-fields of individual 3-axis coils and synthesizing the 'hot spot' using the array approach with speed and accuracy suitable for human studies.

Conclusions: The multichannel TMS array approach can be used for steering the target area for accurate and efficient stimulation with interactive fast E-field computation and visualization.

Acknowledgment

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Keywords: Multichannel TMS, Neuronavigation, Real-time Targeting, TMS Dosing

P3.108

SPECTRAL-TEMPORAL ELECTROPHYSIOLOGICAL FEATURES PREDICT SHORT-TERM PLASTICITY IN HUMANS

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Abstract

Background: Stimulating specific parts of the brain allows us to better understand the activity of brain networks. Hebbian theory suggests that repetitive stimulation of regions that are functionally connected ('fire together') undergo eventual neural plasticity ('wire together'). However, it is unclear how Hebbian theory manifests when evaluating the local field potential temporal-spectral changes after repetitive stimulation. Our previous research demonstrated a relationship between post-stimulation changes in the evoked potential and pre-stimulation evoked potentials. To date, there is little known about how, when, and where repetitive stimulation modulates temporal-spectral features in the human brain. We hypothesize that baseline temporal-spectral features strongly predict post-stimulation plasticity.

Methods: 14 medically-intractable epilepsy patients undergoing intracranial electroencephalographic (iEEG) recordings received single sessions of 10Hz focal electrical stimulation (10Hz, 5s on, 10s off, 3000 total pulses) chosen to mimic standard TMS. Single pulses were applied before and after 10Hz stimulation and the cortico-cortical evoked potential (CCEP) was quantified. Temporal-spectral features from the CCEP pre and post stimulation were extracted and compared.

Results: Across participants and across standard frequency bands, electrode channels with stronger baseline power were more likely to undergo changes in spectral power after 10Hz stimulation. These changes were specific to temporal window (i.e. 10-50ms baseline spectral power predicted changes in 10-50ms window) and frequency (i.e. baseline alpha power predicted change in alpha power post-stimulation). This relationship was significantly stronger in gamma (30-50Hz) and high gamma (70-120Hz) bands compared to lower frequencies. Together, these results show that temporal-spectral baseline features strongly predict post-stimulation plasticity effects, suggesting that Hebbian learning is specific to the temporal and spectral window of interest.

Conclusions: These findings can help improve our understanding of spectral-temporal electrophysiological features and their relationship with short-term plasticity in humans, leading to the development of better brain stimulation techniques and tools.

Keywords: Neuroplasticity, iEEG

P3.109

EFFECTS OF AUDITORY BINAURAL BEATS ON CONSCIOUSNESS AND THE HUMAN NERVOUS SYSTEM: A TRANSDISCIPLINARY REVIEW OF THE EVIDENCE

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Abstract

This presentation of my doctoral dissertation research offers a transdisciplinary synthesis of peer-reviewed research on the effects of auditory

binaural beats on patterns of the brain activity and the autonomic nervous system. Binaural beats create an auditory illusion when two different sound frequencies are heard simultaneously and separately in the left and right ears. The result is the illusion of a third "difference" tone at a pitch that matches the difference between the two original frequencies. This difference tone affects brain activity, influencing a person's state of consciousness, which is measurable in EEG rhythms. The present transdisciplinary overview of binaural beats research summarizes the progress of binaural beats investigations in the disciplines of health, neuroscience and psychology, providing a broad perspective of the state of binaural beats research and applications. Reviewed here are investigations of brainwave states, methods of measurement, and experimental protocols for binaural beats. Recommendations for future research on binaural beats are suggested.

Keywords: Binaural Beats, Hemispheric Synchronization, Brainwave Rhythms, Cognitive Neuroscience

P3.110

DUAL TRANSCRANIAL DIRECT CURRENT STIMULATION FOR SUBACUTE STROKE PATIENTS WITH COMPROMISED CORTICOSPINAL INTEGRITY: A RANDOMIZED, DOUBLE-BLIND, SHAM-CONTROLLED STUDY

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Abstract

Background: Dual transcranial direct current stimulation (tDCS) over the primary motor cortex (M1) simultaneously modulates bilateral corticospinal excitability and interhemispheric interaction. However, the efficacy of dual tDCS for moderate-to-severe poststroke paresis remains unclear.

Objective: To investigate the effects of multi-session dual tDCS on upper limb motor recovery in subacute stroke patients.

Methods: First-ever subacute stroke patients with unilateral subcortical infarction and Fugl-Meyer Assessment of Upper Extremity (FMA-UE) scores between 3-56 were double-blind, randomized to receive either real or sham dual tDCS over bilateral M1 during task practice for 20 sessions over two weeks. Each 20-minute session was followed by 90-minute rehabilitation therapy. The primary outcome was the change scores in FMA-UE; the secondary measures were the changes in Action Research Arm Test (ARAT) and seed-based functional connectivity (FC) using resting-state functional MRI after intervention and 3 months after stroke.

Results: Twenty-sixth participants (n=13/group), including 19 patients (73%) absence of motor-evoked potentials from paretic forearms, completed the intervention without major adverse events. The baseline characteristics were similar. After intervention, the real tDCS group showed significant improvement of FMA-UE ($U = 38, p < 0.008$, effect size $r = 0.47$) and ARAT scores ($p < 0.022, r = 0.40$) compared with the sham group, which lasted until 3 months after stroke ($p < 0.011, r = 0.44-0.76$). Interestingly, FC strengths increased specifically between the ipsilateral M1 and primary sensory cortex in bilateral hemispheres, which associated in synergy with FMA-UE improvement after real tDCS ($R^2 = 0.77, p = 0.005$). By contrast, after sham tDCS, only the ipsilesional FC strengths decreased, which negatively associated with FMA-UE improvement ($R^2 = 0.51, p = 0.02$).

Conclusion: Dual tDCS over bilateral M1 during task training potentially facilitate upper limb motor recovery and modulate bihemispheric sensorimotor networks in subacute stroke patients with compromised corticospinal integrity.

Keywords: Transcranial direct current stimulation, Stroke, Upper extremity, Functional connectivity

P3.111

AT-HOME TELEMEDICINE CONTROLLED TAVNS TWICE DAILY FOR 4 WEEKS IS FEASIBLE AND SAFE FOR LONG COVID SYMPTOMS.

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Abstract

Coronavirus disease of 2019 (COVID-19) can enter and directly infect the brain, creating several neurologic and psychiatric symptoms. Some have coined the term 'Long Covid' to describe this direct CNS infection and damage and differentiate this aspect of the disease from the more widely discussed systemic pulmonary and cardiovascular effects. Transcutaneous auricular vagus nerve stimulation (taVNS) is a non-invasive alternative to implanted VNS and both may have anti-inflammatory effects. We wanted to test whether we could administer taVNS entirely at home to long Covid patients using online recruitment and screening and then training and monitoring them through telemedicine platforms.

We enrolled 13 subjects (mean age 48.5 ± 11.3 , 8 female) with long COVID symptoms. Subjects received two treatment sessions/day, 6 days per week, for 2 weeks (randomized) followed by 2 weeks open label (active). Each treatment session lasted 60 minutes. Subjects thus received either 24 or 48 active taVNS sessions over 4 weeks. Subjects were provided videos showing how to use the devices included in the treatment kit and were trained and monitored prior to self-administering.

Subjects were able to self-administer taVNS with 1 training session (i.e., session with no stimulation) and 4 monitored treatment sessions. The mean stimulation perceptual threshold was $0.3\text{mA} \pm 0.1\text{mA}$, with treatment mean at $0.6\text{mA} \pm 0.2\text{mA}$. Two subjects reported minor and transient skin irritation around the tragus. There were no dropouts. For the first four sessions, patients were monitored for blood pressure, heart rate, and respirations. There were no problems with syncope or lowered heart rate or blood pressure. Clinical outcomes are presented in a separate poster (Austelle et al.).

This double-blind, at home taVNS treatment pilot study demonstrates that it is feasible and safe to train long Covid subjects to self-administer taVNS solely at home.

Keywords: taVNS, COVID-19, telemedicine

P3.112

AT-HOME TELEMEDICINE CONTROLLED TAVNS TWICE DAILY FOR 4 WEEKS REDUCES LONG COVID SYMPTOMS OF ANXIETY AND FATIGUE

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Abstract

Introduction: Coronavirus disease of 2019 (COVID-19) can enter and directly infect the brain, with myriad neurologic and psychiatric problems. After recovery from the acute infection, many patients struggle with residual neuropsychiatric symptoms (called Long Covid), including fatigue, anxiety and depression. Transcutaneous Auricular Vagus Nerve Stimulation (taVNS) is non-invasive and has anti-inflammatory functions that might treat Long Covid.

Methods: In this pilot study (Dec 2020 to July 2021), we enrolled 13 subjects who were previously COVID positive and developed at least one new neuropsychiatric symptom after acute COVID infection (anxiety, depression, vertigo, anosmia, headaches, fatigue, irritability, or impaired cognitive processing). Subjects were screened via telemedicine, and the device and monitoring kit were shipped to their homes. They never physically encountered the research team. Subjects self-administered taVNS twice daily, six days/week, for an initial 2-week double blind phase followed by an additional two weeks of active, open treatment. Thus, subjects received either 24 or 48 actual sessions of taVNS over 4 weeks.

Results: Randomized data remains blinded at abstract deadline. Overall, 72.7% of participants reported anxiety as a symptom at the initial visit. After 4 weeks (blinded and open label phases), only 25% reported anxiety. Average scores on the GAD-7 anxiety scale progressively decreased over the course of the study (13.7 ± 7.4 at initial visit, 8.6 ± 6.3 immediately after blinded phase (2 wks), and 3.4 ± 4.2 at end of the open phase (4wks)). Measures of stress and fatigue also decreased over 4 weeks. Unblinded data will be presented at the conference.

Conclusions: At home taVNS may reduce anxiety and improve stress and fatigue. Initial results support further at home taVNS studies to treat Long Covid and potentially other neuroinflammatory disorders or primary anxiety disorders.

Keywords: taVNS, Long COVID, Anxiety, Telemedicine

P3.113

INCREASING THE NUMBER OF DAILY STIMULATION SESSIONS ADMINISTERED DURING TAVNS-PAIRED BOTTLE FEEDING SPEEDS RESPONSE TIME IN NEWBORNS WITH FEEDING DIFFICULTY

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Abstract

Introduction: Neonates born premature or who suffer brain injury at birth frequently have oral feeding dysfunction, leading to extended hospital stays while trying to learn to feed and/or surgical implantation of gastrostomy tubes (G-tube). In previously published pilot data, over 50% of infants who were clinically determined to need a G-tube attained full oral intake volumes with once daily taVNS (1X) paired with bottle-feeding rehabilitation. In this subsequent prospective open-label study, we investigated whether increasing the number of daily stimulation sessions administered would enhance outcomes.

Methods: We enrolled 21 infants (n=16 premature, n=5 hypoxic-ischemic encephalopathy) failing oral feeding and meeting criteria for G-tube placement. We delivered taVNS to the left tragus at 0.1mA below perceptual threshold, twice-daily (2X) during 30minute feeding for 14-28 days. The primary outcomes were rate of feeding volume increase and number of infants who attained full oral feeding volumes.

Results: Similar to findings with 1XtaVNS-paired feeding, 52% (11/21) of infants receiving 2X taVNS achieved adequate oral feeding volumes for discharge without G-tube. We observed significant increases in feeding volume trajectories and fewer days to reach full volume oral feeds in taVNS 2X compared with 1X responders ($p < 0.001$): median 7days (2X) versus 12.5days (1X taVNS). Interestingly, across all 35 infants (n=14 1X, n=21 2X taVNS), 10 were infants of diabetic mothers (IDM), and 90% IDM did not respond to taVNS. Further, a subset of 7 non-responders (44%) initially improved po feeding volumes on pace with responders, then regressed and ultimately required G-tube placement, suggesting a block to consolidation of learning this motor skill.

Conclusion: Our data suggest that 2X stimulation sessions accelerates the time to response, but not the overall response rate with taVNS-paired feeding rehabilitation. If confirmed in a randomized clinical trial, taVNS may improve oral feeding in infants with oromotor dyscoordination.

Keywords: transcutaneous auricular vagus nerve stimulation, pediatric rehabilitation, vagus nerve stimulation, feeding

P3.114

VAGUS NERVE STIMULATION INDUCED COGNITIVE ENHANCEMENT: HIPPOCAMPAL NEUROPLASTICITY IN HEALTHY MALE RATS

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Abstract

Vagus nerve stimulation (VNS) is reported to improve learning and memory, but the mechanisms of this cognitive enhancement have yet to be elucidated. Behavioral performance, electrophysiology, and brain derived nerve growth factor (BDNF) expression were measured after VNS to investigate changes in cognition and hippocampal neuroplasticity. Healthy male Sprague-Dawley rats ($N = 47$) aged 10-12 weeks were implanted with a platinum/iridium electrode cuff around the unsheathed left VN. After recovery, VNS was administered as fifteen 100 μs biphasic pulses at 30 Hz, 0.8 mA constant current every 18 s for 30 min. Novel Object Recognition (NOR) and Passive Avoidance Task (PAT) training were paired with VNS ($N = 28$). NOR/PAT testing was measured 24 hr after training and