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Fruit flies use flight auto-stabilization to recover from aerial "stumbles" LEIF RISTROPH, ATTILA BERGOU, Cornell University, GUNNAR RISTROPH, Ascendant Engineering, KATHERINE COUMES, GORDON BERMAN, JOHN GUCKENHEIMER, Z. JANE WANG, ITAI COHEN, Cornell University — Just as manned flight was made possible by control mechanisms, the flapping-wing flight of animals also relies on strategies that ensure recovery from disturbances. Previous studies performed on tethered and dissected insects indicate that the sensory, neurological, and musculoskeletal systems play important roles in flight control. Such studies, however, have yet to produce an integrative model of flight stability since they do not incorporate the interaction of these systems with free-flight aerodynamics. Here, we directly investigate control and stability through the application of brief torques to free-flying fruit flies and measurement of their behavioral response. High-speed video and a new motion tracking method capture the aerial "stumble", and we discover that flies respond to gentle disturbances by accurately returning to their original orientation. This accurate and fast recovery motivates a feedback control model that includes the insect's ability to sense body rotations, process this information, and actuate the wing motions that generate corrective aerodynamic torque. Thus, as with modern fighter jets, the common fruit fly employs an auto-stabilization scheme that maintains its flight course and allows for navigation through complex aerial environments.

Itai Cohen
Cornell University

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