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Parallel processing of olfactory information in social Hymenoptera

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Social insects face an enormous complexity of chemical signals and cues used for communication, recognition and orientation. The diversity and complexity of odorants involved in many social behaviors requires advanced sensory processing and perception. We investigated neuronal adaptations promoting these amazing capabilities in the honeybee (*Apis mellifera*) and carpenter ant (*Camponotus floridanus*) by combining structural and functional analyses of underlying neuronal circuits. Olfactory information is relayed from primary (antennal lobes) to secondary olfactory centers (mushroom bodies, lateral horn) via a dual olfactory pathway formed by a medial and lateral tract of projection neurons. Comparative studies across insects suggest that this configuration represents a special feature in Hymenoptera (Galizia and Rüssler 2010, Annu Rev Entomol; Rüssler and Brill 2013, J Comp Physiol). Tracing studies show that this dual pathway is sex-specific; the m-tract is reduced in males compared to females. This is associated with the lack of Sensilla basiconica in males - one type of antennal olfactory sensilla. We developed a technique for dual-tract multi-unit electrophysiological recordings to simultaneously monitor odorant induced activity from large numbers of projection neurons in both olfactory tracts (Brill et al. 2013, J Neurosci). The results demonstrate that all tested odorants were processed in parallel via both tracts, but with significant differences regarding quality and temporal coding indicating that the two information streams transfer different features from similar odors. Whereas projection neurons of the medial tract are more narrowly tuned to specific odorants, neurons of the lateral tract respond more generalistic and faster. Based on these features we propose a model for parallel processing and coincidence coding of olfactory information at the level of the mushroom bodies. We suggest that coincidence coding via a dual olfactory pathway supports fast coding and efficient recognition of complex odorant mixtures. Supported by DFG-SPP 1392 (Ro1177).