RESPONSE VARIABILITY OF MARMOSET PARVOCELLULAR NEURONS

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ABSTRACT

The parvocellular division of the primate retina contains neurons with a range of sensitivity to luminance and chromatic contrasts. Understanding the functional specialization of these neurons requires a characterization of not only sensitivity, but also response variability. Noise in the phototransduction process and spike generation are likely to have similar effects on response variability across parvocellular neurons, independent of how their cone inputs are combined. However, the intraretinal circuitry that underlies the combination of cone signals may result in differences in response variability across parvocellular neurons with varying degrees of opponency.

We investigated the variability of responses of parvocellular lateral geniculate neurons of genetically-defined dichromat and trichromat marmosets, during stimulation by sinusoidal luminance and chromatic gratings. In dichromats and trichromats, for all parvocellular neurons, firing rate variability was approximately consistent with a Poisson process. Consistent with the findings of Croner et al. (1993), variability of the fundamental frequency component was approximately independent of response amplitude, although there was a modest tendency for larger responses to be more variable. There were also subtle differences in responses driven by chromatic and luminance stimuli. For neurons with pronounced color opponency, chromatic responses were less variable (10-15%, p<0.01) than luminance responses of equal magnitude. Conversely, parvocellular neurons with minimal color opponency showed the opposite tendency. In sum, though noise characteristics of parvocellular neurons are largely independent of the way in which they combine cone signals, the noise neural circuitry may augment specialization of parvocellular neurons to signal luminance or chromatic contrast.

RESULTS

156 neurons in 13 animals: 7 dichromats, 6 (potential) trichromats, 8 (potential) non-opponent P-cells. Visual stimulation: CRT monitor, 80 Hz, mean luminance 55 cd/m2. All chromatic and spatial conditions pooled.

VARIABILITY VS. CONTRAST

Responses were collected for each of 10 nonzero contrasts and blank (c=0). The response to each stimulus cycle was Fourier analyzed (only c=0 and c=4 are shown here). The response amplitude is the vector mean of the cycle-by-cycle components (arcsine). The response variance is the average squared deviation of each trial’s response from the vector mean. Radii of the circles indicate variance1/2. It is similar in dichromat and trichromats, and in cells with minimal or pronounced color opponency.

CONTRAST GAIN: POPULATION DATA

Consistent with the results of Croner et al. (1993) in the macaque and Kremers et al. (2001) in the marmoset, response variability is largely independent of response amplitude. However, variability does increase somewhat (typically 30%) as response amplitude increases.

REFERENCES


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