Print this Page

Presentation Abstract

Program#/Poster#:	382.2/XX18
Title:	Some basic features of the neural response in motor and premotor cortex
Location:	Halls B-H
Presentation Time:	Monday, Nov 15, 2010, 9:00 AM -10:00 AM

Authors: ***M. M. CHURCHLAND**[1], M. T. KAUFMAN[1], J. P. CUNNINGHAM[3], S. I. RYU[2], K. V. SHENOY[1];
[1]Dept Elec Eng, [2]Dept. of Neurosurg., Stanford Univ., STANFORD, CA; [3]Dept. of Engin., Univ. of Cambridge, Cambridge, United Kingdom

Abstract: Different viewpoints on the function of motor cortex lead to different predictions regarding fundamental attributes of the neural response. We employed a pair of reaching tasks to investigate one such attribute: the dimensionality of the neural response. We assessed dimensionality in two ways: across neurons and across conditions. Dimensionality across neurons indicates how many different response patterns are seen for different neurons. Dimensionality across conditions indicates how many response patterns are seen for different reaches. A common view is that neural activity represents some number (k) of factors (e.g., velocity and position). This ‘representational perspective’ predicts that the dimensionality across neurons should be modest ($\leq$ k). The dimensionality across conditions is likely >k, as factors may differ across conditions in both mean value and timecourse.
It has also been suggested that the motor cortices act as a dynamical system that generates movement, and may not represent movement parameters directly. This ‘dynamical perspective’ predicts that dimensionality should be greater across neurons than conditions. The dimensionality across neurons is predicted to be high: a neural pattern generator will contain a greater diversity of responses than

exists in its final output. Yet if similar dynamics underlie the responses to different conditions, the dimensionality across conditions will remain relatively modest. Thus, the two perspectives yield opposing predictions regarding the relative dimensionality across neurons versus conditions.
Using principal component analysis, we found that the data dimensionality across neurons was fairly high: on average 25 principal components were necessary to account for 90% of the variance. Thus, one would need to observe 25 neurons before seeing the full space of possible response types. The dimensionality across conditions was lower (but not small): on average 16 principal components were necessary. Thus, observing the response (of all neurons) for 16 conditions is sufficient to largely span the space of responses for all conditions. Over 4 datasets (involving 27-108 conditions) dimensionality was on average 1.9 times higher across neurons than across conditions. In contrast, simulations of a traditional tuning model yielded the opposite result: dimensionality across neurons was 0.4 times that across conditions, and dimensionality was low overall (4 and 12 dimensions respectively). Thus, the dimensionality of the data is roughly consistent with expectations under the dynamical perspective, but is difficult to reconcile with a view where neural responses represent movement parameters.

Disclosures: **M.M. Churchland:** None. **M.T. Kaufman:** None. **J.P. Cunningham:** None. **S.I. Ryu:** None. **K.V. Shenoy:** None.

Keyword(s): motor cortex

reach

premotor cortex

Support: Burroughs Wellcome Fund

NSF graduate fellowship

NIH Pioneer award 1DP1OD006409

NIH CRCNS R01-NS054283

Christopher Reeve Foundation

[Authors]. [Abstract Title]. Program No. XXX.XX. 2010 Neuroscience Meeting Planner. San Diego, CA: Society for Neuroscience, 2010. Online.