Impact of Nerve Block on Cortical Decoding of Tongue Movement Across Axes of Motion and Marker Regions

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INTRODUCTION

- The orofacial sensorimotor cortex plays an important role in tongue and jaw movements, such as eating/speaking
- Which features of movement drive its complex neuronal activity is still poorly understood
- In this study, we aim to investigate how information in the orofacial primary motor cortex (MIo) varies based on tactile sensation, axis of motion, and tongue region

METHODS

- Data collected from two male *Macaca mulatta*
- Tongue marker kinematics and neuronal activity from MIo simultaneously recorded during feeding trials
- LSTM model used to predict marker position from neural data, using R^2 as decoding performance criteria
- Local anesthesia injected into trigeminal nerve

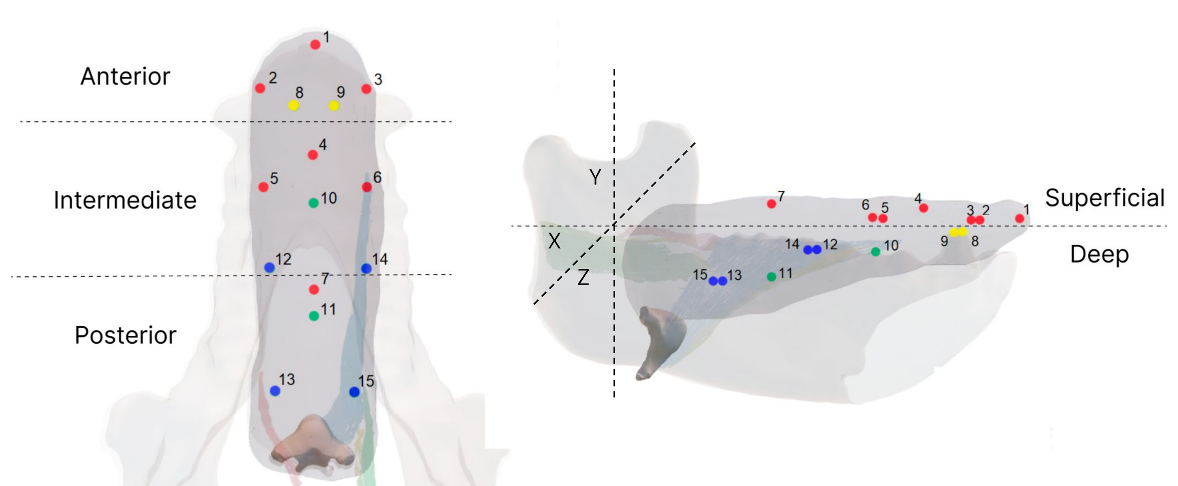

Fig 1.
Tongue markers divided into regions. Anterior vs. intermediate vs. posterior (left) and superficial vs. deep (right)

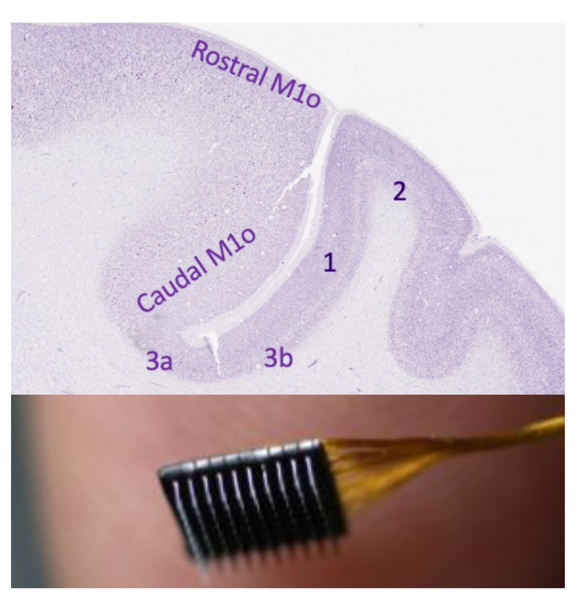

Fig 2.
Recording site (top), Utah array (bottom)

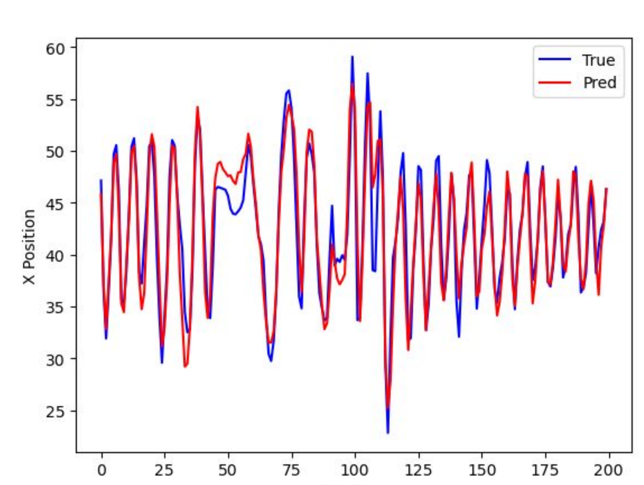

Fig 3.
Example decoding of neural activity using LSTM

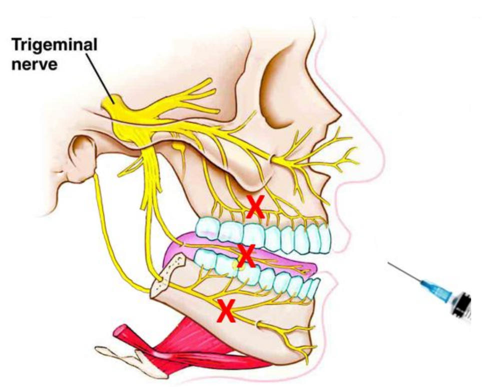

Fig 4.
Trigeminal nerve, which was injected with local anesthesia during nerve block trials

RESULTS

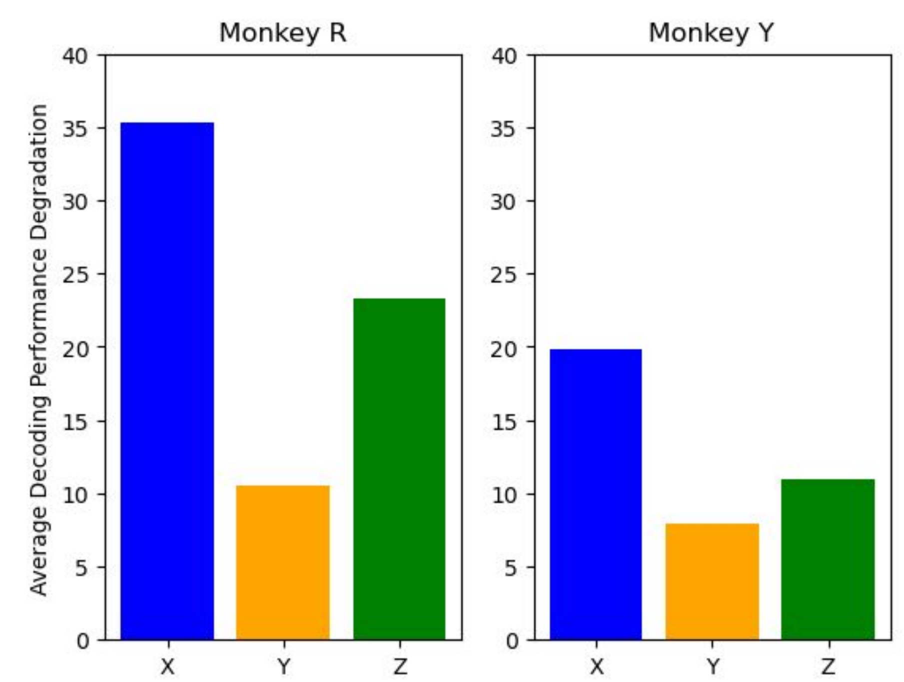

Fig 5.
Average % decrease in R^2 post-nerve block

- Administering nerve block decreased model performance (Mann-Whitney, $p<0.05$)
- X-position of markers showed greatest performance decrease post-nerve block ($p<0.001$)
- Z-position of markers shows the next highest performance decrease, followed by the Y-position

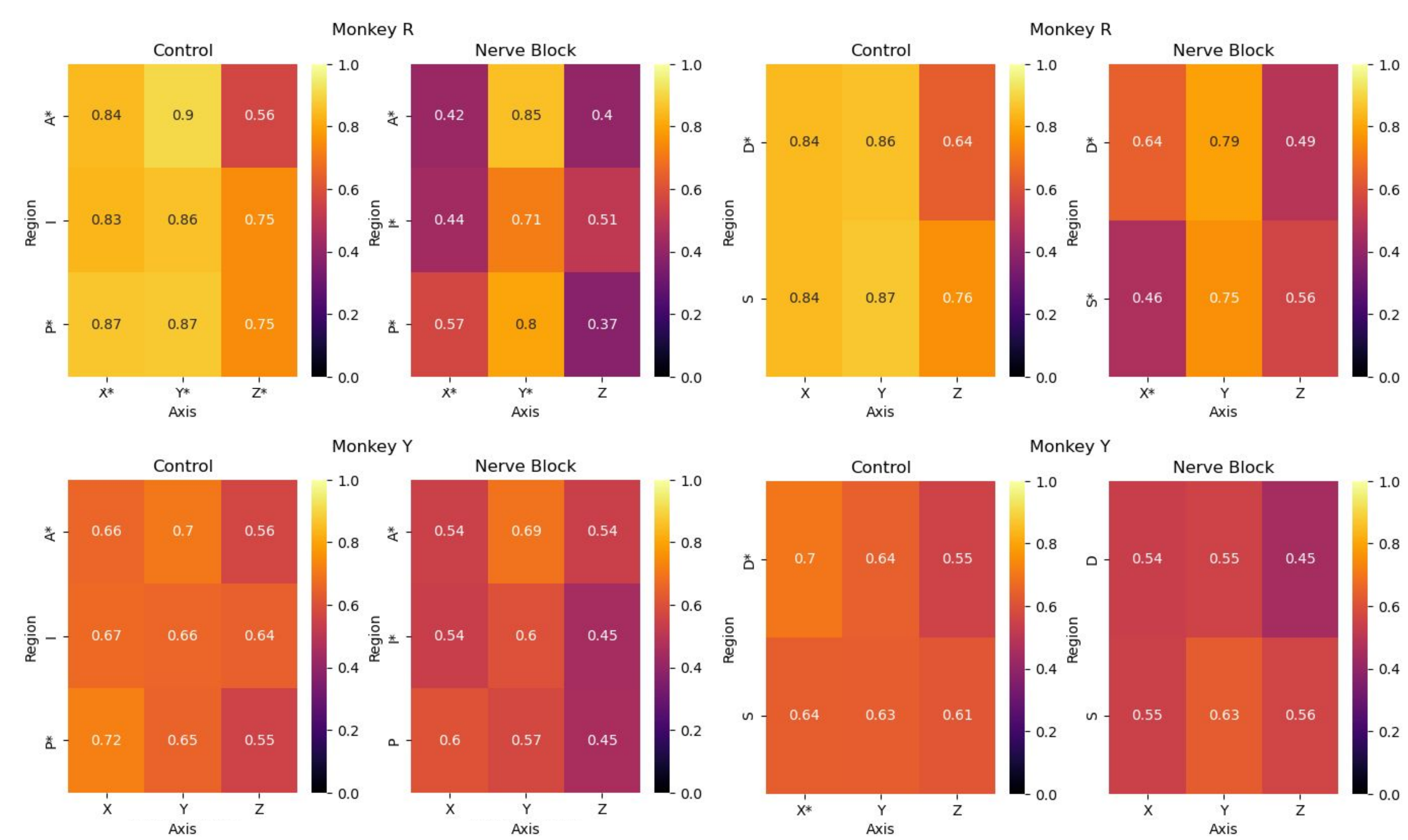

Fig 6.
Heatmap of decoding performance in R^2 by marker region and axis of motion. Asterisks indicate a significant ($p<0.05$) relationship along that category.

- Model tends to have the highest performance along the Y-axis and lowest performance along the Z-axis (Kruskal Wallis, $p<0.05$)
- Along the X-axis, markers located in the posterior region of the tongue resulted in superior model performance ($p<0.05$)
- Performance does not seem to depend on the depth of the marker ($p>0.1$)

DISCUSSION

- LSTM was selected for the highest model performance among 9 models, such as Kalman Filter and SVR
- Decoding methods may not fully capture network dynamics, such as inhibitory vs. excitatory
- For future work, we plan on extending our research to include data from the somatosensory cortex (SIo) and floating microelectrode arrays
- Results have implications for the development of evaluation tools, rehabilitation strategies, and neural prostheses to restore orolingual function in particular and limb sensorimotor function in general

SUMMARY/CONCLUSION

- Information carried by MIo neurons:
  - Decreases following sensory loss, especially along the X-axis
  - Is highest along the Y-axis, and the posterior region of the tongue along the X-axis
  - Is lowest along the Z-axis
- Overall, these findings indicate that information carried by MIo neurons differ as a function of the tongue's motion axis, region, available tactile information, and varying combinations of these factors.

ACKNOWLEDGEMENTS

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