

Magnetic Bees

Each honeybee hive produces about 29 kg of honey per year. To help them make this honey, the bees talk to each other - and just recently, some scientists have learnt to **speak** this language!

The story begins back in 1923, when Karl von Frisch from the University of Munich in Germany, published his first paper on the language of the honeybees. He reckoned that they "spoke" with each other by dancing the dance!

Suppose a honeybee has found a flower bed rich in nectar and pollen. She flies back, into the hive, and tells her fellow workers about the flowers - by dancing.

If the flowers are within 100 metres of the hive, she flies in circles. Soon, her fellow workers leave the hive, and fly in ever-enlarging circles until they find the flowers.

But if the flowers are further away (up to 3 kilometres away), she dances a different dance inside the nest. She flies in a straight line, while wagging her rear end, and then flies a curved line to the beginning of the straight line, and does it all again. If her straight line points vertically up, then the other bees leave the nest, and fly in the direction of the Sun. And if the straight line points 60° to the right of vertical, the other bees fly in a direction 60° to the right of the Sun. And the speed of her wagging bottom tells the other bees the distance to the flowers - the faster the waggle, the closer the food!

Karl von Frisch received a Nobel Prize for this theory in 1973. But his theory didn't go far enough. Most beehives are pretty dark inside, and like us, honeybees can't see very well in the dark. So how can they see each other do the dance?

In the 60s, other scientists discovered that dancing honeybees emitted a sound from their wings, vibrating at 220 beats per second. They were singing a song with their wings. And honeybees do have a sort-of-ear on the second joint of their antennae. It seemed reasonable that bees could hear this song, but how do you **prove it**?

In the late 80s, Wolfgang H. Kirchner and William F. Towne proved it with a robot honeybee. It had razor blades for wings, and tiny computer-controlled motors to make it dance. It could sing the song with its razor blade wings, and dance the dance via its electric motors.

A real honeybees would ignore their robot razor blade honeybee, if it just danced the dance, **or** just sang the song. But when it did **both** the song **and** the dance, the real honeybee would obey it. The scientists could actually talk to the animals! They could get their robot honeybee to send the real honeybees out of the nest in any direction they wanted!

So by using a song-and-dance routine, the bees can tell each other the best place to eat out.

But once they've picked up their nectar and pollen, how do they find their way back to the hive? Honeybees have another trick - tiny compasses, in their tummies, that sense the Earth's magnetic field.

Now under the right conditions, magnetic fields can effect humans. Susan Blackmore wrote about her experiences in the New Scientist, after a neuroscientist had blasted her brain with intense magnetic fields in his laboratory.

She felt nothing for the first ten minutes. Then, even though she knew that she was reclining perfectly still in a chair, she felt as though she was swaying on a hammock. Almost immediately afterwards, even though she knew that there was nobody near her, she could feel "two hands grabbing her shoulders and pulling her upwards." As the magnetic fields continued to act on her brain, she could "feel" something grab one of her legs and try to pull it up the wall - although her eyes told her nothing was happening!

And then the magnetic fields began to act on her emotions. She suddenly felt very angry - but she didn't know what she was angry about, nor at whom she was **angry**. This anger lasted only 10 seconds, but as it faded, she was suddenly beset with a very intense attack of fear. Again, she was not scared of anyone or anything, but she was very afraid.

Now the human brain is very complicated, and we don't know why intense magnetic fields can cause such dramatic changes. But we do have a better idea of what's going on in honeybees.

There are a few different types of magnetic materials. One is a type of iron oxide called magnetite, which is naturally magnetic, and we know that lots of creatures have tiny magnets of magnetite in their bodies.

But there's another type of iron oxide which is paramagnetic. Paramagnetic materials are themselves not magnetic, but, they are pulled by magnetic fields. So a non-magnetic paper clip made of soft iron is actually paramagnetic, because it can be pulled by a magnet.

According to doctors Hsu and Li of the National Tsing Hua University in Taiwan, honeybees have tiny paramagnetic particles in their bodies. These paramagnetic particles are inside cells inside the bees' tummy. Depending on whether they are lined up side-by-side, or end-to-end, these paramagnetic particles can, as the external magnetic field changes, swell or shrink. But, these paramagnetic particles are attached to the "walls" of the cells that they are in, so as the paramagnetic particles change shape, so do the cell walls. And nerves, attached to the outside of these cells, carry signals up to the honeybee's brain.

So the magnetic cells in the bees tummy are like tiny onboard compasses. This is the first time scientists have actually followed the "line of information" in a living animal, from the magnets to its brain.

Now honeybees are told how to leave the nest and where to go by the buzzing wings and wagging dance of another honeybee. And, by using the paramagnetic particles of iron oxide, these honey bees can avoid getting lost on the way home, and iron out their problems with a little magnetic navigation.

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