Effect of Intracortical Microstimulation in Somatosensory Cortex on Activity in Motor Cortex

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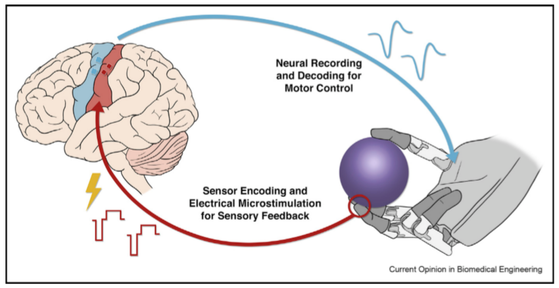
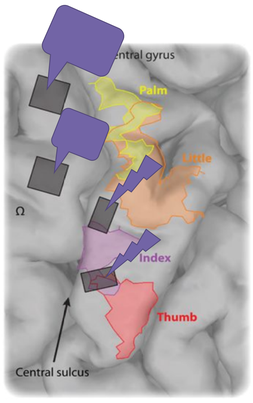
Motivation

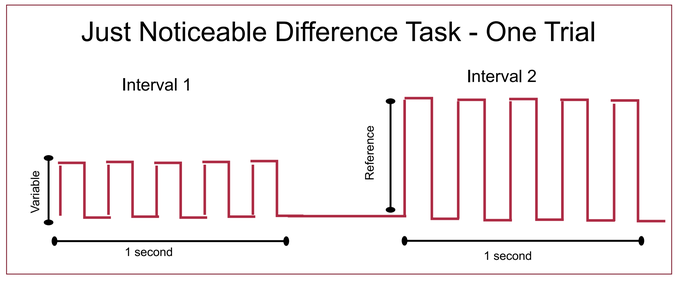


- Intracortical microstimulation (ICMS) feedback significantly improved performance on functional grasping tasks (Flesher et al., 2019).
- Why do we see this improvement ? Two theories:
  - ICMS provides additional information to the participant similar to sensory substitution, but does not directly affect motor cortex activity
  - ICMS feedback recruits pre-existing sensorimotor pathways resulting in changes in motor cortex activity
- **Project Goal**: Determine whether ICMS in somatosensory cortex changes neural activity in motor cortex.

Data Collection

- Neural recording in motor cortex (M1) during microstimulation in somatosensory cortex (S1)
- 176 recording channels and 64 stimulation channels implanted in cortex.
- Just noticeable difference stimulation task
- One reference (70 μA) and one variable stimulus (30 - 64 μA) delivered for one second at 100 Hz
- 60 -120 stimulus pairs per day
- Subject is not moving during task
- Data recorded on multiple days, however examples on this poster are from a single day.

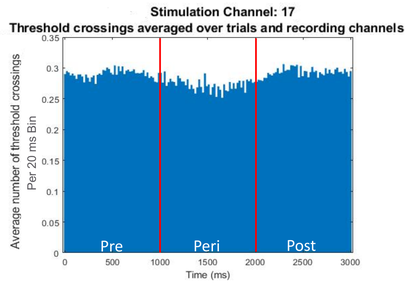




Artifact Removal and Filtering

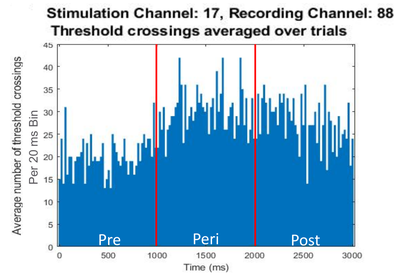
- Online artifact removal was done by blanking data in an window approximately 1.2 ms long around each stimulus pulse.
- Blanking was also applied to non-stimulus intervals to account for the reduction in available recording time.
- Binned spike counts were filtered with a 400-ms decaying exponential

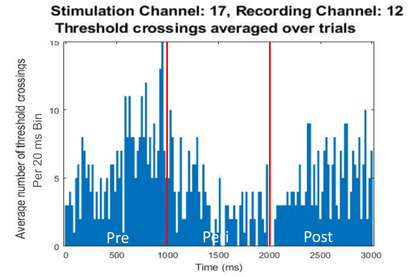
Differences in Neural Responses Across Channels



To explore the neural responses we examined threshold crossings in epochs before, during and after a 1 s stimulus train.

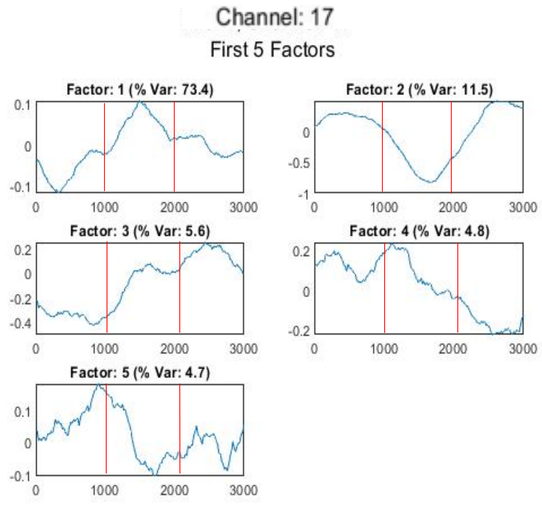
Across all recording channels and all trials there was a minimal effect during stimulation.





On individual channels however, both increases and decreases in threshold crossings occurred during the stimulation trains.

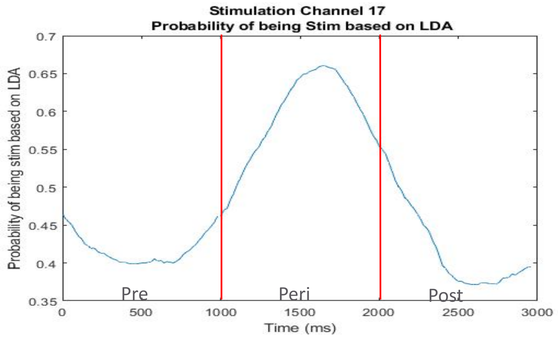
Identifying Predominant Responses to Stimulation



To assess the different responses across channels we ran factor analysis on the data.

Factor analysis is a dimensionality reduction tool that maximizes shared variance. The factors here show varying responses to stimulation in M1 for the first 5 factors.

Classifying when stimulation was delivered



- Linear discriminant analysis was run on the factors to see if differences could be found between stimulation and non-stimulation intervals.
- The figure above shows the probability of a specific bin being classified as coming from a pre-stimulus or stimulus interval.
- The overall accuracy was 68.5% . LDA can detect whether stimulation is occurring in S1 from recordings in M1 above chance.

Findings

- Differences between stimulation times and non-stimulation times can be seen
- The evidence is consistent with the idea that ICMS feedback can **activate pre-existing sensorimotor pathways**

Future Work

- Examine motor cortex responses during stimulation while a relevant motor task is being performed
- Study the effect of different kinds of sensory substitution on motor cortex before and after training

Limitations

- Issues with artifact removal in the online collection of the data
- Dataset was not intended to explore the effect of stimulation on motor cortex

Acknowledgements

I would like to thank the CNBC for inviting me to this program as Rob Gaunt, my PI, and Brian Dekleva, the post doc who worked with me on most of this project.

Works Cited

1. Flesher, Sharlene N, et al. “Restored Tactile Sensation Improves Neuroprosthetic Arm Control.” 2019, doi:10.1101/653428.