The Effects of Essential Tremor on Motor Adaptation

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Background

- Essential tremor (ET) is the most common movement disorder that classically manifests as rhythmic shaking of the upper limbs during purposeful movement.[1]
- The pathophysiology of ET is still an area of active research, but current neuroimaging and pathological data suggests cerebellar involvement.[2,3]
- The cerebellum is critical for integrating sensorimotor information and motor learning[4] and is part of the cortico-thalamo-cerebellar processing pathway.
- The ventral intermediate nucleus (VIM) in the thalamus is the traditional target for treatment. ET is treated with either deep brain stimulation (DBS) or high intensity focused ultrasound (HIFU).
- To date, very few studies have investigated the effect ET has on motor adaption.
- We hypothesize that ET patients will take longer to adapt to novel visuomotor scenarios due to cerebellar deficits.

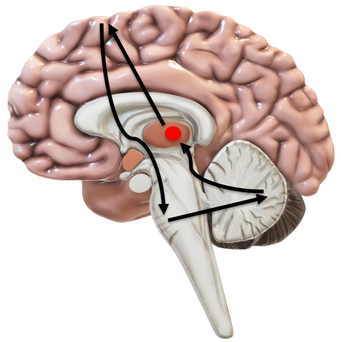

Figure 1: Cortico-thalamo-cerebellar pathway

Objectives

- Collect data using a computer simulation motor adaptation task and compare results between healthy controls and patients with ET.
- Understand the role of cerebellar dysfunction and cerebellar communication pathways in ET.
- Use the results of this project to assess the efficacy of current treatment paradigms in helping ET patients regain their motor adaptation abilities.

Methodology

Figure 2: Experimental settings for motor adaptation task. All data will be collected using NIMH MonkeyLogic in MATLAB. (a) Screen setup where targets can potentially appear. The yellow cross in the center represents the participant's cursor and the box at the bottom represents the joystick that will be used. (b) Target appears on screen and participant must move their joystick from the center to the right as quickly as they can. (c) A +60° directional bias is introduced into the task. If the participant moves their joystick from the center to the right, the cursor will move in a different direction then what is intended. (d) Once the participant figures out what the directional bias is, they can make the correct adjustments to reach to their target as quickly as possible.

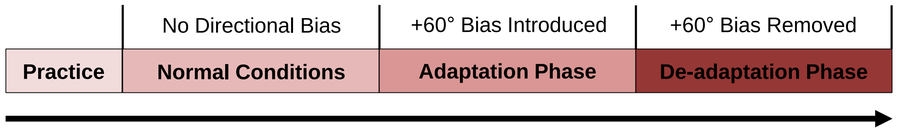

Figure 3: Experimental timeline for motor adaptation task. In the first phase of the task, there will be no directional bias. In the second phase of the game, a +60° will be introduced. Finally, in the last phase, the directional bias will be removed.

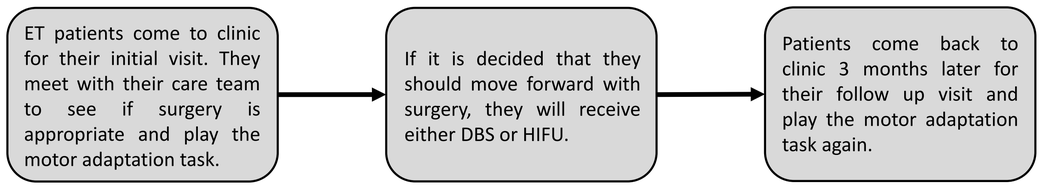

Figure 4: Experimental timeline for ET patients playing the motor adaptation task and receiving deep brain stimulation (DBS) or high intensity focused ultrasound (HIFU).

Limitations

- The motor adaptation task will be performed in succession with other tests and participants may be fatigued by the time they start it.
- ET has multiple subgroups and varying levels of severity that may impact the interpretation of the results.
- ET patients may be using pharmacologic treatments that could impact motor adaptation times.
- IRB study protocol needs to be renewed before data can be collected.
- Time spent in clinic needs to be increased so that patients can complete the task.

Future Directions

- For patients that receive deep brain stimulation (DBS) for their ET, we want to see how motor adaptation is affected with DBS on and DBS off. Then compare these results to ET patients who receive high intensity focused ultrasound (HIFU).
- Examine how tremor severity can impact an ET patient's ability to adapt to novel scenarios.
- Correlate data from motor adaptation task with functional magnetic resonance imaging data.

References

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