Odor-induced spatio-temporal activity patterns of synchronized potentials mediated by local interneurons in the cockroach antennal lobe

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In insects, odor-induced spatial activity patterns of glomeruli and temporal structures of oscillatory signals formed by synchronized activities of neural assembles in the antennal lobe (AL) play critical roles in odor representations. In this study, we revealed the neural correlations between the spatial and temporal odor representations in the cockroach *Periplaneta americana*. The high-speed optical recordings using voltage sensitive dyes (VSD) revealed different kinds of odorants (citral, pentanol and enanthic acid) induced the different temporal patterns of synchronized potentials in the odor-specific sets of glomeruli. Therefore, odor identities are represented as spatio-temporal activity patterns of glomeruli in the cockraoch AL. To identify origins of the VSD signals, we intracellularly recorded the enanthic acid-induced neural activities from projection neurons (PNs) and local interneurons (LNs). Analyses of the temporal patterns of olfactory responses suggest that VSD recordings detect the synchronized firing of multiple GABAergic LNs. In addition, all PNs innervating glomeruli where enanthic acid induced synchronized potentials exhibited excitatory responses to the odor. Since multiple LNs synapse onto a single PN in each glomerulus, converging inhibitory inputs from GABAergic LNs shape the olfacotry responses of postsynaptic PNs. Therefore, synchronized firings of GABAergic LNs play critical roles in spatio-temporal odor representations of PNs.