

home over the sea, even flying at night or in fog. Despite a century of effort, no scientific experiment has thrown any light on how they do it

miracle of the bird brain

Clearly, these remarkable homing abilities are closely related to migrations from one home to another. In many cases such as that of British swallows, migration is a double homing system. They migrate in the autumn to their winter home in eastern parts of South Africa (where it is spring) and return to Britain in the Northern spring.

More amazing still is the instinctive ability of young birds to home to their ancestral winter quarters for the first time without the need to be guided by birds that have done it before. For instance, European cuckoos, raised by birds of other species, do not know their parents. In any case, the parent cuckoos leave in July or August for southern Africa, about a month before the new generation is ready to go. In due course the young cuckoos congregate and migrate in flocks to their African home to join their elders.

How do migrating animals know where to go? In the case of migrant birds, the most popular hypothesis is that they orientate by the stars, and perhaps are also exquisitely sensitive to the Earth's magnetic field. They are also supposed to have an inborn

program, complete with star map and maybe also a magnetic map. In the scientific literature this is called an "inherited spatio-temporal vector-navigation program".

But little is really understood. This impressive sounding technical term merely restates the problem, rather than solving it.

Numerous experiments on homing have already been carried out with pigeons. Nevertheless, after nearly a century of dedicated but frustrating research, no one knows how pigeons home and all attempts to explain their navigational ability in terms of known senses and physical forces have so far proved unsuccessful.

Charles Darwin proposed a hypothesis of pigeon homing by a kind of "dead reckoning", registering all the twists and turns of the outward journey, even when enclosed in a box. J. J. Murphy proposed a mechanical analogy in terms of a ball hanging from the roof of a railway carriage, reacting to shocks given to it by changes in the carriage's direction and velocity.

But in 1803 S. Exner showed

that pigeons could still home perfectly well after being transported to the release site under heavy anaesthetic. More recent experiments with other species, such as herring gulls, have confirmed Exner's findings. Nor does taking the pigeons to the point of release by complex and devious routes make them lose their way. They can even home after being transported in a large, light-proof rotating drum.

In any case, if the birds were to sense and integrate all the twists and turns of the journey, the appropriate organ would be the semi-circular canals in the middle ear, which detect accelerations and rotations. The total destruction of this organ stops birds flying properly, but in experiments involving the surgical cutting of the horizontal canals, the pigeons still homed normally after being taken more than 200 miles away.

It is sometimes suggested that homing depends on familiar landmarks. This is probably the case when the pigeons are released a few miles from the loft, and also when they home repeatedly over the same terrain. But pigeons can home from completely unfamiliar places, hundreds of

miles from anywhere they have been before. After flying around in circles on their release, or even without circling, they generally set off in a homeward direction. They can also home over the sea, even flying at night or in fog, as in the spectacular performances of some of the pigeons used by the Royal Air Force in the Second World War.

Many other theories to explain homing have been advanced. They range from dependence on smell to the pigeon's use of an exquisitely sensitive magnetic sense which not only enables them to detect compass directions but also sense changes in the Earth's magnetic field. But all these hypotheses have been shown to be false.

Perhaps we should be investigating a hitherto unknown "sense of direction" with possible links to "extra-sensory perception" or ESP. I propose that the sense of direction of homing pigeons depends on something rather like an invisible elastic band connecting them to their home, and drawing them back towards it. When they are taken away, this band is stretched. If on their return flight they overshoot their home, this connection pulls them back again.

I do not know how this interconnection might work. It might be related to the non-local connections implied by modern quantum physics.

To attempt to unravel the mystery I propose an experiment with a mobile pigeon loft. If pigeons can find the mobile loft repeatedly, rapidly, over long distances, in arbitrary directions and when the

(eliminating any possibility of smelling its direction) this would show that there is a direct connection between the pigeons and their home.

When the pigeons are used to homing to the mobile loft over a particular area, it can be moved further and further. The further it is moved, the more interesting the results will be. If pigeons can indeed find their homes and their companions after the loft has been moved far away, then a series of strange but persistent stories about pets will be seen in a new light.

On the other hand, if the pigeons cannot find the mobile loft, the outcome would unfortunately be inconclusive.

It could mean there is no invisible connection between the pigeons and their home. Or it could mean that there is a connection to the home but moving the loft alone is not enough. More of the home environment might need to be transported, for example by mounting the loft on a ship.

There is much to discover, but the vital point is that in the case of pets that know when their owners are coming home, and of pets that find their owners, and of pigeons that find their lofts, and of homing behaviour in general, and of migration, appropriate explanations may lie beyond the current limits of science.

● *Extracted from Seven Experiments That Could Change the World by Rupert Sheldrake, Fourth Estate, £15.99. A review will be published in Weekend on Saturday.*