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Is Shunting Inhibition Responsible for Motion Detection in the Fly Visual System?

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Extraction of motion information from temporally changing retinal images requires some basic computations which have been specified in an algorithmic model (Reichardt 1987). A multiplication-like interaction of the signals from two neighboring visual elements, followed by a subtraction play a decisive role in this system (Fig.1). A simple synaptic mechanism proposed to account for the multiplication relies on the nonlinear interaction between a single pair of cells by an excitatory and a GABAergic inhibitory synapse (shunting inhibition model, Torre and Poggio 1978). Evidence for this model arises from experiments where a reduction of direction-selectivity in movement-sensitive cells following injection of a GABA antagonist was obser-ved.

For two reasons, we question this model for the fly visual system on the basis of an electrophysiological analysis of local detector responses. Hereby, the frequency doubling of the input signal caused by the multiplication was taken as a fingerprint for the nonlinear interaction. (i) Modeling shunting inhibition reveals that pronounced 2nd harmonic frequency components in the detector output signals occur only together with higher harmonics. This is in contrast to the responses of motion-sensitive cells in the fly (Fig.2). (ii) Blocking of GABAergic synapses by injection of Picrotoxinin leads to an increase of the power of the 2nd harmonic (Fig.3). This suggests that GABA is the inhibitory transmitter at the subtraction stage and is not expected if the nonlinear interaction of the detector input channels were solely based on GABAergic shunting inhibition. More complex wiring schemes to account for the multiplication in cellular terms are under investigation.

References:
Reichardt W (1987) Evaluation of optical motion information by movement detectors. J Comp Physiol A 161: 533-547
Torre V, Poggio T (1978) A synaptic mechanism possibly underlying directional selectivity to motion. Proc.R.Soc.Lond.B 202: 409-416

Fig.1

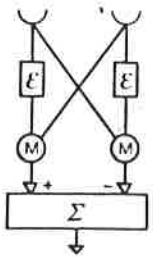

Fig.2

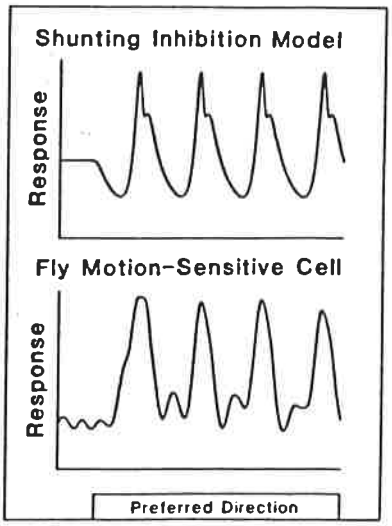

Fig.3