Supplementary Materials

Stimulus onset quenches neural variability: a widespread cortical phenomenon

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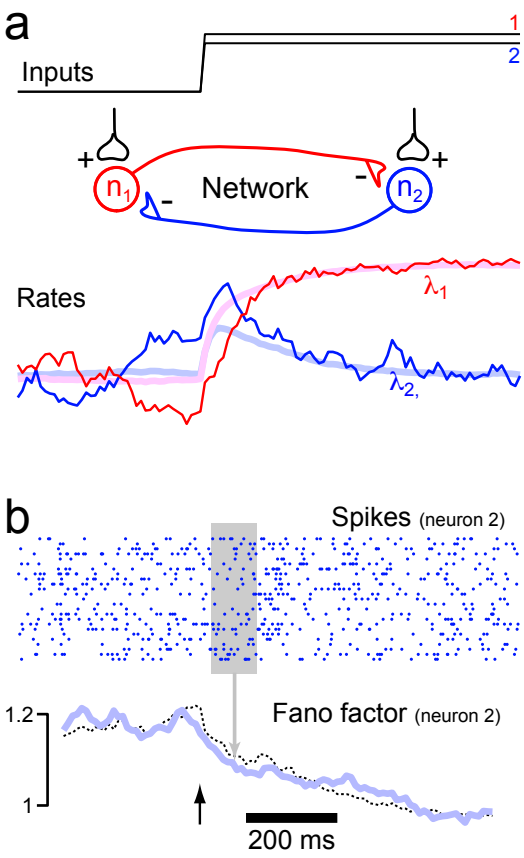

supplementary figure 1
(stimulus-driven changes in variability for a simple simulation)

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Supplementary figure 1. Stimulus-driven changes in across-trial variability can be exhibited even by simple network architectures. Details of the simulations are described in the supplementary materials below. ***a.*** A simulated two-neuron recurrent network. The inputs were initially zero, and stepped to new values at the indicated time. The evolution of rates (λ) was different on each trial, as the network contained noise. One example trial is shown (*saturated colored traces*). Light, thicker traces show the mean λ across all trials. ***b.*** Simulated spike-trains were produced via an inhomogeneous Poisson process based on each trial's λ_2. 25 trials are shown. The FF (*blue, bottom*) was computed from 10,000 such trials, using a 100 ms sliding window (*gray shading*). The dashed trace plots the true across-trial variance of λ_2. The black arrow indicates the step input.

In the absence of an input, this network has two shallow competing attractors. It is thus unstable given small amounts of noise, but becomes more stable when driven. As a consequence, average rates (*thick light-colored traces* in *a*) are initially unrepresentative of singe-trial firing rates (*colored traces* give each neuron's rate for that trial). Following the input step, single-trial rates hew more closely to their means; across-trial variability is reduced. That decline depends on the attractor dynamics of this example 'winner-take-all' network. A network with different dynamics – e.g., integrator dynamics[1,2,3] – might produce rising variance. As in Figure 1*a* of the text, mean rate alone may be inadequately informative. For example, neuron 2 exhibits only a modest mean response (*thick blue trace*). This might (mistakenly) suggest weak participation in the network computation. In contrast, the sustained variance decline reveals the involvement of both neurons, and correctly suggests attractor dynamics.

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