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Honeybee scent memories regulate olfactory receptor expression

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Olfactory learning and memory formation has been well investigated in honeybees, including the neural and molecular changes that occur in the antennal lobes and mushroom bodies of the honeybee brain as a function of odour learning. One potential area of learning-induced plasticity has received little attention to date, namely the sensory neurons in the honeybee antennae where odours are first detected. Here, we present evidence that odour learning triggers molecular changes in the expression of 7-transmembrane olfactory receptor proteins (ORs) on dendrites of olfactory neurons in the honeybee antennae. The expression of six honeybee ORs that were shown to bind common floral odorants such as linalool and nerol, varies significantly with transition from hive nurse bee to outdoor foraging bees, and with exposure to different flowering plants in the four seasons. When bees were conditioned to these specific floral odorants using the PER-assay, the respective ORs in the antennae were down-regulated. The physiological response of the corresponding olfactory neurons in the antennae was also reduced after scent conditioning. Importantly, OR down-regulation only occurred in context of scent learning; mere exposure to the same scents induced no changes in OR expression, suggesting that molecular mechanisms involved in memory formation also regulate OR expression. Our research demonstrates that the olfactory system of honeybees is highly plastic, constantly adapting via differential gene expression to scent experiences, which in turn affects odour preferences. We propose that this plasticity enables the olfactory system to be optimally tuned to process familiar odorants as well as detect novel ones.