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Decorrelation of low-frequency neural activity by inhibitory feedback

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To correctly judge the functional role of cooperative neural activity it is essential to understand how neural correlations are determined by the structure and dynamics of neural networks. Shared presynaptic input is one of the major sources of correlated synaptic activity in such systems. In the asynchronous state of recurrent neural network models, however, spike correlations are considerably smaller than what one would expect based on the amount of shared presynaptic sources [1,2]. A similar lack of correlations in the spiking activity of neighbouring cortical neurons has been observed experimentally [3]. Recently, it has been pointed out that shared-input correlations can be actively suppressed by the dynamics of recurrent networks [4]. Here, we show that both in networks with purely inhibitory coupling (Fig. 1A) and in those with mixed excitatory-inhibitory coupling (Fig. 1B) this active decorrelation affects mainly the activity at low frequencies (<20 Hz). High-frequency activity, in contrast, is rather unaffected. Simulations rule out that this phenomenon is the result of refractoriness. By means of a simple linear population-rate model we demonstrate that the effect is essentially explained by inhibitory feedback.

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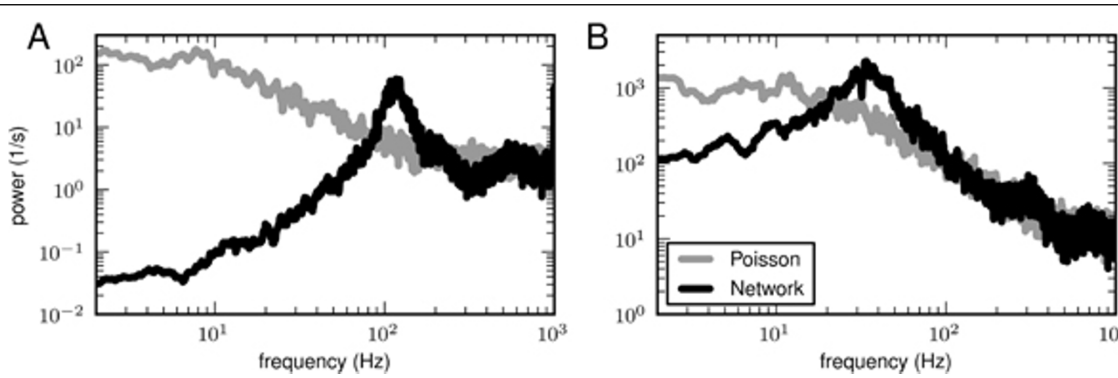

Figure 1 Population-rate power spectra for an inhibitory (**A**) and a balanced recurrent network (**B**) of leaky integrate-and-fire model neurons (black curves). Grey curves represent population-rate spectra of ensembles of unconnected neurons receiving stationary Poisson input spike trains with the same shared-input structure as in the respective recurrent cases (black curves).

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