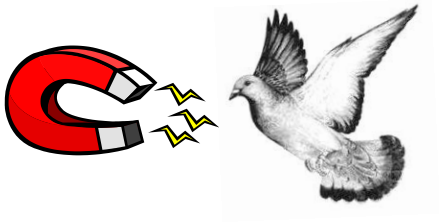
ScienceWatch – The Magnetic Sense of Pigeons



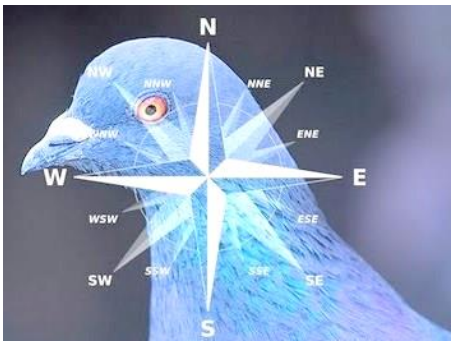
"The brain cells signal the direction, intensity, and polarity of the earth's magnetic field. These signals could be used like a GPS." – J. David Dickman

Scientists have long known that migrating birds use earth's magnetic field to navigate, and since homing pigeons (*Columbia livia*) are renowned for their navigating ability, they have been a favorite subject for studying magnetosensation. But exactly how they sense and process magnetic field information has remained a vexing mystery.

In 2007 scientists discovered iron-rich cells in the skin surrounding the upper beak of homing pigeons and thought they had found the magnetic receptors the birds use (http://hras.org/sw/swsept07.html). However, in 2012 it was proven that the "receptors" are really white blood cells that remove old red blood cells and collect the iron from hemoglobin. Adding to the frustration, different investigators found different areas of the central nervous system that appeared to respond to magnetic fields, and no one could provide clear-cut evidence for a region in the brain or spinal cord where magnetic signals were processed.

Now a study in the April 26, 2012 issue of *Sciencexpress* does just that. Le-Quin Wu and J. David Dickman, neuroscientists at Baylor College of Medicine, Houston, TX, have identified nerve cells in the pigeon brainstem that register detailed information on the earth's magnetic field.

Earlier work by these two investigators indicated that the vestibular brainstem region, which receives signals from the inner ear, was the processing center for magnetoreception. So they focused on that part of the central nervous system.



Seven pigeons were kept in the dark with their heads in a fixed position. The pigeons had been genetically manipulated so that a visible marker was produced in each brain cell when it was activated. This allowed the investigators to delineate where in the pigeon's brain magnetic field information is processed.

Each pigeon was exposed to a strong rotating magnetic field in the intensity range naturally produced by the earth's magnetic field. As the strength and direction of the field was varied, the scientists found close to 100 nerve cells in the vestibular brainstem responding to changes in the applied magnetic field. While all the cells were activated by the magnetic field, different cells responded with greater intensities as the field was rotated around the birds' heads.

These results show that different cells in the pigeon brainstem respond as the direction of the magnetic field is changed. According to the authors, "We have shown that single vestibular brainstem neurons encode the direction, intensity, and polarity of an applied magnetic field." Now that they know the processing neurons are located in the vestibular brainstem, Wu and Dickman say it is likely that the not-yet-found magnetoreceptive cells reside in the pigeon's inner ear.

Once the information on position is registered in the brainstem the bird has to compare it with a map stored somewhere in its brain (http://hras.org/sw/swjan10.htm). Dickman says the hippocampus, a brain region involved in remembering locations, is a likely candidate.

Pigeons are not so dumb after all.

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