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INSIDE JEB

Flies' halteres sense vertical acceleration

Time-lapse images of a fly with halteres falling vertically in a plastic box and taking off after the box reaches the ground. Photo credit: Noah DeFino and Alexandra Yarger.

Without the minute auxiliary wings, known as halteres, tucked behind their true wings, airborne flies are going nowhere. William Derham, clergyman and Fellow of the Royal Society, first described how the tiny dumbbell-shaped appendages whirl around over 300 years ago in his book 'Physico-theology', adding that insects that had lost the structures fall out of the air 'manifesting the defect of some very necessary part'. Fast-forwarding to today, we now understand that the halteres detect acceleration and tell flies how their bodies are twisting and turning during flight, but it wasn't clear whether the sensory structures could also sense gravity and alert the insects when they take a tumble.

Although flies have a plethora of additional senses that could warn them when they begin to pitch, Kathryn Daltorio and Jessica Fox from Case Western Reserve University, USA, wondered how flies that lack acceleration-sensing halteres would react as they fell. Would they cope as well as intact flies? Constructing a fly-sized fairground ride from a transparent Perspex box, a ball bearing and an electromagnet – to give grey flesh flies the experience of free fall when the electricity was switched off – the duo filmed the insects, first with halteres and then without, as they walked horizontally and vertically, and during a drop, to find out how they would react.

Not surprisingly, the flies that had halteres scuttled around at similar speeds regardless of whether they were on the flat or scaling a wall. However, the climbing insects slowed dramatically after the loss of their halteres (from 42 mm s^{-1} to 20 mm s^{-1}). In addition, when the duo compared the free-falling descents of the flies, it was clear that the insects that had lost their halteres were less well prepared. For example, the flies with halteres sometimes bent their legs, lifted their feet or even took off during the sudden descent. In contrast, the haltere-less flies rarely adjusted their limbs, often clung to the walls of the chamber and were 4.5 times slower unfurling their wings to take off after impact.

Wondering why flapping the halteres may be necessary, Daltorio and Fox compared the forces pulling on the gyrating and static sensory organs as the fly tumbled forward. Impressively, the force on the flapping halteres increased by 50% in just 0.0038 s – 20% faster than when the halteres were stationary – which should allow the insects to distinguish quickly between rotating tumbles and vertical falls.

Daltorio and Fox say, 'These calculations show that flies can use halteres to detect vertical accelerations whether they are moving or stationary', although they admit that the structures are just one of an arsenal of senses upon which the flies can depend when they unexpectedly lose their footing and gravity takes over.

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