In superposition eyes, light from many focusing lenses converge on a small number of photoreceptors.

Cajal’s Anatomical study of the Insect Eye

Cajal wrote, “the complexity of the insect retina is stupendous, indeed disconcerting, and with no precedent in other animals”

The eye of the fly is divided into ommatidia

Transduction takes place in the rhabdom

Like vertebrates, insect eyes often have a fovea capable of acute vision
The fovea varies according to the visual behavior of the insect. For four species, contour plots of numbers of ommatidia per unit solid angle.

- Caliphora (blowfly)
- Apis mellifera (honeybee)
- Amax junius (dragonfly)
- Gerris (waterstrider)


The speed of the eye varies with the flight patterns of two flies.

- Tipula: crane fly, is nocturnal, slow flying
- Fleshflies are diurnal, fast moving

The lamina and a lamina monopolar cell

- The photoreceptor responds with depolarizing potential (overshoot, then relax to plateau)
- Axon responds with depolarizing potential
- The LMC neuron is inhibited by the photoreceptor and is more "phasic"
- DC response is eliminated, edges enhanced (hi-pass)


The lamina neurons enhance the transient (flicker) responses by removing background light levels


The fly lamina enhances the high frequency component of the amplitude modulated light

- Flash (50Hz)
- Fast + slow (0.4Hz)


Werner Reichardt

Bernhard Hassenstein
Early Experiments

Glossary
- Luminance
- Contrast
- Temporal frequency = velocity/wavelength (variation that a single receptor sees)

The Reichardt (Correlation) Motion Detector

\[ R(t) = A_2(T)F_1(T - t) - A_1(T)F_2(T - t) \]

Lobula Plate Tangential Cells (LPTC) in the lobula plate of the blow fly, Calliphora, respond to motion in the horizontal plane (HS neurons) (a) or vertical plane (VS neurons) anywhere in the visual field of the eye.

H1 neurons allow left right comparisons (distinguish rotation from forward visual flow)

Delay line coincidence detector produces motion response in H1 neurons (elementary motion detector)

Sequential activation of just two photoreceptors within a single ommatidium evoke responses from H1 only in the preferred direction. (From Franceschini et al., 1989)
Motion sensing neurons in Lobula Plate

Reichardt Motion Detector Model

Possible connectivity

References


Egelhaaf and Borst (1993)