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## Which direction to choose? Compasses of migratory songbirds

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Birds, one of the most mobile animal groups in the world, sometimes travels tens of thousands of kilometers from their wintering home to breeding area. It is quite amazing how they could find their ways during the journey even when flying over the endless oceans. The more amazing fact is that in some birds groups, such as many songbirds, the juvenile birds accomplish this enormous journey on their own without their parents and previous experience. This means these birds need to have an orientation programme inbuilt in their gene. Till now, scientists have found out there are at least three compasses involved in this process: the magnetic compass, the sun compass and the star compass.

Unlike the magnetic compass we use, the birds possess a so called inclination compass, which does not use the polarity. This compass poses one problem for birds migrating across the magnetic equator. If the birds do not reverse their response to the inclination compass after crossing from the north hemisphere to the south hemisphere, they will think the magnetic south as the north. To figure out whether the experience with the horizontal field is the trigger for the birds to reverse their response, we designed experiments with willow warblers and sedge warblers. In my experiments, I used magnetic coils inside a wooden house to create a magnetic field similar to the magnetic equator (only horizontal field). The exposure to this simulated equator environment was done by putting birds inside these coils for five days. Before and after the exposure to the 'equator', we tested the birds for their preferred migratory direction in simulated overcast condition and clear sky condition. As expected, the birds shifted their orientation after the exposure. However whether the reason for this shift was the experience with horizontal magnetic equator environment was not clear. There were other factors, like the difference between the test date and fat deposition, which might influence the result. More experiments would be needed to draw the correct conclusions.

The sun compass used by the birds is not only the direction of the sun, but also the polarization pattern of the skylight. Most humans can see this polarized light but this information is usually filtered out by our brain. However birds can use this for finding their direction. Most birds migrate during night and take off during sunset, when light was polarized approximately north to south (perpendicular to the sun). During the autumn, European robins were tested during sunset for their preferred direction. When the direction of the polarization was shifted by a polarizer, similar to the polarizer used for photography, the birds generally followed the shift. While when magnetic and polarization information were excluded, the birds still did find their direction, suggesting that the color gradient and light intensity could also be used.