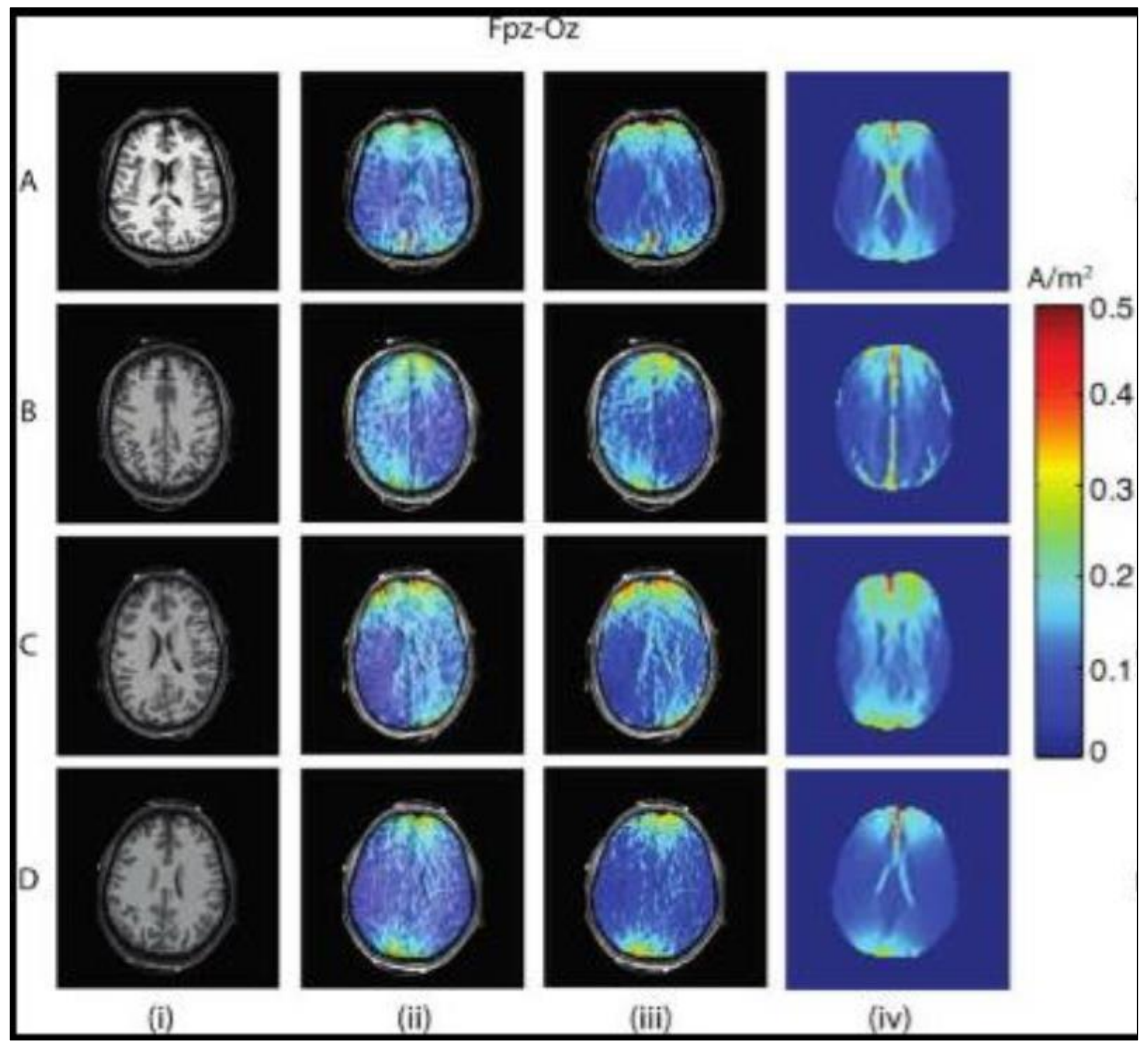
Directly Relating Magnetic Resonance Electrical Impedance Tomography (MREIT) Data to Neural Activity In Vitro

Cole Barnett, Biomedical Engineering
Mentor: Dr. Rosalind Sadleir, Assistant Professor
School of Biological and Health Systems Engineering

Research question: Is MREIT capable of directly measuring changes in conductivity due to neural activity in vitro?

Introduction

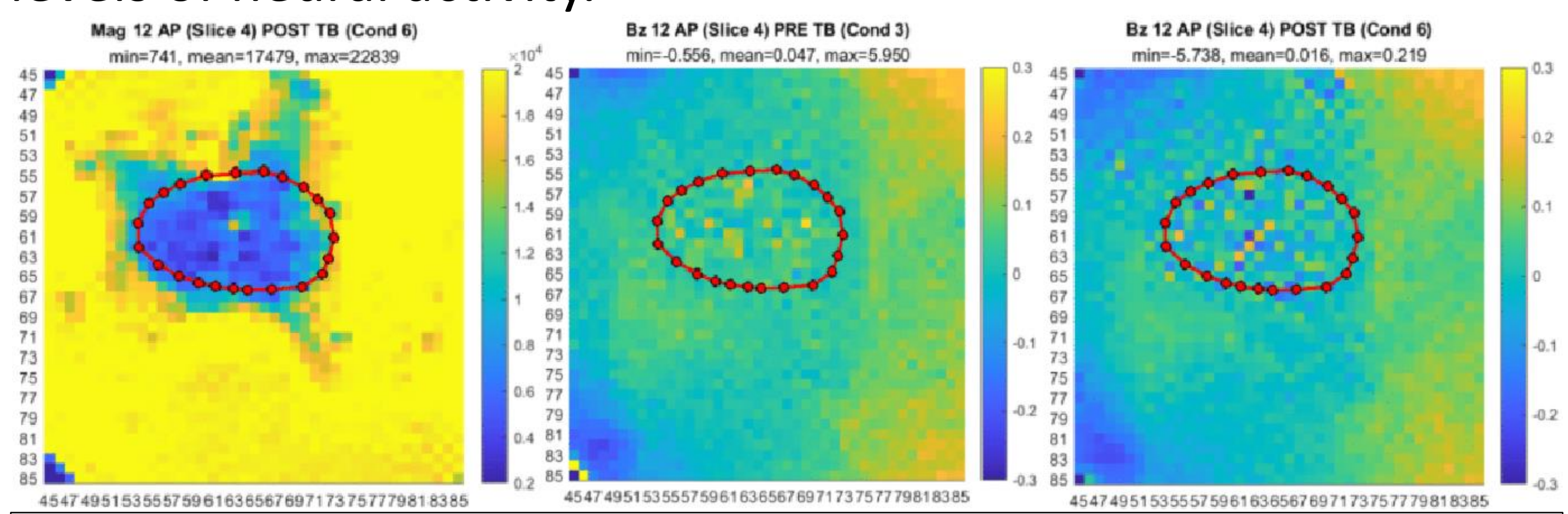
Magnetic resonance electrical impedance tomography (MREIT) is a relatively new medical imaging technique which has the potential to better image brain function. The research presented here reanalyzed data from a 2017 MREIT experiment in order to explore the technique's capability to directly measure neural activity changes at realistic noise and resolution levels.



An MREIT image of transcranial electrical stimulation current flow in the brain. By seeing where the current flows, we may be able to determine which stimulation has more effect.

Methods

The experimental data from 2017 analyzed in this research was gathered by taking MRI images of nerves isolated from sea slugs whilst an electrical current was passed through them. These MREIT images were captured before and after half of the slugs were treated with an excitotoxic agent. If MREIT is indeed capable of directly measuring changes in nerves due to changes in neural activity, then there should be seen a significant difference between the experimental group which had increased neural activity due to the addition of the neurostimulator and the control group with normal levels of neural activity.

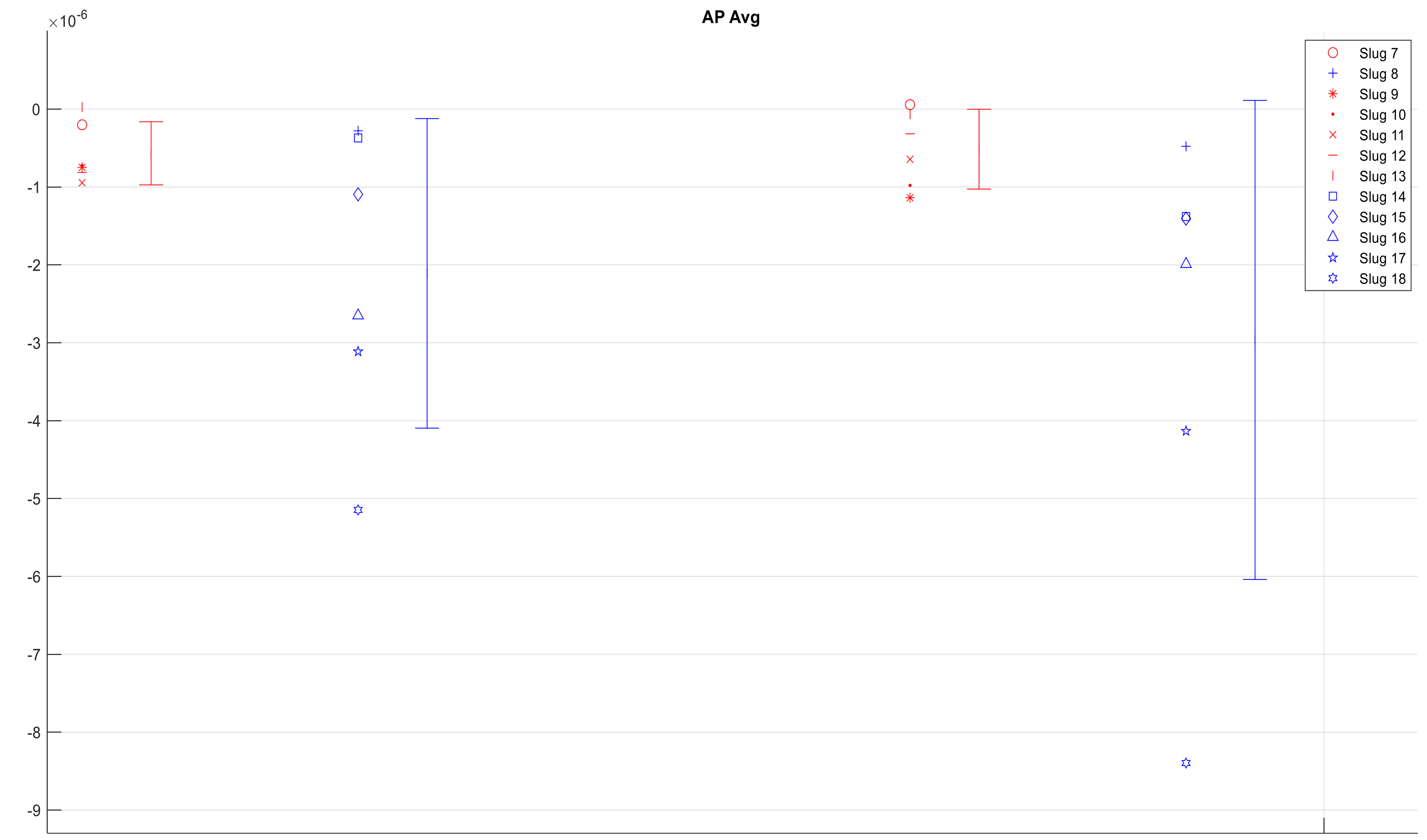


Left: An MRI magnitude image of the aplysia abdominal ganglion showing overlaid region of interest selection. Middle: The Pre-stimulation MREIT image of the ganglion. Right: The Post-stimulation MREIT image of the ganglion.

Previous analyses of these MREIT data found significant standard deviation increases in treated ganglia compared to control animals in the period after administration of the excitotoxic agent or control media. In this next stage, conductivity reconstruction will be attempted using more finely selected regions of interest and noise mitigation strategies. The approach we will use will likely involve finding relative differences in conductivity markers between pre- and post-agent administration

Results

Thus far into this research, the results have failed to show a significant difference between the treatment and control groups.



Plot comparing the treatment groups (in red) to the control groups (in blue). The overlap between the two groups for each pair indicate that the MREIT cannot differentiate between the treatment and control groups

Discussion & Conclusion

This failure to find significant differences between experimental groups at this stage may demonstrate that this method of performing MREIT is unable to reliably differentiate between different levels of neural activity with the levels of resolution and noise current present in the 2017 experiment. However, we are iteratively refining data processing methods to better highlight desired conductivity changes. We will also use the methods developed here to determine if this approach can be used to highlight conductivity changes caused by activity in data from another similar experiment performed in a lower noise environment.