Analysis of responses to drifting and stationary gratings in V1 of alert monkey

Igor Kagan[1], Moshe Gur[1,2], D. Max Snodderly[2]

[1]*Dept. of Biomedical Engineering, Technion, Haifa, Israel;*

[2]*Schepens Eye Research Institute, Boston, MA*

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The majority of cells in monkey V1 have overlapping increment and decrement activating regions (ARs) and nonlinear response properties ("duplex" cells). We have recently shown that responses of these cells to sinusoidal luminance gratings are diverse and can not be predicted from receptive fields' spatial maps. Many of these cells have a significant quasi-linear (fundamental, F1) harmonic in the responses to drifting gratings. At the same time, flashing bars, moving edges and counterphase gratings mostly evoke on-off, or frequency doubled (second harmonic, F2) responses. Here we studied the neuronal responses in V1 of an alert monkey to grating patches of varying temporal and spatial frequency and patch width. We found that some cells responded with F1 modulation to high temporal frequency gratings, but showed frequency doubled (F2) or mixed (F1, F2, F3) responses at low temporal frequencies. In other cells little or no effect of temporal frequency on their harmonic content was seen. Most cells, however, showed profound dependence of the harmonic content on grating spatial frequency and width. The three main patterns were: 1) F2 responses to gratings of very low spatial frequency and/or small window; 2) Decrease of F2 and increase of F1 component with increase of spatial frequency and/or patch width; 3) Decrease of F1 component and appearance of "subF1" (i.e. less than F1) modulation with further increase of spatial frequency. Finally, the responses of many cells to stationary gratings of middle to high spatial frequency unexpectedly exhibited robust modulation in the range similar to "subF1" modulation elicited by drifting gratings. These results demonstrate that the form of the response, as well as the amplitude, depends on stimulus parameters, and they suggest an elaborate spatiotemporal structure of duplex receptive fields, based on interactions of increment and decrement ARs and surround.

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