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In Focus

Featured Articles in This Month's *Animal Behaviour*

When Many Wrongs are Right on Target

Sir Francis Galton famously demonstrated that, by combining the individual estimates of people guessing the weight of an ox at a country fair, one could arrive at an estimate that was considerably more accurate than any one individual's guess. He named this effect the 'vox populi' and, since then, there have been many other demonstrations of 'the wisdom of the crowds' (for an excellent review, see Surowiecki 2005). In this month's issue (pp. 587–591), Jolyon Faria from Leeds University, U.K., and his colleagues Edward Codling, John Dyer, Fritz Trillmich and Jens Krause, apply Galton's insight to another domain, and test whether crowds are wiser than individuals when it comes to navigating accurately towards a target.

Specifically, Faria and colleagues set out to test 'the many-wrongs principle'. This states that many wrongs can, in fact, make it right because the pressure to remain together in a group can compensate for any tendency that individuals might have to wander off course. As a result, the group as a whole stays on target, and does so more accurately than any given individual. The principle has some support from studies on bird flocks, but none had yet tested whether humans would show a similar kind of improved group-based accuracy. Faria and colleagues recruited schoolchildren and university students, formed them into groups of different sizes (1, 2, 6 and 10 individuals), and recorded how accurately they could move towards a target on the edge of a circular arena (Fig. 1).

Around the edge of the arena, there were 16 numbered landmarks. For each trial for each different kind of group, the experimenters would select a target landmark (say, number 7). The people in the groups were not told exactly which landmark was the target, but each was given a consecutive sequence of landmarks printed on a paper slip, and told to head towards whichever one they liked, as long as they stayed within arm's reach of everyone else in their group. The sequences were randomly generated, but all of them contained the target (so, one person might get the sequence 4, 5, 6, 7 while another person might get 6, 7, 8, 9). If the many-wrongs principle was operating, then groups of people, each of whom possessed approximate knowledge of the target location, should have converged on the correct target more accurately than a single person, because all their individual errors should cancel each other out via the mechanism of sticking together as a group. The sequences of numbers ensured that each person in the group possessed the same amount of 'directional uncertainty' about where they should head.

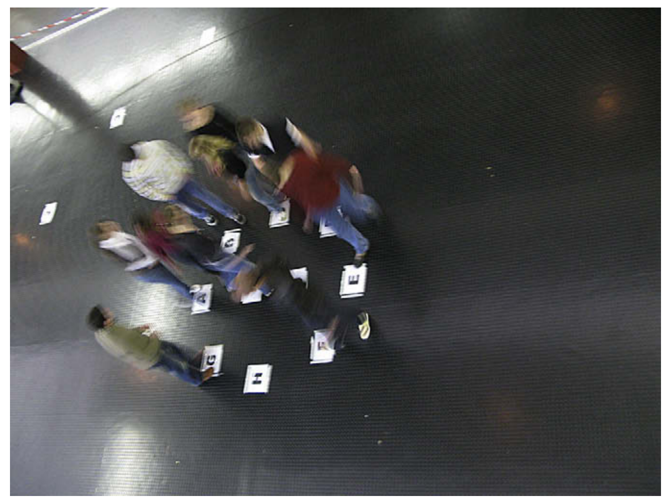

Figure 1. Sticking together as a group can lead to greater accuracy in reaching a target thanks to the 'many-wrongs' principle. Photo: Jolyon Faria.

Cleverly, by varying the length of these sequences across trials, the experimenters could also manipulate the level of individual uncertainty experienced and see how this affected group navigation skills. So, with a sequence of only two landmarks – 6, 7 – where 7 is the target, one could be out by, at most, one landmark (or 22.5°). With a sequence of six landmarks – 2, 3, 4, 5, 6, 7 – a person could be off by as many as five landmarks (or 112.5°). A long sequence therefore provided much poorer information, which made individual directional uncertainty higher, and increased the probability of individual error. Overall, then, the experiment was designed to see whether group size influenced accuracy, and also whether an increased likelihood of error led to improved group performance compared to that of single individuals.

The results showed that the many-wrongs principle operated in the manner predicted, but only when group size was large (10 people) and directional uncertainty was high (112.5°). It also took groups longer to reach the target than single individuals, suggesting that greater accuracy comes at the cost of slower decision-making speed.

Interestingly, theoretical models suggest that groups of all sizes should navigate more accurately than lone individuals. They assume, however, that all individuals have the same degree of influence on each other, something that is not usually true in

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the real world. As Faria and colleagues note, although people were forbidden to communicate directly, it was clear that some had greater influence on others as a result of the way they behaved. While some people repeatedly checked the positions of their neighbours as well as the landmarks, others were more single-minded, and looked only at the landmarks and their paper slips. Single-minded individuals, being less compromising about where they were headed, probably had a greater influence on the 'sociable checkers' and so may have influenced overall group direction to a greater extent. This probably explains why only the largest groups were more accurate: the effects of single-minded individuals are likely to have less of an effect in such groups, either because their effects are swamped by the more sociable checkers or because there are more single-minded types who cancel out each other's influence. Similarly, larger groups will be better at overcoming individual errors only when the likelihood of actually making such an error is high. If the chance of making an error is small per individual, then the many-wrongs effect will have a smaller part to play, which explains why groups only did better when directional uncertainty was at its maximum.

These neat experimental results demonstrate both the value of using humans to test principles derived from the animal literature (especially as, for once, using humans is more practical and they are easier to control than an animal model) as well as providing a novel demonstration of the power of the 'vox populi'.

Louise Barrett
Executive Editor

The Sweet Smell of Spawning Success

Some ocean-dwelling fishes, such as salmon and sea lamprey, complete their lifecycle by migrating, as adults, into freshwater streams to spawn and die (Fig. 2). This lifestyle is called anadromy. Anadromous lifecycles that alternate between juvenile life in a freshwater stream and adult life in the ocean probably allow each developmental form to occupy habitats best suited for that stage of life.

This observation leads to an interesting question: how do adults find their way into the right freshwater habitats for egg laying and rearing young? In salmon the answer is fairly well understood; past success is a good indicator of future success. Thus, juvenile salmon learn the odours of their natal streams and then, later in life, use these odours to migrate back into the stream from the ocean.

For sea lampreys the riddle is still unravelling; one hypothesis has been that adult lamprey orient to pheromones produced by juveniles, and adult lampreys follow the odour of juveniles to appropriate spawning grounds. In this issue, Michael Wagner and his colleagues (pp. 593–599) show that adult lampreys orient to the presence of larval odours in water, and prefer water with a strong odour concentration.

Because lamprey larvae take several years to develop, the presence of successful (and 'smelly') larvae is a strong clue that, year to year, good nursery habitat is maintained in a stream. If a stream habitat is poor for spawning, or conditions periodically induce high larval mortality, then larval odours in the water will be absent or in low concentration. When males and females are attracted to the same locations, finding mates is also facilitated. This is an excellent example of how 'publicly' available information can be used by animals to steer their habitat choices in the appropriate directions.

Figure 2. Spawning sea lamprey. Photo: Charles C. Krueger.

The sea lamprey's mechanism for finding spawning habitats is very different from the imprinting strategy of salmon, but the ultimate result is the same. One logical outcome of the lamprey mechanism, which may present a contrast to salmon, is that spawning lampreys should be concentrated in certain streams. The higher the concentration of larval odour, the more attractive the stream, so this could function as a positive feedback mechanism to make larval populations high. This suggests that competition among larvae may be less important in this species, or that a predator saturation tactic has evolved in this system (too many larvae are present for predators to eat all of them).

Why care about lampreys? In their native habitats, sea lampreys are interesting and important components of food webs, and are exploited by humans as food. The English King Henry I is said to have died in 1135 of 'a surfeit of lampreys'! Despite that unfortunate outcome, Europeans remain keen to restore sea lampreys to rivers that have lost native populations because of dams and habitat degradation. Discovering just how sea lampreys choose habitats may very well lead to applications of larval odour to attract and establish new populations.

Unfortunately, sea lampreys have proven to be very adaptable to new habitats; the construction of canals linking the Great Lakes of North America to the Atlantic Ocean in the early 20th century allowed sea lampreys to invade the Great Lakes, with disastrous consequences for native fishes. Equipped with a round mouth lined with rows of sharp teeth, adult sea lampreys latch onto fish, such as lake trout, gouge a hole, prevent healing with a powerful anticoagulant, and feed on the fish, consuming large amounts of the animal's blood. By the 1950s, sea lampreys had reduced populations of some species of Great Lakes fish to less than 10% of their preinvasion levels. Current lamprey control efforts rely on pesticides, lowhead barrier dams, trapping and releases of sterile males; understanding the biology of adult attraction to spawning grounds may open the door to alternative modes of regulating destructive populations of sea lampreys in non-native habitats.

Michael Breed
Executive Editor

Reference

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