Do homing pigeons navigate with gyroscope in brain?

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Feral Pigeon (Columba livia domestica) in flight. Credit: Alan D. Wilson/Wikipedia.

No one knows how homing pigeons do it, but now a team of Swiss and South African scientists have discovered that the bird's navigation is affected by disturbances in gravity, suggesting that they navigate using a gravity map and that they may carry an internal gyroscope to guide them home.

Human communication has long been associated with an unlikely companion, the homing pigeon; but how these pigeons find their way home is still largely a mystery. 'There is widespread agreement that pigeons are able to determine and maintain flight (compass) directions based on solar and magnetic cues,' says Hans-Peter Lipp from the University of Zurich, Switzerland, and Kwazulu-Natal University, South

Africa. However, another piece of the puzzle - how the bird determines its position, known as the map sense - was unclear. Dissatisfied with the current theories - that pigeons navigate via an odour or geomagnetic map - and after decades of direct experience of working with pigeons in the Swiss Army, Lipp was intrigued when he encountered Valeryi Kanevskyi from the High-Technologies Institute, Ukraine. 'Valeryi had formulated a simplistic yet astonishing theory,' recalls Lipp. The Ukrainian had suggested that the birds could use their memory of the gravity field at their home loft for guidance. 'I realised that he had solved the map problem by one simple assumption: birds must have a gyroscope in their brain,' says Lipp. Lipp, Kanevskyi and their team publish their discovery that homing pigeons are affected by disturbances in the gravity field in *The Journal of Experimental Biology* and suggest that the birds navigate using an internal gyroscope to guide themselves home.

First the team needed to show that gravity anomalies - without geomagnetic contamination - would mislead pigeons and, fortunately, Kanevskyi and Vladimir Entin knew of just such a location in the Ukraine: a massive circular meteorite crater filled with sediment where gravity was weaker than usual. The team wondered whether crossing the edge of the crater could disrupt a pigeon's gyroscope navigation system and send the birds off in the wrong direction. Lipp and Nicole Blaser were also lucky to find a family of pigeon fanciers - the Widergolds - in the nearby town of Novoukrainka, Ukraine, who could train the birds. Then, over a series of days the duo released 26 of the trained birds, each equipped with a light-weight GPS tracker, from the middle of the crater and waited anxiously for their return.

Of the 18 pigeons that made it home successfully, seven birds struck out in the correct direction and managed to cross the edge of the crater without deviating much from the bee-line home. However, other birds that set off in more random directions seemed to become disorientated at the edge of the crater. And when the birds crossed a second gravity

disturbance, they also lost their bearing, setting new ones that split off in three different directions. Sergei Guskov and David Wolfer then compared the flight paths of the birds that encountered the gravity distortions with birds that had an unhindered return home and found that the disturbed birds' routes were much more widely dispersed than the unhindered groups and showed that the birds veered off most severely when they crossed the edge of the meteorite impact.

The team suggests that the birds initially set a bearing home by comparing their home gyroscope setting with their local gyroscope reading. However, some birds initially set the wrong bearing, often taking several days to correct the error and return home, suggesting that they rarely use the alternative navigation strategy of regularly checking the difference between their actual and anticipated return routes.

So it seems that perception of gravity plays a major role in guiding pigeons home and Lipp is keen to find out more about the cellular mechanisms that allow the birds to detect the weak gravitational forces that keep them on the straight and narrow.

More information: Blaser, N., Guskov, S. I., Entin, V. A., Wolfer, D. P., Kanevskyi, V. A. and Lipp, H.-P. (2014). Gravity anomalies without geomagnetic disturbances interfere with pigeon homing - a GPS tracking study. *J. Exp. Biol.* 217, 4057-4067.
jeb.biologists.org/content/217/22/4057.abstract

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