Directional-dependent plasticity in neural and behavioral responses to air currents in the cricket

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Crickets perform the oriented walking behavior in response to air-current stimuli detected by cercal sensory system. Repetitive stimulation of unidirectional air-currents in a few seconds interval causes habituation in the behavioral response to that relevant direction. This habituation will involve temporal attenuation of the wind sensitivity in the identified giant interneurons (GIs), which directly receive synaptic inputs from mechanosensory afferents and trigger the wind-evoked behavior. The repetitive stimulation significantly reduced EPSPs in GIs, suggesting that the attenuation in GI's responses results from synaptic depression at the sensory-to-GI synapses. Effect of the repetitive stimulation on directional selectivity varied by the type of GIs. In GI 8-1, sensitivity to direction of the repetitive air-currents was more attenuated than that to the other directions, while the sensitivity to all stimulus directions was equally attenuated in GI 10-2. Further, we examined spatio-temporal patterns of the dendritic Ca^{2+} accumulation in GIs, which induces short-term depression at the sensory-to-GI synapses. The Ca^{2+} accumulation induced by repetitive air-currents elevated the peak of each Ca^{2+} transient in GI 10-2 but not alter the Ca^{2+} peak in GI 8-1. It is possible that difference in the Ca^{2+} accumulation pattern underlies directional-dependent attenuation of the response to the repetitive air-currents.