Neural mechanism for directional control of wind-evoked walking behavior in the cricket

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Cricket detects air current using cercal sensory system mediating its direction, and walks in the opposite direction from the stimulus source. However, time-course changes of walking direction and body-axis angle and neural mechanism for control of these parameters are not clarified. We developed a spherical treadmill system for high-speed monitoring of the locomotory parameters in the wind-evoked walking. In the initial response for several hundreds milliseconds, the walking direction and the body-axis angle correlated with the stimulus angle, but followed different rules in their relationships. Further, the stimulus with shorter duration (50 ms) induced directionally-controlled walking, but not yaw rotation for the body-axis changes. This observation suggests that the walking direction and the body-axis angle are regulated independently.

Next, we examined the walking response under the conditions that connective nerve cords containing ascending and descending axons were partially cutoff. Hemi-disconnection of the ascending pathways had little effects on directional dependency in response to the wind stimulus from intact side. However, if the descending signals from cephalic ganglia were unilaterally blocked, neither walking direction nor body-axis angle collated with the stimulus angle. The result demonstrates that the directional control in the wind-evoked walking behavior requires the descending signals from the brain.