RESEARCH NOTE

Lateral Inhibition Between Orientation Detectors in the Cat's Visual Cortex

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Neurones in the visual cortex of higher mammals respond very selectively to white or black bars at particular orientations in the visual field (Hubel and Wiesel, 1962, 1968). Psychophysical experiments in man have led several authors to suggest that there is mutual inhibition between detectors with slightly different preferred orientations (Andrews, 1965; Blakemore et al., 1970). We now have physiological evidence for such inhibition in the cat.

We recorded in areas 17 and 18 while the cat was paralysed with Gallamine triethiodide and anaesthetized with nitrous oxide. For each neurone we generated a bright bar of optimum dimensions on an oscilloscope, made it move repetitively across the receptive field and varied its orientation to determine the "tuning curve". Figure 1A shows the "tuning curve" for a "complex" cell. Now we chose the best orientation and stimulated the cell repeatedly with that stimulus, but covered the whole screen, except for a circular area slightly larger than the receptive field, with a high-contrast grating moving back and forth randomly. We continued to measure the response to the optimum moving bar as a function of the orientation of the background grating, and Fig. 1B shows the result.

Clearly the grating inhibited the cell over a broad range of orientations centred on the same orientation as the peak of the "tuning curve" itself, exactly as predicted from psychophysics. We assume that the inhibitory mechanism extends across the receptive field and indeed is strongest there.

The direct input to each cortical cell might make it into a crude orientational filter, and inhibition from cells in the same column and nearby columns could sharpen up the "tuning curve". This may be a rather fundamental property of sensory cortex.

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Fig. 1. The upper graph shows the orientational "tuning curve" in the left eye, for cell A6R1. The receptive field was 6.5 deg long and 2.5 deg wide and the arrangement of the stimulus is shown in the inset diagrams. The larger rectangle represents the receptive field and the smaller one is the moving bar. The luminance of the background was about 9 cd.m\(^{-2}\) and of the bright bar 30 cd.m\(^{-2}\); its velocity was 5 deg. sec\(^{-1}\). The ordinate shows the mean number of impulses (N = 8) produced during a gating period of 2.5 sec centred on the time for which the stimulus was crossing the receptive field. The dashed line shows the mean spontaneous activity of the cell (N = 8) during the same gating period, in the absence of a stimulus. For the lower graph the moving bar was always at the optimal orientation, 15 deg anticlockwise to the horizontal. The cell's response (mean of N = 8) is plotted as a function of the orientation of a background grating whose dark bars had a luminance of 3 cd.m\(^{-2}\) and bright bars 15 cd.m\(^{-2}\). (So its average luminance was the same as that of the background for the upper graph.) The solid horizontal line shows the level of response (about 33 impulses per presentation) that the cell produced in the absence of the grating.

References


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Surprise! There were pronounced excitatory and lateral inhibitory responses to the light flash.

1. The stimulus was a red light of 4000 Angström and for 0.5 sec.

2. The retina was stimulated by the red light and for 0.5 sec.

The retina was stimulated by the red light and for 0.5 sec.

3. The retina was stimulated by the red light and for 0.5 sec.

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Key words

It has been shown that the retina can modify the perception of light flashes by masking them. This masking affects the perceptual experience of light flashes when the retina is stimulated by a red light flash for 0.5 sec. The masking effect is to indicate that the retina is not stimulated while in the dark, and that the red light flash on the retina is not masked.