More Fun Than Fun: The Smart Animals That Helped Scientists Demystify Altruism

28/10/2020

A raven (Corvus corax) in Southern California. Photo: Ingrid Taylar/Flickr, CC BY-NC 2.0.

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This article is part of the 'More Fun Than Fun' column by Prof Raghavendra Gadagkar. He will explore interesting research papers or books and, while placing them in context, make them accessible to a wide readership.

Some time ago, I read a remarkable book with a provocative title: *Are We Smart Enough To Know How Smart Animals Are?* Probably not, the author – Frans de Waal, a well-known Dutch-American primatologist – argued. I agree, but I think we should keep trying. After all, human smartness is largely due to trial and error.

The inability to know how smart animals are can be a serious professional handicap for those of us who study animals and build theories to explain their behaviour. Our theories may be quite off the mark if our smartness limits our attribution of smartness to animals. But we hope that there are some (not enough, I worry) maverick scientists bold enough to keep pushing the boundaries of their imagination.

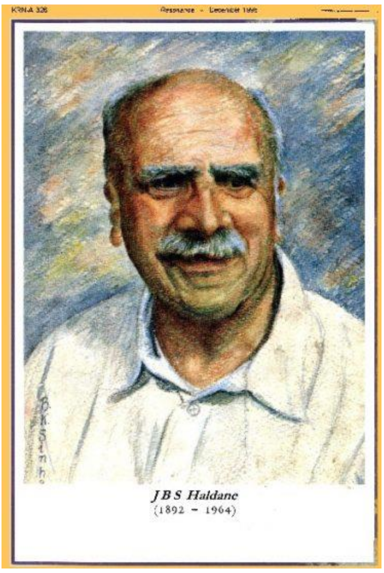
A major evolutionary paradox concerns why animals are nice to each other. Many of my humanist friends think that we scientists are depraved to think so. What they don't understand is that our best theories have difficulty accommodating niceness. We love niceties for sure, but that's not enough.

Our understanding of animals from first principles and our mathematics about what evolution should make them do should predict niceness – but they often don't.

You might say that the problem is with our theories. You are right, of course, but how to make our theories consistent with evolutionary logic on the one hand and with the observed niceties in the animal kingdom on the other?

Enter scientist #1, John Burdon Sanderson Haldane (1892-1964). In the words of his student John Maynard Smith:

> "[Though] Haldane will be remembered for his contribution to the theory of evolution … he is difficult to classify. A liberal individualist, he was best known as a leading communist and a contributor of a weekly article in The Daily Worker. A double first class in classics and mathematics at Oxford, he made his name in biochemistry and genetics. A captain of the Black Watch who admitted to rather enjoying the First World War, he spent the end part of his life in India writing in defence of non-violence."



A portrait of J.B.S. Haldane. Image: Resonance/IASc

Haldane is supposed to have declared (around 1953), "If one or two of my brothers were drowning in a river, I might not risk my life to save them, but if more than two of my brothers were drowning, I might attempt to save them at risk to my life", or something close to it. This quip is the kernel of the modern theory of kin selection. But if Haldane was maverick enough to think it, he was also maverick enough to leave it at that – not much more than a quip.

Enter scientist #2, William Donald Hamilton (1936-2000), who wrote an essay entitled 'My Intended Burial and Why', in which he said:

> "I will leave a sum in my last will for my body to be carried to Brazil and to these forests. It will be laid out in a manner secure against the possums and the vultures just as we make our chickens secure; and this great *Coprophanaeus* beetle will bury me. They will enter, will bury, will live on my flesh; and in the shape of their children and mine, I will escape death… So finally I too will shine like a violet ground beetle under a stone."

And then he went on an expedition (which some would say was foolhardy) to the Democratic Republic of the Congo, in search of evidence for the origin of AIDS, and died of complications from cerebral malaria that he contracted there.

But before all this, he developed the idea in 1964 – probably conceived largely independently of Haldane – that being nice, even altruistic, towards close genetic relatives can be reconciled with Charles Darwin's theory of natural selection. Today, we recognise that this is perhaps the most significant modification to Darwin's theory of natural selection ever, and commemorate it as Hamilton's rule. And we have since found that most organisms – bacteria, plants, insects, worms, fish, frogs, lizards, birds and mammals and many more – have developed smart ways of telling who their relatives are.

But the problem is that animals are often nice also to non-relatives, and that amounts to disobeying Hamilton's rule.

Enter scientist #3, Robert Trivers. Trivers is an American scientist who has been described as "arguably today's most original thinker in evolutionary theory". In 1974, Trivers proposed the theory of 'reciprocal altruism', the simple idea that no act of helping or altruism is evolutionarily harmful to the actor as long as it is reciprocated at a future point in time.

Theorists have since been busy imagining different kinds of reciprocity: direct reciprocity ('I will help you because you helped me in the past'), indirect reciprocity ('I will help you because I saw you help someone else') and generalised reciprocity ('I will help you because I am generally feeling good that someone helped me out').

Unfortunately, the idea of reciprocal altruism as a solution to the paradox of altruism toward strangers gathered dust for a long time. Why? Because most people were not smart enough to think that animals – let alone bacteria and plants – could be smart enough to keep track of who helped whom, when, and how much, and work out how much return help now is commensurate with past good deeds.

W.D. Hamilton, at dinner (left), during fieldwork (centre) and giving a lecture during my visit to Japan in 1991. Courtesy: Prof Yosiaki Itô and his students for the invitation and the photos

I am happy to say that over the last few decades, we are gradually becoming smart enough to know how smart animals are.

In 1984, Gerald S. Wilkinson, then at the University of California, San Diego, provided the first clear example of direct reciprocity in the context of food-sharing among the vampire bats (*Desmodus rotundus*) he was studying in Costa Rica. These bats live together in small groups of 8-11 individuals for as long as 2-11 years. They go out every night to drink blood from cattle and horses. If they are lucky, they can ingest a quantity of blood equal to their body weight. But some are always unlucky and return on an empty stomach.

Those that fail to feed on three consecutive nights will die, implying that those that have had a good meal today have three days' worth of reserves and, hence, something to spare. The bats groom each other's stomachs, making it difficult for well-fed bats to bluff. Thus they have all the right conditions for reciprocal altruism to evolve. But do they have the cognitive abilities to carry out honest transactions?

Using field and laboratory experiments, Wilkinson showed that the vampire bats fulfilled all three required conditions for reciprocal altruism. They had (1) repeated blood exchange interactions with the same individuals; (2) the benefit of donating blood was greater than the cost of doing so; and (3) most importantly, they recognised those that had donated blood in the past and preferentially donated blood to them, irrespective of kinship, and refused to donate to those who had refused them in the past. His student, Gerald Carter, presently at the Ohio State University, Columbus, has since reconfirmed this result with larger samples and more rigorous experiments.

Indirect reciprocity requires that animals keep track of what others do to them as well as a running score of what others do to yet others. This seems even more far-fetched to expect from animals. And yet some people have been bold enough to look for it and have found that it is not entirely beyond the capability of some animals.

In the tropical oceans, many large fish have themselves, including the insides of their mouth, cleaned by smaller fish, which feed on dead skin and ectoparasites. This relationship between the cleaner and the client is a delicate one. Both parties can cheat: the cleaners can bite off some healthy tissue, and the clients can gobble up the cleaners, but they usually trust each other. Depending on the relative levels of demand and supply, there may be a long queue of clients waiting for the cleaning service or a long queue of cleaners waiting for work. This provides opportunities, especially for those in waiting, to observe and score the performance of others.

Redouan Bshary of the University of Neuchâtel in Switzerland and Alexandra S. Grutter from the University of Queensland, Australia, teamed up to show that clients keep track of the work 'ethics' of different cleaners and prefer to be serviced by the more honest ones. Cleaners can also eavesdrop on clients, score them for their propensity to be observant, and stay more honest while cleaning those clients that tend to eavesdrop on cleaners at work.

Generalised reciprocity requires that animals not only feel good when someone helps them but also feel the urge to be nice to strangers at such times. Instead of dismissing this as too anthropomorphic, Claudia Rutte and Michael Taborsky of the University of Bern put the theory to the test. They trained Norwegian rats (*Rattus norvegicus*) in the lab to pull a stick in order to produce food for another rat, though they got nothing for themselves. Using this experimental setup, they showed that rats were more likely to help unknown rats if other unknown rats had previously helped them.

Animals, therefore, seem to be smart enough to show direct, indirect as well as generalised reciprocity. With this realisation, scientists have become motivated to investigate the limits of animal cognition and memory with newfound enthusiasm and confidence. Some really cool and fun experiments are now being done with corvids (birds of the crow family).

One research group in Austria is experimenting with ravens (*Corvus corax*) in large enclosures. A trainer gives a raven a piece of bread but ravens like a piece of cheese better. Another experimenter offers a piece of cheese in exchange for the piece of bread. The ravens love this and promptly hop over to the good Samaritan experimenter and exchange their bread for cheese. But some experimenters are 'unfair': they accept the bread, and in full view of the waiting raven, they themselves eat the cheese. Ravens remember the identities of 'fair' and 'unfair' human experimenters for up to a month, even after a single interaction. They then avoid 'unfair' experimenters and preferentially take their bread to 'fair' experimenters.

A new mindset among scientists, open to the possibility of animal cognition beyond our expectations and perhaps beyond our own capabilities, has generated a new hope of understanding the logic of animal behaviour. I think it is fair to say that animals are making us smart! But we should also chip in by tweaking our education system and our social norms to create and tolerate more mavericks.

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Gadagkar, R., 2020. More Fun Than Fun: The Smart Animals That Helped Scientists Demystify Altruism. The Wire Science. URL https://science.thewire.in/the-sciences/altruism-animal-kingdom-reciprocity-animal-cognition/