The neural basis of Drosophila larval light/darkness preference

In a project funded by NSFC, a team led by Associate Professor Gong Zhefeng and Professor Liu Li from the Institute of Biophysics, Chinese Academy of Sciences, discovered that two pairs of central brain neurons control the switch of the preference between light and darkness, by applying the GAL4/UAS system to block function of certain neural cells and investigating the consequent changes in Drosophila larval light avoidance behavior. A short report article published on *Science* on Oct. 22, 2010 reported this discovery.

According to the report, animal behaviors are generally quite flexible. Animals can adjust their behavior according to the changes in natural environment, nutritional condition as well as factors like age. But, how are animals' innate behaviors affected by external and internal factors? The underlying neural circuit is still not fully understood. In the case of human being, the behavioral habits and preferences change as the external environmental factors or internal factors like age change. In the case of invertebrates like Drosophila, behavioral preferences also change to meet the physiological needs as environmental condition changes. Young Drosophila larva prefers to stay in darkness whereas the older leaves for sites with more light—the larvae no longer need food but they need a cleaner place for pupation.

Associate Professor Gong and his group first screened more than 700 Gal4 lines to obtain preliminary neural map, the paper says. Then by comparing Gal4 expression patterns, they ascertained that two pairs of isomorphic neurons (NP394 neurons) participate in the regulation of larval phototaxis. The higher activity of NP394 neurons corresponds to stronger light avoidance whereas less to stronger preference for light. Furthermore, they found that these two pairs of neurons are in connection with known larval visual pathway. NP394 neurons are close to the axonal terminal of pdf neurons, which have been well established to receive visual input from light sensory neurons. Thereafter, they proved that there exists synaptic connection between the dendritic terminus of NP394 neurons and the axonal terminus of pdf neurons. These result showed that NP394 neurons are downstream of pdf neurons. Further experiments with functional calcium imaging confirmed not only that NP394 neurons are responsive to light stimulation, but also that pdf neurons play an inhibitory role in NP394 neuron's response to light. This study not only extends the Drosophila neural pathway for visual information processing, but also deepens our understanding on how animal brain interprets visual cues. It is one more step towards the complete resolution of the neural basis of how environmental factors and internal factors affect animal innate behavior.