

POSTER PRESENTATION

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Key features of neural variability emerge from self-organized sequence learning in a deterministic neural network

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Cortical responses to identical stimuli show high trial-to-trial variability. This variability is commonly interpreted as resulting from internal noise. However, much of the variability can be explained by the pre-stimulus spontaneous activity [1]. In fact, the contribution of this spontaneous activity to the evoked response is sufficiently strong to bias perceptual decisions [2]. Importantly, spontaneous activity is structurally similar to evoked activity [3] and this similarity may be the result of learning an internal model of the environment during development [4]. Consistent with this idea, spontaneous activity seems to be a superset of possible evoked responses [5] and trial-to-trial variability drops at

stimulus onset [6]. At present, it is unclear how these features of neural variability arise in cortical circuits.

Here, we show that all of these phenomena emerge in a completely deterministic self-organizing recurrent network (SORN) model [7]. The network consists of recurrently connected excitatory and inhibitory populations of McCulloch-Pitts units. The dynamics are shaped by spike-timing dependent plasticity (STDP) and homeostatic plasticity mechanisms in response to structured input sequences. After a period of self-organization, during which the network learns an internal model of the input sequences, we observe all phenomena mentioned above: evoked responses and perceptual decisions can be

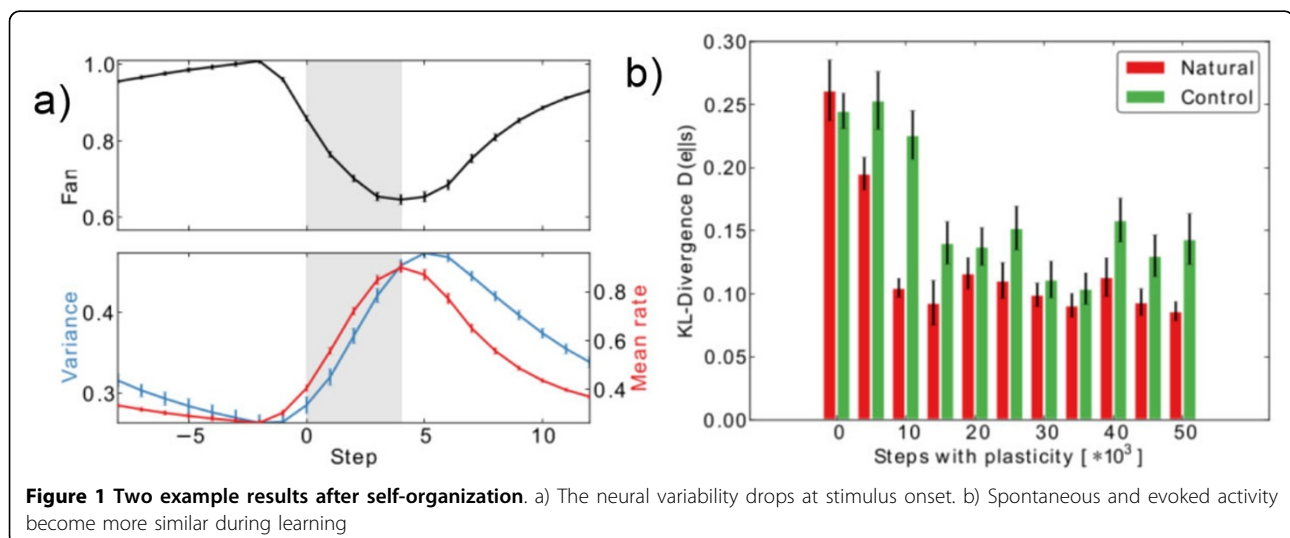


Figure 1 Two example results after self-organization. a) The neural variability drops at stimulus onset. b) Spontaneous and evoked activity become more similar during learning

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predicted from prior spontaneous activity, spontaneous activity outlines the realm of evoked responses, Fano factors drop at stimulus onset, and spontaneous activity closely matches evoked activity patterns. In addition, the network produces the common signs of Poissonian variability in single units.

In sum, our model demonstrates that key features of neural variability emerge in a fully deterministic network from self-organized sequence learning via the interaction of STDP and homeostatic plasticity mechanisms. These results suggest that the high trial-to-trial variability of neural responses need not be taken as evidence for noisy neural processing elements.

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