CORRESPONDENCE OF DENDRITIC FIELD STRUCTURE, RECEPTIVE FIELD ORGANIZATION, AND SPECIFIC FLOW PATTERNS IN VISUAL INTERNEURONS OF THE BLOWFLY *Calliphora*

Holger Krapp, Bärbel Hengstenberg and Roland Hengstenberg

Max-Planck-Institut für biologische Kybernetik Spemannstraße 38 D-72076 Tübingen

Locomotion generates, on the eyes, optic flow patterns that depend upon the three-dimensional layout of the surroundings, the direction of gaze, and the direction and speed of locomotion (Koenderink, 1987). Conversely, optic flow information is probably used for locomotor control in humans, insects and other animals (Nakayama and Loomis, 1974).

In flies, optic flow is thought to be analyzed by large arrays of small field motion detectors with different preferred directions. Global features of optic flow are thought to be extracted by selection of local motion signals and retinotopical widefeld integration in certain interneurons of the third visual neuropil - the lobula plate (Krapp and Hengstenberg, 1993). These so-called 'tangential neurons' are believed to be involved in visual course control (Hausen, 1984). Some of the tangential neurons can be identified individually and are attached to two neuronal systems: the Horizontal-System (HS; Hausen, 1982) and the Vertical-System (VS; Hengstenberg et al, 1982). The HS-neurons respond mainly to horizontal wide field motion whereas the VS-neurons show more complex responses.

To decide wether the 10 VS-neurons (VS1-VS10) are functionally specialized to detect specific aspects of optic flow we investigated their receptive field organization with respect to the distribution of (i) local preferred directions and (ii) local motion sensitivities. Therefore we developed a stimulus procedure that is fast enough to determine intracellularly the two parameters at 52 positons reasonably distributed over more than the ipsilateral visual hemisphere of one eye (Krapp and Hengstenberg, 1992). In Fig a) the results of the recording of a VS1 neuron arc presented in a map of the visual hemisphere. Each arrow originates at the site of stimulation within the visual field (dots; arrows at non-stimulated locations - without dot - were obtained by interpolation). The orientation of the arrows show the local preferred direction, and their length denote the motion sensitivity relative to the maximal response (f=frontal, d=dorsal, c=caudal, v=ventral). The motion responses of the VS1-neuron suggest that it responds predominantly to an optic flow generated by a rotation around the transverse axis of the fly. Figure b) shows a reconstruction of the neuron that has been stained with Lucifer Yellow. Its dendritic arborizations occupy, in the retinotopic map of the lobula plate, a dendritic field that corresponds to the receptive field in the visual space. Its dendrites are stacked regionally in depth of the lobula plate, corresponding to the local preferred direction. The other VS-neurons, like the VS1, also seem to be specialized to detect the rotatory aspect of selfmotion around various horizontal axes. The position of the maximal motion sensitivities and the respective axes of rotation gradually change from neuron to neuron. These changes are correlated with the position of their maindendrites within the lobula plate. In order to prove the tuning of the VS-neurons to the rotatory aspect of selfmotion two further points have to be made: (i) the organization of the contralateral visual field has to be investigated and (ii) self motion parameters have to be calculated from the response fields.