BMC Neuroscience

BioMed Central

Poster presentation

Information content and robustness of various types of codes in integrate and fire networks presented with naturalistic stimuli

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

Published: 13 July 2009

BMC Neuroscience 2009, **10**(Suppl 1):P95 doi:10.1186/1471-2202-10-S1-P95

This abstract is available from: http://www.biomedcentral.com/1471-2202/10/S1/P95

Several candidate neural codes have been proposed to convey sensory information, from spike count to spike patterns, to the timing of spikes relative to oscillations in the Local Field Potential (LFP). Recent experimental studies compared the information content of different codes in V1 [1] and A1 [2]. A code combining the spike count and the phase of firing relative to the low frequency component of the LFP contained more information than spike count [1,2] and displayed also a higher robustness to noise [2]. Spike patterns also conveyed more information than the spike count over the same window [2].

An interesting question regards the mechanisms underlying the generation of such robust temporal codes. Here, we investigated to which extent randomly and sparsely connected recurrent networks of integrate-and-fire neurons [3] subject to naturalistic external stimulation [4] can generate precise and robust temporal codes. We injected the network with inputs built from multi-unit recordings in the LGN of anesthetized monkeys presented with naturalistic movies [4]. As in [2], we divided the recording time into windows and we computed the information content of i) the window spike count; ii) the window spike count combined with its phase relative to the low frequency component of the LFP; iii) the spike patterns obtained dividing the windows into bins of 4–8 ms; iv) the spike patterns combined with the phase.

We found that spike patterns of 3–4 bins conveyed up to 20% more information than spike count, that adding the phase of firing to the spike count increased information up to 100%, and that the combination of the two codes produced a further increase in the information content. Results are qualitatively similar to what was found in experimental recordings, suggesting that such temporal codes can be generated even in the absence of a particular network architecture. The robustness of these codes was then tested against different kinds of noise. When the inputs were injected with jitters of several ms, the information content of spike patterns decreased sharply while the phase of firing code was more robust than the spike count code. Conversely, spike pattern information was less affected than phase information by increases in the amplitude of the external noise. In recurrent networks, codes involving both spike patterns and phase of firing with respect to low frequency components of the LFP appear therefore to be both significantly more informative than simpler spike count codes and more robust to noise.

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