Study on adaptability of a silkworm moth using a brain-machine hybrid system: Sensory feedback during odor triggered behavior

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Insects perform adaptive behavior according to changing environmental conditions using comparatively small brains. Because adaptability is generated through the relationship among brain, body and environment, it is necessary to examine how a brain works under these conditions.

To understand neural processing involved in adaptive behavior, we constructed a brain-machine hybrid system using motor signals related to the steering behavior of the male silkworm moth for controlling a two-wheeled mobile robot. Using this hybrid system, we could observe the programmed behavioral pattern and orientation toward a pheromone source. We also compared the orientation behavior of moths with that of the hybrid system at different pheromone stimulus frequencies. From these experiments, we concluded that we could reconstruct silkworm moth behavior on the hybrid system.

In this study, to examine adaptability, we recorded moths' compensatory responses to forcibly given movement on the hybrid system. Moths responded to given angular velocity to cancel the disturbance when visual information was available. Moreover, by changing the conversion rule to make behavior from motor signals, responses to the changes were observed under left and right motor gain biased conditions. We discuss the effect of these responses on the behavior triggered by a pheromone stimulus.