Title:

Lattice array of microcolumnar functional units in neocortex

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Abstract:

The functional organization of the brain is determined by the structure of its circuit. Whether the mammalian neocortical circuit contains a repeating functional unit that tiles the cortex remains unclear. We demonstrate that microcolumns, radial clusters of layer 5 excitatory subcerebral projection neurons, have a regular two-dimensional arrangement and operate as functional units in multiple cortical areas. Microcolumns were organized into a near hexagonal lattice with wide distribution over mouse neocortex. *In vivo* neuronal activity was synchronized within individual microcolumns in visual, somatosensory, and motor cortices. In visual cortex, neurons in single microcolumns exhibited similar ocular dominance properties. Synchronized synaptic activity in microcolumns originated in common upstream inputs suggesting ordered synaptic connectivity. During cortical development, microcolumn neurons were electrically coupled by gap junctions in a cell type-selective manner. These results suggest that parallel information processing by a two-dimensional lattice of layer 5 microcolumns is a canonical functional organization of neocortex.