Sense of smell is key factor in bird navigation

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A Scopoli's shearwater. Credit: Miguel McMinn

How do birds navigate over long distances? This complex question has been the subject of debate and controversy among scientists for decades, with Earth's magnetic field and the bird's own sense of smell among the factors said to play a part.

Now, researchers from the universities of Oxford, Barcelona and Pisa have shown in a new experiment that olfaction – or sense of smell – is almost certainly a key factor in long-distance oceanic navigation, eliminating previous misgivings about this hypothesis.

The research is published in the journal *Scientific Reports*.

Study leader Oliver Padget, a doctoral candidate in Oxford University's Department of Zoology, said: 'Navigation over the ocean is probably the extreme challenge for birds, given the long distances covered, the changing environment, and the lack of stable landmarks. Previous experiments have focused on the physical displacement of birds, combined with some form of sensory manipulation such as magnetic or olfactory deprivation. Evidence from these experiments has suggested that removing a bird's sense of smell impairs homing, whereas disruption of the magnetic sense has yielded inconclusive results.

'However, critics have questioned whether birds would behave in the same way had they not been artificially displaced, as well as arguing that rather than affecting a bird's ability to navigate, sensory deprivation may in fact impair a related function, such as its motivation to return home or its ability to forage.

'Our new study eliminates these objections, meaning it will be very difficult in future to argue that olfaction is not involved in long-distance oceanic navigation in birds.'

In this new experiment, the researchers closely followed the movements and behaviour of 32 free-ranging Scopoli's shearwaters off the coast of Menorca. The birds were split into three groups: one made temporarily anosmic (unable to smell) through nasal irrigation with zinc sulphate; another carrying small magnets; and a control group. Miniature GPS loggers were attached to the birds as they nested and incubated eggs in crevices and caves on the rocky Menorcan coast. But rather than being displaced, they were then tracked as they engaged in natural foraging trips.

All birds went out on foraging trips as normal, gained weight through

successful foraging, and returned to exchange incubation periods with their partners. Thus, removing a bird's sense of smell does not appear to impair either its motivation to return home or its ability to forage effectively.

However, although the anosmic birds made successful trips to the Catalan coast and other distant foraging grounds, they showed significantly different orientation behaviour from the controls during the at-sea stage of their return journeys. Instead of being well-oriented towards home when they were out of sight of land, they embarked on curiously straight but poorly oriented flights across the ocean, as if following a compass bearing away from the foraging grounds without being able to update their position.

Their orientation then improved when approaching land, suggesting that birds must consult an olfactory map when out of sight of land but are subsequently able to find home using familiar landscape features.

Senior author Tim Guilford, Professor of Animal Behaviour and leader of the Oxford Navigation Group in Oxford's Department of Zoology, said: 'To the best of our knowledge, this is the first study that follows free-ranging foraging trips in sensorily manipulated birds. The displacement experiment has – rightly – been at the heart of bird navigation studies and has produced powerful findings on what birds are able to do in the absence of information collected on their outward journey.

'But by its nature, the displacement experiment cannot tell us what birds would do if they had the option of using outward-journey information, as they did in our study. This heralds a whole new era of work in which careful track analysis of free-ranging movements, with and without experimental interventions, can provide inferences about the underlying behavioural mechanisms of navigation. Precision on-board tracking

technology and new analytical methods, too computationally heavy to have been possible in the past, have made this feasible.'

More information: O. Padget et al. Anosmia impairs homing orientation but not foraging behaviour in free-ranging shearwaters, *Scientific Reports* (2017). DOI: 10.1038/s41598-017-09738-5