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Presentation Abstract

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Title:	Local and distributed mechanisms of persistent activity vary as a function of network size and symmetry
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Abstract: Previously, we have shown that complex persistent activity (PA) in spatial networks can be brought about by changes to network structure. In the present study, we simultaneously vary network size and structure in order to identify and parse out the mechanisms responsible for the shifts in threshold for PA. Specifically, we examined the propensity for PA in simulated networks of varying size (from 200 units to 12,800) as well as varying degrees and types of heterogeneity. The models consisted of two-layer networks with inhibitory and excitatory populations of spiking units with columnar connectivity. Units were connected to their neighbors in the same population, as well as to the corresponding cells in the opposite population. Changes in structure were brought about via the progressive deletion of cells starting at p=0 deletions to p=0.95. The simulations were initiated with random distributed stimuli. We thus measured the probability of persistence in 50 simulations for each network size (8 sizes), each deletion rate (20 levels) and each symmetry condition (symmetrical and asymmetrical) for a total of 16,000 network simulations. Results showed that the propensity for complex persistent activity tended to increase both with network size and deletion level. However, at high deletion rates networks became too sparse to support propagating waves so that the complexity and the propensity for persistence of activity dropped off substantially. Moreover, probability of persistence was reduced in asymmetric, as compare to symmetric, networks across all sizes. These differences in probability as a function of heterogeneity and network size demonstrate that there are at least two underlying structural mechanisms by which network-based changes in threshold take place: (1) The strong presence of PA in asymmetric networks at high deletion rates absent in symmetric networks suggests that the initiation of local activity is brought about by shifts to local circuits including inhibitory-excitatory balance resulting in simple, localized, persistent oscillations. (2) On the other hand, the strong propensity for propagating waves in the mid-deletion levels seen in both asymmetrical and symmetric networks, suggests that these persistent waves are distributed percolation-like phenomena that are independent of balance factors. These changes bring about complex, propagating, waveform activity, including spiral waves. These observations underscore the plurality of mechanisms and potential importance of cell loss for tuning of neural dynamics during development as well as the harmful effects of excessive cell death in post-traumatic epilepsy and in neurodegeneration.

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