

Towards a Darwinian theory of decision making: Games, markets and the biological roots of behaviour

Peter Hammerstein*, Gerd Gigerenzer**

*Institute for Theoretical Biology, Invalidenstr. 43, 10115 Berlin

**Max Planck Institute for Human Development, Lentzeallee 94, 14195 Berlin

Game theory studies problems of decision making in the context of strategic interaction. The history of this discipline has been shaped by endless debates on how to approach such problems using appropriate ‘solution concepts’. In many of these concepts the Nash equilibrium plays a central role. For decades after it had first been proposed by John Nash, this equilibrium was routinely viewed as an attempt to mathematically capture a basic aspect of rational decision making. This interpretation of the Nash equilibrium requires a strong assumption of the kind that “all players in the game know that all players in the game know that all are rational” – an artificial scenario with fictitious beings rather than human players. In the actual human world, a rational decision maker would of course have to consider the realistic properties of others, properties that are biologically and culturally induced. Unrestrained by this objection, a number of refinements of the Nash equilibrium have been suggested in pursuit of a concise concept of rationality. The more concise this concept became, however, the more game theory lost touch with reality, undermining its scientific relevance. But even when the monument of game theory started to crumble, some attempts to put a new monument on its pedestal came close to a remake. What sense does it make, for example, to acknowledge the boundedness of rationality assuming limited memory of the player and then let the same player have a superbrain with unlimited computational power, solving any optimization problem at no cost in no time?

This problem was elegantly circumvented when decades ago biologists created a new conceptual foundation of game theory. In their evolutionary game theory, the computation of strategies was ‘laid into the hands’ of natural selection, a powerful mechanism for creating adaptive properties. From the early work by John Maynard Smith and others it quickly became evident that the Nash equilibrium plays a central role again, but this time in an edifice of thought with empirical content. In addition, the replicator equation - the simplest model for natural selection – turned out to be interpretable as a social learning process. Based on this interpretation, a parallel branch of evolutionary game theory flourished towards the end of last century in economics and the social sciences. This parallel with biology is less solid than it seems, however, since the replicator equation often fails to realistically capture human social learning in populations.

Returning to biology, some of the refinements of the Nash equilibrium can play a role when they are applied with great caution and in the appropriate context. Perfect equilibria matter, for example, in the evolutionary study of conflict between males and females over parental investment. The concept of trembling hand perfection helps us understand who takes the burden of parental care and why the division of labour among males and females is in most species very ‘unfair’. This in turn matters to the study of animal mating markets, where biologists need to understand why market clearance (according to the law of supply and demand) typically fails to occur. Biological markets differ generally from the conventional Walrasian market model in that potential trades cannot be subject to a complete contract that is enforceable at no cost to the exchanging parties. It would thus be unwise to blindly apply the concept of market clearance to biology.

The biological version of game theory has now spread through the life sciences. Even in medicine researchers have started to think about problems in the spirit of evolutionary game theory. Strategic analysis contributes, for example, to the understanding of drug seeking and addiction. Yet, while there has been a steady increase in the number of fruitful applications to real life, we also observe an ever growing body of abstract modelling attempts that relate little if at all to biological facts. Some highly suggestive ideas from original game theory and its biological counterpart, such as the logic of cooperation in repeated games, do not stand up well to empirical scrutiny. The project aims to explore why game theory has created these illusions and how its concepts can be revised in order to achieve a closer match with reality.