Progress towards discovering the biophysical basis of magnetic sensing

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Many animals, including migratory and non-migratory birds derive directional information from the geomagnetic field to orient their movements. This magnetic compass has been well characterized behaviorally, but the underlying reception mechanism has remained enigmatic. For many years, the use of biological magnetic materials such as magnetite crystals, had been assumed to underlie biological compasses. Recently, the suggestion that magnetically sensitive photochemical radical-pair reactions can provide a basis for magnetic sensitivity has received renewed attention. The radical pair model proposes a role of spin-selective processes as the magnetically sensitive step, suggesting a role of quantum physics in a key biological response. Modeling possible mechanisms of magnetic field effects on biological systems have proved a key step in generating new ideas and experiments. We will review behavioral, spin-chemical, and neurobiological evidence from our and other groups supporting this suggestion. Finally, we will discuss future avenues of research towards identifying not only the mechanism, but also the chemical nature of the receptors underlying magnetoreception, and in particular the photoreceptor chryptochrome, an emerging candidate for the long sought after magnetoreceptor.

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