Marquette Law Review

Volume 87
Issue 4 *Special Issue* Article 16

2004

Game Theory: Game Theory Behaves

David Sally

GAME THEORY BEHAVES

DAVID SALLY*

I. INTRODUCTION

Half a century ago, bargaining was central to the maturation of game theory, a field that uses mathematical theories and laboratory experiments to study strategic interaction. Traditionally, the analysis of what would happen when two economic actors negotiated over a trade of their endowed goods had yielded a plethora of potentially viable contracts.[1] John Nash attacked this indeterminacy by making "certain idealizations" and employing mathematics in order to obtain a single solution that determined "the amount of satisfaction each individual should expect to get from the situation."[2] His idealizations assumed "that the two individuals are highly rational, that each can accurately compare his desires for various things, that they are equal in bargaining skill, and that each has full knowledge of the tastes and preferences of the other."[3]

Nash's beautiful bargaining solution can be easily expressed. First, accurate comparison of desires allows each bargainer's preferences to be represented by a utility function, u_1 or u_2, respectively. Second, each bargainer has a threat point, the outcome if no deal occurs—in current negotiation parlance, the best alternative to a negotiated agreement, $BATNA_1$ and $BATNA_2$. The solution to the negotiation is the contract that maximizes the following multiplicative quantity:

$$(u_1 - BATNA_1) \cdot (u_2 - BATNA_2)$$

More importantly, Nash demonstrated that his idealizations could produce a solution in not just the bargaining game, but all other games as well.[4] The Nash equilibrium is a pair of strategies in a two-player game that are the best possible responses to each other. For example, there is one Nash equilibrium in the matching pennies game. Two players have a penny and must decide

* Ph.D. University of Chicago; A.B. Harvard.

1. F.Y. EDGEWORTH, MATHEMATICAL PSYCHICS: AN ESSAY ON THE APPLICATION OF MATHEMATICS TO THE MORAL SCIENCES (1881).
2. John F. Nash, Jr., *The Bargaining Problem*, 18 ECONOMETRICA 155 (1950).
3. *Id.*
4. John Nash, *Two Person Cooperative Games*, 21 ECONOMETRICA 128 (1953).

which face to show. One player wins if the same face (head or tail) is shown; the other wins if there is a mismatch. The stable pair of strategies consists of each player flipping his or her coin so that the presented face is chosen randomly. Given the other side's strategy of flipping, the best possible response is to randomize between heads or tails. Nash's foundational result was to prove that *every* game, without exception, has at least one equilibrium pair of strategies.

Of course, Nash understood how important his idealized assumptions were to his proof. With respect to whether his model matched the reality of the bargaining game, he wrote, "the usual haggling process is based on imperfect information, the hagglers trying to propagandize each other into misconceptions of the utilities involved. Our assumption of complete information makes such an attempt meaningless."[5] A greater part of the history of game theory over the last half century involves the analysis of what happens when these assumptions of perfection are relaxed, and the comparison of the outcomes predicted by the formal models and those chosen by players in real games. Much of the former development involves technical advances and mathematical sophistications that are beyond our purview here.[6] The second set of developments, however, is essential to our purpose as it has demonstrated that accepted formal models often predicted "heads" when players in the laboratory or market played "tails." Such mismatching was disconcerting to members of a field who had empirical, scientific aspirations, and it is this disconcert that has led to the rise of behavioral game theory.

The purpose of this essay is to review a pocketful of the new matches between theory and reality that behavioral game theory has been responsible for in the last decade, especially those concurrences that have relevance to those who teach and study the bargaining game. One historical mismatch that I assume most readers are familiar with occurred in the testing of the prisoners' dilemma.[7] This game has served as an exemplar of the tension between cooperation and competition, between self-interest and joint maximization. Since this game and, to a lesser extent, the ultimatum game have been widely discussed and employed in negotiation classrooms, I will focus on games that are not as widely known and on newly identified motives for cooperative or fair behavior.

5. *Id.* at 138.

6. COLIN F. CAMERER, BEHAVIORAL GAME THEORY: EXPERIMENTS IN STRATEGIC INTERACTION (2003); DREW FUDENBERG & JEAN TIROLE, GAME THEORY (1991).

7. For a review of experimental results, see David Sally, *Conversation and Cooperation in Social Dilemmas: A Meta-Analysis of Experiments from 1958 to 1992*, 7 RATIONALITY & SOC. 58 (1995).

II. New Games, New Motives

A. Strategic Sophistication

One of the primary pieces of advice offered to negotiators is to prepare, prepare, prepare, just like the Boy Scouts, only more. The negotiator is told to consider not only her own interests and issues, but also those of her opponent. Yet, there is a basic question that is almost never addressed: Should I prepare for a prepared opponent or an unprepared opponent? This question and its more complicated variants (prepare for a prepared opponent who knows I am preparing?) involve the issue of strategic sophistication. A high degree of strategic sophistication was inherent in Nash's idealizations: His equilibrium arises from two very rational players who choose strategies that are reciprocally the best responses to each other. However, if one player is boundedly rational and not really thinking things through, the other's best response to this naïvete might be quite different from the Nash equilibrium strategy.

A clever new guessing game that can diagnose strategic sophistication was introduced in 1995.[8] The standard numerical guessing game involves a group of players trying to come closest to a target integer between zero and one hundred that someone has picked. This someone might be, for example, a third grade teacher deciding which student gets to take the class bunny home and care for it over vacation week. Here, in Nagel's version, the target number is generated by the players themselves—it is some positive fraction, greater than zero and less than one, of the average of all of their guesses. The person closest to this sheared mean wins a prize. Players need to anticipate where the average guess will be and then adjust downward, a cognitive process that depends on making some assumptions about the other players.

As a numerical example, suppose there are ten players whose guesses are equally spaced between 0 and 90, i.e., 0, 10, 20, 30, etc. Suppose, also, that the target is ½ of the mean. Then, the average guess is 45, the target is 22½, and the person who guessed 20 would win. Note that the person who guessed 90 is not even close. If you held everybody else's guesses fixed, then she would much prefer to change her guess to 19.[9] Now, the person guessing 80 would like to slash her guess, and so on. It turns out that the only Nash equilibrium consists of each player guessing 0.

Because of the structure of the game, a player's guess reveals how

8. Rosemarie Nagel, *Unraveling in Guessing Games: An Experimental Study*, 85 AM. ECON. REV. 1313 (1995).

9. The solution to the equation that sets one half of the new mean equal to her guess, x: 1/2 *(360+x)/10=x.

sophisticated she believes the other players are. Assume, for the moment, that all the players except for one are not even bothering to think through the game. We can call them zero-step players because they refuse to enter into the strategic domain, foregoing any consideration of what might be the best move. If our tenth player was strategic, she would choose the best response to her naïve co-participants. This one-step player would select 24,[10] and would win the game if her prediction about the other players comes true. A two-step player would make a best response to opponents who are all one-step players—a guess of 11.[11] Three-step players would assume that all others are two-step and would choose the corresponding strategy. The process continues and converges on Nash's idealized players who are infinitely sophisticated and choose 0. Note that this progression makes the number line diagnostic, as only zero-step players will make guesses significantly greater than 25, one-step players will be around 25, two-step players will cluster around 11, and the like.

Experimental tests have revealed how far real players are from Nash's archetypes: the strong majority of participants are either one-step or two-step players.[12] The remainder are more likely to be zero-step than three-step or more. Other games and experimental technologies have confirmed this finding of modest strategic sophistication.[13] The best place to be in these games, all else being equal, is close to the two-step players, adjusting upward if the game is complicated and more zero-step players are anticipated, or downward if more two-step players are forecasted. In the example game above, that position might be a guess of 13 or 14.

These behavioral game theory results provide a foundation for training in negotiation. Many bargainers are one-step strategists, worried only about their own interests and outcomes and incurious about those of the other side. Much of the knowledge imparted in the classroom is designed to make students be two-step strategists. The prescriptive rule is that you want to be one degree more strategically sophisticated than your counterparts, for it can be just as costly to over-think a negotiation as to under-think it (5 is as bad a

---

10. Because the nine zero-step players would be choosing randomly, the expected total of their guesses is 450. The one-step player solves the following equation to determine her best guess, x: 1/2 *(450+x)/10=x.

11. The solution to 1/2 *(216+x)/10=x.

12. Nagel, *supra* note 8; Teck-Hua Ho et al., *Iterated Dominance and Iterated Best Response in Experimental "p-Beauty Contests,"* 88 AM. ECON. REV. 947 (1998).

13. Miguel Costa-Gomes et al., *Cognition and Behavior in Normal-Form Games: An Experimental Study*, 69 ECONOMETRICA 1193 (2003); T. Hedden and J. Zhang, *What Do You Think I Think You Think? Strategic Reasoning in Matrix Games*, 85 COGNITION 1 (2002); Dale O. Stahl & Paul W. Wilson, *On Players' Models of Other Players: Theory and Experimental Evidence*, 10 GAMES & ECON. BEHAV. 218 (1995).

guess in the example game as 25 is). "Plan, plan, plan" may be too much; "plan plus one" (i.e., go one step further than your opponent) may be just right. In addition, there is a good chance that your counterpart is a one-step player, and therefore, you will need to directly educate him or her about your interests and issues. The counterpart's reticence and lack of inquiry may be due to ineptitude rather than strategy.

B. Learning

As one might imagine, if these guessing games are repeated with the same players, all the guesses drop pretty quickly to the Nash equilibria.[14] Players are effective and quick learners in this type of game, but there are others in which the players never quite figure things out. Learning, both the speed and process of knowledge acquisition and its strategic implementation, has been a very active topic in game theory. Theories and experiments investigate whether players use history to alter their assumptions about other players and then optimally respond to these changed expectations, or use it simply to mimic strategies that won in earlier rounds.[15] Note that the first approach, "fictitious play," takes more cognitive effort than the second, "reinforcement." A hybrid model that allowed for both learning approaches, depending on the characteristics of the individual and the game, was able to explain the evolution of strategic choices by many players in a wide range of repeated games.[16]

This hybrid model was predictive in part because it allowed sophisticated players to both learn and to anticipate that others were learning as well.[17] Consider the guessing game for a last time, and suppose the target (½ of the mean) for the first round turned out to be 13. Pure reinforcement learners might choose 13, naïve fictitious play learners would choose 6 or 7, but more sophisticated learners would anticipate the learning of the other players and adjust their strategy accordingly. Camerer writes, "[A]s players gain experience with the game, the degree of sophistication rises—they learn that others (like themselves) are learning."[18]

---

14. Ho et al., *supra* note 12.

15. Y.W. Cheung and D. Friedman, *Individual Learning in Normal Form Games: Some Laboratory Results*, 19 GAMES & ECON. BEHAV. 46 (1997); I. Erev and A. Roth, *Predicting How People Play Games: Reinforcement Learning in Experimental Games with Unique, Mixed-Strategy Equilibria*, 8 AM. ECON. REV. 848 (1998).

16. Colin Camerer and Teck-Hua Ho, *Experience-Weighted Attraction Learning in Normal-Form Games*, 67 ECONOMETRICA 827 (1999).

17. Colin F. Camerer et al., *Sophisticated Experience-Weighted Attraction Learning and Strategic Teaching in Repeated Games*, 104 J. ECON. THEORY 137 (2002).

18. Colin F. Camerer, *Behavioral Studies of Strategic Thinking in Games*, 7 TRENDS COGNITIVE SCI. 225, 225-31 (2003).

Negotiation scholars, because of their familiarity with the prisoners' dilemma, are well versed in the effects of repetition on creating value and encouraging cooperation. They are less attuned to the learning that takes place across repetitions. On the experimental side, the reason for this is due to the pools of the usual subjects—students enrolled in a negotiation class and those from the larger campus. The former are rarely, if ever, confronted with the same negotiation from an earlier week, and the latter are generally quite inexperienced negotiators.

Negotiation should follow the lead of game theory and place learning near the top of its research agenda. The relationship between learning and complexity and the relative importance of reinforcement and fictitious play lead to many fascinating questions that could be studied more rigorously:

- If a negotiator has success with a particular tactic, how likely is she to use that tactic in the next negotiation? Conversely, if a counterpart has succeeded with a tactic, under what conditions are you likely to trot out the same tactic, or, go one step deeper and introduce a counter-tactic?
- What is the most effective way to teach key principles such as interest-based bargaining? Is there a path or process that is clearly to be preferred? I know that I am always disappointed when my negotiation students fail to craft a contingency contract for a second time after having learned about them a few weeks earlier.
- Does the Nash bargaining solution appear more frequently when negotiations are recurring?
- How much is experience worth? What is the return on the investment of sending a neophyte negotiator to the bargaining table?

C. Social Preferences

A basic principle of negotiation, one that is learned through both reinforcement and the negative effects of its absence, is trust. The trust game was developed in the last ten years and has been employed as another tool to examine the factors of cooperation, reciprocity, fairness, and generosity that the prisoners' dilemma and ultimatum games have traditionally illuminated.[19] The trust game is a two-person bargaining game that is played as follows: Player *P* is given a certain amount of money, say, $10. *P* may give some portion of the endowment to the other player, the receiver, *R*. Every dollar

19. Joyce Berg et al., *Trust, Reciprocity and Social History*, 10 GAMES & ECON. BEHAV. 122 (1995).

that *P* sends to *R* is doubled or tripled. *R*, then, makes another allocation decision—how much of the newly augmented pot will be remanded to *P*. (This basic game is varied by constraining the options for the amounts offered to *R* and back to *P*.) As is true in its companion games, the trust game rarely results in the uncooperative, untrusting Nash equilibrium of no money being sent in either direction. Rather, positive amounts are usually sent and reciprocated, with the mean and median being around half of the total.[20]

The unmistakable implication of these results to behavioral economists has been that individuals are endowed with social preferences, not with the atomistic, self-concerned preferences traditionally assumed in economics.[21] "Full knowledge of the tastes and preferences of the other" [22] reveals that the other places some weight on the utility of the self (and vice versa). Nash's bargaining solution is transformed:

$$(u_1 + \lambda_{12}u_2 - \text{BATNA}_1)\cdot(u_2 + \lambda_{21}u_1 - \text{BATNA}_2),$$

with λ_{ij} representing the weight player i places on player j's utility. Although such weights are an idea with deep roots in economics going back to Adam Smith and Alfred Marshall, it is only recently that formal other-concern has moved from the margins to a central object of study.[23]

Behavioral game theorists have rediscovered the importance and malleability of intentions. A willingness to trust the other party and the evaluation of an offer as fair depend critically on our perception of the other's intentions.[24] In the trust game, for example, if player *P* publicly forgoes a lucrative option, receiver *R* is much more likely to be generous than if *P* had no choice.[25] The reason, of course, is that *R* credits *P* with good intentions in the first case but not in the second. The utility weight, λ_{ij}, is negative if player j has bad intentions and deserves to be punished, but it is positive if player j is credited with good intentions and deserves to be rewarded.

The perception of intentions, like all perceptions, is ultimately subjective. It is influenced by the personality of the perceiver, the particulars of the social

---

20. *Id.*; Kevin A. McCabe et al., *Reciprocity, Trust, and Payoff Privacy in Extensive Form Bargaining*, 24 GAMES & ECON. BEHAV. 10 (1998).

21. Gary Charness & Matthew Rabin, *Understanding Social Preferences with Simple Tests*, 117 Q. J. ECON. 817 (2002); David Sally, *A General Theory of Sympathy, Mind-Reading, and Social Interaction, With an Application to the Prisoners' Dilemma*, 39 SOC. SCI. INFO. 567 (2000).

22. Nash, *supra* note 2.

23. *See* ALFRED MARSHALL, THE EARLY ECONOMIC WRITINGS OF ALFRED MARSHALL, 1867-1890 (1975); ADAM SMITH, THE THEORY OF MORAL SENTIMENTS (Claredon Press 1976) (1790). For a review of the history, see Sally, *supra* note 21.

24. Matthew Rabin, *Incorporating Fairness into Game Theory and Economics*, 83 AM. ECON. REV. 1281 (1993); Sally, *supra* note 21.

25. Kevin A. McCabe et al., *Positive Reciprocity and Intentions in Trust Games*, 52 J. ECON. BEHAV. & ORG. 267 (2003).

interaction, and the norms and rules of the greater society. One measure of personality is social values orientation, which is disclosed through a series of outcome choices involving various payoffs for self and other.[26] Those who are identified as "prosocial" in this test tend to be more cooperative in a variety of games and are more productive in integrative negotiations.[27] More importantly, if the players are physically or psychologically close, prosocial behavior is much more likely.[28] The chance to make eye contact, co-presence in a room, shared opinions and attitudes, similarity of appearance and tastes, positive mood and affection all make trust more likely and reliably boost λ_{ij}.[29] One study of the trust game allowed participants to meet each other and identify commonalities before choosing, and these participants sent significantly larger offers than did the anonymous, distant subjects of other experiments.[30] Finally, the norms of society serve as a basis for the perception of intentions and the appropriate ways to react to benign or malign intent. A trust game played across segments of Israeli society discovered that all segments were equally unlikely to trust a receiver whose family emigrated from Africa or Asia.[31] Despite the fact that these Israelis remitted as large a proportion as did those whose families originated in America or Europe, they were entrusted with, on average, only half of the amount that the "Western" Israelis were, and far more "Easterners" than "Westerners" were given nothing at all. The most parsimonious explanation is that the norm in Israel considers "Easterners," wrongly, to be unreliable and ungenerous.

That economists have finally recognized social preferences may be greeted by negotiation researchers with a chorus of "it's about time" and "so what?" Nevertheless, this belated "discovery" does present some challenges and opportunities, if only to respond to economists' innate desire to model and measure as much as they can. Clearly, the process of negotiation may alter social preferences and raise or lower λ_{ij}: the questions are, how much? how often? at what cost? For example, schmoozing can be thought of as the exchange of trivial personal information with the goal to find salient and

---

26. D.M. Messick & C.G. McClintock, *Motivational Basis of Choice in Experimental Games*, 4 J. EXPERIMENTAL PSYCHOL. 1 (1968).

27. Carsten K.W. De Dreu et al., *Influence of Social Motives on Integrative Negotiations: A Meta-Analytic Review and Test of Two Theories*, 78 J. PERSONALITY & SOC. PSYCHOL. 889 (2000).

28. Elizabeth Hoffman et al., *Social Distance and Other-Regarding Behavior in Dictator Games*, 86 AM. ECON. REV. 653 (1996); Janice Nadler, *Rapport in Negotiation and Conflict Resolution*, 87 MARQ. L. REV. 875 (2004); Sally, *supra* note 21.

29. The complete argument including connections to the literature in social and cognitive psychology is contained in Sally, *supra* note 21.

30. Edward L. Glaeser et al., *Measuring Trust*, 116 Q. J. ECON. 811 (2000).

31. C. Fershtman and U. Gneezy, *Discrimination in a Segmented Society: An Experimental Approach*, 116 Q. J. ECON. 351 (2001).

public similarities that, in turn, will foster trust (e.g., "You were in Des Moines last week? Oh, my cousin's best friend's mother is from there.") How much value is there in schmoozing, physical co-presence, familiarity, and other factors that narrow social distance?[32]

Because we actively, and sometimes unconsciously, participate in the preservation of our perceptions and preferences, situations of great conflict and social distance are especially troublesome. We perceive our enemies to be evil, distant, strange, unapproachable, unfamiliar, distasteful, and unknowable.[33] Moreover, we actively resist any evidence to the contrary. Hence, productive negotiations must take a great deal of time, and the process will necessarily have to decrease social distance slowly and imperceptibly.

Finally, there is renewed emphasis on the active management and manipulation of intentions. The following tactics are examples: letting the other side know that a valuable option was foresworn in order to bargain, demonstrating good faith by sharing information early on, apologizing for any wrongs perceived as intentional or excusing them as inadvertent errors,[34] and watching your wallet when someone is overaggressive about narrowing social distance.

D. Networks

The existence of social preferences means that friends will negotiate quite differently than strangers, and strangers who share a common acquaintance or know of each other will bargain differently than two completely disconnected individuals. Such network effects are yet another area of activity within game theory. Although networks have been extensively studied by sociologists, game theory's value added has been to develop strategic models of network formation and examine the tradeoff between individual incentives and overall network value.[35] Here, in these models, players are nodes and their primary decisions involve whether to create a connection with another player.

---

32. *See* Nadler, *supra* note 28.

33. D. Sally, *Into the Looking Glass: Discerning the Social Mind Through the Mindblind*, 18 ADVANCES IN GROUP PROCESSES 99 (2001).

34. *See* Jennifer Gerarda Brown, *The Role of Apology in Negotiation*, 87 MARQ. L. REV. 665 (2004).

35. Some of the most well-known works in sociology are K.S. Cook & R.M. Emerson, *Power, Equity, and Commitment in Exchange Networks*, 43 AM. SOC. REV. 721 (1978); K.S. Cook et al., *The Distribution of Power in Exchange Networks: Theory and Experimental Results*, 89 AM. J. SOC. 275 (1983); B. Markovsky et al., *Power Relations in Exchange Networks*, 53 AM. SOC. REV. 220 (1988); NETWORK EXCHANGE THEORY (David Willer ed., 1999). For a comprehensive survey of network game theory, see M.O. Jackson, *A Survey of Models of Network Formation: Stability and Efficiency*, *in* GROUP FORMATION IN ECONOMICS: NETWORKS, CLUBS AND COALITIONS (G. Demange and M. Wooders eds., forthcoming).

Network stability is, roughly, an extension of the Nash equilibrium—a network of connections is stable if no player wishes to erase a connection, and there are no unmade connections that would benefit one player without hurting another. Depending on the benefits and costs arising from connections, very different structures will be stable (e.g., a circle with each player linked to two others, or a star with every other player linked only to a central person).[36] In theory, players may form stable networks that leave a lot of socially profitable connections unmade.

As we have seen throughout this essay, the equilibria in theory are often not manifest in practice. One experiment that explicitly tested network theory found that very few participant groups were able to spontaneously and voluntarily organize themselves into a star network, a structure that results in a lower payoff for the central player.[37] Note that this difficulty arose in anonymous groups: It would be very valuable to learn how a richer social context—prior social ties, status, and reduced social distance—might alter the network.

Another approach to network analysis is embodied by sociology's network exchange theory which fixes the network structure and then tests how resources flow across the available links.[38] In bargaining terms, each connected pair of players is engaged in a simple distributive negotiation. The fixed structure creates varying BATNAs among the nodes since some players have only one possible trading partner, while others have two, three, or more. The key result is that central players with poor BATNAs claim less value than do peripheral players with better BATNAs.

Network game theory pushes and pulls negotiation research. The push is two-fold: First, to consider macro-social variables such as network structure and centrality and their effects in bargaining situations; second, and more importantly, to allow negotiators in theory and empirical work to choose their partners. Network formation could and should be studied in negotiations.[39] The pull is simple: Network research thus far has utilized the most minimal of

---

36. V. Bala and S. Goyal, *A Noncooperative Model of Network Formation*, 68 ECONOMETRICA 1181 (2000).

37. A. Falk and M. Kosfeld, It's All About Connections: Evidence on Network Formation (2003) (unpublished manuscript, on file with the University of Zurich).

38. *See supra* note 35. For an economics example, see G. Charness & M. Corominas-Bosch, Bargaining on Networks: An Experiment (2000) (unpublished manuscript, on file with the Universitat Pompeu Fabra).

39. For two early efforts along this path, see R. Larrick & G. Janicik, Social Network Schemas and the Learning of Incomplete Networks (2003) (unpublished manuscript, on file with Duke University); D.F. Sally & K.M. O'Connor, The Psychology of Entrepreneurship: Spanning the Structural Hole in Network Research (2003) (unpublished manuscript, on file with Cornell University).

negotiations—anonymous, distributive bargaining. Negotiation researchers know a great deal about testing richer social contexts and more complicated negotiations, and both of these elements would be extremely valuable additions to network game theory.

This essay, ultimately, concerns network formation. There ought to be a connection: A stronger link between negotiations and behavioral game theory would result in fruitful cross-fertilization not only in networks but also in strategic sophistication, learning, and social preferences.

APPENDIX: FURTHER READING

Colin F. Camerer, *Behavioural Studies of Strategic Thinking in Games*, 7 TRENDS COGNITIVE SCI. 225-31 (2003).

Robert Gibbons, *An Introduction to Applicable Game Theory*, 11 J. ECON. PERSP. 127-49 (1997).

Jacob Goeree & Charles Holt, *Ten Little Treasures of Game Theory and Ten Intuitive Contradictions*, 91 AM. ECON. REV. 1402-22 (2001).

David F. Sally, *Dressing The Mind Properly for the Game*, 358 PHILOSOPHICAL TRANSACTIONS ROYAL SOC'Y: BIOLOGICAL SCI. 583-92 (2003).

* * *