OR327

Neuroanatomical bases of absolute and differential color learning in honeybees

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Color vision is important in honeybees to identify flowers as potential food sources. To enable highly efficient foraging, bees have to learn, memorize and retrieve color information. The color discrimination performance of bees is highly dependent on how stimuli are perceived. Discrimination of perceptually similar colors requires differential conditioning with target and distracter stimuli, but fails when target colors are learnt in isolation with absolute conditioning (Dyer and Chittka, 2004; Giurfa, 2004). An enduring question is where in a bee brain is such information processed and stored. Here we present data on fine color discrimination in free-flying honeybees on a rotating screen apparatus (Dyer et al., 2005). Bees were trained with either absolute or differential conditioning considering two similar 'blue' color stimuli. A control group was confronted with an unpaired presentation of the grey background color and a sucrose solution reward. After 50 conditioning trials, the bees were tested with a non-rewarded touch test which simultaneously presented both colors. Bees trained with differential conditioning performed significantly better in the final test than bees of the alternative groups (absolute, grey). For the neuroanatomical analyses, the bees from the three groups were kept for three days in individual chambers excluding light to avoid new stimulus input, but to enable long-term memory formation. Subsequently, these animals were analyzed for differences in the neuronal network of the mushroom bodies by whole-mount immunostaining to search for variations in the number of synaptic boutons in the olfactory lip region and the visually innervated collar. With this work we aim to provide insights into the neuronal mechanisms behind complex color learning and memory in insects. Dyer, A. G. and Chittka, L. (2004). Naturwissenschaften 91(5): 224-227. Dyer, A. G., Neumeyer, C. and Chittka, L. (2005). J Exp Biol 208(Pt 24): 4709-4714. Giurfa, M. (2004). Naturwissenschaften 91(5): 228-231.