In a recent paper, we showed that domestic chickens can be trained to search for a social stimulus in specific magnetic directions. Chickens can hardly fly and have only small home ranges, hence their having a functional magnetic compass may seem rather surprising. Yet considering the natural habitat of their ancestors and their lifestyle until recently, the advantages of a magnetic compass become evident.

In a recent paper, we reported that young domestic chickens, *Gallus gallus domesticus*, can use their magnetic compass to find a hidden social stimulus from day 8 after hatching onward. This finding raises the question: Why do birds like chickens have a magnetic compass at all?

When the avian magnetic compass was first discovered in European Robins, *Erithacus rubecula*, its biological significance seemed evident: robins are migrants and use their magnetic compass to orient their migratory flights. The same was true for several other avian species that were shown to have a magnetic compass (for a list, see 3). The first avian non-migrant that was demonstrated to have a magnetic compass was the homing pigeon, *Columba livia f. domestica*, but here, too, one might argue that these birds home over long distances and hence might need a magnetic compass. But for what reason do domestic chickens, birds that are barely able to fly, using their wings mainly to fly up perches or trees for security at night, and that have only a rather small home range, need a magnetic compass?

The magnetic compass of domestic chickens was demonstrated in directional training experiments with young chickens that had been imprinted on a red table tennis ball and searched for this ball—their “mother”—when it was hidden. The subsequent analysis showed that the chicks’ magnetic compass worked in the same way as the magnetic compass of robins: it is an inclination compass, has a flexible biological window, depends on short-wavelength light, and is based on radical pair processes with cryptochrome 1a as the most probable receptor molecule. This type of magnetic compass has been found in all bird species analyzed so far, regardless whether they are migrants or non-migrants like the homing pigeon or the Zebra Finch, *Taeniopygia guttata*—it seems to be a mechanism common to all birds. Chickens and robins belong to different avian lineages—the Galloanseres and the Neoaves—that separated 95 million years ago in the Late Cretaceous; the finding that they have the same type of magnetic compass suggests that this compass was probably developed by the common ancestor of modern birds in the Mesozoic.

Hence chickens have probably inherited their magnetic compass from their ancestors. However, it would be surprising if such a complex mechanism remained intact and functional over such a long time without being maintained by some selective pressure. Today, chickens are domestic animals, living in the care of humans.
of man. They descended from the Red Jungle Fowl, *Gallus gallus*,11,12 and their wild ancestors roamed in the dense jungle of Southeast Asia.13 In this environment, wild ancestors roamed in the dense jungle, and bushes are all quite similar, and they change with time, sometimes rapidly because of storms. Using the magnetic compass to keep track of their movements, or using the compass together with some prominent landmarks, as proposed by the concept of the mosaic map,14,15 would be a useful, efficient strategy.

Humans began to domesticate chickens some 8000 years ago.12,16 But at first, their environment did not change so much. Until about 50 to 100 years ago, most chickens were running around freely in farm yards and adjacent fields,17 and here, it would have been still advantageous to have a compass available. Only very recently chickens have been confined to small cages with hardly any space to move. Still, 2 different modern strains of chickens, both bred for egg laying, have been shown to have retained their ability to orient with the magnetic compass.18

The magnetic compass found in chickens and other non-migrants suggests that it is an important mechanism for orientation within the home range. It may have developed to optimize the daily movements between the nest, food sources, water, to save energy, and minimize the chance of predation—here, an efficient navigational system represents a great advantage. A magnetic compass is also demonstrated in a number of animals from other groups (see 19 for review), and these are mainly not migratory. When some birds later began to migrate, they could call on their already existing magnetic compass to orient their long flights.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

References

1. Denzau S, Niessner C, Rogers LJ, Wiltschko W. Ontogenetic development of magnetic compass orientation in domestic chickens (*Gallus gallus*). J Exp Biol 2013; 216:3143-7; PMID:23661773; http://dx.doi.org/10.1242/jeb.088815

2. Wiltschko W. On the effect of static magnetic fields on the migratory orientation of the robin (*Erithacus rubecula*). Z Tierspsychol 1968; 25:537-58; PMID:5710023; http://dx.doi.org/10.1111/j.1439-0310.1968.tb00028.x

3. Wiltschko W, Wiltschko R. Magnetoception in birds: two receptors for two different tasks. J Ornitol 2007; 148:561-76; http://dx.doi.org/10.1010/10336-007-0223-2

4. Keeton WT. Magnets interfere with pigeon homing. Proc Natl Acad Sci U S A 1971; 68:102-6; PMID:5276278; http://dx.doi.org/10.1073/pnas.68.1.102

5. Walcott C, Green RP. Orientation of homing pigeons altered by a change in the direction of an applied magnetic field. Science 1974; 184:180-2; PMID:4815725; http://dx.doi.org/10.1126/science.184.4133.180

6. Freire R, Munro U, H., Rogers LJ, Wiltschko W, Wiltschko R. Chickens orient using a magnetic compass. Curr Biol 2005; 15:620-1; http://dx.doi.org/10.1016/j.cub.2005.08.017

7. Wiltschko W, Freire R, Munro U, Ritzi T, Rogers L, Thalau P, Wiltschko W, Bischof HJ. Oscillating magnetic field disrupts magnetic orientation in Zebra finches, *Taeniopygia guttata*. Front Zool 2009; 6:25; http://dx.doi.org/10.1186/1742-9994-6-25; PMID:19852792

8. Niessner C, Denzau S, Gross JC, Peichl L, Bischof HJ, Fleissner G, Wiltschko W, Wiltschko R. Avian ultraviolet/violet cones identified as probable magnetoreceptors. PLoS One 2011; 6:e20091; http://dx.doi.org/10.1371/journal.pone.0020091; PMID:21647441

9. Keary N, Ruploh T, Voss J, Thalau P, Wiltschko W, Wiltschko R, Bischof HJ. Oscillating magnetic field disrupts magnetic orientation in Zebra finches, *Taeniopygia guttata*. Front Zool 2009; 6:25; http://dx.doi.org/10.1186/1742-9994-6-25; PMID:19852792

10. Ericson PG, Anderson CL, Britton T, Elzanowski J, Johansson US, Källersjö M, Ohlson JI, Parsons TJ, Zuccon D, Mayr G. Diversification of Neoaves: integration of molecular sequence data and fossils. Biol Lett 2006; 2:543-7; http://dx.doi.org/10.1098/rsbl.2006.0523; PMID:17148284

11. Siegel PB, Haberfeld A, Mukherjee TK, Stallard LC, Marks HL, Anthony NB, Dunnington EA. Jungle fowl-domestic fowl relationships: A use of DNA fingerprinting. Worlds Poult Sci J 1992; 8:147-55; http://dx.doi.org/10.1017/S0043933900003366

12. Fumihito A, Miyake T, Sumi S, Takada M, Ohno S, Kondo N. One subspecies of the red junglefowl (*Gallus gallus gallus*) suffices as the matriarchic ancestor of the malleable domesticated chicken (*Gallus domesticus*). Z Tierpsychol 1968; 25:537-58; PMID:5710023; http://dx.doi.org/10.1007/s10071-012-0580-0

13. Lawler A. Animal domestication. In search of the wild chicken. Science 2012; 338:1020-4; PMID:23180839; http://dx.doi.org/10.1126/science.338.6110.1020

14. Wallraff HG. Das Navigationssystem der Vögel. Schriftenreihe Kybernetik. München, Wien: Oldenbourg Verlag, 1974

15. Wiltschko W, Wiltschko R. The role of outward journey information in the orientation of homing pigeons. In: Papi F, Wallraff HG, eds. Avian Navigation. Berlin: Springer Verlag; New York: Heidelburg, 1982:239-252

16. West B, Zhou B-X. Did Chickens Go North? New Evidence for Domestication. J Archaeolog Sci 1988; 15:515-633; http://dx.doi.org/10.1016/0305-4403(88)90080-5

17. Wood-Gush DGM. Behaviour of the Domestic Fowl. Studies in Biology. Heinemann Educational Publishers, 1971

18. Denzau S, Niessner C, Wiltschko R, Wiltschko W. Different responses of two strains of chickens to different training procedures for magnetic directions. Anim Cogn 2013; 16:395-403; PMID:23179110; http://dx.doi.org/10.1007/s10071-012-0580-0

19. Wiltschko R, Wiltschko W. Magnetic Orientation in Animals. Berlin: Springer Verlag; New York: Heidelburg, 1995