EVENT ABSTRACT

Three-dimensional visual receptive fields of target-selective descending neurons in the dragonfly

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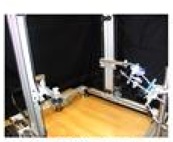
In the dragonfly, eight bilateral pairs of target-selective descending neurons (TSDNs) transmit visual information about object location and velocity from the brain to the thoracic ganglia. Because of their selectivity for small object motion, and because their activity elicits small adjustments in wing orientation, we hypothesize that these neurons direct prey interception flights.

Until recently TSDN receptive fields have been characterized by moving contrasting targets on a projection screen or high frequency monitor. However, results from three pilot experiments suggest that the distance to the object could play a role in TSDN responses. (1) Outdoor recordings of TSDN responses to small objects (beads) moving around the dragonfly showed that one neuron (DIT1), which shows a preference for small targets in flat-screen experiments, responded maximally to nearby objects; object proximity took precedence over small angular size. (2) Monocular occlusion experiments showed much greater responses to projected objects viewed with both eyes than with either eye alone, i.e., the binocular response was greater than the sum of monocular responses. (3) The responses of one TSDN to real approaching objects showed differences from those elicited by the expansion of a projected image whose time-course simulated a looming object. Specifically, doubling the approach speed and halving the object size results in identical time-courses of image expansion on the retina; however, varying the size and speed of a real approaching object in this way resulted in a significant timing difference in the neural responses.

The above observations suggest that depth may be an important factor in TSDN responses. To test this hypothesis, we designed and built an apparatus that moves a glass bead in three dimensions (Figure 1). Using DC motors with closed-loop computer control, this "3-D Object-Motion Generator" (3-D OMG) moves beads of various sizes, suspended on taut nylon monofilament, up to 1 m/s in all three dimensions within a cubical volume 46 cm on a side. Using the 3-D OMG we have characterized TSDN receptive fields with pseudorandom movement patterns that are designed to simulate the flight trajectories of prey insects. Our results illustrate the importance of depth to the receptive field properties of some of the TSDNs.

Figure 1



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