Transcranial Magnetic Stimulation of the Midline Cerebellum in a Theta-Burst Pattern Induces Changes in EEG Gamma Frequency Compared to Sham Nicholas T. Trapp^{1 3}, Arun Singh², Laren Garrett^{1 3}, Brandt Uitermarkt³, Aaron Boes^{1 2 3}, Krystal Parker¹

1. Department of Psychiatry, University of Iowa, Iowa City, Iowa, USA 2. Department of Neurology, University of Iowa, Iowa City, Iowa, USA 3. Neuroimaging and Noninvasive Brain Stimulation Laboratory, University of Iowa, Iowa City, Iowa, USA

Introduction

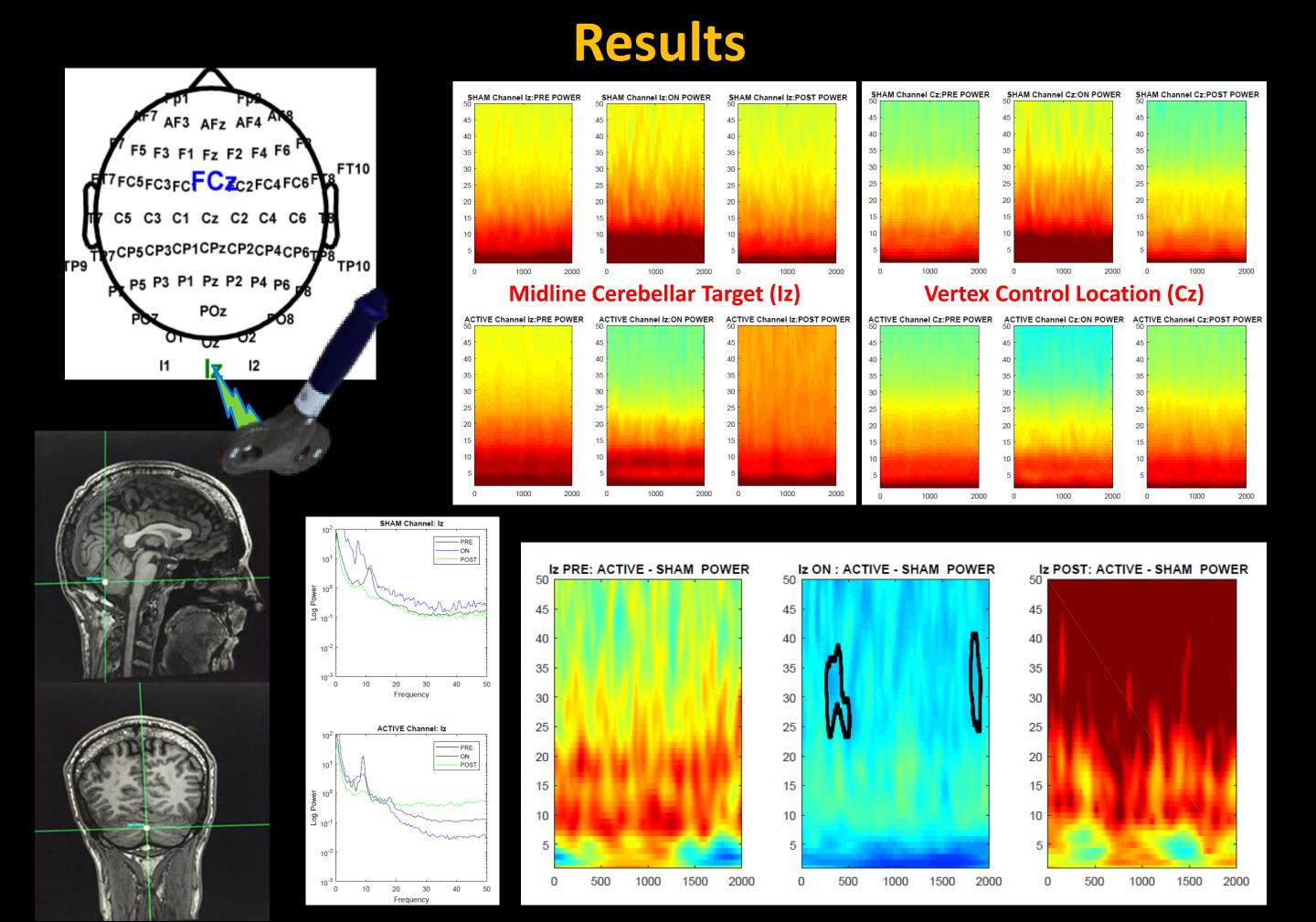
Transcranial magnetic stimulation (TMS) is a technology capable of inducing an electrical field on the surface of the brain[1]. When applied repetitively over a matter of minutes, this can induce longlasting changes in brain activity[1]. A certain pattern of stimulation, termed theta burst stimulation, has demonstrated promise for inducing both neuroplasticityrelated changes and behavioral changes in animal and human studies[2-5]. Few studies have looked at EEG changes induced by repetitive TMS targeted at the cerebellum [6-7].

Methods

- 11 patients with various neuropsychiatric disorders (6 schizophrenia, 3 bipolar, 2 autism) completed one 3-minute session of either active or sham theta burst stimulation targeted with neuronavigation at Lobule VIIB of the midline cerebellum, as part of ongoing clinical trials
- Theta burst protocol = Triphasic burst (3 pulses with 50 Hz interpulse interval) applied at 5 Hz frequency for 200 total bursts (600 pulses); 10 bursts per train (2s duration) with 8s intertrain interval; 100% motor threshold
- 5 minutes of resting EEG were recorded for each subject immediately pre- and post-stimulation (sampling rate 500 frames/sec)
- EEG was actively recorded during the period of stimulation (sampling rate 10,000 to 25,000 frames/sec)
- EEG results were analyzed in the prestimulation, on-stimulation, and poststimulation phases

Theta burst stimulation of the midline cerebellum will induce midline posterior ("Iz" lead) EEG changes in the delta, theta, and gamma frequencies in the active group as compared to the sham group across all diagnoses.

These changes will manifest as 1) an increase in power in the poststimulation as compared to the pre-stimulation resting EEG in delta and theta ranges, and 2) a within-stimulation increase in theta frequency in active compared to sham.



Hypothesis

Discussion & Conclusions

- were noted
- of psychiatric patients

- enrolled)

[1] Fitzgerald PB, Daskalakis ZJ. An introduction to the basic principles of TMS and rTMS. Repetitive Transcranial Magnetic Stimulation Treatment for Depressive Disorders, pp 1-6. 14 March 2013. [2] Li CT, Chen MH, Juan CH, et al. Efficacy of prefrontal theta-burst stimulation in refractory depression: a randomized sham-controlled study Brain 2014; 137: 2088-2089. [3] Oberman L, Ifert-Miller F, Najib U, et al. Transcranial magnetic stimulation provides means to assess cortical plasticity and excitability in humans with fragile X syndrome and autism spectrum disorder Frontiers in Synaptic Neuroscience 2010 Jun 28; 2: 1-8. [4] Blumberger DM, Vila-Rodriguez F, Thorpe KE, et al. Effectiveness of theta burst versus high-frequency repetitive transcranial magnetic stimulation in patients with depression (THREE-D): a randomized non-inferiority trial Lancet 2018 Apr 28; 391: 1683-1692.

[5] Oberman L, Edwards D, Eldaeif M, et al. Safety of Theta Burst Transcranial Magnetic Stimulation: A systematic review of the literature *J Clin Neurophysiol*. 2011 Feb; 28(1) 67-74.

[6] Casula EP, Pellicciari MC, Ponzo V, et al. Cerebellar theta burst stimulation modulates the neural activity of interconnected parietal and motor areas. Scientific Reports 2016 Oct 31; 6: 36191 [7] Harrington A, Hammond-Tooke GD. Theta burst stimulation of the cerebellum modifies the TMS-evoked N100 potential, a marker of GABA inhibition. *PLOS One* 2015 Nov 3; 10(11): e0141284.

 Theta burst stimulation of the midline cerebellum resulted in within-session decreases in gamma frequency activity, followed by immediate post-stimulation increases in gamma frequencies There was no obvious predisposition for theta or delta range changes as hypothesized, although global changes

• These results are limited by a small sample size and a heterogeneous sample

Future Plans

 Recruitment for the clinical trial continues (n=11 of proposed 120

 Subanalyses by diagnosis underway Connectivity analyses and induction of prefrontal EEG changes being explored

References