Sharp-eyed robins can see magnetic fields

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A Robin Wearing Goggles

(PhysOrg.com) -- It has been known for decades that some birds are able to sense the Earth's magnetic field and set their direction as if following a compass heading, which is an extremely useful ability for birds migrating long distances. The ability is believed to be linked to the availability of light and it is thought that specialized molecules in the birds' retinas allow them to literally see the magnetic fields, which appear as patterns of light and shade superimposed over the regular image from light. Now a new study shows that the internal compass also depends on the birds having clear vision in their right eyes.

Researchers led by Katrin Stapput of Goethe-Universitat in Frankfurt, Germany, studied the vision of the European robin to try to learn more about how the magnetic sensing might work. They found that if the right eye was covered by a frosted goggle, the birds could not navigate effectively, while they could navigate perfectly well if the left eye was covered instead.

Numerous studies have been carried out on the ability of birds to sense magnetic fields since the phenomenon was first discovered in 1968 in the European robin. These studies had already revealed that the sense depends on light and that it involves the right eye and the left side of the brain, but the details were still unclear.

The most likely molecules involved in the sensing of magnetic fields are thought to be cryptochrome and flavin adenine dinucleotide (FAD), which are found in the light-sensitive cells in the retina. When struck by blue light, cryptochrome and FAD both shift into an active state in which each molecule has an unpaired electron, creating a “radical pair.” The presence of magnetic fields affects the time it takes for the radical pair molecules to revert to their inactive state.

Cryptochrome also affects the light sensitivity of retinal cells, which suggests it may also affect sensitivity to magnetic fields. In effect, the magnetic fields create light or dark shadings over what the bird usually sees, and the shadings change as the bird turns its head, giving it a visual compass from the patterns of shading.

Stapput decided to test the theories by fitting robins with goggles that were covered with clear foil on one side and frosted foil on the other. Both sides of the goggles were equally translucent, allowing 70 percent of the light to get through, but on the frosted side the image was less clear. The birds were then kept in cages until it was time for them to migrate.

The birds were released into a funnel-shaped cage with its walls painted with correction fluid, which was scratched if the birds touched them. The results were that birds with no eye coverings, and birds with the left eye covered set off in a northerly direction as expected, while those with the right eye covered were disoriented and headed in random directions.

Stapput's experiment is the first to show that magnetic sensing does not just depend on light being present as previously thought, but that the bird must have a sharp, focused image in its right eye. The magnetic sensing is overlaid over the normal vision, and if that is distorted, Stapput said the patterns of light and dark would make little sense since the bird cannot separate the information from the visual and magnetic images. The visual and magnetic images both involve variations in light and shade, but visual images tend to have sharp lines and edges, while the magnetic images have more gradual changes from light to dark.

The experiments lend support to the radical pair hypothesis but do not rule out another explanation.

More information: Magnetoreception of Directional Information in Birds Requires Nondegraded Vision, Katrin Stapput et al., *Current Biology*, doi:10.1016/j.cub.2010.05.070