BMC Neuroscience

Oral presentation

Open Access

Rich single neuron computation implies a rich structure in noise correlation and population coding

Sungho Hong*[1] and Erik De Schutter[1,2]

Address: [1]Computational Neuroscience Unit, Okinawa Institute of Science and Technology, Okinawa 904-0411, Japan and [2]Theoretical Neurobiology, University of Antwerp, B-2610 Antwerpen, Belgium

Email: Sungho Hong* - shhong@oist.jp

* Corresponding author

from Eighteenth Annual Computational Neuroscience Meeting: CNS*2009
Berlin, Germany. 18–23 July 2009

Published: 13 July 2009

BMC Neuroscience 2009, **10**(Suppl 1):O5 doi:10.1186/1471-2202-10-S1-O5

This abstract is available from: http://www.biomedcentral.com/1471-2202/10/S1/O5

Pairwise correlation in a population activity is a widely observed neural phenomenon. In particular, even with the same mean stimulus, noisy fluctuations in the population firings are often correlated, and this so-called noise correlation has attracted a lot of attention in regard to whether it might transfer independent information beyond a mean population response [1]. However, in the context of the common input model where a common input noise drives the noise correlation, a recent influential study suggested that the noise correlation must have a simple relationship with the average firing rate, or more precisely the average gain, and therefore claimed that the noise correlation might not carry any independent information [2].

In this work, we carried out a model study to probe the correlation-gain/rate relationship with biophysically defined single neuron models and found out that the relationship with gain actually fails to capture large noise correlations in some models. We suggest that this is closely related to the type 3 excitability of these neuron models. Type 3 excitability has been seen recently in model studies [3] and in some cortical neurons in the *in vitro* [4,5] and *in vivo*-like conditions [6]. One of its interesting and relevant characteristics is that a type 3 neuron encodes not only the stimulus mean but also the variance [3-5,7]. By using an artificial functional model, we showed that these variance sensitive neurons, when given common noise, can generate sharply synchronized spikes, which contribute to the correlation that the correlation-gain relationship fails to predict.

Our result implies that a population of individual neurons with this rich coding strategy might use the correlation/synchrony as an extra channel for information transfer at the population coding level. Therefore the population code would not be an average of the individual responses where the fluctuations around the mean firing are simply suppressed by a population size.

References

1. Averbeck BB, Latham PE, Pouget A: **Neural correlations, population coding and computation.** *Nat Rev Neurosci* 2006, **7:**358-366.
2. de la Rocha J, Doiron B, Shea-Brown E, Josić K, Reyes A: **Correlation between neural spike trains increases with firing rate.** *Nature* 2007, **448:**802-806.
3. Lundstrom BL, Hong S, Higgs M, Fairhall AL: **Two computational regimes of a single-compartment neuron separated by a planar boundary in conductance space.** *Neural Comput* 2008:1239-1260.
4. Higgs MH, Slee SJ, Spain WJ: **Diversity of gain modulation by noise in neocortical neurons: regulation by the slow afterhyperpolarization conductance.** *J Neurosci* 2006, **26:**8787-8799.
5. Arsiero M, Lüscher HR, Lundstrom BL, Giugliano M: **The impact of input fluctuations on the frequency-current relationships of layer 5 pyramidal neurons in the rat medial prefrontal cortex.** *J Neurosci* 2007, **27:**3274-3284.
6. Prescott SA, Ratté S, De Koninck Y, Sejnowski TJ: **Nonlinear interaction between shunting and adaptation controls a switch between integration and coincidence detection in pyramidal neurons.** *J Neurosci* 2006, **26:**9084-9097.
7. Hong S, Lundstrom BL, Fairhall AL: **Intrinsic gain modulation and adaptive neural coding.** *PLoS Comp Bio* 2008, **4:**e1000119.