On how network architecture determines the dominant patterns of spontaneous neural activity

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A major challenge in current neuroscience is to understand the emergence of coherent complex activity from the interactions between neurons and its role in normal and pathological brain function. Approaches to facing this challenge have become more urgent in the last few years, as experimental techniques to record from many neurons simultaneously are being developed and improved, providing valuable data sets for analysis. These techniques have revealed that, <u>even in the absence of stimulation, network activity organizes in complex spatiotemporal patterns that are thought to reflect relevant properties of the network</u>. Reciprocally, it is also assumed that the synaptic connections of the network constrain the repertoire of emergent, spontaneous patterns. Although the link between network architecture and network activity has been extensively investigated in the last few years from different perspectives, our understanding of the relationship between the network connectivity and the structure of its spontaneous activity is still incomplete. Using a general mathematical model of neural dynamics we have studied this relationship. In particular, <u>we have shown mathematically how the synaptic connections between neurons determine the repertoire of spatial patterns displayed in the spontaneous activity</u>. To test our theoretical result, we have also used the model to simulate spontaneous activity of a neural network, whose architecture is inspired by the patchy organization of horizontal connections between cortical columns in the neocortex of primates and other mammals. The dominant spatial patterns of the spontaneous activity, calculated as its principal components, coincide remarkably well with those patterns predicted from the network connectivity using our theory. <u>The equivalence between the concept of dominant pattern and the concept of attractor of the network dynamics is also demonstrated</u>. This in turn suggests new ways of investigating encoding and storage capabilities of neural networks.

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