Orientation selectivity in V1 of alert monkeys

Gur M [1,2], Kagan I [1,2], and Snodderly DM [2]
[1]*Biomedical Engineering, Technion, Haifa;*
[2]*Schepens Eye Research Institute, Harvard Medical School*

Area V1 is known for its neural cell density and intricate histology. Physiological recordings, however, often are not integrated into this complex anatomy. We have previously shown, in alert monkeys, that physiological properties of single cells reflect an alternating arrangement of anatomical layers. Here we report how orientation selectivity is related to the cortical layers and to the cell properties of spontaneous activity, classical receptive field (CRF) size, and spatial organization. Recordings were made from single cells in area V1 of alert monkeys performing a fixation task. The cells' spatial organization was studied with drifting increment and decrement bars while compensating for fixational drift. Orientation selectivity was measured by the orientation tuning curve bandwidth and by circular variance. Orientation selectivity by either measure was clearly correlated with CRF size and spontaneous activity but not with overlap of increment and decrement zones (Simple/Complex) or with relative modulation in response to sinusoidal gratings. The former 3 measures were strongly predicted by the layer of origin such that small CRFs, low spontaneous activity, and a high degree of orientation selectivity were found in the output layers 2/3, 4B and 5 while the reverse was true for the input layers 4A, 4C and 6. We conclude that the conjunction of these physiological measures with their anatomical locations reflect interactions between excitatory and inhibitory mechanisms specific to each lamina. When excitation is stronger than inhibition, large CRFs, high spontaneous activity and a low degree of orientation tuning are found. When inhibition becomes dominant, CRFs shrink, spontaneous activity almost disappears and orientation selectivity is high.

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