

Sensory feedback from Campaniform sensilla (CS) contributes to the adaptation of motor output to changes in load during locomotion. But even when the animal is resting, it must be able to react appropriately to external stimuli. In resting and walking insects, changes in load as well as imposed forces trigger CS-induced reflex effects in different motor neurons (MNs). However, the neuronal mechanisms of these effects and the specific influences of individual CS groups on the different MN pools that contribute to the movement of single leg joints are still incompletely understood.

I applied forces in horizontal and vertical directions to the immobilized leg of mainly resting stick insects (*Carausius morosus*) using a motor-driven lever for CS stimulation, and electromyographically or extracellularly recorded the evoked electrical muscle or motoneuronal activity. Through targeted mechanical ablation or optical inactivation of individual CS groups (or subgroups), the evoked reflex effects could be assigned to the CS group/s involved. While the conventional method of mechanical CS ablation is invasive, irreversible, and may lead to injury discharges, the new method of optical CS inactivation by means of light application using a blue LED (420-480 nm) or a 473 nm laser that I established, proved to be particularly gentle, effective and, depending on the light intensity, even reversible.

Here, I provide a detailed and almost complete picture of the excitatory influences of trochanteral, femoral and tibial CS groups onto motor neurons (MNs) of the thoraco-coxal (ThC), coxo-trochanteral (CTr) and femur-tibial (FTi) joints in the inactive stick insect. Evoked reflexes were mainly found to constitute a negative force feedback system that reduces cuticular strain. In the FTi-joint, however, different CS groups contributed to the co-activation of antagonists and thus to joint stiffening that increases stability. My data also revealed state-dependent effects of CS activation onto MNs of the FTi-joint, demonstrating that different CS groups can trigger excitatory reflexes in antagonistic MNs, depending on whether the animal is in the inactive or active behavioral state. Using fluorescent dyes, I could show that all CS groups, with minor exceptions, share a common projection pattern. This common projection pattern of various CS groups potentially allows different CS groups to influence various MN pools, and thus facilitates fast and task-dependent adaptation of leg movements and appropriate reactions to external perturbances.

My results have extended the leg reference frame concept set-up by Zill and colleagues (2012), which provides the framework for the perception of force direction and CS-induced motor control with reference to the plane of joint movement, by showing that its boundaries are less sharply defined. Although I found that some MN pools (*depressor trochanteris*, *flexor tibiae*) are influenced exclusively by dorsal CS groups that lie in the plane of joint movement as predicted by the concept,

effects of most CS groups are not limited to MN pools moving the leg along or orthogonally to the leg plane. Overall, regardless of the location of CS groups on the insect leg (dorsal or lateral), most trochantero-femoral CS groups were found to have intersegmental effects, as they affected MNs of both, the ThC- and FTi-joint. However, whether the leg reference frame concept will define the force direction that evokes strongest sensory discharges as a function of their location on the insect leg and the extent of contribution of certain CS groups to evoked reflexes remains an open question.

Taken together, the results of this dissertation contribute significantly to the understanding of load-mediated motor control and provide a good foundation for subsequent research that will, for example, address the task-specific contribution of CS signals by using the new method for CS inactivation.