Bird brains can flick switch to perceive Earth's magnetic field

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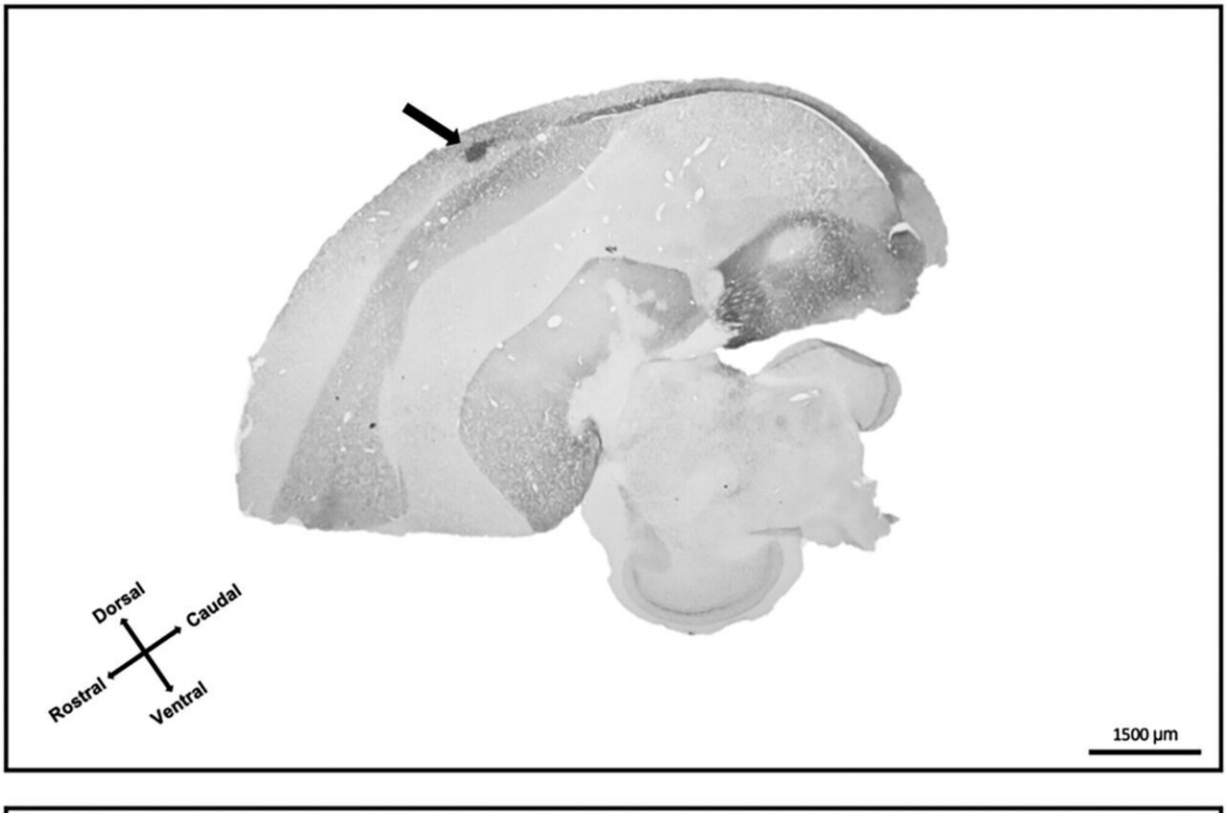

Top panel: photomicrograph of a representative GluR-1-labeled brain section from cohort 2. The black arrow indicates the DNH (dorsal nucleus of the hyperpallium), which is a neurochemical landmark used to localize Cluster N. Scale bar, 1.5 mm. Bottom panel: line drawing of a brain section showing sampling boxes for counting ZENK-labeled neurons from the Cluster N images. The outlined shaded area indicates Cluster N's location. The dark ellipse indicates the location of the DNH. Boxes indicate fields of view for which we took photomicrographs to quantify ZENK immunoreactivity. Scale bar, 1.5 mm.

Credit: *European Journal of Neuroscience* (2023). DOI: 10.1111/ejn.15995

Earth's magnetic field, generated by the flow of molten iron in the planet's inner core, extends out into space and protects us from cosmic radiation emitted by the sun. It is also remarkably used by animals like salmon, sea turtles and migratory birds for navigation.

But how? And why? A new study from researchers at Western's Advanced Facility for Avian Research (AFAR), home to the world's first hypobaric climatic wind tunnel for bird flight, explores a brain region called cluster N that migratory birds use to perceive Earth's magnetic field. The team has discovered the region is activated very flexibly, meaning these birds have an ability to process, or ignore, geomagnetic information, just as you may attend to music when you are interested or tune it out when you are not.

The findings were published in the *European Journal of Neuroscience*.

Specifically, the research team led by psychology Ph.D. candidate Madeleine Brodbeck and AFAR co-director Scott MacDougall-Shackleton studied white-throated sparrows and found they were able to activate cluster N at night when they were motivated to migrate (to avoid prey and fly during cooler periods) and make it go dormant when they were resting at a stopover site.

This is the first demonstration of this brain region functioning in a North American bird species, as all prior research in this area was completed in Europe.

"This brain region is super important for activating the geomagnetic compass, especially for songbirds when they migrate at night," said

Brodbeck. "Almost all previous work on this specific brain function was done at one lab in Europe, so it was great to replicate it in a North American bird like the white-throated sparrow."

Earth's magnetic field, likely first investigated and identified by German mathematician Carl Friedrich Gauss in the 1830s, has long fascinated physicists, aerospace engineers and even science fiction writers like Frank Herbert and Stephen King. Brodbeck, a bird psychologist, is equally intrigued.

"Magnetic fields are really fun to think about because they're invisible to humans. We can't see them or sense them, but most animals perceive them in some way," said Brodbeck. "For birds, using Earth's magnetic field to know if they're going towards a pole or towards the equator is obviously really helpful for orientation and migration. It's incredible that they can activate their brain in this way, and we can't."

Understanding the physical mechanisms of how animals make their way around in the world is a fundamentally important question for researchers, says MacDougall-Shackleton, a psychology professor and cognitive neuroscientist.

"If we want to understand bird migration or how other animals move from one place to another, we need to know how they do it. And more importantly, we need to know what we're doing, as humans, that might influence them," said MacDougall-Shackleton.

"Birds don't just use their magnetic compass. We know they pay attention to the sun and the stars as cues too. And we also know that things like lights at night, or windows in buildings, and all these things that we put in the world disrupt their migrations," said MacDougall-Shackleton. "This type of basic research informs us and lets us know the full suite of ways that animals perceive the world when they're migrating

and what we as humans need to do to minimize our impact."

More information: Madeleine I. R. Brodbeck et al, Neuronal activation in the geomagnetic responsive region Cluster N covaries with nocturnal migratory restlessness in white-throated sparrows (Zonotrichia albicollis), *European Journal of Neuroscience* (2023). DOI: 10.1111/ejn.15995

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