Pigeon 'chain of command' aids navigation

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Homing pigeon flocks with a few well-connected leaders navigate more accurately than groups with other social structures, an Oxford University-led study has found. Credit: Oxford University

Having a hierarchical social structure with just a few well-connected

leaders enables pigeon flocks to navigate more accurately on the wing, new research shows.

Hierarchical organisation also enables flocks to cope better with navigation errors made by individual birds.

Researchers from Oxford University and the Zoological Society of London created 'virtual flocks' of homing pigeons to test how different social networks affect the navigation performance of these groups. The team's simulations looked at everything from no networks (all connections between individuals were of equal strength) to random networks (some connections were stronger than others but randomly distributed) to hierarchical networks with just a few well-connected individuals leading the way.

Flocks in which each individual follows just a single other bird, allowing information to rapidly pass down this 'chain of command', perform best at navigating accurately to a desired location, the study suggests.

A report of the research is published this week in the *Journal of the Royal Society Interface*.

The research was led by Dr Andrea Flack whilst she was at Oxford University's Department of Zoology: she is now at the Max Planck Institute for Ornithology in Germany.

Dr Dora Biro of Oxford University's Department of Zoology, a co-author of the paper said: 'We've previously shown - through high-resolution GPS tracking of bird flocks - that homing pigeons have structured hierarchical relationships where individuals form stable leader-follower pairs during flight. Our approach here was to model the process mathematically, examining different types of social structures and their effects on navigational performance.'

Lead author Dr Flack said: 'We modelled pigeon flocks aiming to reach a target - in real life, the birds' home loft - in which individuals behave according to a set of rules based on what we know from our homing experiments with real pigeons. To model the impact of different social structures, we varied how much 'attachment' there was between any given pair of individuals, and how the full set of these attachments were distributed within the group. We found that the different structures gave rise to different navigational accuracies by the groups.'

Dr Robin Freeman of the Zoological Society of London, a co-author of the paper, said: 'Perhaps most interestingly, we find that the presence of hierarchical social structure enables the group to both make decisions more accurately and to do so when the information it relies upon becomes worse.'

He adds: 'When individual group members' decisions become less accurate, a group with hierarchical social structure is still able to make more accurate decisions than other social structures. We find that groups are most accurate when each individual tends to follow one other bird, with information moving quickly along this 'chain of command'.'

In hierarchically organised groups, the researchers found there was a clear tendency for leaders to be located near the centre of the flock. Positioned here, they could interact with the largest number of individuals, or followers, who, in turn, tended to be more spatially peripheral. For other social structures, they didn't find any relationship between leading and spatial position.

Whilst the simulations are simplified models of how real animals behave they are informed by research on real life flocking interactions such as typical group size, flight speed, distances that birds like to keep between themselves and flock-mates, and the distances over which birds interact by following each other's turns.

Dr Dora Biro of Oxford University said: 'Our models included a parameter for each individual which we can describe as "assertiveness": it stood for the relative weight that the individual attached to its own information (where it thought the target was) versus the input from its flock-mates. Our simulations showed that when leaders were 'assertive' they were able to effect better overall performance in their group. Unassertive social leaders - individuals who had many followers but who were less willing to act on their personal preferences - caused groups to perform worse.'

The researchers say that the results are relevant to many animals where the strength of the social bonds between individuals in groups may vary and accurate navigation is essential for survival - for instance long-distance migratory species which often travel in relatively small kin or socially-bonded groups.

More information: Modelling group navigation: Transitive social structures improve navigational performance, rsif.royalsocietypublishing.or … .1098/rsif.2015.0213

Provided by Oxford University

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