Box 1 'Public goods' experiments

In the 'public goods' game, each subject is given an endowment, w. Each subject may contribute any part of this endowment to a common account. Following this contribution stage, there is a pay-off stage in which the experimenter gives each of n subjects a fraction, $q \in (1/n, 1)$, of the amount in the common account. Contributing is an altruistic act as it increases the average group pay-off (because $q > 1/n$) at a cost to oneself (because $q < 1$).

In the 'public goods with punishment' game, following the contribution stage there is a punishment stage in which the contributions of each subject, a_i, are made public and each player is given the opportunity to reduce the pay-offs of subject j by m_{ij} at a cost to the punisher of cm_{ij}. After the punishment stage, the pay-off stage is as above. Thus the pay-offs to subject i are:

$$y_i = w - a_i + q\Sigma a_j - \Sigma m_{ji} - c\Sigma m_{ij}$$

where the summation is over all the group members. What the subject keeps is captured by the first two terms ($w - a_i$); $q\Sigma a_j$ is the amount received from the common account; Σm_{ji} is the cost of being punished by others; and $c\Sigma m_{ij}$ is the cost of punishing others.

Interactions are anonymous and may last for a just a single round or a known number of rounds. In the 'partner treatment', membership of the groups remains unchanged during the game. In the 'stranger treatment', membership is shuffled after each round. The 'perfect stranger' treatment implemented by Fehr and Gächter[3] ensures that no two subjects will interact more than once. **S.B. & H.G.**

this type of situation is just as altruistic as actually contributing to the public good. The key difference is that the punishment is conditioned by the behaviour of others — hence our term *Homo reciprocans*. Cooperation can be sustained because altruistic punishers induce even selfish group members to contribute to the common project. But is such altruistic punishment common?

Fehr and Gächter[3] show that it is. The results of their well-designed experimental 'public-goods' game (Box 1) reveal that most people incur costs to themselves in order to punish those who have shirked in contributing to a public good. This form of altruistic punishment is common even when it is unmistakably the case that there can be no subsequent (direct or indirect) material benefits to those doing the punishing, because the groups of players are shuffled after every round such that no participant encounters any other more than once. Those who are punished for shirking contribute more in subsequent rounds, with the result that high overall levels of cooperation are sustained.

This result is striking in view of the fact that, in public-goods experiments with no provision for punishing free riders, contributions are substantial in early rounds of the game but dwindle to virtually nothing in subsequent rounds[7]. By showing that cooperation can be sustained by altruistic punishment where altruistic contribution may fail, the experiment will direct attention to why humans are so willing to punish those who violate norms, rather than focusing on why humans are also (sometimes) unconditionally generous to strangers.

Fehr and Gächter's work goes beyond previous studies[8,9] by reshuffling participants such that no subject interacted more than once with any other. This treatment precludes both reputation and repetition, the mechanisms underlying direct and indirect reciprocity and other self-interested explanations. As a result of this 'perfect stranger' treatment, subjects knew that punishing others could not raise their own pay-offs even if the shirkers they punished contributed more in later rounds. Rather, punishment *per se* provided the motivation, not some consequence anticipated by the player.

But why would the idea of punishing shirkers be a motivating factor? In the one-shot public-goods game, not punishing and not contributing maximize pay-offs irrespective of what the other group members do. So the willingness of subjects to reduce their own pay-offs by punishing shirkers but not to reduce their pay-offs by contributing to the public good in the absence of punishment needs to be explained in terms other than self-interest. Fehr and Gächter advance the view that punishment of shirkers is not evidence of a general-purpose predisposition to contribute to the public good, but rather reflects a negative emotional reaction to free riding. They stress a particular motivation — the desire to punish those who violate norms — rather than the more general motivation to contribute to the well-being of others. But the players are public-spirited nonetheless, as they do not themselves benefit from doing the punishing.

Shirkers, too, appear to have an emotional response to being punished. In other experiments[10], even when punishment takes the form of verbal criticism rather than a pay-off reduction, shirkers contribute more in subsequent rounds, suggesting that punishment may evoke emotions of shame in the free rider.

Fehr and Gächter's experiment[3] has implications for the design of constitutions and policies. It suggests that the objective should be to provide opportunities for the public-spirited to punish free riders, rather

100 YEARS AGO

Under the entrance gate, in the gravel, I saw a light of a brilliant greenish-bluish tint; it moved forward, leaving behind a trail of light which, gradually separating, became a scattered mass of brilliant points. The leading light had the form of a living, curving thread. A lighted match soon showed what the scattered points of light in its trail were, a dozen or so of red ants pursuing the *Geophilus*; one was clinging to it, each ant shone like a spark in the gravel, the centipede had discharged its fluid over them. I picked up the centipede and dropped it into a tumbler, where it splashed out a mass of light. Hurriedly placing my hand over the tumbler to prevent the insect from escaping, I felt suddenly a strange prickly sensation such as is caused by a slight contact with electricity, so that I hastily removed my hand, calling to a friend who, placing her hand over the tumbler, felt the same thing… Defence seems certainly to be one of the uses of this secretion, attributed by some authors merely to purposes of attraction. Rose Haig Thomas

From *Nature* 9 January 1902.

50 YEARS AGO

The arrival at Plymouth on December 6 of the Royal Research Ship *Discovery II* marked the completion of a twenty-month voyage of oceanographical survey… The Southern Ocean is a continuous belt of deep water encircling a central land mass; in consequence the prevailing currents and water circulation, and the fauna and flora, are distributed in a simpler pattern than in other oceans… A detailed knowledge of the bottom topography of the ocean is essential to the full understanding of the water circulation, and during the recent voyage the *Discovery II* has supplemented her earlier depth charts by an enormous number of new echo-soundings, and has recorded many continuous bottom profiles, running the sounding machine for long periods. Information of the depths of bottom sediments was also obtained in a number of places by seismic echo soundings with 1¼-lb. explosive charges. Four long bottom cores were obtained in the Indian Ocean with a Kullenberg corer. South of Australia, the corer struck a hard substance — possibly a meteorite — on the bottom; the nose-piece was blocked with hard brownish-black material which had to be chipped out. It was handed to the Geological Department of the University of Western Australia for further examination.

From *Nature* 12 January 1952.