Humans Could Have Geomagnetic Sight

By Brandon
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The ability to see Earth's magnetic field, thought to be restricted to sea turtles and swallows and other long-distance animal navigators, may also reside in human eyes.

Tests of cryptochrome 2, a key protein component of geomagnetic perception, found that its human version restored geomagnetic orientation in cryptochrome-deficient fruit flies.

Flies are a long, long way from people, but that the protein worked at all is impressive. There's also a whole lot of it in our eyes.

"Could humans have this cryptochrome heavily expressed in the retina as a light-sensitive magnetoreceptor?" said University of Massachusetts neuroscientist Steven Reppert, lead author of a June 21 *Nature Communications* cryptochrome study. "We don't know if the molecule will do this in the human retina, but this suggests the possibility."

Reppert, whose laboratory specializes in the biological mechanisms underlying long-distance butterfly migration, showed three years ago that cryptochrome allowed fruit flies to geomagnetically orient themselves using light.

Before then, cryptochrome's navigational role was a matter of inference and proposition. Since then, researchers have described how cryptochrome seems to be a quantum compass that detects infinitesimally subtle, geomagnetically-induced variations in the spin of electrons struck by photons. From those variations, animals seem able to determine their orientation in relation to Earth's magnetic field.

Many gaps still remain in cryptochrome theory, but it's generally thought that the cryptochrome system may be active across the animal kingdom, from fish to reptiles to birds. Humans, however, were thought to be an exception. Our own cryptochrome is considered a piece of circadian machinery, part of our molecular clock rather than any optical compass.

The new study, however, suggests that cryptochrome may be more than a clock. Seeking to test how a vertebrate cryptochrome would work in fruit flies, Reppert decided to use the human version. His team engineered flies to be cryptochrome-deficient: They struggled to orient within a magnetically-charged maze. When the researchers spliced human cryptochrome into the flies, they again found their bearings.

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"This is a very exciting paper," said Klaus Schulten, a University of Illinois at Urbana-Champaign biophysicist and cryptochrome research pioneer who was not involved in the new study. According to Schulten, the findings add even more support for the general role of cryptochrome in vertebrates, and of course raise questions about cryptochrome's role in people.

"We can't show that it will do the same in humans, but it sure restored geomagnetic sight in the flies," said Reppert.

Whether humans can sense geomagnetism is somewhat controversial. In the 1980s, research by British zoologist Robin Baker suggested that humans have a magnetic sense, but the findings proved difficult to replicate. More recently, however, work by German researchers hints at geomagnetic effects on vision.

Whether any of this is linked to high levels of cryptochrome in human eyes — and, if so, whether that quantum compass system still works for us — is completely speculative, but it's speculation that Reppert welcomes. "It's perfectly reasonable to think that humans have a magnetosensing response," he said. "Maybe we've been looking at it in a way that's not been fruitful in the past."

Schulten, however, thinks evolution might have traded geomagnetic orientation for longevity. His own research suggests that the cryptochrome compass needs superoxide, a type of free radical oxygen molecule, to work. Free radicals tend to destroy DNA. That's fine for a relatively short-lived animal, but not for one that intends to live for decades.

Nevertheless, said Schulten, "it might be that we humans, along with many other animals, might have been capable a long, long time ago of orienting ourselves."

Reppert himself is now concentrating on how brains read their cryptochrome compass. "At the most fundamental level, we're interested in how cryptochrome information is transferred to the nervous system," he said. "Nobody knows how that occurs."

Top image: GaelG, Flickr.

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Citation: "Human cryptochrome exhibits light-dependent magnetosensitivity." By Lauren E. Foley, Robert J. Gegear, & Steven M. Reppert. Nature Communications, June 21, 2011.