Modeling of the locust flight control network: Interaction of central network and sensory feedback.

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We have modeled the locust flight oscillator network using 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 (Hodgkin & Huxley 1952, J. Physiol 117) currents. 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.

The goal of the present study is to examine possible relationships between network structure and network function, exemplified in the locust flight control circuit, which is both, electrophysiologically well-studied and sufficiently complex (e.g. Robertson & Pearson 1984, J Insect Physiol 30). Particular emphasis is on (i) interconnected neuron circles with recurrent inhibition, (ii) structural redundancy and functional robustness and (iii) integration of sensory feedback into central network function.

With regard to sensory feedback, tegula and wing hinge stretch receptors are of particular importance (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 core oscillator interneurons and of their relative synaptic strengths compared to the functional relevance of external reflex pathways is not understood. Here is the focus of our present experiments.