Summary

This thesis investigates odor learning in the mushroom body (MB) of the honeybee *Apis mellifera carnica*. Using extra cellular long term recordings of alpha lobe extrinsic neurons [ENs] that read out the information of the MB were characterized and their changes during and after applying different learning paradigms documented. The results allow conclusions about the MBs role regarding learning and memory formation. At the level of the ENs the information about the conditioned stimulus “CS” (odor) and the unconditioned stimulus “US” (sucrose reward) seems to be integrating into the bee brain. The result is a stable stimulus specific response. Furthermore the level of integrating the information of both brain sides into one compound is shown.

Chapter I addresses the general response properties of the ENs to repeated odor stimulation. Single mushroom body-extrinsic neurons were recorded while the bees have been exposed to repeated odor stimulations of 10 different odors. The responses were characterized regarding their odor specificity and their reliability. I can show that ENs are initially odor unspecific, meaning that most of them respond to all of the 10 tested odors. When focusing on the responses to the repetitions of one identical odor, it appears that ENs respond rather unreliable. The results indicate that the neural population activity at the level of the MB output does not reliably represent sensory stimuli.

Chapter II discussed the question if the properties characterized in chapter 1 can be influenced by applying differential conditioning of two odors, the forward-paired CS+ and the unpaired CS- and three control odors. After conditioning the odors, two groups of neurons appeared. One group was completely unaffected (“stereotypic”). Units related to the other group showed learning dependent plasticity. I found two types of “plastic” units. One type responded, before the subjects had built an association rather unreliable to only a few different odors, meaning that they were more odor specific compared to the stereotypic units. After the animals had built an association, 30 % of these units were recruited to respond to the rewarded odor (CS+) more reliable. Other plastic units were initially odor non-responding and started to respond for different odors after the conditioning. These units started already to respond during the overlap (coincidence) of the CS and the US.

Chapter III deals with the question, if the information of both MBs is integrated at the level of the ENs. Side specific conditioning experiments were performed during which the antennae of the bees received different input. The differential conditioning of the odors, where one odor was presented reinforced (CS+) and the other non reinforced (CS-), was always performed on the contralateral side related to the recording position. Like in chapter II also during the contra lateral conditioning I observed activity changes in the recorded ENs if the CS and the US were presented overlapping, although I recorded the activity of ENs of the contra lateral brain site, where the antennae of the bees received no odor input. However, after three hours resting time a stable and reliable representation of the different side specific stimuli was established.

Thus, the general properties described in chapter I changed after differential odor conditioning as demonstrated in chapter II. Also the conditioning at only one antennae recruits units and changed the general response properties of the contralateral recorded ENs as demonstrated in chapter III. The representation of the odor stimulus at the output of the MB is laterally dissolved.