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INSIDE JEB

How bumblebees mind the gap

A bumblebee approaching the gap in the first wall during flight experiments. Photo credit: Charlotte Doussot.

Lying on the ground, gazing through stalks of grass on a warm summer's day is the only way to truly appreciate the world from a bumblebee's perspective. As the intrepid foragers close in on tempting clover flowers they must negotiate a flight path cluttered with vegetation. 'Looking for a gap and assessing whether you can pass through is a fundamental step to traversing cluttered environments', says Sridhar Ravi from Royal Melbourne Institute of Technology, Australia. Intrigued by the bumblebee's ability to assess whether a gap is passable, Ravi and Martin Egelhaaf from Bielefeld University, Germany, set out to discover how bumblebees gauge the width of an opening so effectively.

'We wanted to uncover the most elemental aspects of locomotion through a cluttered environment', says Ravi, who built a 1.5 m long tunnel on a bee's scale for the insects to fly along, lined with randomly chequered wallpaper, so that they could keep track of how far and fast they had flown. Having previously investigated how bumblebees react to individual obstacles, Ravi, Tim Siesenop and Lea-Sophie Manz positioned a 5 cm wide gate 90 cm along the flight path, with a second randomly chequered wall located behind it – at distances ranging from 55 cm to tight against the gate – to see how the bees approached the aperture as the view through it altered. Filming and then analysing the bees' approaches with Olivier Bertrand, Charlotte Doussot and Alex Fisher, Ravi and Englehaaf realised that the insects flew at a consistent average speed of 0.7 m s^{-1} until they neared the aperture. Then, they began weaving to and fro, zig-zagging only once when the rear wall was distant. However, as the distance between the gate and rear wall narrowed, the approaching bees slowed more, in addition to weaving increasingly from side to side, with the bees that were faced with a blocked gate frantically zig-zagging from side to side until the team removed the obstruction, allowing them to pass.

Knowing that bees track the angle spanned by an object on the retina to estimate its size during an approach, the team realised that the insects began slowing when the gate spanned 35 deg of the insect's retina. They also suspect that the weaving insects assess the width of the gap by analysing how it moves relative to the rear obstacle to determine whether or not they can pass with ease. 'This is akin to us closing one of our eyes and moving our head sideways', says Ravi. In addition, as the distance between the gate and rear wall became increasingly narrow, the bees began zig-zagging to and fro faster to increase the apparent movement between the two, 'which is likely to give them higher confidence in their depth estimation', says Ravi. He also suspects that the insects are essentially 'hesitating' when they spend more time contemplating the most obstructed passages, to allow themselves time to assess whether they can negotiate a particularly tight manoeuvre safely.

'It's always surprising to witness the exceptional flying capacity of bees', says Ravi, who admits admiring the insect's precision and wants to learn more about the cues that bumblebees heed when minding the gap.

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