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Characterizing oscillatory activity and spike timing in the AL of the moth Manduca sexta and their role in olfactory acuity.

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Studies of primary olfactory networks suggest that odor driven LFP oscillations play a general role in fine odor discrimination by synchronizing distributed outputs from this network on an oscillatory timescale. We find that odor driven oscillations are readily observable in Manduca sexta AL and can be characterized as spatially localized, strongly frequency modulating, GABA-$_A$- and odor-dependent. Interestingly vector strength measures indicate that spike phase locking is significantly greater during spontaneous activity, indicating an ongoing process. Behavior pharmacological studies establish that disruption of oscillatory activity with $GABA_A$ receptor antagonists generally disrupts discrimination as well as detection thresholds.

Wing beating in Manduca, causes a 20-30 Hz oscillating air flow around the antennae, which can periodically enhance odor/receptor interactions. Wing beating also physically distorts the antenna. When stimuli were pulsed at frequencies around the wing beat, AL unitary spiking patterns and LFP oscillations from antenna and AL, tracked olfactory and blank (mechano-sensory) stimuli with extraordinary fidelity. This ability to extrinsically drive periodic activity requires an intact animal; isolated head preparations produce tracking to only 10 Hz. These differences might be mediated by a single pair of histamine immunoreactive cells, which possess bilateral dendrites in the mesothoracic ganglia, where flight CPG's are located, and project bilaterally to the core of both ALs.

Preliminary extracellular results indicate that unitary pulse tracking is actually strongest for blanks and low volatility odors. Histamine bath application significantly increased pulse tracking. Intracellular results demonstrate that both local and projection neurons can track pulsed stimuli up to 40 Hz. Cutting the neck connectives, increases spiking from the connective and presumably transiently increasing AL histamine. This too resulted in enhanced pulse tracking. Finally, behavior pharmacological results indicate that injection of histamine antagonist's into the ALs increased detection thresholds. These preliminary results suggest that ascending input from mesothoracic ganglia may provide a mechanism to regulate olfactory sensitivity under conditions of flight.