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SPATIO-TEMPORAL INTEGRATION OF VISUAL INFORMATION IN THE FLY'S LANDING SYSTEM

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When approaching a landing site flies extend their legs in order to prevent crash-landing. The release mechanism of this reflex has been analysed. Pattern expansion in front of a tethered fly seems to mimic an approach towards a landing site, and elicits a rather stereotyped motor pattern (Borst 1986, Biol Cybern 54: 379-383). As the only variable parameter of this landing response the latency of its onset decreases significantly with increasing stimulus strength. Quantitative studies of the stimulus-latency relationship (Borst and Bahde 1986, Biol Cybern 55: 59-69) led to the formulation of a simple model which describes the processing of movement information in the fly's visual system in order to release the landing reflex. We assume that the output of local movement detectors sensitive to front-to-back motion in each eye undergo spatial and temporal integration. Whenever the level of the integrated signal reaches a given threshold landing is released.

To investigate the spatial integration of the output signals of the movement detectors we compared the responses to movement stimuli presented to different parts of the eyes with the response to the sum of these stimuli. The response turned out to be roughly proportional to the number of stimulated movement detectors if allowance is made to their position-dependent sensitivity. The results for intraocular as well as for interocular integration suggests that the output signals of the movement detectors from both eyes are summated algebraically.

The application of a sub-threshold stimulus prior to the test stimulus further elucidates the temporal integration mechanism: if the landing system uses the instantaneous output signal of movement detectors, then the latency of the response to the test stimulus should not be affected by pre-stimulation. If, in contrast, the signal becomes integrated in time, then pre-stimulation should 'load' the integrator to some level thus shortening the latency of the reflex to the test stimulus. Two different patterns were used as prestimuli: one had the same contrast but a lower velocity, the other had the same velocity but a lower contrast with respect to the test pattern. In both cases the latency of the response to the test pattern was significantly shorter than without pre-stimulation. This strongly suggests that landing is not triggered by the instantaneous movement signal but rather by its temporal integral.