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Social Preferences in Three-Player Ultimatum Game Experiments

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Abstract

We study social preferences in a three-person ultimatum game experiment with one proposer and two responders. Any responder can unilaterally punish the proposer. In three treatments, we vary the pecuniary consequences of rejection in such a way that upon rejection of one responder the other responder is (i) affected negatively, (ii) not affected, and (iii) positively affected. We collect complete strategies and are able to classify (almost) all of them in intuitively plausible strategy types. Half of the responders submitted strategies that are sensitive to the relative standing with respect to the proposer and the other responder. The other half of responders submitted strategies with an acceptance threshold concerning the own material payoff, only. Moreover, we observe a treatment effect. A responder is more likely to reject a proposal if this does not negatively affect his relative standing with respect to the other responder. Recently developed models of social preferences are not able to organize our data.

JEL Classification Number: A13, C72, C91, D63, Z13
Keywords: behavioral game theory, laboratory experiment, social preferences, three-person ultimatum game

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1 Introduction

There is now a considerable amount of experimental evidence indicating that people not only care about their own material well-being but also about the well-being of others. In particular, in bargaining-like environments subjects exhibit behavior that seems to be motivated by some kind of social preferences. In ultimatum games, for instance, subjects acting in the role of the 'responder' show a strong tendency to reject small but strictly positive offers and subjects being 'proposers' make rather generous offers.

Most of this evidence comes from two-person ultimatum game experiments with one proposer and one responder. (The experimental research on ultimatum games was initiated by Güth, Schmittberger, and Schwarze (1982); for a recent overview see Camerer, forthcoming). Extending such a bargaining situation to more than two players raises several interesting issues about distributional concerns. For instance, in contrast to two player games where the equal split is focal, norms of fairness may not be that 'obvious' any more when three or more players are involved. Also, the willingness to punish behavior perceived as unfair may be altered if other (possibly 'innocent' parties) are also affected by a punishment move. Connected to this the question arises whether the position of the others relative to the position of oneself (e.g. responder-proposer versus responder-responder) also influences a person's readiness to punish unfair behavior.

To study these questions experimentally we extent the standard ultimatum game to a three-person game with one proposer and two responders. The proposer makes a three-way proposal how to allocate a given pie between himself and the responders. Each responder can either reject or accept the proposal. In the experiment we use the so-called strategy method introduced by Selten (1967). The strategy method provides more information about responder behavior, particularly for offers rarely observed in 'behavioral' experiments. We conduct three different treatments with varying payoff consequences for the *other* responder in case of rejection. The consequences for a proposer stay constant across the treatments. (The details of our experimental design are described in Section 3.) With the help of this design our experiment delivers for the first time rich information, namely complete strategies, about responder behavior in three-person ultimatum games. Moreover, it allows us to investigate whether responder-responder comparison plays an important role in ultimatum bargaining and how different payoff relevant consequences of a rejection influence acceptance behavior. In addition to that, we are also able to test the predictive performance of recently developed models based on (outcome oriented) social preferences (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2000).[1]

Related studies

Only a few experimental studies exist that extent the ultimatum game to more than two players. Güth and van Damme (1998) conducted an ultimatum game experiment involving three players: one proposer, one active responder, and one inactive dummy

[1]Our experiment is not especially designed to test these theories. We are more interested in gaining a deeper insight in social comparison processes in general than in testing particular theories. For experiments designed to test these theories see e.g. Kagel and Wolfe (1999), Bereby-Meyer and Niederle (2001) and Engelmann and Strobel (2001).

player. The proposer had to make a three-way offer and the active responder could accept or reject it. As treatment variable they changed the information of the responder about the proposed allocation. The main result the authors obtain is that neither the proposer nor the active responder seem to care about the well-being of the dummy. In two similar experiments Kagel and Wolfe (1999) and Bereby-Meyer and Niederle (2001) varied the consolidation prizes in case of rejection for the dummy player exogenously. They find that, in particular, responders do not care about how much the inactive player receives in case of rejection. This third-party neglect is also observed in a three-person coalition formation ultimatum game experiment with two (potentially) active responders conducted by Okada and Riedl (1999). They observe that proposers do not hesitate to exclude a responder from bargaining when this seems to be in their (material) self-interest. Nor does the not excluded responder punish the proposer for excluding the other responder.[2]

Knez and Camerer (1995) present experimental evidence for ultimatum game experiments with three players when all of them are active. In their experiment one proposer played two ultimatum games with two different responders simultaneously. In the control treatment the responders were not informed about the proposal in the parallel ultimatum game. In the experimental treatment this information was given and responders could condition their acceptance thresholds on the offer made to the other responder.[3] In all treatments responders received commonly known strictly positive (asymmetric) outside option payoffs. One of the main findings the authors report is that about half of the subjects show some kind of between-responder social comparison.

In the experiment presented in this paper we also find support for the hypothesis that social comparison between responders matters. However, our findings go considerably beyond this observation. About half of the responders submit strategies that 'care' about the other responder. This 'carrying', however, is not uni-directional. Some of the responders exhibit altruistic behavior towards the other responder by rejecting offers that give too little to the other responder. Others, on the contrary, submit strategies consistent with spite against the other responder by rejecting offers that give too much to the other responder. The other half of responders submit strategies exhibiting an acceptance threshold or aspiration level, which is independent of the offer to the other responder. That is, they reject any offer that gives them less than a certain amount of money. Furthermore, we observe that the rejection rates decrease significantly when a rejection makes the other responder considerably better off. Hence, altruism towards the other responder decreases with the worsening of the relative standing in case of rejection. Besides these results we are also able to classify (almost) all submitted strategies into 'plausible' strategy types and relate these types to the behavioral hypotheses derived from the above mentioned models of social preferences. Unfortunately, it turns out that the predictive power of the models is low. The behavior of only one responder is completely in line with one of the proposed models of inequality aversion.

[2]Two other ultimatum game experiments involving three players in a two-stage design were conducted by Güth, Huck and Ockenfels (1996) and Güth and Huck (1997).

[3]As we did in our experiment, Knez and Camerer (1995) also used the strategy method. They were, therefore, able to elicit acceptance thresholds for each possible offer to the other responder.

The rest of the paper is is organized as follows. In Section 2 we describe the three-person ultimatum game with the three different payoff treatments and also define plausible strategy-types of responders. There we also formulate a number of behavioral hypotheses, some of them being based on the above mentioned models of social preferences. In Section 3 we describe the experimental design and in Section 4 our results are presented. In Section 5 we summarize our findings and draw some conclusions.

2 Game and hypotheses

The implemented game is a three-person (simultaneous move) ultimatum game with one proposer and two responders. The proposer proposes a split of a pie (money) between himself and the two responders. Both responders simultaneously decide whether to accept or reject the proposal. If both responders accept all players' earnings are according to the proposal. If at least one responder rejects the proposer earns zero. The earnings of the responders in case of any rejection depend on the treatment. We implemented three different treatments.

- Treatment $T1$: Upon rejection of at least one responder all players earn zero.
- Treatment $T2$: A rejecting responder reduces only the proposer's earning and her own earning to zero. A non-rejecting responder always earns according to the proposal.
- Treatment $T3$: A rejecting responder reduces the proposer's earning to zero *and* transfers the money proposed to her to the other responder. Hence, in case only one responder rejects, the non-rejecting responder earns the amount proposed to her *plus* the amount proposed to the other (rejecting) responder. If both responders reject each earns what is offered to the other responder.

In all three treatments, both responders have a unilateral power to punish the proposer. The pecuniary cost of punishment for the responders is also the same in all treatments. The three treatments differ only in the earning consequence of rejection for the other responder. She is either negatively affected by a rejection (treatment $T1$), or unaffected (treatment $T2$), or positively affected (treatment $T3$).

In the experiment, the proposer makes a proposal $X = (X_P, X_i, X_j)$ such that $X_P + X_i + X_j = K$, with pie size $K = 3000$ points. X_P, X_i, and X_j are the points offered to the proposer, responder i, and responder j, respectively. For convenience, we represent the strategy of a proposer in terms of shares of the pie: $x_k := \frac{X_k}{K}$ for $k \in \{P, i, j\}$ and $x_p + x_i + x_j = 1$. We refer to the proposer's offer as $x = (x_i, x_j)$, the shares offered to responders i and j. Table 1 shows the material shares for responder i (the row player) for the simultaneous move decision of the two responders, for all three treatments, given a proposal x.

Table 1 – Material payoff matrix of responder i (row player)

	$T1$		T2		T3	
	Accept	Reject	Accept	Reject	Accept	Reject
Accept	x_i	0	x_i	x_i	x_i	$x_i + x_j$
Reject	0	0	0	0	0	x_j

2.1 Responder behavior: strategy types and behavioral hypotheses

Before formulating the hypotheses concerning responder behavior we introduce some plausible types of responder strategies. These strategy types are defined with the help of the probability with which responder i will accept a proposal. This probability may depend on the material share x_i, proposed to him, as well as the material share x_j, proposed to the other responder. In the following the probability with which responder i will accept proposal x is denoted by $q_i(x)$. We define the following strategy types of which a graphical representation is given in Figure 1:

A(a) Responder i follows an $A(a)$-type strategy with an effective *aspiration level* (acceptance threshold) $a \geq 0$ if $q_i(x) = 1$ for any x with $x_i \geq a$ and $q_i(x) = 0$, otherwise. There are two important sub-categories of this type of strategy: $A(+)$ which denotes the strategy of a money-maximizing responder who accepts any strictly positive offer, and $A(0)$ which denotes the strategy according to which all feasible splits of the pie are accepted.

RA Responder i follows an RA-type strategy with *altruism towards the other responder* if for each x_i there exists an x_j such that if $x = (x_i, x_j)$ is accepted (i.e. $q_i(x) = 1$), any $x' = (x'_i, x'_j$ with $x'_i \geq x$ and $x'_j \geq x$ is also accepted (i.e. $q_i(x') = 1$), and rejected if $x'_i \leq x$ and $x'_j \leq x$ (i.e. $q_i(x') = 0$) with at least one inequality strict. The responder's minimal acceptable share is decreasing in the share offered to the other responder. A special case of this strategy is obtained when it can be characterized by two constants a and b in the following way: $q_i(x) = 1$ whenever x is such that $x_i \geq a$ and $x_j \geq b$ and $q_i(x) = 0$, otherwise. The share a can be interpreted as the responder's aspiration level given the proposals that give at least b to the other responder.

RS Responder i follows an RS-type strategy with *spite against the other responder* if for each x_i there exists an x_j such that if $x = (x_i, x_j)$ is accepted (i.e. $q_i(x) = 1$), any $x' = (x'_i, x'_j$ with $x'_i \geq x$ and $x'_j \leq x$ is also accepted (i.e. $q_i(x') = 1$), and rejected if $x'_i \leq x$ and $x'_j \geq x$ (i.e. $q_i(x') = 0$) with at least one inequality strict. The responder's minimal acceptable share is increasing in the share offered to the other responder.

W Responder i follows a W-type strategy if there is a $\hat{x}_j$ such that for all x with $x_j < \hat{x}_j$ responder i follows the RA-type strategy and for all x with $x_j > \hat{x}_j$ responder i follows the RS-type strategy. This amounts to switching from 'altruism towards the other responder' to 'spite against the other responder' when the other responder starts to earn too much.

V Responder i follows a V-type strategy if there is a $\hat{x}_j$ such that for all x with $x_j < \hat{x}_j$ responder i follows the RS-type strategy and for all x with $x_j > \hat{x}_j$ responder i follows the RA-type strategy.

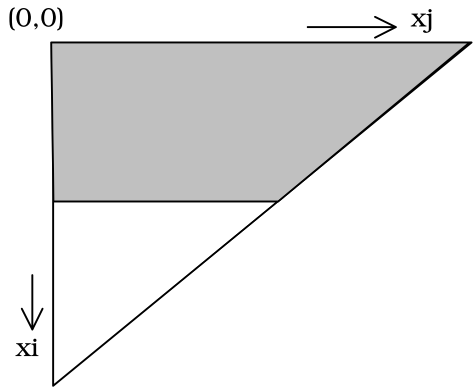
F Let $O(E)$ be a neighborhood of the equal split $(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ with radius E. Responder i follows a *fair strategy* $F(E)$ if $q_i(x) = 1$ for all $x \in O(E)$ and $q_i(x) = 0$, otherwise. A responder i using such a strategy is willing to accept only proposals that give nearly the same share to all three players.

In the graphical representation (see Figure 1) the strategy types are drawn from the viewpoint of responder i. The strategies are presented in the space of the shares x_i and x_j offered to responders i and j, respectively. The shares are increasing in the direction of the arrows. Each point in the figure corresponds to a proposal that could be chosen by the proposer. The grey areas depict the proposals that are rejected by responder i using a strategy of the respective type.

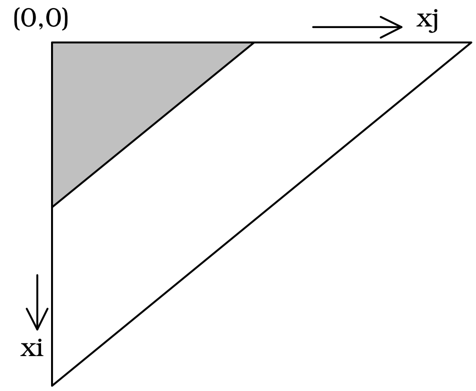
We now formulate some behavioral hypotheses for the responders. Besides the standard money maximizing hypothesis they will be be based on various recently developed alternative models of players' motivation. In the following we assume that each responder expects that the other responder accepts a given proposal x with some probability $p^t(x) \in]0, 1[$. This is a subjective probability and $t \in \{T1, T2, T3\}$ stands for the three experimental treatments introduced earlier. It is quite natural to assume that a participant in an experiment cannot be sure about the motivation and behavior of the other participants. Hence, each responder in the experiment is inherently facing some uncertainty about the actions of the other players. The subjective acceptance probability lying strictly between 0 and 1 captures this fact. When formulating the behavioral hypotheses we furthermore assume that $p^t(x)$ is constant in the proposal x but may vary with the treatment t. When deriving the hypotheses we suppose that a responder takes a best response, $B(x, p^t)$, to a proposal, x, given her belief, p^t. In the following we formulate the hypotheses by way of the dependence of the acceptance probability of a proposal (x_i, x_j) on x_i and x_j. When this probability is independent of x_j then responder i uses an A-type strategy. If it is increasing (decreasing) in x_j then responder i uses a RA-type (RS-type) strategy. All formal derivations necessary to formulate the following hypotheses are delegated to Appendix A.

Money maximization hypothesis. As a benchmark we present first the standard prediction for a responder who is a selfish money-maximizer. In this case, the material payoff shares for the row player (responder i) depicted in Table 1 represents also the responder's motivation matrices in the different treatments. The acceptance of any offer with $x_i > 0$ is the best response of a selfish money-maximizer in all three treatments.

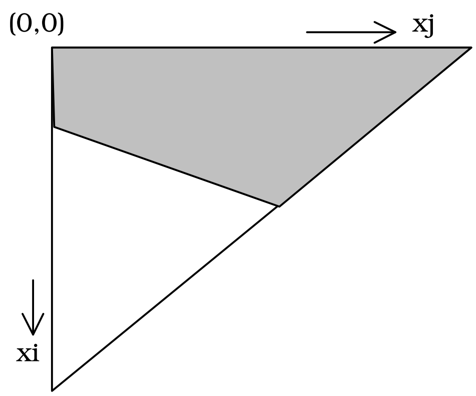
Hypothesis MM Suppose responder i is purely motivated by his own material payoff. Then i chooses strategy $A(+)$ in all three treatments. That is, any proposal with $x_i > 0$ is accepted.



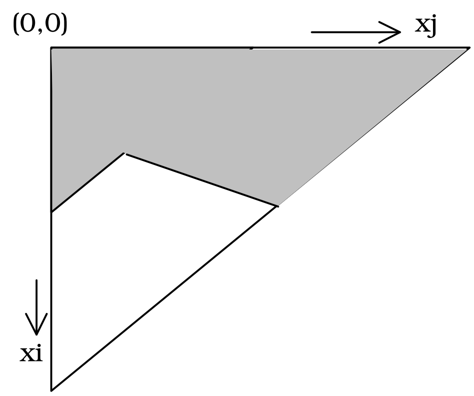
(a) Strategy type A



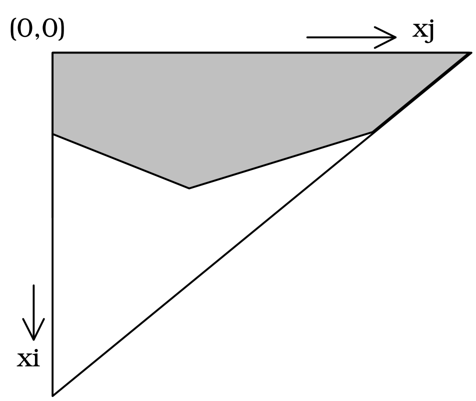
(b) Strategy type RA



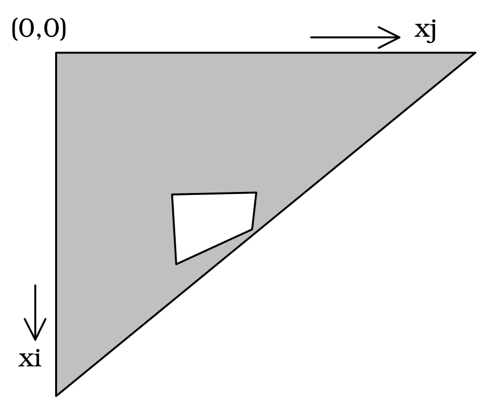
(c) Strategy type RS



(d) Strategy type W



(e) Strategy type V



(f) Strategy type F

Figure 1 – Strategy types in the three-person ultimatum game

Table 2 – Aspiration level motivation matrix of responder i

	$T1$		$T2$		$T3$	
	Accept	Reject	Accept	Reject	Accept	Reject
Accept	x_i	u_i	x_i	x_i	x_i	$x_i + x_j$
Reject	u_i	u_i	u_i	u_i	u_i	x_j

Aspiration level hypothesis. This hypothesis is based on a premise, formulated by Ochs and Roth (1989), for two-person ultimatum games. Under this hypothesis a responder bases his decision on a fixed material share she desires to receive. We model the aspiration level as a strictly positive utility $u_i > 0$ responder i foregoes when accepting (earning) the offered material share. These considerations lead to the motivation matrices depicted in Table 2. Based on them we can state:

Hypothesis AL Suppose responder i is motivated by an aspiration level u_i. Then i chooses an aspiration level type of strategy $A(a)$ in all treatments. The effective aspiration level a depends on the treatment. In $T1$ and $T2$ it is equal but in $T3$ it is lower. Hence, the (overall) acceptance rate of such a responder is the same in $T1$ and $T2$ and higher in $T3$.

Table 3 – Bolton-Ockenfels inequality aversion motivation matrix of responder i

	$T1$		$T2$		$T3$	
	Accept	Reject	Accept	Reject	Accept	Reject
Accept	$u_i(x_i, x_i)$	$u_i(0, \frac{1}{3})$	$u_i(x_i, x_i)$	$u_i(x_i, 1)$	$u_i(x_i, x_i)$	$u_i(x_i + x_j, 1)$
Reject	$u_i(0, \frac{1}{3})$	$u_i(0, \frac{1}{3})$	$u_i(0, 0)$	$u_i(0, \frac{1}{3})$	$u_i(0, 0)$	$u_i(x_j, \frac{x_j}{x_i+x_j})$

Inequality aversion hypothesis: the Bolton and Ockenfels model. Bolton and Ockenfels (2000) (henceforth BO) propose a behavioral model according to which in an N-player game, player i's utility function $u_i(\pi)$ for a material payoff vector $\pi = (\pi_k)_{k=1,\ldots,N}$ has the form $u_i(\pi) = u_i(\pi_i, \phi_i(\pi_i))$ where $\phi_i(c, \pi_i) = \frac{\pi_i}{c}$ if $c > 0$ and $\phi_i(c, \pi_i) = \frac{1}{N}$ if $c = 0$. Here $c = \sum_{i=1}^{N} \pi_i$ is the total material payoff of all players, and $\phi_i(c, \pi_i)$ measures the relative share of player i in terms of the sum of the material payoffs of all players. According to this model the distribution of the material payoffs among the other players does not play a role. Only the relative share of the total monetary payoffs earned by all players does. The model postulates that, other things equal, the optimal payoff share is the equal share of the total material payoff. Responder i's motivation matrix with inequality aversion as in the BO model can be found in Table 3. Based on it we can state:

Hypothesis BO. Suppose responder i is motivated by inequality aversion as in the BO model. Then i chooses an aspiration level strategy type $A(a)$ in $T1$ and $T2$, and an RS-type strategy in $T3$.

Table 4 – Fehr and Schmidt inequality aversion motivation matrix of responder i

Case $x_j \geq x_i > 0$:

	$T1$		$T2$		$T3$	
	Accept	Reject	Accept	Reject	Accept	Reject
Accept	L	0	L	$(1-\beta_i)x_i$	L	$(1-\beta_i)(x_j+x_i)$
Reject	0	0	$-\frac{\alpha_i}{2}x_j$	0	$-\frac{\alpha_i}{2}(x_j+x_i)$	$x_j - \frac{\beta_i}{2}(2x_j - x_i)$

where $L = x_i - \frac{\alpha_i}{2}(x_p + x_j - 2x_i)$.

Case $x_i \geq x_j > 0$:

	$T1$		$T2$		$T3$	
	Accept	Reject	Accept	Reject	Accept	Reject
Accept	K	0	K	$(1-\beta_i)x_i$	K	$(1-\beta_i)(x_i+x_j)$
Reject	0	0	$-\frac{\alpha_i}{2}x_j$	0	$-\frac{\alpha_i}{2}(x_i+x_j)$	$x_j\frac{2+\alpha_i-\beta_i}{2} - x_i\frac{\alpha_i}{2}$

where $K = x_i - \frac{\alpha_i}{2}(x_p - x_i) - \frac{\beta_i}{2}(x_i - x_j)$

Inequality aversion hypothesis: the Fehr and Schmidt model. Another model of inequality aversion is proposed by Fehr and Schmidt (1999) (henceforth, FS). Applied to our three person ultimatum game their model implies for responder i a motivation function of the following form:

$$\begin{aligned} u_i(\pi_i, \pi_j, \pi_P) &= \pi_i - \frac{\alpha_i}{2}\left[\max\{\pi_j - \pi_i\}, 0\} + \max\{\pi_P - \pi_i, 0\}\right] \\ &\quad - \frac{\beta_i}{2}\left[\max\{\pi_i - \pi_j\}, 0\} + \max\{\pi_i - \pi_P, 0\}\right], \end{aligned}$$

where π_k $(k = i, j, P)$ is the material payoff player i receives at the current strategy. It is assumed that the values of the inequality aversion parameters α_i and β_i satisfy the conditions $\alpha_i \in [0, 1[$ and $\beta_i \in [0, \alpha_i]$. Hence, according to the FS model players are assumed to dislike advantageous inequality less than disadvantageous inequality.

In deriving the behavioral hypothesis based on the FS-model we have to distinguish between two cases. The case where the proposal satisfies $x_j \geq x_i > 0$ and where it satisfies $x_i \geq x_j > 0$ (with $x_p \geq x_i, x_j$ assumed). In the first case the responder in question (responder i) is offered less than the other responder and in the latter case it is the other way round. Table 4 depicts the motivation matrices of a responder i who is inequality averse as in the FS model.

With the help of these motivation matrices the following behavioral hypothesis can be stated.

Hypothesis FS Suppose responder i is motivated by inequality aversion as in the FS model and has a relatively low advantageous inequality aversion parameter ($\beta_i < \frac{2}{3}$). Then i chooses in $T1$ a strategy that is in the class of RA-type strategies (A-type strategy for x with $x_i < x_j$ and a (pure) RA-type, otherwise). In $T2$ an

Table 5 – Quasi maximin motivation matrix of responder i

	$T1$		$T2$		$T3$	
	Accept	Reject	Accept	Reject	Accept	Reject
Accept	π_{AA}	0	π_{AA}	$x_i(1-\delta\gamma)$	π_{AA}	$(x_i+x_j)(1-\gamma)$ $+\gamma(1-\delta)(x_i+x_j)$
Reject	0	0	$\gamma(1-\delta)x_j$	0	$\gamma(1-\delta)x_j$	$x_j(1-\gamma)$ $+\gamma(1-\delta)(x_i+x_j)$

where $\pi_{AA} = x_i(1-\gamma(1-\delta)) + \gamma(1-\delta)$ if $x_i < x_j$,
$\pi_{AA} = (1-\gamma)x_i + \gamma\delta x_j + \gamma(1-\delta)$ if $x_i > x_j$

RA-type strategy is chosen. In $T3$ such a responder chooses either an RA-type strategy, or a union of an RA-type (if $x_i < x_j$) and an RS-type (if $x_i > x_j$).

Quasi-maximin hypothesis. Charness and Rabin (2000) propose a model of so-called quasi-maximin preferences. In their model the player's utility function is a convex combination of the material payoff and a maximin payoff. The latter is a convex combination of the material payoff of the 'poorest' player and the total material payoff achieved.[4] Applied to our three person ultimatum game the quasi-maximin motivation function has the form:

$$u_i(\pi_i, \pi_j, \pi_P) = \gamma\pi_i + (1-\gamma)(\delta \min\{\pi_i, \pi_j, \pi_P\} + (1-\delta)(\pi_i + \pi_j + \pi_P)),$$

where π_k $(k = i, j, P)$ is the material payoff player k receives at the current strategy and $\gamma, \delta \in]0, 1[$.

Assuming $x_P \geq x_i, x_j$, Table 5 depicts the motivation matrices of responder i endowed with such quasi-maximin preferences. Based on these matrices the following hypothesis can be derived.

Hypothesis QM Suppose responder i is motivated by the quasi-maximin criterion as in the model of Charness and Rabin. Then i chooses $A(+)$ in all three treatments $T1$, $T2$ and $T3$.

Proposer-responder spite hypothesis. Table 6 depicts the motivation matrices of a responder who is not only motivated by his own material payoff but also by spite against the proposer and the other responder. The spite is related to the player positions in the game and via that to the material payoffs the players receive. This leads to a motivation function for responder i of the form $u_i(\pi_i, \pi_j, \pi_P) = \pi_i - a_i\pi_P - b_i\pi_j$ with $a_i, b_i \in [0, 1]$, where π_k $(k = i, j, P)$ is the material payoff player k receives at the current strategy.[5] Again, based on these motivation matrices the following hypothesis can be stated.

[4] The authors extend this distributional type of preference model to a model including intentions. We do not deal with this model here because we do not measure beliefs.

[5] An axiomatic foundation of preferences that can be represented by this class of utility functions can be found in Segal and Sobel (2001).

Table 6 – Proposer-responder spite motivation matrix of responder i

	$T1$		T2		T3	
	Accept	Reject	Accept	Reject	Accept	Reject
Accept	$x_i - a_i x_P$ $-b_i x_j$	0	$x_i - a_i x_P$ $-b_i x_j$	x_i	$x_i - a_i x_P$ $-b_i x_j$	$x_i + x_j$
Reject	0	0	$-b_i x_j$	0	$-b_i(x_i + x_j)$	$x_j - b_i x_i$

Hypothesis PRS Suppose responder i is motivated by spite against the proposer and the other responder. Then i chooses in $T1$ an RA-type strategy, if spite against the proposer is stronger than the spite against the other responder ($a_i > b_i$) and an RS-type strategy, otherwise. In treatments $T2$ and $T3$ always an RA-type strategy is chosen.

Table 7 – Strategy types predicted by behavioral hypotheses

Hypothesis	$T1$	$T2$	$T3$
MM and QM	A(+)	A(+)	A(+)
AL	A(a)	A(a)	A(a)
BO	A(a)	A(a)	RS
FS, $x_i < x_j$	RA	RA	RA
FS, $x_i > x_j$	RA	RA	RS
PRS, $a_i > b_i$	RA	RA	RA
PRS, $a_i < b_i$	RS	RA	RA

Table 7 summarizes the behavioral hypotheses derived in this section by identifying the strategy types that are consistent with the motivation function underlying a particular hypothesis. According to the hypotheses MM and QM all proposals (giving a strictly positive amount to responder i) will be accepted in all treatments (by responder i). The hypotheses AL and BO both predict that a fixed aspiration level type strategy is used in $T1$ and $T2$. For $T3$ hypothesis AL predicts an A-type strategy whereas BO predicts an RS-type strategy. The inequality aversion model of FS makes qualitatively different predictions for our game. It predicts an RA-type strategy in $T1$ and $T2$ but for $T3$ a hybrid of an RA-type and an RS-type strategy (depending on whether $x_i < x_j$ or $x_i > x_j$ holds) is predicted. Finally, a model introducing spite parameters assigned to player positions, predicts an RS-type strategy in $T1$ and a RA-type strategy in $T2$ and $T3$ if the spite against the responder is smaller than the spite against the proposer (i.e. $a_i < b_i$). If $a_i > b_i$ then an RA-type strategy is predicted for all three treatments.

2.2 Proposer behavior

In each treatment of the three-person ultimatum game we study each responder has the possibility to punish the proposer unilaterally. In analogy with the two-person ultimatum game the proposer's expectation of rejection of too low offers may make him reluctant to offer only small amounts. However, the treatments differ in the nonpecuniary costs of punishment the responders face. A proposer anticipating social preferences on the responders' side may therefore not only offer strictly positive amounts to the responders but may also alter the offers across treatments. We hypothesize therefore that the proposers will give up considerable amounts and choose different proposals in $T1$, $T2$ and $T3$. In $T2$ and $T3$ proposers may also try to exploit the rejection consequences and make asymmetric offers.

3 Experimental design and procedures

We conducted two experimental sessions. Both sessions were run in October 1998 at the Institute for Advanced Studies in Vienna. 34 undergraduate students of law, economics, and business administration participated in the first session (henceforth, referred to as S1). These participants had previously experienced a three-person coalition decision ultimatum game experiment. In the second session (henceforth, S2) also 34 subjects of the same study orientation participated. These subjects were experienced in a computerized unstructured bargaining experiment.

Since we are particularly interested in the behavior of responders we applied the strategy method introduced by Selten (1967). This method allows us to collect complete strategies of all three players in each of the three treatments of our three-person ultimatum game. In particular, it gives us the possibility to collect a sufficient number of observations concerning acceptance and rejection behavior for proposals rarely made in behavioral ultimatum game experiments.

After arriving in the reception room the participants were randomly assigned (by drawing a card) one of the three letters A, B and C. One participant drew a card "observer" and joined the experimenters to monitor them. All participants were informed about this. We decided do use this procedure because during an experimental session material was carried from one room to another and we wanted to avoid any doubts that the decision sheets could be manipulated.

The participants were randomly matched in such a way that one individual with letter A, one individual with letter B and one individual with letter C formed a group to play the three-person ultimatum game. The letter A participants were assigned the role of the proposer. The letter B and C participants were in the role of the two responders. During the whole experimental session neither the roles nor the group composition changed. The proposers were seated in a different room than the responders. Furthermore, the room for the responders was separated by a shield into two parts, such that the groups B and C could not see each other. Any kind of communication was prohibited.

An experimental session consisted of three "rounds". In each round, each participant had to submit a strategy for the game played in that round. The proposers had to choose a proposal from a menu of feasible proposals, and the responders indicated on a decision sheet (see Figure 2) all proposals they wanted to accept. All feasible proposals were stated in points. In each round the total number of points to be allocated was

Decision sheet of person B - Round 1 **Participant: ____**

	Offer to person C														
	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700
Offer	800	800	800	800	800	800	800	800	800	800	800	800	800	800	
to	900	900	900	900	900	900	900	900	900	900	900	900	900		
me	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000			
	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100				
	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200					
	1300	1300	1300	1300	1300	1300	1300	1300	1300						
	1400	1400	1400	1400	1400	1400	1400	1400							

Please, circle in the grey field all offers you accept.
Please notice that all offers that you will NOT CIRCLE are taken as REJECTED!

FIGURE 2 – DECISION SHEET OF A RESPONDER

3000.[6] In money terms this was worth approximately USD 20.– (100 points equaled ATS 10.– ≈ 67 US cents).

Participants were informed that they will play three rounds but will learn the results (i.e. decisions of other players and earnings) only after the end of the whole experiment. In round 1, subjects received and read the instructions for the treatment $T1$. They also had to answer some questions to demonstrate their understanding of the instructions. The round was not started before all participants had answered the questions correctly. Thereafter, each subject had to indicate his or her strategy. The proposers by circling one of the feasible proposals and the responders by circling all proposals they want to accept. Then the decisions sheets were collected and the next round was announced. Rounds 2 and 3 were organized in exactly the same way. In round 2 subjects received the instructions for $T2$ and in round 3 they received the instructions for $T3$.[7] After the third round an experimenter - monitored by the observer - evaluated the results of the game in each round for every player. Subjects were then individually and anonymously paid out.

In addition to the money they earned in two randomly selected rounds each participant also received ATS 70, – as show-up fee. The average earning inclusive the show-up fee was ATS 220, – ≈ USD 15.–. Each session lasted approximately 90 minutes.

Note that the participants did not receive any information about the decisions of the other players between rounds. In this way we approximated a true one-shot situation for

[6] There was a minor change in the decision sheets between sessions S1 and S2. The smallest unit of divisibility was 50 points in S1 and 100 points in S2. The change was made to simplify the task of filling the tables for the responders inexperienced in three-person ultimatum games.

[7] The complete set of instructions used in the experiment can be found in Appendix B.

each treatment as close as possible. The subjects were also told that this experiment is the last one they will participate in. In this way we avoided possible supergame considerations across experiments.

4 Experimental results

In this section we present our observations concerning the submitted strategies of proposers and responders. We shall first shortly report on the proposals made in the different treatments and then switch to the more interesting and richer observations concerning the strategies of responders. In particular, we shall show that almost all submitted strategies fall into one of the categories (strategy-types) introduced in Section 2. Based on these results we shall discuss how the actual behavior relates to the behavioral hypotheses based on the different behavioral models also presented in Section 2. In the following we shall make use of the pooled data set from both sessions S1 and S2.[8]

4.1 Proposer behavior

Table 8 depicts all proposals made in sessions S1 and S2. For convenience they are sorted in descending order with respect to demands in treatment $T1$. On average, proposers keep the same share of the pie (43 percent; 1300 out of 3000 points) in all three treatments. Most often proposers keep exactly 1000 points, i.e. one third of the pie. The number of equal distributions decreases slightly over treatments (11 in $T1$, 8 in $T2$, 7 in $T3$). However, according to the Page test for ordered alternatives there is no difference in proposals between treatments ($z = 0.754, N = 44$).[9] Furthermore, nearly all proposals (91 percent; 60 out of 66) treat responders symmetrically. 4 out of the 6 asymmetric proposals occur in treatment $T3$, with a maximal difference of 400 points between the responders. This leads us to the following

[8]One might argue that this is not without problems because the two sessions slightly differ in two respects. Firstly, the subjects in S1 had some experience in a three-person ultimatum game whereas those in S2 did not. Secondly, the responders' decision sheet was 'coarser' in S2 than in S1 (In S1 the feasible proposals increased in steps of 50 whereas in S2 they increased in steps of 100 points.). We therefore investigated for both, proposers and responders, whether there are any differences between sessions. For proposers the Kolmogorov-Smirnov test does not reject the null hypothesis of identical proposals in both sessions for all three treatments (The two-sided p-values are never smaller than 0.8.). For responders we created an 'individual aggregate' acceptance rate by calculating for each responder the percentage of accepted proposals out of all feasible proposals. The Wilcoxon-Mann-Whitney-U test does not reject the hypothesis that these acceptance rates are the same in both sessions for each treatment (two-sided p-values are always larger than 0.3). We also ran additional tests for the 'semi-aggregated' acceptance rate at a given material payoff. That is, for each feasible share offered to the responder in question we calculated the acceptance rate across the shares to the other responder. In only three cases (at 800 points in $T1$ and $T3$ and 900 points in $T2$ and $T3$) we can reject the hypothesis of no difference between the two sessions. In our view this is rather weak evidence for a session effect and we therefore decided to use the pooled data in the empirical analysis. All empirical results we present also hold when looking at the two sessions separately.

[9]As the number of observations is large enough, we use the large-sample approximation of test statistics, see Siegel and Castellan (1988), p.185.

Table 8 – Proposers' decisions

	Treatment $T1$			Treatment $T2$			Treatment $T3$		
Proposer	x_p	x_i	x_j	x_p	x_i	x_j	x_p	x_i	x_j
S1_P3	3000	0	0	1400	800	800	1400	800	800
S1_P5	3000	0	0	3000	0	0	3000	0	0
S1_P9	1600	700	700	2000	500	500	1800	400	800
S2_P11	1500	800	700	1700	600	700	1800	600	600
S1_P8	1500	750	750	1700	650	650	1500	850	650
S1_P2	1200	900	900	1200	900	900	1200	900	900
S1_P6	1200	900	900	1200	900	900	1000	1050	950
S2_P5	1200	900	900	1200	900	900	1200	900	900
S2_P6	1200	900	900	1000	1000	1000	1000	1000	1000
S2_P10	1200	900	900	1200	900	900	1200	900	900
S1_P11	1100	950	950	1200	900	900	900	1050	1050
S1_P1	1000	1000	1000	1000	1000	1000	1000	1000	1000
S1_P4	1000	1000	1000	1200	900	900	1100	950	950
S1_P7	1000	1000	1000	1000	1000	1000	1000	1000	1000
S1_P10	1000	1000	1000	1000	1000	1000	1000	1000	1000
S2_P1	1000	1000	1000	1000	1000	1000	1200	900	900
S2_P2	1000	1000	1000	1200	900	900	1100	1000	900
S2_P3	1000	1000	1000	1000	1000	1000	1000	1000	1000
S2_P4	1000	1000	1000	1000	1000	1000	1000	1000	1000
S2_P7	1000	1000	1000	1400	800	800	1600	700	700
S2_P8	1000	1000	1000	1000	1000	1000	1000	1000	1000
S2_P9	1000	1000	1000	1200	900	900	1400	800	800

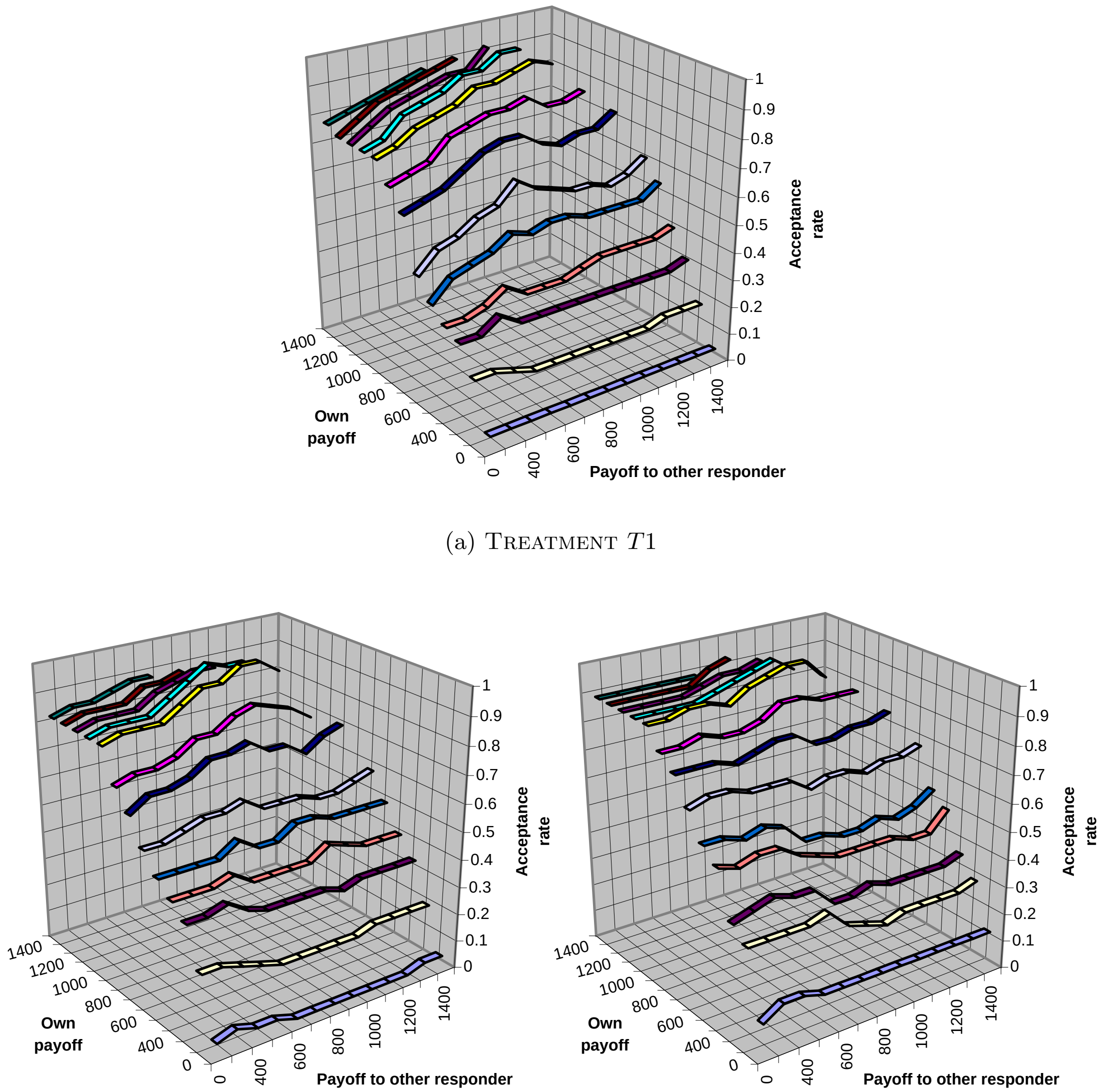
Note: Sx_Py stands for *P*roposer y in *S*ession x.

Observation 1. Proposer behavior
On average, proposers give up a considerable portion (57 percent) of the pie in all treatments. In general, they treat the responders symmetrically. The modal offer is the equal split of the pie among all three players. There is no significant difference across treatments.

For $T1$ the observation of equal splits and symmetric treatment of responders is in line with findings in other three-person ultimatum game experiments where both responders have veto power (see Okada and Riedl (1999)). That there is basically no difference between treatments seems a little bit surprising. We ask, therefore, whether - from the viewpoint of a money maximizing proposer - the observed strategies are also good strategies, on average. To answer this question we can use the observed acceptance frequency of any feasible proposal (x_i, x_j) to calculate the proposer's money maximizing strategy. It turns out that the equal split maximizes the proposers expected earnings in each treatment. Hence, the modal offer turns out to be a 'good' strategy and proposer behavior is consistent with (risk neutral) money maximizing behavior, at least on average.

4.2 Responder behavior

Figures 3(a)-(c) depict the average acceptance rates in treatments $T1$ to $T3$, respectively. They nicely show that - for any given payoff to the other responder - acceptance



(a) Treatment $T1$

(b) Treatment $T2$

(c) Treatment $T3$

Figure 3. Average acceptance rates

rates are increasing with the own payoff, in all three treatments. This behavioral pattern is consistent with the findings in standard two-person ultimatum game experiments where the acceptance rate is also increasing with the offer. However, our three-person set-up offers more information. Holding constant the own payoff the acceptance rate exhibit some kind of inverse V-shape supplemented with an increase in acceptances at high payoffs for the other responder. Furthermore, the acceptance rate is maximal at the symmetric proposal in all treatments. This pattern is most striking in treatment $T1$ but to a lesser extent also present in the other two treatments. Hence, on average responders seem to prefer symmetric offers in all treatments.

Besides these patterns the figures also indicate some differences between treatments. In particular, acceptance frequencies seem to be lower in $T1$ than in $T2$ and $T3$ (especially at relatively low offers to the other responder). That is, rejections seem to be more likely if it does the rejecting responder not make worse off relative to the other responder. To test the conjecture of different acceptance behavior in the three treatments we calculated for each responder the 'individual aggregate' acceptance rate. This rate is defined as the number of accepted proposals divided by the number of feasible proposals. Table 9 depicts these acceptance rates (in descending order for $T1$) for all 44 responders in each treatment.

On average, the individual acceptance rates increase from 55 percent in $T1$ and $T2$ to 63 percent in $T3$. The Page test for ordered alternatives rejects the null hypothesis of equal acceptance rates in the three treatments in favor of the alternative hypothesis for increasing acceptance rates across the treatments ($L = 463$, $z = -3.69$, one-sided). A pair-wise comparison of acceptance rates with the help of the Wilcoxon sign test reveals a statistically significantly higher acceptance rate in $T3$ than in $T2$ ($p = 0.03$, one-sided). Between $T1$ and $T2$ no significant difference can be detected ($p = 0.16$, one-sided). We summarize these findings in the following observation.

Observation 2. Acceptance rates
There is no difference in individual aggregate acceptance rates between treatments $T1$ and $T2$. However, a proposal is statistically significantly more likely accepted in treatment $T3$ than in treatments $T1$ and $T2$.

The individual aggregate acceptance rate is a very rough measure of individual acceptance behavior. To obtain a deeper understanding of responder behavior and to relate it to the various behavioral hypotheses developed in Section 2 we investigate individual responder behavior more profoundly now.

The submitted strategies by the responders reflect quite some heterogeneity and, at the same time, exhibit lots of structure. This structure allows us to classify almost all strategies into one of the strategy types introduced in the previous section. Table 10 shows this classification by responder and treatment and Table 11 summarizes this information for each treatment. With the help of these tables we can state

Observation 3. Heterogeneity and structure
In each treatment, around one half of the responders (22 out of 44, 25 out of 44, and 23 out of 44 in $T1$, $T2$, and $T3$, respectively) use an $A-$type strategy with an effective aspiration level ranging from 0 to 1000 points. The remaining responders submit a strategy that conditions acceptance on the distribution of payoffs among the other two players. Among these responders, less than 10 percent use the egalitarian strategy type F.

The observed heterogeneity among responders is perfectly in line with empirical evidence from other experiments. The most prominent examples in this respect are the different giving rates in dictator games and the differences in acceptance thresholds in two-person ultimatum games (see e.g. Güth and Huck, 1997). Besides the heterogeneity the observed structure in the submitted strategies is striking. Only four of the 132

Table 9 – Responders' acceptance rates (in percent)

Responder	Treatment $T1$	Treatment $T2$	Treatment $T3$
S2_R4	100	100	100
S2_R13	100	93	100
S1_R14	91	82	100
S1_R18	91	91	99
S2_R8	91	91	92
S2_R15	91	91	91
S2_R16	91	91	91
S1_R9	82	91	72
S1_R15	82	82	91
S2_R3	82	82	82
S2_R18	82	82	84
S1_R22	80	81	80
S2_R17	77	72	72
S1_R13	72	82	82
S1_R5	67	62	71
S1_R1	65	52	32
S1_R17	63	63	55
S1_R20	59	59	70
S1_R11	58	57	75
S2_R7	56	28	100
S2_R20	53	63	59
S1_R3	52	59	72
S1_R12	52	91	54
S1_R4	50	60	44
S1_R16	45	45	53
S1_R19	45	36	36
S1_R21	45	82	99
S2_R10	45	28	63
S2_R12	45	45	45
S2_R9	43	43	43
S1_R2	41	59	72
S2_R6	40	14	37
S1_R7	38	38	91
S1_R8	36	54	45
S2_R22	36	45	32
S2_R21	35	28	28
S2_R1	28	30	38
S2_R11	28	28	28
S1_R10	26	11	7
S2_R14	13	17	14
S2_R5	11	43	52
S2_R19	7	15	15
S2_R2	6	9	9
S1_R6	4	9	56
Average	55	55	63

Note: Sx_Ry stands for *R*esponder y in *S*ession x.

submitted strategies do not fall into one of the 'intuitive' strategy types presented in the previous section.[10]

[10]In the experimental study closest to ours Knez and Camerer (1995) observe in another three-person game strategies that can be categorized in a similar way. In their study out of 40 responders 19 submit

Table 10 – Submitted strategy types by responders

Responder	Treatment $T1$	Treatment $T2$	Treatment $T3$
S2_8	A(+)	A(+)	A(+)
S2_15	A(+)	A(+)	A(+)
S2_16	A(+)	A(+)	A(+)
S1_18	A(+)	A(+)	A(+)*
S2_13	A(+)*	A(+)	A(+)
S1_14	A(+)	A(400)	A(+)*
S2_4	A(0)	A(0)	A(0)
S1_9	A(400)	A(+)	A(500)
S1_15	A(400)	A(400)	A(+)
S2_3	A(400)	A(400)	A(400)
S1_13	A(500)	A(400)	A(400)
S1_17	A(600)	A(600)	RS
S1_19	A(750)	A(850)	A(900)
S1_21	A(750)	A(400)	A(+)*
S1_16	A(800)	A(750)	A(700)
S2_10	A(800)	A(1000)	A(600)
S2_12	A(800)	A(800)	A(800)
S1_8	A(850)	A(700)	A(800)
S2_11	A(1000)	A(1000)	A(1000)
S2_18	A(400)	A(300)	W
S2_22	A(900)	A(800)	RA
S2_1	A(1000)	RA	RS
S2_7	RA	A(100)	A(+)
S2_17	RA	A(500)	A(500)
S2_20	RA	A(600)	RS
S1_7	RA	RA	A(+)
S1_5	RA	RA	A(500)
S1_10	RA	RA	RA
S1_11	RA	RA	RA
S2_6	RA	RS	RA
S1_4	RA	RS	W
S1_1	RA	W	other
S1_12	RS	A(+)	A(700)
S1_22	RS	RS	RS
S2_9	RS	RS	RS
S2_21	RS	RS	RS
S1_3	RS	RS	V
S1_20	V	V	RS
S2_2	F	F	F
S2_14	F	F	F
S2_19	F	F	F
S1_6	F	F	W
S1_2	other	W	V
S2_5	other	other	RS

* Accepts all offers except (3000,0,0).

Given the clear structure in the submitted strategies there may be a good chance that responder behavior may be explained by (or at least be consistent with) one or more of the recently developed behavioral models. We can easily test this by confronting the behavioral hypotheses derived from these models with the empirical evidence gathered.

an A-type strategy, 13 an RS-type strategy and 8 a RA-type strategy.

Table 11 – Summary of strategy types by treatment

Strategy type	Treatment $T1$	Treatment $T2$	Treatment $T3$
A(+)	7	8	11
A(a)	15	17	12
RA	10	5	4
RS	5	6	8
V	1	1	2
W	0	2	3
F	4	4	3
else	2	1	1

One of the advantages of our design is that the different models predict the use of different strategy types in the different treatments.[11] This makes it relatively easy to test the predictive power of the behavioral models.

Table 12 summarizes the behavioral hypotheses and the number of subjects submitting a strategy consistent with the hypothesis in question. Though we are able to relate more than half of the responders (24 out of 44) to one of the behavioral hypotheses the distributional models perform rather weak.

Observation 4. BEHAVIORAL HYPOTHESES BASED ON DISTRIBUTIONAL MODELS
13.6 percent (6 out of 44) of the responders behave consistent with simple money maximization (MM- and QM-hypothesis), 11.4 percent (5 out of 44) behave consistent with a simple model of spite (PRS-hypotheses), and 2.3 percent (1 out of 44) behave consistent with the inequality aversion model of Bolton and Ockenfels (BO-hypothesis).
The huge majority of 72.7 percent of responder behavior cannot be explained by any of the discussed behavioral models.

Table 12 – Behavioral hypotheses

Hypothesis	Strategy type predicted in $T1$,T2,T3	Responders consistent with hypothesis	
MM and QM	A(+), A(+), A(+)	6/44	13.6%
AL	A(a), A(a), A(a)	12/44	27.3%
BO	A(a), A(a), RS	1/44	2.3%
FS	RA, RA, RA if $(x_i < x_j)$ RA, RA, RS $(x_i > x_j)$	0/44	0.0%
PR with $a_i > b_i$	RA, RA, RA	2/44	4.5%
PR with $a_i < b_i$	RS, RA, RA	3/44	6.8%
egalitarian norm	F, F, F	3/44	6.8%
other		20/44	45.5%

An non-negligible subset of 41 percent (18 out of 44) of responders uses a simple aspiration level strategy type ($A(a)$ or $A(+)$) in all three treatments. Applying the Page test for ordered alternatives on this subset of 18 players reveals statistically significantly ($\alpha = 0.05$, one-sided) decreasing aspiration levels across treatments. Hence, the acceptance rates significantly increase from $T1$ to $T3$ among the responders using the simple aspiration level strategy.

[11] The only exception is that we cannot discriminate between hypotheses MM and QM. Under both hypotheses all non-zero offers are accepted for sure.

Observation 5. ASPIRATION LEVEL STRATEGIES ARE PROMINENT
Most frequently (41 percent) responders submitted in each treatment an A-type strategy, $A(a)$ or $A(+)$. Furthermore, the aspiration levels decrease and consequently acceptance rates increase from $T1$ to $T3$, on average.

Besides the prominence of the aspiration level strategies it is of interest that a non-trivial fraction of 52 percent (those neither using an A- nor an F-type strategy in each treatment) of participants use strategies sensitive to the distribution of payoffs among all players. What about these 23 yet 'unexplained' responders? Do these responders change their behavior according to some identifiable structure? Most of these responders use an RA- type strategy (8 responders) in treatment $T1$, an A-type strategy (7) in treatment $T2$, and some other strategy in treatment $T3$. That is, we observe a switch from the concern that the proposer shares a sufficiently high amount with both responders, demonstrated by the use of RA-type strategies in treatment $T1$, towards the concern for the responder's own material payoff only, as demonstrated by the more frequent use of A-type strategies in $T2$. We cannot detect a predominant strategy type in $T3$. Interestingly, however, the use of strategies with an RS-type component (i.e. the strategies RS, V, and W) where for at least a subset of proposals the acceptance rates are decreasing in the payoff of the other responder, increases from 8 in $T1$ to 14 in $T3$ whereas the use of an RA-type strategies decrease from 10 in $T1$ to 4 in $T3$ (see Table 11). A possible interpretation of this observation is that the change in the consequences of a rejection moved the behavior from carrying altruistically about the other responder towards more spite against the other responder.

5 Summary and conclusions

In this paper we investigate experimentally a three-person ultimatum game. Two responders independently and simultaneously decide to accept or reject three-way proposals in a menu of a number of feasible proposals. At the same time the proposer chooses the actual proposal. Any responder can unilaterally reject a proposal, thereby punishing the proposer by reducing his material payoff to zero. This punishment is costly for the rejecting responder as well since she loses the share of the pie offered to her. Our treatment variable is the consequence of a rejection for the *other* responder. In treatment $T1$ the rejecting responder reduces the material payoff of the other responder to zero as well. In treatment $T2$ the rejection by one responder leaves the material payoff of the other responder unaffected. In treatment $T3$ the rejection by a responder leaves the material payoff offered to the other responder unaffected *and in addition* the material payoff offered to the rejecting responder is transferred to the other responder.

We use the strategy method, which allows us to collect complete strategies of responders. That is, we receive information about the acceptance or rejection for each feasible three-way proposal potentially made by the proposer under varying payoff consequences for the responder. This provides us with the possibility to categorize the decisions of responders in a set of intuitively plausible strategy types, which in turn delivers unique information about the distributional concerns of responders in the three-person ultimatum game. With the help of the different treatments we are able to elicit whether and how the material standing of a responder relative to the other responder matters. Furthermore, we develop a couple of behavioral hypotheses (some of them based on recently developed behavioral models of social preferences) and investigate how well they can organize our data.

We observe quite some heterogeneity in the behavior of responders, which at the same time also shows lots of structure. About half of the responders showed no concern for the distribution of the material payoffs relative to the other responder. They submitted a strategy with a fixed acceptance threshold (aspiration level) in all treatments. This aspiration level shows quite some variance across subjects and varies between 0 points (accept all feasible proposals) and 1000 points (accept only if at least one third of the pie is offered). Only 14 percent of all responders submitted a strategy consistent with selfish money maximizing behavior, i.e. a strategy indicating that all proposals that give a strictly positive amount are accepted.

The other half of responders chose strategies that are sensitive to the absolute and relative standing with respect to the proposer *and* the other responder. Many of these strategies can be categorized either as exhibiting altruism towards the other responder or as exhibiting spite against the other responder. In the first case responders reject proposals that give the other responder too little, whereas in the second case they reject proposals that give the other responder too much. Only a few strategies exhibit the egalitarian norm of accepting only offers in a close neighborhood of the equal split.

Across treatments we observe two interesting patters. Firstly, the submitted strategies become more spiteful when the payoff consequences of rejection change from influencing the other responder negatively (as in $T1$) to influencing she positively (as in $T3$). Secondly, the individual aggregated acceptance rates significantly increase from $T1$ and $T2$ to $T3$, on average. That is, the number of accepted feasible proposals is significantly higher in the treatment where a rejection affects the other responder positively than in the treatments where the other responder is affected negatively or not affected at all. Both observations indicate that a considerable subset of responders is sensitive concerning their relative standing towards the other responder.

One might object that the second observation is due to a coordination problem faced by the responders. Since, one rejecting responder is sufficient to induce punishment of the proposer each responder might - because of the material cost of rejection - prefer that the other responder to punishes the proposer. Therefore, in $T2$ and $T3$ both responders might choose to accept a proposal and try to free-ride on the other responder's rejection. We do not think that this explains our observation because then we should observe an increase in acceptance rates from $T1$ to $T2$, what we don't. We prefer the following - admittedly also speculative - explanation based the endowment effect.[12] The responder - allocated hypothetically a particular share of the pie - has the option to punish the proposer. In $T3$ this has - besides the material cost - also the cost of giving up the 'ownership' of the share that could be allocated to her and

[12]See Kahneman, Knetsch and Thaler (1991) for a discussion of the endowment effect and Huck, Kirchsteiger and Öchssler (1997) for an indirectly evolutionary explanation.

of transferring it to the other responder. This may - at least partly - explain why we observe no difference in acceptance rates between $T1$ and $T2$ but observe increased acceptance rates in $T3$.

Though our experiment was not explicitly designed to test the recently developed behavioral models of social preferences of Fehr and Schmidt (1999), Bolton and Ockenfels (2000), and Charness and Rabin (2000) we were able to formulate hypotheses based on these models. Our general finding is that none of the models is able to organize the obtained data in a satisfying way. Only one subject submitted strategies consistent with the models of inequality aversion. This observation of a rather weak performance of the mentioned behavioral models is in line with findings of other studies explicitly designed to test these models (Kagel and Wolfe, 1999; Bereby-Meyer and Niederle, 2001; Engelmann and Strobel, 2001). However, we do not conclude from this that these models - which can organize quite some data obtained in other earlier experiments - have to be considered as useless. Rather, we are convinced that the above cited studies and our empirical results show that these models are not complete, yet. Based on the results obtained in our experiment it seems to be necessary to develop theoretical models that capture the heterogeneity of people, in particular, with respect to their reference group and player position in a better way than the existing models do.

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A Formal derivation of hypotheses

In the following we make use of the motivation matrices depicted in Tables 2 to 6 of the main text.

A.1 Hypothesis AL

It is easily shown that *accept* $\in BR_i(x, p^t)$ for $t = T1, T2, T3$ if condition (al1), (al2), (al3) is satisfied, respectively. Where,

(al1) $x_i - u_i > 0$

(al2) $x_i - u_i > 0$

(al3) $x_i - p^{T3}u_i > 0$.

Hence, a responder i with an acceptance threshold uses an aspiration level type strategy $A(a)$ in all treatments. The 'effective' aspiration level a is given by u_i in $T1$ and $T2$, and $p^{T3}u_i \in]0, u_i[$ in $T3$.

A.2 Hypothesis BO

Bolton and Ockenfels postulate the following properties of the utility function $u_i(\pi)$:

(A1): $u_i(\pi)$ is increasing in material payoffs at a decreasing rate: $\frac{\partial u_i}{\partial \pi_i} \geq 0$, $\frac{\partial^2 u_i}{\partial \pi_i^2} \leq 0$;

(A2): keeping other things equal, the egalitarian distribution is preferred: $\frac{\partial u_i}{\partial \phi_i} = 0$ for $\phi_i = \frac{1}{|N|}$ for any fixed material payoff π_i;

(A3): $u_i(\pi)$ is strictly concave in ϕ_i : $\frac{\partial^2 u_i}{\partial \phi_i^2} < 0$;

(A4): for a fixed π_i, $u_i(\pi)$ is increasing for $\phi_i < \frac{1}{|N|}$, and decreasing otherwise.

Each player with this utility function can be characterized by two material payoff thresholds: $r_i(c)$ and $s_i(c)$.
The first threshold $r_i(c)$ is defined by $r_i(c) \equiv \arg\max_{\phi_i} u_i(c\phi_i, \phi_i)$ for $c > 0$. It is the division of the pie chosen by a dictator i in the dictator game, capturing the trade-off between monetary payoff and relative payoff with respect to the average payoff in the group. The second threshold $s_i(c)$ is defined by $u_i(cs_i(c), s_i(c)) = u_i(0, \frac{1}{|N|})$. It is the rejection threshold in an ultimatum game that requires the acceptance of all responders so that the proposal is implemented, and otherwise all players earn a material payoff of zero. The assumptions $(A1)$ to $(A4)$ guarantee the existence of a unique $r_i(c) \in [\frac{1}{|N|}, 1]$, and a unique $s_i(c) \in]0, \frac{1}{|N|}]$.

We normalize the utility of the worst outcome by $u_i(0, 0) = 0$. In the three person ultimatum game, it holds that *accept* $\in BR_i(x, p^t)$ for treatment $t = T1, T2, T3$ if condition (bo1), (bo2), (bo3) is satisfied, respectively. Where,

(bo1) $u_i(x_i, x_i) - u_i(0, \frac{1}{3}) > 0$

(bo2) $p^{T2}(u_i(x_i, x_i) + u_i(0, \frac{1}{3}) - u_1(x_i, 1)) > u_i(0, \frac{1}{3}) - u_1(x_i, 1)$

(bo3) $p^{T3}(u_i(x_i, x_i) + u_i(x_j, \frac{x_j}{x_i+x_j}) - u_i(x_i + x_j, 1)) > u_i(x_j, \frac{x_j}{x_i+x_j}) - u_i(x_i + x_j, 1)$

For $T1$, observe that by $(A1)-(A4)$, there is an $s_i \in [0, \frac{1}{3}]$ satisfying $u_i(0, \frac{1}{3}) = u_i(s_i, s_i)$. By the monotonicity assumption $(A1)$, responder i rejects in treatment $T1$ any proposal with $x_i < s_i$. Moreover, if i accepts some proposal x then i accepts any proposal x' such that $x'_i = x_i$, because the function u_i is independent of x_j and x_P. Hence, the Bolton and Ockenfels model predicts in $T1$ an aspiration level type strategy with an aspiration level s_i.

For $T2$, define $M(x_i) = u_i(0, \frac{1}{3}) - u_i(x_i, 1)$. Observe that $M(x_i)$ is decreasing in x_i because the function u_i is increasing in x_i for a fixed ϕ_i. Condition (bo2) can be written as $p^{T2}u_i(x_i, x_i) - (1 - p^{T2})M(x_i) > 0$. The left hand side is increasing in x_i for $x_i < \frac{1}{3}$, and independent of x_j. Hence, i's best response in $T2$ is an aspiration level type strategy.

For $T3$, define $R(x_i, x_j) = u_i(x_j, \frac{x_j}{x_i+x_j}) - u_i(x_i + x_j, 1)$. Condition (bo3) can be written as $p^{T3}u_i(x_i, x_i) - (1-p)R(x_i, x_j) > 0$. For a fixed x_i, $R(x_i, x_j)$ is increasing in x_j. To see this, note that $\frac{\partial R}{\partial x_j} = u_{i1}(x_j, \frac{x_j}{x_i+x_j}) - u_{i1}(x_i + x_j, 1) + u_{i2}(x_i + x_j, 1)\frac{x_i}{(x_i+x_j)^2} > 0$. [13] u_{i1} is decreasing in its first component by $(A1)$. Hence, if (x_i, x_j) is accepted, then also (x_i, x'_j) such that $x'_j < x_j$ is accepted. Hence, i's best response in $T3$ is a RS-type strategy.

A.3 Hypothesis FS

In deriving the behavioral hypothesis based on the FS-model we have to distinguish the two cases $x_P \geq x_j \geq x_i > 0$ and $x_P \geq x_i \geq x_j > 0$.

Case: $x_P \geq x_j > x_i$
It holds that *accept* $\in BR_i(x, p^t)$ for treatment $t = T1, T2, T3$ if condition (fs1), (fs2), (fs3) is satisfied, respectively. Where

(fs1) $x_i > \frac{\alpha_i}{2+3\alpha_i}$

(fs2) $x_i > \frac{p^{T2}\alpha_i}{3p\alpha_i+2p^{T2}\beta_i+2(1-\beta_i)}(1 - x_j)$

(fs3) $x_i > \frac{p^{T3}\alpha_i}{2-3\beta_i+p^{T3}(4\alpha_i+3\beta_i)}(1 - x_j)$

In $T1$, i's best response is an aspiration level strategy type with the effective aspiration level $\frac{\alpha_i}{2+3\alpha_i} \in [0, \frac{1}{5}]$.

In $T2$, the expression $3p\alpha_i + 2p^{T2}\beta_i + 2(1 - \beta_i)$ is strictly positive for $\beta_i \in [0, 1[$. Therefore, i's best response is an RA-type strategy. Moreover, if x is accepted in $T1$ then it also accepted in $T2$, because the inequality $\frac{\alpha_i}{2+3\alpha_i} > \frac{p^{T2}\alpha_i}{3p\alpha_i+2p^{T2}\beta_i+2(1-\beta_i)}$ is always satisfied for our parameters.

Suppose that $\beta_i < \frac{2}{3}$, then - in $T3$ - the denominator in (fs3) is strictly positive for any $p^{T3} \in]0, 1[$, so that i's best response is an $RA-$ type strategy.[14]

Case: $x_P \geq x_i > x_j$
It holds that *accept* $\in BR_i(x, p^t)$ for treatment $t = T1, T2, T3$ if condition (fs1'), (fs2'), (fs3') is satisfied, respectively. Where

(fs1') $x_i > \frac{\alpha_i-(\alpha_i+\beta_i)x_j}{2\alpha_i+2-\beta_i}$

[13] $u_{i1}(.)$ is the partial derivative of the utility function u_i with respect to its first argument, and $u_{i2}(.)$ is the partial derivative of the utility function u_i with respect to the its second argument.

[14] A high advantageous inequality aversion parameter (e.g. $\beta > \frac{2}{3}$) represents the unlikely case of altruistic preferences. There is no strong experimental support for the existence of such preferences, at least in three-person ultimatum games (see, Güth and van Damme, 1998; Okada and Riedl, 1999). For the sale of completeness we note here that if $\beta_i > \frac{2}{3}$, then (fs3) is always satisfied because the right-hand side is strictly negative, so that i's best response is an $A(+)$-type strategy.

(fs2') $x_i > p^{T2} \frac{\alpha_i - (2\alpha_i + \beta_i) x_j}{p^{T2}(2\alpha_i + \beta_i) + 2(1-\beta_i)}$

(fs3') $x_i > \frac{p^{T3}\alpha_i + (\alpha_i + \beta_i - p(3\alpha_i + 2\beta_i)) x_j}{2p^{T3}\alpha_i + \alpha_i + p^{T3}\beta_i + 2(1-\beta_i)}$

The denominator in the conditions (fs1'), (fs2') and (fs3') is strictly positive for $\beta_i \in [0, 1[$. Hence, in $T1$ and $T2$, i's best response is an RA-type strategy. In $T3$, i's best response is either an RS-type or an RA-type strategy, depending on $\alpha_i, \beta_i, p^{T3}$. If $p^{T3} > \frac{\alpha_i + \beta_i}{3\alpha_i + 2\beta_i}$ then an $RA-$type strategy is optimal, else an $RS-$type strategy.

A.4 Hypothesis QM

In deriving the behavioral hypothesis based on the quasi maximin model we have to distinguish the two cases $x_P \geq x_j \geq x_i > 0$ and $x_P \geq x_i \geq x_j > 0$.

Case: $x_P \geq x_j > x_i$

It holds that *accept* $\in BR_i(x, p^t)$ for treatment $t = T1, T2, T3$ if condition (qm1), (qm2), (qm3) is satisfied, respectively. Where,

(qm1) $p^{T1} \left(x_i(1 - \gamma(1-\delta)) + \gamma(1-\delta)\right) > 0$

(qm2) $x_i \ (1 + \gamma(\delta(2p - 1) - p^{T2})) > p^{T2}\gamma(1-\delta)(x_j - 1)$

(qm3) $x_i(\gamma\delta p^{T3} + 1 - \gamma) > p^{T3}(1-\delta)\gamma \, (x_j - 1)\,.$

In all treatments $A(+)$ is predicted. To see this note that the right hand side of the conditions (qm1), (qm2) and (qm3) is non-positive in all cases because $x_j \in [0, 1[$ and $\delta \in]0, 1[$. Furthermore, the left hand side of the conditions is positive for $\gamma, \delta \in]0, 1[$. In particular, in $T2$ this is the case if $1 + \gamma(\delta(2p^{T2} - 1) - p^{T2}) > 0$. Consider now first the case where $\delta > \frac{1}{2}$. Then, $\gamma(\delta(2p^{T2} - 1) - p^{T2})$ is increasing in p^{T2} and attains its minimum at $p^{T2} = 0$, where $1 + \gamma(\delta(2p^{T2} - 1) - p) = 1 - \gamma\delta > 0$. Consider now the case $\delta < \frac{1}{2}$. Then, $\gamma(\delta(2p^{T2} - 1) - p)$ is decreasing in p^{T2}, and attains minimum at $p^{T2} = 1$ where $1 + \gamma(\delta(2p^{T2} - 1) - p^{T2}) = 1 - \gamma(1-\delta) > 0$.

Case: $x_P \geq x_i > x_j$

It holds that *accept* $\in BR_i(x, p^t)$ for treatment $t = T1, T2, T3$ if condition (qm1'), (qm2'), (qm3') is satisfied, respectively. Where,

(qm1') $p^{T1} \left((1-\gamma)x_i + \gamma\delta x_j + \gamma(1-\delta)\right) > 0$

(qm2') $x_i(1 - p^{T2}\gamma - \delta\gamma + p^{T2}\delta\gamma) > p^{T2}\gamma(x_j(1 - 2\delta) - 1)$

(qm3') $x_i(1-\gamma) > p^{T3}\gamma(x_j(1-2\delta) - 1)$

In all three treatments $A(+)$ is predicted. To see this note that the right hand side of the conditions (qm1'), (qm2') and (qm3') is non-positive in all cases. In particular, in $T2$ and $T3$ this is the case because $x_j \in [0, 1[$ and $\delta \in]0, 1[$, therefore $x_j(1 - 2\delta) < 1$ holds. The left hand side of the conditions is positive. In particular, in $T2$ this is the case if $1 - p^{T2}\gamma - \delta\gamma + p^{T2}\delta\gamma > 0$. This expression is decreasing in p^{T2}, attaining its minimum at $p^{T2} = 1$, where $1 - \delta\gamma > 0$ for $\gamma, \delta \in]0, 1[$.

A.5 Hypothesis PRS

It easily shown that *accept* $\in BR_i(x, p^t)$ for treatment $t = T1, T2, T3$ if condition (pr1), (pr2), (pr3) is satisfied, respectively. Where,

(pr1) $x_i > \frac{a_i}{1+a_i} - x_j \frac{a_i - b_i}{1+a_i}$

(pr2) $x_i > \frac{p^{T2}a_i}{p^{T2}a_i+1}(1-x_j)$

(pr3) $x_i > \frac{p^{T3}a_i}{1+p^{T3}a_i+b_i}(1-x_j)$

If $a_i > b_i$, i's best response in all treatments is an RA-type strategy if $a_i > b_i$. If $a_i < b_i$, i's best response in $T1$ is an RS-type startegy, and in $T2$ and $T3$ an RA-type strategy.

B Instructions for the experiment

These are the instructions for subjects who had drawn the letter A {B (C)}, *respectively. The instructions are translated from German.*

Instructions You will now participate in an experiment on economic decision making that is used to study human behavior in bargaining situations. This experiment is financed by several scientific institutions. If you read the following explanations carefully, you can (besides a fixed amount of 70 Schilling) earn money with the decisions you will make in the experiment. Therefore, it is very important that you read the instructions carefully.
The experiment consists of three rounds. After the third round, the experiment is over. You will then be paid out the amount you earn in two out of the three rounds. The two rounds determining your earning will be chosen at random after the third round.
During the experiment we speak of points instead of Schillings. Your total earnings will therefore be calculated in points. Your earnings in Schillings will be calculated with the exchange rate 10 points = 1 Schilling.
The instructions handed out to you are for your private information only. It is prohibited to talk during the experiment. If you have questions, please raise your hand. We will then come to you and answer your question. If you do not obey this rule you will earn nothing in the respective round. On the following pages we describe how the experiment proceeds.

General instructions
In this experiment, you are either a person A, a person B, or a person C. What person you are is shown on the upper right corner of this sheet. One person A, one person B and one person C form a group. The group composition stays the same for all three rounds. You will, however, receive no information about the identity of the persons with whom you form a group.
In all rounds, you are person A {B (C)}.

Round 1: Instructions
Person A has to make a proposal how to divide 3000 points between person A, person B and person C. Persons B and C decide simultaneously and independently of each other, if they accept or reject the proposal.
If both person B and person C, reject the proposal nobody earns anything in this round. If only person B rejects the proposal (that is, person C accepts the proposal), nobody earns anything in this round. If only person C rejects the proposal (that is, person B accepts the proposal), nobody earns anything in this round. If neither person B nor person C rejects the proposal (that is, both, person B and person C, accept), then everybody in the group earns points according to the proposal of person A.
Please note: a unilateral rejection by person B as well as a unilateral rejection by person C leads to a situation where everybody in your group earns nothing in this round.
Person A has a decision sheet (Decision sheet A - round 1) where he/she chooses which division of the 3000 points he/she proposes. Person A indicates his/her decision on this decision sheet. (The precise way how to do this is described in the specific instructions for person A.)
While person A is making her/his decision, persons B and C are filling in their decision sheets anonymously and independently from each other. Person B and C each has one decision sheet (Decision sheet B/C - round 1). On this sheet person B and C indicate for each feasible proposal whether they accept of reject the proposal. (The precise way how to do this is described in the specific instructions for person B and C.)
After all persons have filled in their decisions on the decision sheets all decision sheets will be collected. The experimenters record the decision of person A in your group and put it together with the decisions of person B and C in your group. All three decisions together determine your earnings in this round according to the above described rules. How much you have earned in this round you will learn only after the third round. All decisions are anonymous and you

have to keep them for yourself.

Specific instructions for person A

We describe here how you have to fill in your decision on the decision sheet. On the Decision sheet - round 1 you indicate what your proposal for the division of 3000 points between yourself, person B and person C is.

You will make your proposal by filling in the relevant number of points in the grey fields after the words “I propose for myself:”, “I propose for person B:”, “I propose for person C:”.

Please, note that you can make only one of the proposals shown in the table on your decision sheet. In this table, you can find the possible offers to person C in the first row and the possible offers to person B in the first column. The numbers in the grey field show how much you demand for yourself, for a given combination of offers to person B and C. For instance, if you make an offer of x points to persons B and an offer of y points to person C, then you demand 3000-x-y points for yourself.

After you have filled in your decision, please indicate it also by circling the corresponding numbers in the first row (offer to person C) and the first column (offer to person B) in the table.

{**Specific instructions for person B (C)**

Here we explain how you fill in your decisions on the decision sheet.

You have received an Information sheet B (C) - round 1 and a Decision sheet B (C) - round 1. The grey table on the decision sheet shows you all possible combinations of offers person A can make to you - given an offer to person C (B). In the first (white) row of this table you find all possible offers to person C (B). In each column below an offer to C (B) you find all possible offers to you given the offer to C (B). Please note that each combination of an offer to you and an offer to person C (B) automatically determines how much person A demands for him/herself. How much person A demands for him/herself for a combination of offers to you and person C (B) you can easily read off the Information sheet B (C). Please, have a look at this sheet. In the first column (next to the words “offer to me”) you find all possible offers of person A to you. The columns left to the first column of the table shows you the amount person A demands for himself/herself given an offer to you and an offer to person C (B). The possible offers to person C (B) you can find in the first row of the table under the heading “offer to person C (B)”.

The formula for the calculation of the demand of person A is: Person A’s demand = 3000 points - offer to me - offer to person C (B).

You make your decision which of the feasible proposals you want to accept by circling them on the decision sheet B (C) - round 1. Note that all proposals that you do NOT circle will be regarded as rejected.}

General instructions (continued)

As already mentioned, this experiment consists of three rounds. In the second and third round, the same amounts of money as in round 1 are at stake. The rules, however, will be slightly different in each round. You will be person A {B (C)} again. You will learn about the details of the new rules at the beginning of each round.

Person A will learn only after the end of round 3 whether the proposal made by person A was accepted or rejected. Similarly, person B and C will learn only after round 3 which offer was actually made to them.

At the end of round 3 we will publicly and transparently for you randomly determine which two out of the three rounds you will be paid out. The determination of your earnings in all rounds will be monitored by the ‘observer’ who was chosen from among you. The observer will acknowledge the correct determination of your earnings with his/her signature on the payoff-forms. The money you earn during this experiment will be paid out to you privately and anonymously. Your earnings are your private information.

It is important that you understood the consequences of your decisions and the decisions of the other persons in your group. Your decisions have a substantial effect on the amount of money you earn. If you have any questions, please raise your hand. We then come to you and answer your question. Before you make your decisions, please answer the following questions.

Suppose person A makes the following proposal: X points for person B and Y points for person C

1. How much does person A demand for himself?
2. Suppose person B and C reject the proposal. How much does person A, person B and person C earn in this case?
3. Suppose person B rejects the proposal but person C accepts the proposal. How much does person A, person B and person C earn in this case?
4. Suppose person B accepts the proposal but person C rejects the proposal. How much does person A, person B and person C earn in this case?
5. Suppose person B accepts the proposal and person C accepts the proposal. How much does person A, person B and person C earn in this case?

After you have answered all questions and the answers were controlled by the experimenters, please take your decision sheet A {B (C)} - round 1.

Now you have to decide which proposal you make. Fill in your proposal in the corresponding fields on your decision sheet A - round 1 (left upper corner). Thereafter, please also circle the corresponding numbers in the first row ("offer to person C") and first column ("offer to person B").

{Now you have to decide which of the possible proposals you accept (and which you reject). This you do by circling in the table all offers you accept in a clear and distinct way. Please note that all offers you do not circle are regarded as being rejected.}

You do not have to hurry. Take your time and think well about your decision before you indicate it on the decision sheet. After you filled in your decision, you can change it only with the approval of the experimenter. When you are ready, please control whether you indicated your participant number on the decisions sheet (in the upper right corner). Then, turn the decision sheet face down so that we can collect it.

The instructions for rounds 2 and 3 have been the same as for round 1, except that the explanations concerning the payoff consequences of a rejection differed. They were described in the same way as for round 1. Subjects also had to answer questions about the calculation of payoffs again.