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Presentation Abstract

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Title:	Heterogeneity and asymmetry in neural network structure can effect non-evoked transitions in population activity
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Abstract: It is often assumed that transitions in neural population activity, as measured for example by EEG, are the result of external stimuli or ongoing random perturbation. Using spatial neural network models, we demonstrate that complex persistent activity with ongoing transitions can be maintained without either of these factors. The models consisted of two-layer networks with inhibitory and excitatory populations of up to 10,000 spiking units with columnar connectivity. Units were connected to their neighbours in the same population, as well as to the corresponding cells in the opposite population. The simulations were initiated with either random distributed stimuli or point stimuli. In the case of fully connected networks, the activity initiated by both forms of stimulation quickly dissipated. We then proceeded to create heterogeneous networks by randomly deleting units. When deletions reached a threshold activity remained persistent for all stimuli. We demonstrate that at low levels of deletion the probability of persistent activity is critically dependent on the asymmetry of deletions between populations thus indicating that local inhibitory-excitatory balance plays an important role at these levels of heterogeneity. However, we also found that such local imbalance was not absolutely necessary and that persistent activity can be maintained even in fully symmetrical deletions, although less reliably and at a much narrower range of deletion rates (e.g., for the asymmetrical networks studied activity persisted at deletions rates ranging from 0.3 to 0.9 whereas for symmetrical networks the range was approximately 0.5 to 0.7). Most notably perhaps is the fact that the persistent

activity also showed prominent autonomous transitions. The activity transitioned between well-defined low frequency oscillations of varying frequency and more random-like activity with higher frequency components. These transitions persisted in the absence of any external stimulation. The findings demonstrate that ongoing changes seen in EEG may be the result of structural network heterogeneity and that these transitions do not require external stimuli or stochastic perturbations. The observations could also help explain the importance of cell loss for tuning neural dynamics during development as well as the effects seen following excessive cell death in post-traumatic epilepsy and in neurodegeneration.

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