Behavioral Motor Tasks and Closed Loop Deep Brain Stimulation in Essential Tremor

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INTRODUCTION

- Essential tremor (ET) is the most common motor movement disorder in adults.
- ET is thought to be caused by a dysfunction of the central tremor network, but little is known about the pathophysiology of this network.
- DBS of the Ventral Intermediate Motor (VIM) thalamus has been shown to significantly reduce the amplitude, increase the frequency and decrease the regularity of hand tremor as well as alter other neurophysiological aspects of ET.[1]
- There is a lack of studies exploring adaptive motor movement tasks in patients with ET.
- Patients with cerebellar ataxia were asked to perform a reaching task where perturbation was imposed slowly. Patients adapted their motor commands, but were unable to predict the sensory consequences of these motor commands.[2]

METHODS

- Using MATLAB we coded a two point behavioral task.
- Three primary measures will be assessed: Tremor Magnitude (TM), timing of task, and vector magnitude (VE).
- TM is the power of oscillations detected by the accelerometer signal or the joystick trace within the tremor frequency of 3-8 Hz.
- VE is classified as the degree variance between the subject's cursor movement and the 180-degree line drawn between each circle.
- We will perform 50 trials with each subject; VIM DBS on in 25 trials and off in 25 trials.
- We hypothesize that forward motor plans depend on communication from the cerebellum to the motor cortex, disruption of this communication (by DBS) will lead to worsened performance on the motor task.

RESULTS

Thus far, we have examined the task on 2 patients with Parkinson's Disease in order to look at the ease of the task. After introducing control trials the patients we were able to adjust the task to ensure clarity. Patients control the position of the white cursor on the black screen using a joystick. The white cursor will appear first with the second dot along a circle with a radius of 4 centimeters. As the subject moves the cursor to the second dot, the first dot will disappear and the third dot will appear directly 180 degrees horizontally to left or right of the second dot. The goal is to move the tracer as close along a 180-degree path between each circle.

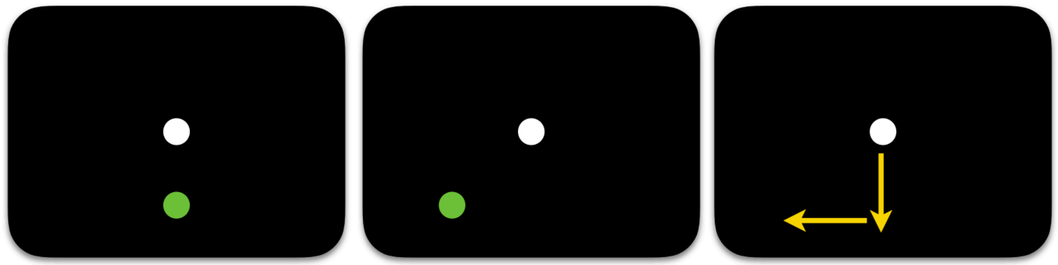

Figure 1. Behavioral Task

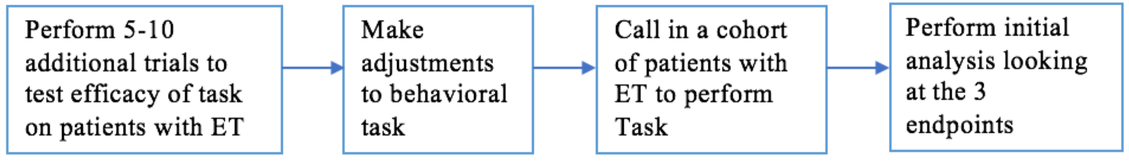

Figure 2. Project Timeline

Questions to be answered:

1. Does VIM DBS affect forward movement plans in a patient with ET?
2. What is occurring at a cellular level such that cerebellar function is disturbed?

DISCUSSION

This project is the first step in further understanding the pathophysiology behind the VIM-motor-cortex and cerebellar tract. Although the VIM is a known target for patients with essential tremor it is still poorly understood how the VIM is involved in the motor dysfunction seen in patients with ET. We hope that by studying the behavioral aspect of VIM DBS we can then identify what types of motor movements are relayed through the VIM into the motor cortex.

We will compare the distribution of timing, TE and VE scores calculated across the DBS ON trials to the total distribution of these values calculated in the same manner across both age-matched controls and the distribution across DBS OFF values. A potential limitation that could occur in this task is that ET patients with large tremor may interfere with the measurement of VE. We may need to limit our assessment of this variable in subjects with a high TM.

CONCLUSION

This behavioral task will allow us to examine the role of the cerebellum in DBS. Based on the results furthers studies must be done to understand the neuronal patterns that will allow for closed-loop DBS.

References

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Acknowledgments

I would like to thank Dr. Asaad, Shane Lee and Peter Lauro for their help this past summer, assisting me with the creation and coding of this task.