Focal transcranial electrical stimulation on a realistic head model via temporal interference

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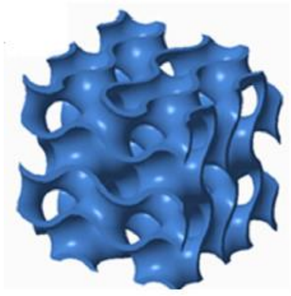
Introduction

- Transcranial electrical stimulation (TES) has limited spatial resolution and induces a large stimulation artifact that obscures EEG.
- Temporal interference stimulation (TIS) overcomes these limitations by stimulating at high frequency (>1 kHz).
  - Interference between waveforms (e.g., 1 + 1.005 kHz) results in an amplitude-modulated signal at the difference frequency (5 Hz)
- Artifacts can be removed with a simple low pass filter.

Phantom Construction

- 3-d printed (ABS-CB) conductive skull
  - Gyroid infill to mimic mass transport, conductivity, and density of trabecular bone layer

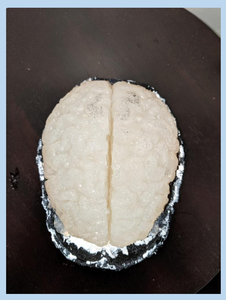


- Agar gel brain
  - 3-d printed (PLA) brain formed a positive mold.
  - RTV silicone was poured over the positive mold to form the negative mold.
  - Near-boiling saline-dosed agar was poured into the negative mold and allowed to harden.

Phantom Brain Construction

3-d printed PLA brain

Agar mold



Agar Brain

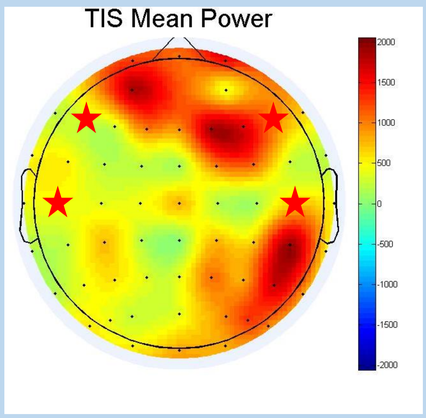
Phantom Skull Construction

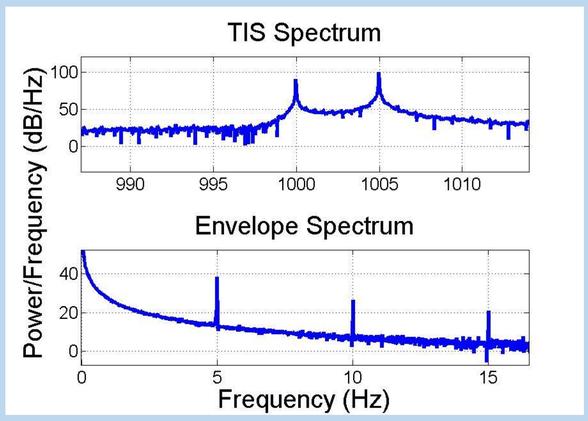
3-d printed ABS-CB skull

Liquid Latex Application

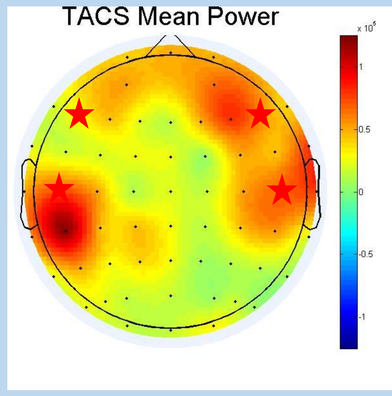
Complete skull & brain

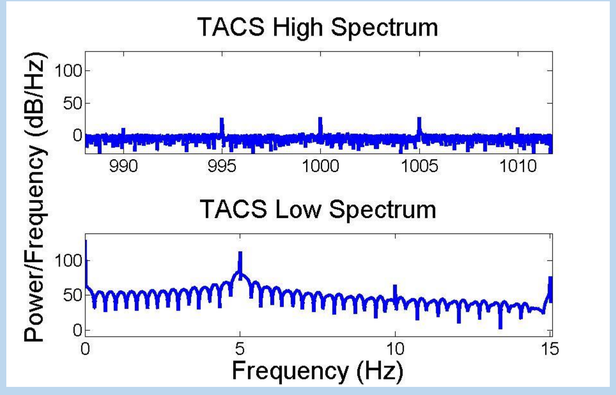
TIS Results





TACS Results





Results

- TIS (1+1.005 kHz) was compared to 5 Hz TES on a Phantom head model.
- As expected, there was a prominent 5 Hz peak in the power spectrum for both TIS and TES.
- but TIS exhibited a more central scalp topography.

References

Balmer, T. W., Vesztergom, S., Broekmann, P., Stahel, A., & Büchler, P. (2018). Characterization of the electrical conductivity of bone and its correlation to osseous structure, 1–8.
Grossman, N., Bono, D., Dedic, N., Tsai, L., Pascual-leone, A., Boyden, E. S., … Suk, H. (2017). Noninvasive Deep Brain Stimulation via Temporally Interfering Electric Fields. *Cell*, *169*(6), 1029–1041.
Ma, Tang, Feng, Song, Han, and Guo. (2018). Mechanical Behaviours and Mass Transport Properties of Bone-mimicking Scaffolds Consisted of Gyroid Structures Manufactured Using Selective Laser Melting. *Journal of the Mechanical Behavior of Biomedical Materials* 93, 158-69
Rammohan, Abhishek & Lee, Taeyong & Tan, V B C. (2015). A Novel Morphological Model of Trabecular Bone Based on the Gyroid. International Journal of Applied Mechanics. 7. 1550048.
Tsizin, E., Mund, T., & Bronstein, A. (2018). Printable anisotropic phantom for EEG with distributed current sources.
Zhang, J., Yang, B., Li, H., Fu, F., Shi, X., Dong, X., & Dai, M. (2017). A novel 3D-printed head phantom with anatomically realistic geometry and continuously varying skull resistivity distribution for electrical impedance tomography. *Scientific Reports*, *7*(1), 1–9.

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