15 Summary

The aim of this study was to measure learning-specific changes in the neuronal activity in the honeybee brain *in vivo*. Therefore multichannel recordings were used. The advantage of multichannel recordings is the possibility to measure simultaneously the electrical activity of several neurons of an assembly and to combine high temporal resolution with spatial resolution. Measurements of neuronal activity were taken separately from two neuropiles of the olfactory system of the honeybee brain: The antennal lobe (AL) as the first olfactory neuropile, and the α-Lobe (α-L) which is an output region of the mushroom body (MB). Simultaneously, the animals were differentially conditioned to two odours (CS+ and CS-). A third odour served as a control (Ctrl). Neuronal activity was measured both in a 10-100 Hz frequency range for the recording of the local field potential (LFP) and in a 300-600 Hz frequency range for the recording of neuronal spike activity. Spike signals were analysed as multi unit activity (MUA). Registration of the electrical activity of the muscle M17 served as a monitor for the successful conditioning to the rewarded odour.

It was demonstrated that multichannel recordings are able to register changes in the neuronal network and that it is possible to perform a learning experiment with this technique.

In the AL, those MUA response characteristics to odours were found that are already known from intracellular recordings. Assembly representations within the same animal were odour-specific. The frequency spectrum of the LFP was both local and non-odour-specific. A strong contingent of the 45-55 Hz frequency band to the dominant frequency bands of the odour induced LFP oscillations was found, and there was a significant correlation of 30% of all MUAs to that band.

The investigation of the changes of the olfactory responses of AL MUAs over all animals due to conditioning revealed that the majority of MUAs decreased their response strength. When asking for a change in response strength without looking for the sign of the strength one can find that significantly more MUAs changed for the CS+ than for the CS- or Ctrl. In the LFP a significant shift of the 41-100 Hz frequency band towards the 15-40 Hz band was observed after conditioning for the CS+. Taken together, these effects point to a general change in the neural assembly activity within the AL.

In the α-L, all those MUA response characteristics to odours were found that are already known from intracellular recordings of MB output neurons. MUA responses showed less odour specificity than in the AL and the composition of the frequency spectrum of odour-induced LFP oscillations was less complex. After conditioning, the majority of MUAs showed stronger olfactory responses, but they were non-stimulus-specific. The only significant difference between MUA responses to CS+ and CS- was a stronger increase for the CS+ relative to the CS- after conditioning within the second 500 ms after stimulus onset. Therefore it is possible that many of the recorded α-L MUA responses conveyed other or additional information than the identy of odours or the association between odour and reward.