Imaging synaptically distributed memory traces in the brain of Drosophila

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Deciphering how neuronal circuits encode sensory stimuli, control behavior, learn and store memories represents a key task in modern neuroscience. For such an endeavor, the fruit fly *Drosophila melanogaster* is particularly suitable. It combines relative brain simplicity, behavioral richness, and, due to many genetic tools, unique experimental accessibility. Associative odor learning provides a means to analyze how sensory representations are encoded across widely distributed neurons and synapses, and how the synaptic stimulus representation is modified through learning. Our research focuses on the mushroom body of the *Drosophila* central brain. The mushroom body is an evolutionary ancient, higher-order brain structure, comprising but ~2200 intrinsic neurons. It integrates input from multiple sensory modalities as well as information about internal states with positive or negative experience. Its output then is integrated with innate behavioral tendencies to bring about learned behavior. Our recent research focuses on how sparsely activated, distributed synapses de-synchronize as a result of associative learning. Using calcium imaging and information theory we follow up the hypothesis that coherent activity among synapses distributed across different neurons carries information about a learned stimulus. Data supporting this concept will be presented and discussed as a paradigmatic case of how a neuronal circuit operates to encode learned information.