

NEURAL CIRCUITS

Out of synch

Previous studies have shown correlated spiking activity within local populations of cortical neurons, an effect thought to arise as a result of shared inputs to the neurons. However, two new papers suggest that correlations in firing between neighbouring neurons may be much weaker than was thought.

Ecker *et al.* sought to improve on previous studies of correlated firing that used single microelectrodes or multielectrode arrays by chronically implanting arrays of tetrodes (each of which consists of four recording microwires) into the primary visual cortex of awake monkeys, a set-up that enables better isolation of spikes from individual neurons. They compared the firing patterns of pairs of neurons during the presentation of various stimuli, including drifting gratings, moving bars and naturalistic images.

“ correlated activity in cortical populations may be weaker than previously thought ”

In contrast to previous findings, Ecker *et al.* observed only very low correlations in the activity of pairs of neurons recorded from the same

tetrode or from different tetrodes, even when the neurons shared response characteristics or had overlapping receptive fields.

The authors suggest that the high correlations measured in previous studies may be the result of internal variables such as motor plans or attention, instability in the positioning of electrodes or difficulty in isolating the spikes of individual neurons. Indeed, the addition of these variables to their data resulted in the detection of ‘false’ correlations.

These findings suggest that shared inputs might not necessarily result in strongly correlated firing patterns. In the second paper, Renart *et al.* provided support for this hypothesis by showing theoretically that the dynamics of neural networks can result in asynchronous activity despite shared inputs. They first showed how the extent of correlation of the inputs to a pair of neurons affects the correlations in firing of the neuronal pair. Importantly, if one of a pair of neurons receives an excitatory input and the other receives an inhibitory input and these two inputs are correlated, they will have opposing effects on the postsynaptic currents and thus tend to decorrelate the activity of the two neurons.

To determine whether such decorrelation arises spontaneously in neuronal networks in which

inputs are shared, the authors considered a recurrent circuit model consisting of two populations of densely and randomly connected excitatory and inhibitory neurons that receive shared excitatory inputs. They found that the network’s activity tended to be asynchronous because spontaneous fluctuations of activity in the excitatory population were ‘tracked’ by fluctuations in the inhibitory population (as a result of fast inhibitory feedback). Such tracking generates negative current correlations, which cancel positive correlations due to shared inputs. Similar effects were seen in a more biologically plausible model network of randomly connected integrate-and-fire neurons and in neuronal recordings in the rat cortex.

These studies show that correlated activity in cortical populations may be weaker than previously thought and demonstrate how this can arise as a result of network dynamics. Such weakly correlated firing is likely to improve the efficiency of information processing in cortical circuits as it allows fast and accurate estimation of firing rates by averaging the activity of large neuronal populations.

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ORIGINAL RESEARCH PAPERS Ecker, A. S. *et al.* Decorrelated neuronal firing in cortical microcircuits. *Science* **327**, 584–587 (2010) | Renart, A. *et al.* The asynchronous state in cortical circuits. *Science* **327**, 587–590 (2010).

