BMC Neuroscience

Poster presentation

From multiple neural cortical networks to motor mechanical behavior: the importance of inherent learning over separable space-time length scales

Kanuresh Ganguly[1], Elizabeth B Torres*[2], Jorge V José[3] and Jose M Carmena[4]

Address: [1]Neurology, UCSF, San Francisco, CA 94143, USA, [2]Biology-CNS, CALTECH, Pasadena, CA, 91125, USA, [3]Physics, Physiology and Biophysics, SUNY, Buffalo, NY, 14260, USA and [4]Computer Science, Electrical Engineering, UC Berkeley, Berkeley, CA, 94720, USA

Email: Elizabeth B Torres* - etorres@vis.caltech.edu

* Corresponding author

from Seventeenth Annual Computational Neuroscience Meeting: CNS*2008
Portland, OR, USA. 19–24 July 2008

Published: 11 July 2008

BMC Neuroscience 2008, **9**(Suppl 1):P70 doi:10.1186/1471-2202-9-S1-P70

This abstract is available from: http://www.biomedcentral.com/1471-2202/9/S1/P70

An important question in neuroscience is how different cortical areas bind during the planning and execution of voluntary, goal-directed behavior. Learning visually-guided reaches can provide important theoretical and experimental insights into this problem, particularly when combined with Brain-Machine Interface (BMI) and multi-electrode measurements over extended periods of time across multiple cortical regions. We exploit the force-field paradigm [1] that alters the arm dynamics of the subject to monitor the ensuing adaptive processes in order to understand across multiple regions the differences between a habitual reach and a reach that requires learning. We quantify the translation of movement plans into their physical implementation by studying the representation of time [2] in relation of its well documented separability from the spatial components of motion trajectories [3]. Previously the internal representation of environmentally-dependent forces on position and velocity was found to be time-invariant [2]. We aim at explaining this feature in relation to the motor system's plasticity [4] during closed loop BMI. To this end we followed the evolution of tuning, mean firing rate levels and spike-time statistics across separable cell classes simultaneously recorded in the pre-motor and motor cortical regions of rhesus macaques as they adapted to new movement dynamics imposed by an external mechanical device.

We find that (1) several stable spatio-temporal representations co-exist in a given cell which permits identification and selection of different motor programs to operate the external device, and (2) these multiple representations can be extracted from the multi-electrode neuron spike patterns reflecting various spatial re-parameterizations compatible with the ones imposed by the external mechanical device. A neural theoretical formulation in terms of a Hodgkin-Huxley excitatory and inhibitory neural ring network is used [5] to model multi-electrode spiking statistics, explicitly considering the separation of different motor dynamical times.

Acknowledgements
Funding Sources NIH, NSF

References
1. Shadmehr R, Mussa-Ivaldi FA: **Adaptive representation of dynamics during learning of a motor task.** *J Neurosci* 1994, **14:**3208-3224.
2. Conditt MA, Mussa-Ivaldi FA: **Central Representation of time during motor learning.** *Proc Natl Acad Sci USA* 1999, **96:**11625-11630.
3. Torres EB, Andersen RA: **Space-time separation during obstacle avoidance learning in monkeys.** *J Neurophysiol* 2006, **96:**2613-2632.
4. Carmena JM, Lebedev MA, Crist RE, O'Doherty JE, Santucci DM, Dimitrov DF, Patil PG, Henriquez CS, Nicolelis MAL: **Learning to control a brain-machine interface for reaching and grasping by primates.** *PLoS Biology* 2003, **1:**193-208.
5. Tiesinga PHE, Fellous JM, Salinas E, Jose JV, Sejnowski TJ: **Inhibitory Synchrony as a mechanism for attentional gain modulation.** *J Physiol (Paris)* 2004, **98:**296-314.