BMC Neuroscience

POSTER PRESENTATION Open Access

Mutual information density of stochastic integrate-and-fire models

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From Twenty Second Annual Computational Neuroscience Meeting: CNS*2013
Paris, France. 13-18 July 2013

The coherence function of integrate-and-fire neurons shows low-pass properties in the most diverse firing regimes [1]. While the coherence function provides a good approximation to the full information transfer properties in the case of a weak input, for a strong input non-linear encoding could play an important role. The complete information transfer is quantified by Shannon's mutual information rate [2] which has been estimated in certain biological model systems [3]. In general, the exact analytical calculation of the mutual information rate is unfeasible and even the numerical estimation is demanding [4].

Numerical calculation of the mutual information rate is now a commonly adopted practice, but it does not indicate what aspects of the stimulus are best represented by the neuronal response. We developed a numerical procedure to directly calculate a frequency-selective version of the mutual information rate. This can be used to study how different frequency components of a Gaussian stimulus are encoded in neural models without invoking a weak-signal paradigm.

Acknowledgements
This work was funded by the BMBF (FKZ: 01GQ1001A).

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Published: 8 July 2013

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doi:10.1186/1471-2202-14-S1-P245
Cite this article as: Bernardi and Lindner: **Mutual information density of stochastic integrate-and-fire models.** *BMC Neuroscience* 2013 **14**(Suppl 1): P245.

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