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Sensory stimuli reduce the dimensionality of cortical activity
LUCA MAZZUCATO, ALFREDO FONTANINI, GIANCARLO LA CAMERA, State Univ of NY- Stony Brook — Neural ensembles in alert animals generate complex patterns of activity. Although cortical activity unfolds in a space whose dimension is equal to the number of neurons, it is often restricted to a lower dimensional subspace. Dimensionality is the minimal number of dimensions that accurately capture neural dynamics, and may be related to the computational tasks supported by the neural circuit. Here, we investigate the dimensionality of neural ensembles from the insular cortex of alert rats during periods of 'ongoing' (spontaneous) and stimulus-evoked activity. We find that the dimensionality grows with ensemble size, and does so significantly faster during ongoing compared to evoked activity. We explain both results using a recurrent spiking network with clustered architecture, and obtain analytical results on the dependence of dimensionality on ensemble size, number of clusters, and pair-wise noise correlations. The theory predicts a characteristic scaling with ensemble size and the existence of an upper bound on dimensionality, which grows with the number of clusters and decreases with the amount of noise correlations. To our knowledge, this is the first mechanistic model of neural dimensionality in cortex during both spontaneous and evoked activity.

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