Migratory Songbirds Have a Specialized Night-Vision Brain Area

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Research shows special molecules help the birds navigate at night

Neurobiologists have discovered a specialized night-vision brain area in night-migratory songbirds. They believe the area might enable the birds to navigate by the stars, and to visually detect the earth's magnetic field through photoreceptor molecules, whose light-sensitivity is modulated by the field.

The researchers published their findings May 23, 2005, in the early online edition of the *Proceedings of the National Academy of Sciences*. The collaboration was led by Henrik Mouritsen of the University of Oldenberg in Germany and Erich Jarvis of the Duke University Medical Center. Other co-authors were Gesa Feenders and Miriam Liedvogel in Mouritsen's laboratory and Kazuhiro Wada in Jarvis's laboratory. The research was supported by the VolkswagenStiftung to Mouritsen and the National Science Foundation's Waterman Award to Jarvis.

To migrate successfully over thousands of miles at night, night-migratory birds need to see where they fly, as well as navigate by stars and the earth's magnetic field. Surprisingly, Jarvis said, recent scientific evidence has suggested that birds have specialized molecules in their visual system that translate magnetic compass information into visual patterns. Thus, , the researchers hypothesized that night migratory birds would need a specialized night-vision brain area.

"There was no evidence of such a specialized region in night migratory birds before we began this research," Jarvis said.

In their study, the researchers compared two species of night-migratory songbirds -- garden warblers and European robins -- with two non-migratory songbirds -- zebra finches and canaries. Using a transparent cylindrical cage in Mouritsen's laboratory, they first accustomed the birds to the illumination equivalent of moonlight. They waited until the birds were sitting quietly to eliminate brain activity from movement. The researchers then quickly preserved the birds' brains, and in Jarvis's laboratory analyzed the brain structures for the active expression of two genes called ZENK and c-fos that signal activity in a particular brain region.

The researchers found that the night-migratory species showed strikingly high activity in a particular cluster of cells located adjacent to a known visual pathway. According to Jarvis, what excited the researchers was that the area, which they named Cluster N, was not active in the migratory birds during the daytime. Furthermore, non-migratory songbirds did not show strong activation in the Cluster N even under moonlight conditions.

To determine whether the brain cluster is really specialized for night-vision, the researchers performed the same gene expression analysis on the night-migratory songbird species with the birds' eyes covered. The researchers found that blocking night-time vision dramatically reduced gene activity in cluster N.

"This result confirmed that night-migratory birds seem to have a brain area specifically adapted for seeing during their night-time flight," Jarvis said. The researchers suspect that the newly discovered brain region could be involved in processing and integrating light-dependent magnetic compass information and star compass information; and thus may be responsible for the impressive navigational abilities of birds migrating during the night. In future studies, Jarvis, Mouritsen and their colleagues plan to test this hypothesis in more detail, they said.

Source: Duke University