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" Spatial computations in mouse visual cortex "

Cortical neurons are connected through networks of lateral connectivity. To probe the functional impact of these lateral networks we used optogenetics to cause activity in a local region of mouse primary visual cortex (V1), and measured its effects at distal V1 locations. These effects depended on visual contrast: at low contrast there was only activation, whereas at higher contrast there was invariably suppression. These effects were precisely captured by a model of divisive normalization, where activation is summation, and suppression is division. We suggest that divisive normalization may be a canonical cortical computation, one that is performed not only in primary visual cortex but also in multiple other cortical maps. Next, we examined the relationship of individual cells to larger population patterns, and the circuit mechanisms underlying these relationships. We found that much of the structure in the population activity can be predicted by a single degree of freedom: the “population rate”, i.e., the total activity of the local population, summed without regard to neuronal identity. The relationship of neurons to population rate lies along a continuum, from cells whose firing is strongly correlated with it (“choristers”), to others that fire independently of it (“soloists”). This relationship is invariant to visual stimuli, and unrelated to differences in visual preferences and response properties. The relation of individual cells to population rate is causal and rooted in robust differences in synaptic connectivity. Thus, a surprisingly simple, single dimension characterizes each neuron’s relationship to a larger population, and is central to explaining seemingly complex population patterns in terms of underlying circuit variables.

Host: Wulfram Gerstner

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