Freeloaders' shoulder to the wheel

When institutions are weak, being less co-operative than public-spirited is perceived as the way to go

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Group exercises, where people engage and transact, can be designed in ways that uncover conflicts of self-interest and co-operation. An example is where different participants seek to profit from a common, limited resource, like harvesting fish from a lake. Narrow self-interest leads to the resource getting depleted. True self interest would lie in co-operation, where each person draws a limited quantity and allows the resource to regenerate.

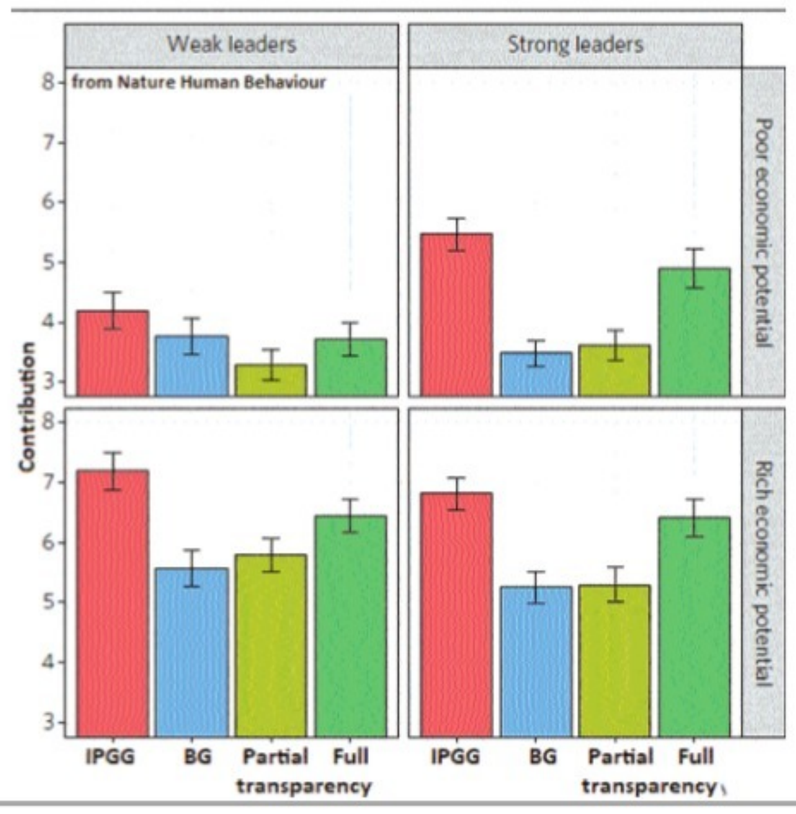
A well-known exercise to analyse behaviour is the Public Goods Game, where players are each given a personal, starting endowment. They may now make contributions to the public pool. The pool is then multiplied by some number and equally divided among the players. As a player receives an equal share of the pool regardless of what she put in, it would be in her interest to contribute the least, even nothing. This, however, would soon be understood by all players and this is not the behaviour we see in practice. What we see is that players make contributions, induced in part by aversion to being seen as "free-riders" and in part because of the multiplier.

In one form of the game, there are four players who start with twenty tokens each. Each one then receives 0.4 tokens for each token that is contributed to the pool. As this amounts to a return of 0.4 on an investment of a full token, it may be better to hold on to one's tokens. Putting in all the tokens, however, would result in 80 tokens in the pool and a return of 32 tokens to each player. But if one player held back, there would still be 60 tokens in the pool, with 24 tokens given to each player, and the one that held back would have 20+24!

Michael Muthukrishna, Patrick Francois, Shayan Pourahmadi and Joseph Henrich, from schools of psychology and economics from London, Vancouver, Massachusetts and New York, report in the journal, *Nature Human Behaviour*, that their trials with variations of the PGG included penalties for non-co-operative behaviour and then an element of corruption, which eroded the penalising action.

The first variation of the PGG is where players can penalise, or punish low contributors, but at a cost to themselves. The cost that must be borne moderates the level of punishment, but the practice does increase the level of co-operation. And then, there is the reverse factor of co-operators or large contributors being penalised, because they are seen as progenitors of punishments.

The paper in Nature Human Behaviour examines a particular form, the Institutional PGG where an individual is chosen as a leader, to mete out punishment to those who contribute less. When all the contributions have been received, a portion is extracted as the tax, and this is used to administer punishments. The punishment consists of reducing tokens, according to the part of the tax income that the leader uses for punishing, multiplied by a factor. The level of tax and the multiplier are measures of the leader's power to punish. The multiplier of the contributions, which yields what is returned to the members, represents the economic level of the community.



Trials with IPGG are reported to have shown that punishment generally improves levels of contributions. Another form of IPGG is with rewards given to high contributors, but it is reported that punishing the low contributors is more effective. With "rational" players, of course, one can imagine that the reward/penalty effect would depend on the level of punishment or reward — whether the penalty negates the benefits of contributing less, or whether the reward compensates the lower personal gains of generous contribution.

Muthukrishna and team next developed the Bribery Game, in which players and leaders have more ways to function. In addition to contributions to the pool (if any), players can choose to deliver tokens to leaders, to improve the leaders' income. The leaders can choose to accept or refuse the gifts, like bribes, and respond by punishing or not punishing a player, either one who contributes less, or one who does not offer a bribe.

The team carried out the trials with 274 Canadian participants, men and women, of different ages and ethnicities, in randomly assigned groups of four to seven. In playing the IPGG, the multipliers, of the pool return, which indicated the economic level, and multiplier of the punishment, which reflects the leaders' potency, were varied from low to high. And in the BG, a device (transparency), to mitigate corruption, was introduced at three levels — partial transparency (disclosing contributions by leaders), full transparency (revealing all leader behaviour, including bribe taking) and leader investment (forcing leaders to contribute their endowment to the public pool). And the leaders were changed in each iteration of the game.

The paper observes that without punishment, the contributions shrink down to zero (excepting infrequent, pathological "givers"), as contributions depend on the power of leaders to punish low contributors. Leaders, who also pay the tax which is used to empower themselves, could be counted on to use the tax to punish players, first as the tax itself was low, and then, as promoting contributions was good for the leaders too. Strengthening leaders, with tax resource and a robust penalty multiplier would hence promote contributions, in IPGG.

When it comes to the BG, the paper says, there would be no incentive to contribute to the pool or to offer bribes unless players were punished for not doing either. Where the bribe is an option, however, making sure of bribes is more lucrative for the leader than punishing low contribution. Hence, in contrast to the IPGG, empowering leaders in a bribe-taking environment would lower the contributions to the public pool, the paper suggests. However, if the players were from an environment where contribution was more rewarding (high pool multiplier) and anti-corruption norms had sway, low contributions would be punished more severely than low bribe offers. "In contrast, growing up in a more corrupt society may lead to a higher preference for eliciting, offering and accepting bribes," the paper says.

In the trials carried out by the team, it was found that the public contributions dropped by a whole 25 per cent when IPGG was changed for BG, or when bribes became possible. "…When corruption could enter, it did, and co-operation deteriorated," the paper says. On further analyses of behaviour when the multipliers were varied, by cultural experience and based on past decisions of leaders, it was found that powerful leaders were twice as likely to accept bribes and three times as likely to punish players. Based on individual data, it was found that leaders who had been exposed to corruption were significantly more likely to accept bribes, and conversely, those with different parental corruption norms were less likely to do so.

The next assay was to see the effect of corruption mitigation by transparency. Here, as shown in the diagram, in a low economic potential (pool multiplier) environment, strong leaders did more to improve public contribution, and full transparency had a positive effect. In poorer countries where leaders often abuse power and do economic harm, it was still important that leaders be powerful, but with strong anti-corruption measures, like full transparency be put in place. If the leaders are not powerful, making low public contribution and free-riding would be the rational course, and transparency would only present the same example.

The paper cautiously concludes that while less government action may be the way for areas of high economic potential, poorer regions would benefit from strong government action, but essentially paired with strategies to keep corruption in check.

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PLUS POINTS

Possible new planet

Astronomers believe they have discovered a new planet in the solar system the size of Mars. A recent research paper claims there is a massive object lurking on the edge of our solar system that is likely to be a previously undiscovered world. It follows suggestions last year that another planet — nicknamed Planet 9 — appeared to be orbiting the sun from the outer regions of the solar system.

Scientists discovered Planet 9 after noticing that something was exerting a gravitational force on objects in the Kuiper Belt — an area of comets, the dwarf planet Pluto and huge icy objects beyond Neptune that encircles the whole solar system. The unusual orbits of the objects could be explained by a planet with a mass 10 times that of Earth exerting a gravitational pull on them, researchers said.

Now a similar analysis has revealed the possibility of a second new planet, dubbed Planet 10. In a study to be published in the Astronomical Journal, Kat Volk and Renu Malhotra from the University of Arizona discovered that a number of Kuiper Belt objects are not orbiting in the way they would normally be expected to, therefore suggesting something in the region is exerting a strong gravitational force on them.

"Imagine you have lots and lots of fast-spinning tops, and you give each one a slight nudge," Professor Malhotra said, "If you then take a snapshot of them, you will find that their spin axes will be at different orientations, but on average, they will be pointing to the local gravitational field of Earth."

Scientists said the most probable explanation for the discrepancy was the existence of a planet, similar in size to Mars, at the edge of the solar system. "The most likely explanation for our results is that there is some unseen mass, Volk said, "According to our calculations, something as massive as Mars would be needed to cause the warp that we measured."

Scientists hope the launch of the Large Synoptic Survey Telescope will help them spot the two new planets, should they exist. Scientific models suggest most planets that enter our solar system would be ejected without causing a significant impact.

The independent

Better batteries

Researchers at Singapore's Institute of Bioengineering and Nanotechnology have developed a new way of producing more durable and longer-lasting lithium-ion batteries, which are used to power an array of things, from mobile phones to electric cars.

They have invented a method to produce anode materials, made from metal oxide nanosheets, for lithium-ion batteries. The simpler and faster way uses graphene oxide, a 2D carbon material with chemical reactivity that facilities the growth of metal oxides on its surface.

Graphene oxide was used as the template to grow metal oxides into nano-sheet structures via a simple mixing process, followed by heat treatment.

"The new technique takes one day to produce the nano-sheets, compared with one week for previously reported methods. It does not require the use of a pressure chamber and has just two steps in the synthesis process, making the nano-sheets easy to manufacture on a large scale," IBN said.

IBN, an institution under the Agency for Science, Technology and Research, said that the anodes made from metal oxide nano-sheets, which are 50,000 times thinner than a sheet of paper, allow faster charging of power compared with current battery technology. The wide surface area of the nano-sheets also makes better contact with the electrolyte, increasing the storage capacity. It is also durable and does not break easily, which improves the battery shelf life, IBN said.

The Straits Times/ann

Meeting cellular needs

Eukaryotic cells are made up of organelles, the most prominent of which is the mitochondria

TAPAN KUMAR MAITRA

The internal volume of the cell exclusive of the nucleus is called the cytoplasm and is occupied by organelles and by the semi-fluid cytosol in which they are suspended. Let's take a look at each of the major eukaryotic organelles. In a typical animal cell, these compartments make up almost half of the total internal volume of the cell.

As one continues on a tour of the eukaryotic cell and begins to explore its organelles, one may find it helpful to give these sub-cellular structures a human perspective and acquainting oneself with some of the hereditary human diseases that are associated with specific organelles. In most cases, these disorders are caused by genetic defects in specific proteins — enzymes and transport proteins, most commonly — which are localised to particular organelles.

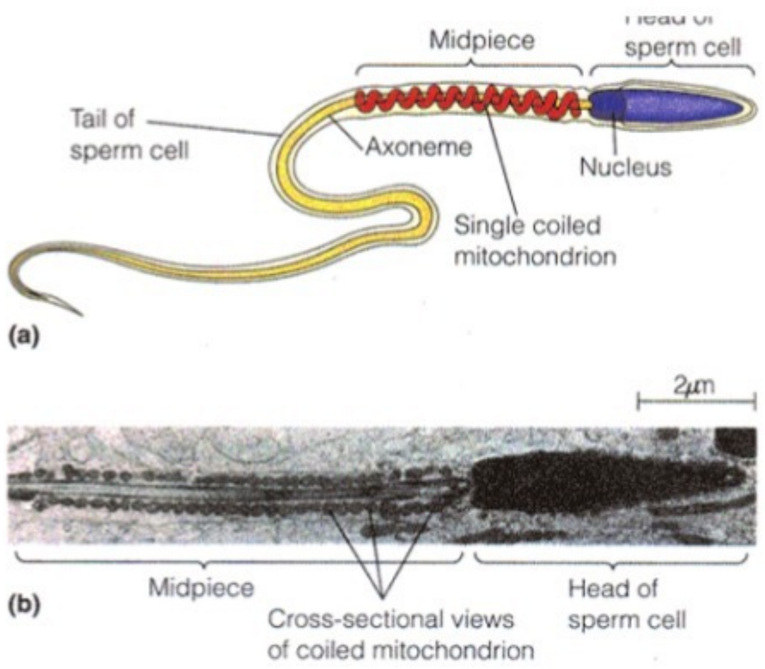
Our tour of the eukaryotic organelles begins with a very prominent organelle, the mitochondrion. Mitochondria are large by cellular standards — up to a micrometre across and usually a few micrometres long. A mitochondrion is therefore comparable in size to a whole bacterial cell. The fact that most eukaryotic cells contain hundreds of mitochondria, each approximately the size of an entire bacterial cell, emphasises the great difference in size between prokaryotic and eukaryotic cells. The mitochondrion is surrounded by two membranes, designated the inner and outer mitochondrial membranes.

Most of the chemical reactions involved in the oxidation of sugars and other cellular "fuel" molecules occur within the mitochondria. The purpose of these oxidative events is to extract energy from food and conserve as much of it as possible in the form of the high-energy compound Adenosine Tri- Phosphate. It is within the mitochondrion that the cell localises most of the enzymes and intermediates involved in such important cellular processes as the Tri-Carboxylic Acid cycle, fat oxidation, and ATP generation. Most of the intermediates involved in the transport of electrons from oxidisable food molecules to oxygen are located in or on the cristae, in foldings of the inner mitochondrial membrane. Other reaction sequences, particularly those of the TCA cycle and those involved in fat oxidation, occur in the semi-fluid matrix that fills the inside of the mitochondrion.

The number and location of mitochondria within a cell can often be related directly to their role in that cell. Tissues with an especially heavy demand for ATP as an energy source can be expected to have cells that are well endowed with mitochondria, and the organelles are usually located within the cell just where the energy need is greatest. This localisation is illustrated by the sperm cell.

As the drawing indicates, a sperm cell often has a single spiral mitochondrion wrapped around the central shaft, or axoneme, of the cell. Notice how tightly the mitochondrion coils around the axoneme, just where the ATP is actually needed to propel the sperm cell. Muscle cells and cells that specialise in the transport of ions also have numerous mitochondria located strategically to meet the special energy needs of such cells.

Fluorescent images of mitochondria in living cells show them to be very large and highly-branched. This type of structure is more widespread than just in sperm mid-pieces and may, in fact, be more representative of mitochondrial shape and size than most conventional diagrams indicate.



The single mitochondrion present in a sperm cell is coiled tightly around the axoneme of the tail, reflecting the localised need of the sperm tail (flagellum) for energy, (a) A schematic drawing of a sperm, (b) An electron micrograph of the head and the midpiece of a sperm cell from a marmoset monkey.

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