

POSTER PRESENTATION

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Key factors dominating the neural coding preference to 1/f signal

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From 24th Annual Computational Neuroscience Meeting: CNS*2015
Prague, Czech Republic. 18-23 July 2015

Experiments have demonstrated that cortical and sensory neurons prefer to respond to signals with characteristics of long-term correlation or 1/f noise feature better than signals with no correlation like white-noise-type [1]. In order to study the underlying mechanism, we built up a cortical neuronal model [2] based on Hodgkin-Huxley theory to study the correlations between neuron kinetics and signal statistics. Interestingly, we observed that (see Figure 1a,b) white-noise-type signal (cutoff frequency >10000Hz) is hard to induce action potentials unless signals with very strong intensity while 1/f signal and low-pass filtered white noise type signal (cutoff frequency <1000Hz) can easily induce action potentials with high firing rate at low signal intensity (quantified by signal standard deviation STD), see Figure 1a. Moreover, the half-height duration of action potentials is also varying with more sensitivity to 1/f signal or filtered white noise than pure white noise (Figure 1b). In addition, neural firing rate and spike duration are more sensitive to 1/f signal than filtered white noise. This is a clear positive evidence of neuronal coding preference to signals with long-term correlations.

To further reveal the key factors dominating the preference of neuronal dynamics to colored and white noise, we systematically varied the values of Na⁺ and K⁺ channel time constants and channel rate constants. Figure 1c showed that the firing rate doesn't change much as a function of sodium activation time constant (τ_m) for a given 1/f signal (STD = 1). However, the firing rate decrease dramatically with an increase of sodium inactivation time constant (τ_h) or potassium activation time constant (τ_n) for this signal. For very large τ_h and τ_n , neuronal response dynamics start to be saturate for all signals, see Figure 1d.

These results indicate that both sodium inactivation time constant (τ_h) and potassium activation time constant (τ_n) may be the key factors dominating neural coding preference to signals with different correlated statistic features.

In sum, this study demonstrated that ionic channel time constant of sodium inactivation and potassium activation may be the dominating factors accounting for the neuronal spiking sensitivity favorable to signals with temporal correlations.

Acknowledgements

This project is funded by NNSF of China (31271170) and Shanghai Eastern Scholar program SHH1140004.

Published: 18 December 2015

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doi:10.1186/1471-2202-16-S1-P296

Cite this article as: Fan et al.: Key factors dominating the neural coding preference to 1/f signal. *BMC Neuroscience* 2015 **16**(Suppl 1):P296.

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