Print this Page

Presentation Abstract

Program#/Poster#:	319.8
Title:	Evidence for smooth and inertial dynamics in the evolution of neural state
Location:	Washington Convention Center: Room 206
Presentation Time:	Monday, Nov 17, 2008, 9:45 AM -10:00 AM
Authors:	***A. AFSHAR**[1], B. M. YU[2,5,3], G. SANTHANAM[2], S. I. RYU[2,4], K. V. SHENOY[2,3], M. SAHANI[5]; [1]Sch. Med, Elec Eng, [2]Elec Eng, [3]Neurosci Prog, [4]Dep of Neuorsurg, Stanford Univ., Stanford, CA; [5]Gatsby Unit, UCL, London, United Kingdom

Abstract:

Many recent studies have attempted to characterize frontal cortical areas in dynamical, rather than representational, terms. Identifying the nature of dynamical state transitions in these networks is thus of considerable interest. Theoretical models of recurrent spiking networks typically fall in two classes: one in which dynamic state maps smoothly to neural firing rate (FR) so that FRs change continuously as the state evolves ('smooth' dynamics); and another in which successive dynamic states may map to substantially different FRs, allowing potentially unlimited change in FR within a short time ('abrupt' dynamics).
To ask which type of model better characterized the dynamics of dorsal premotor cortex (PMd) at the initiation of a pre-prepared reach, we used a micro-electrode array to record from populations of neurons in macaque monkeys performing a delayed-reach task. Subjects were motivated to initiate a reaching movement rapidly upon seeing a go cue. We hypothesized that smooth PMd dynamics might limit the speed of movement initiation. In particular, smooth dynamics would imply that if FRs at the time of the go cue fell further away from those

associated with the onset of movement then reaction time (RT) would be longer. By contrast, abrupt dynamics would not constrain the change in FRs, allowing similar RTs to be achieved even if a greater change in FR was required. We found that the difference between FRs measured at the time of the go cue and an estimated reference FR associated with movement initiation did indeed correlate with RT across many movement endpoints ($p<1e-7$; Wilcoxon signed-rank test). This suggests that the neural network in PMd obeys smooth dynamics, with a timecourse dependent on the magnitude of the change.
We also report evidence suggesting that the evolving neural state requires time to alter its direction of motion in FR terms, by showing a significant anti-correlation between velocity and path curvature in FR space (1 dimension per neuron) ($p<1e-8$; linear regression) and between RT and mean change of direction of neural dynamics ($p<0.01$; linear regression). This result is consistent with second-order or inertial dynamics, a finding that may reflect coupling between the smoothly evolving network in PMd and other recurrent networks in the brain.
These results enable further analyses based on the smootly evolution of FRs, including those that describe single-trial neuronal behavior concisely (see Yu et al and Cunningham et al in these proceedings).

Disclosures: **A. Afshar**, NIH/NSF, B. Research Grant (principal investigator, collaborator or consultant and pending grants as well as grants already received); **B.M. Yu**, None; **G. Santhanam**, None; **S.I. Ryu**, None; **K.V. Shenoy**, None; **M. Sahani**, None.

Support: MSTP, BioX

NSF, NDSEG, BWF

CRPF, ONR, Sloan, Whitaker

Gatsby

NIH/CRCNS 5-R01-NS054283-02

[Authors]. [Abstract Title]. Program No. XXX.XX. 2008 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2008. Online.