CORTICAL NETWORKS

Dynamic networking

Whether external inputs from the thalamus or the internal circuitry of the cortex has the greater role in determining the activity of primary sensory cortices has been a topic of discussion for many years, as it reflects the larger philosophical issue of to what extent our minds are driven internally or by the outside world. Results reported by MacLean, Yuste and colleagues in *Neuron* go some way to resolving this issue, suggesting that intracortical connections govern the cortical response to thalamic stimulation.

It has previously been shown that the thalamus is not essential for spontaneous activity in the cortex, as spontaneous activity arises in brain slices that have no intact thalamic inputs. However, it has yet to be resolved how, if at all, spontaneous activity and activity that is triggered by external thalamic inputs are linked.

Using mouse thalamocortical slices in which connections from the thalamus to the cortex are intact, MacLean and colleagues investigated cortical activity arising spontaneously and compared it with activity generated by thalamic stimulation. Calcium imaging of layer 4 cortical neurons in these brain slices showed that spontaneous activity, as reported by imaging, was coincident with a transition from a DOWN state (hyperpolarized potential) to an UP state (prolonged depolarization) in patch-clamped neurons. How does the response to thalamic input compare with this activity? The authors found that the cortical activity triggered by stimulation of the thalamus (>10 Hz) could not be differentiated from spontaneous activity. Moreover, the same neuronal population was activated in a specific spatiotemporal pattern in both spontaneous and thalamically triggered activity.

The authors went on to explore whether the thalamus is the source of the spontaneous activity in the cortex. Spontaneous activity, and the accompanying intracellular UP states, was observed in thalamocortical slices in which the connection between the thalamus and the cortex had been severed, which suggests that spontaneous activity originates not from the thalamus but from the cortex as a result of intrinsic cortical dynamics and/or connectivity. In addition, spontaneous cortical activity seems to be neither maintained nor influenced directly by the thalamus.

This finding, when coupled with the observation that the thalamus can trigger intrinsic cortical dynamics, led MacLean and colleagues to suggest that the thalamus serves to activate the internal circuitry dynamics of the cortex. Taken together, the results reported by these authors indicate that internal dynamics dominate the cortical response to thalamic stimulation and, therefore, that the cortex sits in the driver's seat of sensory perception.

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ORIGINAL RESEARCH PAPER MacLean, J. N. *et al.* Internal dynamics determine the cortical response to thalamic stimulation. *Neuron* **48**, 811–823 (2005)