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How Werner Güth's ultimatum game shaped our understanding of social behavior☆

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ABSTRACT

Werner Güth's ultimatum game played a key role in the development of multiple research areas, several of which are highlighted.

1. Introduction

The ultimatum game (UG), introduced by Güth et al. (1982) in a classic article published in this *Journal*, depicts a two-person bargaining situation. Player 1 proposes a division of a sum of money. Player 2 observes the proposal and either accepts it, in which case payoffs will be as indicated, or rejects it, in which case the players make 0 each.

This special article for the special issue honoring Werner Güth highlights research areas where this game played a key role. The topics span game theory, learning, bargaining, fairness, reciprocity, discrimination, development, neuroeconomics, ethics, and bounded rationality, and the article ends with a citation analysis.

2. Werner's ultimatum game: a building block towards unified social science

By Eric van Damme [1]

A large part of economics is based on the joint assumptions that individuals are selfish and rational, and aims to understand observed outcomes of strategic or market interaction as equilibria of associated games. Other social sciences deviate from these basic assumptions. The UG challenges the first and spawned a very large literature challenging the second. It showed that we were in a *cul-de-sac* and forced us to reflect and move elsewhere. As a result, we now have a much better understanding of what motivates people and what are the limits on actual human rationality. Some of this understanding is even captured in formal models, which some researchers even call theories. While these, obviously, do not capture the full richness of human motivation and all limits of rationality, they offer possibilities for further improvement. This may ultimately lead to integration into economics of insights from psychology, sociology and law, thus leading to a unified social science, with game theory being a main methodology.

☆ We present this article as a single one with many coauthors, but different people had sole responsibility for each section (as indicated). We are very grateful to Lea Pyhel who helped us create the unified document.

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How has the ultimatum game changed my perspective on economic behavior? As many things happened in 30 years, it is impossible to answer this question. The UG was published in the same year as Rubinstein's paper on alternating offer bargaining, and the subsequent literature built on both. In human behavior, one can distinguish between ends and means, between motivation and rationality. The first is concerned with what drives people, the second with how they reason and come to decisions; are the means appropriate for the ends? Assuming selfishness of individuals, the experimental literature after Güth, Schmittberger and Schwarze (GSS) first focused on the rationality question, investigating whether players do backward induction. The attention for "what drives people?" came only later. I will limit myself mainly to this aspect, as I personally have learned more about it and believe that a satisfactory "theory" of bounded rationality is still further away. The most important direct lessons are that people are different and that their behavior differs in systematic ways from that assumed in conventional models. More generally, the 30 year history of the UG shows the importance of continuity, cumulativeness and simplicity in science. One further lesson is that assumptions that are originally introduced as "first approximations," over time, get to be viewed as being part of the core of a discipline, until they ultimately become untenable and crumble away. As collectively we seem to suffer from imperfect recall, perhaps intellectual effort would be better spent at the margin if we had at least some sense of a field's history.

I first met Werner in September 1979, when we were both presenting in the same session at an Operations Research conference in Germany. I had started working on my PhD-thesis 6 months earlier and it was my first presentation ever. I was quite nervous, also because I was quite confused about my topic. I had followed courses (with Stef Tijs) on non-cooperative and cooperative game theory. I considered the latter more elegant and easy, but it was also less satisfactory: it had multiple solution concepts and I could not accept its underlying assumption of social rationality. That the grand coalition always forms and that players reach an efficient outcome, which only depends on the characteristic function of the game, was hard to swallow.[2] I was puzzled by the lack of connections between the two branches of game theory and the absence of a theory of individual behavior in cooperative games. I hoped that the then recently published Harsanyi (1977) would solve my puzzles and had spent much of the previous months in studying classics (such as Luce and Raiffa's *Games and Decisions* and Schelling's *Strategy of Conflict*) in order to better understand that book and the foundations of game theory. In my presentation, I argued that Harsanyi's rationality postulates were not convincing. Werner presented joint work with Reinhard Selten on equilibrium selection in market entry games. As our work had the same underlying motivation (in the standard "rationalistic" interpretation of a game, the focus on Nash equilibrium is justified only when the equilibrium is unique), we naturally came to talk to each other. Although, in the fall of that year, Werner would do his UG experiments, we did not talk about that topic.

At that time, normative and descriptive game theories were completely separate. Reinhard Selten advocated a strong separation between the two, probably to bring out the sharp contrast and to emancipate the descriptive branch. As a "methodological dualist," he, however, was unique in contributing to both. I met Reinhard for the first time in the Oberwolfach conference on Game Theory in March 1980. He gave me a reprint of his Chain Store paper, as well as references to his papers on perfectness and that of Roger Myerson on proper equilibria. Each provided puzzles, but the first seemed insolvable, hence, the latter two shaped my research program. When pursuing this program for my PhD-thesis, I regularly visited Reinhard to get (very useful) feedback. As will be clear, most of the time, however, I simply listened to his ideas. Although experiments were sometimes mentioned, that topic was competing with evolutionary theory and rational theory. For me, the latter had to be completed first (through the refinement and equilibrium selection literature), before I could clearly see its limits and lapse out of "naïve rationalism".

To see from how far not only I have come, but also the profession, one should realize that still in 1979 Al Roth published his *Axiomatic Models of Bargaining*. The ESEM meetings were then dominated by mathematical economics and general equilibrium theory; research in game theory had just started to shift from cooperative theory to non-cooperative theory. With perhaps Germany as the single exception, economics was separated from psychology. Kahneman and Tversky's prospect theory was published in 1979 and IAREP (the International Association for Research in Economic Psychology) was founded only in 1982. This *Journal* only started in 1980.

There are clear traces of the 1970s in the GSS paper; for example, see the remarks on maximin-strategies and on the limited value of cooperative theory at the end of the paper. Furthermore, the paper not only discusses the UG as we now know it, but also a more complicated divide and choose game (DC). In the latter, there are 5 black chips and 9 white ones; P_1 divides them into 2 piles and P_2 chooses one of these. Both players know that P_1 values each chip at 2, while, for P_2, black chips are worth 2 and white ones 1. The SPE (subgame perfect equilibrium) on the basis of selfish preferences is easily derived: P_1 divides into white and black and P_2 takes the black ones, yielding payoff (18, 10). If P_2 would take the white chips, however, payoffs are (10, 9). Hence, P_2 can punish P_1 if P_1 exploits his favorable bargaining position. Interestingly, the SPE with selfishness predicts much better in DC than in UG. In UG, it is much clearer and immediately obvious that this SPE-outcome is unfair; DC requires calculation. Besides, DC is a real life game; hence, we may be more inclined to accept the game as well as the associated outcome. As GSS note, this may also explain why Fouraker and Siegel (1963), in their

[2] It is interesting that only 22 years after the publication of Von Neumann and Morgenstern (1944), George Stigler coined the term "Coase Theorem" for a very similar "result" that appears in the first part of Coase's 1960 paper *The Problem of Social Cost*. As far as I know, Stigler never related it to game theory. I also note that Coase never had much interest in this "Theorem"; for him it showed the incoherence of the conventional economic theory at the time and the importance of taking into account transaction costs; see Coase (1988), pp. 10–16.

"market" variants of the UG (Stackleberg games in which one player quotes a price and the other responds with a quantity), had not observed such large and systematic deviations from the SPE-prediction.

Werner has said that the second part of GSS is never read. The comparison of UG with DC, however, provides important lessons. At the time, Werner pursued a research program on fair division; he came to UG via DC and had studied much more complicated bargaining problems before. He has said that he wanted to study the most simple, but still interesting, bargaining situation. The UG satisfies this condition, but focusing on such a simple game does not come naturally. Perhaps, Reinhard Selten inspired Werner to also experiment with this game. The game is beautiful; it is trivial from the conventional game theoretic point of view, but psychologically it is very rich. Earlier experimental papers (such as Kalisch et al., 1954) had noticed that considerations of fairness can be confounding factors when testing theories of rationality, but had advised to manipulate the game such that these would not come to the forefront. For testing theories this may be fine, but for improving theories or finding better ones, Werner's approach seems better.[3]

A model cannot contain everything; by trivializing one aspect, another, perhaps more important, comes to stand out more clearly. The UG nicely illustrates Einstein's saying "Everything should be made as simple as possible, but not simpler." Only if we understand the basics, can we fruitfully move to more complicated settings. The UG has given rise to a series of other simple games (such as the dictator game, the trust game, gift exchange, and public goods games with punishment) which have allowed us to get a much better view on the psychological aspects involved in decision making. Many papers each making one small step together can yield one giant leap for mankind.

It has been said, even by Werner, that the UG demonstrates that game theory is wrong. While I might agree that game theory is faulty, I do not think that Werner's UG demonstrates this. Conventional game theory assumes that players have a Von Neumann Morgenstern utility function. The theory is consequentialist, hence, it assumes that each player $i \in N$ only cares about which outcome, $x \in X$, is realized. However, this does not imply that a player is selfish and cares only about "his part" of the outcome, x_i; there is nothing in the axioms that justifies the latter restriction. In fact, although the vNM-axioms preclude making interpersonal comparisons of utility, in both their zero-sum and their cooperative theory, the founding fathers actually assume $u_i(x) = x_i$. Hence, in their game theories, Von Neumann and Morgenstern make much more restrictive assumptions (comparability, transferability, materialistic selfishness and risk neutrality) than their 1-person decision theory allows. With such seeming inconsistency between the 1-person theory and its application in a social context, it is easy to understand why many people equate the players' payoffs in a game with material payoffs and not with utilities. The auxiliary assumptions, however, are not necessary for the theory; to the opposite, Nash has shown that a stronger theory is possible if one does not make the comparability assumption.

To a certain extent, the founders of game theory themselves are, therefore, to blame for some misunderstandings associated with their theory. Reviewing their text shows that we here have another instance of serendipity. While searching for selfishness, they found measurability and non-comparability. On p.8, they write:

> We wish to concentrate on one problem [the game problem, EvD] – which is not that of the measurement of utilities and of preferences – and we shall therefore attempt to simplify all other characteristics as far as reasonably possible. We shall therefore assume that the aim of all participants in the economic system, consumers as well as entrepreneurs, is money, or equivalently, a single monetary commodity.

A few pages later, on p. 16, they continue with:

> Many economists will feel that we are assuming far too much (. . ..) and that our standpoint is a retrogression from the more cautious modern technique of indifference curves' (. . .). We feel, however, that one part of our assumptions at least – that of treating utilities as measurable quantities – is not quite so radical as is often assumed in the literature. We shall attempt to prove this point in the paragraphs which follow.

Indeed, the formal proof was added as an Appendix to the second edition. The founders of game theory wanted to concentrate on their main contribution and to divide the difficulties. For that, they set out to justify their simplifying assumption of preferences being numerically representable (first sentence of the first quote), and they achieved exactly that, up to a positive affine transformation for each player. They, however, could not justify their second assumption, and I conjecture that, when pressed, they would have conceded that this was too much to ask for.

To make progress, compromises may be necessary. Concepts with weak foundations may not be entirely satisfactory, but may nevertheless be useful. Of course, what is useful in one context may be useless in another. The history of utility theory, as documented in Stigler (1950), shows how economists have always struggled with the trade-offs between tractability and realism. Even in a market context, great thinkers, in principle, always allowed for utility to depend on more than just own consumption. For reasons of tractability and a belief that, in a market context, selfishness was a good approximation, it was not pursued in depth. The imperialism of economics since the 1960s has been made possible to a considerable extent by the redefinition of the discipline in Robbins (1932). We now routinely state that "Economics is the science which studies human behavior as a relationship between ends and scarce means which have alternative uses" (p. 16), but we seem to have forgotten that Robbins' Essay contains, in Chapter IV, an extensive discussion on the relation between Economics and

[3] In Chapter 6 of *The Strategy of Conflict*, Thomas Schelling had already warned that there is a danger in too much abstractness; he rejected an exclusive focus on the mathematical structure of the game, and argued that empirical analysis forms an essential part of the study of games.

Psychology, the rationality assumption and "The Mythology of *Homo Œconomicus)*." Robbins does not only make clear that purposeful behavior is not the same as consistent behavior, but he also remarks that:

> The general absurdity of the belief that the world contemplated by the economist is peopled only by egoists or 'pleasure machines' should be sufficiently clear from what has been said already. (p. 94)

The extensive discussion on the UG has made clear that 50 years after Robbins' *Essay* was written, such belief was no longer as absurd as it was in the 1930s. Economics had expanded its domain, while simultaneously narrowing its view on human motivation; clearly these two don't match and things had to collapse.

Experiments with the UG and related games show that (most) people care about more than just their personal material payoffs. Several models have now been developed to better capture these aspects of human behavior. In line with tradition, the models that have been cited most thus far have retained the assumption of consequentialism. We know, however, that people care about more than outcomes: in a UG, P_2 is more likely to accept (9, 1) if this results from chance, or if the rules of the game force P_1 to make unfair offers. Intentions matter and betrayal aversion plays a role. It not only matters what players do, but also what they say; people don't like to be lied to. Behavior differs according to whether it is observed or not. Although consequentialist models are rejected by the data, they may be useful in bringing us further. However, even if they do fit the data, the question is whether they really *explain* these. Although I do not share Werner's critique on the neoclassical repair shop (I believe in gradual improvement), my work with him on the 3-person UG (Güth and van Damme, 1998) has convinced me of the importance of context dependence.

While a lot of work has already been done, we still seem far removed from having a satisfactory model of human motivation in our theories. Ever since I saw the results of the UG, I have been wondering "What is *really* explaining these results?" Subsequent experiments have provided clues and in thinking about which theory unifies these, I have found it useful to have Adam Smith's view of man as a benchmark. Adam Smith did not think of man as a rational utility maximizer. I find it striking how "true" his view appears and also how close it is to modern psychology (as I understand it) and to the "two systems" model of Kahneman (2011). It may, therefore, be useful to briefly sketch this view; also see Coase (1976).

Ashraf et al. (2005) have already linked several modern behavioral economics concepts to "follies in human behavior" that were discussed in the *Theory of Moral Sentiments* (TOMS).[4] However, they also write that, in TOMS, Adam Smith proposed "a theory of human behavior that looks anything but self-interested," and they suggest a tension with his *Wealth of Nations*, the latter being clearly based on self-interested behavior. While in a footnote they acknowledge that modern scholarship establishes that there is no essential contradiction between these two books, their paper nevertheless suggests that Smith viewed man, although being folly, as being nice and fair-minded. That, however, is a distorted picture. As Coase has stressed, Smith's view of man is almost entirely self-centered. People are driven mainly by how they think about themselves. True, Smith allows for altruism towards kin and the fact that people may rejoice in the pleasures of others; hence, man may treat others fairly because he wants to be *perceived* as fair and because it makes him feel good. Furthermore, he cares much more about procedural and retributive fairness than about distributional fairness. Man is concerned about others' fairness in the sense of them playing according to the rules and norms of the game; when there are violations, punishment is in order. As Konow (2003) makes clear, recent theorizing on fairness has, however, mostly been limited to distributional issues.

There is a deeper sense in which Smith's model of man deviates from the way he is pictured in most of the recent economics papers. In contrast to the consequentialist view that people care about *outcomes*, in Smith's view, people derive pleasure and pain from *thoughts* (or beliefs): people care how other people think about them. Smith's view is very game theoretic: being conscious, people can picture themselves in the shoes of the others; they can feel what they feel, and as such they can judge their own behavior. If we think others think badly about us, then we think badly about ourselves. Ultimately, we care only about what we think about ourselves.

Smith argues that behavior is determined by the struggle between the "passions" (including emotions) and the "impartial spectator." Behavior is under the direct control of the passions, but the internal spectator can intervene to control. The judgment of an act by the internal spectator (either *ex ante* or *ex post*) gives raise to feelings of pleasure and pain, which then guide behavior. The impartial spectator "subjects all the movements of our nature to what our own dignity and honor, and the propriety of our own conduct, require" (TOMS Part I, Chapter V, 1.1.40). In some cases, the passions may be so strong, however, that there is no control; in other cases, the impartial spectator is led astray. As it is more pleasurable to think about pleasures than about pains, we engage in self-deception; we engage more in the former, resulting in the follies of human behavior. However, others and society may benefit from such irrational behavior. The misguided belief that wealth brings happiness drives the market economy and enhances total welfare.

Clearly, this picture about what drives individuals is very different from what appears in our models. Similarly, Smith's view of how the economy works and how, by pursuing their private interests, individuals promote general welfare, is very different from the Arrow-Debreu formalization of the invisible hand. Whether individual "Smithian" motivation and behavior can produce collective optimality is completely unclear. Nevertheless, we have building blocks to formalize this picture and

[4] Among others: loss aversion, present-day bias, overestimating the marginal increase in well-being resulting from improvements in position or wealth, and overconfidence.

to investigate the conjecture. On the formal side, the idea that people care about beliefs has been resurrected by the theory of psychological games, as proposed in Geanakoplos et al. (1989), and further developed in, among others, Battigalli and Dufwenberg (2009). While their framework is very rich, it is also complicated to handle and I have not yet been able to construct with it a satisfactory model of a Smithian agent. The framework restricts beliefs to be derived entirely within the given game, so that there is no connection to social norms. People, however, come to a game carrying experience from previous games with them and I think it is important to take this into account. Maybe a satisfactory theory thus requires analyzing games in combination. Also on this dimension there is work to do and plenty of puzzles remain.

At present, positive and normative game theory are not as far apart as they were in 1979. We now even have the beginnings of a prescriptive game theory. The UG and its descendants provided a language allowing different social scientists to talk to each other. It facilitated me talking to, and working with, biologists, economists, lawyers and psychologists. I am very grateful that the UG was developed and I bow to its inventors.

3. Dynamic adjustment in the ultimatum game

By Kenneth G. Binmore[5], Alvin E. Roth[6], and Larry Samuelson[7]

3.1. Dynamic adjustment

It is well known that the behavior of experimental subjects in laboratory games normally changes over time. In games with a unique Nash equilibrium, convergence in population averages in the direction of this equilibrium is often reported when adequate time is available for effective trial-and-error adjustment. A leading example is the one-shot Prisoners' Dilemma in which roughly half of inexperienced subjects defect on average, but more than 90% defect after playing 10 times against a new opponent each time (Camerer, 2003, pp. 45–46; Ledyard, 1995; Sally, 1995). This phenomenon is observed even in games in which the unique Nash equilibrium requires the use of mixed strategies (Binmore et al., 2001). In the latter case, Roth and Erev (1995) show that simple variants of a model of reinforcement learning (Bush and Mosteller, 1955; Cross, 1983) can be successfully fitted to the population averages as they evolve over time.

With the exception of public goods games (of which the Prisoners' Dilemma is the simplest example), significant levels of dynamic adjustment seem largely to be absent in the experimental games regarded as canonical in the behavioral economics literature. In this brief paper, we offer a possible explanation for this apparent anomaly in the case of the UG, for whose study Werner Güth is justly celebrated (Güth et al., 1982; Güth, 1995).

3.2. How long does it take?

Roth and Erev (1995) simulate the use of a simple model of dynamic adjustment in the UG. Their model is a variant of that of Bush and Mosteller (1955) with rewards identified simply with money payments. The basic model is modified to take account of empirical regularities reported in the psychology literature and the practicalities of running simulations. (In particular, psychologists report that behavior in one-person learning problems flattens sooner than the Bush-Mosteller model predicts.) However, Roth and Erev argue that the precise details of the adjustment model employed are unlikely to matter greatly for the conclusions they report—an observation endorsed by the results discussed in the next section.

Roth and Erev find that their simulated adjustment behavior is consistent with that reported in experimental studies of the UG. Insofar as convergence toward the subgame-perfect equilibrium is observed, it takes a very large number of iterations. For the ten iterations or so that are common in experimental studies, little movement is observed from the initialized behavior. As Roth and Erev observe in this paper and elsewhere, their results suggest that the common assumption in economic theory that a subgame-perfect equilibrium will always be played in real-life games needs to be modified in cases like that of the UG in which experimental and simulation results show that any convergence toward an equilibrium is likely to be slow.

Why is adjustment slow in the UG but not in the Prisoners' Dilemma? A factor emphasized in the next section is that the subgame-perfect equilibrium in the UG (in which the proposer gets everything) is not the only Nash equilibrium. Any split of the money between the proposer and the responder is a Nash equilibrium outcome. In fact, such a multiplicity of neglected Nash equilibria is common in canonical experimental games, and so it is perhaps not surprising that the experimental results showing convergence in games with a unique Nash equilibrium do not seem to extend to such canonical games. An exception is the Best-Shot Game studied by Roth and Erev (1995) (in the same paper as the UG). In this game, which has structural similarities to the UG, they do find fairly brisk convergence to the subgame-perfect equilibrium. How come?

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[7] Larry Samuelson, Yale University, Larry.Samuelson@yale.edu. Larry Samuelson is grateful to the National Science Foundation (SES-1153893).

It is well known that experiments on behavior in the UG carried out in different cultures can yield different results (Henrich et al., 2004). The various initial conditions in Roth and Erev (1995) were taken from the first such paper (Roth et al., 1991), in which significantly different behavior was observed in Israel, Japan, Slovenia and the USA. It is commonly argued that such differences reflect variations in the fairness norms of different cultures. One expects the initial play of experimental subjects to be largely determined by these norms. In addition, the basin of attraction of the subgame-perfect equilibrium in the Best-Shot game is larger than its counterpart in the UG. If norms of behavior lead to an initial conditions in the Best-Shot game in the (relatively large) basin of attraction of the subgame-perfect equilibrium, while leading to initial conditions in the UG near one of the many Nash equilibria that are not subgame-perfect, it is not surprising that we observe convergence to subgame perfection in the former and very little movement in the latter. To put it another way, once we recognize that players adapt to their experience in a game, it becomes apparent that not only the equilibria of the game but also the landscape of incentives away from equilibrium will influence how the game is played as experience is gained.

3.3. Replicator dynamics

The work of Roth and Erev (1995) is complemented by Binmore et al. (1995) study of the replicator dynamics in the UG.[8] The replicator dynamics are imported from evolutionary biology and we use the language of population dynamics in describing the results.[9] However, one is also led to variants of the replicator dynamics by passing to continuous time in models of social learning through imitation and in models of individual reinforcement learning. The fact that the results endorse those of Roth and Erev (1995) therefore supports their contention that the precise details of the dynamics in their simulation are not important.

Fig. 1 shows a typical example (previously unpublished) of a very large number of computer simulations reported by Binmore et al. (1995). The version of the UG employed assumes that the original sum of money is $40. The simulation begins with Alice offering Bob about $33, leaving $7 for herself. This split of the money (like any other split) is a Nash equilibrium outcome in the one-shot UG. One has to imagine that the operant social norm in the society from which Alice and Bob are drawn selects this Nash equilibrium outcome from all those available when ultimatum situations arise in everyday life.

The figure shows a perturbed version of the replicator dynamics leading the system away from the vicinity of this (7, 33) equilibrium. The system eventually ends up at a (30, 10) equilibrium. This final equilibrium is not subgame-perfect (where the split would be (39, 1) because the offer of $0 is not allowed), but this fact is not the point of drawing attention to the simulation (because we can change the final outcome by varying how we perturb the dynamics). What is important here is that it takes some 6,000 interations before the simulated adaptive process moves the system any significant distance from the vicinity of the original (7, 33) equilibrium.

More generally, if a society's social norms lead inexperienced players to start playing close to a Nash equilibrium of a one-shot laboratory game, then, if there is any movement away from the original Nash equililibrium at all due to adaptive learning, we must expect such movement to be very slow at the outset.

3.4. Werner Güth

When Werner Güth received a first draft of Prasnikar and Roth (1992), which was written before but published after the four country study of Roth et al. (1991), it contained only a comparison of UGs and best shot games. In correspondence he suggested that the different results might perhaps have to do with the fact that no equitable outcome of the best shot game was also Pareto efficient, since the set of outcomes was non-convex. It was as part of this very productive and friendly dialog that market games were added to the comparison set: they have both an extreme equilibrium and equitable outcomes that are efficient.

It may be of interest to recall how experimental economics was regarded at the time of the publication of his 1982 paper with Schmittberger and Schwarze. During a marathon session in the bar on a visit to the London School of Economics, Reinhard Selten took delight in telling how his students had just confirmed his prediction that subgame-perfect equilibrium would fail in the UG. Binmore et al., (1985) were doubtful that the same result would be observed in a two-stage bargaining game (Binmore, 2007). But there was much hostility to experimental work in those days; theoreticians thought that there was no need to test their ideas and psychologists thought that there was no need to pay the subjects. The then editor of the American Economic Review was particularly hostile. However, he eventually published a much abbreviated version of the paper—but with its replication of Güth, Schmittberger and Schwarze's results relegated to a footnote. However, the profession has since rendered a different opinion of Güth et al. (1982), which has now garnered more than 2500 citations.

[8] The alphabetical ordering of the authors' names was somehow permuted during publication. Binmore and Samuelson (1999) extend this analysis to more general games.

[9] However, we do not argue that the social norms uncovered in experiments on the Ultimatum Game around the world are the end-products of such an evolutionary process because we do not think they are adaptations to one-shot versions of the Ultimatum Game.

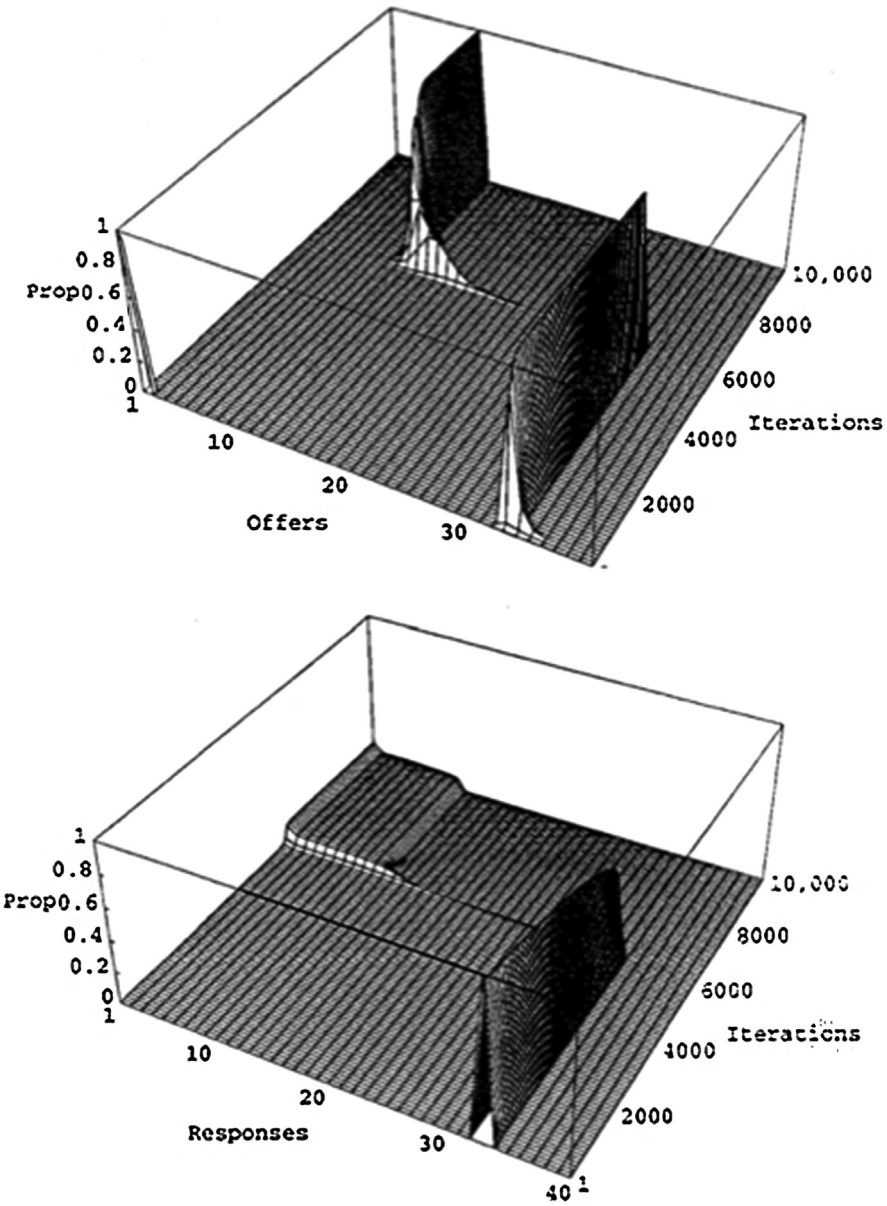

Fig. 1. Replicator dynamics in the Ultimatum Game. Two large populations of players (proposers and responders) are programmed with offers and responses on how to play the Ultimatum Game when the amount of money to be divided is \$40. (A response consists of the minimum offer to be accepted.) The vertical axes shows that proportion of players in each population using each of the 40 possible strategies (\$0 is not allowed). At the first iteration, each population is centered around \$33, but there is some dispersion. The population distributions evolve over time in accordance with the perturbed replicator dynamics in use. Little action is observed until after about 6000 interations when the system moves within a few hundred iterations to its final configuration. (Responders are then spread over the interval [1, 10] because there is no evolutionary pressure against any response of \$10 or less.)

4. Bargaining

By Eyal Winter [10]

The UG was known as "Ultimatum Bargaining" in its infancy. This was the name used by Güth et al. (1982) in their seminal paper, and this is the term used by many other authors who built on this paper in the first decade following its appearance. Indeed Güth et al.'s (1982) paper concerns not only the single-offer game. It also discusses bargaining games that feature alternating offers through a finite time horizon. The term UG that came later reflects the fact that the economic community

[10] The Center for the Study of Rationality, The Hebrew University of Jerusalem.

recognized that the contribution of the paper bears on far more general issues than just bargaining situations and that its implications go deep into the foundations of rationality and strategic behavior. Nevertheless, I wish to return to the game's nostalgic name and discuss in this section the important impact the paper has had on the study of bargaining situations.

Much of the experimental literature testing bargaining models was triggered by Güth et al. (1982). An early contribution building on this paper is Binmore et al. (1985). These authors designed an experiment consisting of a two-stage alternating offer game with a discount factor of 0.25. Two rounds of this game were played with player 2 playing the role of player 1 in round 2. In the first round the opening demand was 50%, while in the second round it reached 75%, which is also an equilibrium demand. Hence, Binmore et al. interpreted their experimental results as strong support for the assumption of sequential rationality in bargaining games. However, as Güth and Tietz (1988) argued, much of this support was a direct consequence of the moderate discount factors that the experimenters had chosen. These discount factors sustain equilibrium allocations that are socially acceptable. Güth and Tietz went on to predict that in bargaining games with more extreme discount factors that give rise to more extreme equilibrium allocations, the experimental outcome will depart more substantially from equilibrium predictions. They therefore tested two bargaining games, both with two stages, and selected a discount factor of 90% for one game and 10% for the other. Indeed, their conjecture was fully confirmed: in the first game with the discount factor of 10% the average demand of the first player stood at 67%, while the equilibrium prediction was 90%. A much larger discrepancy emerged in the second game with the discount factor of 90%. The average demand of the first player here was 59%, while the subgame perfect equilibrium predicted that it would be only 10%!

Aimed at contributing to the debate on the predictive power of equilibria in finite horizon bargaining games, Ochs and Roth (1989) conducted a comprehensive study of a larger set of games in which each player is allowed to participate in a large number of iterations of the game (without repeating any with the same player). Arguably the most striking result of Ochs and Roth (1989) concerned "disadvantageous counterproposals." Ochs and Roth (1989) showed that the occurrence of "irrational" rejections of offers is not unique to ultimatum bargaining. A common reaction to a severely unequal proposal in their alternating offer game was a rejection followed by a counterproposal in which the rejecter offered himself less than the share he was proposed by his partner in the previous round. This willingness to "leave money on the table" rather than accept a humiliating offer is an ultimate proof of fairness concerns in bargaining, which was the primary message of Güth et al.'s (1982) original UG. This was the important message that subsequently revolutionized the multidisciplinary literature on interactive decision making. The direct influence of this message was the triggering of a body of research on the role of fairness in bargaining environments. Another interesting result in Ochs and Roth (1989) showed that when the parameters of the game yield equilibrium predictions of severely inequitable offers, the actual offers are tilted towards more equal allocations. This phenomenon seems to be persistent in much more general frameworks, including multilateral bargaining games (see for example Frechette et al. (2003) and Kagel et al. (2010) in the context of committee negotiations). This broad phenomenon, which is relevant to almost any bargaining situation brought into the lab, is known as the "Ultimatum Effect," taking its name from the original Güth et al. (1982) paper. In multilateral bargaining situations that involve the possibility of coalition formation and in particular political games, the ultimatum effect not only has implications on payoff allocations, but it also affects the resulting coalition. Because unfair offers tend to be rejected, non-minimal winning coalitions also tend to form when the equilibrium predicts the formation of only minimal winning coalitions. For example, Kagel et al. (2010) demonstrate that in the presence of high delay costs, proposers increase the propensity of proposing winning coalitions that are not minimal. They do so by forgoing some of their own payoff in return for an "insurance policy" against potential rejection by some of the coalition members. Such rejections often arise because of fairness considerations induced by the ultimatum effect, but because the fairness standards are unclear to proposers, they often choose to reduce the risk of delay by expanding the proposed coalition and thus guarantee majority support for their proposal.

Ultimatum bargaining also substantially extended our understanding of cultural differences in bargaining, starting Roth et al.'s (1991) four-country paper which demonstrated substantial differences across countries in the perception of what constitutes a fair offer. Roth et al. showed that subjects in Israel and Japan were significantly more aggressive as proposers than subjects in Slovenia and the U.S. But more importantly they showed that proposers' offers are well synchronized with responders' reactions. In countries where offers tend to be low the willingness to accept low offers is greater. The alignment between offers and responses is so strong that the modal offer in each country maximizes the proposer's expected return based on the empirical distribution on responses made in his/her group. Roth et al.'s (1991) significant contribution was thus to show that fairness norms and social standards are nothing other than equilibrium phenomena. As tourists in a foreign country we often perceive this strange feeling of not being well calibrated with local conventions, whether in driving or in social interactions. In such situations our behavior is off the local equilibrium. If we stay longer, a process of adaptation will alter our behavior, bringing us closer to the local equilibrium behavior. But cultural differences in the way ultimatum bargaining is played may well arise not only from small differences in the threshold of what constitutes a fair offer, but also from cultural differences in attitudes. Henrich (2000) conducted ultimatum bargaining among Machiguenga tribes of the Peruvian Amazon. Compared with the behavior of his U.S. control group where the average proposal was above 40% of the pie (quite similar to other results in Western countries), the average offer among Machiguenga participants was merely 26%. Even more surprising is the fact that the modal offer was only 15%! Can one attribute this enormous gap only to cultural heterogeneity in the threshold of what's fair? I would doubt it. Indeed Henrich (2000) discovered (based on questionnaires and interviews) that the Machiguenga participants perceive the game in a completely different way from their Western counterparts as they attribute both their role in the game and the amount offered to them to a pure lottery determined by nature. This perception induces a behavior by which they basically accept any offer, which incentivized

proposers to make low offers. From the proposer's point of view ultimatum bargaining is very much like the dictator game. In contrast, Western participants attribute to themselves a certain property right to the pie even in the role of responders. More extensive multicultural studies have been carried out by Henrich and his associates (see Henrich et al. (2001) and Henrich et al. (2005)). These studies were based on 15 small-scale societies around the world including countries like Indonesia, Kazakhstan, Mongolia, Nigeria, and more. Again, the researchers discovered substantial differences across cultures in the way the ultimatum bargaining was played.[11] Average offers ranged between 26% of the pie in Machiguenga to 57% (!) for the Lamalera in Indonesia.

Finally, the ultimatum bargaining has also been used to demonstrate how cultural differences may generate different gender effects in the play of the game. Results on gender effects in ultimatum bargaining are inconclusive and the issue is to a large extent left open. However, Gong and Yang (2012, 2013) conducted an experiment on the one-shot UG using subjects in two Chinese villages: the matrilineal Mosuo village and the patriarchal Yi village. They find that Yi women as proposers demand significantly higher shares than Yi men do, while Mosuo women demand less than Mosuo men. Moreover, the modest demands yield Mosuo women the highest payoffs of all, while the aggressive demands leave Yi women with the lowest payoffs. Mosuo women in their matrilineal families are responsible for resource allocations in their extended families that include many adults of similar status. They are therefore much more familiar with this task than Yi women and are more conscious of the consequences of imposing unfair allocations.

Ultimatum Bargaining is discussed in every serious course on negotiations in top MBA programs, simply because the game is the most transparent and insightful tool to demonstrate the role of psychology and emotions in real-life negotiations. To this extent the UG has influenced not only research in the field of bargaining but also the education of bargaining practitioners in both their professional and their private life. Bargaining practitioners were probably aware of the role of psychology in bargaining even before ultimatum bargaining, but the Güth et al. (1982) paper and those that followed moved the issues of emotions, fairness, and social norms to the forefront of the research and educational agenda in bargaining. A fascinating and important question in this respect is whether this line of literature was also welfare improving as far as the practice of bargaining and negotiations is concerned. Put differently, does the heightened awareness of bargaining practitioners to the role of fairness, emotions, and social norms facilitate more welfare-enhancing agreements and fewer breakdowns in real-life negotiations? I believe that this is indeed the case for several reasons. First, internalizing the fact that we often react emotionally in bargaining situations in a way that is incompatible with our material interests may be conducive to agreement. It may make proposers more cautious when contemplating greedy offers and it may diminish emotional reactions by responders who intend to reject advantageous proposals. Second, the vast literature on cultural differences in the context of the UG contributes to the awareness that different cultures may have different social norms regarding what constitutes a fair offer in bargaining. This may have a determinal effect on agreements as well, particularly in negotiations that are carried out across cultures. If individuals from one culture migrate to a different culture carrying the social norms they were used to in their original culture, they may experience substantial difficulties in reaching agreements due to miscoordination of expectations. Over time a process of adaptation will lead to the convergence of norms and with it to an increase in the propensity toward agreements. Winter and Zamir (2005) demonstrate how such an adaptive process operates in the context of the UG. However, many of the cross-cultural negotiations are one-shot events, where adaptation or learning has a small role. In these environments it is essential that bargainers be aware of cultural differences and adjust their expectations based on existing experimental results.

The outstanding contribution of Güth et al.'s (1982) seminal paper is in pointing at an extremely important issue. This is not a paper about an unexpected experimental finding nor is it a paper about a deep theoretical observation. It is a paper about an insight that strategic interactions are not always resolved solely on the basis of material preferences. This is a simple, almost trivial insight that was practically ignored by modern economic theory. It is an insight that revolutionized the entire field, including the subfield of bargaining theory.

5. The ultimatum game and the empirical nature of fair choice

By Gary E. Bolton[12] & Axel Ockenfels[13]

The UG began life as a heresy. Introduced in an age when the fully rational analysis of games was *the* analysis of games, (rational) play in such a simple game seemed completely obvious. As Binmore et al. (1985) put it, in one of the first responses to Güth et al., "A tension exists between this work and the theoretical approach [to bargaining] revitalized by Ariel Rubinstein (1982)."

Tension indeed. Güth et al.'s data challenged more than just the theoretical bargaining literature. It challenged what was then a sacred cow of rational choice, the assumption that individuals could be counted on to choose the action in his or her material self-interest. An assumption that had, in the economics literature at least, gone largely untested.[14] Contrary to this

[11] In addition to the Ultimatum Bargaining they also tested the Public Good game and the Dictatorship Game.

[12] University of Texas at Dallas.

[13] University of Cologne.

[14] One of us, the one who earned his Ph.D. in 1990, recalls making this observation as part of his job talk. Invariably, someone in the audience would explain that the assumption "is obviously true." Today, one rarely hears such statements made. To the opposite, researchers assuming material self-interest in their models now find themselves sometimes asked about the robustness of their predictions regarding social motivations.

assumption, Güth et al. concluded that many UG subjects chose their action on the basis of "what they consider a fair or justified result. Furthermore, the ultimatum aspect cannot be completely exploited since subjects do not hesitate to punish if their opponent asks for 'too much.'" (p. 384) This characterization, highly controversial at the time, has been elaborated and refined over the years, and is now widely accepted largely because the empirical patterns Güth et al. reported have proven remarkably robust (Güth and Kocher, 2012; Güth and Tietz, 1990).

Prevailing notions of economic behavior weren't the only theoretical constructs to take a hit from the UG. Researchers have, of course, discussed fairness and its role in human society for centuries. Prior to Güth et al., however, these discussions remained mostly normative in nature, a question of ethics, where acting fair requires altruistic sacrifice of one's self-interest independent of the trade-offs (ex. Rawls' 1971 concept of justice-as-fairness) or strategic circumstances (ex., the Shapley value, see Young, 1992, pp. 32–33).

Different, the UG surfaced, and began the charting of, the *empirical nature of fair choice*. Around the time Güth et al. were running their experiments in Cologne, the Nobel prize winning economist George Stigler gave a lecture aimed at persuading economists to account for ethical considerations such as equity, not just efficiency, when analyzing social welfare. Stigler clearly understood his mission to be an uphill battle, primarily for lack of a clear empirical characterization of how ethics influences behavior. "Why shouldn't the full range of consequences important to the society be important to the economist?" Stigler asked. "I suspect that . . .economists have decided, possibly implicitly and silently, that the other values that might overcome the efficiency presumption are usually weak or conflicting . . .(1981, p. 163)."

Clearly, greater social efficiency enables people to improve their material well-being. However, rejections in the UG demonstrate forcefully that even Pareto-improvements in terms of material well-being are not acceptable to everyone if they imply unfair outcomes. The social welfare analysis of fairness also requires a parallel understanding of fair choice. Below are five characteristic of that nature, all established in the line of research work pioneered by Güth et al. (1982).

Fair choice is profoundly heterogeneous. The choices we observe in the UG reveal that people place widely varying weight on fairness. Some do not care about fairness at all. For a few, the UG is all about fairness. Many people weight fairness somewhere in between (see DeBruyn and Bolton 2008 for a quantitative calibration of this trade-off derived from UG data). Interestingly, people tend to underestimate this heterogeneity, and tend to believe that others weight fairness similar to themselves (e.g., Güth et al., 2007; Selten and Ockenfels, 1998).

Fair choice is largely an exercise in trade-offs not principle. One UG statistic suffices to make this clear: The first mover ultimatum offer with the highest expected value typically sits somewhere above 40% but often below 50%. Few second movers reject an offer that gives them a little less than $50-50$, demonstrating a willingness to compromise fairness – somewhat – in the name of their self-interest.

Fair choice is asymmetrically self-centered. The side of fair choice we see in the UG demonstrates what might be termed the strong equity effect – people sacrificing their self-interest in the name of achieving fairness *for themselves*. We know from the dictator game, closely associated with the UG (Forsythe et al., 1994; Güth and Huck, 1997) that there also exists a weak equity effect in which people sacrifice self-interest to help others. Those most likely to fight an unfair distribution by sacrificing their own self-interest are those whose own relative standing would be most diminished by it (Güth and van Damme, 1998; Bolton and Ockenfels, 1998).

Fair choice is strategic choice. While evident in the UG, the influence of fair choice all but vanishes from sight in competitive markets (Roth et al., 1991). We can explain the seeming contradiction by the different strategic options players have in the two environments. Whereas the second mover can force a fair outcome in the UG, a trader in a competitive environment cannot force an equal split, and an effort to do so risks them falling behind traders less interested in fairness. In competitive markets, strategic considerations compel the fair minded to behave as *if* they are self-interested (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000). Similarly, the influence of fair choice tends to be mitigated, in strategic ways, when information about payoffs and strategic options becomes incomplete or less transparent (Mitzkewitz and Nagel, 1993; Güth et al., 1996, Dana et al., 2007).

Fair choice is predictable choice. This is not an obvious statement, given points 1 through 4. Indeed points 1 through 4 might explain why economists have traditionally considered fairness as a weak, non-robust force. Yet, not only has UG behavior been shown to be very robust in hundreds of experiments, but also social preference theory has been proven to capture and predict many of the non-selfish behaviors observed both in the laboratory (see the survey of Cooper and Kagel (forthcoming)) and, more recently, in the field (e.g., Card et al., 2012, Bolton and Ockenfels, 2014, Ockenfels et al., forthcoming). This robustness, in turn, allows social choice research to contribute to the engineering of better incentives and institutions (Chen et al., 2010, Bolton et al., 2013, Bolton and Ockenfels, 2012, 2014).

The above characterizations represent an incomplete list of the progress made in understanding fair choice. Still, many important yet unresolved challenges remain. The issues include the impact of procedures and uncertainty on fairness – currently a very active research field (including Güth et al, this issue). The role of bounded rationality and social cognition are a severely under-researched topic. The processing of (social and context) information requires more attention (e.g., (Güth and Kliemt, 2010)).

In concluding this section, we want to acknowledge our gratitude to Werner Güth, for the role he has played in our academic and personal lives. Werner was critical to both our academic paths and the excitement and satisfaction we have found in it. His work, together with the work of many of the other contributors of this chapter, inspired our own efforts in social preferences. He has always supported us, even while maintaining his strong and forceful critique of all social preference

models, including our own, as efforts in the "neoclassical repairshop"[15]. One of us (Axel) met Werner for the first time in 1995, just after he finished his diploma thesis, at an economic conference in Bergen, Norway. A young PhD student, with no publication and too shy to talk much, Werner took care of me, inviting me to a boat trip in Bergen together with his daughter. I was very impressed that Werner treated me – as any other young researcher – just like he treated a big professor or established colleagues. He later invited me to work with him at the MPI in Jena, and over the years we have collaborated on a couple of joint papers. The other of us (Gary) met Werner at the 1993 Stony Brook Summer Festival on Game Theory. I have fond memories of my visits with Werner, at his generous invitation, first in Berlin and then in Jena. I was much influenced by our intellectual discussions, influenced personally too. I was in Jena in 2002, just a couple weeks from adopting my son, and I was very nervous about whether I would be an attentive father. "Don't worry," Werner counseled with a smile. "When you become a parent, you will realize that you really don't matter."

Werner's approach to research and people does not fit with most of the behavioral models we currently have. He is not interested in selfish gain or even in strategic behavior of a social nature. Nor does he care about status, what's mainstream, or professional rankings. He stands as a member of a rare breed: a scientist exclusively concerned with scientific progress and the people around him.

6. Reciprocity and the ultimatum game

By Martin Dufwenberg[16] & Georg Kirchsteiger[17]

The UG has been an important workhorse for the empirical analysis of non-consequential forms of other-regarding preferences, and in particular reciprocity (the idea that people wish to hurt those who intend to hurt them, and vice versa). In a pioneering paper, Blount (1995) investigated experimentally the responder's motivation. In one treatment subjects played the standard UG. In other treatments, offers were not made by the "proposers," but by the experimenter or by a random device. Blount's idea was to explore whether responders accepted lower offers if these were not made by the "proposer" but by a third party, i.e. by the experimenter or the random device. This would not be possible to explain if responders cared only about payoff distributions, but would support the notion that responders reciprocate unkind intentions.

Related ideas were further examined in a series of experiments where the proposer's strategy set was restricted – so-called mini-UGs (Brandts and Sola, 2001; Falk et al., 2003, 2008) where the proposer can only choose between two possible offers. One of these, say offer #1, is fixed and lop-sided in favor of the proposer, while offer #2 varies by treatment. The idea was to test if changes to offer #2 have an impact on the responder's willingness to accept offer #1. If, for example, responders reject offer #1 more often if offer #2 were an equal split than if it were as lop-sided as offer #1 then this would be in line with reciprocation.

Did the data lend support? We will not sort that, somewhat contentious, issue out.[18] Rather, we explore the implications of reciprocity in the UG theoretically. Rabin's (1993) normal-form theory of reciprocity highlights key intuitions of the logic of getting even but one needs the extensive-form theory of Dufwenberg and Kirchsteiger (2004) (D&K) to deal with economic situations with a dynamic structure. Presenting that framework in detail is not feasible here. We sketch its main features and explain how to solve the UG. We deviate from D&K by restricting players to choose pure strategies; this simplifies without any interesting change of predictions.

Take a discrete version of the UG, where player 1 offers player 2 an integer amount x between 0 and M (= the feasible amount of money). Hence, 1's set of pure strategies is given by $A_1 = \{0, 1, \ldots, M\}$.[19] Player 2 may either accept or reject the offer. Her set of pure strategies A_2 includes all functions from A_1 into $\{accept, reject\}$. If the responder accepts the offer, she gets x and the proposer $M - x$. In case of rejection, both get 0. Hence, as long as player 2 is solely motivated by her material payoff, i.e. by the money she gets, she should accept every positive offer. A purely "materialistic" proposer thus offers 0 or 1 in a subgame perfect equilibrium.

With reciprocity, the result is very different. As we will see, a reciprocal responder rejects low offers. That is of course the fundamental result of all the UG experiments – responders react unkindly to an unkind offer of the proposer. The possible patterns of equilibrium behavior of player 1 are quite complex. For all parameter values there exists equilibria such that the proposer makes the lowest offer acceptable for the responder. Furthermore, if reciprocity is important enough there exists equilibria that are characterized by rejected offers. In these equilibria players hold beliefs that make them view one another as unkind along the equilibrium path, which in turn leads the players to be actually unkind. Such an equilibrium exhibits self-fullfilling negative expectations of both players.

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[15] He forcefully expressed his critique the first time at a 1997 conference in Bonn, where both Fehr and Schmidt (1999) and Bolton and Ockenfels (1998, 2000) presented models and since then our discussions have inspired many of our papers.

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[17] ECARES, Universit é Libre de Bruxelles, CEPR, CESifo, and VCEE. Financial support of the "Fonds de la Recherche Fondamentale Collective" grant on "Preference Dynamics in Adaptive Networks" is gratefully acknowledged.

[18] For example, Blount's data lined up only to a degree: Subjects were willing to accept lower offers if generated by a random device, but whether a treatment difference separated the other two ways of generating offers depended on details of how responders' behavior was elicited. We refer to Bolton et al. (2005) for critical further commentary, largely giving an alternative interpretation ("procedural fairness") downplaying reciprocity.

[19] We follow D&K in considering finitely many pure strategies. The UG is sometimes analyzed such that A_1 is an interval: $A_1 = [0, M]$. D&K's theory can easily be adjusted to handle this case, and everything that follows would have direct analogs.

A reciprocal player answers kind intentions by kindness and unkind intentions by unkindness. Denote by $\pi_i : A_i \times A_j \to \mathbb{R}$ player i's material payoff function. κ_{ij} denotes the how kind player i is to j. λ_{iji} denotes player i's belief about how kind j is to i. To incorporate reciprocity, i's utility has the shape $u_i = \pi_i(\cdot) + Y_i \times \kappa_{ij} \times \lambda_{iji}$, with $Y_i \geq 0$ being i's inclination to reciprocal behavior.

In order to measure the kindness of a player, we need to consider the beliefs the player holds about the strategy of the other player. Denote by $b_{ij} \in A_j$ the first-order belief of player i about j's strategy.[20] We also need the second-order beliefs of i about j's belief about i's strategy, denoted $c_{iji} \in A_i$.

Player i is kind to j if i intends to give to j a relatively high material payoff. Formally, the intended payoff is given by $\pi_j(a_i, b_{ij})$. For a strategy of i to be regarded as kind, the intended payoff has to be large compared to the average payoff i thinks that he could give to j. This average or "equitable" payoff π_j^e is given by

$$\pi_j^e(b_{ij}) = \frac{1}{2}\left(\max_{a_i \in A_i} \pi_j(a_i, b_{ij}) + \min_{a_i \in \overline{A}_i} \pi_j(a_i, b_{ij})\right),$$

with $\overline{A}_i \subseteq A_i$ defined below. Player i's kindness from choosing a_i when holding belief b_{ij}, is defined as

$$\kappa_{ij}(a_i, b_{ij}) = \pi_j(a_i, b_{ij}) - \pi_j^e(b_{ij}).$$

But there is a subtle problem. Suppose we extend the strategy space of player i by a strategy which gives to both players material payoffs for sure that are much below the material payoffs of all other outcomes. Compared to this "disaster strategy", any other strategy of player i would be kind. To avoid that the kindness measure of other strategies is influenced by the presence or absence of such a disaster strategy, the calculation of π_j^e takes into account only those strategies of i that do not for sure lead to Pareto-inferior outcomes in material terms.[21] The set of all those strategies is denoted $\overline{A}_i$.

Player j's belief about the kindness of player i, λ_{jij}, is derived the same way as κ_{ij}, replacing i's actual strategy a_i by b_{ji} (j's first-order belief about i's strategy), and by replacing i's first-order belief b_{ij} about j's strategy by c_{jij} (j's second-order belief about i's first-order belief about j's strategy). Formally

$$\lambda_{jij}(b_{ji}, c_{jij}) = \pi_j(b_{ji}, c_{jij}) - \pi_j^e(c_{jij}).$$

To close the model we require that in equilibrium all beliefs coincide with the chosen strategies and that at the root of every subgame beliefs are updated such that they are consistent with reaching this particular subgame. Furthermore, we require that in all subgames all choices are optimal given the beliefs.

First we analyse the responder's equilibrium behavior. For any x the only action of player 2 leading to an outcome that is not Pareto-dominated is acceptance. This implies that the equitable payoff for the calculation of 2's kindness, $\pi_1^e(b_{21})$ is $M - x$, the payoff 1 gets when 2 accepts the offer x. Consequently, if player 2 accepts the offer x, her kindness $\kappa_{21}(a_2, b_{21}) = 0$. If she rejects, $\kappa_{21}(a_2, b_{21}) = -M + x \leq 0$. From the proposer's perspective his beliefs about the kindness of the responser, $\lambda_{121}(b_{12}, c_{121})$, are either 0 (if he expects acceptance) or $-M + x$ (if he expects rejection).

What does the responder believe about the kindness of the proposer, i.e. what is $\lambda_{212}(b_{21}, c_{212})$? To see this, note that for $x = M$ player 1's material payoff does not depend on 2's choice. Hence, in this case 2 cannot be kind or unkind, and she will make her choice for purely materialistic reasons. Therefore, in any equilibrium 2 will accept an offer of $x = M$. Since in equilibrium beliefs have to be correct, 2 knows that 1 knows that an offer of M will be accepted, and hence the highest possible material payoff 1 can intend for 2 is M. On the other hand, for $x = 0$ player 2 gets 0 regardless of her choice. Hence, the equitable payoff of what 1 could intend for 1 is given by $\pi_2^e(c_{212}) = M/2$ for any second-order belief c_{212} consistent with equilibrium. If c_{212} is such that 2 believes 1 believes that x is accepted, then 2 believes that 1's kindness is $\lambda_{212}(b_{21}, c_{212}) = x - M/2$. If c_{212} is such that 2 believes 1 believes that x is rejected, then $\lambda_{212}(b_{21}, c_{212}) = -M/2$. From 1's perspective his evaluation of his own kindness when offering x is given by $\kappa_{12}(x, b_{12}) = x - M/2$ if his first-order beliefs b_{12} are such that he believes x is acceptable, and $\kappa_{12}(x, b_{12}) = -M/2$ otherwise.

The responder's equilibrium behavior is characterized by

Observation 1: For any $Y_2 > 0$ it holds that:

(a) Rejection is part of an equilibrium for all offers x with

$$x \leq \frac{Y_2 \times M^2}{2 + Y_2 \times M}.$$

[20] All beliefs are point-beliefs, assigning probability 1 to whatever is believed.

[21] Refer to D&K for more elaboration; look for the discussion of "inefficient" strategies.

(b) Acceptance is part of an equilibrium for all offers x with

$$x \geq \frac{2 + 3Y_2 \times M - \sqrt{4 + 12Y_2 \times M + Y_2^2 \times M^2}}{12Y_2}.$$

Proof.

(a) Take an offer with $x \leq (Y_2 \times M^2)/(2 + Y_2 \times M)$, and assume that rejecting this offer is part of an equilibrium. Since in equilibrium all the beliefs have to be correct, $\lambda_{212}(b_{21}, c_{212}) = -M/2$. As discussed before, the kindness of 2's rejection is given by $\kappa_{21}(a_2, b_{21}) = -M + x$. The resulting utility from rejection is therefore

$$u_2 = Y_2 \times (-M + x) \times \left(-\frac{M}{2}\right).$$

If 2 deviates to accepting x, the first- and the second-order beliefs of 2 do not change. Hence, $\lambda_{212}(b_{21}, c_{212})$ does not change. But since a_2 changes, 2 is no longer unkind to 1, *i.e.* $\kappa_{21}(a_2, b_{21}) = 0$. The utility from acceptance is therefore

$$u_2 = x + Y_2 \times 0 \times (-M + x).$$

From that it follows that rejection is optimal as long as

$$x \leq \frac{Y_2 \times M^2}{2 + Y_2 \times M}.$$

(b) Take an offer with $x \geq 2 + 3Y_2 \times M - \sqrt{4 + 12Y_2 \times M + Y_2^2 \times M^2}/12Y_2$ and assume that accepting this offer is part of an equilibrium. Since in equilibrium all the beliefs have to be correct, $\lambda_{212}(b_{21}, c_{212}) = x - M/2$. As discussed before, the kindness of 2's acceptance is given by $\kappa_{21}(a_2, b_{21}) = 0$. The resulting utility from acceptance is therefore

$$u_2 = x + Y_2 \times 0 \times \left(x - \frac{M}{2}\right).$$

If 2 deviates to rejecting x, **her** first- and second-order beliefs do not change. Hence, $\lambda_{212}(b_{21}, c_{212})$ does not change. But since a_2 changes, the responder becomes unkind to the proposer, *i.e.* $\kappa_{21}(a_2, b_{21}) = -M + x \leq 0$. The resulting utility from rejection is therefore

$$u_2 = 0 + Y_2 \times (-M + x) \times (x - \frac{M}{2}).$$

From that it follows that acceptance is optimal as long as

$$x \geq \frac{2 + 3Y_2 \times M - \sqrt{4 + 12Y_2 \times M + Y_2^2 \times M^2}}{12Y_2} \blacksquare$$

As $Y_2 \to 0$, the bounderies of the validity of parts (a) and (b) of Observation 1 converge to 0 from above. Hence if the reciprocity motivation vanishes, the result subsumes the usual subgame perfect equilibrium strategies of the responser. But whenever the responder is motivated by reciprocity, she rejects low and accepts high offers.

Note further that the upper bound of part (a) of Observation 1 is strictly larger than the lower bound of part (b). For an offer in the intersection range, acceptance as well as rejection can be part of an equilibrium. Consequently, there exist multiple equilibria.

Turning to the proposer's behavior we get the following result:

Observation 2:

(a) For any Y_1, Y_2 there exists an equilibrium where 1's offer is the lowest among those which are acceptable according to 2's equilibrium strategy.
(b) For Y_1 large enough and $Y_2 > 0$ there exists an equilibrium where the offer gets rejected.

Proof.

(a) Recall that 1 views 2's kindness as "neutral" (*i.e.* $\lambda_{121}(b_{12}, c_{121}) = 0$) in case 1 believes that 2 expects an acceptable offer. Denote by $\widetilde{x}$ the lowest offer that 1 foresees will be accepted. For correct beliefs $\widetilde{x}$ creates a proposer's utility of $u_1 = \widetilde{x} + Y_1 \times \kappa_{12}(a_1, b_{12}) \times 0$. Since $\lambda_{121}(b_{12}, c_{121}) = 0$ does not change when 1 deviates to another offer a_1', any alternative offer a_1' would result in a lower utility.
(b) For $Y_2 > 0$, Observation 1 states that low offers will be rejected. Assume that in equilibrium 1 makes such an offer x. If beliefs are correct, $\lambda_{121}(b_{12}, c_{121}) = -M + x$. For correct beliefs 1's kindness from making an unacceptable offer is given by $\kappa_1(x, b_{12}) = -M/2$ (since in this case 2's material payoff is 0 and, as noted above, the equitable payoff is given by $\pi_2^e(b_{12}) = M/2$). For correct beliefs 1's utility from making the unacceptable offer x is given by $u_1 = 0 + Y_1 \times (-M/2) \times (-M + x)$. Deviating to another unacceptable offer would not change 1's utility, since both players' material payoffs remain unaffected by this deviation. Deviating to the lowest acceptable offer $\widetilde{x}$ does not change $\lambda_{121}(b_{12}, c_{121})$. But this deviation changes 1's kindness: $\kappa_{12}(\widetilde{x}, b_{12}) = \widetilde{x} - M/2$. 1's material payoff is now given by $M - \widetilde{x}$. As a result 1's utility from deviating to $\widetilde{x}$ would be $\widetilde{u}_1 = M - \widetilde{x} + Y_1 \times (\widetilde{x} - M/2) \times (-M + x)$. Therefore $u_1 > \widetilde{u}_1$ iff

$$Y_1 > \frac{M - \widetilde{x}}{(M - x) \times \widetilde{x}} \blacksquare$$

Until now we investigated the standard UG with the offer made by the proposer. But what happens when the offer is made by a third party with no direct material interests in the outcome, or by a computer, as in Blount's experiments? In this case the "proposer" is not responsible for the offer. Since he is inactive, he is neither kind nor unkind, and therefore reciprocity plays no role for the responder's acceptance decision. Hence, for such a game the responder should accept lower offers than in the standard UG.

In a mini-UG the equitable payoff the proposer can intend for the responder, $\pi_2^e(b_{12})$, depends on the set of feasible offers. Hence a reciprocal responder's best reply to a certain offer depends (*inter alia*) on the set of feasible offers.

We close on a different note. We hope our text exudes that combining experiments and theory is fun. Why do we feel that way? One important reason is that we met Werner Guth. He stormed into each of our PhD student lives in Austria, teaching a game theory course at the Institute of Advanced Study in Vienna in 1991 that Georg took, running a game theory boot camp in Riezlern in 1992 that Martin came down from Uppsala to attend. Copy what Uri writes, in the next section, about how Werner "impressed us all," and about "his kindness". Here is our chance to reciprocate: thank you Werner!

7. Discrimination

By Uri Gneezy[22]

Werner visited The Center for Economic Research at Tilburg University a few times when I was working toward my PhD there in the mid-nineties. One of the first things that impressed us all about him was his energy, his enthusiasm, and his eagerness to discuss research—like a kid in a candy store who doesn't just want the sweets, but wants to share them with everyone who walks in. My impression hasn't changed: Werner is always full of new ideas he can't wait to test. The second thing that impressed us was his kindness. He is always willing to help with advice and with investing in educating the new generation of researchers.

Partly as a result of my many interactions with Werner, I used the UG in three of my thesis papers. Werner's game can be used to test some basic theoretical predictions, and this role is extremely important. Yet from my perspective, no less important is the game's contribution as a workhorse that allows us to compare social interactions under different conditions, and understand what influences behavior in such interactions. In that respect, it is part of the very exclusive club of games such as the prisoners' dilemma and the trust game that influence our understanding of the world.

One of my favorite examples of this use of the UG to understand social interactions is in experiments on discrimination. The good news about discrimination in the last decades is that, at least in the western world, it is much less accepted than it used to be. Not that long ago, ethnic minorities in Europe and the United States were suffering horribly as a result of pure hate-based discrimination. Fortunately, such discriminatory behavior is illegal and unacceptable today. Political-correctness practices deter most people from even making discriminatory remarks. Unfortunately, this change does not

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mean discrimination has disappeared from the world. Disguised discrimination challenges social scientist to find methods to uncover it in economic interactions. In doing so, they try to show where and why discrimination exists.

Due to the strong norms and legal actions against discrimination, one cannot uncover it and the motivations for it by simply asking people if they treat different groups differently. Experimental games, and in particular the UG, become extremely important in this process. In our first paper on discrimination (Fershtman and Gneezy, 2001), Chaim and I wanted to test whether students in Israel treat each other differently based on their backgrounds. The two major groups in Israel are those who immigrated from mostly European countries (Ashkenazic Jews) and those who immigrated from Arab countries (Eastern or Sephardic Jews), with the latter being from a typically lower socio-economic background.

Utilizing the fact that last names often indicate the origin of the person, we recruited students to participate in the UG as proposers, and provided them with the name of the responder with whom they were matched. This last name was a strong signal regarding the responder's group and the first name indicated gender. We found that males (but not females) discriminated against Ashkenazic men (but not against women), offering them less than they offered Sephardic men. The use of simple games also allowed us to test whether this discrimination was taste based or statistical. In particular, we compared the behavior in the UG to behavior in the dictator game. Taste-based discrimination would predict that the dictator game would reveal similar patterns of behavior. If, however, the proposals in the dictator game did not depend on background, one can conclude that the differential treatment in the UG was based on the perception that Sephardic men are more likely to reject unfair proposals, and hence, in order to increase profits, one would need to offer them more. Our results offered a strong support for the statistical discrimination.

An anecdote reveals the importance of using such games to study discrimination. Above, I argued that observing actual behavior through games is important because people try to disguise their actions when they discriminate. But in this case, when we discussed the results with the participants after they made their choices, they were shocked to learn they had discriminated. That is, although we found strong evidence of discrimination, participants did not, at least in many cases, discriminate knowingly.

In a similar line of research, Chuah et al. (2007) report results of an UG experiment designed to study cultural differences in cross-culture interactions. In their experiment, Malaysian Chinese and UK participants played opponents of their own as well as of the other culture. The main finding was that Westerners and Asians played differently with participants of their own group than with members of the other group. Chuah et al. interpret the results as evidence of a "clash of cultures."

Another example of the use of the UG in the study of discrimination is Ferraro and Cummings (2007), who study the effect of cultural diversity on behavior in the UG. Their participants (from Hispanic and Navajo cultures in the southwestern United States) took part in sessions in which the ethnic mix of the group was changed (in a between subject design). This difference in the mix of the participants in the group allowed the authors to infer the effect of inter-cultural interactions on behavior. They found that the ethnic composition of the session affected behavior. In particular, Hispanic and Navajo participants not only behaved differently, but they also responded differently to the ethnic composition of the session.

I chose these examples of discrimination research, because they give a taste of how we can use the UG, alongside other experimental games, to understand the motives of people in social interactions. The need for using such games when studying discrimination is particularly important when our participants either try to disguise their motivation or are not even aware of their motives for making their choices.

8. Development

By Martin G. Kocher[23] & Matthias Sutter [24]

Bargaining is crucial in many day-to-day situations, and very early on in life human beings start bargaining to satisfy their needs. Think of a toddler who tries to convince her parents by all means possible to receive a certain toy, or of a kindergarten child who attempts to persuade his parents to be allowed to stay up a little longer in the evening. Later on, bargaining about weekly allowance becomes a prime example where children and teenagers learn more about the process of bargaining, and the ideas of fairness associated with it. Moreover, there is also a lot of bargaining going on between children and teenagers directly, about where to go and what to do together, about the exchange of toys or about the allocation of presents or money.

Werner Güth's UG has offered a fascinatingly simple and straightforward paradigm to study how human beings (or even animals) bargain and to analyze the strategic implications of a particular bargaining structure. Somewhat surprisingly, it took more than a decade after the publication of the first UG experiment in 1982, until psychologists and economists discovered the game in order to study how bargaining behavior develops with age. However from the late 1990s on, the bargaining behavior of children and teenagers started to receive attention in the economics literature, largely due to the seminal contributions of Bill Harbaugh and Kate Krause (see e.g., Krause and Harbaugh, 1998).

While the two of us met Werner Güth around that time and started working together with him on behavior in guessing games, the personal contact with Werner Güth and the chance to discuss bargaining experiments with him led us, later on, to investigate the bargaining behavior of children and teenagers. From the quickly growing literature that emerged in the context of socio-economic variables and bargaining one can conclude that age is probably the variable that is associated

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with the strongest effects in bargaining behavior. A very solid amount of evidence tells us that behavior in simple bargaining games develops over time and that it is by no means stable across childhood, adolescence, and adulthood.

Murnighan and Saxon (1998) reported results from UGs with 385 participants from five different age groups, ranging from kindergarten children to university students. They found that, in general, younger children offered more and accepted less than older children or adults. Girls were, by and large, more generous than boys.

Harbaugh et al. (2003) conducted a study with 310 children and teenagers aged seven to eighteen years, in which they used both ultimatum and dictator games to obtain a clean separation of the fairness component and the strategic component inherent in the standard UG. The experiment was incentivized with real money for older children and tokens (exchangeable into toys) for younger children. The results clearly showed that even the youngest children in their subject pool played strategically, since they made much smaller proposals in the dictator game than in the UG. Contrary to the findings of Murnighan and Saxon (1998), Harbaugh et al. (2003) found that the youngest children offered the smallest average amount as proposers.

One plausible explanation for the inconsistency between the two studies is that Harbaugh et al. (2003) used real incentives instead of hypothetical ones. The lower offers of younger children, combined with very low rejection rates and small amounts sent in the dictator games, made the youngest children's behavior look closest to the subgame perfect equilibrium prediction for selfish decision makers. These stylized facts led to a well-known statement by Colin Camerer, who stressed that "the youngest children . . . are *closer* to the self-interest prediction of game theory than virtually any adult population! This is a huge hint that experience does *not* teach people to behave like payoff-maximizing game-theorists, as is often presumed. If anything, the opposite seems to be true." (2003, p. 66; emphasis in original)

If pro-social behavior becomes more prevalent in older children and teenagers, one can ask how outcome-based thinking and intention-based thinking evolves with age in bargaining situations. Sutter (2007) examined the behavior of 200 children, teenagers, and university students in a series of four incentivized mini-UGs in which proposers were restricted to choose from only two offers. One of them (allocation 8/2) was identical across the four games, while the alternative differed and was more or less favorable to the responder (10/0 ;8/2 ;5/5 ;2/8). The results showed that subjects of all age groups reacted systematically to perceived intentions (accepting 8/2 more often when the alternative was 10/0, for instance), but at the same time pure aversion against inequitable outcomes was quite common for all subjects, irrespective of the proposer's intention. Yet, children and teenagers rejected unequal outcomes, even if they were favorable, much more often than university students, leading to the conclusion that (fair) bargaining outcomes were relatively more important than (good) intentions for younger children.

In Sutter and Kocher (2007), we studied behavior in another famous bargaining game, the trust game, with 662 participants from eight-year-old children to retired persons, thus covering almost the entire life span of humans. The trustor was endowed with ten units of money and could send as much as she liked to the trustee. The trustee received three times the amount sent by the trustor and could return whatever he liked. We found that the transfer of the trustor increased almost monotonically with age in childhood and adolescence. Similar to trust, the degree of trustworthiness increased with age. Even children at a relatively early age, however, showed already trustworthy behavior and thus a certain degree of reciprocity.

More recent papers have confirmed earlier evidence. All of this suggests that social behavior (towards strangers) undergoes a substantial development in the early years of life, during childhood and adolescence. Humans become more social when they grow up! As such, knowing more about bargaining behavior and social preferences of young children and teenagers increases our understanding of adult bargaining behavior, to whose understanding Werner Güth has contributed eminently. It also provides important insights into the nature and origins of preferences as well as on the degree and the determinants of their malleability. Although Werner Güth has (so far) not been involved in experimental studies with children and teenager subjects on the development of bargaining behavior, in particular, and on economic behavior more generally, his ground-breaking work on the UG has had a considerable influence on this quickly growing research field, both through personal contact to, discussions with and inspiration of contributors (like us) and through his huge scholarly work on human bargaining, on which we all draw heavily in our research.

9. Decision neuroscience

By Alan G. Sanfey[25]

One of the more consequential developments over the past decade in understanding the processes that underlie human decision-making has been the increasing integration of several disciplines which have traditionally been interested in this topic, though which have typically examined these questions from rather different perspectives. One of these interdisciplinary approaches, often popularly termed Neuroeconomics or Decision Neuroscience (Glimcher, 2008), has endeavored to integrate ideas and methods from Economics, Psychology, and Neuroscience in order to specify more accurate descriptive accounts of decision-making. The goal of this approach has been to take advantage of the strengths of these component disciplines in order to build more robust models of decision and choice behavior, and real progress is beginning to be made in addressing this objective.

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Traditional studies of judgment and decision-making across these three disciplines have primarily focused on situations in which people choose between outcomes that are purely self-relevant, such as playing a lottery where choices are described in terms of their outcomes and concomitant probabilities, with players required to pick their preferred lottery. However, given that we live in highly complex social environments, many of our most important decisions are made in the context of social interactions, that is, in a social context in which the outcome of a decision has consequences not only for one's self but for others as well, and where we need to consider these desires and values of others before making an optimal decision (Sanfey, 2007).

To explore these highly relevant but relatively understudied questions, the use of interactive economic games have proved one of the most productive examples of the integration across disciplines that has characterized Neuroeconomics. The games themselves have many qualities which are well-suited to psychological and neuroscientific investigation, most notably that they are simple but sophisticated. These tasks are straightforward to both explain and present to participants, are compelling to play, and are relatively easy to convert to use in the complex technical environments employed by neuroscientific investigation. The practical advantages of these tasks should not be minimized, as it is often difficult to develop tasks which both allow for the investigation of complex psychological states and are also appropriate for use when players are either immobilized in an MRI scanner (as is the case with functional magnetic resonance imaging – fMRI – measurements) or are administered hormones to examine pharmacological effects on decision-making, to give but two examples. In addition of course, the tasks also allow questions to be asked about fundamental psychological processes such as fairness, trust, reciprocity, and cooperation, and offer both a substantial body of behavioral data as well as rigorous models to help interpret the brain results.

To date a wide variety of games have been used to study several important aspects of social decision-making, but the task that has proved both most popular and has led to greatest insights has been the UG (Güth et al., 1982). Indeed, probably more than any other social decision, the brain response to fairness and unfairness has been examined with a variety of neuroscientific methods.

The first fMRI investigation of UG behavior examined the decision-making, and associated brain correlates, of the responder, in particular examining the question of what brain activation was associated with the receipt of unfair offers and whether in turn this brain activity discriminated between proposed monetary divisions that were subsequently accepted or rejected (Sanfey et al., 2003). Receiving an unfair as compared to a fair offer engaged activation in a specific brain area known as the anterior insula, with this activation stronger for offers from human than from purported computer partner making identical offers. Also, the degree of activation in the anterior insula scaled to the magnitude of unfairness, with lower offers leading to greater brain activity. Controlling for monetary amount, rejected offers were associated with a stronger insula response than those that were subsequently accepted, indicating that the accept/reject decision was influenced by the magnitude of anterior insula activation. Given the insula's association with basic negative emotional states, such as pain, disgust, and autonomic arousal (Calder et al., 2001), the involvement of this area in the experience of unfairness and the subsequent decision to punish showed that brain regions previously thought to be involved in low-level affective states could be recruited for the processing of complex social motivations. Further studies have shown that inducing negative moods in players prior to the receipt of unfair offers, a manipulation which appears to 'target' the anterior insula specifically, leads to increased rejection rates as compared to a non-negative mood induction (Harlé et al., 2012). This indicates both a causal role for this region in decisions about fairness, as well as demonstrating that fairness norms can be relatively unstable and susceptible to even minor cognitive or affective influences.

This insula involvement has been replicated in further neuroimaging studies (e.g. Tabibnia et al., 2008),with further attention paid to what might underlie acceptance of unfair offers, behavior of course predicted by standard models of selfish preferences. These 'accept' decisions were associated with activation of the ventrolateral prefrontal cortex (VLPFC), an area often involved in the regulation of our emotional states (Ochsner and Gross, 2005), implying that VLPFC may contribute to acceptance of unfair offers by 'top-down' reduction of insula-based negative affect.

Altering the underlying brain pharmacology has also been used to better understand the neural mechanisms underlying responses to unfairness. For example, when serotonin levels are decreased in non-clinical populations by using dietary tryptophan depletion, higher rejection rates of unfair offers are observed when compared to a control group with normal serotonergic functioning (Crockett et al., 2008). A plausible mechanism for this effect is that the depletion of serotonin acts to reduce the subjective value of the monetary incentive relative to the social reward of punishing a proposer who has acted unfairly. There have also been explorations of the role of sex-steroid hormones such as testosterone on UG decisions. Men with higher salivary testosterone tend to exhibit greater rejection rates for low offers (Burnham, 2007), though these testosterone effects have not been observed in women (Eisenegger et al., 2009; Zethraeus et al., 2009). Though very much in its infancy, exploring of the role of hormones such as serotonin, testosterone, and oxytocin on fairness considerations, either by direct alteration by pharmacology, examining differences in baseline levels, or even assessing susceptibility via genetic screening has the potential to offer a great deal to our understanding of the individual differences in the willingness to accept or reject unfairness.

Other developments have been to use neuroscientific findings to examine traditional accounts of behavior in the UG, with important implications for the theoretical models proposed to explain UG rejections. For example, one recent study used a novel computational model of social preferences in combination with fMRI to understand how prior expectations influence decision-making in the UG (Chang and Sanfey, 2011). In contrast to previous accounts of why players reject unfair offers, suggesting that this is based on a fundamental principle of 'inequity-aversion' (Fehr and Schmidt, 1999), the results here

indicated that a model based on players' expectations of the type of offers they would encounter in the UG was a better fit for behavior, with deviations from expectation associated with an increase in rejection levels and a corresponding activation of anterior insula. Further, violations of social expectations were processed by the anterior cingulate cortex, an area involved in resolving conflict between options in decision-making (Pochon et al., 2008). This evidence points to the relevance of so-called psychological games that can model belief-dependent motivations (see Geanakoplos et al., 1989; Battigalli and Dufwenberg, 2009).

The neuroscientific study of interactive decision-making is still in its relative infancy, and outlined here are but a small handful of studies that have attempted to address these questions. Nonetheless, even in these early stages progress has been made in understanding the fundamental brain mechanisms and their involvement in decisions about fairness and unfairness, with this approach potentially providing important biological constraints on the processes involved in decision-making. Additionally, these findings can play an important role by discriminating between alternate theories that may predict very similar behavioral results.

The use of the UG in neuroscientific studies has also had a positive effect on other questions concerning the social motivations involved in interactive decision-making. A wide variety of game theoretic tasks have now been employed in neuroimaging and pharmacological studies, with many standard games such as the Dictator Game, Trust Game, and Public Goods Game employed to examine the neural underpinnings of processes such as altruism, trust, reciprocity, cooperation and competition. Taken together, this has allowed for a much richer understanding of social decision-making.

In the near future, neuroscientific techniques will become more mainstream, as new developments are likely to make both functional imaging and brain intervention methods more accurate, cheaper, and easier to use. Although the field is young, decision neuroscience as a field is growing at a rapid rate and can hopefully further its integration with experimental economics to advance the understanding of decision-making in social interactive scenarios, with the UG likely to continue to be a key component of this progress.

10. The ultimatum game "goes ethics"

By Hartmut Kliemt[26]

The UG focuses on opportunistically rational forward looking choice-making and thereby tests the core assumption of the so-called economic approach. The roots of the approach date back at least to the 17th century. Spinoza (1670/1951, 203-204) summed up a then already extended discussion by stating: "Now it is a universal law of human nature that no one ever neglects anything which he judges to be good, except with the hope of gaining a greater good, or from the fear of a greater evil; nor does anyone endure an evil except for the sake of avoiding a greater evil, or gaining a greater good. That is, everyone will, of two goods, choose that which he thinks the greatest; and of two evils, that which he thinks the least. I say advisedly that which he thinks the greatest or the least, for it does not necessarily follow that he judges right. This law is so deeply implanted in the human mind that it ought to be counted among the eternal truths and axioms."

After presenting extrinsically motivated case-by-case maximization in view of the expected future causal consequences of each act taken separately, Spinoza goes on to spell out the ethical and social implications of such an 'economic approach to human behavior' with the example of 'subgame perfect promise keeping': "As a necessary consequence of the principle just enunciated, . . ., no one will abide by his promises, unless under the fear of a greater evil, or the hope of a greater good. . .Hence though men make promises with all the appearances of good faith, and agree that they will keep to their engagement, no one can absolutely rely on another manś promise unless there is something behind it. Everyone has by nature a right to act deceitfully, and to break his compacts, unless he be restrained by the hope of some greater good, or the fear of some greater evil." The economic responses to Spinoza's 'commitment and/or principal agent problem' typically propose ways of providing incentives for promise keeping. They put 'extrinsic motives' "behind it."

Today the emergent second-order free-riding problems – 'who guards the guardians?' – are typically tackled within the framework of repeated game arguments. Indeed, such and related arguments of the "folk theorem" type show how the so-called "shadow of the future" may conceivably operate. Yet, what is conceivable is not necessarily what is real and feasible. Quite to the contrary, what is actually observed in social life seems more in line with the assumption of intrinsically motivated norm-obedient behavior than with explanations in terms of the extrinsic motives provided by expected causal (future) consequences of overt behavior: At some level of the system of mutually supporting threats and rewards somebody will act in violation of the economic model of opportunity taking rational choice making and simply do something for motives or reasons other than the expected causal consequences of that act.

Explanations in terms of expected causal consequences of overt behavior are central to economists while psychologists, sociologists and moral philosophers accept some role of intrinsic motivation. The original UG experiment directly speaks to the foundational controversy between those who intend to stick to the behaviorist framework of revealed preferences and as if optimization in view of extrinsic motivation in terms of external stimuli and those who intend to assign a role to intrinsically motivating psychological factors. It carefully eliminates all sources of extrinsic motivation except the monetary consequences of rejecting or accepting an offer in a case at hand. Effects that overt behavior is expected to have on substantive future monetary payoffs cannot explain observed responder behavior in the UG. Some intrinsically motivating – emotional or

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rule following – factors influencing behavior are as a matter of empirical fact present. That they cannot be disqualified as mere noise is of great consequence. For, referring either to "retributive emotions" or to intrinsically motivated "rule following" in explaining overt behavior amounts to giving up the economic approach's core assumption of rational forward-looking choice making.

Whether the "pro-social" punishment behavior of responders on which the UG focuses is driven by "moral emotions" or by "moral principles" does matter for many problems but not for the central foundational issue as such. Assuming that non-opportunistic intrinsic motives play a decisive role in explaining social behavior goes against the grain of the economic model. The presence of such motives explains the constitution and operation of organizational order – moral and legal institutions etc. – in realistic rather than merely conceivable ways. In terms of the UG: the proposer has indeed opportunistic motives to behave as "if fair" if confronting the possibility that the responder might be guided by retributive emotions attached to some ethical code or other.

Once we allow for an intrinsic motivation like, in particular genuine rule following behavior, the explanatory framework changes in a fundamental way. Guidance by some "ethical code" or other – comparable to the ethical codes guiding, say, "medical doctors" or the "honor codes of thieves" – becomes viable. "Moral tribes" (Greene, 2013) of all sorts including companies, associations, governments etc. become viable. Ethical conventions ("customs") and the subjective perception of their normative requirements can play a causal role in the real world. The so-called Hobbesian problem of social order "how can there be institutional orders among rational actors who can shift their behavioral gears any time?" can be solved. The existence and stability of norm-orders (legal, moral, customary. . .) is not an anomaly as it must be in a Spinozist world in which individuals are not guided by accepted norms and do not emotionally feel under corresponding obligations.

The UG has been a "game changer" in the foundational controversy between economists and other social scientists since it uses the empirical weapons of economics against the classical model of opportunistically rational choice making: Ethical codes and convictions shaped by those codes ("internalized norms") are a real motivational factor. Even if this factor were effective only at low (extrinsic) stakes its presence would change the world of social explanation, since it is erroneous to assume that low, even insignificant costs (as in the case of decisively important democratic voting) imply minor social importance of the acts. The social fabric systematically brings some in the position to exert high costs on (often many) others at low costs to themselves. Intrinsic motivation by some "ethics" can do its work, power relations become viable and the division of labor can be extended to the enforcement of norms.

Economists nowadays seem to accept the results of experiments like the UG as relevant. The way the results have been incorporated into the body of revealed preference analyses is, however, not hospitable to a clear acknowledgement of intrinsic motivation and the necessity to account for it in (cognitive) psychology terms. If we intend to understand how individual perceptions of ethical codes and motives do in fact causally influence the world a move towards cognitive economic psychology is required. The "revealed motives" strategy by which most economists try to incorporate their often striking empirical results into the "as if optimization" of their revealed preference framework remains alien to empirical law based "if then" accounts.

In particular introducing so-called "social preferences" as well as the many "aversions" of which we nowadays hear so much does not do full justice to the factual role of retributive emotions and genuine rule following behavior. As far as the latter is concerned, one should be quite optimistic that modifications of the UG experiment may in future research lead to empirical vindications of the relevance of genuine rule following behavior. Such a future variant of the UG experiment might induce economists to acknowledge the role of intrinsic motivation as a fundamental building block of social order. If so, the UG would help economists to keep ahead of the pack of social scientists and thus at the place where they, due to the analytical strengths and empirical merits of their discipline, belong.

11. Werner Güth, an early, original contributor to bounded rationality, experimental economics, and game theory

By Reinhard Selten[27] & Rosemarie Nagel [28]

Werner Güth is rightly named the originator of the UG experiment, uncovering behavior which invoked a long series of experiments and discussions about the tension between fairness norms and rational behavior. In this note we especially focus on bounded rational modeling or modeling of cognitive processes. We also include our personal encounter with Werner Güth as a coauthor and teacher.

In his early theoretical work (PhD and habilitation) Werner Güth developed ideas about cooperation in the economy. He wanted to show that instead of competitive market interaction the economy could be organized by cooperation. In the beginning of the 70s he visited me (Reinhard Selten, RS from now on) in Berlin where I was teaching in the Freie University in order talk to me about his work, which I found highly original but not completely satisfactory. It was obvious that in Münster he had no contact with mathematical economists and therefore he did not quite conform to the standards of mathematical theory. He was shocked by my criticism. Yet I immediately had the impression that he is a highly original researcher.

In 1972 I moved to the University Bielefeld's Institute of Mathematical Economics (IMW), located in the Schloss of Rheda. Therefore I bought a town house in Wiedenbrück. Rheda and Wiedenbrück are two smaller towns which became united to

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[28] Universitat Pompeu Fabra, ICREA, and BGSE.

one community Rheda-Wiedenbrück. Wiedenbrück is halfway between Bielefeld and Münster. When I was in Bielefeld and Werner Güth was still in Münster we kept close contact working together on various theoretical topics. He tried to learn as much as possible in game theory, applications of non-cooperative game theory to economics, and also about the equilibrium selection theory by John Harsanyi and Selten (1988).

Like me he also became interested in the psychology of decision making. The necessity of the development of bounded rationality became clear to Güth and I, and thus we began to shift attention from purely theoretical approaches to empirical or to experimental research on this new topic. At that time it was very difficult to conduct experiments without having a laboratory anywhere in Germany and to obtain funding for paying subjects. The University of Bielefeld was not supplying more than very limited funds for such experiments. The first lab I founded in Bonn after 1985 with 12 computers, the first of this kind in Europe.

Werner Güth is famous for his experimental work on the UG. When he observed that sizeable amounts were rejected by receivers, this created a great puzzlement in the community of economic theoreticians. The behavior of the sender in repeated UGs with random matching can be explained as adaptation to the behavior of the receiver.

Yet, Werner Güth, in his long scientific career has written many experimental and theoretical papers, in many different areas. He publishes about 10 papers every year. For example he has written a paper together with his daughter on the social behavior on primates with game theoretic interpretation (Güth and Güth, 2000). We find this paper very illuminating and recommend this to everybody in biological game theory. He has initiated a literature on indirect evolution (Güth and Yaari, 1992; Dufwenberg and Güth, 1999). Together with me (RS) he has written several papers about applications of the equilibrium selection theory by Harsanyi and Selten (1988). We wrote papers on a number of economic problems, e.g. on the notion of the Condorcet paradox by a non cooperative game model (Güth and Selten, 1991) or the problem of "original and fake" where a buyer has incomplete information about this question whereas the seller knows exactly what he sells (Güth and Selten, 1991). With Güth, W., Kalkofen, B., 1989 have developed a theory of equilibrium selection that rivals Harsanyi and Selten (1988). The theory of equilibrium selection is still an open problem and any contribution to this field may still be of great significance.

Also in the future we can still expect interesting contributions by Werner Güth to the areas mentioned in this short appraisal, especially to modeling bounded rationality in decision and game situations. Werner is very concerned about describing a cognitive process that yields a modal behavior of the subjects.

One of his papers in this direction is Güth et al. (2014) where he describes mental models of a normal form game with payoffs depending on stochastic events. He models beliefs of a player as sets of scenarios. A scenario is essentially a future course of the play. He then explains how aspirations are formed for only one goal variable, but he also allows vectors of aspirations levels, one for each scenario, not excluded by the beliefs of the players. Werner Güth looks at satisficing in this framework. He also develops a concept of optimal satisficing. His approach is certainly worth looking upon carefully. It is an interesting approach to the problem of modeling boundedly rational behavior.

Werner Güth, together with his coauthors (2012), video-taped an experiment in which two subjects communicate about a common choice in a risky decision task and in a game against another pair in order to examine the reasoning of bounded rational players. However, in our view he does not receive really conclusive results. In Selten et al. (2012), a paper within the project "Rationality in the Light of Experimental Economics" at the University of Bonn, financed in the working group of the Nordrhein-Westfalen Akademie, and two other papers discussed below we propose alternative ways. Nevertheless, we appreciate Werner Güthś efforts to develop a formal model of bounded rational behavior in games. What can we expect of a theory of boundedly rational behavior in games?

Such a theory may explain known results from the experimental literature, for example the results of Mitzkewitz and Nagel (M/N, 1993), a paper which originated from many discussions with Werner Güth as described below. M/N introduce an UG with incomplete information using the strategy method. The proposer knowing the actual pie size has to make a proposal (an inter multiple of 0.5) for every pie (1, 2, . . , 6 with an expected average of 3.5). At the same time the responder, knowing that these pie are drawn with equal probability, has to accept or reject every possible proposal (0, 0.5, . . . 5.5, 6).

Here we present a cognitive thought process only for offer games, i.e., the proposer offers an amount to the responder, and the responder does not know what the proposer gets. Mitzkewitz and Nagel develop a three step bounded rational model about how the proposer determines his proposal. In the first step the proposer has to anticipate how the receiver determines his minimum acceptance level; in Güth's language, the proposer then excludes all scenarios, in which the receiver accepts less, given the proposerś beliefs. His own aspiration level is at least half the actual pie. In step 2 the proposer determines the best reply to his anticipated acceptance level without considering that his proposal cannot be greater than the actual pie size. In this way the true best reply to the acceptance level is determined. In step 3 the proposal is the true best reply to the acceptance level unless it leaves less than half of the pie for the proposer or offers more than the actual pie. For those pies the proposal is reduced to proposerś aspiration level, half the actual pie.

Note that the anticipation level of the proposer will take into account the structure of the game and the knowledge of the players in the game. Here the most important aspect is that the proposer knows that the responder does not know precisely the pie size, but only a probability distribution with an average pie of 3.5. Therefore a typical anticipation level is half of the expected pie size and thus players offer only 1.5 or 2 for the highest pie of 6 (25% or 33%), for pie 5, and 4, and exactly half of the pie for the remaining pies. Also an acceptance level of 1 is considered. The two alternative strategies are equal split together with near equal spit (which is just equal split minus 0.5) and the sequential equilibrium strategy of offering always 0.5.

M/N allow some deviations from these strategies and apply the measure of predicted success for area theories axiomatized by Selten (1991). They find that indeed the anticipation strategies have a greater explanatory power than equal split proposals which reduce to about 20% after some learning has occurred. Over time the sequential equilibrium is more and more chosen. Thus introducing incomplete information might be a good mechanism to elicit truthful revelation about fairness types in a strategic bargaining setting (see also Gueth, 1996; Kriss et al., 2013).

The three-step theory is very different from the modern approach of describing behavior in terms of utility functions with other regarding arguments like inequality aversion by Fehr and Schmidt (1999) and Bolton and Ockenfels (2000). The three-step theory attempts to sketch the reasoning processes of the players without postulating utility functions. It is not an equilibrium concept as it does not require consistency of beliefs between the two players. Adaptive behavior can nevertheless lead to consistency of beliefs. Furthermore, given that equal split has much less explanatory power than in UGs with complete information, it is questionable to interpret bargaining results parsimoniously with social preferences. Still to date incomplete bargaining situations are understudied but could potentially lead to further understanding of bargaining outcomes.

Theories with utility functions depending on unusual arguments like inequality aversion are very popular in the literature, because the use of these instruments requires minimal adjustment of neoclassical theory. They lend themselves to the neoclassical "repair shop" as Werner Güth says. With his theoretical approach to bounded rationality he wants to overcome this repair shop, understanding the way in which subjects in experiments form models of strategic situations. However, these mental models have a different structure from game forms. Next we exemplify this with an approach to supergames.

In Selten et al. (1997) we report on experiments with 20 times repeated duopoly with asymmetric costs, in which subjects know both cost functions and the demand function. All our subjects had sufficient computer knowledge. They played the duopoly supergame twice. First they played it in the usual way in the laboratory and then programmed strategies for the computer tournament. One of the two firms had low fixed and high variable costs and one had high fixed and low variable costs. The subject, writing a strategy for this game in both roles, has to have a mental model of the situation.

Our empirical results suggest the following mental model. The play of the supergame has three phases, an initial phase, a main phase, and a final phase. Both initial phase and the final phase last up between four to six periods.

Usually the players are guided by cooperative goals (x^1, x^2), which specify a quantity for each of both players. In the initial phase they try to come to an agreement about the cooperative goal. Thus player i begins with a relatively high quantity x^i and gradually lowers his supply towards his ideal point. If both players behave in this way, they may meet at a point $(x^{1\prime}, x^{2\prime})$ on the way to their cooperative goals and perhaps they can then agree on this compromise and play it in the main phase. In the final phase they have an incentive to deviate from a quasi agreement if they have reached it. In the main phase they have the problem of achieving and securing cooperation at their cooperative goals or at a compromise of both goals. This is usually accomplished by responses to deviations of the opponent, e.g. if an opponent increases or decreases his quantity, oneself will also react with the same quantity changes. We call this a measure for measure strategy.

The strategic problem can be summarized by two questions: First, what is a player's cooperative goal, and second, how does a player achieve his cooperative goal in the main phase? The first question is answered by the selection of a reasonable ideal point (x^1, x^2), and the second question is answered by a measure for measure strategy.

The ideal point should be carefully selected. If both players select high quantities for themselves, their measure for measure strategies will very likely lead to the Cournot equilibrium. However, if both players have moderate own quantities in their ideal points, they will reach a compromise by their measure for measure strategies.

Here bounded rationality is very different from the usual approach of oligopoly and game theory, where people optimize against the expected behavior of the other player. Contrary to this, the measure for measure approach tries to induce the other player to movements favorable towards once own cooperative goal.

Such problems are well known in real life. For example, parents are told that they should be consequent in the behavior towards their children. They should always keep their promises and execute their threats. On the other hand one must consider that not only parents have their cooperative goals but also their children. Both can stick to their measure for measure strategies, but they finally have to come to a solution that is tolerable for both.

It is an important feature of the mental model that one can decide to deviate in the final phase without committing to deviations in a specific period. Game theoretically this is not possible. But in a three phase mental model there is no contradiction in deciding first to cooperate and then to deviate in one of the last periods. A formal approach to bounded rationality must answer such questions. A broad concept of mental models for games and strategies must be developed, which then can lead to boundedly rational analysis. We need more theorists like Werner Güth who are willing to consider such problems.

It also seems to be necessary to perform experiments on complex decision situations and games. In complex environments there is a better chance to observe unexpected behavior that nevertheless is reasonable. Most practical decision problems with or without strategic interactions are very complex and game theoretic analysis is usually not feasible. One needs a theory of qualitative strategies in order to find ways to analyze such situations without modeling the situation as a decision problem or a strategic game.

11.1. Personal note by Rosemarie Nagel

In spring 1989 after my economic diploma in Bonn, I (Rosemarie Nagel) came to Frankfurt University working with Reinhard Tietz, before entering the European Doctoral Program (EDP) in Bonn in fall 1989. I attended some of Werner Güth's lectures in game theory for undergraduates, a course which was taught only in handful German universities at the time.

Unlike Reinhard Selten who strictly separated aspects of experimental economics and economic theory in different courses, Werner Güth, similar to Eric Van Damme, started to explain many theoretical concepts with now so-called classroom experiments. Güth also discussed psychological motivations of the studentśbehavior. Additionally, in the beginning of the experiment we had to fill out a personality inventory which I had never seen in any economics lecture (see also Selten and Schuster (1968) who used the Raven test to measure IQ, risk attitudes and correlate it with behavior). A typical economist would have said in the beginning of the 90s - This is psychology and therefore there is no need to include it in economics – a position, which is often held about neuro economics today - Do we need a brain in economics? (discussed e.g. in Camerer et al. (2005)). As many say in this volume, Werner Güth in many aspects strives for non-typicality in his own way of doing research, to be different and search for truth in his own manner.

In the mentioned experiment, we had to play an UG, which I didn't know then. But this was not the only game. Güth combined the UG with an auction, in order to determine the proposer and responder position in the following UG. He typically made a lot of money by this pregame! Also I bid in the auction much more than reasonable, namely half of the pie in the role of a responder. A random draw because of a tie with another winning bidder saved me from becoming a responder and making losses. This observation of my own erroneous behavior helped me later to understand, how little a subject can look through a game protocol in the first instance, and the power of focal points. Since proposers typically pay more than responders in such an auction, a 50-50 offer has been rarely observed in such a bargaining problem (see Güth and Tietz, 1986).

Güth and Tietz (1986), also Güth et al. (1992) use the link between personality characteristics and behavior using factor analysis. The combination of multiple simple games and psychology measures was and is still rare in experimental economics. However, in the last decade personality questionnaires and an evaluation with behavior are appearing in economic journals (e.g., Brandstätter and Güth (2002)).

The time in Frankfurt was very influential for me. I tried to confront Werner Güth with his idea of distributive justice, arguing that players are strategically fair or mimic a fair player rather than being intrinsically fair.

One evening, in a bar in Frankfurt, drinking Frankfurter Äbbelwoib (apple wine), Manfred Koenigstein, then a master student of Reinhard Tietz, and I discussed Güth's fairness concepts. There I got the idea of the UG with incomplete information about the pie size on the side of the responder (mentioned above), while Manfred started thinking about an experiment with humans playing against computers in UGs, another no-go at the time in economics, for his master thesis.

Werner and I had many interesting discussions about the new UG. However, we did not converge on a common explanation for my hypothesis that subjects will not split equally. A similar discussion can be found in Güth (1988) on his ideas of distributive justice and those held by Roth and Malouf (1979), who study bargaining behavior under different information structures about the value of chips to be divided between two players. The latter actually was in line with my reflections that expectations and beliefs about the opponentś acceptance levels are important for constructing rules; this is different in different information settings and thus in contrast with the idea of distributive justice.

Finally today, as I learned and profited in Werner Güth ś lectures from the theory-experiment combination, many experimenters now promote a systematic inclusion of experiments in lectures in economic undergraduate and graduate studies, participating in classroom, lab-experiments, and field experiments etc.

It is important that young students receive a more complete education including theory, experiments, empirics, and the necessary statistical tools early in their training. This combination will lead to a deeper understanding of the models through playing them and establish a more holistic way of perceiving economic situations, especially of long term effects, but also using intuition and being emotional, as feeling for a few minutes to be unemployed in different markets, or be a manager in part of a supply chain (e.g. the beer game) encountering bulling effects, an overreaction of other players. These experiences counteract the mechanical optimization required for mathematical problem sets. Often long run effects of models cannot be theoretically shown because the theory is too difficult. However, by playing, even complicated models can be discussed and consequences of e.g. short run maximization can be experienced.

Students will see at the same time the beauty of the theory and the great variety of possible deviations or compliances of actual behavior with the theory. They can also find out important structures in their own behavior, maybe not easily seen by an outside observer as I describe it in Büren et al. (2012). This will hopefully inspire young graduate students to develop original ideas, find new ways of solving problems in the society, beside the short term gain of doing better in exams. It also uses methods already used in natural sciences and forethought by Confucius 3000 years ago in:

> By three methods we may learn wisdom:
> First, by reflection, which is noblest;
> Second, by imitation, which is easiest; and
> Third by experience, which is the bitterest.

Just using only one of these methods might lead, as we see it in many ways today, to

Learning without thinking is useless, and thinking without learning is dangerous. (also Confucius)

To understand these two quotes for the purpose of teaching and creating research in economics, "thinking" or "reflection" may be replaced by "theory"; "learning", "experience" or "praxis", what students always ask for, can be interpreted as "experiments." Behavior in experiments has to be structured, analyzed, and generalized through theories; otherwise it might remain on an intuitive, or case by case observation, and even sometimes misleading level. But an application of the theory in reality without tests through some channels of empirical fine tuning can lead to fatal errors (see also "The economist as engineer", Roth, 2003). It is never too early to get exposure to both, theory and experiments. Most of my own (early) research has been inspired by being (first) a subject, as described above, with good training of theory at the same time already during my undergrad and early grad studies.

All in all, Werner Güth has very essentially shaped the beginning of my career for which I am very grateful to him. My first paper is truly initiated by his lectures, his ultimatum papers, and discussions with him. Also my current teaching innovations of combining theory with experiments has been inspired through him.

12. A citation analysis of "An experimental analysis of ultimatum bargaining" (Güth et al., 1982)

By Ofer H. Azar [29]

One of the most famous games in the experimental economics and behavioral economics literatures is the UG, which was invented by Güth et al. (1982). A common way to evaluate the importance and impact of academic articles is to analyze the citations they received, and below I provide such an analysis for the UG paper of Güth et al. (1982). Before analyzing in detail the citations to this article, it seems interesting to see an overview of the citations to the most influential UG papers. Table 1 provides the list of the ten most-cited papers in the Web of Science database that have the word "ultimatum" in their title.

As Table 1 shows, Güth et al. (1982) not only pioneered the literature on the UG, but they also remained the most-cited paper. They did, however, inspire many other studies that have become highly cited themselves. To understand how impressive is the number of 936 citations that the article received, it is worth mentioning that in all the articles published in *JEBO* since its inception in 1980, only one paper was cited more than Güth et al. (1982).[30] This is especially impressive if we remember that *JEBO* is the top journal in behavioral economics and socio-economics (Azar, 2007).

Table 1
Most-cited papers with "ultimatum" in their title.

Authors	Title	Journal	Year	Times cited
GUTH, W; SCHMITTBERGER, R; SCHWARZE, B	AN EXPERIMENTAL-ANALYSIS OF ULTIMATUM BARGAINING	JOURNAL OF ECONOMIC BEHAVIOR AND ORGANIZATION	1982	936
SANFEY, AG; RILLING, JK; ARONSON, JA; NYSTROM, LE; COHEN, JD	THE NEURAL BASIS OF ECONOMIC DECISION-MAKING IN THE ULTIMATUM GAME	SCIENCE	2003	755
CAMERER, C; THALER, RH	ULTIMATUMS, DICTATORS AND MANNERS	JOURNAL OF ECONOMIC PERSPECTIVES	1995	363
PILLUTLA, MM; MURNIGHAN, JK	UNFAIRNESS, ANGER, AND SPITE: EMOTIONAL REJECTIONS OF ULTIMATUM OFFERS	ORGANIZATIONAL BEHAVIOR AND HUMAN DECISION PROCESSES	1996	232
GUTH, W; TIETZ, R	ULTIMATUM BARGAINING BEHAVIOR - A SURVEY AND COMPARISON OF EXPERIMENTAL RESULTS	JOURNAL OF ECONOMIC PSYCHOLOGY	1990	211
THALER, RH	ANOMALIES - THE ULTIMATUM GAME	JOURNAL OF ECONOMIC PERSPECTIVES	1988	205
GALE, J; BINMORE, KG; SAMUELSON, L	LEARNING TO BE IMPERFECT - THE ULTIMATUM GAME	GAMES AND ECONOMIC BEHAVIOR	1995	183
NOWAK, MA; PAGE, KM; SIGMUND, K	FAIRNESS VERSUS REASON IN THE ULTIMATUM GAME	SCIENCE	2000	181
KOENIGS, MICHAEL; TRANEL, DANIEL	IRRATIONAL ECONOMIC DECISION-MAKING AFTER VENTROMEDIAL PREFRONTAL DAMAGE: EVIDENCE FROM THE ULTIMATUM GAME	JOURNAL OF NEUROSCIENCE	2007	163
BOLTON, GE; ZWICK, R	ANONYMITY VERSUS PUNISHMENT IN ULTIMATUM BARGAINING	GAMES AND ECONOMIC BEHAVIOR	1995	157

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[30] The most-cited paper in JEBO is "Toward a positive theory of consumer choice" (Thaler, 1980) with 1088 citations, followed by Güth et al. (1982), and third is "A theory of anticipated utility" (Quiggin, 1982) with 692 citations. JEBO published over 2500 articles since 1980.

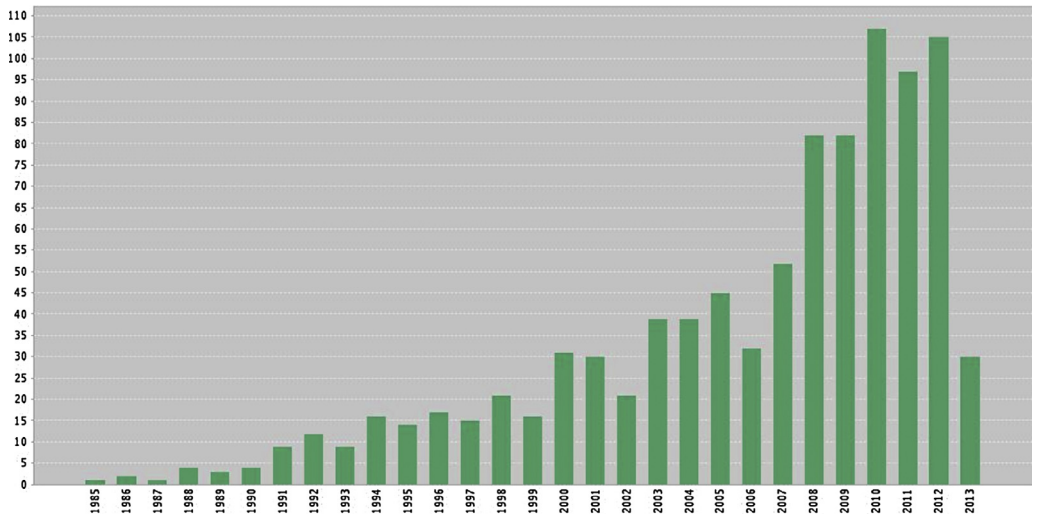

Fig. 2. Citations in each year.

Table 2
Citing journals.

Citing journal	Citations	Citing journal	Citations
JOURNAL OF ECONOMIC BEHAVIOR ORGANIZATION	55	JOURNAL OF EXPERIMENTAL SOCIAL PSYCHOLOGY	10
JOURNAL OF ECONOMIC PSYCHOLOGY	40	JOURNAL OF PERSONALITY AND SOCIAL PSYCHOLOGY	10
ORGANIZATIONAL BEHAVIOR AND HUMAN DECISION PROCESSES	24	MANAGEMENT SCIENCE	10
GAMES AND ECONOMIC BEHAVIOR	23	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	10
AMERICAN ECONOMIC REVIEW	21	SCIENCE	10
PLOS ONE	13	BEHAVIORAL AND BRAIN SCIENCES	9
ECONOMIC JOURNAL	11	ECONOMIC INQUIRY	8
ECONOMICS LETTERS	11	EXPERIMENTAL ECONOMICS	8
JOURNAL OF BEHAVIORAL DECISION MAKING	11	JOURNAL OF THEORETICAL BIOLOGY	8
THEORY AND DECISION	11	QUARTERLY JOURNAL OF ECONOMICS	8
JOURNAL OF ECONOMIC LITERATURE	10		

Next, we can turn to analyze how citations of Güth et al. (1982) changed over time, presented in Fig. 2. We can see that it took the article some time to get a significant number of citations, and that its impact during most of the time since its publication has gradually increased.[31]

Which journals cited Güth et al. (1982) most often? This is analyzed in Table 2, which lists all the journals that cited the article at least eight times. We can see that the same journal that published the original article, *JEBO*, is also the one that cited the article the most times. The next journal is the *Journal of Economic Psychology*, a journal that publishes many experimental studies in economic psychology and decision making. It is followed by the journal *Organizational Behavior and Human Decision Processes*, a psychology journal that publishes mostly on organizational behavior and decision making. Closely afterwards we find *Games and Economic Behavior*, the top game-theory journal, and the *AER*, a top general-interest economics journal. Overall we can see that economics and psychology journals are the ones that cited the UG paper most often, but we can find also top management journals (*Management Science*), science journals (*PLOS ONE, PNAS, Science*), and even a biology journal (*Journal of Theoretical Biology*).

A more encompassing analysis of the areas that were influenced by the UG and consequently cited Güth et al. (1982) can be performed by using two different fields in the Web of Science database. One is the research areas field, and the other is the Web of Science categories. Table 3 shows the thirty most-citing areas according to these two fields. The table shows that economics and psychology (in particular social psychology) are by far the two disciplines on which the UG had the most impact. However, we can also see a significant impact in the areas of neurosciences, business and management, government and law, sociology, and environmental sciences, among others. The diverse list of citing areas in Table 3 shows the broad impact that the UG had in so many different academic disciplines.

[31] The reduction in the number of citation in 2013 is a result of the fact that the data was analyzed in June 2013.

Table 3
Citing research areas and Web of Science categories.

Research areas	Citations	Web of Science categories	Citations
BUSINESS ECONOMICS	443	ECONOMICS	350
PSYCHOLOGY	242	PSYCHOLOGY SOCIAL	86
NEUROSCIENCES NEUROLOGY	75	NEUROSCIENCES	69
GOVERNMENT LAW	73	MANAGEMENT	66
SCIENCE TECHNOLOGY OTHER TOPICS	51	PSYCHOLOGY MULTIDISCIPLINARY	59
SOCIAL SCIENCES OTHER TOPICS	38	MULTIDISCIPLINARY SCIENCES	51
BEHAVIORAL SCIENCES	35	PSYCHOLOGY APPLIED	46
MATHEMATICAL METHODS IN SOCIAL SCIENCES	33	PSYCHOLOGY EXPERIMENTAL	45
SOCIOLOGY	29	BUSINESS	40
MATHEMATICS	26	LAW	39
ENVIRONMENTAL SCIENCES ECOLOGY	25	BEHAVIORAL SCIENCES	35
LIFE SCIENCES BIOMEDICINE OTHER TOPICS	23	POLITICAL SCIENCE	34
COMPUTER SCIENCE	15	SOCIAL SCIENCES MATHEMATICAL METHODS	33
OPERATIONS RESEARCH MANAGEMENT SCIENCE	15	PSYCHOLOGY	30
PSYCHIATRY	14	SOCIOLOGY	29
EVOLUTIONARY BIOLOGY	13	PSYCHOLOGY BIOLOGICAL	28
PHYSICS	13	BIOLOGY	23
MATHEMATICAL COMPUTATIONAL BIOLOGY	11	MATHEMATICS INTERDISCIPLINARY APPLICATIONS	22
BIOMEDICAL SOCIAL SCIENCES	10	ETHICS	19
INTERNATIONAL RELATIONS	9	BUSINESS FINANCE	18
PUBLIC ADMINISTRATION	8	ECOLOGY	17
COMMUNICATION	6	SOCIAL SCIENCES INTERDISCIPLINARY	17
ANTHROPOLOGY	5	OPERATIONS RESEARCH MANAGEMENT SCIENCE	15
PHILOSOPHY	5	PSYCHIATRY	14
AGRICULTURE	4	EVOLUTIONARY BIOLOGY	13
HISTORY PHILOSOPHY OF SCIENCE	4	STATISTICS PROBABILITY	13
RADIOLOGY NUCLEAR MEDICINE MEDICAL IMAGING	4	ENVIRONMENTAL STUDIES	11
ZOOLOGY	4	MATHEMATICAL COMPUTATIONAL BIOLOGY	11
EDUCATION EDUCATIONAL RESEARCH	3	SOCIAL SCIENCES BIOMEDICAL	10
ENGINEERING	3	COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE	9

Table 4
Citing authors.

Citing author	Citations	Citing author	Citations
FEHR E	25	BINMORE K	8
VAN DIJK E	18	FALK A	8
GÜTH W	15	GNEEZY U	8
SANFEY AG	14	SAMUELSON L	8
FISCHBACHER U	10	CHARNESS G	7
BAZERMAN MH	9	DE DREU CKW	7
DE CREMER D	9	LIST JA	7
ROTH AE	9	RAPOPORT A	7
VAN BEEST I	9	–	–

Finally, we can take a look at who are the people who cited Güth et al. (1982) most often. The list of those who cited this paper at least seven times is presented in Table 4.

References

Ashraf, N., Camerer, C.F., Loewenstein, G., 2005. Adam Smith, Behavioral Economist. J. Econ. Perspect. 19 (3), 131–145.
Azar, O.H., 2007. Behavioral economics and socio-economics journals: a citation-based ranking. J. Socio-Econ. 36 (3), 451–462.
Battigalli, P., Dufwenberg, M., 2009. Dynamic psychological games. J. Econ. Theory 144, 1–35.
Binmore, K., Shaked, A., Sutton, J., 1985. Testing non-cooperative bargaining theory: a preliminary study. Am. Econ. Rev. 75, 1178–1180.
Binmore, K., 2007. Does Game Theory Work? The Bargaining Challenge. MIT Press, Cambridge, MA.
Binmore, K., Gale, J., Samuelson, L., 1995. Learning to be imperfect: the ultimatum game. Games Econ. Behav. 8, 56–90.
Binmore, K., Samuelson, L., 1999. Evolutionary drift and equilibrium selection. Rev. Econ. Stud. 66, 363–394.
Binmore, K., Swierzbinski, J., Proulx, C., 2001. Does minimax work? An experimental study. Econ. J. 111, 445–465.
Blount, S., 1995. When social outcomes aren't fair: the effect of causal attribution on preferences. Org. Beh. Hum. Decis. Process. 43, 131–144.
Bolton, G.E., Brandts, J., Ockenfels, A., 2005. Fair procedures: evidence from games involving lotteries. Econ. J. 115, 1054–1076.
Bolton, G.E., Greiner, B., Ockenfels, A., 2013. Engineering Trust: Reciprocity in the Production of Reputation Information. Manage. Sci. 59 (2), 265–285.
Bolton, G.E., Ockenfels, A., 1998. Strategy and equity: an ERC-analysis of the Güth-van damme game. J. Math. Psychol. 42, 215–226.
Bolton, G.E., Ockenfels, A., 2000. ERC: a theory of equity, reciprocity and competition. Am. Econ. Rev. 90 (1), 166–193.
Bolton, G.E., Ockenfels, A., 2012. Behavioral economic engineering. J. Econ. Psychol. 33 (3), 665–676.
Bolton, G.E., Ockenfels, A., 2014. Does Laboratory Trading Mirror Behavior in Real World Markets? Fair Bargaining and Competitive Bidding on eBay. J. Econ. Behav. Org. 97, 143–154.
Brandstätter, H., Güth, W., 2002. Personality in dictator and ultimatum games. Central Eur. J. Oper. Res. 3 (10), 191–215.
Brandts, J., Sola, C., 2001. Reference points and negative reciprocity in simple sequential games. Games Econ. Behav. 36, 138–157.
Büren, C., Frank, B., Nagel, R., 2012. A historical note on the beauty contest. Joint discussion paper series in economics, 2012.

Burnham, T.C., 2007. High-testosterone men reject low ultimatum game offers. Proc. Biol. Sci. R. Soc. 274 (1623), 2327–2330.
Bush, R., Mosteller, F., 1955. Stochastic Models for Learning. Wiley, New York.
Calder, A.J., Lawrence, A.D., Young, A.W., 2001. Neuropsychology of fear and loathing. Nat. Rev. Neurosci. 2 (5), 352–363.
Camerer, C., 2003. Behavioral Game Theory: Experiments in Strategic Interaction. Princeton University Press, Princeton NJ.
Camerer, C.F., Loewenstein, G., Prelec, D., 2005. Neuroeconomics: how neuroscience can inform economics. J. Econ. Lit. 34 (1), 9–64.
Card, David, Alexandre, Mas, Enrico, Moretti, Emmanuel, Saez, 2012. Inequality at work: the effect of peer salaries on job satisfaction. Am. Econ. Rev. 102 (6), 2981–3003.
Chang, L.J., Sanfey, A.G., 2011. Great expectations: neural computations underlying the use of social norms in decision-making. Soc. Cogn. Affect. Neurosci.
Chen, Y., Maxwell Harper, F., Konstan, J., Xin Li, S., 2010. Social comparisons and contributions to online communities: a field experiment on movielens. Am. Econ. Rev. 100 (4), 1358–1398.
Chuah, S.-H., Hoffmann, R., Jones, M., Williams, G., 2007. Do cultures clash? Evidence from cross-national ultimatum game experiments. J. Econ. Behav. Org. 64, 35–48.
Coase, R.H., 1976. Adam Smith's view of man. J. Law Econ. 19 (3), 529–546.
Coase, R.H., 1988. The Firm, the Market and the Law. The University of Chicago Press, Chicago/London.
Cooper, D., Kagel, J., 1988. Other Regarding Preferences: A Selective Survey of Experimental Results. In: Kagel, J., Roth, A. (Eds.), The Handbook of Experimental Economics vol. 2.
Crockett, M.J., Clark, L., Tabibnia, G., Lieberman, M.D., Robbins, T.W., 2008. Serotonin modulates behavioral reactions to unfairness. Science 320 (5884), 1739, New York, N.Y.
Cross, J., 1983. A Theory of Adaptive Economic Behavior. Cambridge University Press, Cambridge.
Dufwenberg, M., Kirchsteiger, G., 2004. A theory of sequential reciprocity. Games Econ. Behav. 47, 268–298.
Dana, J., Weber, R.A., Kuang, J.X., 2007. Exploiting moral wiggle room: experiments demonstrating an illusory preference for fairness. Econ. Theory 33, 67–80.
DeBruyn, A., Bolton, G.E., 2008. Estimating the influence of fairness on bargaining behavior. Manage. Sci. 54, 1774–1791.
Dufwenberg, M., Güth, W., 1999. Indirect evolution versus strategic delegation: a comparison of two approaches to explaining economic institutions. Eur. J. Polit. Econ. 15, 281–295, 1999.
Eisenegger, C., Naef, M., Snozzi, R., Heinrichs, M., Fehr, E., 2009. Prejudice and truth about the effect of testosterone on human bargaining behaviour. Nature 463 (7279), 356–359.
Falk, A., Fehr, E., Fischbacher, U., 2003. On the nature of fair behavior. Econ. Inq. 41, 20–26.
Falk, A., Fehr, E., Fischbacher, U., 2008. Testing theories of fairness: intentions matter. Games Econ. Behav. 62, 287–303.
Fehr, E., Schmidt, K.M., 1999. A theory of fairness, competition, and cooperation. Q. J. Econ., 817–868.
Ferraro, P.J., Cummings, R.G., 2007. Cultural diversity, discrimination and economic outcomes: an experimental analysis. Econ. Inq. 45 (2), 217–232.
Fershtman, C., Gneezy, U., 2001. Discrimination in a segmented society: an experimental approach. Q. J. Econ. 116 (1), 351–377.
Forsythe, R., Horowitz, J., Savin, N.E., Sefton, M., 1994. Fairness in simple bargaining experiments. Games Econ. Behav. 6, 347–369.
Fouraker, L., Siegel, S., 1963. Bargaining Behavior. McGraw-Hill, New York.
Frechette, G.R., Kagel, J.H., Lehrer, S.F., 2003. Bargaining in legislatures: an experimental investigation of open versus closed amendment rules. Am. Polit. Sci. Rev. 97 (2), 221–232.
Geanakoplos, J., Pearce, D., Stacchetti, E., 1989. Psychological games and sequential rationality. Games Econ. Behav. 1, 60–79.
Glimcher, P.W., 2008. In: Glimcher, P.W., Camerer, C.F., Fehr, E., Poldrack, R.A. (Eds.), Neuroeconomics Decision Making and the Brain. Elsevier Inc.
Gong, B., Yang, C., 2012. Gender differences in risk attitudes: field experiments on the matrilineal mosuo and the patriarchal Yi. J. Econ. Behav. Org. 83, 59–65.
Gong, B., Yang, C., 2013. Ultimatum game and risk experiment Onmatrilineal Mosuo and Patriarchal Yi (unpublished manuscript).
Greene, J.D., 2013. Moral tribes: emotion, reason, and the gap between us and them. Penguin.
Güth, S., Güth, W., 2000. Morality based on cognition in primates commentary discussion of Flack and de Waal's Paper "Any animal whatever: Darwinian building blocks of morality in monkeys and apes". J. Conscious. Stud. 7 (1-2), 43–46.
Güth, W., 1988. On the behavioral approach to distributive Justice - A theoretical and experimental investigation. In: Maital, S. (Ed.), Applied Behavioral Economics, Vol. II. Brighton, Wheatsheaf Book Ltd., pp. 703–717.
Güth, W., 1995. An experimental analysis of ultimatum bargaining. J. Behav. Org. 27, 329–344.
Güth, W., van Damme, E., 1998. Information, strategic behavior, and fairness in ultimatum bargaining: an experimental study. J. Math. Psychol. 42, 227–247.
Güth, W., Huck, S., Ockenfels, P., 1996. Two-level ultimatum bargaining with incomplete information: an experimental study. Econ. J. 106 (436), 593–604.
Güth, W., Huck, S., 1997. From ultimatum bargaining to dictatorship: an experimental study of four games varying in veto power. Metroeconomica 48/3, 262–279.
Güth, W., Kliemt, H., 2010. Comments on Vernon Smith's: theory and experiment: what are the questions? J. Econ. Behav. Org. 73, 44–48.
Güth, W., Kocher, M., 2012. Thirty years of ultimatum bargaining experiments: motives, variations, and a survey of the recent literature.
Güth, W., Levati, V., Ploner, M., 2014. Does procedural fairness crowd out other-regarding concerns? A bidding experiment. J. Inst. Theor. Econ.
Güth, W., Ockenfels, P., Tietz, R., 1992. Distributive justice versus bargaining power. In: Lea, S.E.G., Widely, P., Young, B.M. (Eds.), New Directions in Economic Psychology: Theory, Experiment and Application. Edward Elgar, Aldershot, UK, pp. 153–175.
Güth, W., Schmidt, C., Sutter, M., 2007. Bargaining outside the lab: a newspaper experiment of a three-person ultimatum game. Econ. J. 117 (2007), 449–469.
Güth, W., Schmittberger, R., Schwarze, B., 1982. An experimental-analysis of ultimatum bargaining. J. Econ. Behav. Org. 3 (4), 367–388.
Güth, W., Selten, R., 1991. Majority Voting in the Condorcet Paradox as a Problem of Equilibrium Selection, Game Equilibrium Models IV., pp. 7–40.
Güth, W., Tietz, R., 1986. Auctioning ultimatum bargaining positions. How to decide if rational decisions are unacceptable? In: Scholl, R.W. (Ed.), Current issues in West German Decision Research. Verlag Peter Lang, Frankfurt, pp. 173–185.
Güth, W., Tietz, R., 1988. Ultimatum Bargaining for a Shrinking Cake: An Experimental Analysis. In: Tietz, R., Albers, W., Selten, R. (Eds.), Bounded Rational Behavior in Experimental Games and Markets. Springer, Berlin.
Güth, W., Tietz, R., 1990. Ultimatum bargaining behavior: a survey and comparison of experimental results. J. Econ. Psychol. 11, 417–449.
Güth, W., Yaari, M., 1992. Explaining reciprocal behavior in simple strategic games: An evolutionary approach. In: Witt, U. (Ed.), Ch 2 Explaining Process & Change: Approaches to Evolutionary Economics. University of Michigan Press, Ann Arbor, pp. 23–34.
Harbaugh, W.T., Krause, K., Liday Jr., S.G., 2003. Bargaining by Children. Unpublished Working Paper, University of Oregon.
Harlé, K.M., Chang, L.J., van't Wout, M., Sanfey, A.G., 2012. The neural mechanisms of affect infusion in social economic decision-making: a mediating role of the anterior insula. NeuroImage 61 (1), 32–40.
Harsanyi, J.C., 1977. Rational Behavior and Bargaining Equilibrium in Games and Social Situations. Cambridge University Press, Cambridge, United Kingdom.
Harsanyi, J.C., Selten, R., 1988. A General Theory of Equilibrium Selection in Games. MIT Press.
Henrich, J., 2000. Does culture matter in economic behavior? Ultimatum game bargaining among the Machiguenga of the Peruvian Amazon. Am. Econ. Rev. 90, 973–979.
Henrich, J., Boyd, R., Bowles, S., Camerer, C., Gintis, H., McElreath, R., Fehr, E., 2001. In search of homo economicus: experiments in 15 small-scale societies. Am. Econ. Rev. 91 (2), 73–79.
Henrich, J., Boyd, R., Bowles, S., Gintis, H., Fehr, E., Camerer, C., McElreath, R., Gurven, M., Hill, K., Barr, A., Ensminger, J., Tracer, D., Marlow, F., Patton, J., Alvard, M., Gil-White, F., Henrich, N., 2005. 'Economic man' in cross-cultural perspective: ethnography and experiments from 15 small-scale societies. Behav. Brain Sci. 28, 795–855.

Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., 2004. Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies. Oxford University Press, New York.
Kagel, J., Sung, H., Winter, E., 2010. Veto power in committees: an experimental study. Exp. Econ. 13, 167–188.
Kahneman, D., 2011. Thinking Fast and Slow. Macmillan.
Kalisch, G.K., Milnor, J.W., Nash, J.F., Nering, E.D., 1954. Some experimental n-person games. In: Thrall, R.M., Coombs, C.H., Davis, R.L. (Eds.), Decision Processes. Wiley, New York, pp. 301–327.
Konow, J., 2003. Which is the fairest one of all? A positive analysis of justice theories. J. Econ. Lit. 41, 1188–1239.
Krause, K., Harbaugh, W.T., 1998. Economic experiments that you can perform at home on your children. Unpublished Working Paper, University of Oregon.
Kriss, P.H., Nagel, R., Weber, R.A., 2013. Implicit vs. explicit deception in ultimatum games with incomplete information. J. Econ. Behav. Org., special issue.
Ledyard, J., 1995. Public goods: A survey of experimental research. In: Kagel, J., Roth, A. (Eds.), Handbook of Experimental Economics. Princeton UniversityPress, Princeton.
Mitzkewitz, M., Nagel, R., 1993. Experimental results on ultimatum games with incomplete information. Int. J. Game Theory 22 (2), 171–198.
Murnighan, J.K., Saxon, M.S., 1998. Ultimatum bargaining by children and adults. J. Econ. Psychol. 19, 415–445.
Ochs, J., Roth, A., 1989. An experimental study of sequential bargaining. Am. Econ. Rev. 79, 355–384.
Ochsner, K.N., Gross, J.J., 2005. The cognitive control of emotion. Trends Cogn. Sci. 9 (5), 242–249.
Ockenfels, A., Dirk S., Peter W., Forthcoming. Bonus payments and reference point violations. Manage. Sci.
Pochon, J.-B., Riis, J., Sanfey, A.G., Nystrom, L.E., Cohen, J.D., 2008. Functional imaging of decision conflict. J. Neurosci. 28 (13), 3468–3473.
Prasnikar, V., Roth, A.E., 1992. Considerations of fairness and strategy: experimental data from sequential games. Q. J. Econ., 865–888.
Quiggin, J., 1982. A theory of anticipated utility. J. Econ. Behav. Org. 3 (4), 323–343.
Rabin, M., 1993. Incorporating fairness into game theory and economics. Am. Econ. Rev. 83, 1281–1302.
Robbins, L., 1932. An Essay on the Nature and Significance of Economic Science. MacMillan, London, Page numbers refer to the 2nd Edition 1935.
Roth, A.E., Erev, I., 1995. Learning in extensive-form games: experimental data and simple dynamic models in the intermediate term. Games Econ. Behav. 8, 164–212.
Roth, A.E., Malouf, M., 1979. Game theoretic models and the role of information in bargaining. Psychol. Rev. 86, 574–594.
Roth, A.E., Prasnikar, V., Okuno-Fujiwara, M., Zamir, S., 1991. Bargaining and market behavior in Jerusalem, Ljubljana, Pittsburgh, and Tokyo: an experimental study. Am. Econ. Rev. 81, 1068–1095.
Rubinstein, A., 1982. Perfect equilibrium in a bargaining model. Econometrica 50, 97–109.
Sally, D., 1995. Conversation and cooperation in social dilemmas: a meta-analysis of experiments from 1958 to 1992. Rational. Soc. 7, 58–92.
Sanfey, A.G., 2007. Social decision-making: insights from game theory and neuroscience. Science 318 (5850), 598–602.
Sanfey, A.G., Rilling, J.K., Aronson, J.A., Nystrom, L.E., Cohen, J.D., 2003. The neural basis of economic decision-making in the ultimatum game. Science 300 (5626), 1755–1758.
Selten, R., 1991. Properties of a measure of predictive success. Math. Soc. Sci. 21 (2), 153–167.
Selten, R., Pittnauer, S., Hohnisch, M., 2012. Dealing with dynamic decision problems when knowledge of the environment is limited: an approach based on goal systems. J. Behav. Deci. Making 25 (5), 443–457.
Selten, R., Ockenfels, A., 1998. An experimental solidarity game. J. Econ. Behav. Org. 34, 517–539.
Selten, R., Schuster, K.G., 1968. Psychological Variables and Coalition Forming Behavior. In: Borch, K., Mossin, J. (Eds.), Risk and Uncertainty, Proceedings of a Conference held by the International Economic Association. London-Melbourne-Toronto-New York, Macmillan/ St Martin's Press, pp. 221–240.
Stigler, G.J., 1950. The development of utility theory. J. Polit. Econ. 58 (4), 307–327 (Part I) and 58 (5), 373-396 (Part II).
Stigler, G.J., 1981. Economics or ethics? In: McMurrin, S. (Ed.), The Tanner Lectures on Human Values II. Cambridge University Press, Cambridge, UK.
Sutter, M., 2007. Outcomes versus intentions: on the nature of fair behavior and its development with age. J. Econ. Psychol. 28, 69–78.
Sutter, M., Kocher, M.G., 2007. Trust and trustworthiness across different age groups. Games Econ. Behav. 59, 364–382.
Tabibnia, G., Satpute, A.B., Lieberman, M.D., 2008. The sunny side of fairness preference for fairness activates reward circuitry (and disregarding unfairness activates self-control circuitry). Psychol. Sci. 19 (4), 339–347.
Thaler, R., 1980. Toward a positive theory of consumer choice. J. Econ. Behav. Org. 1 (1), 39–60.
Von Neumann, J., Morgenstern, O., 1944. Theory of Games and Economic Behavior. Princeton University Press, Princeton, NJ (Page numbers refer to the paperback printing from 1990).
Winter, E., Zamir, S., 2005. An experiment with ultimatum bargaining in a changing environment. Jpn. Econ. Rev. 56, 363–385.
Young, P.H., 1992. Fair Division. In: Young, P.H. (Ed.), Negotiation Analysis. Ann Arbor, University of Michigan Press, pp. 25–44.
Zethraeus, N., Kocoska-Maras, L., Ellingsen, T., von Schoultz, B., Hirschberg, A.L., Johannesson, M., 2009. A randomized trial of the effect of estrogen and testosterone on economic behavior. Proc. Natl. Acad. Sci. U. S. A. 106 (16), 6535–6538.