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Correlation susceptibility and single neuron computation

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Neurons in many systems exhibit temporal correlation between their firings and it has been hypothesized that the correlations contribute to population coding [1]. Recently, de la Rocha et al. [2] showed that a correlation between the spike trains of two neurons, estimated by a simple covariance measure, depends on the firing rates when the correlated noisy input current drives the neurons, in *in vitro* recordings and simulations. It was also theoretically derived that a ratio of an output and input correlation, termed correlation susceptibility, can be written in terms of the firing rate and its gain under some assumptions. This result revisited the question of how rate and correlation based coding would work in a neural population.

In this work, we tried to extend and further test their results by considering heterogeneity in the intrinsic computational property of neurons. From simulated data, we computed the rate-correlation relationship of two neuron types which are known to show distinct response patterns to changes in the mean and variance of a stimulus: one is a normal Hodgkin-Huxley (HH) which is relatively sensi-

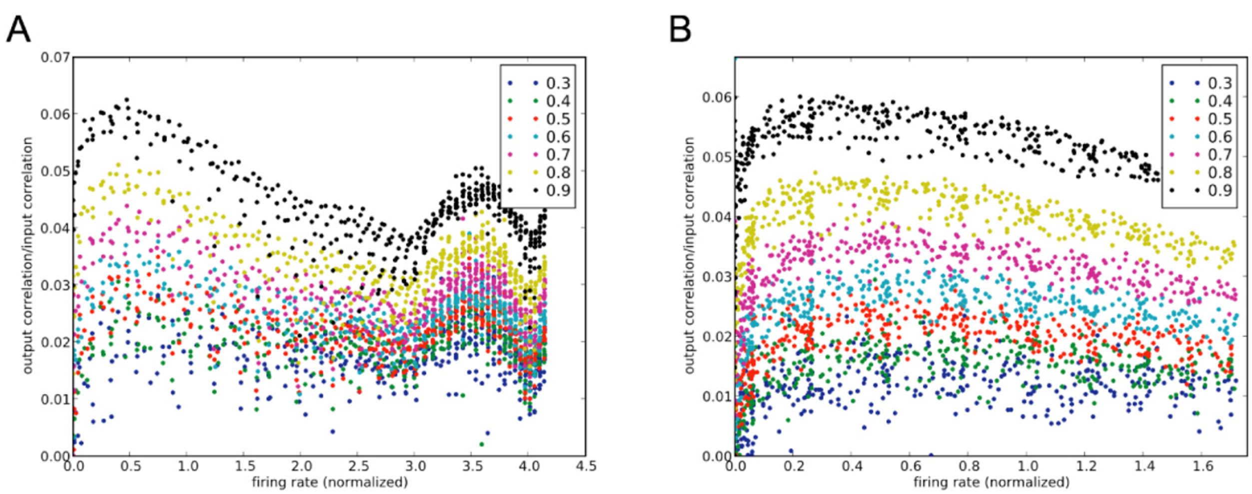

Figure 1
Correlation susceptibilities with various input correlations. **A**. An HH neuron. **B**. An HHLS neuron. In both figures, the color represents an input correlation. Each point corresponds to a stimulus statistics, (mean, variance) of the injected Gaussian white noise current.

tive to the mean (integrator), and the other one is a Hodgkin-Huxley neuron with low sodium conductance (HHLS) which show higher sensitivity to the stimulus variance (coincidence detector). Differences in the intrinsic computational property between two neurons result in differences in variance-dependent gain modulation and intrinsic adaptation [3-5]. See Figure 1

In the HH case, we show that the output correlation qualitatively follows the prediction by the firing rate and gain. However, in the HHLS case, there remains a significant correlation even when the gain of a firing rate almost vanishes, and therefore so should the prediction of de la Rocha et al. [2]. Our results suggest that correlation susceptibility depends on the neuron's intrinsic computation and its adaptation to stimulus statistics.

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