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The up and down states of cortical networks MARYAM GHORBANI, ALEX J. LEVINE, MAYANK MEHTA, ROBIJN BRUINSMA, UCLA —
The cortical networks show a collective activity of alternating active and silent states known as up and down states during slow wave sleep or anesthesia. The mechanism of this spontaneous activity as well as the anesthesia or sleep are still not clear. Here, using a mean field approach, we present a simple model to study the spontaneous activity of a homogenous cortical network of excitatory and inhibitory neurons that are recurrently connected. A key new ingredient in this model is that the activity-dependant synaptic depression is considered only for the excitatory neurons. We find depending on the strength of the synaptic depression and synaptic efficacies, the phase space contains strange attractors or stable fixed points at active or quiescent regimes. At the strange attractor phase, we can have oscillations similar to up and down states with flat and noisy up states. Moreover, we show that by increasing the synaptic efficacy corresponding to the connections between the excitatory neurons, the characteristics of the up and down states change in agreement with the changes that we observe in the intracellular recordings of the membrane potential from the entorhinal cortex by varying the depth of anesthesia. Thus, we propose that by measuring the value of this synaptic efficacy, one can quantify the depth of anesthesia which is clinically very important. These findings provide a simple, analytical understanding of the spontaneous cortical dynamics.

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