World Wide NeuRise

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Global AND Scale-Free? Spontaneous cortical dynamics between functional networks and cortico-hippocampal communication

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Recent advancements in anatomical and functional imaging emphasize the presence of whole-brain networks organized according to functional and connectivity gradients, but how such structure shapes activity propagation and memory processes still lacks asatisfactory model. We analyse the fine-grained spatiotemporal dynamics of spontaneous activity in the entire dorsal cortex. through simultaneous recordings of wide-field voltage sensitive dye transients (VS), cortical ECoG, and hippocampal LFP in anesthetized mice. Both VS and ECoG show cortical avalanches. When measuring avalanches from the VS signal, we find a major deviation of the size scaling from the power-law distribution predicted by the criticality hypothesis and well approximated by the results from the ECoG. Breaking from scale-invariance, avalanches can thus be grouped in two regimes. Small avalanches consists of a limited number of co-activation modes involving a sub-set of cortical networks (related to the Default Mode Network), while larger avalanches involve a substantial portion of the cortical surface and can be clustered into two families: one immediately preceded by Retrosplenial Cortex activation and mostly involving medial-posterior networks, the other initiated by Somatosensory Cortex and extending preferentially along the lateral-anterior region. Rather than only differing in terms of size, these two set of events appear to be associated with markedly different brain-wide dynamical states: they are accompaniedby a shift in the hippocampal LFP, from the ripple band (smaller) to the gamma band (larger avalanches), and correspond to opposite directionality in the cortex-to-hippocampus causal relationship. These results provide a concrete description of global cortical dynamics, and shows how cortex in its entirety is involved in bi-directional communication in the hippocampus even in sleep-like states

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