Safonov et al. BMC Neuroscience 2010, 11(Suppl 1):P52
http://www.biomedcentral.com/1471-2202/11/S1/P52

BMC Neuroscience

POSTER PRESENTATION Open Access

Seven-hour multiunit recordings from rats reveal very long-term correlation in the cortical activity

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From Nineteenth Annual Computational Neuroscience Meeting: CNS*2010
San Antonio, TX, USA. 24-30 July 2010

In the present study, we investigate how history of activity is retained in neurons embedded in the intact brain. For this purpose, we employ the so-called multiscale analysis for the fluctuations of interspike intervals (ISIs). An ability of neuronal networks, but not of isolated neurons, to retain information at different time scales greatly enriches their computational ability because now they can access the information across the full space-time domain, rather than spatially but at a single temporal scale.

We analyze the intact brain of rats without anesthesia using a special chamber[1], namely the neural activity of the normally working brain. Recorded data with multiunit electrodes reveal evidence for the long-term in neuronal activity. We apply multiscale analysis because it has been proven to be powerful to uncover multiple time scales in hydrodynamic turbulence [2], human heartbeat interval fluctuations [3,4], stock price fluctuations [5], etc.

In the multiscale analysis, we study concatenated ISIs instead of the original ISIs. We first determine a 'scale' that specifies how many consecutive ISI are concatenated (connected) and ask how large the fluctuations of the concatenated ISIs are. The upper panel of Figure 1 shows the fluctuations at scale of four (s=4) and the lower panel shows the corresponding histogram displayed in the semilog coordinate. Gaussian fluctuations should be shaped as a parabola in this coordinate. The histogram in Figure 2 implies that the fluctuations are highly non-Gaussian. As we increase the scale, more and more ISIs are concatenated. The central limiting theorem should ensure that the histogram become increasingly Gaussian if ISIs are statistically independent. However, Figure 3 shows that at scale s=32 or at even s=256, the histogram remains non-Gaussian. This implies very strong non-Gaussianity or strong long-term correlation of ISIs.

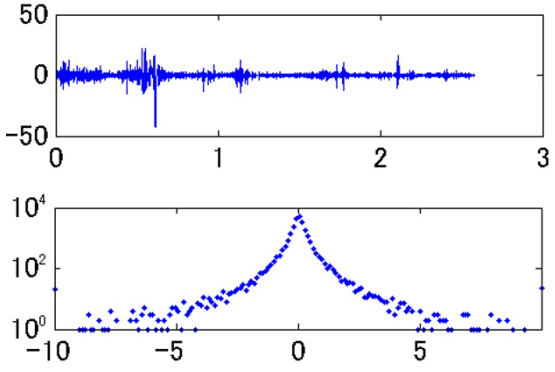

Figure 1 ISI fluctuations (upper) and the histogram (lower) of neuron #6 at s=4.

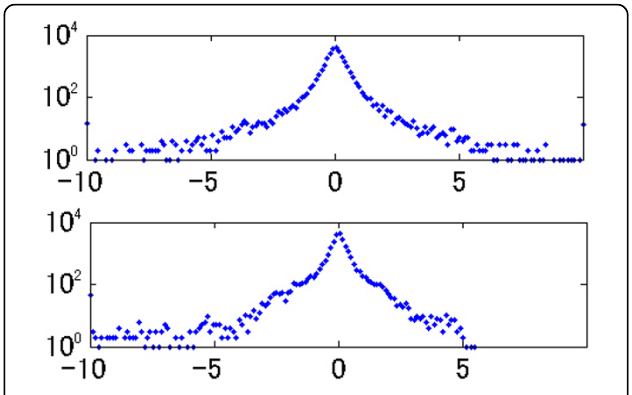

Figure 2 ISI fluctuation histogram of neuron #6 calculate at s=32 (upper) and s=257 (lower).

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Published: 20 July 2010

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doi:10.1186/1471-2202-11-S1-P52
Cite this article as: Safonov *et al.*: Seven-hour multiunit recordings from rats reveal very long-term correlation in the cortical activity. *BMC Neuroscience* 2010 **11**(Suppl 1):P52.