This Week in The Journal

mGluRs Induce LTD and LTP of Electrical Synapses

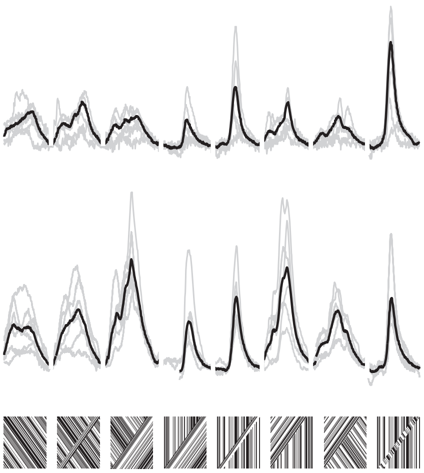
Zemin Wang, Ryan Neely, and Carole E. Landisman

(see pages 7616–7625)

Electrical synapses are channels formed between two neurons by connexin proteins, and they have generally been considered to mediate relatively constant communication that lacks the intricate regulation exhibited by chemical neurotransmission. But accumulating evidence indicates that electrical synapses can undergo plasticity that lasts minutes to days. For example, tetanic stimulation of cortical inputs to the thalamic reticular nucleus (TRN) causes long-term depression of electrical synapses (eLTD) between the TRN′s GABAergic principal neurons (Landisman and Connors, 2005, Science 310:1809). This effect is mimicked by a nonspecific agonist of metabotropic glutamate receptors (mGluRs).

Two major classes of mGluRs are expressed in the TRN. Group I mGluRs are coupled to Gs, which activates adenylyl cyclase, leading to increased production of cAMP and activation of protein kinase A (PKA). In contrast, Group II mGluRs couple to Gi/o, which inhibits adenylyl cyclase, thus reducing cAMP production. Wang et al. asked which of these pathways is responsible for eLTD between TRN neurons in rat thalamocortical slices. Group I mGluR agonists, adenylyl cyclase activators, and cAMP analogs reduced coupling strength, indicating that activation of Group I mGluRs underlies eLTD. Unexpectedly—but perhaps unsurprisingly—applying Group II mGluR agonists, Gi/o-activating peptides, or PKA inhibitors had the opposite effect, that is, they increased coupling strength between neurons, thus producing long-term potentiation (eLTP).

These results suggest that glutamate can induce eLTD or eLTP in TRN neurons by acting on Group I or Group II mGluRs, leading to increased or decreased PKA activity, respectively. One might therefore hypothesize that PKA reduces coupling by directly phosphorylating connexin molecules. But previous studies on amacrine cells found that PKA activation reduced electrical coupling by causing dephosphorylation of connexins, likely by activating protein phosphatase 2A (Kothmann et al., 2009, J Neurosci 29:14903). Whether a similar pathway is involved in TRN remains to be seen. In addition, whether and under what circumstances eLTP is induced by glutamatergic inputs *in vivo* remains unknown. These—as well as the effects of electrical synaptic plasticity on TRN′s regulation of thalamocortical communication—are important topics for future investigations.



Different neuron classes (top and middle panels) in *Drosophila* optic lobule show different responses to visual stimuli (bottom panels) representing figures and edges moving on ground. See the article by Aptekar et al. for details.

Lobule Neurons Help Flies Distinguish Figure from Ground

Jacob W. Aptekar, Mehmet F. Keleş, Patrick M. Lu, Nadezhda M. Zolotova, and Mark A. Frye

(see pages 7587–7599)

The ability to discriminate objects in a complex environment is essential for nearly all animal behaviors, from finding food and avoiding predators to simply moving around without bumping into things. Many visual features, including color, luminance, and contrast, are generally used for object discrimination. Coherent motion of visual elements can also be used to discern objects: thus, a well-camouflaged animal can be distinguished when it moves. The neural mechanisms of this ability are poorly understood, however.

Aptekar et al. have begun to explore the neural mechanism of motion-based figure–ground discrimination in *Drosophila*. They presented vertical edges or striped figures moving horizontally across a striped background to flies in a flight simulator. Importantly, edges, figures, and grounds could not be distinguished when stationary. To infer the flies' visual perception, the authors measured the amplitude of left and right wing beats. The difference between beat amplitudes is proportional to yaw torque, and thus indicates flies' navigational adjustments in response to the stimuli. They then constructed a perceptual graph—which statistically clusters stimuli by their elicited responses—to define visual classes flies used for perception.

Next, the authors used calcium imaging to measure the responses of four classes of neurons in the lobula—a relatively little-studied neuropil of the optic lobe—to these same visual stimuli. All classes, which are defined by their projection targets, responded similarly to bars moving across static ground; but they responded differently to figures moving on stationary or moving ground. Perceptual graphs created from cellular responses indicated that each neuron class responded to different types of stimuli: one class responded similarly to all stimuli, another responded selectively to edges moving on stationary ground, and the remainder responded to figures moving on stationary or moving ground, but not to ground alone.

Together, the results suggest that flies process visual information in parallel, with different cell classes extracting information about different stimulus features and passing the information to different targets. Future work will need to determine which specific features are detected by each cell class. This information can then be used to construct models of how flies distinguish figures from ground.

This Week in The Journal is written by Teresa Esch, Ph.D.