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Inside JEB

GYMNASTIC BATS TIP OR TWIST TO HANG

Picture by Daniel Riskin

Since they gave up walking routinely on four legs, bats' hind limbs have become very spindly. Which made Daniel Riskin wonder how the mammals' fragile-looking rear legs hold up as they get around. Having previously investigated the way that some bats walk on all fours, Riskin was curious to find out more about something that almost all bats do; land upside down to roost. 'This is something you don't normally see,' says Riskin. 'They fly past in a cave and suddenly they're on the ceiling. It's that fast,' he adds. Curious to find out how landing bats manoeuvre themselves into a hanging position, Riskin and his colleague John Ratcliffe travelled to Le Biodôme de Montréal, home of several bat species, to find out how *Artibeus jamaicensis* bats flip up to roost (p. 945).

Setting up a force plate in the corner of a ceiling to measure each landing bat's impact, Riskin and Ratcliffe filmed the animals as they tried to perch and saw that the bats somehow flipped their hind legs up, grabbing hold of the screen covering the force plate with their hind legs. But the force plate was too small and the film too grainy for Riskin to get clear measurements of the bats' manoeuvres. So when Riskin joined Sharon Swartz's lab, he built a larger force plate to use with three synchronized digital cameras to record bat landings at high speed.

Constructing a plastic lined enclosure with the force plate mounted at the highest point, Riskin encouraged tree dwelling dog faced fruit bats, *Cynopterus brachyotis*, to alight on the force plate as he filmed their landings. But something was wrong; instead of grasping hold with their rear legs, *Cynopterus* landed on all four. Replaying the slowed down movie, Riskin could see that the animals flew up vertically towards the force plate, before tipping backwards (until they were horizontal in the air on their backs), ready to grasp the netting covering the force plate with all four feet. Riskin admits that his first reaction was surprise. 'I thought they were doing it wrong,' he says, 'but then I realised: oh, it's a different bat'. And when he looked at the force plate recordings, he could see that the bats were really slamming into the force plate, impacting with forces ranging from 1.1 up to 10.5 times their own body weights.

Travelling down to Maryland to work with Cynthia Moss's leaf nosed bats, Riskin was able to test out two smaller, cave dwelling, species' landing techniques. Both *Carollia perspicillata* and *Glossophaga soricina* grasped hold of the force plate's netting with their hind feet. Like *Cynopterus*, they approached the roost site vertically, but then their technique deviated from that of the larger bats. Both *Carollia* and *Glossophaga* twisted their bodies so that they athletically lifted their feet up along one side of their body until the feet were above their heads and they could grab hold of the netting. Riskin also noticed that the animals' landings were significantly softer than those of *Cynopterus*, with the smaller bats registering forces up to twice their own body masses.

Riskin suspects that the differences between the three species' landing forces probably reflect their different life styles. 'If you smash into a leaf it's OK, but if you smash into a cave, that will hurt,' explains Riskin.

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Riskin, D. K., Bahlman, J. W., Hubel, T. Y., Ratcliffe, J. M., Kunz, T. H. and Swartz, S. M. (2009). Bats go head-under-heels: the biomechanics of landing on a ceiling. *J. Exp. Biol.* **212**, 945-953.

ANTS NEED LANDMARKS TO RETAIN NAVIGATION MEMORIES

Picture by Matthew Collett

When a forager ant sets out on her mission she's got three goals in mind; get food, do it quickly and don't die. According to father-and-son team, Thomas and Matthew Collett, ants rely on three navigation strategies for efficient foraging. First they keep a record of the route they travelled from the nest to a tasty treat, quickly calculating the most direct route when they return home. The ants also remember the size and location of the surrounding landmarks and use them to refine their trajectories. The third strategy only comes into effect as an ant becomes familiar with a route. Matthew Collett explains that if a route is composed of several sections, ants learn the direction and distance that they must go along each section to reach their goal. According to Collett, ants were already known to use this type of memory while homing, but it wasn't clear whether ants used it to return to a feeding site (p. 895).

Travelling to Tunisia, the duo set *Cataglyphis fortis* a navigation challenge. Clearing the barren landscape of vegetation around the nest, the Colletts surrounded the nest with an enclosure, which had one exit into a 10 m long channel. Placing a small tray between the exit and channel, the pair trained the ants to scamper across the tray and along the channel for 6 m before they took a sharp 90 deg. turn toward a feeder 6 m to the west. Once the ants had learned the route after leaving the channel, the Colletts tried foxing them by carefully carrying the ants on the tray and putting them down a few metres further along the channel. If the ants were undisturbed by their tray flight and they were using their route memories, they would carry on making their 90 deg. turn after leaving the channel, and head out to where the feeder should be: which is what they did. The ants appeared to be using a route memory.

But when the duo got down to the ants' level, they realised that the insects may still have been able to see two bushes 30 m away on their horizon. The crafty insects could still be using them to navigate by, so the Colletts grubbed the bushes up and retested the ants' accuracy.

Initially everything was fine. During the first day the ants turned successfully, after scampering along the channel, and headed west for 6 m. They were clearly using their memory of the direction and length of the route's final section. However, by the following day, many of the ants were losing their way, and the situation did not improve. They seemed to have lost their navigation memory. Matthew Collett remembers that it was immediately obvious that it had something to do with the grubbed up bushes. Maybe the landmarks were essential for the insects to retain their memory.

Placing two plastic tubes on the ground where the bushes had stood, the father–son team was delighted to see that the ants soon recovered their ability to locate the feeder. The landmarks were essential for the insects to both learn and hold on to their route memory. So ants are capable of learning familiar routes but they need some local landmarks to retain the memory.

10.1242/jeb.031005

Collett, M. and Collett, T. S. (2009). The learning and maintenance of local vectors in desert ant navigation. *J. Exp. Biol.* **212**, 895-900.

BEES' ROLES AFFECT THEIR MEMORIES

Picture by Sandra Brandt

Failing memory is one of the most distressing symptoms of old age. We forget things and learning new tasks becomes difficult. But we are not the only species to suffer such problems; ageing fruitflies, zebrafish and worms also lose the ability to learn and retain memories. Yet bees take on new responsibilities in the hive as they age, graduating from tending the brood when young to foraging during their last few weeks. It seems that older bees can learn new tricks, which made Ricarda Scheiner and Gro Amdam wonder how bees' memories fare, but not with age alone: as the insects' roles change. They wondered how foragers' memories compared with nurses', but to find out they'd have to compare insects of the same age. Fortunately, Scheiner explains that it is possible to trick some young bees into taking foraging roles, even though they are the same age as nurses, so Scheiner and Amdam decided to test identically aged foragers and nurses to find out how their roles affect their memories (p. 994).

Despite working in the heart of Berlin, Scheiner has no problems keeping her bees happy. 'Berlin is a very green city,' she says, 'the city's bee keepers get 20% more honey from their hives than bee keepers in the surrounding countryside'. Taking brood combs from her city centre hives, Scheiner collected young bees each day, as they emerged from the brood combs, and installed them in separate mini-hives to found new communities where all of the inhabitants had identical ages. Supplying each new nest with a queen, some honey, pollen and brood, the youngsters soon coalesced into a new community and establish their roles. Scheiner was ready to test the insect's memories.

Focusing on the insects' abilities to learn new tasks, Scheiner trained the insects to extend their proboscises whenever they stroked their antennae across a metal grating engraved with a specific pattern. Comparing nurses with young foragers that had been gathering food for less than 13 days, the two groups seemed to learn the task equally well with 63% of the nurses and 73% of the recently fledged foragers learning the task. However, the longer-term foragers, who had been out foraging for at least 15 days, didn't learn as well. Only 46% of the veterans learned the task, compared with 73% of nurses of the same age. Scheiner suspects that the veteran foragers' brains had deteriorated significantly compared with their nurse nest mates who had never left the nest. So the length of time that a bee has been foraging has a big impact on her ability to learn new tricks.

However, when Scheiner tested the insects' long-term memories, she was in for a surprise. Comparing the experienced and less experienced foragers' memories with nurse bees of the same age, there was no difference between the foragers' and nurses' abilities to remember to stick out their tongues. Their memories were equally good. Even more surprisingly, by the time 3 days had passed the veteran foragers' memories were better than the nurses' and younger foragers'. Even though the veterans found it more difficult to learn, they retained the memory better than the young foragers.

Having found that a bee's role has a big impact on its brain function, Scheiner is keen to understand the differences between veteran foragers' and nurses' brains with the hope of one day understanding more about the mechanisms of memory loss in ageing human populations.

10.1242/jeb.031021

Scheiner, R. and Amdam, G. V. (2009). Impaired tactile learning is related to social role in honeybees. *J. Exp. Biol.* **212**, 994-1002.

BATS SCAN SCENES SEQUENTIALLY

Eyes aren't much use when you hunt at night and hole up in caves during the day: it's too dark to see. So many bat species have opted for echolocation to perceive their environment, squeaking and interpreting the returning echoes. While some bats produce narrow beams of sound that focus on individual obstacles, many produce a wide beam that could result in 'cascades of echoes, arriving from different directions,' explains Cynthia Moss from the University of Maryland. Moss wondered whether bats emitting wide beams of sound interpret all of the returning echoes simultaneously to sense their surroundings, or focus the centre of the echolocating beam briefly on every feature in the environment, to build up the picture sequentially (p. 1011).

Moss, Annemarie Surlykke and Kaushik Ghose filmed and recorded the bats' echolocation calls as they flew through a gap in a mist net to capture a mealworm tethered on the other side. Analysing the position of each bat's beam of sound, it was clear that the approaching animals were investigating the lay of the land sequentially. First they focused the centre of their beam on one edge of the gap and then turned their attention to the second edge before focusing on the tasty treat beyond. The bats were scanning the scene sequentially, rather than 'viewing' it all simultaneously, even though the beam of sound was wide enough to capture all of the features simultaneously. The team explain that this is similar to the way that we scan objects with our eyes and may give the bats a more accurate picture of their surroundings.

10.1242/jeb.031039

Surlykke, A., Ghose, K. and Moss, C. F. (2009). Acoustic scanning of natural scenes by echolocation in the big brown bat, *Eptesicus fuscus*. *J. Exp. Biol.* **212**, 1011-1020.

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