Rich cell-type-specific network topology in neocortical microcircuitry

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Abstract:

Uncovering structural regularities and architectural topologies of cortical circuitry is vital for understanding neural computations. Recently, an experimentally constrained algorithm generated a dense network reconstruction of a ~0.3-mm
3 volume from juvenile rat somatosensory neocortex, comprising ~31,000 cells and ~36 million synapses. Using this reconstruction, we found a small-world topology with an average of 2.5 synapses separating any two cells and multiple cell-type-
specific wiring features. Amounts of excitatory and inhibitory innervations varied across cells, yet pyramidal neurons maintained relatively constant excitation/inhibition ratios. The circuit contained highly connected hub neurons belonging to a small subset of cell types and forming an interconnected cell-type-specific rich club. Certain three-neuron motifs were overrepresented, matching recent experimental results. Cell-type-specific network properties were even more striking when synaptic strength and sign were considered in generating a functional topology. Our systematic approach enables interpretation of microconnectomics ?big data? and provides several experimentally testable predictions.

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