Mathematical Analysis of Preparatory Neural Activity to Predict Physical Behavior in Motor Sequences

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Unveiling the behavioral and neural activity underlying hand movements sheds light on mammalian motor control and bolsters advancements in brain-machine interfaces and prosthetic arms. Veterans and war survivors are among more than 35 million people who require prosthetic services, emphasizing the importance of improving these devices. This investigation uses neural activity from the motor cortex to predict major patterns in physical movements of mice during object-reaching tasks. Principal Component Analysis was implemented to streamline multi-dimensional data analysis and identify significant behavioral motifs through ordering colorings and Pearson correlations. The optimal weighted sum of neuronal firing was determined using Ridge regression, revealing the relationship between a trial's neural activity and behavioral motif. This comprehensive analysis yields evidence for a clear behavioral distinction and neural firing correlation during certain hand movement stages. The behavioral motifs detected during the analysis window likely continued for the larger movement, with a correlation of 0.665 and 0.767 for the lift- and grasp-centered data, respectively. The decoding error for the neural activity was minimized for time periods further away from the start of the lift, indicating optimal timings for decoding of preparatory neural activity, which account for global movement patterns. The grasp-centered data exhibited a similar trend but less pronounced. The ability to decode neural activity that occurs slightly before the motif suggests that the grasp and the lift are prepared independently of each other. These findings provide valuable insights into movement dynamics, potentially leading to more effective treatments for movement-related conditions and neural disorders.

Awards Won:
Third Award of $1,000
Air Force Research Laboratory on behalf of the United States Air Force: Glass trophy and USAF medal for each recipient
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Regeneron ISEF Category,