Abstract View

FAST ODOR LEARNING AND RELIABILITY OF ODOR RESPONSES IN THE LOCUST ANTENNAL LOBE

G.J. Laurent[1*]; M. Bazhenov[2]; M. Stopfer[1]; T.J. Sejnowski[2]

1. Div Biology 139-74, California Inst Tech, Pasadena, CA, USA
2. Computational Neurobiology Lab, Salk Institute, La Jolla, CA, USA

Intracellular and local field potential recordings in the locust antennal lobe (AL) have revealed stimulus-dependent changes in projection neurons (PNs) and local neurons (LNs) response patterns over repeated odor presentations (Stopfer and Laurent, 1999). The PNs responded with nonsynchronized bursts of spikes when a novel stimulus was presented. After 4-6 presentations, however, the PN response intensity decreased while spike time precision increased, leading to coherent oscillations. Here we tested with a computational model the hypothesis that initially weak inhibitory synapses between LNs and PNs are partially responsible for the absence of oscillatory responses to stimulation with novel odors. In our simulations, activity-driven facilitation of fast GABAergic synapses between LNs and PNs during repetitive stimulus presentations created a temporary network structure "tuned" specifically for the repeated stimulus, enabling coherent responses in the population of responding PNs. Using stimuli with added noise, we found that at the level of the AL, this fast learning enhanced the reliability of odor identification. A model network endowed with synaptic plasticity responded to a familiar stimulus with stereotypical spatio-temporal patterns from trial to trial despite random input fluctuations. A network without learning, however, responded with patterns that changed markedly between trials, reflecting input variability. Thus, fast odor learning could selectively improve the signal/noise ratio for responses to odorants encountered or sampled repeatedly.
Supported by: NIH and NIDCD

Citation:
G.J. Laurent, M. Bazhenov, M. Stopfer, T.J. Sejnowski. FAST ODOR LEARNING AND RELIABILITY OF ODOR RESPONSES IN THE LOCUST ANTENNAL LOBE Program No. 660.7. 2002 Abstract Viewer/Itinerary Planner. Washington, DC: Society for Neuroscience, 2002. Online.

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