Interaction of sensory feedback and central network in the locust flight control system: a modeling study

Ausborn J, Mader W, *Neumann H, Wolf H

Dept of Neurobiology and Dept of *Neural Information Processing,
University of Ulm, D-89069 Ulm, Germany;
jessica.ausborn@biologie.uni-ulm.de

Networks that control motor behavior are often well understood with regard to their cybernetic properties and the cellular functions of involved neurons. By contrast, functional consequences of underlying network structure often remain unclear. The goal of the present study is to examine possible relationships between network structure and network function in the locust flight control circuit.

Previous simulations employing simpler models were able to demonstrate basic features, such as robustness resulting from network redundancy (Grimm & Sauer 1995, Biol. Cybern. 72). However, they could not reproduce more subtle features such as graded transmitter release or dynamic spike frequency ranges up to 300Hz, which may well prove relevant for network function.

To investigate structure - function relationships in the central pattern generator of locust flight, we used the simulation environment *madSim* (Mader et al. 2003, Proc. Goettingen Neurobiology Conf. 29: 1055). Neurons were implemented as multi-compartment neurons with Hodgkin-Huxley-like currents (Hodgkin & Huxley 1952, J. Physiol 117).

The locust flight control circuit is electrophysiologically well-studied and at the same time sufficiently complex (e.g. Robertson & Pearson 1984, J. Insect Physiol. 30) to show emergent network properties.

Particular emphasis in our studies is on the functional relevance of (i) interconnected neuron circles with recurrent inhibition, (ii) structural redundancy and functional robustness and (iii) integration of sensory feedback into central network function.

The latter aspect is the present focus of our work. Two sets of wing receptors are of particular importance for flight pattern generation. These are the wing stretch receptors and the tegulae (Wolf & Pearson 1988, J. Neurophysiol. 59). They signal upper and lower stroke reversals, respectively, and the tegula effectively resets the wing stroke. Connectivity with flight interneurons is well-known for the tegula, however, the functional relevance of connections to these core oscillator interneurons and of their relative synaptic strengths compared to the functional relevance of external reflex pathways is not understood. We are currently investigating these aspects.