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Rock and Roll - How Do Flies Recover From Serial Stumbles? TSEVI BEATUS, Physics Dept. Cornell University, JOHN GUCKENHEIMER, Mathematics Department, Cornell University, ITAI COHEN, Physics Dept. Cornell University — Flying insects manage to maintain aerodynamic stability despite the facts that flapping flight is inherently unstable and that they are constantly subject to mechanical perturbations, such as gusts of wind. To maintain stability against such perturbations, insects rely on fast and robust flight control mechanisms, which are poorly understood. Here, we *directly* study flight control in the fruit fly *D. melanogaster* by applying mechanical perturbations in mid-air and measuring the insects' correction maneuvers. On each fly we glue a small magnet and use pulses of magnetic field to apply torque perturbations along the fly's roll axis. We then use high-speed filming and 3D reconstruction to characterize the kinematics of their correction maneuver and show how the flies fully recover from roll perturbations of up to 70° within 7-8 wing beats (30-40ms), which is faster than their visual response time. In addition, we study the dynamics of the maneuver by calculating the aerodynamic forces and torques the fly produces. Finally, we present a control mechanism that can explain the roll correction maneuver. These results have implications ranging from the neurobiological mechanisms that underlie flight control to the design of flapping robots.

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