

This time last year, Martin Novak, Director of the Program for Evolutionary Dynamics and Professor of Mathematics and Biology at Harvard University, published a controversial book called, *Super Cooperators, (Altruism, Evolution and Why we Need Each Other to Succeed)* arguing that cooperation is as much a driving force for evolution as mutation and natural selection. The book was co-written by *Daily Telegraph* columnist and *New Scientist* editor, Roger Highfield, and will be serialized in the *Daily Telegraph*.

The book evolved from the Program for Evolutionary Dynamics which was established in 2003 from a \$30 million dollar grant by Jeffrey Epstein and The Jeffrey Epstein Foundation. "I wanted to provide a platform where evolution and biology could be explained from a purely mathematical point of view," Epstein notes. "The beauty of mathematics is in its accuracy and objectivity. It can lead to unpredictable theories." Since then, Novak and the Program have gone on to establish the first quantitative analysis of several diseases including the kinetics behind in vivo human cancer cells.

The premise of *Super Cooperators* is that mathematically, biological cooperation is as important in evolution as mutation and the dog-eats-dog world of Darwin's survival of the fittest. Novak stresses that, "The two pillars of evolution are mutation and natural selection: mutation generates diversity, and natural selection chooses the winner. What I want to argue in this book is that, in order to get complexity, there is a third principle, co-operation. It's not just a small phenomenon; it's something that's really needed to explain the world as we see it."

Novak's description of evolutionary cooperation is not to be confused with inclusive fitness, a core tenant of evolutionary cooperative theory today. Inclusive fitness suggests that evolution can favor creatures that do not reproduce, so long as they assist in the survival and reproduction of relatives who carry the same genes – for example, the sterile workers in an ant colony, who help the queen to raise their sisters.

According to Novak, inclusive fitness is "somewhat like an epicycle," referring to the Ptolemaic solar system with the Earth at its center. The theory required the planets to move in complicated patterns to explain their varying orbits. "Somehow you have the impression that there is some reality attached to it, but the actual mathematical description of any evolutionary process shows that evolutionary fitness is an unnecessary concept."

Instead, *Super Cooperators* sets forth five mechanisms of cooperation that *are* mathematically necessary for evolution: direct reciprocity, indirect reciprocity, spatial games, such as networking, group selection and kin selection. Cooperation also functions at every biological level: "Genes cooperate in cells, cells cooperate in organisms, and individuals cooperate in societies." Each mechanism, such as direct reciprocity, also reveals a *de facto* co-existence and co-dependence of entities, which just so happens to lead to evolutionary change. Evolution therefore, is more of a mathematical by-product than a goal.

Even kin selection, which includes nepotism or sacrifices for the survival of a relative, has a pragmatic explanation, such as embedded chemical triggers to promote one's genes: strip the lamb of its scent and its mother will let it die. Cover an orphaned lamb in the placenta of a ewe's offspring and she will adopt it as its own.

To understand sacrifice and acts of kindness to nonrelatives and to complete strangers, however, Nowak ostensibly agrees with evolutionary biologist and renowned atheist, Richard Dawkins, that there could be lingering cooperative genes carried over from when survival stemmed more from the capacity to live harmoniously in clans. Indeed, the human body is awash with evolution's remnants: from eyebrows to useless male nipples.

But despite the dispassionate description of cooperation in strictly mathematical terms, Novak is a devout Catholic. Benevolence is also part of God's bequest he believes and cannot be limited to a mere linear sequence. It's not even a question of belief but one of faith. And faith is simply a state of grace.

To debate the origin or purpose of cooperation though, misses the point of the book. *Super Cooperators* is about the power of mathematical description and how, when left onto its own, untarnished by ideas and theories, it has the capacity to describe the truest patterns of life. It sets the stage for analysis. Novak writes, "At the heart of a successful mathematical model is a law of nature, an expression of truth that is capable of generating awe in the same way as Michaelangelo's extraordinary sculptures, whose power to amaze comes from the truth they capture about physical beauty."