Zacksenhouse *et al. BMC Neuroscience* 2010, **11**(Suppl 1):P126
http://www.biomedcentral.com/1471-2202/11/S1/P126

BMC Neuroscience

POSTER PRESENTATION — Open Access

Signal-to-noise ratio of binned spike-counts and the timescales of neural coding

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From Nineteenth Annual Computational Neuroscience Meeting: CNS*2010
San Antonio, TX, USA. 24-30 July 2010

The timescales at which information in encoded in the neural activity are usually determined with respect to well identified stimuli or actions. However, neurons may encode multiple signals, including hidden or internal signals, which are not under experimental control. Here we derive a method for estimating the signal-to-noise ratio of binned spike-counts, without any assumption about the encoded signals, and use it to determine the relevant timescales. The method is applied to investigate the timescales relevant during experiments with Brain-Machine Interfaces (BMIs).

Methods

The basic method is based on estimating the signal-to-noise ratio in the binned spike trains, under the sole assumption that the spike trains are realizations of either doubly stochastic Poisson process (DSPP) or dead-time modified DSPP [1]. This assumption is verified by demonstrating that the probability densities of the recorded ISIs are approximated well by a mixture of two exponential distributions. Furthermore, it is shown that the estimated SNR is proportional to the actual SNR for signal-dependent additive noise, so it is appropriate for sensitivity analysis.

Experimental results

In agreement with theoretical results, we show that the SNR increases with the bin-width. However, since the update rate decreases with the bin-width, we suggest the relevant time-scales should maximize the ratio between the SNR and the bin-width. The importance of this ratio is also motivated by its relation to the capacity of the neural channel. Using this method we investigate the relevant time scale in cortical spike trains during experiments with Brain-machine interface, and show that they peak at bin-widths around 100msec, as shown in Figure 1. Interestingly, this is the bin-width selected experimentally, by trial and error, for BMI operation. Furthermore, the relevant timescales remain the same during the training

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Theoretical and simulation results

Theoretical analysis indicates that the behavior of the results at low bin-width reflects the effect of the refractory period, while the behavior of the results at long bin-widths reflects the frequency band-width. Simulations results depict similar behavior and demonstrate the effect of the refractory period and frequency bandwidth.

Acknowledgements
This research was supported by BERNSTEIN RESEARCH FUND, and conducted in collaboration with Nicolelis Lab. at the Center for Neuro-engineering at Duke University, where the BMI experiments were conducted.

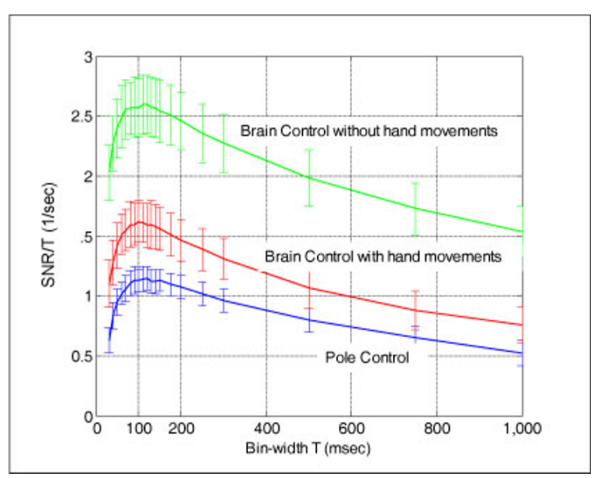

Figure 1 Experimental results

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Published: 20 July 2010

Reference
1. Zacksenhouse M, Lebedev MA, Carmena JM, O'Doherty JE, Henriquez CS, Nicolelis MAL: **Cortical modulations increase during early sessions with Brain-Machine Interface.** *PLoS-ONE* 2007, **2(7)**:e619.

doi:10.1186/1471-2202-11-S1-P126
Cite this article as: Zacksenhouse *et al.*: **Signal-to-noise ratio of binned spike-counts and the timescales of neural coding.** *BMC Neuroscience* 2010 **11**(Suppl 1):P126.