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Litigation and Settlement in a Game with Incomplete Information

An Experimental Study

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1. INTRODUCTION

We investigate a two-person game of litigation and settlement with incomplete information on one side. So far, various theoretical attempts have been made to answer the question of why some people choose not to resolve their disputes and instead go to court and incur litigation costs, even if bargaining leaves room for both parties to fare better when avoiding the conflict. We can distinguish between games which focus on strategic elements like games with incomplete information (see, for example, P'ng (1983), Samuelson (1982) and Schweizer (1989)) and decision-theoretic models neglecting strategic elements (see, for example, Landes (1971) and Gould (1973)).

The single-person decision theory approach to litigation assumes litigants to have a subjective estimate of the likelihood that the plaintiff will win the action. Differing views on the probability of winning the court case help to explain the fraction of cases that actually go to trial. Among others, P'ng (1983) points out the shortcomings of the single-person decision theory approach which does not take into account, for example, the different fee systems in England and the U.S. and the differences in information conflicting parties may have. P'ng constructs a model of one-sided incomplete information where the settlement terms are given exogenously.

Schweizer (1989), on the other hand, extends P'ng's model and allows for two-sided asymmetric information where the settlement terms are determined endogenously. Schweizer characterizes the set of sequential equilibria and examines the conditions under which the case ends in court or the parties agree to settle. Since the single-person decision-theoretic approach has major shortcomings and decisions based on faulty views do not appear to be in accord with the rationality assumptions of economic theory, we use Schweizer's model as a guideline to our experiment. The theoretical solution only serves as a normative solution that we compare our empirical evidence with. Game theory is committed to rationality and assumes that individuals are payoff-maximizing players who are indifferent to the interests of others. However, we cannot expect our subjects in the experiment to be fully rational and rather assume that players have limited calculation abilities and make use of decision heuristics.

Schweizer's game deals with a bargaining situation where both the defendant and the plaintiff have incomplete information about the other player's bargaining position. He lets nature provide both parties with information on the merit of the case in a preliminary move. The information can either consist of bad or good news. After nature has provided the defendant with information on the merit of the case, it is the defendant's turn to propose her settlement terms. In the final stage the plaintiff who is not informed about the defendant's information either accepts or rejects the proposed terms. If the plaintiff rejects, a lottery will decide on whether the defendant has to pay back the loss to the plaintiff or not.

However, we modify Schweizer's game in several ways. We deal with a setting of one-sided asymmetric information.[1] Schweizer introduces asymmetric information on both sides. We ask the defendant to submit a settlement offer in both the bad and good bargaining position, while in Schweizer's game the defendant only chooses one settlement offer. In our experiment the defendant and the plaintiff decide simultaneously. Consequently, the defendant chooses her two settlement offers without knowledge of the plaintiff's choice and the plaintiff chooses his acceptance limit without knowledge of the defendant's choices. Schweizer, on the other hand, models a sequential game in which the plaintiff chooses to accept or reject the offer after the defendant has made her choice.

A pre-experimental study using questionaires showed that the original game where both the defendant and the plaintiff have incomplete information is difficult to explain to the subjects and, therefore, less suitable for experimental studies. For this reason, we

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1 The essence of asymmetric information is that some player has useful private information. Although it does not seem to be obvious from the introductory explanation of the game that the defendant has an informational advantage over the plaintiff, since both players do not know the defendant's bargaining position that nature draws in the course of the game, the defendant can discriminate among the two bargaining postions and, therefore, condition her actions on the two positions. From a game-theoretic point of view this is equivalent to letting the defendant know nature's move.

changed Schweizer's game into a setting of one-sided asymmetric information.[2] In our experiments we do not provide the defendant with any information about nature's draw at the time of her decision-making. The bargaining position is not revealed until both the defendant and the plaintiff have made their choices. The introduction of nature after the defendant has proposed two settlement terms changes the model into one of imperfect information. The theorectical analysis, however, does not change. In addition, the subject has to think about settlement terms in both the good and bad bargaining position as an exact game-theorectic analysis would require. From an experimental point of view this approach is advantageous, since it gives us additional information on how subjects analyse the game. This information would not have been available if we had revealed nature's draw to the defendant.

In the game under study here we omit the signaling character and let the players decide simultaneously in the experiment.[3] Both players are not informed about nature's move. The defendant makes two settlement proposals. At the same time the plaintiff determines his acceptance limit. After both players have made their choices and nature has chosen D's position, the respective settlement offer is compared with the

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[2] We sent approximately 250 questionaires to students of the Universities of Bonn and Osnabrück by post. After the introduction of Schweizer's game with two-sided asymmetric information, the subject was asked to write down two settlement offers - one settlement offer in the bad bargaining position and another offer in the good position - if he was sent the defendant's version of the questionaire. If the subject was in the plaintiff's bargaining position, we asked him which acceptance limits between 0 and 1000 he was willing to accept. Subjects had the chance to comment on the game and the design of the questionaire at the end.

[3] Altogether we ran three different experiments. In one experiment we kept the signaling character. The settlement offer of defendant D's position that had been drawn by nature was sent to the plaintiff. However, the plaintiff did not know defendant D's position when he had to decide whether to accept or reject the offer. In another experiment we let the plaintiff and the defendant decide simultaneously as in the game under study. However, in contrast to the game considered here we sent both players the acceptance limit and the settlement offer of D's position that had been drawn by nature irrespective of the bargaining outcome. Finally, in the experiment that is described here we did not inform the subject about the other player's choice if bargaining failed and an out-of-court settlement could not be reached.

acceptance limit A, the lowest offer that P is still willing to accept. For any offer below A the case will be litigated and a lottery decides on the outcome.

Schweizer's main goal is to explain by incomplete information when and how often rational players go to court and when they agree to settle out-of-court. Apart from the litigation and settlement aspect, we are interested in two other points: Learning and bounded rationality. Our study deals with behaviour; we try to describe and understand subjects' behaviour. Since behaviour is based to a large extent on learning and acquired characters, the examination of learning has gained a dominant role in psychology and also in economics after economists have mainly dealt with substantive rationality, i.e., the study of results of rational or consistent behaviour (Binmore, 1988). In this context, bounded rationality becomes relevant as well.

A fully rational player does not have to learn to play the rational solution. The game-theorectic problem that may occur if there are many equilibria is which equilibrium point rational players choose. Our subjects are not expected to be able to handle the same computational burden as a rational player would have to do. The two-sided asymmetric information case has already proven to be too demanding for experimental analysis. For learning to take place, however, we need to make sure that the problem is not incomprehensible to the subjects. The one-sided asymmetric case is complex enough to investigate the question of how subjects change their bargaining behaviour and yet not too difficult to explain to subjects for an experimental study. Inexperienced subjects play the game for 15 rounds.

As far as possible, we invite subjects for a second and third time each repetition consisting of 15 rounds again. This gives us the possibility to examine the question of whether overall aggregated behaviour stabilizes and converges to some stationary point. Since theory provides us with different types of equilibrium strategies, it will be of interest to us which type of equilibrium strategy subjects tend to follow. Furthermore, we want to find out if players learn to play more rationally when they are experienced.

We also want to investigate the question of how subjects adjust their values and whether we can find a learning model that describes the observed behaviour satisfactorily. Finally, we are interested in the question of whether subjects who score high on the machiavellian questionaire developed by Geis and Christie (1973) behave differently from subjects who score low.

In the next chapter we describe the game and determine the equilibrium points. In a subsequent chapter we introduce alternative rationality concepts. We apply elimination and iterative elimination of weakly dominated strategies and examine which strategies remain for the plaintiff and the defendant.[4]

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[4] Elimination of weakly dominated strategies means that subjects eliminate their weakly dominated strategies only once. Iterative elimination of weakly dominated strategies, on the other hand, refers to a repeated elimination of weakly dominated strategies until subjects cannot find any weakly dominated strategies any more.

2. THE GAME-THEORETIC MODEL AND EQUILIBRIUM SETS

We first introduce the game-theoretic model in section 2.1 with four stages. However, since both players make their choices without any knowledge of previous random choices and choices of the other player, the analysis can later be based on the normal form. In section 2.2 we describe the Bayesian Nash equilibrium points of the normal form game in pure strategies. In section 2.3, finally, we apply elimination of weakly dominated strategies as an alternative theoretical solution concept to Bayesian Nash in pure strategies.

2.1 The Game Model

The game is played by two players, defendant D and plaintiff P. D incurs a loss of W=1000 to P. The defendant can have two types, b (bad) or g (good). We denote by p the probability of a court decision in disfavour of D where p_b=0.70 (p_g=0.40) is the probability of D losing the trial in case of type b (g). In our representation of the game we distinguish between four stages which specifiy the rules of the game.

Stage 1: D not knowing her type makes two settlement offers S_i, namely S_b for the case of a bad position and S_g for the case of a good position, with $0 \leq S_i \leq W$ where i can be either equal to b or g. Both S_b and S_g must be integers.

Stage 2: D's type i is randomly selected. The two types b and g are chosen with probability p_b=0.25 and p_g=0.75 respectively.

Stage 3: The plaintiff P who is not informed about D's type and the offer of type i selects an acceptance limit A with $0 \leq A \leq W$. The acceptance limit A must be an integer. If the defendant's offer S_i is greater or equal to acceptance limit A, the game ends with $-S_i$ for the defendant and $+S_i$ for the plaintiff. If the defendant's offer S_i is less than the acceptance limit A, the game moves to stage 4.

Stage 4: Nature decides whether the plaintiff P or the defendant D wins at court. D wins with probability $1-p_i$ where i is nature's choice b or g at stage 2 and $1-p_b$=0.30 and $1-p_g$=0.60. The plaintiff wins with probability p_i. If P wins, the game ends with payoff -W-C=-1100 for the defendant where C=100 are the court costs and W for the plaintiff. If D wins, the game ends with payoffs 0 for the defendant and -C=-100 for the plaintiff.

In the following we shall describe the payoffs $U_D(S_b,S_g,A)$ of the defendant D and $U_P(S_b,S_g,A)$ of the plaintiff P in the normal form of the game. For this purpose, we now introduce some auxiliary variables:

(1) $$L_i = p_i(W + C) \qquad \text{for } i=b,g$$

(2) $$L = p_b L_b + p_g L_g$$

L_i is the expected loss incurred by a defendant of type i due to the possibility of a court decision in her disfavour. L is the defendant's ex-ante expected loss before the determination of her type. We now define type i's payoff $U_i(S_i,A)$ as:

(3) $$U_i(S_i,A) = \begin{cases} -L_i & \text{for } S_i < A \\ -S_i & \text{for } S_i \geq A \end{cases}$$

for i=b,g. The defendant's payoff can now be written as follows:

(4) $$U_D(S_b,S_g,A) = p_b U_b(S_b,A) + p_g U_g(S_g,A)$$

A plaintiff who meets a defendant of type i can expect the following gain by a court decision:

(5) $$G_i = p_i W - (1 - p_i)C$$

This is equivalent to:

(6) $$G_i = p_i(W + C) - C = L_i - C$$

The plaintiff's expected gain from a court decision on the basis of the type probabilities p_b and p_g is as follows:

(7) $$G = p_gG_g + p_bG_b$$

We now are ready to describe the plaintiff's payoff $U_P(S_b,S_g;A)$:

(8) $$U_P(S_b,S_g,A) = \begin{cases} G & \text{if } S_b < A \text{ and } S_g < A \\ G + p_b(S_b - G_b) & \text{if } S_b \geq A \text{ and } S_g < A \\ G + p_g(S_g - G_g) & \text{if } S_g \geq A \text{ and } S_b < A \\ p_gS_g + p_bS_b & \text{if } S_b \geq A \text{ and } S_g \geq A \end{cases}$$

In the numerical example which underlies our experiment the parameters appearing in the formulas for $U_D(S_b,S_g,A)$ and $U_P(S_b,S_g,A)$ have the following values:

(9) $p_b = 0.25$

(10) $p_g = 0.75$

(11) $p_b = 0.70$

(12) $p_g = 0.40$

(13) $L_b = 770$

(14) $L_g = 440$

(15) $L = 522.5$

(16) $C = 100$

(17) $W = 1000$

(18) $G_b = 670$

(19) $G_g = 340$

(20) $G = 422.5$

2.2 Pure Strategy Equilibria

The pure strategy combinations can be described as triples (S_b,S_g,A). In the following we shall examine which of these triples are equilibrium points in pure strategies. We first observe that a pure strategy (S_b,S_g) of D is a best reply to a pure strategy A of P if the following conditions are satisfied:

(21) $$U_b(S_b,A) = \max_{0\le\tilde{S}_b\le W} U_b(\tilde{S}_b,A)$$

(22) $$U_g(S_g,A) = \max_{0\le\tilde{S}_g\le W} U_g(\tilde{S}_g,A)$$

A pure strategy A of P is a best reply to a pure strategy (S_b,S_g) of D if we have:

(23) $$U_P\,(S_b,S_g,A) = \max_{0\le\tilde{A}\le W} U_P(S_b,S_g,\tilde{A})$$

In view of formula (3) it follows by (21) and (22) that in equilibrium neither S_b nor S_g can be greater than A. It would be unprofitable to the defendant to offer more to the plaintiff than his acceptance limit A. For (S_b,S_g,A) to be an equilibrium we must have:

(24) $S_b \le A$

(25) $S_g \le A$

We shall now distinguish six types (i)-(vi) of strategy combinations (S_b,S_g,A) satisfying (24) and (25):

(i) $S_b = S_g = A$

(ii) $S_b = S_g < A$

(iii) $S_b = A > S_g$

(iv) $S_g = A > S_b$

(v) $S_b < S_g < A$

(vi) $S_g < S_b < A$

The strategy combinations of type (i) and (ii) are called pooling and those of types (iii), (iv), (v) and (vi) are called separating. We now shall look at each of the six cases (i)-(vi) separately. For each case we shall determine necessary and sufficient conditions for a strategy of this type to be a pure strategy equilibrium.

Case (i): We first show that in an equilibrium of this type the acceptance limit A must be at least 423. Suppose that the acceptance limit A is smaller. Then, the plaintiff could obtain the payoff G=422.5 by deviation to a higher acceptance limit which would result in a court procedure against both types of the defendant. It is also clear that the plaintiff has no advantage by a deviation to a lower or higher acceptance limit if A is at least 423.

The defendant of type g can expect L_g=440 if he offers less than A. Therefore, in case (i) the acceptance limit A can be at most 440. It is also clear that for A≤440 neither type b nor g has an incentive to offer more or less than G. Offering less would provoke a court decision with a loss of 440 for type g; type b would choose 770. From what has been said, it follows that a strategy combination of type (i) is a pure strategy equilibrium iff we have:

(26) $$A \in \{423,...,440\}$$

Case (ii): If S_b=S_g is at least 423, it is not optimal for the plaintiff to choose an acceptance limit A greater than S_b=S_g, since in this way he could only expect G=422.5 instead of S_b=S_g≥423. Therefore, in an equilibrium of type (ii) we must have:

(27) $$S_b = S_g < 423$$

If A<L_b=770 holds, then the best reply of type b is S_b=A, since in this case losing S_b would be better than the expected loss L_b=770 incurred by a court procedure. Therefore, in an equilibrium of type (ii) we also must have:

(28) $$A \geq 770$$

It can be seen that conditions (27) and (28) are sufficient for equilibrium at a strategy combination of type (ii). In view of (27) the plaintiff has no incentive to accept S_b=S_g

and in view of (28) neither the defendant of type b nor of type g has an incentive to avoid the court procedure.

Case (iii): If S_b=A is smaller than G_b=670, then it is profitable for the plaintiff to raise his acceptance limit in order to receive 670 by court procedure against type b instead of accepting the offer S_b<670. Therefore, in an equilibrium of type (iii) we must have:

(29) $$A \geq 670$$

Suppose that A is greater than L_b=770, then the defendant of type b has an incentive to provoke a court procedure by a reduced offer in order to lower his loss to 770. Therefore, we must have:

(30) $$A \leq 770$$

If S_g>340, it is advantageous for the plaintiff to lower his acceptance limit to S_g (or something smaller), since his expected gain from a court procedure against type g is G_g=340. The lower acceptance level would not change the agreement with b. Therefore, in an equilibrium of type (iii) we must have:

(31) $$S_g \leq 340$$

It can also be seen without difficulty that the plaintiff has no incentive to change his acceptance limit if the three conditions (29), (30) and (31) are satisfied. Moreover, in this case, neither type of the defendant has an incentive to change his offer. It follows that a strategy combination of type (iii) is an equilibrium iff we have:

(32) $$A \in \{670,...,770\}$$ and

(33) $$S_g \in \{0,...,340\}$$

Case (iv): We shall show that equilibria of this type are impossible. Assume that (S_b,S_g,A) is an equilibrium of this type, then S_g=A must be at most 440, since otherwise the defendant of type g could improve her payoff by lowering her offer and, thereby, decreasing her expected loss to L_g=440. However, in view of A≤440 it would be better for the defendant of type b to increase her offer to A in order to avoid the expected loss L_b=770. This shows that a strategy combination of this type cannot be an equilibrium.

Case (v): In an equilibrium of this type we must have:

(34) $$S_g \leq 340$$

If condition (34) was not met, the plaintiff would gain by lowering his acceptance limit to S_g which would be greater than his expected gain of 340 obtained in a court procedure against a defendant of type g. If A is smaller than 770, then the defendant of type b has an incentive to increase her offer S_b to A, since in this case an agreement at A is less costly than the court procedure with L_b=770. Therefore, in an equilibrium of this type we must have:

(35) $$A \geq 770$$

If conditions (34) and (35) are satisfied, the plaintiff has no incentive to lower his acceptance limit A and it does not pay the defendant of both types to avoid the court procedure. It follows that a strategy combination of type (v) is an equilibrium iff we have:

(36) $$A \in \{770,...,1000\}$$

(37) $$S_g \in \{0,...,340\}$$

Case (vi): As in case (v) in an equilibrium of this type we must have:

(38) $$A \geq 770$$

since otherwise type b could improve his payoff by raising his offer to A. We also must have:

(39) $$S_b \leq 670$$

If condition (39) was not met, the plaintiff could improve his payoff by lowering his acceptance limit to S_b. If the plaintiff lowers his acceptance limit to S_g he obtains S_b

with probability 0.25 and S_g with probability 0.75. This possiblity is attractive for the plaintiff unless we have:

(40) $$0.25\,S_b + 0.75\,S_g \leq 422.5$$

In an equilibrium of type (vi) this condition must be satisfied. It can also be seen without difficulty that conditions (38), (39) and (40) are sufficient for an equilibrium of a strategy combination of type (vi).

The examination of the six types of strategy combinations can be summarized by saying that except for case (iv) every equilibrium belongs to one of the three classes (a), (b) or (c) of pure strategy equilibria.

(a) Pooling equilibria with agreement: These are the equilibria of type (i).

(41) $$A \in \{423,...,440\} \quad \text{and}$$

(42) $$S_b = S_g = A$$

(b) Separating equilibria: These are the equilibria of type (iii).

(43) $$A \in \{670,...,770\}$$

(44) $$S_b = A > S_g$$

(45) $$S_g \in \{0,...,340\}$$

(c) Conflict equilibria: These are the equilibria of type (ii), (v) and (vi).

(46) $$A \in \{770,...,1000\}$$

(47) $$S_b \in \{0,...,670\}$$

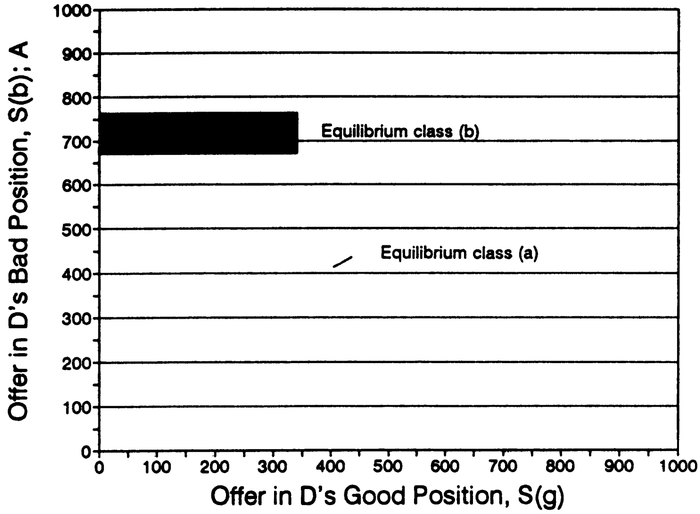
(48) $$S_g \in \{0,...,340\} \qquad \text{for} \quad S_b < S_g$$

(49) $$0.25\,S_b + 0.75\,S_g \leq 422.5 \qquad \text{for} \quad S_b \geq S_g$$

Figure 2.1 shows the strategy combinations (S_b,S_g) of equilibrium class (c). In Figure 2.2 we illustrate equilibrium classes (a) and (b). In the next chapter we introduce alternative rationality concepts. We apply one-step and iterative elimination of weakly dominated strategies. In the subsequent chapters elimination of weakly dominated strategies and one-step elimination of weakly dominated strategies are used interchangeably. On the basis of the theoretical analysis we investigate the question of whether subjects perform (iterative) elimination of weakly dominated strategies at all, and if they do, how often subjects perform elimination of weakly dominated strategies, i.e, we want to find out if subjects perform elimination of weakly dominated strategies once, twice or even more often.

Figure 2.1: *Illustration of defendant D's strategy combinations (S_b,S_g) of equilibrium class (c) in which the plaintiff chooses some acceptance limit A with A≥770 and subjects never settle the conflict out-of-court*

Figure 2.2: *Illustration of defendant D's strategy combinations (S_b,S_g) and plaintiff P's acceptance limits A with A=S_b of equilibrium classes (a) and (b) where equilibrium class (a) refers to equilibria in which subjects always settle the conflict out-of-court and equilibrium class (b) contains those equilibria in which subjects only settle the conflict in the defendant's bad bargaining position*



2.3 One-Step and Iterative Elimination of Weakly Dominated Strategies

In the analysis of our experimental data we first investigate the question of whether subjects play some pure strategy Bayesian Nash equilibrium. Since it is possible that the observed behaviour cannot adaequately be described by the predictions of pure strategy Bayesian Nash equilibria, we also introduce two alternative rationality concepts: One-step elimination and iterative elimination of weakly dominated strategies. One-step elimination of weakly dominated strategies refers to a single elimination of all weakly dominated strategies of both players simultaneously. Subjects who perform one-step elimination of weakly dominated strategies cancel out all their weakly dominated strategies of the original game once. In our game player P and both types of player D simultaneously eliminate all their weakly dominated strategies at once. Iterative elimination of weakly dominated strategies refers to a repeated elimination of weakly dominated strategies. At each step player P and both types of player D simultaneously eliminate all their weakly dominated strategies. If subjects iteratively eliminate weakly dominated strategies, they repeatedly eliminate all their weakly dominated strategies both at the same time until no weakly dominated strategies remain for any player. After each step the defendant and the plaintiff take the reduced game and recalculate to find which remaining strategies are weakly dominated. We also shall look at the possibility that the process of elimination stops after two or three steps in which cases we speak of second-step or third-step elimination respectively.

As far as the defendant is concerned, the elimination of weakly dominated strategies needs some further comment. In our game the defendant makes two choices, one choice in the good bargaining position and a second choice in the bad position. Each type of the defendant has a 1001-by-1001 game and the defendant of type g eliminates all her weakly dominated strategies S_g in her game, whereas the defendant of type b eliminates all her weakly dominated strategies S_b. The plaintiff, who simply makes one choice, does not know the defendant's type and, thus, assigns a probability of 0.75 to the defendant of type g; a probability of 0.25 is assigned to the defendant of type b. For the plaintiff to find out if some acceptance limit A' is weakly dominated by some other acceptance limit A, he has to calculate for all possible settlement offer combinations S_b and S_g the payoffs that result from choosing A and A' respectively. If strategy A is always as good as strategy A' and at least once strictly better, the plaintiff can eliminate A'. It turns out that iterative elimination of weakly dominated strategies reduces drastically the number of strategies in our game. Furthermore, elimination of weakly dominated strategies does not bear the crucial coordination problem of choosing the same equilibrium point as the concept of Bayesian Nash does.

However, iterative elimination of weakly dominated strategies in general also gives rise to objections. It is important to bear in mind that equilibria may be lost when weakly dominated strategies are deleted (see also Fudenberg and Tirole (1991)). Also, the order in which dominated strategies are deleted can sometimes make a difference. Different end products may sometimes be obtained by changing the order in which weakly dominated strategies are eliminated.[5] The order-dependence problem does not arise if subjects only eliminate strongly dominated strategies. Iterative elimination of strongly dominated strategies, however, does not have much bite in our game. Since we want to avoid the discussion of which player starts the iterative elimination of weakly dominated strategies, we let both players simultaneously eliminate their weakly dominated strategies until we have a residual game in which no weakly dominated strategies can be found. The results of the one-step elimination of weakly dominated strategies can be inferred from our analysis of the iterative elimination of weakly dominated strategies after the first step. It is a weaker concept than the iterative elimination of weakly dominated strategies. However, one-step elimination of weakly dominated strategies is not a weaker concept than Bayesian Nash. As we will see in the subsequent analysis, one-step elimination of weakly dominated strategies already leads to a refinement of Bayesian Nash, since all equilibrium points where subjects always go to court are excluded.

The following analysis describes the consequences of a process of iterative elimination of weakly dominated strategies in which at each step player P and both types of player D simultaneously eliminate all weakly dominated strategies. One-step elimination of weakly dominated strategies stops after step 1, two-step elimination of weakly dominated strategies stops after step 2. Iterative elimination of weakly dominated strategies continues in this manner until no weakly dominated strategies remain for either the defendant or the plaintiff.

We first show that any acceptance limit A greater than 670 is weakly dominated. We know that the plaintiff can guarantee himself 670 from litigation in the defendant's bad bargaining position. The plaintiff is indifferent between A=670 and A=671 when he plays against a defendant of type b. If the defendant of type b chooses a settlement

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5 In our game the order in which weakly dominated strategies are eliminated does not matter as long as at each step the players eliminate all their weakly dominated strategies. Irrespective of whether the defendant or the plaintiff starts the iterative elimination of weakly dominated strategies, we get the same final result. Plaintiffs choose their acceptance limit A with $341 \leq A \leq 439$ or A=670 and the defendants choose in the bad bargaining position their settlement offer S_b with $341 \leq S_b \leq 439$ or $S_b=670$ and in the good bargaining position their settlement offer S_g with $341 \leq S_g \leq 439$.

offer S_b=671, the plaintiff gets 671 irrespective of whether he chooses A=670 or A=671. If the defendant of type b chooses a settlement offer S_b of 670, the plaintiff also receives a payoff of 670 irrespective of whether he chooses A=671 or A=670. However, when the plaintiff plays against a defendant of type g, the plaintiff has an expected payoff of 340 from a court procedure. Thus, he wants to avoid a conflict if he is offered more than 340 by a defendant of type g. If the plaintiff chooses A=671 and the defendant of type g offers S_g=670, he provokes a court procedure and expects to receive only 340 instead of 670 that he would have received if he had avoided the conflict. From our discussion it is clear that for any acceptance limit A with A>670 the plaintiff might forego some payoff larger than 670 that he could have received if he had avoided a conflict.

We now show that the plaintiff shall never ask for less than 341. An acceptance limit A with A=341 yields a higher payoff than A=340 if the defendant of type b chooses S_b=340. Asking for 341 provokes a court procedure and, therefore, gives the plaintiff an expected payoff of G_b=670. For any other strategy combination (S_b,S_g) the plaintiff is indifferent between A=340 and A=341. Any acceptance limit A between 340 and 671 is not weakly dominated. For any acceptance limit A with 341≤A≤670 there exists a strategy combination (S_b,S_g) such that the plaintiff's payoff is greater than for any alternative acceptance limit 341≤A'≤670 and, thus, A is not weakly dominated.

The argument runs as follows: For the strategy combination S_b=670, S_g=341 the acceptance limit A=341 yields a higher payoff than any other A' with 342≤A'≤670. For 342≤A≤670 the strategy combination (S_b=A-1,S_g=A) gives the plaintiff a higher payoff or a payoff at least as high than any other acceptance limit A' with 342≤A'≤670. If the plaintiff plays against a defendant of type g who chooses S_g=A, he receives more than the expected payoff G_g from a court procedure.

Therefore, the plaintiff wants to avoid a court procedure. Any acceptance limit A>S_g would result in a lower payoff. Any acceptance limit A'<S_g would give him the same payoff. If the plaintiff plays against a defendant of type b, the plaintiff provokes a conflict and receives his expected payoff G_b from a court procedure. However, if he chose an acceptance limit A'≤S_b, he would avoid a conflict and receive less than what he can expect from a court procedure. From what has been said, it follows that the plaintiff chooses his acceptance limit A as follows after his first-step elimination of weakly dominated strategies:

(50) $341 \leq A \leq 670$

Next, we show that the defendant of type g shall choose his settlement offer $S_g \leq 439$ and the defendant of type b shall choose his settlement offer $S_b \leq 769$. Any settlement offer $S_g > 440$ is weakly dominated. The defendant of type g has an expected loss of 440 from a court procedure. As long as the plaintiff chooses his acceptance limit A greater than 440 and also greater than the settlement offer of the defendant of typ g, the defendant is indifferent between $S_g > 440$ and $S_g \leq 440$. However, if the plaintiff chooses his acceptance limit $A \leq S_g$ and the defendant of type g offers $S_g > 440$, she has to pay more than she would have had to pay if she had offered $S_g \leq 440$ and her settlement offer, possibly, had provoked a court procedure. Settlement offer $S_g = 440$ is weakly dominated by $S_g = 439$. Settlement offer $S_g = 440$ yields the same payoff as settlement offer $S_g = 439$ unless the plaintiff chooses his acceptance limit A=439. The argument for the defendant of type b runs in a similar manner. The defendant in the bad bargaining position has an expected loss of 770. Offering more than the expected loss would result in a lower payoff than if the defendant had provoked a court procedure. The settlement offer $S_b = 770$ is weakly dominated by $S_b = 769$ which gives the defendant of type b a higher payoff if the plaintiff chooses his acceptance limit A=769. After the first elimination of weakly dominated strategies, the defendant shall choose his settlement offers S_b and S_g as follows:

(51) $S_b \leq 769$

(52) $S_g \leq 439$

After both players have eliminated their weakly dominated strategies of the original game, the defendant and the plaintiff simultaneously eliminate their weakly dominated strategies of the residual game for a second time. First, we shall consider the plaintiff who chooses his acceptance limits as follows after the elimination of weakly dominated strategies on step 2:

(53) $341 \leq A \leq 439 \quad \text{or} \quad A = 670$

Let us recall that the defendant of type g chooses a settlement offer S_g with $S_g \leq 439$ after the first-step elimination, while the defendant of type b chooses a settlement offer S_b with $S_b \leq 769$. Any acceptance limit A with 439<A<670 is weakly dominated by the acceptance limit A=670. The reasoning goes as follows: For any acceptance limit A with A≥440 the plaintiff provokes a court procedure in the defendant's good bargaining position, since the defendant in the good position chooses $S_g \leq 439$. In the bad bargaining position, however, the defendant chooses her settlement offer $S_b \leq 769$ after the first-step elimination of weakly dominated strategies. Therefore, an acceptance limit A with A≤669 might give the risk-neutral plaintiff less than he can expect if he goes to court in the defendant's bad position. For any settlement offer S_b with $440 \leq S_b \leq 669$ some acceptance limit A' with A' ∈ {440,...,669} and $A' \leq S_b$ results in a lower payoff than A"=670 at least once. For any settlement offer S_b with $S_b<440$ or $S_b>670$ the resulting payoff is the same to the plaintiff who chooses some A ∈ {440,...,670}. It follows directly that A"=670 weakly dominates any acceptance limit A' with 440≤A'≤669. For any settlement offer S_b with $S_b<670$, the acceptance limit A"=670 yields an expected payoff that is always at least as high than any other acceptance limit A' and at least once strictly greater.

As far as the defendant is concerned, the defendant of type b shall never offer more than 670, since the plaintiff does not choose his acceptance limit greater than 670. Since the plaintiff does not choose his acceptance limit A below 341, the defendant shall not choose a settlement offer $S_i<341$ with i=b,g. Offering less would provoke a court procedure with an expected loss of 440 for the defendant of type g. However, if the defendant of type g chooses $341 \leq S_g \leq 439$, she may avoid a conflict and, as a result, may have to pay at least one unit of currency less than if she had chosen some settlement offer of less than 341.

The defendant of type b shall never offer more than 670, since the plaintiff does not choose his acceptance limit greater than 670. However, she shall not offer less than 341 for the same reason as a defendant of type g shall not offer less than 341. From what has been said the defendant's non-weakly dominated strategies are as follows after the second-step elimination:

(54) $$341 \leq S_b \leq 670$$

(55) $$341 \leq S_g \leq 439$$

In the game remaining after step 2 subjects simultaneously delete their weakly dominated strategies for a third time. It turns out that there do not remain any weakly dominated strategies for the plaintiff. The defendant of type b, on the other hand, can eliminate some remaining strategies that are weakly dominated as a result of the second-step elimination of weakly dominated strategies. The defendant shall choose his settlement terms (S_b,S_g) as follows after the third elimination of weakly dominated strategies:

(56) $341 \leq S_b \leq 439$ or $S_b = 670$

(57) $341 \leq S_g \leq 439$

The defendant of type g cannot eliminate any other weakly dominated strategies on step 3. However, the defendant of type b can eliminate any settlement offer S_b greater than 439 and smaller than 670. Any offer in this range would either result in a court procedure with an expected loss of 770 or in an out-of-court settlement that would also be achievable with a lower settlement offer.

In summary, we can say that the plaintiff shall choose his acceptance limit A as follows if he applies iterative elimination of weakly dominated strategies:

(58) $341 \leq A \leq 439$ or $A = 670$

The defendant shall choose a strategy combination (S_b,S_g) that satisfies

(59) $341 \leq S_b \leq 439$ or $S_b = 670$

(60) $341 \leq S_g \leq 439$

No further elimination of weakly dominated strategies is possible after step 3. There does not exist any acceptance limit A with $A \in \{341,...,439\}$ or A=670 that is weakly dominated. For the proof we first consider acceptance limits A with $A \in \{341,...,422\}$, then $A \in \{423,...,439\}$ and, finally, A=670. For any acceptance limit A with $A \in \{341,...,422\}$ we can find settlement offers S_b and S_g with S_b=670 and S_g=A such that any acceptance limit $A' \leq A$ with $A' \in \{341,...,422\}$ is a best response. At the same time, we can find settlement offers S_b and S_g with S_b=S_g=A such that any acceptance limit A">A with A" ∈ {342,...,439} or A"=670 is a best response. It follows that there does not exist any acceptance limit A with A ∈ {341,...,422} that weakly dominates some acceptance limit A' with A' ∈ {341,...,422} or A" with A" ∈ {342,...,439} or A"=670. At the same time, there does not exist any acceptance limit A with A ∈ {341,...,422} that is weakly dominated.

In the same manner, we can find for any acceptance limit A ∈ {423,...,439} settlement offers S_b and S_g with S_g=341 and S_b=A such that any acceptance limit A'>A where A' ∈ {423,...,439} or A'=670 is a best response, whereas for settlement offers S_g=S_b=A any acceptance limit A"≤A is a best response where A" ∈ {423,...,439}. From what has been said, the reader can conclude that there does not exist any acceptance limit A with A ∈ {424,...,439} that is weakly dominated or weakly dominates some acceptance limit A' or A". But this implies that acceptance limit A=670 cannot be weakly dominated either.

As far as the defandant is concerned, we can find for any settlement offer S_b (S_g) with S_b ∈ {341,...,439} or S_b=670 (S_g ∈ {341,...,439} or S_g=670) an acceptance limit A with A ∈ {341,...,439} or A=670 for which S_b (S_g) is the strongly best response, i.e. no other strategies are equally good. But this just implies that there does not exist any S_b (S_g) that is weakly dominated. In the next chapter we report the organization and design of the experiment.

3. EXPERIMENTAL DESIGN AND ORGANISATION OF THE EXPERIMENT

Prior to describing any details of the experimental design and organisational set-up, it is useful to introduce some terminology. For purposes of clarity, we will adopt the following terminology: (1) Session: A sequence of periods involving the same group of subjects who play the game on the same day. (2) Play: A unique configuration of treatment variables of a group of sessions. We distinguish between first, second and third play in order to specify the different levels of experience. First play, thus, refers to sessions involving inexperienced subjects; second play refers to subjects who have already played the game for 15 rounds, whereas third play refers to subjects who have already played the game for 30 rounds. (3) Experiment: A collection of sessions and/or plays designed to evaluate one or more related economic propositions.

The subjects who participated in the experiments were recruited from the student population of the University of Bonn. Altogether, 54 students participated in the experiment we report here: 33 economics students, 11 law students, 8 social science students and 2 science students. During the session communication was prohibited and subjects were seated at visually isolated terminals. We organized sessions with either six or twelve subjects. Payoffs were calibrated to produce average earnings of about 13.3 German Marks per hour. Inexperienced subjects needed three hours on average to finish the first play. They played the game for 15 rounds and were credited 7,500 Taler at the beginning of the session. One Taler amounted to 0.56 German Pfennige. The organisation of the experimental session was always such that six participants formed an independent group. There was no interaction between the two groups of six subjects in the sessions that involved 12 subjects. Altogether we have nine independent groups of inexperienced players for our data analysis. We let subjects change their bargaining positions repeatedly; hereby, we hope that a frequent change of the bargaining position faciliates the learning of subjects. Players were assigned at maximum nine times to one of the two bargaining positions. The matching of inexperienced subjects was always the same for all groups (see Table B.1 in Appendix B for the matching in an independent subject group). After five rounds the matching is repeated and subjects play against the other players in the same order again. This allows us to test for within-play effects. Subjects, however, were only told that the matching was random and opponents changed repeatedly. When subjects came to the laboratory, they first read and then, after all subjects had arrived, had read to them a set of instructions (the instructions are reproduced in Appendix D). With the help of several numerical examples it was made sure that subjects understood the rules of the game. A pilot study that had preceded the experiment reported here had shown that special attention had to be paid to the rule which says that although only one position is relevant to the outcome of the game, defendants make two settlement offers, whereas plaintiffs just choose one acceptance limit.[6] We also double-checked that subjects understood that the plaintiff had to state how much he wanted to claim back from the 1,000 Taler that were incurred as a loss to him by the defendant, whereas the defendant had to specify how much she was willing to give to the plaintiff voluntarily without provoking a court procedure. The subjects are told and, later, also explained their conditional probabilities of winning a court procedure given the defendant's bargaining position. In addition, the plaintiff gets to know his probability of winning a court case before uncertainty about the defendant's bargaining position is resolved and the defendant's position is reported.[7] The most relevant computer screens of the game were printed on the introductory sheet. In addition, the relevant keys on the computer that could be used by the subjects during the play were explained.

After all subjects of one group had made their choices in one round, subjects were sent the outcome of their bargaining. If bargaining was successful, the plaintiff received the defendant's offer of type i with i either equal to b or g as his payoff. Both players got to know the defendant's type. The defendant, however, was not reported the plaintiff's choice. He only knew that her offer in position i had been at least as large as the plaintiff's acceptance limit A if bargaining was successful. If bargaining failed, neither the defendant nor the plaintiff got to know the opponent's choice. Since we provided subjects with little information on the opponent's choice, we had to consider the

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[6] The pilot study preceded the first experimental session two weeks earlier. The subject pool consisted of European Doctoral Program (EDP) and other Ph.D. students at the University of Bonn. Subjects were not given any monetary incentives.

[7] Subjects' level of statistics and game theory is not uniform. For this reason, it is important that the experimentator's use of (conditional) probabilities adds as little additional variance as possible and does not cause too much bias a priori.

possibility of information seeking. Information seeking implies that the plaintiff would reduce his acceptance limit in order to find out the defendant's settlement offer, while the defendant would try to narrow down the interval in order to find out about the plaintiff's acceptance limit.[8] Irrespective of whether bargaining was successful or not, we always reported the bargaining outcome, the present total payoff, the payoff that resulted from bargaining, the defendant's type and the player's own choices of all preceding rounds to the subjects.

Inexperienced subjects had to answer altogether three questionaires (see also Appendix D). In the first one subjects were asked prior to the introduction of the game their age, major, sex and their knowledge of game theory and statistics. We included some additional questions that we think might help to attribute observed actions to specific characteristics of subjects. We asked subjects if they attributed success and failure to their own actions or rather to events that cannot be influenced. Also, we asked subjects if they preferred to stick to traditional behaviour and habit, or if they rather liked to try new ways of behaviour. During the experiments we asked subjects to write comments on their strategies. Comments after the first bargaining round are used in order to categorize subjects' decision-making. Subjects were asked to assess their bargaining performance after each round. In addition, we asked subjects if they were satisfied with their behaviour and if they would have taken another choice in retrospect. Since learning plays an important role in our experiments, we think that a reevaluation of the bargaining round helps subjects to recall and assess their actions. For learning to take place it is necessary that subjects reflect upon their actions and the consequences of their actions.[9] After the experiment we tested subjects on machiavellianism. We used the "Mach IV" scale which was developed by Christie and Geis (1977).

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[8] The hypothesis of information seeking was the reason of why we conducted an experiment where subjects played the same game as described here with the only difference that subjects were given their opponent's choice irrespective of the bargaining outcome.

[9] In card games, e.g., we can observe how players evaluate the course of the game afterwards. Players think about which actions can be improved if they should enter a similar situation the next time and what they could have done better if they had the chance to change their actions in retrospect. Actions are evaluated from an ex-post point of view after uncertainty or risk of the game has evolved.

All 54 students were reinvited. 36 students accepted the reinvitation and played the game for another 30 rounds at most four weeks after the first play. All subjects of the first session (players 1-12) and the last two sessions (players 43 to 54) accepted the reinvitation. The remaining 12 subjects were recruited from the other sessions of the first play. All 36 subjects played twice the 15-round-game with a short break between the second and third play. Subjects started with 15,000 Taler at the beginning of the second and third play irrespective of whether they were assigned the plaintiff's or defendant's bargaining position in the first round. One Taler was equal to 0.1 German Pfennige. Since not all subjects/groups accepted the invitation to the second and third play, we made sure that inexperienced subjects of the same group did not play in different groups in the subsequent plays. The matching in the second and third play was always such that all subjects who played against each other in the first play were assigned to the same group in the second and third play. Experienced subjects also changed their bargaining position repeatedly. Again, subjects were assigned at maximum nine times to one of the two bargaining positions. Subjects were told at the beginning of the second play that the matching was random and subjects played against changing opponents. However, a repeated interaction with the same subject was not excluded ex-ante.

Different from inexperienced subjects, experienced subjects were asked after the first round of the second play if their experience in the first play was of any importance for their initial choice in the second play. Subjects were also asked to assess their bargaining outcome after each round in the second play. Before the third play started, subjects had the chance to comment on their forthcoming behaviour. In the third play, however, subjects were not asked to evaluate their strategies any more. We only asked for comments if subjects changed their strategy. In all our sessions we used the fictitious currency Taler. At the beginning of each round the plaintiff was deducted W Taler from his account, whereas the defendant got W Taler credit. Payoffs were determined by the bargaining outcome. If bargaining was successful, the plaintiff received the defendant's offer S_i as reimbursement, whereas the defendant was deducted her settlement offer S_i.

The remainder of this book is organized as follows: In Chapter 4 we analyse the observed behaviour. We compare the actually observed behaviour with the theoretically predicted behaviour. First, we investigate the question of whether subjects play Bayesian Nash equilibria in pure strategies. Since it turns out that subjects' behaviour does not conform to the predicted outcomes of Bayesian Nash in pure strategies, we turn our attention to different theoretical solution concepts. Of course, we could enlarge the strategy space and allow mixed strategies. However, the extension to mixed strategies demands even more computational abilities from the subjects and aggravates the coordination problem. Therefore, we turn our attention to rationality concepts that do not assume that subjects will coordinate the expectations on a particular equilibrium. We examine if strategies conform to (iterative) elimination of weakly dominated strategies. Furthermore, we examine behavioural regularities and analyse how learning evolves over time.

In chapter 5 we discuss existent learning theories; we present a learning theory that serves as an explanation of observed behaviour within a session.

In chapter 6 we compare this learning theory against a simple alternative theory and describe the design and set-up of the Monte-Carlo simulations.

In chapter 7 we report the results of the simulations and the comparison of the two competing theories. We conclude our experimental study in chapter 8.

4. EXPERIMENTAL RESULTS

In section 1 of this chapter we start analyzing subjects' behaviour in the experiment. We distinguish between subjects in the defendant's and plaintiff's bargaining position. Furthermore, we distinguish between first, second and third play. We call subjects who have never played the game before and participate in the first play inexperienced subjects. Subjects who participate in the second and third play are called first-level experienced and second-level experienced subjects respectively. In section 2 we look at the changes in behaviour and the causes of changes in behaviour.

4.1 General Results

4.1.1 Offer and Acceptance Behaviour of Inexperienced Subjects - Observed Behaviour versus Equilibrium Behaviour

Our first goal in this subsection is to find out how often subjects follow any of the pure strategy Bayesian Nash equilibria that we have found in our theoretical analysis. Next, we investigate the question of how often subjects apply one-step or iterative elimination of weakly dominated strategies. Since it turns out that the theoretical concept of pure strategy Bayesian Nash is not a good predictor of observed behaviour, we compare the observed behaviour with alternative rationality concepts. Finally, we want to know if experience has any impact on whether subjects move towards or away from the theoretical solution concepts.

In our equilibrium analysis we have found three types of pure strategy Bayesian Nash equilibria. In an equilibrium of type (a) subjects always settle the conflict. The defendant always chooses the same settlement offers in both the good and bad bargaining position. In section 2 of chapter 2 we have called this type of equilibrium a pooling equilibrium; an equilibrium of type (a) refers to case (i) (see also page 11). In an equilibrium of type (b) subjects always settle the conflict in the defendant's bad bargaining position, whereas in the good position they never settle the conflict. Equilibria of type (b), thus, refer to case (iii). The defendant plays a separating strategy and chooses two different settlement offers. Finally, in an equilibrium of type (c) where subjects never settle the conflict out-of-court, the defendant may either choose the same two settlement offers, i.e., $S_b=S_g$, or two different settlement offers, i.e., $S_g \neq S_b$. In both cases the strategy combination (S_b,S_g) has to be such that the expected plaintiff's payoff - the payoff is determined by multiplying the two settlement offers S_b and S_g by the probabilities p_b and p_g respectively - is not greater than what the plaintiff can expect from a court procedure. It follows that equilibria of type (c) may refer to cases (ii), (v) or (vi). Equilibria of type (a) are of the pooling type, whereas equilibria of type (b) are of the separating type. Equilibria of type (c) allow for both pooling and separating strategies.

Therefore, if the defendant chooses a separating strategy, we look if the settlement offers can be classified as an equilibrium of type (b) or (c). On the other hand, if the defendant chooses a pooling strategy, we look if the settlement offers can be classified as an equilibrium of type (a) or (c). Any other strategy is classified as a non-equilibrium strategy.

As far as the plaintiff is concerned, we do not distinguish between a pooling and separating strategy. However, we classify acceptance limits as equilibria of type (a), (b) or (c) as well. If the acceptance limit does not fall within the range of any of the three types of equilibria, we classify the acceptance limit as a non-equilibrium strategy. In addition, we report how many of the 405 acceptance limits in the first play are iteratively weakly dominated or even one-step weakly dominated.

One-step elimination of weakly dominated strategies refers to a **single** elimination of weakly dominated strategies. The players simultaneously eliminate their weakly dominated strategies only once. Iterative elimination of weakly dominated strategies refers to a repeated elimination of weakly dominated strategies. Subjects simultaneously eliminate their weakly dominated strategies, recalculate to find which of the remaining strategies are weakly dominated and continue this process until there remain no weakly dominated strategies for the players. If the plaintiff eliminates his weakly dominated strategies only once in our game, he will choose his acceptance limit A with $341 \leq A \leq 670$, whereas if he iteratively eliminates weakly dominated strategies, he will choose his acceptance limit A with $341 \leq A \leq 439$ or $A=670$. All results of the first play for the plaintiff's bargaining position are reported in Table 4.2. In subsection 4.1.2 we also investigate the question of how the proportion of one-step and iterative elimination of weakly dominated acceptance limits change for the individual groups of first-level and second-level experienced subjects. As we have learned from the experimental design in chapter 3, we have 36 subjects who also participate in the second and third play. Altogether we have six independent observations in the second and third play. The examination of independent groups allows us to perform statistical tests.

In Table 4.1 we report how many of the 405 settlement offers in the defendant's good and bad bargaining position in the first play can be classified according to a pooling or separating strategy. For each strategy classification we look what proportion of settlement offers belongs to one of the three types of equilibria. Furthermore, we report how many settlement offers are iteratively or one-step weakly dominated where we distinguish between settlement offers in the defendant's good and bad bargaining position. In Appendix B the distributions of settlement offers and acceptance limits are presented graphically.

Strategy Classification	Equilibrium Strategies of Type			Weakly Dominated		Iteratively Weakly Dominated		Non-Equilibrium Strategies
	(a)	(b)	(c)	S_b	S_g	S_b	S_g	
Pooling	0.005	-	0.005	0	0	0	0	0
Separating	-	0.007	0.623	0	0.08	0.90	0.57	0.36

***Table 4.1**: Classification of settlement offers of 54 inexperienced defendants according to pooling or separating and equilibrium strategies of type (a), (b), (c), weakly dominated, iteratively weakly dominated or non-equilibrium strategies where entries are relative frequencies in the first play*[10]

Strategy Classification

Pooling: The defendant chooses $S_g=S_b$

Separating: The defendant chooses $S_g \neq S_b$

Equilibrium Strategies of Type

(a) Conflict-avoiding strategy: $S_g=S_b \in \{423,...,440\}$

(b) Strategy avoiding conflict in the defendant's bad bargaining position:
$S_g \in \{0,...,340\}$;
$S_b \in \{670,...,770\}$

(c) Conflict-seeking strategy: $S_g \in \{0,...,340\}$; $S_b \in \{0,...,670\}$ such that $0.75S_g+0.25S_b<422.5$ (see also Figure 2.1)

Non-Equilibrium Strategies

Proportion of pooling (separating) strategies that cannot be assigned to any of the three equilibrium classes

Weakly Dominated

The defendant of type g chooses $S_b>440$; the defendant of type b chooses $S_b>770$

Iteratively Weakly Dominated

The defendant of type b chooses $S_b<341$, $440 \leq S_b<670$ or $S_b>670$; the defendant of type g chooses $S_g<341$ or $S_g>439$

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[10] The relative frequencies of equilibria of type (a), (b) and (c) and non-equilibrium strategies have to sum up to 1. Note that (iteratively) weakly dominated settlement offers may contain both equilibrium and non-equilibrium strategies.

Equilibrium Strategies of Type[11]			Non-Equilibrium Strategies	Weakly Dominated	Iteratively Weakly Dominated
(a)	(b)	(c)			
0.037	0.136	0.019	0.808	0.215	0.757

Table 4.2: *Classification of acceptance limits of 54 inexperienced plaintiffs according to equilibrium strategies of type (a), (b), (c), weakly dominated, iteratively weakly dominated or non-equilibrium strategies where entries are relative frequencies observed in the first play*

Equilibrium Strategies of Type

(a) Conflict-avoiding strategy: $423 \leq A \leq 440$

(b) Strategy avoiding conflict in the defendant's bad bargaining position: $670 \leq A \leq 770$

(c) Conflict-seeking strategy: $A \geq 770$

Non-Equilibrium Strategies

Acceptance limit A does not conform to an equilibrium of type (a), (b) or (c)

Weakly Dominated

Plaintiff chooses acceptance limit A with $A<340$ or $A>670$

Iteratively Weakly Dominated

Plaintiff chooses acceptance limit A with $A<340$, $439<A<670$ or $A>670$

Tables 4.1 and 4.2 give several interesting insights into the behaviour of inexperienced subjects. We notice that altogether only 2% of the settlement offers can be classified as pooling. Subjects almost exclusively choose a separating strategy with $S_g<S_b$. They never offer more in the defendant's good bargaining position than in the bad

[11] If the plaintiff chooses his acceptance limit A=770, we cannot clearly identify the equilibrium strategy unless subjects explicitly point it out. Since plaintiffs in the experiments never choose A=770, the problem of assigning the acceptance limit incorrectly does not arise. The relative frequencies of equilibria of type (a), (b) and (c) and the non-equilibrium strategies have to sum up to 1. It is clear from our discussion earlier that (iteratively) weakly dominated strategies may contain both equilibrium and non-equilibrium strategies.

position.[12] With very few exceptions we can summarize that defendants either choose an equilibrium of type (c) or a non-equilibrium strategy. In an equilibrium of type (c) subjects theoretically never settle the conflict out-of-court: Plaintiffs choose their acceptance limit A≥770 and defendants choose their settlement offers small enough in order not to give the plaintiff an incentive to deviate from A.

However, Table 4.2 shows that few plaintiffs choose an acceptance limit A>670 (15.5%) or even A≥770 (1.9%). Observed behaviour in the defendant's position is not consistent with the observed behaviour in the plaintiff's position although subjects are assigned to both the defendant's and plaintiff's bargaining position repeatedly. Consistent behaviour refers to the choice of the same type(s) of strategies in both the defendant's and plaintiff's bargaining position. As soon as a subject at least once chooses a strategy in a category in which he does not always stay in the other position, we label his behaviour as inconsistent. For example, consider a subject who chooses non-equilibrium strategies in the defendant's position. This subject is consistent if he only chooses non-equilibrium strategies in the plaintiff's position as well and inconsistent if he chooses at least once an equilibrium of type (a), (b) or (c) in the plaintiff's position. Altogether, we only have six inexperienced subjects (11.1%) who consistently choose among the same type(s) of strategies in both bargaining positions.

If subjects choose a conflict-seeking strategy of type (c) in the defendant's position, they choose a strategy combination (S_b,S_g) that results in a payoff of less than what the plaintiff can expect from a court procedure. However, this behaviour conflicts with written comments where subjects express that they do not want to provoke a court procedure in the defendant's bad bargaining position. If players are rational and the

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[12] Intuitively, one would expect that a defendant of type g offers less to the plaintiff than a defendant of type b. However, the theorectical analysis has shown that a defendant of type b may offer less than a defendant of type g if she follows an equilibrium of type (c) when subjects never settle the conflict out-of-court. In the pilot study we observed that some players offered more in the defendant's bad bargaining position than in the good position. However, this deviation was due to a misunderstanding of the rules of the game. Subjects who made the "mistake" thought that the defendant had to announce how much she wanted to keep for herself instead of how much she was willing to offer voluntarily to the plaintiff without provoking a court procedure.

defendant chooses an equilibrium of type (c), the plaintiff will choose his acceptance limit A≥770 which guarantees him an expected payoff of G=422.5. Most acceptance limits, altogether 78.5%, fall within the range of 340 and 671. The evaluation of the questionaires during the first play shows that inexperienced subjects often use their probability of winning a court procedure as a decision aid (see also subsection 4.2.3). Subjects argue that the plaintiff does not know the defendant's bargaining position at the time of his decision-making and, contrary to the defendant, can only choose one acceptance limit.

Therefore, the 47.25% probability of winning which is the weighted average of winning over the two defendant's bargaining positions serves as a guideline to the plaintiff's choice of acceptance limit. Factors such as risk aversion add to the observed variance. If the plaintiff chooses his acceptance limit between 440 and 670, he gives the defendant an incentive to offer less in the defendant's bad bargaining position than he can expect from a court procedure. At the same time the acceptance limit exceeds the maximum theoretical settlement offer that a rational defendant will ever choose in the good position.

Plaintiffs as well very rarely choose equilibria of type (a). The percentage of acceptance limits that are classified as non-equilibrium strategies is overwhelmingly high. Since so many inexperienced plaintiffs choose an acceptance limit that does not even fall within the range of one of the three types of equilibria and, therefore, violate the concept of pure strategy Bayesian Nash equilibrium, we turn our attention to alternative solution concepts instead.[13]

In our theoretical analysis we have already mentioned two alternatives: One-step and iterative elimination of weakly dominated strategies. One-step elimination of weakly dominated strategies is a weaker concept and less demanding than iterative elimination of weakly dominated strategies. Moreover, the strategies which are

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[13] Although we could extend our analysis of pure strategy Bayesian Nash equilibria and allow for mixed strategies, the written comments on how subjects solve the decision task show that subjects do not make the attempt to calculate the mixed strategy Bayesian Nash equilibria. For this reason, we look at alternative theoretical solution concepts that demand less computational burden from the subjects.

excluded by one-step elimination are also excluded by iterative elimination of weakly dominated strategies. Therefore, it is natural to look first how often subjects perform one-step elimination and then to determine how often the chosen strategies conform to iterative elimination of weakly dominated strategies.

We know that plaintiffs who eliminate weakly dominated strategies never choose their acceptance limits below 341 or above 670. About 20% if we consider all 54 inexperienced subjects and approximately 16% of the acceptance limits if we only consider subjects who also play in the second and third play are weakly dominated in the first play. Defendants as well rarely choose weakly dominated settlement offers. Defendants in the bad bargaining position never choose weakly dominated strategies; defendants in the good position only choose in 7.9% of the cases a weakly dominated strategy. Iterative elimination of weakly dominated strategies, on the other hand, is frequently violated. We test by the use of a binomial test if inexperienced subjects tend to choose non-weakly dominated strategies more often than weakly dominated strategies. For the binomial test we aggregate all choices of the six individuals who are assigned to the same group. For a one-sided binomial test we always reject the null hypothesis that the probability of a group choosing less weakly dominated strategies is equal to the probability of a group choosing more weakly dominated strategies. In the first play we have nine independent groups and the significance level is 2% for the acceptance limits and 0.2% for the settlement offers in the defendant's good and bad bargaining position using a one-tailed binomial test.

We conclude that irrespective of the bargaining position aggregated choices of all individuals of one group tend to be weakly dominated. At first glance, it seems as if elimination of weakly dominated strategies can describe the typical behaviour of subjects well. However, this impression is misleading as we will see when we look at first- and second-level experienced plaintiffs.

In summary, we can describe the behaviour of inexperienced subjects as conflicting and inconsistent. Defendants most often choose a conflict-seeking strategy, whereas plaintiffs tend to choose a conflict-avoiding though non-equilibrium strategy. The lack of information as far as the defendant's type is concerned leads the plaintiff to choose an acceptance limit of "medium" value in the range between 340 and 671. This gives rise to the observed high rate of litigation in the first play.

The high rate of litigation will also be an important factor in explaining the behaviour of experienced players; it will also be the subject of discussion in a subsequent chapter on the polarization of acceptance limits of experienced subjects. One-step elimination of weakly dominated strategies as an alternative solution concept to Bayesian Nash conforms well to observed acceptance limits and settlement offers in the first play, whereas iterative elimination of weakly dominated strategies is frequenty violated. In the next section we discuss the observed behaviour in the second and third play.

4.1.2 Analysis of First-Level Experienced and Second-Level Experienced Subjects

In this subsection we investigate the question of whether first-level and second-level experienced subjects have learned to play more rationally and consistently. In the first play defendants play most often a conflict-seeking strategy, whereas subjects in the plaintiff's bargaining position choose a non-equilibrium strategy which is not consistent with the defendant's strategy. We also want to find out how the proportion of pooling and separating strategies change in the defendant's position. Inexperienced subjects almost exclusively choose a separating strategy. A separating strategy, however, can never avoid a conflict in the defendant's good bargaining position in theory. After we have classified the settlement offers according to pooling and separating, we further classify them according to equilibria of type (a), (b), (c) or non-equilibrium strategies. Plaintiffs, on the other hand, most often choose a non-equilibrium strategy in the first play.

It is our goal in this subsection to find out if experienced plaintiffs more often choose equilibrium strategies. Furthermore, we pay attention to the proportion of weakly dominated strategies in the second and third play. We have 36 subjects who participate in the second and third play; therefore, we get 18x15 acceptance limits for the second and third play respectively. In the defendant's bargaining position we have 18x15 settlement offers in the good and bad bargaining position respectively. The results for the defendants are reported in Table 4.3. Table 4.4 reports the results for the plaintiffs.

In subsection 4.1.1 (Table 4.2) we have seen that inexperienced plaintiffs most often choose an acceptance limit between 340 and 671. Altogether, inexperienced plaintiffs choose in 21.5% of the cases weakly dominated strategies. Inexperienced plaintiffs who also participate in the second and third play choose in about 15% of the cases a weakly dominated equilibrium strategy. 76% of their acceptance limits fall in the range between 440 and 670. Therefore, the polarization of acceptance limits in the second and third play is quite eye-catching. Subjects in the plaintiff's position either reduce their acceptance limits quite drastically and, consequently, reduce the risk of a trial, or the plaintiffs choose a relatively high acceptance limit and, therefore, make a trial more likely. The polarization of acceptance limits also becomes evident in the proportion of weakly dominated strategies. Second-level experienced subjects choose in almost 57% of the cases a weakly dominated strategy which implies that the acceptance limit is either above or below the "medium" range which subjects preferably choose in the first play. Recall that the "medium" range refers to values between 340 and 671. The polarization effect is also statistically supported if we test the behaviour of the independent subject groups. The two-tailed binomial test rejects the null hypothesis that experience has no systematic effect on the choice of weakly dominated acceptance limits. That is, inexperienced plaintiffs just as likely choose weakly dominated strategies as 1st-level experienced subjects do. Our null hypothesis is rejected at $p \leq 0.032$ significance level. As a next step we include all three levels of experience. For somebody who is an orthodox game theorist might argue that subjects need more practice in our game in order to choose weakly undominated strategies. Since the binomial test can only be applied to the case of two related samples - in our case the two samples consist of inexperienced and first-level experienced subjects, we use the order test. The order test is applicable to the case of 3 or more related samples.[14]

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[14] The order test is taken from Bettina Kuon (1993). The test was introduced by Selten (1967). The order test is designed to test whether a sequence of observations follows a trend. For each level of experience we assign ranks to the relative frequency of weakly dominated strategies observed in the six sample groups. We compare the actually observed rank order with a perfectly increasing time trend. A measure of the "difference from the perfect order" is the number of inversions that is defined as the number of pairwise changes that have to be performed in order to transform the observed rank order into the perfectly increasing rank order (see also section 5.3).

The two-sided order test as well rejects the null hypothesis that there is no systematic relationship between the level of experience and the relative frequency of weakly dominated strategies at $p \leq 0.1$ significance level. Moreover, the test does not confirm the hypothesis that subjects learn to play more rationally. The result points into the opposite direction. In a subsequent section we introduce a theory that predicts the direction of the difference. In Table 4.5 we report how many plaintiffs violate elimination of weakly dominated strategies (iteration step 1) and iterative elimination of weakly dominated strategies (iteration step 3) for the different plays. For the sake of completeness, we also report the results of iteration step 2. Table 4.3 shows that experienced defendants never choose a pooling strategy. The proportion of equilibrium strategies of type (c) is even larger than in the first play. The proportion of non-equilibrium strategies reduces to less than 16%. An equilibrium of type (c), however, assumes that subjects in both the defendant's and plaintiff's bargaining position are litigation-seeking. We find in Table 4.4 that less than 12% of the acceptance limits in the second or third play are conflict-seeking. The proportion of acceptance limits that avoids a conflict in the defendant's bad bargaining position even increases from 13.6% in the first play to 21.1% in the second play and 28.1% in the third play; most acceptance limits are less than the expected payoff from a court procedure in the defendant's bad bargaining position. Altogether, we observe that more than 67% of the acceptance limits are less than 670. This gives the defendant an incentive to offer less than the payoff that the plaintiff can expect from a court procedure in the defendant's bad bargaining position. In the defendant's good bargaining position first-level and second-level experienced subjects tend to overrate their chance of winning a court procedure. In 61.9% of the cases first-level experienced defendants of type g choose settlement terms that are less than the plaintiff's expected payoff from a court procedure. Second-level experienced defendants of type g even offer in 80% of the cases settlement terms of less than the plaintiff's expected payoff from a court procedure.

Contrary to the plaintiffs' acceptance limits, the proportion of weakly dominated settlement offers does not change greatly over the three plays. The relative frequency of weakly dominated settlement offers in the defendant's good bargaining position reduces from 7.9% in the first play, to 2.6% in the second play and, finally, 2.2% in the third play. A settlement offer in the defendant's good bargaining position is weakly dominated if $S_g > 439$, whereas in the defendant's bad bargaining position any settlement offer S_b>769 is weakly dominated. However, it turns out that only once a defendant chooses S_b as high as 800. It turns out that the six independent groups do not show any significant change in their choice of weakly dominated settlement offers over the three plays. Consider the null hypotheses that within one group the first play and the second play are equally probable to show the higher number of weakly dominated or iteratively weakly dominated settlement offers. Both null hypotheses can be rejected at the 10% significance level (two-sided binomial test). Table 4.6 reports the proportion of weakly dominated settlement offers (iteration step 1), second-step weakly dominated strategies (iteration step 2) and iteratively weakly dominated strategies (iteration step 3). The distributions of settlement offers and acceptance limits of first-level and second-level experienced subjects are presented in Appendix A.

The main result of the data analysis in this section is that neither Bayesian Nash nor (iterative) elimination of weakly dominated strategies can satisfactorily explain the observed behaviour. Even though subjects most often choose an equilibrium strategy of type (c) in the defendant's bargaining position, subjects tend to choose non-equilibrium strategies in the plaintiff's bargaining position. The acceptance limit is higher than a pooling equilibrium with out-of-court settlement allows and too low for a separating equilibrium with settlement in the defendant's bad bargaining position. The concept of pure strategy Bayesian Nash equilibrium, however, requires that subjects choose their values from one of the three types of equilibrium strategies. One-step or even iterative elimination of weakly dominated strategies as an alternative explanation of how subjects choose their values is not fruitful either. The frequency of acceptance limits that are weakly dominated rises drastically in the second and third play. However, if the choices of acceptance limits do not even conform to one-step elimination, then necessarily the same holds for iterative elimination of weakly dominated strategies. Settlement offers are iteratively weakly dominated to a large extent as well. Only one-step elimination of weakly dominated settlement offers also remains in the second and third play a good predictor of observed behaviour. One-step elimination of weakly dominated strategies as a predictor of behaviour, however, is still unsatisfactory and asks for better explanations.

Level of Experience	Strategy Classification	Equilibrium Strategies of Type			Non-Equilibrium Strategies
		(a)	(b)	(c)	
First-	Pooling	0.000	-	0.000	0.000
Level	Separating	-	0.026	0.815	0.159
Second-	Pooling	0.000	-	0.000	0.000
Level	Separating	-	0.070	0.789	0.141

Table 4.3: *Classification of settlement offers of 36 first-level and second-level experienced defendants according to pooling or separating, equilibrium strategies of type (a), (b) or (c) and non-equilibrium strategies*

Equilibrium Strategies of Type

(a) Conflict-avoiding strategy: $423 \leq A \leq 440$

(b) Strategy avoiding conflict in the defendant's bad bargaining position: $670 \leq A \leq 770$

(c) Conflict-seeking strategy: $A \geq 770$

Strategy Classification

Pooling: The defendant chooses $S_g = S_g$

Separating: The defendant chooses $S_g \neq S_b$

Level of Experience

First-Level: Subjects have already played the game for 15 rounds

Second-Level: Subjects have already played the game for 30 rounds

Non-Equilibrium Strategies

Acceptance limit A does not conform to an equilibrium strategy of type (a), (b) or (c)

Weakly Dominated Equilibrium Strategies

Plaintiff chooses some acceptance limit A with $A \geq 670$ which belongs to equilibrium class (b) or (c)

Weakly Dominated Non-Equilibrium Strategies

Plaintiff chooses some acceptance limit A with $A \leq 340$ which does not belong to any equilibrium class

Level of Experience	Equilibrium Strategies of Type			Weakly Dominated (b)+(c)	Non-Equilibrium Strategies	
	(a)	(b)	(c)		Weakly Dominated A≤340	Other
First-Level	0.059	0.211	0.115	0.326	0.215	0.400
Second-Level	0.056	0.281	0.115	0.396	0.196	0.352

Table 4.4: *Classification of acceptance limits of 36 first-level and second-level experienced plaintiffs according to equilibrium strategies of type (a), (b) or (c) or non-equilibrium strategies and proportion of weakly dominated acceptance limits*

Number of Elimination Steps	Level of Experience		
	First Play	Second Play	Third Play
1	0.159	0.515	0.567
2	0.757	0.819	0.796
3	0.757	0.819	0.796

Table 4.5: *Proportion of acceptance limits that are (iteratively) weakly dominated including only subjects who also participate in the second and third play*

Elimination Step 1: The plaintiff chooses A≤340 or A>670
Elimination Step 2: The plaintiff chooses A≤340, 440≤A≤669 or A>671
Elimination Step 3: The plaintiff chooses A≤340, 440≤A≤669 or A>671

Number of Elimination Steps	Level of Experience					
	First Play		Second Play		Third Play	
	S_b	S_g	S_b	S_g	S_b	S_g
1	0.000	0.079	0.000	0.026	0.004	0.022
2	0.197	0.563	0.111	0.767	0.148	0.818
3	0.883	0.563	0.981	0.767	0.785	0.818

Table 4.6: *Proportion of settlement offers S_b and S_g that are (iteratively) weakly dominated including only subjects who also participate in the second and third play*

Elimination Step 1: The defendant of type b chooses $S_b>769$; the defendant of type g chooses $S_g>439$

Elimination Step 2: The defendant of type b chooses $S_b<341$ or $S_b>670$; the defendant of type g chooses $S_g<341$ or $S_g>439$

Elimination Step 3: The defendant of type b chooses $S_b<341$, $440\leq S_b<670$ or $S_b>670$; the defendant of type g chooses $S_g<341$ or $S_g>439$

4.2 Behavioural Characteristics and Learning Behaviour

In the last section we found that subjects do not play consistently. The bargaining game gives rise to a coordination problem that subjects do not learn to solve. Defendants and plaintiffs tend to follow equilibrium strategies of different types. However, if subjects do not even agree on the same type of equilibrium strategy, we cannot expect the plaintiff and the defendant to play the same Bayesian Nash equilibrium. Even if we omit our assumptions that subjects correlate their expectations on the same equilibrium and ask how often strategies that are not weakly dominated are played, we find that experienced plaintiffs play weakly dominated strategies more often than inexperienced subjects.

The main result of our first section is that subjects learn in the sense that they change their behaviour with experience, but game theory cannot explain the changes in behaviour satisfactorily. Although it is now desirable to find out how each individual learns and the individual behaviour is driven over time, a lot of data are needed if we want to describe the subjects individually. The complexity of our experiment and the limited number of observations that we have for each individual do not allow us to fully achieve this goal. In our forthcoming analysis we will sort out characteristics that apply to a significantly large number of subjects. The characteristics will then be applied to a learning model. Finally, we run simulations based on our learning model and compare the results of our simulations with the observations in the laboratory.

4.2.1 Frequency of Adjustment and Variation of Settlement Offers and Acceptance Limits

Our data suggests that inexperienced individuals react to bargaining outcomes more frequently than first-level or second-level experienced individuals. For all individuals who repeat the game we count the number of strategy changes in both the plaintiff's and defendant's position. Irrespective of whether the defendant changes one settlement offer or both settlement offers, we count it only as a single change. Subjects who also participate in the second and third play are matched such that we have six independent groups. Each group consists of six players.

The learning literature states that learning curves tend to be steep at the beginning and then become flatter (see, for example, Blackburn (1936) and Roth (1993)). Therefore, we apply the one-sided Page test (Siegel and Castellan (1988)) and reject the null hypothesis that the frequency of change in a group does not decrease over the different levels of experience at the 0.1% significane level against the alternative hypothesis that experienced subjects change their values less often than inexperienced subjects.

The frequency of changes of the individual groups in both the plaintiff's and defendant's bargaining position are reported in Table 4.6. For all six observations we find that the more experienced a group is the less often it adjusts the values. This finding is consistent with the learning literature.

Group Number	First Play	Second Play	Third Play
Group 1	52	33	24
Group 2	53	36	18
Group 3	69	43	24
Group 4	64	44	26
Group 5	74	54	17
Group 6	64	38	13

Table 4.7: Frequency of changes both in the plaintiff's and defendant's bargaining position for groups of different levels of experience including only subjects who also participate in the second and third play[15]

If inexperienced subjects adjust their values more frequently than experienced subjects, we expect the settlement offers and acceptance limits to vary more strongly in the first play than in the second or third play. For all subjects who repeat the game we define the variability measure $D_{i,j}$ of individual i with level j of experience where j can be equal to 1, 2 or 3 as:

$$(36) \qquad D_{i,j} = \sum_{t=P_2}^{P_n} d(v_{i,j}^t)^2 \qquad \text{where} \quad d(v_{i,j}^t) = | v_{i,j}^t - v_{i,j}^{t-s} |$$

The symbol s stands for the number of periods passed since the player was in the same bargaining position. Thus, t-s is the last period in which the player was in the same bargaining position as in period t. In our experiments s may take some value from 1 to 4. A subject is assigned at most four periods later to the same bargaining position again. P_2 denotes the period when the subject is in the corresponding bargaining position for the second time. P_n, respectively, stands for the period when the subject is in the corresponding position for the last time. The variability measure computes the

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[15] Note that any adjustment of settlement offers in the defendant's good and/or bad bargaining position is counted as a single adjustment in the defendant's position.

sum of individual i's squared differences between settlement offers/acceptance limits in period t and settlement offers/acceptance limits in period t-s for t=P_2 to t=P_n. For example, if subject i is defendant of type b in periods 1, 3, 4 and 9, then P_2 is equal to 3 and P_3 is equal to 4. For the first squared difference in the defendant's bad bargaining position t is equal to 3 and s is equal to 2. For the second expression we have t equal to 4 and s equal to 1. We continue in this manner until we have reached the final period, i.e. P_n, where subject i is defendant of type b. We calculate the variability measures for all individuals who repeat the game. For the different levels of bargaining experience, we sum the variability measures over all individuals who belong to the same group in the second and third play.

Altogether, we have three variability measures for each level of bargaining experience which gives us nine variability measures in total for each of the six independent groups. In Table 4.7 we report the results of the Friedman two-way analysis of variance by ranks test (Friedman test) which tests whether the level of experience has a significant effect on the variability measure of acceptance limits and settlement offers in the defendant's good and bad bargaining position.

We find that the level of experience has a significant influence on the variability measure. The significance level is always less than 5% except for the variability measure of the acceptance limits using a two-tailed Friedman test. Both the large variability of the acceptance limits and settlement terms and the frequent change of values in the first play suggest to look for some typical characteristics of how and by what magnitude subjects adjust their values. In a subsequent section we will discuss an adjustment rule that seems to describe the changes in behaviour quite well.

Variable	Significance Level of the Friedman Test
OFFER A	0.003
OFFER B	0.006
ACCEPT	0.115
TOTAL	0.030

Table 4.8: *Friedman test on the variability of acceptance limits (ACCEPT), settlement offers in the defendant's good (OFFER A) and bad bargaining position (OFFER B) and all three values aggregated together (TOTAL=OFFER A + OFFER B + ACCEPT) for the three levels of experience*

4.2.2 Prominence Level

When looking at the distributions of our data, we find that subjects seem to be attracted by "round" numbers. Numbers that are divisible by 50 are chosen more frequently than others. It is our goal in this section to find statistical support for this visual impression. The idea of prominence goes back to Schelling (1960). Schelling argued that bargaining outcomes can often be explained on nonstrategic grounds. Cultural traditions and conventions may give reason to choose points in the bargaining range that do not have any strategic relevance. Albers and Albers (1984) have provided a theoretical framework for a theory of prominence in the decimal system.

However, their method to determine the prominence level of a set of numbers depends on judgemental parameters. For this reason, we apply a method designed by Selten (1987) for determining the prominence level of a data set. Selten follows Albers' and Albers' definintion of a prominence level. A prominence level in X where X is the set of all positive integer multiples of a smallest money unit $g>0$ is a number D of the form $D=m10^h g$, with $m=1,2,2.5,5$ and $h=0,1,2,...$ Let X_0 be the set of all prominence levels in X. The prominence level d(x) of a number $x \in X$ is the greatest prominence level $D \in X_0$ such that x is divisible without remainder by D. For every prominence level $D \in X_0$ let m(D) be the number of values x in Y with $d(x)=D$ where Y is a nonempty finite subset of X and the support of k. The function k is a frequency distribution over X and the number k(x) is interpreted as the frequency with which the value x occurs in the data set. The symbol m(D) is called the number of values on the prominence level D. For every prominence level $D \in X_0$ h(D) is the sum of k(x) with d(x)=D. The symbol h(D) is the number of observations on the prominence level D.

In our analysis we distinguish between three different levels of experience and the plaintiff's and defendant's bargaining position. We calculate the prominence level D of the frequency distributions of the settlement offers in the defendant's good bargaining position, settlement offers in the bad position and plaintiffs' acceptance limits for the three different levels of experience. Let D' denote the next lower prominence level. The idea that there is a distinct dividing line between "round" numbers and other numbers suggests that the ratio of the number of observations on the prominence level D', i.e., h(D'), to the number of values on the prominence level, i.e., m(D'), should be significantly lower than the ratio h(D)/m(D).

We apply a two-sided c^2-test and use Yates correction, if necessary, to test the null hypothesis that the ratio h(D)/m(D) is not signficantly different from h(D')/m(D'). Table 4.8 reports the prominence level and the results of the c^2-test of (a) settlement offers of inexperienced defendants of type g, (b) settlement offers of inexperienced defendants of type b, (c) acceptance limits of inexperienced plaintiffs, (d) settlement offers of first-level experienced defendants of type g, (e) settlement offers of first-level experienced defendants of type b, (f) acceptance limits of first-level experienced acceptance, (g) settlement offers of second-level experienced defendants of type g, (h) settlement offers of second-level experienced defendants of type b and (i) acceptance limits of second-level experienced plaintiffs. (d), (g) and (i) are not significant at the 5 % significance level using a two-sided c^2-test.

However, (d) is significant at the 10 % significance level. Inexperienced and first-level experienced subjects show a high tendency to choose "round" numbers, i.e., multiples of 50, while second-level experienced subjects tend to distinguish less between "round" numbers and other numbers.

Value, Level of Experience	Prominence level	α
Offer A, G-1	50	0.1%
Offer B, G-1	50	0.1%
Acceptance Limit, G-1	50	0.1%
Offer A, G-2	50	10%
Offer B, G-2	50	2.5%
Acceptance Limit, G-2	50	1%
Offer A, G-3	50	*
Offer B, G-3	50	2.5%
Acceptance Limit, G-3	100	*

Table 4.9: *Prominence level of observed acceptance limits and settlement offers of defendants of type g and b according to inexperienced, first-level experienced and second-level experienced level*

α : Significance level of the two-sided c^2-test with Yates correction if necessary
* : Not significant at a significance level of 10%
G-1 : Inexperienced subjects in the first play
G-2 : First-level experienced subjects in the second play
G-3 : Second-level experienced subjects in the third play

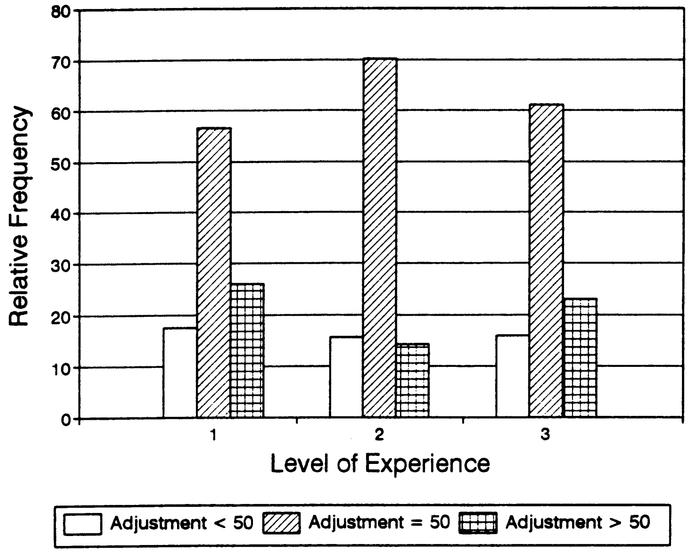
We have found that inexperienced subjects tend to choose "round" numbers. The data also show that subjects irrespective of their bargaining experience have the tendency to adjust their values by 50 Taler the next time they are in the same bargaining position. This observation is in accordance with the prominence levels that we have calulated for the numbers that subjects choose. When we look at the distribution of $d(x^t_{i,j}) \neq 0$, it becomes evident that subjects do not change their values randomly. Inexperienced subjects adjust their values in more than 50% of the cases by 50 Taler in the plaintiff's or defendant's bargaining position. First-level experienced subjects even adjust their values in about 70% of the cases by $d(x^t_{i,j})=50$, second-level experienced subjects in 61% of the cases.

Figure 4.1 presents the distribution of the $d(x^t_{i,j})$s of inexperienced, first-level and second-level experienced subjects. For simplicity, we only distinguish between $d(x^t_{i,j})=50$, $d(x^t_{i,j})<50$ and $d(x^t_{i,j})>50$. The null hypothesis that subjects adjust their values by 50 with the same probability as they adjust their values by some $d(x^t_{i,j})\neq 50$ is rejected in a one-tailed binomial test at $p\leq 0.02$ significance level against the alternative hypothesis that subjects adjust their values by 50 with a higher probability than by some other $d(x^t_{i,j})$. For eight out of nine groups more than 50% of $d(x^t_{i,j})$ in the plaintiff's and defendant's bargaining position are equal to 50.

For experienced subjects, we find a similar result. We apply a one-tailed binomial test again to the six groups that also participate in the second and third play. The null hypothesis that with equal probability within a group the majority of adjustments is 50 or different from 50 is rejected at $p\leq 0.109$ significance level for both first-level and second-level experienced subjects against the alternative hypothesis that within a group an adjustment of 50 is chosen more often than all other adjustments together. Five out of six first-level and second-level experienced groups adjust their values by 50 in more than 65% and 63% of the cases respectively.

In this section we have shown that subjects tend to choose "round" numbers. Moreover, the binomial test has rejected our null hypothesis that the amount of adjustment is merely random. The question by what amount subjects adjust their values can be summarized as follows: Subjects tend to adjust their values by $d(x^t_{i,j})=50$.

Figure 4.1: *Distribution of $d(x^t_{i,j})$ of inexperienced(=1), first-level(=2) and second-level(=3) experienced subjects*[16]



4.2.3 First-Round Values and Decision Heuristics

In our experiments we make extensive use of questionaires. We follow two major goals by using questionaires: First, we want to find out how inexperienced subjects solve the decision problem and how the chosen values are determined in the first period. As far as the determination of values is concerned, we use open questions. We ask inexperienced subjects to write down how they arrive at their acceptance level or settlement offers in the first period. After five rounds subjects have the opportunity to comment on their choices again. If subjects make use of mathematical calcualtions, we ask them to write down their calculations as well. We give subjects a calculation aid on the computer. Any calculations that are done on the computer are automatically recorded. No other utensils except for the ones we supply during the experiment are

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16 $d(x^t_{i,j})$ includes subject i's adjustments in both the plaintiff's and defendant's bargaining position

admitted. In this way, we make sure that we completely collect subjects' records and calculations.

Müller (1980) shows that a cognitive and more dynamic approach to behavioural decision-making does better fit the data and, in addition, gives a more detailed insight into how subjects handle a conflict situation. In Müller's experiments subjects had to negotiate for an outcome distribution against bogus enactment of two confederates. Negotiation continued until demands summed up to DM 42 unless an agreement was not reached within half an hour.

Second, we are interested in learning. Learning can only take place if subjects get direct and immediate feedback on their actions. We give subjects feedback by sending them a report on the bargaining outcome, i.e., we inform subjects about success or failure of settling the conflict out-of-court, and monetary gains or losses from bargaining. We also tell subjects the information situation that has been drawn by the computer. Although this piece of information might only seem to be of secondary importance, it gives the subjects extra information on how acceptance limit and settlement offers are related to each other. We reinforce the feedback information by asking closed questions on the bargaining outcome. Subjects are asked if they are satisfied with their behaviour and if they think they have decided correctly. Subjects can comment on whether they would have done anything different if they could choose again in retrospect.

As far as the first period is concerned, written comments to the question of how they arrived at their values in the first period, can be classifed into 5 categories. We use the letters A,B,C,D and E for our categories. It has to be emphasized that classifications are soley based on written comments. We cannot and certainly do not want to infer any other mental decision-making processes that subjects might have done apart from the comments that subjects write on the questionaires.

In our classification group-A subjects either do not comment on their strategy or comments are incomprehensible to us. We call group-A subjects non-identifiable decision-makers. Group-B subjects apply some intuitive decision-making or choose their values randomly. Group-C subjects use qualitative reasoning. A defendant who uses qualitative reasoning does not write down any arithmetic calculation. Instead the defendant distinguishes between high probability and low probability of winning the court case in order to arrive at her two settlement offers. A plaintiff who follows qualitative reasoning uses arguments such as his chance of winning the court case are almost equally high as the defendant's, or the plaintiff's chance of winning the court case are worse in the good information situation. Group-D subjects make use of simple calculations. They use the probabilities that are given on the instruction sheet. The defendants most often multiply the two conditional probabilities of losing the court case by the loss W=1000 Taler. The plaintiffs take their ex-ante probability of winning the court case and multiply this probability by W=1000 Taler. One plaintiff writes down the range from which she chooses some factor that she multiplies with W=1000 Taler. Group-E subjects can be grouped as strategic decision-makers. They explicitly incorporate their opponent's behaviour into their arguments. They do not solve the problem as a one-person decision problem, but rather as an interactive decision problem. Some group-E subjects use calculations, whereas others only provide qualitative arguments in their answers. Similarly, we find some group-D subjects who, in addition, add some qualitative arguments to their calculations.

There is some overlap between group-C and group-D subjects and in some cases it might be difficult to assign a subject clearly to one of the groups. For example, if a subject argues that her chances of winning a court procedure are better in the defendant's good bargaining position - we abbreviate it by A in the experiments - than in the bad position, which is called B in the experiments, and the subject chooses 400 as his settlement offer in A and 700 as his settlement offer in B, we cannot find out if the subject might not also have used simple calculations in his decision-making process. However, we keep the rule that only written comments are used for classifications. Table 4.10 reports how many subjects use the respective strategy. Our classification shows that six subjects, i.e., only about 11 %, include both the plaintiff's and the defendant's bargaining positions in their decision-making process.

Decision Rule	Number of Subjects
Non-Identifiable Decision-Making	5
Random or Intuitive Decision-Making	10
Qualitative Reasoning	17
Probability-Based Decision	16
Strategic Decision-Making	6

Table 4.10: Classification of written comments of inexperienced subjects in the first bargaining round

Subjects most often look at their own position only and do not think interactively. They use simple decision rules in the first period, and they do not make sophisticated calculations. Very few subjects make use of the calculator on the computer. First period arguments written on the questionaires show that the majority of subjects does not use game theory in order to arrive at their values. The behaviour of inexperienced defendants in the game shows that subjects clearly distinguish between A and B,[17] i.e., the settlement offer in A is less than the settlement offer in B. The difference between the two settlement offers depends on the decision rule that subjects use. There are only two subjects in the first period who make the same settlement offer in A and B. Although subjects are told in the introduction that litigation involves bargaining costs which are irrevocably deducted from their accounts, they show litigation-seeking behaviour, especially the defendants of type g. Inexperienced defendants choose in 48.4% of the cases a settlement offer of less than 340 in A, first-level experienced subjects in 70.7% of the cases and second-level experienced subjects even in 79.6% of the cases. Defendants can discriminate between A and B. This gives them an advantage over the plaintiff's bargaining position. The plaintiff has to choose his

[17] In the experiment and in the questionaires we try to avoid any judgemental remarks. For this reason, we use the letter A for the defendant's good bargaining position and the letter B for the bad position.

acceptance limit without knowing the information situation that nature has drawn. As a result, plaintiffs tend to choose some "medium" acceptance limit which tends to lie above the defendant's settlement offer in A and below the settlement offer in B. As we have learned from the distribution of acceptance limits, this behaviour changes when subjects are experienced.

Experienced plaintiffs either choose a relatively low acceptance limit in order to reduce the probability of litigation or plaintiffs take the risk of litigation and choose a relatively high acceptance limit. Altogether we have 36 subjects who repeat the game. We are interested in the question of whether experienced subjects change their acceptance limits from "medium" to "extreme" where "extreme" can either mean below "medium" or above "medium" and "medium" is defined as some value between 340 and 671. We obtain this interval if the plaintiff eliminates his weakly dominated strategies for the first time. Any acceptance limit that falls outside the interval from 341 to 670 is called "extreme". According to the elimination of weakly dominated strategies the plaintiff shall neither choose his acceptance limit too "low" nor too "high" where "low" refers to some acceptance limit below 341 and "high" means some acceptance limit that is greater than 670. If he chooses his acceptance limit very "low", the defendant can as well choose her settlement offers in A and B very "low" without provoking a court procedure. In this case the plaintiff gets less than he can expect from a court procedure. If the plaintff chooses his acceptance limit very "high", he might turn down a settlement offer which gives him more than the expected payoff from a court procedure in the defendant's bad bargaining position.

Table 4.11 reports how subjects choose their first acceptance limit in the first and second play. We distinguish between four cases: (a) The subject chooses an initial acceptance limit of the "medium" range in the first play, whereas in the second play he chooses an "extreme" initial acceptance limit, (b) he chooses in both plays a "medium" acceptance limit as his first acceptance limit, (c) he chooses in both plays an "extreme" acceptance limit or (d) he chooses an "extreme" value in the first play and starts with a "medium" acceptance limit in the second play. Although the McNemar test is usually applied for studies of the before-and-after type with two related samples, we use the binomial test instead, since the number of independent observations is only six. If the number of cases in the upper left-hand cell(=A) and the lower right-hand cell(=D) is less than five, the binomial test should be used (Siegel and Castellan, 1983). A+D is cell(=A) and the lower right-hand cell(=D) is less than five, the binomial test should be used (Siegel and Castellan, 1983). A+D is the total number of subjects whose responses changed. For our binomial test N=A+D=5 and x=0 where x=min(A,D) is the smaller of the two frequencies A and D. We can then get the probability under H_0 of observing no changes (x=0) in one direction.

We reject our null hypothesis that the probability that subjects change the first-chosen acceptance limit from "medium" in the first play to "extreme" in the second play is equal to the probability that the subjects change the acceptance limit from "extreme" in the first play to "medium" in the second play at $p \leq 0.062$ significance level using a two-tailed binomial test. We conclude that there is a differential change in the choice of acceptance limits.

Acceptance Limit in							
First Play	Second Play	G_1	G_2	G_3	G_4	G_5	G_6
Medium	Medium	0	1	1	**4**	2	2
Medium	Extreme	**4**	**4**	**3**	2	**4**	**3**
Extreme	Medium	1	0	1	0	0	0
Extreme	Extreme	1	1	1	0	0	1

Table 4.11: *Classification of initial acceptance limits in the first and second play according to inside the interval from 341 to 670 (medium) and outside the interval (extreme) including only subjects who repeat the game and form an independent group (G_j where j=1,...,6)*[18]

[18] Numbers that are written in bold letters represent the classification that most subjects follow in this group.

Subjects who also participate in the second and third play are asked again to comment on their strategy. Subjects who choose a "low" acceptance limit, i.e. A≤340, argue that they do not want to take the risk of a court procedure. In the next chapter we will see that the litigation experience in the first play affects the choice of acceptance limits in the plaintiff's bargaining position. Furthermore, a "low" acceptance limit guarantees the plaintiff the profits from offers which are made by a generous or conflict-avoiding defendant. Still, very few subjects go down with their acceptance limit as far as 0 Taler, because there is a limit as to how far the plaintiff is willing to go down with his acceptance limit in order to avoid a conflict. If the defendant tries to go down below this limit, the plaintiff rather prefers to go to court.

Plaintiffs who choose a "high" acceptance limit, i.e., A≥670, can certainly be classified as more risk-loving than their counterparts who choose "low" acceptance limits. However, some plaintiffs argue that "high" acceptance limits deter the defendant from reducing her settlement offers too drastically, especially in the defendant's bad bargaining position where the plaintiff has a 70 % chance of winning the court case. This argument shows that some plaintiffs have understood the decision-problem which is involved in an equilibrium of type (b) where subjects settle the conflict in the defendant's bad bargaining position and always go to court in the good position. However, they ignore the fact that a "high" acceptance limit which is greater than 670 might take away profitable gains. On the other hand, subjects who choose "low" acceptance limits can be considered as some sort of free-riders. They profit from the subjects who choose "high" acceptance limits.

The learning rule that we will specify in the next section shows that "high" acceptance limits prevent defendants from cutting their settlement offers too drastically. According to this learning rule to be explained in chapter 5, average settlement offers in the bad information situation do not drop too sharply if some plaintiffs choose 'high' acceptance limits which frequently result in litigation and cause defendants to increase their settlement offers.

4.2.4 Litigation Behaviour

Subjects have the opportunity to settle the conflict out-of-court and, thereby, avoid the litigation costs. In this chapter we investigate the question to what extent subjects make use of this opportunity. We find that inexperienced subjects in almost 75% of the cases do not settle the conflict and, as a result, go to court and play the lottery instead. Altogether we have 405 observations. In 299 bargaining rounds the defendant and the plaintiff fail to settle the conflict. This proportion of conflicts comes close to what theory predicts if the players follow a separating equilibrium where the plaintiff chooses his acceptance limit equal to the settlement offer in the defendant's bad bargaining position. In this case, subjects never settle the conflict in the defendant's good bargaining position and always avoid a conflict in the bad position. Although the results in the experiments are not far away from the theoretical prediction of court cases, the similarity is deceptive. There is a difference between theory and experiments in the number of court cases in both the defendant's good and bad bargaining position. Bargaining does not always end in court in the defendant's good bargaining position. On the other hand, about 1/3 of the bargaining conflicts are not settled out-of-court in the bad position in the first play. We have found that inexperienced defendants most often follow an equilibrium strategy of type (c) where an out-of-court settlement is theoretically never reached. However, it is the violation of the theoretical prediction that makes it possible that subjects still settle the conflict out-of-court. Inexperienced plaintiffs tend to choose a "medium" acceptance limit, i.e., some value that lies between 340 and 671 (see also section 4.1.1) contrary to theory which predicts that plaintiffs choose their acceptance limits greater than 770.

Experienced subjects even go to court in more than 50% of the cases in the defendant's bad bargaining position in the second and third play. In Figure 4.2 we graph the proportion of acceptance limits that (a) lies below their opponent's settlement offer in the defendant's good bargaining position, (b) is equal to the settlement offer in the defendant's good bargaining position, (c) lies between the settlement offer in the defendant's good and bad bargaining position, (d) is equal to the settlement offer in the defendant's bad bargaining position or (e) is greater than the settlement offer in the defendant's bad bargaining position. In one case inexperienced subjects choose $A=S_b=S_g$. Figure 4.3 shows how many bargaining rounds end in court when subjects are inexperienced(=1), first-level experienced(=2) and second-level experienced(=3).

The aggregated number of court cases in a play does not show if there is any trend observable in the frequency of litigation. Figure 4.4 plots the number of court cases against time. Figure 4.4 already suggests that there is a trend to more litigation towards the end of the first play, whereas in the second and third play no trend is observable. The regression results which are reported in Table 4.12 support this finding as well. In the first 15 rounds the time variable is significant at the 1% significance level indicating that inexperienced subjects more often go to court as time proceeds. In the second and third play, the time coefficient is not even significant at the 10% significance level. Regression I reports the results of inexperienced subjects and regressions II and III report the litigation behaviour over time of first-level experienced and second-level experienced subjects respectively.

Figure 4.2: *Magnitude of acceptance limits with respect to the opponent's settlement offers distinguishing between inexperienced, first-level and second-level experienced subjects*

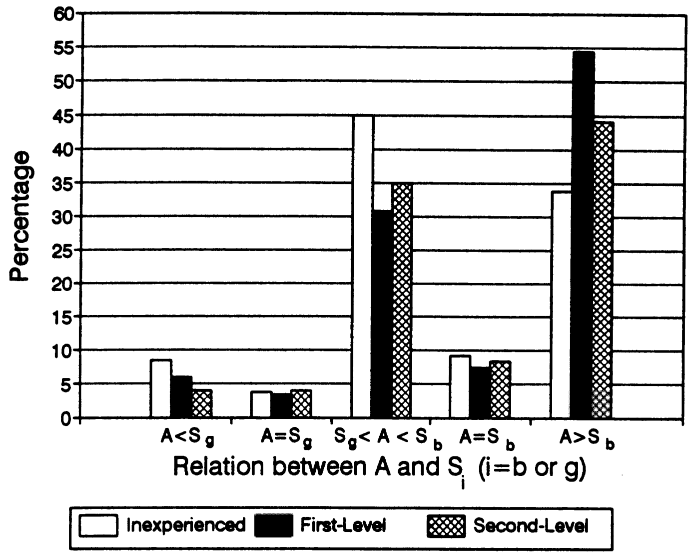


Figure 4.3: *Aggregated proportion of litigation of inexperienced(=1), first-level experienced(=2) and second-level experienced(=3) subjects in the defendant's good and bad bargaining position*

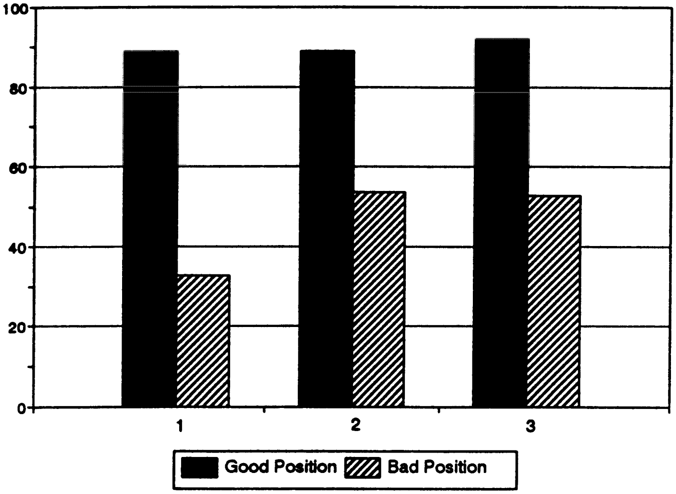
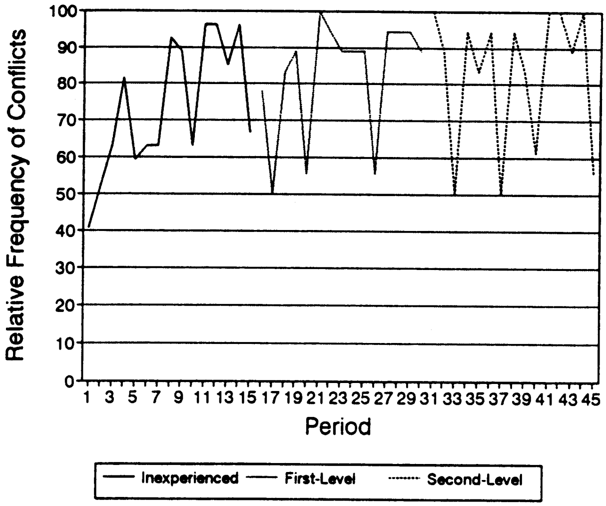


Figure 4.4: *Relative frequency of court cases of inexperienced, first-level experienced and second-level experienced subjects over time from period 1 to period 45 including all subjects who participate in the experiments*



	Regression I	Regression II	Regression III
Multiple R	0.67	0.39	0.01
R Square	0.44	0.15	0.00
Time	2.70*	1.41***	-0.04***
Constant	52.26**	71.71**	83.25**

Table 4.12: *Correlation between litigation behaviour of inexperienced (Regression I), first-level experienced (Regression II) and second-level experienced (Regression III) subjects and time*

* : Significant at the 1% significance level

** : Significant at the 0.1% significance level

***: Not significant at the 10% significance level

Next, we want to give an explanation to why we observe more conflicts in the first play towards the end of the sessions. Our matching of subjects is such that after five rounds subjects play against the other players in the same sequence again. We divide the first 15 rounds into three parts of five rounds each. The three parts, therefore, constitute different levels of experience within the first play. For each part we calculate the mean of acceptance limits and settlement offers in the defendant's good and bad bargaining position for all nine independent groups. In addition, we count the number of conflicts per group that we observe in each part. The Friedman test rejects the null hypothesis that the level of experience within the first play has no effect on the observed frequency of litigation and the observed means of settlement offers in the defendant's good and bad bargaining position. We reject the null hypothesis at the 0.1% significance level for the frequency of conflicts, at the 0.03% significance level for the mean of settlement offers in the defendant's good bargaining position and at the 2.5% significance level for the mean of settlement offers in the defendant's bad bargaining position using a two-tailed test. However, the Friedman test does not reject the null hypothesis for the mean of acceptance limits at any standard significance level in favour of the alternative hypothesis that the level of experience within the first play has a differential effect on the frequency of litigation. The significance level is $p \leq 0.236$

using a two-tailed test. The Friedman two-way analysis of variance by ranks is useful for testing the null hypothesis that the 3 samples have been drawn from the same population with respect to mean ranks.

Since litigation is costly and reduces the amount of money to be paid out to the subjects, we assume that subjects learn to avoid a court procedure. Since the Friedman test does not test our theoretical presumption of less court cases as subjects gain more experience within the first play, we apply the order test. The two-sided order test rejects the null hypothesis that the level of experience does not have any systematic effect on the frequency of litigation within the first play at $p \leq 0.05$ significance level. Although we expect a decrease in the number of court cases, our assumption is not validated. It turns out that the rejection shows into the opposite direction of more court cases.

In case of the settlement offers the results of the Friedman test are confirmed by the order test as well. We reject the null hypothesis that the level of experience is not related to the observed mean of settlement offers at the 0.05 significance level for a two-sided order test. The order test bears the result that the mean of settlement offers in the defendant's good and bad bargaining position is inversely related to the level of experience within the first play. The mean of acceptance limits, on the other hand, does not show any trend either. The null hypothesis cannot be rejected for a two-tailed order test at the 10% significance level. However, it seems to be intuitive that we observe more litigation if subjects on average offer less to the plaintiffs, whereas the plaintiffs do not significantly change their acceptance behaviour on average. In a subsequent chapter on the learning behaviour of subjects within a game, i.e., within the 15 periods that one play lasts, we will discuss why the mean of settlement offers in both the defendant's good and bad bargaining position goes down, but the mean of acceptance limits, on the other hand, does not change significantly. In addition, the learning rule together with the observed tendency of less changes in the second and third play, will give insight into why the downward movement of settlement offers is not significant in the second and third play. The learning rule allows us to infer cause and effect relationships.

The main results of this section can be summarized as follows: First, we observe more conflicts within the first play as time proceeds. Second, the frequency of conflicts cannot change significantly in the second and third play. Third, the observed rates of conflicts in the defendant's good and bad bargaining position do not match the theoretical prediction of litigation and, fourth, the observation of more conflicts towards the end of the first play can be explained by the difference between the mean of acceptance limits and settlement offers. The mean of acceptance limits does not significantly change, whereas the mean of settlement offers decreases significantly. As a result, the difference between the mean of acceptance limits and settlement offers becomes larger and, thus, makes a conflict more likely.

4.2.5 Simultaneous Adjustment of Settlement Offers

Our inspection of the data shows another noticeably interesting characteristic. Defendants sometimes adjust their settlement offers in both the good and bad bargaining position. For example, let us assume that nature draws the defendant's good bargaining position. The settlement offer of the defendant of type g is compared with the plaintiff's acceptance limit. The settlement offer in the defendant's bad bargaining position does not have any effect on the bargaining outcome and on the payoff the defendant of type g receives.

Still, we might observe that the subject does not only change his settlement offer in the good bargaining position the next time he is in the defendant's position again, but also adjusts his settlement offer in the bad position. The reason for this behaviour might be that defendants do not only look at the bargaining outcome in the bargaining position that has been drawn in isolation, but evaluate the outcome as well with respect to the other position. The ex-post bargaining questions on how subjects assess and evaluate their behaviour might give subjects an incentive to think about what would have happened if the defendant's other bargaining position had been drawn.

We want to find out if the direction of adjustment of the settlement offer in the defendant's good bargaining position is independent of the direction of adjustment of the settlement offer in the bad position. Inexperienced defendants change in 272 cases at least one settlement offer. Altogether we have 89 observations where defendants adjust both settlement offers in the first play. The relative frequency of simultaneous adjustments is 32.7%. 38 subjects adjust both settlement offers at least once. 27

subjects adjust both settlement offers more than once in the first play. Repeated observations of the same subject inflate the total number of observations and distort the test statistic. Therefore, we cannot apply the chi-squared test. Instead, we take our nine independent groups and distinguish between two classes: (a) The defendant adjusts his two settlement offers into the same direction, or (b) the subject changes his two settlement offers into different directions. In eight out of nine groups the subjects adjust their settlement offers more often into the same direction than into different directions. We reject the null hypothesis that this happens with probability 1/2 at a significance level of 4% using a two-tailed binomial test.

Since we can rank the differences between the two classes in the order of absolute size, we can also apply the Wilcoxon-matched pairs signed-ranks test. The two-tailed Wilcoxon test even rejects our null hypothesis at a significance level of 3%.

Finally, we find that subjects tend to adjust both settlement offers slightly more often in the defendant's bad bargaining position than we expect from the ex-ante probability of the bad position to be drawn. In 28.4% of the cases subjects adjust both settlement offers after they have been in the bad position. If there was no difference between the defendant's good and bad bargaining position of how often subjects adjust both settlement offers, we would expect subjects to change both settlement offers in 25% of the cases after they have been in the defendant's bad bargaining position and in 75% of the cases after they have been in the good position. Since we do not have enough observations for each individual, we cannot test if the tendency of subjects to change both settlement offers after they have been in the defendant's bad bargaining position is significantly different from the adjustment behaviour of subjects after they have been in the good position. In the second and third play we have altogether 18 observations where subjects adjust both settlement offers. Again, we find that subjects tend to adjust both settlement offers into the same direction. In 14 out of 18 cases subjects choose the same direction. However, the frequency of twofold adjustments reduces drastically when subjects play the game for a second and third time. In the second and third play we have 157 observations where subjects adjust their settlement offer(s) in the defendant's position. Experienced subjects adjust both settlement offers in only 11.7% of the cases.

In this subsection we have found that subjects who are assigned to the defendant's bargaining position do not only adjust their settlement offer in the state of nature that has randomly been drawn, but also in the other state of nature that is irrelevant to the defendant and does not have any effect on the bargaining outcome. Although we observe a high frequency of adjustments especially in the first play, we should not be blind to the fact that subjects differ greatly in their adjustment behaviour. We observe that some subjects never adjust their values in the first play irrespective of the bargaining outcome, whereas other subjects always adjust their values. The question that naturally arises is: Can this difference in behaviour be explained by means of personality characteristics? In the next subsection we attempt to give at least a partial answer to this question.

4.2.6 Machiavellianism and Tendency of Adjustment

In our experimental study of the game we do not merely investigate the bargaining context under which choices are made, but also account for the normative orientations and personality characteristics of the bargainers. In the literature on justice behaviour we find as well several attempts to assess personality differences in the adherence to various justice rules. The Protestant Ethic Scale (PE-Scale) attempts to operationalize the ideas of Max Weber. Studies using the PE-Scale have been concerned primarily with reward allocation, and more specifically with allocation to others. Gerritt (1973), for example, found that high PE subjects awarded performances in proportion to their contribution to a task, whereas low PE subjects followed an equality rule. Scattered throughout the literature are a number of studies that report relationships between various personality dimensions and justice behaviour. Blumstein and Weinstein (1969), for example, looked at the relationship between machiavellianism and need for approval, and responses to inequitable claims by a partner. Low Mach subjects appeared to follow the principle of equity, whereas high Mach subjects were more apt to take advantage of a person who has previously benefitted them. There are many other personality variables which might be considered for the potential linkage to justice behaviour and we refer to the book "Equity and Justice" by Greenberg (1982).

In social psychology experiments are also conducted which examine hypotheses about behaviour, cognitions and feelings in a negotiable allocation situation. The social psychological approach mainly investigates mixed motive situations in which subjects do not only have conflicting interests but in which there is also room for cooperation. Individual maximization can only be achieved on the expenses of the other bargaining player. The social psychological approach tries to give an answer to the question of what determines a destructive rather than a constructive solution to the interpersonal conflict including the influence of attitudes, phrasing and motivational tendency. Since interpersonal conflict situations are often intertwined with intrapersonal conflicts and states of competitive tension (see, for example, Hammond (1965) and Brehmer (1976)), researchers have started to look more closely at behaviour from its cognitive side. Very often, conflicts are caused by uncertainty which persons experience, because situational demands appear ambiguous.

The cognitive approach to interpersonal conflict behaviour (see, for example, Müller (1980), Kelley & Stahelski (1970) and Schlenker & Goldman (1978)) assumes that subjects can be classified as cooperative and competitive in their conflict orientation. The distinction can be made relatively independently of the bargaining situation. The difference in subjects' orientation affects the cognitive process of conflict perception. Subjects develop a different sensibility to the opponent's strategy. Cooperative subjects have a differentiated perception of their opponent. They presuppose that there are cooperative and competitive bargaining partners and attribute their opponent's reactions according to the observed behaviour. Competitive subjects, on the other hand, do not have a differentiated perception. They start bargaining under the assumption that the other person is also competitive. The cognitive approach assumes that conflict behaviour is not merely determined by situation-specific characteristics. This leads us to personality psychology which discriminates between situation-determined and personality-driven behavioural differences.

In personality psychology three main theoretical positions describe the individual and his or her interaction with the environment. Personologism advocates that stable constants such as traits are the main determinants of behavioural variation (see, for example, Alker (1971)). Situationism emphasizes environmental factors as the main sources of behavioural variation (see, for example, Mischel (1968)). Interactionism is a synthesis of personologism and situationism and implies that the interaction between these two factors is the main source of behavioural variance (see, for example, Endler (1975)). We think that neither personologism nor situationism alone can account for the observed behavioural variance. Apart from the role of bargaining context on rational choice, we investigate the relationship between characteristics of the decision maker and decision choices. The influences of social norms and personality attributes on bargainers' choices have received little attention in the past. The personality attributes that we investigate here are machiavellianism, age, sex, major, experience in statistics and game theory, a subject's tendency to engage in conflicts in order to fight for his rights and a subject's tendency to attribute success or failure to his own actions rather than luck or other factors that cannot be influenced. Machiavellianism is described on a scale ranging from +40 to -40 with a midpoint at 0. Experience in statistics and in game theory are described on scales ranging from "very good" to "very bad". A subject's tendency to engage in conflicts and the attribution of success and failure are described on scales ranging from "high agreement" to "low agreement". In this chapter, however, we only focus on machiavellianism. Subjects who score high on the questionaire can be described as high machiavellists (high Machs). Williamson (1985) defines the attitude presribed as high Machs as opportunism. He assumes that in every population of organizational members a sufficient number of people are ready to shirk, misrepresent their preferences or deceive others if that would be in their interest. On the other hand, subjects who score low on the questionaire can be described as low machiavellists (low Machs). Low Machs are seen to make choices so as to be consistent with their beliefs and norms irrespective of outcomes.

We find that the score of the questionaire that assesses machiavellianism has a significant influence on decisional variance. We use the "Mach IV" scale to assess a subject's machiavellianism. This is a social psychological scale developed some time ago by Christie and Geis (1973). The "Mach IV" questionaire is a self-administered 20-item survey that originally tried to develop a social psychological instrument that would allow researchers to identify political leadership potential. However, Christie and Geis found that the degree of machiavellianism was also predictive of a range of social and bargaining behaviour. In ultimatum games, their results suggest that subjects who score high on the "Mach IV" questionaire more often accept one-sided proposals than subjects with a low score whose sense of justice might lead them to reject low offers in indignation.

In a more recent study, Meyer (1992) finds that subjects who are classified as high Mach scorers are more likely to accept one-sided ultimatums when the bargaining conditions force a one-shot accept/reject decision which is labeled as strong ultimatum condition. However, for conditions of repeated play which form the weak ultimatum conditions his results suggest that both high and low Machs resist exploitation by the first-mover.

In this section we want to discuss what effect the degree of machiavellianism has on the observed behaviour. In all our experiments subjects have to complete the "Mach IV" survey after they have played the game for 15 rounds. We do not apply the "Mach IV" questionaire in the second and third play. The questionaire is translated into German and does not need to be calibrated, since we do not want to assess one subject's degree of machiavellianism with regard to a reference group. The questions can be classified according to tactics, people and morality. For example, on a tactics item a high Mach agrees to flatter important people, whereas a low Mach thinks that honesty is the best policy. As far as morality is concerned, a high Mach, for example, says that deception is honourable and desirable in warfare. A low Mach desires to be modest and honourable rather than influential and dishonourable. In a question on people high Machs argue that people only work hard if forced. Low Machs, on the other hand, think that most people are basically good.

It is our goal to learn whether subjects who score low on the "Mach IV" questionaire and who are committed to their beliefs and norms irrespective of the bargaining outcomes behave differently from those committed to self-interest seeking with guile and scoring high on the "Mach IV" questionaire.

Our data suggest that some subjects change their values frequently from one bargaining round to the next when they are in the same position, while other subjects change them infrequently or do not change them at all over the course of the experiment. In the first play, however, we observe that there is hardly any difference between the observed frequencies of adjustment (see also Figure 6.2 in chapter 6). It is difficult to discriminate high Machs from low Machs on the basis of observed frequencies of adjustment in the first play. At the beginning almost every subject has a strong tendency to adjust his values. Altogether there are 31 out of 54 subjects who always adjust their values in the first play. It is only if we also consider the second and third play that we can observe noticeable changes in the adjustment behaviour. Subjects now develop different tendencies to adjust their values. At this point it seems useful to ask if the "Mach IV" score has any impact on a subject's tendency to adjust his values.

As a first step we do a median-split. We take all subjects in the game who play the game for 45 rounds. The subjects whose "Mach IV" score lies above the median of our sample of students who also participate in the second and third play are classified as high Machs and the subjects whose score lies below the median are classified as low Machs. In the same manner we classify the frequencies of adjustments. The frequency of adjustments tells us how often a subject changes his settlement offers and acceptance limits. For each subject we count the frequency of observations where the subject changes his settlement offers and acceptance limits from one round to the next when the subject is in the same bargaining round again. In the defendant's bargaining position the subject can change his settlement offer in the defendant's bad and good bargaining position. Any change in one of the defendant's two bargaining positions is counted as a single change. That is, if a defendant changes his settlement offers in both bargaining positions, we do not count his adjustments double.

Table 4.13 shows that subjects who achieve a high score on the "Mach IV" most often adjust their values with a frequency above the median of observed frequencies of adjustment whereas subjects who score low on the "Mach IV" most often adjust their values with a frequency below the median of observed frequencies of adjustment. However, we cannot apply the median test since subjects within the same group are not independent of each other. Still, the results suggest to examine further the impact of machiavellianism on the adjustment behaviour.

"Mach IV" Classification	Frequency of Adjustment	
	≤ Median	> Median
Low Machs	17	2
High Machs	4	12

Table 4.13: *Low Mach versus high Mach classification and frequency of adjustment of settlement offers and acceptance limits including only subjects who play the game for 45 rounds*[19]

Table 4.13 suggests an association between the "Mach IV" score and the frequency of adjustment. High Machs seem to be more sensitive to bargaining outcomes over the entire course of the game than low Machs.

As a next step, we look if the result that we obtain from Table 4.13 can also be statistically validated. We have 36 subjects who also play the second and third play. For the six independent groups we correlate the "Mach IV" score with the total number of adjustments in the three plays of the experiment. The Spearman Rank correlation coefficients are 0.81 ($p<0.2$), 0.5 ($p<0.5$), 0.83 ($p<0.1$), 0.81 ($p<0.2$), 0.97 ($p<0.02$) and 0.61 ($p<0.5$) for groups 1, ..., 6 respectively where the significance level p is always two-sided.[20] If the correlation between the "Mach IV" score and adjustment behaviour had no predictive power, one would expect positive and negative

[19] Note: We only have 35 subjects here, since one subject completed the questionaire incorrectly. Frequencies of adjustment include both the defendant's and the plaintiff's bargaining position. Any change(s) in the defendant's bargaining position is (are) counted as one adjustment.

[20] Each of the 54 subjects is given a subject number from 1 to 54. One independent group includes six subjects, i.e. subject numbers 1 to 6, 7 to 12,..., 49 to 54. Subjects with the subject numbers 1 to 12, groups 1 and 2, and 43 to 54, groups 5 and 6, play all three plays. Subjects 15, 16, 17, 18, 22 and 42 of group 3 play against each other in the second and third play. Finally, group 4 includes subjects with the subject numbers 26, 27, 29, 32, 34 and 36.

rank correlation coefficients with equal probabilities. The binomial test rejects this null hypothesis at the 0.032 significance level (two-sided). Moreover, two of the six correlation coefficients are significant at the 0.10 level.

The results suggest that low Machs are ex-ante motivated in their bargaining behaviour, while high Machs employ their behavioural norms ex-post to rationalize their choices based on self-interest. High Machs do not want to commit themselves to specific acceptance limits or settlement offers. They look at other subjects' behaviour and then try to optimize their behaviour on the grounds of their observations.

The next question that arises in this context is: Do high Machs win significantly more money than would be expected by chance? To test this question we take inexperienced subjects and rank them on their "Mach IV" score and on their numbers of points after round 15 of the three plays. In the first play we calculate the Spearman-rank-order correlation between machiavellianism and total payoff for 52 subjects. Two subjects are not included, because they filled out the "Mach IV" incompletely or incorrectly. The relation between machiavellianism and total payoff is r_S=-0.098. The obtained r_S is not significant under the null hypothesis that there is no association between machiavellianism and total payoff in the first play at any $p \leq 0.2$ level for a one-tailed test. We use a one-tailed test since we assumed a positive association between machiavellianism and total payoff in the first play. In the second and third play we calculate the Spearman-rank-order correlation between machiavellianism and total payoff for 35 subjects. One subject is excluded because of incorrect completion of the "Mach IV" questionaire. The relationship between machiavellianism and total payoff is r_S=0.121 and r_S=-0.082 for the second and third play respectively. The two Spearman-rank-order correlations are not significant at any $p \leq 0.1$ for a one-tailed test. Although this result comes a little bit as a surprise to us, the experimental environment and set-up might help us to explain why there is no difference between high Machs and low Machs in the monetary payoff in the three plays.

Christie and Geis (1973) - see also Christie (1970) for a review - analysed some 50 laboratory studies and found three parameters that determine whether machiavellianism is salient. High Machs obtain a better score when the following three conditions are met: First, the laboratory interaction is face-to-face with another person. Second, there is room for improvisation. Subjects have the chance to respond freely and are not restricted to pushing buttons or taking tests. Third, the experimental situation permits the arousal of emotions. The experiment has serious consequences as in games where subjects play for money. They found that high Machs were more likely to perform better than low Machs when all three of these conditions were met. However, if they did not win then the conditions were absent. When only one or two conditions were present, high Machs performed better in some experiments, while they performed worse in others. The more conditions are absent, the less often high Machs perform more successfully than low Machs. In our experiment only one condition is met. This reduces high Machs' chance to play better than low Machs drastically. Moreover, the random aspect of our game plays a non-negligible role in the total payoff. Since we cannot expect high Machs to be more successful in lotteries - events such as lotteries do not offer the high Mach the chance of being manipulative or covetous - than others, there is no reason to believe that high Machs should perform significantly better than low Machs.[21]

Our main findings in this section can be summarized as follows: (1) At the beginning most subjects show strong tendency to adjust their values. Machiavellianism does not have much influence on the variance of frequency of adjustment. (2) In the second and third play the tendency of adjustment varies greatly. A correlation between Machiavellianism and frequency of adjustment can be found. (3) For all six groups we observe that subjects adjust their values less often in the repeated plays than in the first play. Subjects who score high on the "Mach IV" also adjust their values less frequently in the second and third play, but still more often than subjects who score low on the "Mach IV" questionaire. (4) None of the three plays shows a significant correlation between final payoff and machiavellianism.

4.2.7 Polarization of Plaintiffs' Acceptance Limits in the Second Play

In this subsection we resume the question of whether plaintiffs perform elimination of weakly dominated strategies. We have shown in our analysis of one-step and

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[21] When inexperienced subjects were paid out after the experiment, they often stated the opinion that the high rate of litigation turned the game into a lottery where the outcome was random and unforeseeable.

iterative elimination of weakly dominated strategies in chapter 2 that the iterative elimination of weakly dominated strategies involves altogether three steps. Since we do not and cannot expect subjects to perform the same elimination process as is required by iterative elimination of weakly dominated strategies, we asked in 4.1.1 and 4.1.2 if plaintiffs eliminate all their weakly dominated strategies at least once. In this case the plaintiff shall choose his acceptance limit above 340 and below 671. Surprisingly, our data analysis has shown that experienced plaintiffs even choose their acceptance limits more often outside the interval from 341 to 670 than inexperienced plaintiffs.

For subjects who repeat the game, we observe a drastic upward movement of acceptance limits that fall outside the "medium" interval at the beginning of the second play. More than 65% of the acceptance limits are weakly dominated. Since Figure 4.5 only includes subjects who play the game for 45 rounds and the subject pool does not change for the 45 rounds, the break cannot be explained by a self-selecting process, i.e., only subjects who tend to choose "extreme" acceptance limits also play the game for a second and third time. We observe in Figure 4.5 that in the first period slightly less than 16% of the acceptance limits fall outside the "medium" interval. Within the 15 periods of the first play the relative frequency of plaintiffs who eliminate their dominated strategies at least once fluctuates greatly, but never exceeds 36%. For this reason, it is interesting to observe an upward jump to more than 65% at the beginning of the second play. The acceptance limits are driven from the "medium" to the "extreme" interval in the second and third play. Although the trend of weakly dominated strategies goes downward within the second play, the trend reverses again in the third play. Figure 4.6 classifies the acceptance limits that fall outside the medium range and shows the percentage of acceptance limits that lie below or above the "medium" interval in periods 1 to 45. Both the relative frequency of acceptance limits that lie below 341 and above 670 rise in the second and third play. Inexperienced subjects who repeat the game choose altogether in three cases (1,1%) an acceptance limit below 341, whereas first-level experienced subjects choose in 57 cases (21%) an acceptance limit of less than 341. In the next chapter we propose a learning rule that might help to explain the polarization effect.

Figure 4.5: *Percentage of acceptance limits that fall outside the "medium" range including only subjects who repeat the game*

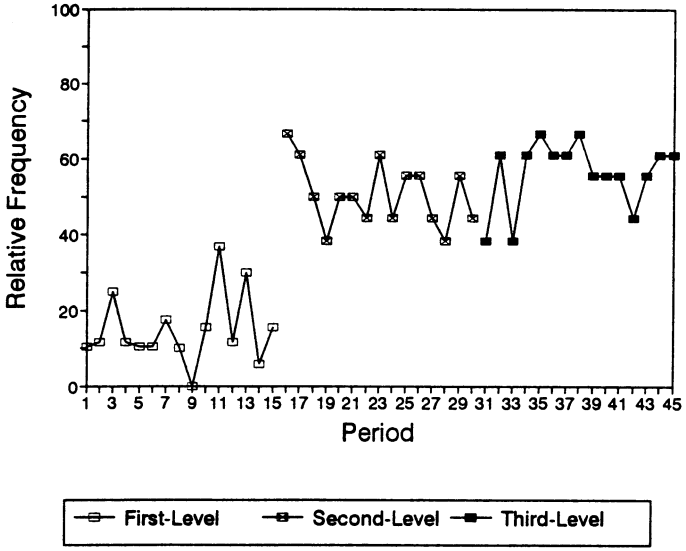
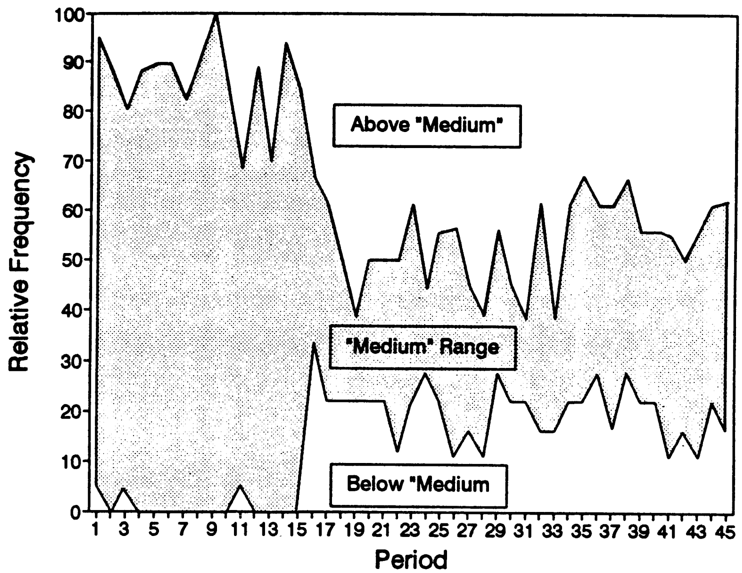


Figure 4.6: *Percentage of acceptance limits below and above the "medium" interval in periods 1 to 15 including only subjects who repeat the game*



5. LEARNING THEORIES

In the last chapter we worked out several behavioural characteristics which can be attributed to a significantly large number of subjects in the game under study. Amongst other results there is the tendency to adjust settlement offers and acceptance limits by 50 Taler if they are adjusted at all the next time subjects are in the same bargaining position. Another important finding is that acceptance limits polarize at the beginning of the second play. In section 5.1 we summarize different approaches to learning in the literature. In section 5.2 we discuss if the direction of adjustment is random or follows some systematic pattern. We propose a learning theory that is based on reinforcement. In section 5.3 we look at deviations from the learning theory. In section 5.4 we propose a learning theory for the polarization effect. Section 5.5 reports the discriminant analysis of the polarization effect and section 5.6, finally, summarizes the behavioural findings of our experimental study.

5.1 Alternative Approaches to Learning

Theories of learning are central theories for explaining human behaviour. Learning can be considered as a change in behaviour based on experience and practice. An individual has experienced a situation repeatedly and has collected experience with this situation and, as a result, reacts differently than he did before the experiment. Learning can therefore be interpreted as a relatively permanent change in behaviour as a result of practice. Hofstätter (1956) defines learning as changes in the probability with which behavioural patterns in certain stimulus situations occur as long as they do not arise due to injury or as a result of spontaneous maturation.

Stimulus-response theories are among the major psychological approaches to the investigation of learning. The basic premise of stimulus-response theories is that learning is the establishment of an association between a stimulus and a response. The two major stimulus-response approaches are classical conditioning and operant conditioning. In classical conditioning, an unconditioned stimulus which, in the absence of learning elicits an unconditioned response, is paired with a neutral stimulus. In time, the previously neutral stimulus becomes conditioned and is able to elicit a conditioned response. Operant conditioning approaches also recognize learning as the establishment of a stimulus-response connection, but operant conditioning requires the learner to assume a more active role. The response that is reinforced is under the control of the learner, whereas classical conditioning reinforces involuntary responses. The response is called an operant, since the learner must operate on the environment in order to obtain the reinforcement (see, e.g., Skinner (1953)). In this context, the concept of the learning curve also comes up frequently. The concept of the learning curve is a fundamental one in learning theory. The learning curve says that the decrease in time it takes to perform a task becomes small as the time of experience with the task increases. However, the speed of learning varies across individuals and animals. In general, learning occurs more quickly if the learner is highly motivated, if the amount of material to learn is small, and if the material is familiar and meaningful (see, e.g., Kolasa (1969)).

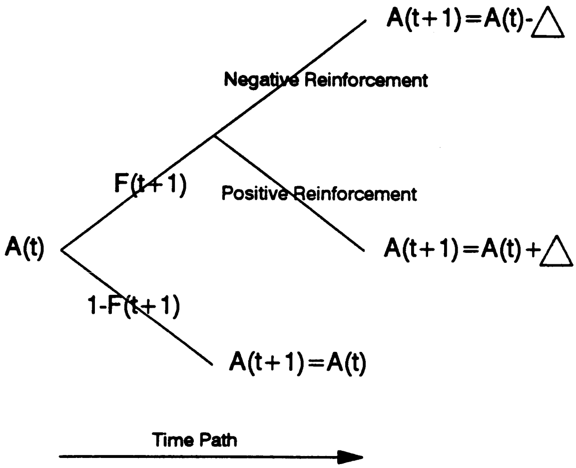
The cognitive approach to learning theory focuses on the structure of existing cognitive patterns and the ways in which that structure adapts to new knowledge and new stimuli (see, for example, Travers (1977) and Estes (1975) for an overview). Other types of learning which we will not further discuss here are, for example, concept learning, discrimination learning and problem solving. Since economists and psychologists know little about the brain processes that bring about a specific type of learning, questions of whether, for example, operant conditioning differs from classical conditioning, or whether concept learning is similar to discrimination learning cannot satisfactorily be answered.

An alternative to the above-mentioned approaches to learning theory is the stochastic learning model. Stochastic models of behaviour have approached learning theory from a probabilistic point of view. These models attempt to quantify the impact of previous learning on current choice behaviour. The stochastic models include a mathematical algorithm through which the changes in the probability of reaction can be determined under the influence of different stimuli. The empirical validity is in general very limited, since it can be only applied to very specific learning processes. The most well-known learning models are by Bush and Mosteller (1950), Estes (1959) and Suppes and Atkinson (1960).

In our learning model that will be used to describe the actual behaviour over time in the experiment we stress the cognitive aspects of decision-making. Subjects are assumed to actively and consciously assess their decisions. With respect to our game subjects consider which other actions could have induced better payoffs in the last period. The new behaviour should be driven into the direction selected by the ex-post thought process. This kind of qualitative learning model breaks with the response-oriented approach in behaviourism. As we have already discussed above, behaviourism is restricted to observing overt responses, the stimuli which arouse them and the observable aspects of the underlying physiological mechanisms, such as nerves, glands and muscles. It is important to note that our qualitative model does not rely on positive and negative reinforcement in order to explain the behaviour in the future. Behaviourists assume that after a negative reinforcement the probability of the choice in the last period is reduced, whereas the probabilities of the other actions are increased and vice versa.

Figure 5.1 shows, as an example, how the acceptance limit A in period t, i.e., A(t), might be changed to the acceptance limit in period t+1, i.e., A(t+1), in a learning model that models the direction of change as the result of an ex post thought process on the basis of the bargaining experience. In our game there are altogether three events that may occur: Out-of-court settlement (event 1), successful litigation (event 2) and unsuccessful litigation (event 3). We can distinguish between three answers: Increase value (answer 1), decrease value (answer 2) and no change of value (answer 3). For example, event 2 might elicit answer 1 in the plaintiff's bargaining position and answer 2 in the defendant's position as a result of the ex post thought process in which the subject gets an idea of whether a higher or lower value of the parameter would have been advantageous in the previous period. F(t+1) denotes the probability that the plaintiff adjusts his acceptance limit in period t+1. Factors such as familiarity with the bargaining context, inertia and also boredom might be the reason of why the subject does not decide to change his value apart from the ex post thought process. 1-F(t+1) is, therefore, the probability that the plaintiff does not change his acceptance limit in the following period. In Figure 5.1 the subject always chooses the same amount of change, i.e., D=50. This assumption is based on the results of the prominence level analysis. Figure 5.1 does not give any further information on whether subjects show a tendency to change their value of parameter conditional on the bargaining experience. The acceptance limit A(t) in period t is some value on the line from 0 to 1000. After the assessment of the bargaining result, we can think of the plaintiff as somebody moving from A(t) along the line. In the ex post thought process the subject reflects on whether an upward or downward movement on the parameter line would have improved his payoff in period t. If the subject has already received his highest possible payoff, he will think about how to choose the value in the future such as to sustain the best outcome. In this case it is possible that some players stick to their value, whereas other subjects decide to choose a higher or lower value. The subsequent section throws light upon this question and will explain how our learning theory links up the possible bargaining experiences to the change of direction.

Figure 5.1: *Adjustment of acceptance limit from period t to period t+1 in a learning model that models the direction of change as a result of an ex post thought process on the basis of the bargaining experience*



(1) Choice of A(t);
(2) Announcement of the bargaining outcome;
(3) Ex post thought process;
(4) Choice of A(t+1) where the subsequent decision tree shows how the plaintiff might choose A(t+1) on the basis of his ex post thought process

F(t+1) := Probability with which plaintiff adjusts his acceptance limit in period t+1; in section 6.3 we discuss how the size of F(t+1) is determined

D := Increment of acceptance limit; following our previous results we always take the same increment of 50

5.2 A Descriptive Theory for the Adjustment Behaviour

In the last section we summarized different learning theories. In this section we want to go on from the last section and specify a learning theory that can reasonably well explain the observed changes in behaviour. The learning theory is called learning direction theory. As the term already suggests this type of learning refers to direction learning. In the following we shall use learning direction theory and direction learning interchangeably. According to direction learning the adjustment of values is a result of an ex post thought process in which players consider which alternative actions could have resulted in a better payoff. In our model of direction learning the plaintiff tends to reduce or not to increase his acceptance limit after he has lost the court trial, whereas the defendant tends to increase or not to reduce her settlement offer. If the defendant wins the court trial or settles the conflict out-of-court, she tends to reduce or not increase her settlement offer; the plaintiff, on the other hand, tends to increase or not to reduce his acceptance limit. Direction learning can explain the directions of change; however, it cannot predict the amounts of change. Since we have found that the amounts of change exhibit a marked regularity in our experiment (see also subsection 4.2.2), we conclude that subjects tend to adjust their values by 50 in all three plays. Learning direction theory has already been applied successfully in other studies as well amongst them Selten and Stoecker (1986), Kuon (1993), Nagel (1993) and Selten and Buchta (1994).

Selten and Stoecker (1986) introduce a model of direction learning for a finitely repeated prisoners' dilemma game. In a series of finitely repeated prisoners' dilemma supergames, players learn to cooperate at the beginning of a supergame and to defect in later rounds near to the end of a supergame. The learning model specifies that the intended period of defection, if it is changed at all is moved towards one period earlier in the next supergame if his opponent defected first or at the same time in the last supergame. If the player himself defected first, the intended defection period is moved to one period later in the case of a change.

Kuon (1993) considers a two-person bargaining game with incomplete information in which the coalition value and the player's own alternative value are known to the subjects, whereas the opponent's alternative value in case of a conflict is unknown. Kuon considers how subjects' bargaining behaviour is related to last period's bargaining outcome. She finds that subjects tend to increase their starting demand if they settled the conflict in the last period and they tend to reduce their starting demand if bargaining was not successful in the last period.

Nagel (1993) considers a four-round interactive competitive guessing game where players have to state simultaneously a number in the closed interval from 0 to 100. The winner is the player whose stated number is closest to the p-fold average of all chosen numbers where p is a fixed parameter and common knowledge. Nagel shows that subjects who stated a number above the p-fold average of all chosen numbers in period t tend to decrease a so called adjustment factor which is the relative deviation of the decision for t+1 from the mean of period t. Subjects who chose a number below the p-fold average tend to increase their factor next time.

Selten and Buchta (1994) consider a sealed bid first price auction repeated for fifty periods. Subjects have to specify in every period a piecewise linear bid function. Subjects change their bid functions where the direction of change depends on last period's outcome. The direction of change exhibits strong regularities which can also be explained by learning direction theory. In the experiments run by Selten and Buchta the learning direction theory explains how bids are adjusted. The bid at last period's value tends to be increased or not to be lowered if the object was not obtained but the price was below the value. On the other hand, if the object was not obtained but the price was below the value, the subject tends to lower or not to increase the bid. Although learning direction theory explains directions of change, it does not attempt to predict the amounts of change.

It is evident that direction learning is not the only behavioural rule that subjects follow in our game, but it serves to be a good predictor of overall behaviour in our experiment. In all three plays we observe deviations from direction learning. In the subsequent section we will discuss how often subjects deviate from our specified model of direction learning. Besides this, we observe that some subjects only adjust their settlement offers and acceptance limits infrequently or do not adjust them at all irrespective of the bargaining outcome. Monetary gains and losses do not seem to have the same impact on these subjects. In the last chapter we have found that subjects who tend to adjust their values less readily significantly more often score below the sample median on the "Mach IV" questionaire. Subjects do not want to change their behaviour ex-post and their arguments on the questionaires show that they act according to principles which they do not like to change. One decision aid that subjects use in the defendant's position are the conditional probabilities of winning a court case. Let us assume that both high and low Machs act according to the same decision principle in the first round. Since the defendant has a 60% chance of winning the trial in the defendant's good bargaining position and a 30% chance of winning in the bad position, subjects, who are categorized as probability-based decision makers, tend to multiply the 1000 Taler by the respective probability of losing the trial. They offer 400 Taler in the defendant's good bargaining position and 700 Taler in the defendant's bad position. After the subjects have been sent information on the bargaining outcome, low and high Machs tend to react differently in their behaviour. The low Mach is not very much influenced by the information on the bargaining outcome, whereas the high Mach uses the information as part of his ex post thought process in order to adjust his behaviour. The low Mach is less influenced by the situational outcome rather than by the bargaining situation as a whole, while high Machs take the bargaining outcome and the monetary payoff which, of course, depends on the bargaining outcome as their main decision aid.

In Table 5.1 we summarize our model of direction learning. Since direction learning does not predict the amount of change, we return to our results of the prominence level analysis. The prominence level is always 50 except for the acceptance limits in the third play. Therefore, if the subject decides to adjust his value in the defendant's or plaintiff's bargaining position, we always choose the amount of change equal to 50. For our table we distinguish between the defendant's and plaintiff's bargaining position. Furthermore, we distinguish between the three events that may occur as a result of bargaining (see also p. 76). If the subject wins the court trial or settles the conflict out-of-court and decides to adjust his acceptance limit the next time he is in the plaintiff's bargaining position again, he tends to raise his claim and asks for 50 more Taler. Note that the sign of the difference between the acceptance limit in period t+s and the acceptance limit in period t is positive in this case. On the other hand, if the plaintiff looses the court case and decides to change his acceptance limit the next time he is in the same position again, he tends to reduce his claim and, as a result, asks for less compensatory payment. In general, subjects tend to ask for 50 Taler less if they change their acceptance limit. By choosing a lower claim the plaintiff could have avoided a court trial. In this case the plaintiff would not have had to pay the litigation costs; in addition, he would have received a non-negative compensatory payment from the defendant. If the defendant of type b or g wins the court trial or settles the conflict out-of-court, she tends to offer 50 Taler less to the plaintiff the next time she is in the same position again. If the defendant settles the conflict out-of-court, direction learning leads her to reduce the settlement offer in the future, since a lower settlement offer would have made a higher payoff possible for the defendant. If the defendant of type b or g looses her trial and decides to change her settlement offer, she tends to offer 50 Taler more to the plaintiff the next time. If the defendant had offered a higher settlement offer, he might have avoided to pay 1000 Taler back to the plaintiff and the extra litigation costs. If subjects adjust both settlement offers, we find that they tend to adjust the settlement offers into the same direction. However, simultaneous adjustments are not further considered, since they will not be modeled in our Monte-Carlo simulations.

	BARGAINING EXPERIENCE		
	Settlement	Subject Wins Trial	Subject Looses Trial
$d_P(v^t)$	+50	+50	-50
$d_{D(b),j}(v^t)$	-50	-50	+50
$d_{D(g),j}(v^t)$	-50	-50	+50

Table 5.1: *Change of plaintiffs' acceptance limits, i.e., $d_P(v^t)$, and defendants' settlement offers, i.e., $d_{D(b),j}(v^t)$ and $d_{D(g),j}(v^t)$ from period t to period t+s depending on the bargaining outcome if a change takes place*[22]

j	:=	Level of experience where j can be equal to 1, 2 or 3
D(b)	:=	Defendant of type b
D(g)	:=	Defendant of type g
P	:=	Plaintiff
$d_{P,j}(v^t)$	:=	$A^{t+s}_j - A^t_j$ where A^t_j is the acceptance limit in period t of play j
$d_{D(i),j}(v^t)$	:=	$S^{t+s}_{i,j} - S^t_{i,j}$ where i can be either equal to b or g

[22] For the explanation of the symbol s see subsection 4.2.1.

5.3 Deviations from Direction Learning

Game theory assumes that subjects are rational and have unlimited computational abilities. There is no need to specify a learning theory of how subjects adjust their values. Experimental evidence looks quite different. Subjects only have limited calculation abilities. A calculation aid, however, is rarely used in the experiments. Hence, subjects' behaviour has to be explained as a result of the course of play and of behavioural characteristics that are relevant to the bargaining context. We have found one learning theory which is called learning direction theory. This learning theory helps us explain how subjects adjust their values within the session. Although this learning theory in general describes the adjustment behaviour well, subjects do not always follow direction learning when they adjust their settlement offers and acceptance limits.

In this section we want to test if the level of experience has any systematic effect on deviations from learning direction theory. If we find that there is a relationship between level of experience and deviations from direction learning, we test if experienced subjects follow direction learning more often than inexperienced subjects. We find that in eight out of nine experiments inexperienced subjects violate learning direction theory in less than 25% of our total observations. Total observations include all non-zero differences of acceptance limits and settlement offers from P_2 to P_n in the first play. In comparison with inexperienced subjects second-level experienced subjects altogether violate learning direction theory in less than 11% of the cases. Again, observations contain all non-zero differences from P_2 to P_n in the plaintiff's and defendant's bargaining position. For each individual who plays the game for 45 rounds we count the number of observations where the difference does not have the same sign as predicted by direction learning theory (see also Table 5.1) for the three different levels of experience, and the subject deviates from direction learning. Observations where the difference is 0 are not interpreted as adjustments and, therefore, not included in the subsequent analysis.

As a first step we apply the Friedman test. Altogether we have six groups who play the game for 45 rounds. For each subject we count the number of deviations and the total number of adjustments for the different levels of experience. Table 5.2 reports the number of deviations of all subjects who repeat the game. We distinguish between inexperienced, first-level experienced and second-level experienced subjects. Since not all subjects repeat the game, the subjects who are put together in one subject group in the second and third play may not necessarily have played against each other in the first play. For example, in subject group 3 subjects 15, 16, 17 and 18 of Table 5.2 are matched together in the first play with two other players who do not participate in the second and third play. In the same manner, subjects 22 and 42 are matched with five other players who only play the game for 15 rounds. In the second and third play, we put subjects 15, 16, 17, 18, 22 and 42 together into one group. The two-sided Friedman test rejects the null hypothesis of no difference in the relative frequency of deviations of subjects with different levels of experience at the 1% significance level. However, the Friedman test does not give us any information on whether the sequence of observations follows a trend. For this reason, we apply the order test as a second step.[23]

The order test is designed to test whether a sequence of observations follows a trend. We apply the test to our data which are measured on three levels of experience. For each level of experience we assign ranks to the relative frequency of deviations that we observe in the six groups. Without loss of generality, we assign rank 3 to the greatest sum of relative frequencies of deviations. If the values follow a perfectly trend, the rank order of the aggregated number of deviations has to be 1 2 3. A measure of the "difference from the perfect order" is the number of inversions. This is the number of pairwise changes that has to be performed in order to transform the given order into a perfectly increasing order. In Table 5.3 we report the ranks of the relative frequency of deviations for the three different levels of experience for each subject group. In addition, the number of inversions that has to be performed in order to transform the actual rank order into the order 1 2 3 is given. The sum of the number of inversions over all subject groups is the test statistic to decide whether a trend is observable. For our experiment the sum is equal to 16. There are six different possibilities to assign three ranks. The null hypothesis is that the order of the observed frequency of deviations is arbitrary for each subject group. This is to say that all six possibilities occur with the same probability. The sixth convolution of the distribution of the

[23] The order test is taken from Bettina Kuon (1993). The test was introduced by Selten (1967). The order test is an alternative to the Page test.

inversions among the six possibilities allows to identify the values which are likely to be expected as sums of the inversion numbers of six subject groups under the null hypothesis, and the values which recommend to reject the hypothesis at a given significance level. Figure 5.1 shows the relative frequency of the sixth convolution of the distributions of the inversions. Our sum of 16 inversions leads to a rejection of the null hypothesis at a significance level of 1% in a one-sided test in favour of the alternative hypothesis of a decreasing order.

Subject	INEXP	FIRST	SECOND	Subject	INEXP	FIRST	SECOND
1	0.15	0.00	0.00	27	0.46	0.08	0.54
2	0.15	0.00	0.00	29	0.31	0.00	0.00
3	0.15	0.08	0.08	32	0.08	0.15	0.00
4	0.43	0.15	0.08	34	0.38	0.00	0.07
5	0.15	0.08	0.08	36	0.31	0.08	0.08
6	0.00	0.15	0.08	42	0.15	0.00	0.00
7	0.15	0.08	0.08	43	0.08	0.00	0.00
8	0.00	0.08	0.00	44	0.15	0.15	0.15
9	0.23	0.00	0.00	45	0.00	0.00	0.00
10	0.31	0.00	0.00	46	0.23	0.00	0.08
11	0.08	0.08	0.00	47	0.08	0.08	0.08
12	0.15	0.00	0.00	48	0.00	0.00	0.00
15	0.08	0.08	0.08	49	0.00	0.00	0.00
16	0.15	0.08	0.08	50	0.08	0.00	0.00
17	0.15	0.00	0.00	51	0.08	0.00	0.00
18	0.23	0.23	0.15	52	0.17	0.15	0.15
22	0.15	0.08	0.08	53	0.00	0.17	0.00
26	0.08	0.08	0.08	54	0.00	0.00	0.00

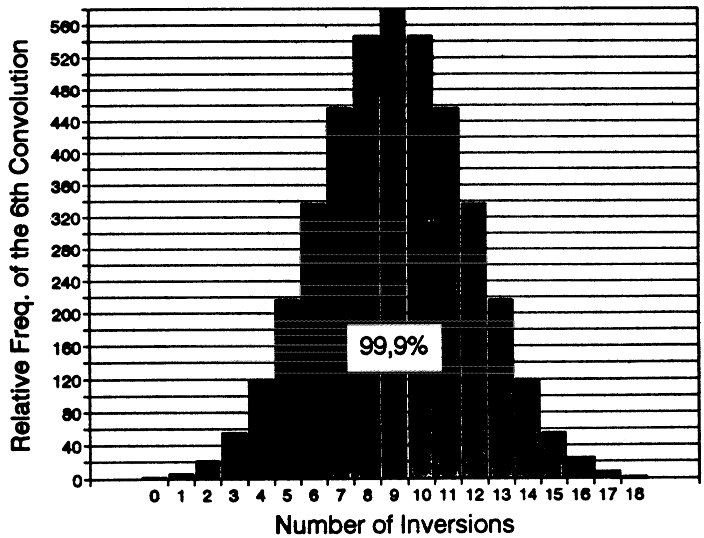
__Table 5.2:__ Relative frequencies of deviations from learning direction theory of inexperienced (INEXP), first-level experienced (FIRST) and second-level experienced (SECOND) subjects[24]

[24] Subject i's relative frequency of deviations from our model of learning direction theory is determined by dividing the number of deviations from direction learning in the plaintiff's and defendant's bargaining position by the total number of positive or negative adjustments.

Subject Group	Rank of the Sum of Mistakes in Level ...			Number of inversions
	1	2	3	
1	3	2	1	3
2	3	2	1	3
3	3	2	1	3
4	3	1	2	2
5	3	1	2	2
6	3	2	1	3

Table 5.3: *Ranks of the frequencies of deviations from direction learning for the three different levels of experience and number of inversions that are needed to transform the actual rank order into a perfectly increasing rank order*

Figure 5.2: *Relative frequency of the sixth convolution of the distribution of the inversions among the 6 possibilities*



5.4 Learning Theory of the Polarization Effect

We have found that experience matters as to how often subjects choose weakly dominated acceptance limits. Elimination of weakly dominated strategies tells subjects not to choose an acceptance limit below 341 and above 670, i.e., $341 \leq A \leq 670$. In the second and third play, however, more observations fall "outside" the medium interval than in the first play. We call this observation polarization of acceptance limits. However, we find that the polarization of acceptance limits is not a result of direction learning according to which success and failure determine the direction into which subjects tend to change their acceptance limits and settlement offers.

Instead, we propose another learning theory for the polarization effect. After inexperienced subjects have played the game for 15 rounds, they evaluate their experience at the beginnning of the second play. Subjects are asked by means of questionaires to what extent their experience in the first play has an effect on their first choice in the initial period of the second play. The vast majority of subjects claims that it is influenced by the bargaining experience in the first play. Since so many bargaining rounds end in court, we investigate the question of whether the ratio of lost trials to the total number of trials in the plaintiff's position can explain subjects' decision. For all subjects who repeat the game we calculate the relative frequency of success if bargaining fails. In a Spearman rank-order correlation test we measure the association between the relative frequency of success in a court trial and the value of the first acceptance limit that subjects choose in the second play. The Spearman rank-order correlation coefficient r_s is equal to 0.592 and is significant at the 0.1% significance level using a one-tailed test.[25] We find that there is a positive relation between a subject's relative frequency of success in a court trial and his initial choice of his acceptance limit in the second play. We conclude that subjects who are successful in litigation tend to choose high acceptance limits as their first choice in the second play and, therefore, make a court procedure more likely, whereas subjects who have

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[25] If we only include subjects who both repeat the game and adjust their acceptance limit at least once within the first play, r_S is even equal to 0.648. However, since we cannot say that subjects who never adjust their accpetnace limit within one play do not still evaluate their bargaining experience after the first play, we take r_S=0.592 as the relevant test statistic.

lost many trials in the first play tend to choose low acceptance limits at the beginning of the second play.

In the first round of the first play subjects have the tendency to take the objective probabilities of winning a court case as a decision aid. The objective probabilities give subjects a guide as to how much they shall offer in the defendant's position or as to how much they shall claim damages at minimum in the plaintiff's position.[26] In the defendant's position the subject is guided by the conditional probabilities of winning a trial in the good and bad bargaining position in the first period of the first play. For this reason, we often observe an offer of 400 or around 400 in the defendant's good bargaining position and an offer of 700 or around 700 in the bad position. The values vary around 400 and 700 depending upon the individual risk aversion and other personality characteristics and differences. Plaintiffs are also guided by their ex-ante probability of winning a court case, which is 47.25%, and, therefore, tend to choose an acceptance limit between 400 and 600.

In the second play the way in which subjects analyse the game changes. Individual bargaining experience seems to matter more than the objective probabilities of winning a court trial. Since the defendant of type g has a higher chance of winning the court case if bargaining fails, learning direction theory moves settlement offers downwards in the defendant's good bargaining position. Defendants of the bad type learn that their settlement offer is, in general, higher than their opponent's acceptance limit. Therefore, subjects tend to reduce their settlement offer according to learning direction theory in the defendant's bad bargaining position. In the second play subjects take this experience into account and start with lower settlement offers from the very beginning. Initial offers of the second play are, in general, smaller than initial offers of the first play. For all subjects who repeat the game, we take the first settlement offer in the defendant's good and bad bargaining position of the first and second play respectively. A one-sided Wilcoxon-test rejects the null hypothesis of no difference between the value of the settlement offer in the first play and the value of the

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[26] Altogether, we have 54 subjects. 15 subjects (28% of the subjects) do not mention the objective probabilities in their comments when being asked how they arrived at their values in the first period of the first play.

settlement offer in the second play at the 0.01% significance level in the defendant's bad bargaining position and at the 0.1% significance level in the good position in favour of the alternative hypothesis that defendants choose lower settlement offers at the beginning of the second play. In addition, we investigate the question of whether the last settlement offers in the defendant's good and bad bargaining position of the first play are significantly different from the first values in the second play. We find that we cannot reject the null hypothesis of no difference in both the defendant's good and bad bargaining position for a two-tailed Wilcoxon test at the 10% significance level. We conclude that the observed settlement offers at the beginning of the second play can be endogeneously explained by learning direction theory.

As far as the plaintiffs' behaviour is concerned, we also find that at the beginning of the second play subjects are not as much influenced by the objective probabilities as at the beginning of the first play. However, if subjects' choice of acceptance limits was only to be explained by learning direction theory, we would expect most acceptance limits to be chosen from the "medium" interval at the start of the second play. The plaintiff has an almost 50% chance of winning the court case. If a subject follows our model of learning direction theory and the vast majority of bargaining rounds end in court, we can expect most acceptance limits to remain in the "medium" interval after the end of the first play. Since this is not the case, there must be an additional learning factor involved in the plaintiff's position which we call the subjective litigation experience. Direction learning is not sufficient to explain plaintiffs' changes in behaviour at the beginning of the second play. We do not claim that litigation in the first play does not enter defendants' decision. However, the litigation experience may not become evident as such, because the two learning theories drive the settlement offers into the same direction.

In the defendant's position subjects have a clearer understanding of what to do. The defendant of type g has an advantage over the plaintiff if bargaining fails. In the defendant's bad bargaining position the plaintiff's chance of winning a court trial is so much higher than the defendant's that the defendant wants to avoid a conflict. The bargaining situation is more difficult in the plaintiff's position. The plaintiff cannot distinguish between the defendant's two bargaining positions. His ex-ante chance of winning is almost the same as the defendant's. The plaintiff has a 47.5% ex-ante probability of winning a court trial, while the defendant has a 52.5% ex-ante chance of winning. Since the plaintiff cannot distinguish between the defendant's two bargaining positions, he tends to choose an acceptance limit that lies below the settlement offer in the defendant's bad bargaining position and above the settlement offer in the defendant's good bargaining position. In the first play 45% of the acceptance limits lie between the settlement offer in the defendant's good and bad bargaining position and 34% of the acceptance limits even lie above the settlement offer in the defendant's bad bargaining position in which case a conflict becomes unavoidable. Subjects learn about this fact. Now, it is the individual litigation experience which seems to matter and determines if the subject wants to avoid a conflict, or if the subject wants to take the risk of litigation. If the subject prefers to avoid a conflict, he chooses a low acceptance limit. Of course, the plaintiffs could choose their acceptance limit as low as 0, but subjects do not want to go down that far and avoid a conflict by all means. Even if the plaintiff wants to avoid a conflict, he makes a minimum demand to the defendant. If the defendant goes below this minimum, the plaintiff prefers to go to court.

In contrast to this, the plaintiff who prefers to take the risk of litigation chooses an acceptance limit that is directed towards the plaintiff's expected gain from litigation in the defendant's bad bargaining position. If the plaintiff wanted to go to court by all means, he could choose his acceptance limit as high as 1000 Taler. However, we never observe this extreme behaviour in the second or third play. Subjects in the plaintiff's position do not want to take the risk of litigation by all means, even the experienced plaintiff who is prone to litigation never chooses an acceptance limit of 1000 Taler. The experienced defendant of type g, on the other hand, goes down with his settlement offer as far as 0 Taler (see, for example, the initial values of subjects for the Monte-Carlo study in Appendix C).

In summary one can say that there are two learning processes in our game. Within a session subjects tend to follow direction learning. In the plaintiff's bargaining position, however, direction learning cannot explain the observed polarization of acceptance limits at the beginning of the second play. We have found that the litigation experience in the first play has a systematic effect on the plaintiff's initial choice of acceptance limit in the second play. Acceptance limits move from the "medium" interval into the upper and lower interval at the beginning of the second play. In the defendant's bargaining position subjects tend to choose their initial settlement offers in the second play lower than in the first play irrespective of the litigation experience.

Even though defendants of type g statistically have a higher chance of winning a trial than plaintiffs have, we observe that some defendants loose more than 40% of the court cases in the good bargaining position. Still, the subjects believe that their chance of winning a court case is superior in the defendant's good bargaining position and, therefore, tend to choose their initial settlement offer in the second play lower than in the first play. The defendant of type b has less litigation experience than the defendant of type g. More than two thirds of the bargaining rounds are settled out-of-court in the first play and, for this reason, the subjective litigation experience plays a minor role in the defendant's bad bargaining position.

Learning direction theory moves the settlement offers downwards in the defendant's bad bargaining position and subjects tend to choose their settlement offers at the beginning of the second play close to the values they have chosen at the end of the first play. Both learning processes seem to fade away towards the end of the second play. Subjects tend to change their values less often and overall learning experience at the end of the second play does not bring any major changes either. Subjects' comments at the end of the second play show that they do not want to change their behaviour greatly in the third play on the basis of their bargaining experience.

5.5 Discriminant Analysis of the Polarization Effect

Discriminant analysis offers another statistical technique to identify explanatory variables that are important for the polarization effect. Due to the polarization effect, we can distinguish among three mutually exclusive groups. Group 1 chooses the initial acceptance limit in the second play below 340. Group 2 chooses the first acceptance limit between 340 and 671, whereas group 3 chooses the first acceptance limit above 671. Discriminant analysis is a statistical technique used to identify the variables that are important for distinguishing among groups and to develop a procedure for predicting group membership for new cases whose group membership is undetermined. The concept of discriminant analysis is based on linear combinations of the independent variables that serve as the basis for classifying into one of the three groups.

It is our goal to identify variables that might be predictors of the polarization effect. We include the following variables as possible explanatory variables: Age, sex, "Mach IV" score, subject's major, statistics knowledge, participation in former experiments, game-theorectic knowledge, subject's tendency to change his behaviour, subject's belief of whether the outcome of their behaviour depends on fortune or rather own action and, finally, the subject's relative frequency of unsuccessful litigation (=PROCESS).

We include some dichotomous variables such as the tendency to change the behaviour among the predictor variables. Although the linear discriminant function requires that the predictor variables have a multivariate normal distribution, Gilbert (1981) shows that the linear discriminant function performs reasonably well even if dichotomous variables are included. We apply the U-statistic which is also called Wilks' lambda and test for the equality of group means for each variable. When variables are considered individually, lambda is the ratio of the within-groups sum of squares to the total sum of squares. Small values of lambda indicate that group means do appear to be different. Wilks' lambda takes in our sample the smallest value for the PROCESS variable. Small values of lambda indicate that group means do appear to be different, while large values indicate that group means do not appear to be different. Also, the F value is highly significant ($p \leq 0.0006$) when using a two-tailed test. For all other variables the F value is not significant ($p > 0.1$).

In Table 5.4 we report the significance tests for the equality of group means for each variable. The F values and their signifcance, shown in columns 3 and 4, are the same as those calculated from a one-way analysis of variance with the magnitude of the initial acceptance limit in the second play as the grouping variable. Both the evaluation of the questionaires and the discriminant analysis have shown that subjects are influenced by their bargaining experience in the first play. We have also found that plaintiffs' choice of acceptance limits in the second play is in particular affected by their litigation experience in the first play.

Variable	Wilks' Lambda	F-value	Significance
PROCESS	**0.60989**	9.59	**0.001** (*)
GAME	0.90278	1.62	0.216
PART	0.91630	1.37	0.270
STATS	0.98631	0.21	0.813
BEH	0.94904	0.81	0.456
SUC	0.98233	0.27	0.765
MACH	0.97400	0.40	0.674
AGE	0.93557	1.03	0.368
MAJOR	0.99050	0.14	0.867
SEX	0.95900	0.64	0.534

Table 5.4: *Significance tests of the equality of group means for the variables age, sex, Machiavelli-score (=MACH), subject's major (=MAJOR), statistics knowledge (=STATS), participation in former experiments (=PART), game-theorectic knowledge (=GAME), subject's tendency to change his behaviour (=BEH), subject's belief of whether the outcome of behaviour depends on fortune or rather own action (=SUC) and the subject's relative frequency of unsuccessful litigation (=PROCESS)*

(*) : The two sided F-statistic rejects the null hypothesis of the equality of group means at the 5% significance level

5.6 Summary of Experimental Findings

In this section we summarize the main results of our experiment. In our Monte-Carlo study we include our model of learning direction theory, the theory of prominent numbers and, finally, the inertia effect. The inertia effect becomes particularly evident in the second and third play. All other results are not included, since we want to avoid ad-hoc assumptions and keep our simulation model as simple as possible.

1st: The observed behaviour does not conform to the theoretical predictions. Subjects do not play pure strategy Bayesian Nash equilibria. Other solution concepts such as elimination of weakly dominated strategies or iterative elimination of weakly dominated strategies cannot describe the observed behaviour either.

2nd: Subjects tend to follow a learning theory that is based on direction learning. According to our model of direction learning, the defendant reduces or does not increase her settlement offer(s) if she is successful; she increases or does not reduce her settlement offer(s) if she is unsuccessful. The plaintiff, on the other hand, increases or does not decrease his acceptance limit if he is successful; he reduces or does not increase his acceptance limit if he looses the trial.

3rd: Plaintiffs tend to evaluate their personal litigation experience. We find that there is a correlation between the relative frequency of successful litigation and plaintffs' first choice of acceptance limit in the second play. Successful plaintiffs tend to choose an initial acceptance limit that lies above the "medium" interval, whereas unsuccessful plaintiffs tend to choose their first acceptance limit below the "medium" interval. This correlation results in the polarization effect.

4th: Subjects tend to adjust their settlement offers and acceptance limits by 50 Taler. This finding is consistent with our prominence level analysis. We have found evidence that 50 is a critical level that separates "round" numbers from other numbers in the eyes of the subjects.

5th: Inexperienced subjects adjust both settlement offers in almost 20% of the cases in which at least one is adjusted. We find that subjects tend to change their two settlement offers into the same direction if they adjust both settlement offers simultaneously.

6th: First-period values of inexperienced subjects can be classified according to random guessing, qualitative reasoning, probability-based or interactive reasoning.

7th: Subjects who frequently change their settlement offers and/or acceptance limits score high on the 'Mach IV' (high Machs), whereas subjects who rarely or never change their values score low on the 'Mach IV' (low Machs).

8th: Subjects tend to adjust their values less often when they are experienced. The tendency to adjust the values less frequently becomes particularly apparent in the second play and stabilizes in the third play.

9th: Subjects tend to deviate from learning direction theory relatively less often when they are experienced.

6. MONTE-CARLO SIMULATIONS AND TESTING OF LEARNING DIRECTION THEORY AGAINST A SIMPLE ALTERNATIVE THEORY

Generally speaking, experiments provide reproducible knowledge about the real world. In the analysis of experimental data our approach involves model building. Model building, in turn, involves the matching of theory and empirical observations. Monte-Carlo studies provide a means to study the random aspects in the matching of theory and experiments. Our goal is to test to what extent our simulation model based on direction learning and the theory of prominent numbers can describe and also predict the observed behaviour in the experiment. Data that we obtain from the simulations are compared with the actually observed data. With this aim in view we exclude some of the observed data from being used in the parameter estimation of the simulation model using them instead for a quasi-predictive test. This practice certainly has some disadvantages. Data are usually so scarce in economics that it is desirable to include all relevant observations for parameter estimation of the simulation model. And as a touchstone in predictive testing, neglected data is not as good as fresh observations. However, experiments are expensive and time-consuning and do not allow an arbitrary supply of new data.

In section 6.1 we describe the Monte-Carlo approach to the two theories to be tested against each other. Section 6.2 summarizes how the behavioural assumptions and the experimental design can be modeled in the Monte-Carlo simulations. Section 6.3 describes the estimation of the adjustment curves. In section 6.4 we discuss the relative frequencies of deviations from direction learning, and in section 6.5 we report by what size subjects' values are adjusted. Finally, section 6.6 describes the tests to be used for the comparison of the two theories.

6.1 Monte-Carlo Approach to our Models of Learning Direction Theory and the Simple Alternative Theory

In this chapter our model of direction learning which we used to describe the actual behaviour over time in the experiment will be tested against a simple alternative theory. The simple alternative theory assumes that no learning takes place in the periods to be simulated by our simulation model of direction learning. Instead, the alternative theory assumes that subjects choose their values with probabilities equal to past observed relative frequencies. Direction learning, on the other hand, assumes that players consider which other actions could have induced better payoffs in the last period of the game. In the next period when the player faces the same decision task new behaviour should be driven into the direction as suggested by the ex-post thought process. The learning direction theory is not a full-fledged learning theory yet, since it does not predict the amounts of change. Therefore, we will incorporate both learning direction theory and the results of the prominence level analysis into our simulation model. We have found that subjects tend to choose "round" numbers in the experiment. By means of the prominence level we determine the level of change.

For the Monte-Carlo simulations of direction learning we take part of our observations in order to estimate the decision parameters of the simulation model that predicts the values of the remaining data that have not been used for estimation of the decision parameters. We run Monte-Carlo simulations for all three plays individually. We only compare the observed values in the final period of the three plays with the values that we obtain from the simulations. In each run of the Monte-Carlo simulations half of the subjects are assigned to the plaintiff's bargaining position, whereas the other half is assigned to the defendant's position in the same way as subjects are matched in the experiments. Subjects repeatedly change their bargaining position. Therefore, we need for each subject a starting value in the plaintiff's bargaining postion and two starting values in the defendant's position. For all three plays the Monte-Carlo simulations start in period 11. We use subjects' values that are observed in period 11 as starting values in the corresponding bargaining position of our simulations. The starting value(s) of the other position is (are) observed after period 11. For convenience of notation, let us now denote the bargaining position in period 11 by Q. Q can be either P or D where P stands for the plaintiff's position and D for the defendant's postion. Let Q' denote the other bargaining position. For example, subject I is in the plaintiff's bargaining position in periods 11 and 12 and assigned to the defendant's position in period 13. Q stands for the plaintiff's position in period 11, and Q' denotes the defendant's position in period 13.

Our alternative theory assumes that subjects choose their values randomly from a set of data that contains all observations from period 1 to 11 and, in addition, the starting values of bargaining position Q'. All observations that are included in the simulation model of direction learning for estimation of the decision parameter are also included in the data set of the alternative theory from which the observations are drawn with equal probability. In this way, we ensure that the simulation model of direction learning does not include any additional information that is not contained in the data set of the alternative theory. We want to make sure that the simulation model of direction learning is not given any advantage over the alternative model a priori.

The data set contains 324 observations in the plaintiff's bargaining position and 2x324 observations in the defendant's bargaining position in the first play. The 324 observations consist of 297 observations from period 1 to 11 and, in addition, 27 starting values between periods 11 and 14. In the second and third play we have altogether 216 observations in the plaintiff's bargaining position and 2x216 observations in the defendant's position. The observations are put in sequential order. We draw a random number between 1 and 324 in the first part and between 1 and 216 in the second and third part of the simulations. We record the acceptance limit or settlement offer that is represented by the drawn random number. Next, we put the drawn number back into the data set and repeat the selection until we have drawn 27 acceptance limits in the plaintiff's bargaining position and 2x27 settlement offers in the defendant's bargaining position for the final period of the first play. In the second and third play we randomly draw 18 acceptance limits in the plaintiff's bargaining position and 2x18 settlement offers in the defendant's bargaining position. For both models we repeat the simulations for 1,000, 5,000 and 10,000 times. The drawn acceptance limits and settlement offers will be compared with the actual observations of the final period of the respective play. The tests that are used for the assessment of the two competing theories will be explained in section 6.6. In the next section we describe the details of the simulation model of direction learning.

6.2 Modeling of Direction Learning and the Experimental Design

A comparison of the results of the Monte-Carlo simulations of direction learning with the observations of the experiment must be based on the same experimental procedure and design. In the experiment we have 54 inexperienced subjects who play the game for 15 periods. 36 subjects participate in the second and third play. They play 30 periods with a short break after the second play. We arrange the Monte-Carlo simulations into three parts. The first part models inexperienced subjects, the second part first-level experienced subjects and, finally, the third part second-level experienced subjects. In the first part we have 27 bargaining pairs. In the second and third part we have 18 bargaining pairs in each round. Inexperienced subjects are divided into nine groups of six players. Experienced subjects are divided into six groups of six players. Subjects in the simulation model of direction learning are assigned to the bargaining position in the same order and are matched in the same manner as in the experiment (see Appendix C for matching table).

In each bargaining round the defendant's settlement offer in the good or bad bargaining position - this depends on which bargaining position has been drawn - is compared with the plaintiff's acceptance limit. Now, two cases can be distinguished: (1) The defendant's settlement offer is greater than or equal to the plaintiff's acceptance limit and bargaining is successful, or (2) the defendant's settlement offer is smaller than the acceptance limit. Case (2) can be further classified into (a) the subject wins the trial, and (b) the subject loses the trial. After the outcome of the bargaining round has evolved, a random number is drawn for both the defendant and the plaintiff. The random number is compared with the adjustment parameter that we obtain from the adjustment curve. The adjustment curve is a function of time and accounts for subjects' adjustment behaviour in each bargaining round.

We estimate adjustment curves on the basis of our observations from period 1 to 10 of the first, second and third play of our experiment by means of a statistical package called SPSS. We can distinguish between two cases: (1) The random number is greater than the adjustment parameter, or (2) the random number is less than or equal to the adjustment parameter. In case (1) we do not change the subject's value in the simulation. The subject is assigned the same acceptance limit in the plaintiff's bargaining position or the same two settlement offers in the defendant's position the next time the subject enters the bargaining position again. In case (2) the value is adjusted by 50 in the Monte-Carlo simulations.

We choose an adjustment of 50, since our prominence level analysis has shown that subjects tend to distinguish between numbers that are divisible by 50 and other numbers. Now it depends on the bargaining position and the outcome of the bargaining in which direction the subject adjusts his value. In the Monte-Carlo study the defendant only adjusts his settlement terms in the bargaining position that nature has actually drawn. Settlement terms are never adjusted in the defendant's good and bad bargaining position simultaneously. In Table 6.1 we present the direction and increments of acceptance limits and settlement offers if the adjustment curve of the simulation model is such that the value is adjusted.

	Defendant's Bargaining Position		Plaintiff's Bargaining Position	
	Defendant Wins	Defendant Loses	Plaintiff Wins	Plaintiff Loses
Increment	- 50	+ 50	+ 50	- 50

Table 6.1: *Overview of the direction and increment of values for both the defendant of type i where i can be equal to b(=bad) or g(=good) and the plaintiff in the Monte-Carlo study*

In our Monte-Carlo study we use the observations of rounds 1 to 11 in the first, second and third play of our experiments in order to estimate the probability of adjustment for the rounds to be simulated. We always start the simulations in period 11. In each of the three parts we take for all subjects the first acceptance limit or settlement offers that we observe from period 11 onwards as starting values. We predict the distribution of acceptance limits and settlement offers on the basis of our observations of previous rounds for the periods 12 to 15. Period 15, however, will be of most interest to us, because in this period no outside information such as starting values are used.

All results in this period are solely based on our parameter estimation of probability of adjustment, the theory of prominent numbers and, most importantly, direction learning. Before we report the results of the estimation of the adjustment curves and the relative frequencies of deviations from direction learning, we summarize the simulation model of direction learning that will be used in the Monte-Carlo simulations.

One run in the simulations consists of 27 matchings in the first play and 18 matchings in the second and third play respectively. The procedural set-up of the simulations is kept identical to the experiments. The same matching and probabilities of winning a court case in the plaintiff's or defendant's bargaining position are used as in the experiments. The simulations start in period 11 of the respective play. The starting values are taken from our observations in round 11 and rounds 12 to 14. For each matching a random number which determines the defendant's bargaining position is drawn. If the random number is less than or equal to 75, the plaintiff plays against a defendant of type g. If the random number is greater than 75, the plaintiff play against a defendant of type b. In the numbering A and B refer to the defendant's good and bad bargaining position respectively; 1 and 2 to court decision and out-of-court settlement respectively and, finally, i and ii to the event that the plaintiff and the defendant respectively wins the trial. Altogether six cases can be distinguished with the following characteristics in the simulations:

A.1.i: Defendant's good bargaining position, $S_g<A$, plaintiff wins the trial.

A.1.ii: Defendant's good bargaining position, $S_g<A$, defendant of type g wins the trial.

A.2: Defendant's good bargaining position, $S_g\geq A$, subjects settle the conflict out-of-court.

B.1.i: Defendant's bad bargaining position, $S_b<A$, plaintiff wins the trial.

B.1.ii: Defendant's bad bargaining position, $S_b<A$, defendant wins the trial.

B.2: Defendant's bad bargaining position, $S_b\geq A$, subjects settle the conflict out-of-court.

In Table 6.2 we summarize the six cases and report by how much the settlement offer of the defendant of type i and the acceptance limit are adjusted.

Bargaining Position	Cases	Adjustment from Period to to Period t+s
Defendant of Type g	A.1.i	$S_g(t+s)=S_g(t)+50$
	A.1.ii, A.2	$S_g(t+s)=S_g(t)-50$
Defendant of Type b	B.1.i	$S_b(t+s)=S_b(t)+50$
	B.1.ii, B.2	$S_b(t+s)=S_b(t)-50$
Plaintiff	A.1.i, A.2, B.1.i, B.2	$A(t+s)=A(t)+50$
	A.1.ii, B.1.ii	$A(t+s)=A(t)-50$

Table 6.2: *Overview of the adjustment of settlement offers and acceptance limits from period t to period t+s for the six cases that can occur in our Monte-Carlo simulations*

A	:= Defendant's good bargaining position
B	:= Defendant's bad bargaining position
1	:= Conflict
2	:= Out-of-court settlement
i	:= Plaintiff wins court case
ii	:= Defendant wins court case
$S_i(t)$	:= Settlement offer of defendant of type i in period t
A(t)	:= Acceptance limit in period
s	:= For the explanation of the symbol s see subsection 4.2.1

In Table 6.3 (see p. 120) we give an overview of the different procedural steps of our simulation model of direction learning. First, the defendant's bargaining position is determined in period t. As a next step, we look if bargaining is successful or whether subjects cannot settle the conflict out-of-court. If subjects do not settle the conflict out-of-court, we have to determine the winner of the court case before we decide if subjects adjust their values or not. As a final step, we adjust the values by the respective increment of 0, -50 or +50.

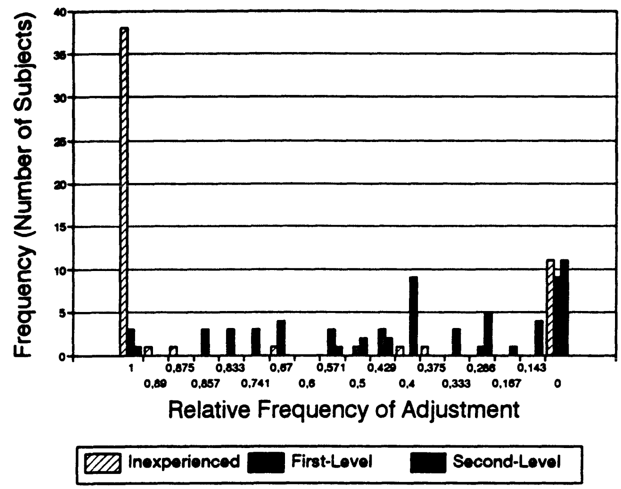
In the next section we estimate the adjustment curves that are used in the Monte-Carlo simulations. The adjustment curves are estimated on the basis of the observed relative frequencies of adjustment. Next, we report the relative frequency with which subjects on different levels of experience deviate from direction learning. Finally, we report the relative frequencies with which subjects adjust their values by 50, more than 50 or less than 50 in periods 1 to 11. Although we do not take the deviations from direction learning into consideration, we give the reader a flavour of the relative frequency of violations of direction learning in order to assess the results more appropriately.

6.3 Estimation of the Adjustment Curves of Inexperienced and Experienced Subjects

In attempting to construct a direction learning model that is sensitive to changes in the adjustment behaviour and test such a model, we need to estimate a parameter that accounts for the adjustment behaviour. We find that inexperienced subjects frequently adjust their values. Despite the fact that there are some subjects who never adjust their values in the plaintiff's or defendant's position, we do not distinguish between subjects who never change their values and subjects who adjust their values at least once in the respective bargaining position. We find that the relative frequency of adjustment of inexperienced subjects remains high throughout the entire first play. The adjustment curve is a function of time and gives us the probability with which the value of the respective bargaining position will be adjusted in period t in the Monte-Carlo simulation after the outcome of the bargaining has evolved. Procedure Curvefit in SPSS is used and selected curves are fitted to our time series. We can choose apart from the linear model among the logarithmic, inverse, quadratic, cubic, compound, power, S, growth, exponential and logistic model. As selection criterion we use the root mean square error in period 11 after we have fitted the different curves on the basis of our observations from period 1 to 10.

In the same manner, the adjustment curves are estimated for the second and third part of the Monte-Carlo simulations on the basis of our observations from period 1 to 10. We always use the CURVEFIT command in SPSS in order to estimate the adjustment curves. In Figures 6.1 and 6.2 we can see how the relative frequencies of adjustment in the defendant's and plaintiff's bargaining position respectively change for the different levels of experience. Table 6.4 reports the adjustment curves that are used in the simulation model of direction learning for the different levels of experience and bargaining positions.[1] Table 6.5 lists the data that we need in order to estimate the adjustment curves by means of SPSS.

Figure 6.1: *Relative frequencies of adjustment of inexperienced, first-level experienced and second-level experienced subjects in the defendant's position*[2]



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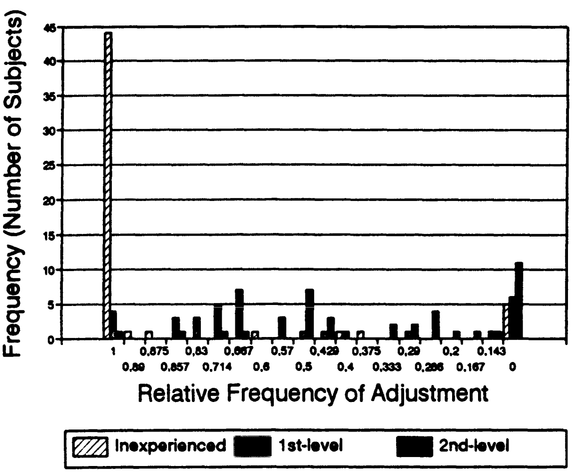
1 Once we have found a curve that fits our observations, we can use it for forecast. With CURVEFIT there are no assumptions on the theory behind the forecast. A way of comparing different models is to use the FIT command which compares error or residual scores from the different models. A good statistic on which to compare the different models is RMS, the root mean square error. We can think of the RMS as the standard deviation of the error variable corrected for the number of coefficients in the model from which the error series was created. We look how well the different models describe the adjustment behaviour. We choose the model with the smallest RMS in period 11.

2 We do not distinguish between the two types of defendant.

Figure 6.2: *Relative frequencies of adjustment of inexperienced, first-level experienced and second-level experienced subjects in the plaintiff's position*



PLAINTIFF'S ADJUSTMENT CURVES

Experience Level	Model[3]	R^2	p	Max RMS	RMS[4]
First	$F(t_1) = 85.32 + 8.55/t_1$	0.258	0.134	11.50	4.65
Second	$F(t_2) = 71.56 + 3.97t_2^2 - 0.74t_2^3$	0.671	0.004	28.41	8.90
Third	$\ln F(t_3) = 3.08 + 0.23/t_3$	0.037	0.440	6.66	0.11

[3] We only choose among those models which give us a $F(t_j)$ in the range between 0 and 100 for t=11 to t=15 where t stands for the period of the respective play. $F(t_j)$ denotes the probability with which the subject will adjust his value the next time.

[4] The root mean square error (RMS) reported here refers to period 11 of the respective play. We use the observations from period 1 to 10 of the first, second and third play in order to estimate the model. We compare the performance of the different models during the validation period on the RMS. We take the model with the lowest RMS in the PREDICT period.

DEFENDANT'S ADJUSTMENT CURVES

Experience Level	Model	R^2	p	Max RMS	RMS
First	$\ln F(t_1) = 4.37 - 0.04/t_1$	0.051	0.531	15.98	8.72
Second	$\ln F(t_2) = 4.70 - 0.14t_2$	0.640	0.005	25.37	8.10
Third	$F(t_3) = 17.76 + 11.48/t_3$	0.218	0.174	9.43	3.35

Table 6.4: *Estimation of adjustment curves in the defendant's and plaintiff's bargaining position for the Monte-Carlo study*

R^2 := Measure of the goodness of fit where R^2=1-(Residual Sum of Squares/Total Sum of Squares)

F := Test statistic that serves to test how well the regression model fits the data where F=(Mean Square Regression/Mean Square Residual)

$F(t_j)$:= Estimated adjustment curve for level j of experience

RMS := Root mean square error

Max RMS:= Maximum observed RMS of the 11 available functions

Round	$d(v^t_{P,j})\neq 0$	$d(v^t_{P,j})=0$	$d^*(v^t_{P,j})=0$	$d(v^t_{D,j})\neq 0$	$d(v^t_{D,j})=0$	$d^*(v^t_{D,j})=0$
1	25	0	2	20	2	5
2	25	1	1	22	2	3
3	24	0	3	22	1	4
4	22	1	4	21	0	6
5	23	1	3	21	3	3
6	25	0	2	19	3	5
7	25	1	1	21	3	3
8	23	1	3	22	1	4
9	22	1	4	21	0	6
10	23	1	3	22	1	4
11	25	0	2	18	3	5
12	25	1	1	19	3	5
13	17	1	3	14	0	1
14	9	1	2	6	0	0
16	13	1	4	13	0	5
17	14	1	3	13	0	5
18	15	1	2	12	1	5
19	12	0	6	12	1	5
20	15	0	3	13	0	5
21	10	3	5	14	0	4
22	14	1	3	7	6	5
23	8	4	6	9	4	5
24	9	7	2	3	9	6
25	7	5	6	4	9	5
26	4	10	4	6	8	4
27	3	9	6	1	12	5
28	3	12	3	2	11	5
29	3	11	4	0	13	5
30	3	13	2	0	12	6

Table 6.5: *Overview of the number of subjects who (a) adjust their value(s) from t-s to t ($d(v^t_{i,j})\neq 0$), (b) do not adjust their value(s) from t-s to t ($d(v^t_{i,j})=0$) and (c) never adjust their value(s) ($d^*(v^t_{i,j})=0$) for each bargaining position from period 1 to 44*

Round	$d(v^t_{P,j})\neq 0$	$d(v^t_{P,j})=0$	$d^*(v^t_{P,j})=0$	$d(v^t_{D,j})\neq 0$	$d(v^t_{D,j})=0$	$d^*(v^t_{D,j})=0$
31	6	6	6	5	6	7
32	3	7	8	5	9	4
33	6	6	6	4	7	7
34	2	8	8	4	8	6
35	4	8	6	4	6	8
36	4	5	9	1	11	6
37	5	7	6	3	7	8
38	5	5	8	3	9	6
39	5	8	5	5	7	6
40	4	6	8	4	8	6
41	4	5	9	4	8	6
42	3	7	8	2	5	5
43	4	5	3	0	10	8
44	1	3	0	1	3	2

Table 6.5, cont.: *Overview of the number of subjects who (a) adjust their value(s) from t-s to t ($d(v^t_{i,j})\neq 0$), (b) do not adjust their value(s) from t-s to t ($d(v^t_{i,j})=0$) and (c) never adjust their value(s) ($d^*(v^t_{i,j})=0$) for each bargaining position from period 1 to 44*

Note that case (c) may occur if a subject decides not to change his value(s) at all in the plaintiff's and/or defendant's bargaining position. Other subjects adjust their values (see case (a)), but sometimes decide not to adjust their value(s) (see case (b)).

6.4 Relative Frequencies of Deviations from Direction Learning

Our model of direction learning is based on success and failure. If the subject is successful, the ex-post thought process leads the subject to raise his claim on the payment. For the plaintiff this means that he tries to get more money back from the defendant; the defendant, on the other hand, offers less to the plaintiff as compensation payment. If the subject is unsuccessful, he tends to lower his sights as a result of his thought process. The plaintiff reduces his acceptance limit and the defendant offers more to the plaintiff in order to avoid litigation.

In Figure 6.3 we graph the frequency of deviations from direction learning over time. The linear regression analysis validates that within the play there is not any significant trend, but over all three plays there is a significantly negative trend in the frequency of deviations from the learning direction theory.[5] In Table 6.6 we report the relative frequencies of deviations from learning direction theory. We distinguish between the plaintiff's and defendant's bargaining position and, in addition, between the different levels of experience.

Our regression analysis has already shown that the relative frequencies of deviations reduce in the second and third play. This is partly due to the fact that subjects tend to adjust their values less often when they are experienced and, as a result, less often have the possibility to violate direction learning. Still, experienced subjects follow the learning direction theory more often than inexperienced do. In the third play, for example, the plaintiffs deviate altogether in 11 cases. The 36 subjects change in 73 cases their acceptance limit after the announcement of the bargaining outcome, i.e., $d(x^t_{i,j})\neq 0$.. This gives us a relative frequency of deviations of 15.1% in the plaintiff's bargaining position. In the defendant's position, respectively, subjects violate the adjustment rule in 7.1% of the cases. Table 6.6 reports both the "corrected" and "uncorrected" relative frequencies of deviations. The "uncorrected" relative frequencies include all observations, i.e., $d(x^t_{i,j})\neq 0$ and $d(x^t_{i,j})=0$. Altogether the subjects of one group may change in 39 cases their acceptance limit and settlement offers respectively. Therefore, the total number of observations amounts to 351 in the first play, i.e., nine times 39 observations, and 234 in the second and third play, i.e., six times 39 observations. The "corrected" frequencies contain only those observations where $d(x^t_{i,j})\neq 0$.

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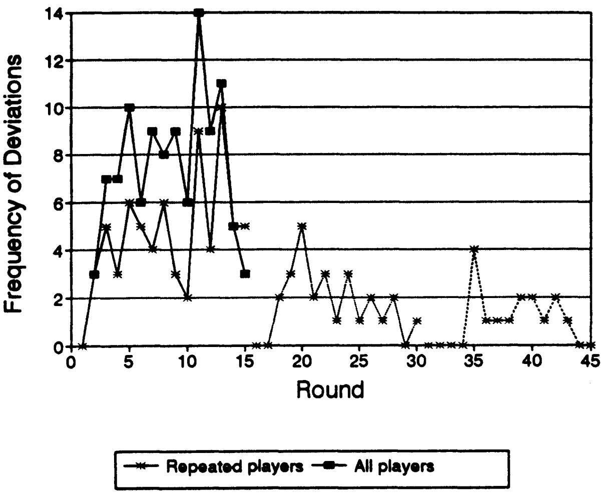
[5] It is not our goal to use the regression analysis as a predictive tool. We are not concerned about the model that best fits our data. Therefore, the linear regression model is a means of testing how the frequency of deviations develops over time. For the regression analyis we omit the first observation of the three plays. The time coefficient is significant at $p\leq 0.0001$ significance level if we consider all three plays jointly. However, the regression line is never significant, if we consider the fequency of deviations within one play. In the first play the time coefficient t is positive, i.e., $t=0.189$. The significance level is $p\leq 0.219$. In the second (third) play we get $t=-0.11$ ($t=-0.002$) and $p\leq 0.234$ (0.978).

In summary we can conclude that although subjects in general follow direction learning if they adjust their values, we find that there are deviations from our learning theory. However, several reasons can be put forward not to take the deviations into account in our Monte-Carlo simulations. First, we do not have any solid theory that explains how the frequency of deviations from learning direction theory arises and is affected over time. If we wanted to include the deviations from the learning direction theory into the simulations, we would have to rely on our observations in the experiments. However, parameter estimation of the deviations solely on the basis of our observations without any theorectical foundation would be ad hoc and could easily be attacked. Moreover, the regression analysis has shown that within one play the frequency of deviations does not change significantly. Finally, we want to be as parsimonious as possible in our model building.

Figure 6.3: *Frequency of deviations from direction learning including (1) all subjects who play the game and (2) only subjects who participate in all three plays of the experiment*



Experience Level	"Uncorrected"		"Corrected"	
	P	D	P	D
Inexperienced	0.18	0.11	0.23	0.14
First-Level	0.08	0.03	0.14	0.06
Second-Level	0.05	0.02	0.15	0.07

Table 6.6: *"Uncorrected" relative frequencies of deviations from direction learning including all observations - also the observations where subjects do not adjust their values - and "corrected" relative frequencies of deviations from direction learning including only observations where $d_f(x^t_i) \neq 0$ in the plaintiff's and defendant's bargaining position for the different levels of experience*[6]

6.5 Increments of Settlement Offers and Acceptance Limits

Another variable in our bargaining game is the increment of values. In constructing our simulation model the question by how much subjects adjust their values naturally arises. We have already found that subjects tend to choose "round" numbers. The prominence level is always 50 except for the acceptance limits in the third play. In this section we determine the relative frequencies of subjects choosing an increment of 50, of less than 50, or more than 50. In Table 6.7 we report the relative frequencies of increments in the plaintiff's and defendant's bargaining position for the different levels of experience. We only include observations from period 1 to 11. In the defendant's position, we distinguish, in addition, between the defendant's good and bad bargaining position. We do not take the direction of adjustment into account when we

[6] For the "uncorrected" relative frequencies reported here we have a total of 351 possible adjustments in the first play and 234 possible adjustments in the second and third play. All observations where the subject does not adjust his value are not counted as deviations from direction learning. Since the frequency of adjustments decreases strongly in the second and third play, the "corrected" relative frequencies of deviations from direction learning are also reported. The "corrected" relative frequencies exclude all observations where subjects do **not** adjust their values the next time they are in the same bargaining position.

report on the increments. For each adjustment we are only interested in the absolute value of adjustment in this section.

The results in Table 6.7 correspond to the results in 4.2.2 where we have already found that over all 15 periods most values are adjusted by 50. Our results here show as well that subjects most often adjust their values by 50 in periods 1 to 11. We do not observe any significant differences within one play. For this reason, it seems legitimate to choose 50 as our increment in the Monte-Carlo simulations. Any observed deviations from choosing an increment of 50 in the plaintiff's or defendant's bargaining position are not taken into consideration. If we wanted to take the deviations into account, we would have to choose the observed relative frequencies of deviations.

However, as in the case of deviations from our learning theroy, we do not have any sound theory that explains how deviations from an increment of 50 arise. Although it is likely that the predictions of our Monte-Carlo model would be better if the deviations were taken into consideration, learning direction theory would be given an a priori advantage over the alternative theory. Any superiority of direction learning over the alternative theory would have to be considered with caution. Before we introduce the tests that we will use for the comparison of the two theories let us summarize the assumptions of our simulation model of direction learning.

Our discussion in this chapter so far has given an answer to three main questions that arise in the context of model building in our experiment. The first question is: In which direction do subjects adjust their values after they have been sent the bargaining outcome? The second question that follows directly is: By what amount do subjects adjust their values if they decide to change their values? Since subjects do not always adjust their values the question arises: How often do subjects adjust their values in the respective bargaining position? Our simulation model of direction learning is kept as simple as possible and does not make the attempt to predict any deviations from the theory of prominence level and direction learning.

Level of Experience	Increment	Plaintiff	Defendant	
			A	B
Inexperienced	<50	0.13	0.13	0.11
	=50	0.57	0.66	0.76
	>50	0.30	0.21	0.13
First-Level	<50	0.14	0.18	0.10
	=50	0.66	0.61	0.85
	>50	0.20	0.21	0.05
Second-Level	<50	0.12	0.03	0.06
	=50	0.58	0.70	0.50
	>50	0.30	0.27	0.44

__Table 6.7:__ Relative frequencies of the absolute increments of adjustments in the plaintiff's bargaining position, the defendant's good bargaining position (A) and the defendant's bad bargaining position (B) for the different levels of experience including periods 1 to 11 of the respective play

6.6. Tests for the Comparison of the Two Alternative Theories

It is our goal to test the learning direction theory against the alternative theory. We approach this goal in two ways. In one approach 1,000, 5,000 and 10,000 simulations are run. In our model of direction learning the simulation starts in period 11 and runs through period 15. For the tests we only consider the values of period 15 of the three plays. The other data are discarded. In our model of the alternative theory we ignore periods 12 to 14. We can do this, since we have assumed before that no learning takes place in the alternative theory. Subjects choose their values randomly and independently. The random drawing of a value does not affect future random drawings. We calculate after each run the means of the simulated acceptance limits and settlement offers for both the learning direction theory and the alternative theory.[7]

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[7] It is important to note that we determine the mean of our values after each run and **not** after we have fininshed to run the 1,000, 5,000 or 10,000 simulations.

The mean is advantageous, since it is more sensitive to changes in the subjects' choices than the mode or the median. We observe that the mode and the median do not always change from one period to another even though subjects change their values. For each run we record the mean of the settlement offer in the defendant's good and bad bargaining position and the acceptance limit. In the first play we have 27 observations for each run of which we calculate the mean. In the second and third play the mean of one run in the simulations contains 18 observations. After the simulations have finished, we choose intervals of the size of five and assign the means to the corresponding intervals. For each interval we calculate the relative frequency of means. After we have assigned each mean of the 1,000, 5,000 or 10,000 simulation runs to one of the intervals, we get a distribution of means for the two alternative theories. As a final step, we take the observed means of period 15, and look if they fall into the region of rejection or acceptance. The region of rejection is located at the upper and lower end of our distribution of simulated means. The size of the region of rejection is expressed by the significance level. If the significance level is 0.1, then the size of the region of rejection comprises 10 percent of the entire observations included under our distribution "curve". If the observed mean yields a value which is in the region of rejection, we reject our null hypothesis that the observed mean comes from our distribution of simulated means.

In another approach we apply a scoring rule to the probability distributions of the values that are generated by the two alternative theories. Scoring rules are mechanisms that theoretically elicit subject's subjective probability of a particular event. Scoring rules are, for example, used when a researcher wants to elicit subjective probability information, for example, in the context of forecasting. By making the subject's payoff a function of his subjective probability information and the observed outcome, incentives can be structured such that the subject reports his true subjective probability. A scoring rule that provides such incentives is said to be proper (see Savage (1971)). The scoring rule that we use here is defined as follows:[8]

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[8] Other possible variants are K'=(K+1)/2, or K''=(K-1)/2. The differences are only in scale unit or range. However, in all cases the minimal value is attained when the total probability is concentrated on a single wrong alternative and the maximal when it is all concentrated on the right answer, i.e., $p_i=1$ (see also de Finetti (1965) and Davis and Holt (1993)).

$$K = 2p_i - \sum_{j=1}^{n} p_j^2 \qquad (37)$$

where i is the right answer and the statistic K can take some value between 1 and -1. The two theories assess the values that the subjects can choose in period 15 of the respective play in terms of probabilities. Before we apply the scoring rule to our theories, let us explain it with the help of a simple example. We consider a situation that has two outcomes E_1 and E_2. There are three persons who repeatedly have to choose among the two events. Now let us assume that Person 1 always chooses outcome E_1, whereas Person 2 always chooses E_2. Person 3 randomizes between the two events and assigns equal probabilities to both events. For simplicity let us further assume that E_1 always occurs. How does the criterion evaluate the individual choices after each draw? In our example, j can be equal to 1 or 2 where $p_1=1$ and $p_2=0$. Next, we compare for each individual the probability that he assigned to the event that has occurred. Person 1 assigned a probability of 1 to the first event and, thus, K=1. Person 2 assigned a probability of 0 to E_1 and, therefore, K becomes -1. Person 3, finally, assigned a probability of 0.5 to E_1 and K becomes 0.5 as well. Persons 1 and 2 choose very extreme probability distributions. If the person guesses correctly, he is highly rewarded, whereas if he makes a wrong guess, he is badly penalized. Person 3 is more risk-averse. He sometimes guesses correctly, other times he is wrong. Therefore, he can never get the maximum score, and, on the other hand, he can also never get the worst score.

In the same manner as described above, we apply this criterion to our two alternative theories. Different from our first approach, however, we classify the data not only into levels of experience, but also into groups. If follows from our experimental design that we have nine independent groups in the first play and six groups in the second and third play. Like in our first approach, we consider the observed data in period 15. Altogether, we have nine observations for each group in period 15. Both theories generate probability distributions of the values that subjects may choose. As we already know, subjects may choose a value from 0 to 1,000 in each bargaining position.

For the simple alternative theory the probability distributions of the subject groups are based upon the observations that also enter the Monte-Carlo study for the parameter estimation. Different from our first approach, we determine the probability distributions for each subject group individually. For direction learning the probability distributions are based upon the 10,000 runs of our Monte-Carlo simulations.

For each theory we take the nine observations of one group and look with which probability the corresponding theory predicts the values. From what has been said, it is clear that we have three measurements for each bargaining position, and the total sum takes some value between +3 and -3. Since the measures are on an interval scale, we use the Wilcoxon signed rank test to test the null hypothesis that the two theories are equivalent and predict the observed values equally well against the alternative hypothesis that direction learning predicts the observed values more precisely than the simple alternative theory.

Period t											
Defendant's good bargaining position											
$S_g < A$								$S_g \geq A$			
P wins				D wins							
$ZV > F_D(t)$	$ZV \leq F_D(t)$	$ZV > F_P(t)$	$ZV \leq F_P(t)$	$ZV > F_D(t)$	$ZV \leq F_D(t)$	$ZV > F_P(t)$	$ZV \leq F_P(t)$	$ZV > F_D(t)$	$ZV \leq F_D(t)$	$ZV > F_P(t)$	$ZV \leq F_P(t)$
Adjustment of S_g		Adjustment of A		Adjustment of S_g		Adjustment of A		Adjustment of S_g		Adjustment of A	
0	+50	0	+50	0	-50	0	-50	0	+50	0	+50

Period t											
Defendant's bad bargaining position											
$S_b < A$								$S_b \geq A$			
P wins				D wins							
$ZV > F_D(t)$	$ZV \leq F_D(t)$	$ZV > F_P(t)$	$ZV \leq F_P(t)$	$ZV > F_D(t)$	$ZV \leq F_D(t)$	$ZV > F_P(t)$	$ZV \leq F_P(t)$	$ZV > F_D(t)$	$ZV \leq F_D(t)$	$ZV > F_P(t)$	$ZV \leq F_P(t)$
Adjustment of S_b		Adjustment of A		Adjustment of S_b		Adjustment of A		Adjustment of S_b		Adjustment of A	
0	+50	0	+50	0	-50	0	-50	0	+50	0	+50

Table 6.3 Overview of how the settlement offers and acceptance limits are adjusted in the Monte-Carlo simulations in dependence of the bargaining outcome and the adjustment curve

S_b	:= Settlement offer of the defendant of type b
S_g	:= Settlement offer of the defendant of type g
A	:= Plaintiff's acceptance limit
ZV	:= Random number from the interval [0,1]
$F_D(t)$	:= Probability of adjustment in the defendant's bargaining position (see also Table 6.4 for determination of adjustment curves in the defendant's bargaining position)
$F_P(t)$	:= Probability of adjustment in the plaintiff's bargaining position (see also Table 6.4 for determination of adjustment curves in the plaintiff's bargaining position)
P wins	:= Plaintiff wins the court case
D wins	:= Defendant wins the court case
+50	:= Increment of +50 of subject's value in period t+s
-50	:= Increment of -50 of subject's value in period t+s
0	:= No increment of subject's value

7. COMPARISON OF THE RESULTS OF DIRECTION LEARNING AND THE SIMPLE ALTERNATIVE THEORY

In chapter 7 we report the results of the learning direction theory and the alternative theory. In section 7.1 we summarize the results of the first play, in section 7.2 the results of the second play are reported and, finally, section 7.3 reports the simulation results of the third play. For all three plays we first report the distributions of means in the final period. We are interested in what proportion of the simulated means that include 27 values in the first play and 18 values in the second and third play fall below or above the observed mean. Then we compare the results of the scoring rule. For both theories we obtain values from the scoring rule. We use a one-tailed Wilcoxon matched-pairs signed-ranks test to test the null hypothesis that the two theories predict equally well against the alternative hypothesis that the learning direction theory predicts the observed values in period 15 of the three plays better than the simple alternative theory also called naive theory here.

7.1 Results of the First Play

In this section we start summarizing the results of the first play. In subsection 7.1.3 we graph the results of our distributions of means for the two theories. We choose an interval size of five. For reasons of clarity we label only every third interval. The number that refers to an interval specifies the upper limit of the interval. For example, the interval 455 comprises all simulated means that lie between 450 and 455 not containing the upper limit 455. The relative frequency of simulated means that falls into any of the intervals is stated in percent. All columns summed together result in 100 percent.

Subsection 7.1.2 reports the results of the scoring rule. We apply a one-tailed Wilcoxon matched-pairs signed-ranks test and test the null hypothesis that the naive theory and learning direction theory predict the observations in period 15 of the first play equally well. For each observation in period 15 we obtain a value from the scoring rule. Since we consider the groups individually, we have altogether nine observations for each group.[9] For each group both theories assess the values that subjects can choose among in terms of probabilities.

7.1.1 Distributions of Means

In this subsection we report the distributions of means for 10,000 runs (see also Table 7.4 in section 7.4 for results of 1,000 and 5,000 runs). Altogether we have for both theories 10,000 means in each bargaining position. The mean is obtained from the 27 simulated values in period 15. We take the observed mean of the respective bargaining position and look what proportion of the simulated means lies above and below the observed mean.

In the subsequent figures the smaller of the two areas is blackened. For each test we examine if the blackened area comprises less than or equal to 5 percent of the simulated means. If less than 5 percent of the simulated means fall either below or above - this just depends on whether the area left or right of the observed mean is smaller - the observed mean, we reject our null hypothesis that the observed mean comes from the distribution of simulated means for a two-tailed test at $p \leq 0.1$.

In Figures 7.1 and 7.2 we report the results of the acceptance limit. For both theories the observed mean of the acceptance limit in period 15 does not fall into the 5 percent region of rejection. In both cases the distributions are relatively normally distributed. Throughout this chapter the abbreviations M-C and A-T refer to Monte-Carlo and Simple Alternative Theory respectively.

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[9] Each group consists of six players. Therefore, we have six and three observations in the defendant's and plaintiff's bargaining position respectively.

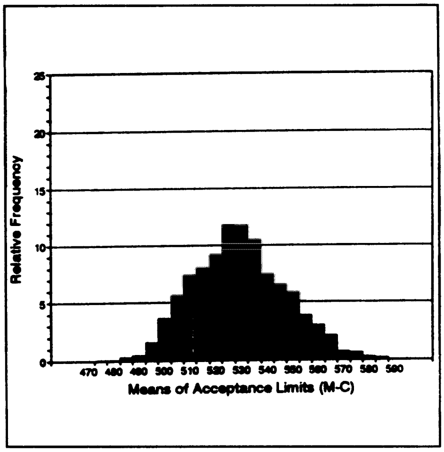

Figure 7.1: *Distribution of means of acceptance limits in the first part of the Monte-Carlo simulation model of direction learning (10,000 runs) and location of the observed mean where the smaller area left or right of the observed mean is blackened*

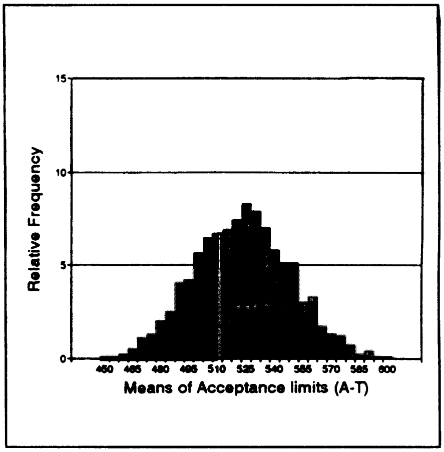

Figure 7.2: *Distribution of means of acceptance limits in the first part of the model of the simple alternative theory (10,000 runs) and location of the observed mean where the smaller area left or right of the observed mean is blackened*

Figures 7.3 and 7.4 show the distributions of simulated means of the two theories in the defendant's bad bargaining position. The two distributions look quite different. The distribution of the naive theory resembles as expected a normally distributed curve. The distribution of means of direction learning has a range from 460 to 585 with a peak that comprises about 31% of the simulated means. All other illustrated intervals contain less than 7% of the 10,000 means. Since we simulate altogether four periods and the defendant's bad bargaining position is only chosen in 25% of the cases, we expect the mean in period 15 to remain unchanged in 31.64% of the cases. If all settlement offers in the defendant's bad bargaining position remain unchanged in the Monte-Carlo simulations, the mean of settlement offers in the bad position is 541.8 (see also Appendix C for initial values).

As a matter of fact, the expected relative frequency comes close to the actually observed relative frequency of 31.2%. Direction learning cannot be rejected at the 10% significance level, while the naive theory can be rejected on grounds of the distribution of means at the 7% significance level for a two-tailed test.

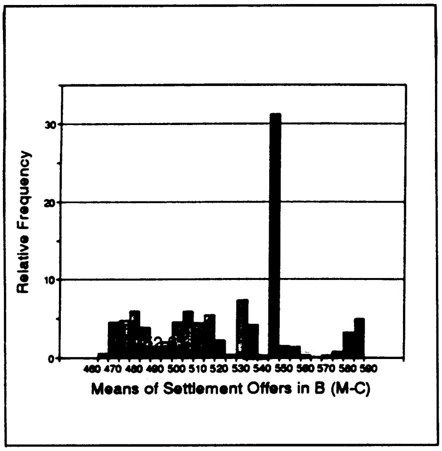

Figure 7.3: *Distribution of means of settlement offers in B in the first part of the Monte-Carlo simulation model of direction learning (10,000 runs)*

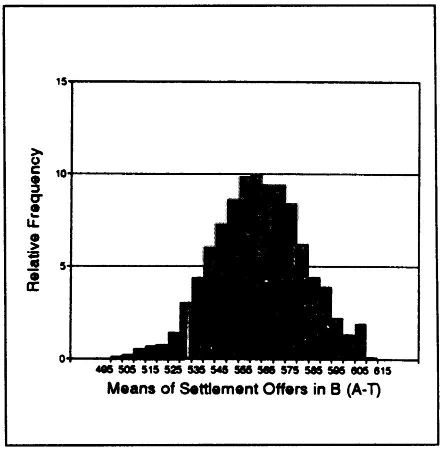

Figure 7.4: *Distribution of means of settlement offers in B in the first part of the model of the simple alternative theory (10,000 runs)*

In the same manner, Figures 7.5 and 7.6 report the results of the settlement offers in the defendant's good bargaining position. The simulated means of the naive theory lie much higher than the observed mean. More than 99% of the simulated means lie above the observed mean. We reject the naive theory at the 0.8% significance level for a two-sided test. Here the advantage of direction learning over the naive theory becomes evident. The naive theory cannot predict the strong downward trend of settlement offers in the defendant's good bargaining position.

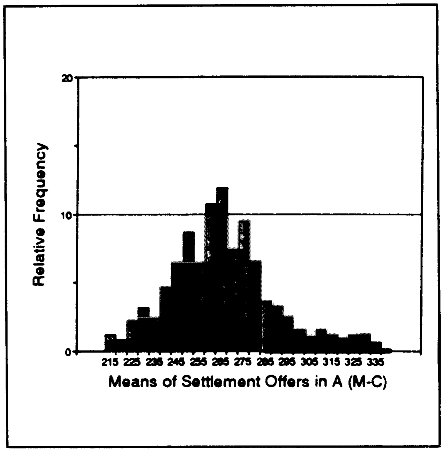

__Figure 7.5:__ Distribution of means of settlement offers in A in the first part of the Monte-Carlo simulation model of direction learning (10,000 runs)

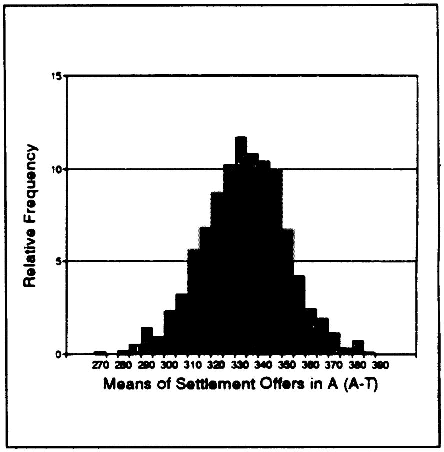

__Figure 7.6:__ Distribution of means of settlement offers in A in the first part of the model of the simple alternative theory (10,000 runs)

7.1.2 Results of the Scoring Rule

In this subsection we report the results of our proper scoring rule. The scoring rule imposes a scheme that rewards correct forecasts and penalizes incorrect forecasts.[10]

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[10] In the mid 60's the concept of objective probability was followed by a subjective interpretation of the world and the adoption of the prescriptive personalistic probability into psychology. The personalistic view of probability represents a degree of belief and is associated with the person making a probabilistic statement. Research aims at answering "how well do people evaluate uncertainty". According to this paradigma, the perception of an event E and the cognitive processing results in a "true" subjective probability. The assumptions referring to the "true" subjective probability are identical with the rationality axioms of the personalistic variant of subjective probability. Either the subject already satisfies the axioms or the axioms are capable of being satisfied by means of training. Therefore, only rational or rationalizable saubjects are of interest. Researchers raised the question of how decision processes in weather forecasting, medical diagnosis or the prediction of stock prices can be made more efficient. Therefore, mechanisms were introduced, so called scoring rules, with the intention of making subjects good probability assessors where good means that subjects truthfully reveal their probability assessments.

The reward depends on the probability that is assigned by the forecasting theory to the actually observed event. We denote the scoring rule of observation i in period 15 as K_i where

(38) $$K_{i,1} = 2\,p_{i,1} - \sum_{j=1}^{n} p_{j,1}^{2}$$

We denote by $p_{j,1}$ where j=0 to 1,000 the theory's prediction of the probability of value j. The probability $p_{i,1}$ refers to the predicted probability of observation i. If the observation is not assigned any weight by the corresponding theory, $p_{i,1}$ takes the value of 0 and $K_{i,1}$ becomes negative. In Table 7.1 we report the values of the nine independent subject groups in the first play for the two alternative theories as specified by the scoring rule. The two theories generate probability distributions of values for the three bargaining positions of each subject group. The naive theory assumes that players of one subject group choose randomly among the 33 values that together with the observations of the other groups enter the Monte-Carlo study for parameter estimation. We have 30 observations in the periods from 1 to 10 and, in addition, three starting values for the Monte-Carlo simulation.

The simulation model of direction learning assumes that subjects adjust their values with a positive probability that is estimated on the grounds of our observations in periods 1 to 10. If we classify the results into groups, we avoid possible inaccuracies that may arise on the basis of data aggregation over all groups like in the first approach. The scoring rule specifies for each observation i a value $K_{i,1}$. First, we sum the three values of each bargaining position together and then we sum over all three bargaining positions. The one-tailed Wilcoxon matched-pairs signed-ranks test rejects the null hypothesis that the naive and the learning direction theory predict eqully well at the 2.73% significance level in favour of the alternative hypothesis which assumes that the learning direction theory has a better hit rate, i.e., the $K_{i,1}$s summed together for one group are significantly often higher than the values that we obtain from the alternative theory. We conclude that the learning direction theory predicts the observed values of the final period of the first play better than the alternative theory. This result is in agreement with the results of the distributions of means. However, the result of this section is even sharper, since we have analysed the values groupwise.

Group	Alternative Theory				Learning Direction Theory			
	A	Offer A	Offer B	S	A	Offer A	Offer B	S
1	0.335	-0.316	0.324	0.343	0.337	-0.088	0.395	0.644
2	0.329	-0.060	0.778	1.046	0.298	0.308	1.113	1.718
3	0.449	-0.310	-0.292	-1.527	0.451	-0.247	0.024	0.228
4	0.222	0.676	0.921	1.819	0.418	0.230	0.876	1.524
5	0.542	-0.204	-0.074	0.264	-0.09	0.124	0.319	0.352
6	0.194	-0.060	0.158	0.292	0.578	-0.134	-0.037	0.407
7	0.177	-0.343	-0.083	-0.249	0.320	-0.228	-0.279	-0.187
8	0.513	0.491	-0.301	-0.703	0.677	0.551	-0.411	0.817
9	0.070	0.509	1.032	1.615	0.408	0.660	0.750	1.818

Table 7.1: *Overview of the values that we obtain from the scoring rule for the two alternative theories in the three bargaining positions in the first play where A refers to the acceptance limits, Offer A to the settlement offers in the defendant's good bargaining position and Offer B to the settlement offers in the defendant's bad bargaining position*

7.2 Results of the Second Play

In section 7.2 we report the results of the second play. Subsection 7.2.1 presents the results of the distribution of means. The observed means determine how many of the 10,000 simulated means lie above and below the dividing line. The smaller of the two areas that we obtain from the dividing line is blackened. In subsection 7.2.2 we report the results of the scoring rule for the second play. Since not all subjects repeat the game, we only have six independent groups in the second play. Like in the first play we obtain for both theories values from the scoring rule. After we have determined the values from the scoring rule for each group, we apply a one-tailed Wilcoxon matched-pairs signed-ranks test and test the null hypothesis that there is no difference between the two theories in the prediction of values.

7.2.1 Distributions of Means

In this subsection we report the distributions of means for the simulations of the second play. Altogether we have for both theories 10,000 means in each bargaining position. The mean is obtained from the 18 simulated values in period 15. We look if the observed mean of the respective bargaining position lies in the rejection region of the distributions of means.

In Figures 7.7 and 7.8 we report the results of the acceptance limit. For both theories the observed mean of the acceptance limit in period 15 does not fall into the rejection region, i.e., the observed mean does not fall into the upper or lower tail that comprises 5% of the simulated means. The distribution of the alternative theory has a range from 430 to 630 and resembles very much a normal distribution, whereas the Monte-Carlo simulations produce a much smaller range that starts at 495 and ends at 565. Since subjects' tendency to adjust their values reduces drastically in the second play, it is not surprising that the range of means becomes smaller in the Monte-Carlo simulations.

The adjustment curve that is based on the observations from period 1 to 10 accounts for the observed inertia. The alternative model, on the other hand, does not take this effect into account. The relative frequency of observed means shows a sharp drop in the interval 530 and does not let the distribution of the Monte-Carlo simulations seem to be normally distributed any more.

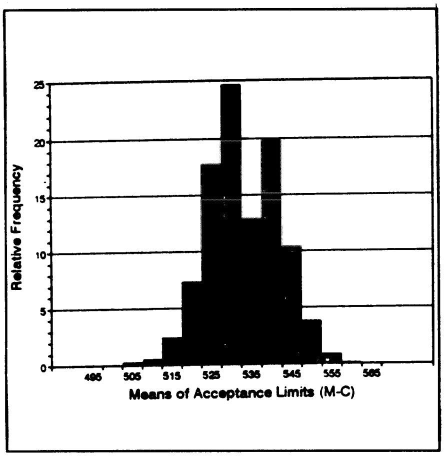

Figure 7.7: *Distribution of means of acceptance limits in the second part of the Monte-Carlo simulation model of direction learning (10,000 runs) and location of the obsɩ rved mean where the left smaller area of the observed mean is blackened*

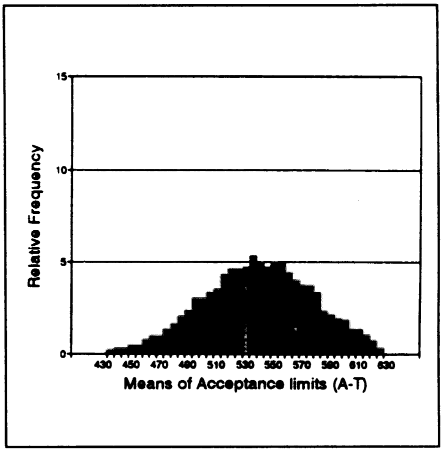

Figure 7.8: *Distribution of means of acceptance limits in the second part of the model of the simple alternative theory (10,000 runs) and location of the observed mean where the smaller area left or right of the observed mean is blackened*

In Figures 7.9 and 7.10 we present the distributions in the defendant's bad bargaining position. The distribution of the naive theory resembles a normally distributed curve. The distribution of means of the Monte-Carlo simulations of direction learning looks similar to the distribution in the first play. In the second play, however, the observed peak in the interval 530 reaches a relative frequency of 41.8%. This can be explained by the fact that the defendant's bad bargaining position is only chosen in 25% of the cases and, in addition, by the inertia effect. Both factors together explain the high rate of means that remain unchanged in period 15.

Different from the second play, subjects' tendency to adjust their values remained high throughout the entire game in the first play. Therefore, the observed relative frequency of unchanged means came close to the relative frequency that we expected on grounds of the 25% probability of the defendant's bad bargaining position to be chosen. The observed mean does not fall into the rejection region of means of direction learning. The significance level is 36.2% for a two-sided test. For the simulation model of direction learning, as well, the observed mean does not fall into the rejection region of 10% for a two-sided test.

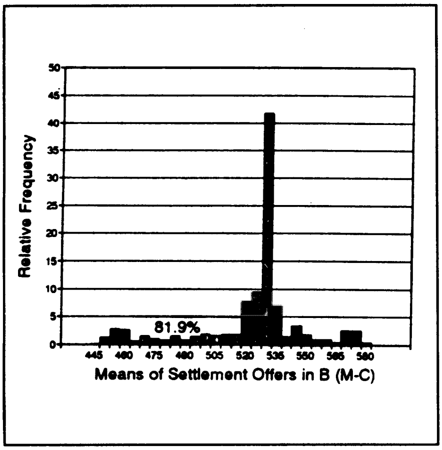

Figure 7.9: *Distribution of means of settlement offers in B in the first part of the Monte-Carlo simulation model of direction learning (10,000 runs)*

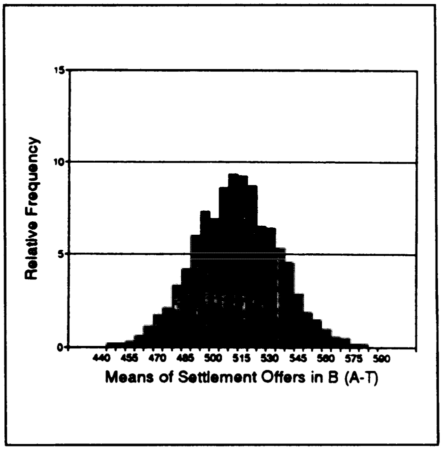

Figure 7.10: *Distribution of means of settlement offers in B in the first part of the model of the simple alternative theory (10,000 runs)*

In Figures 7.11 and 7.12 we report the results of the settlement offers in the defendant's good bargaining position. For both theories the observed mean does not fall into the rejection region of the distributions of simulated means.

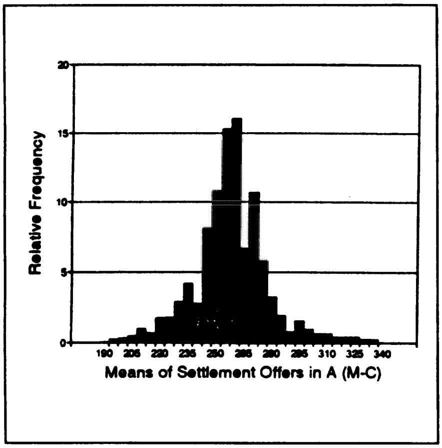

Figure 7.11: *Distribution of means of settlement offers in A in the first part of the Monte-Carlo simulation model of direction learning (10,000 runs)*

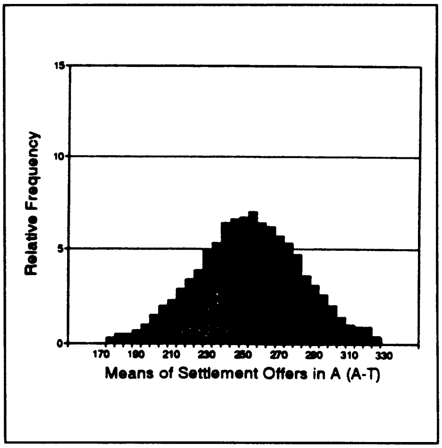

Figure 7.12: *Distribution of means of settlement offers in A in the first part of the model of the simple alternative theory (10,000 runs)*

7.2.2 Results of the Scoring Rule

In this subsection we report the results of the scoring rule in the second play. We denote the scoring rule of observation i in the final period of the second play as $K_{i,2}$ where

$$K_{i,2} = 2p_{i,2} - \sum_{j=1}^{n} p_{j,2}^2 \qquad (39)$$

The probability $p_{i,2}$ refers to the predicted probability of observation i in the second play. For all values that one theory assigns a positive probability, we square the predicted probabilities of the values and then sum over all squared probabilities. Table 7.2 reports the values of the six groups in the second play for the two theories. For each bargaining position and group we get three values from the scoring rule. Data entries in Table 7.2 report the sum of the three values. For the Wilcoxon matched-pairs signed-ranks test we sum for each group over nine values from the scoring rule.

Group	Alternative Theory				Learning Direction Theory			
	A	Offer A	Offer B	S	A	Offer A	Offer B	S
1	0.230	0.465	0.454	1.149	0.514	0.521	0.469	1.504
2	0.454	0.326	0.486	1.266	0.496	0.164	0.837	1.496
3	0.167	0.787	0.593	1.547	0.038	0.498	0.511	1.023
4	0.835	0.923	1.037	2.795	1.064	0.886	1.519	3.468
5	0.190	0.449	0.382	1.021	0.815	0.390	0.801	2.006
6	-0.08	0.494	0.283	0.698	0.787	0.703	0.898	2.388

Table 7.2: *Overview of the values that we obtain from the scoring rule for the two alternative theories in the three bargaining positions in the second play where A refers to the acceptance limits, Offer A to the settlement offers in the defendant's good bargaining position and Offer B to the settlement offers in the defendant's bad bargaining position*

The one-tailed Wilcoxon matched-pairs signed-ranks test rejects the null hypothesis that the naive theory and the learning direction theory predict the actually observed values equally well at the 7.81% significance level in favour of the alternative hypothesis which assumes that the learning direction theory has a better hit rate. We conclude that learning direction theory yields better probability reports than the naive theory. The reader should recall that for the distribution of means we were not able to reject any of our two theories.

In the first play, we noticed a strong downward tendency which learning direction theory could better capture than the naive theory. Both the distribution of means and the scoring rule reject the null hypothesis that there is no difference between the two theories in the prediction of observed values.

In the second play, however, subjects' tendency to adjust their values decreased strongly towards the end of the game and the simulated means of the two theories do not differ significantly from the actually observed means. Therefore, in the second play the distributions of means are a less powerful test. Using the distributions of means, our decision would be not to reject the null hypothesis that direction learning and the naive theory equally well predict the actual observations, whereas the scoring rule enables us to reject the null hypothesis at $p \leq 0.0781$.

The scoring rule takes for each group the probability predictions of observed values into account, whereas the distributions of means aggregate over all groups. Differences between individual groups are not appropiately taken into consideration.

7.3 Results of the Third Play

In section 7.3 we give an overview of the results of the third play. In 7.3.3 we present graphically the results of the distributions of means for both theories and 7.3.2 we report the results of the scoring rule.

7.3.1 Distributions of Means

Subsection 7.3.1 reports the distributions of means that we obtain from the 10,000 simulations for both theories. The mean is obtained from the 18 simulated values in period 15 of the third play. As we did in the previous cases, we take the observed mean of the respective bargaining position and look what proportion of the simulated means lies above and below the observed mean.

In Figures 7.13 and 7.14 we report the distributions of simulated means in the plaintiff's bargaining position. For both theories the observed mean of the acceptance limits in period 15 does not fall into the two-sided rejection region of the distributions of simulated means. For direction learning the significance level is 66.6%, and for the naive theory the significance level is even 88%.

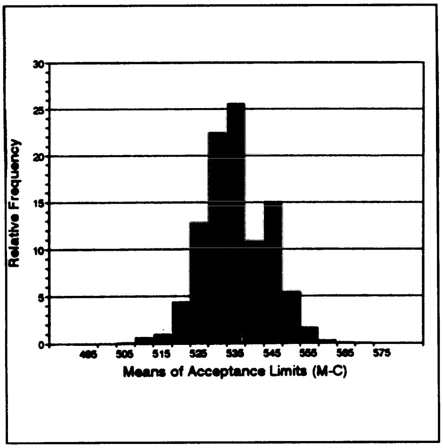

__Figure 7.13:__ Distribution of means of acceptance limits in the third part of the Monte-Carlo simulation model of direction learning (10,000 runs) and location of the observed mean where the smaller area left or right of the observed mean is blackened

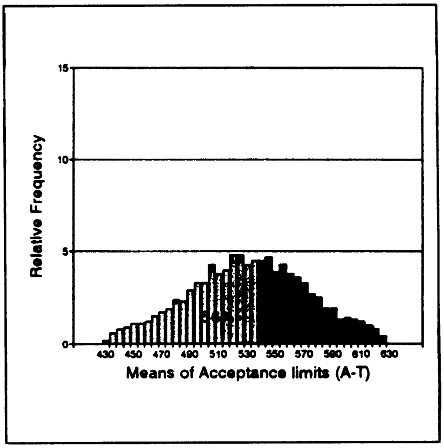

__Figure 7.14:__ Distribution of means of acceptance limits in the third part of the model of the simple alternative theory (10,000 runs) and location of the observed mean where the smaller area left or right of the observed mean is blackened

Figures 7.15 and 7.16 we show the distributions of simulated means of the two theories in the defendant's bad bargaining position. As we already know from the first and second play, the distributions of means of direction learning is single-peaked. The single-peakedness is caused by the high relative frequency of unchanged means in period 15. In the third play the peak can be observed in the interval 530. The observed mean does not fall into the rejection region of the distribution that we obtain from the Monte-Carlo simulations. The significance level is 53.2% for a two-sided test. In accordance with the results of the Monte-Carlo simulations, the naive theory cannot be rejected on grounds of the distribution of means of settlement offers in period 15 of the third play. 8.9% of the simulated means fall below the observed mean. The significance level is 17.8% for a two-sided test.

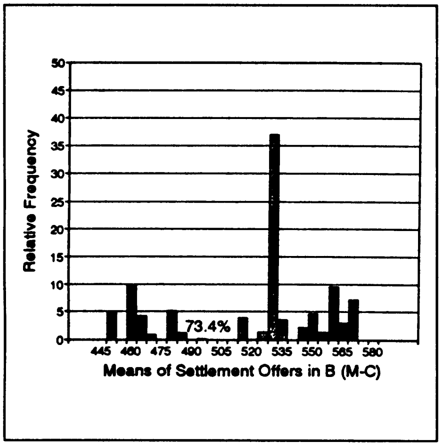

__Figure 7.15:__ Distribution of means of settlement offers in B in the third part of the Monte-Carlo simulation model of direction learning (10,000 runs)

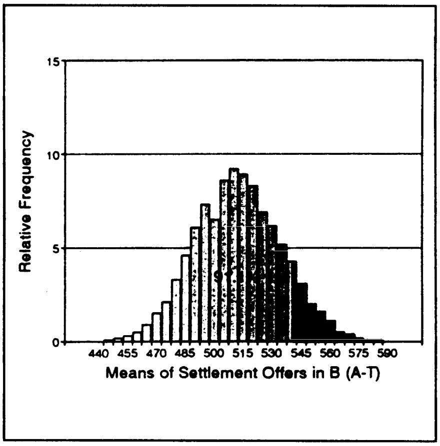

__Figure 7.16:__ Distribution of means of settlement offers in B in the third part of the model of the simple alternative theory (10,000 runs)

Last but not least, Figures 7.17 and 7.18 present the results of the settlement offers in the defendant's good bargaining position. The distribution of means of the simple alternative theory is more evenly distributed over the range from 170 to 320. None of the columns exceeds the 9% level. The simulated means of direction learning are concentrated in the intervals 250 and 255. For both theories the observed means do not fall into the 10% rejection region of the distributions of simulated means for a two-sided test.

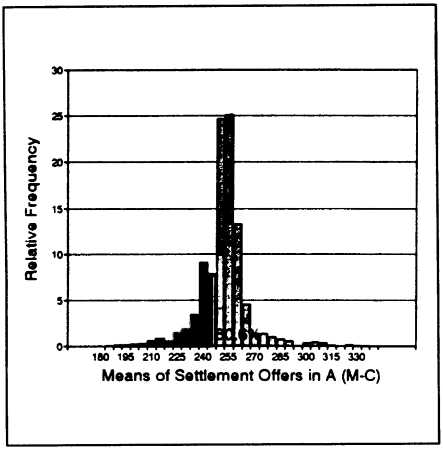

Figure 7.17: Distribution of means of settlement offers in A in the third part of the Monte-Carlo simulation model of direction learning (10,000 runs)

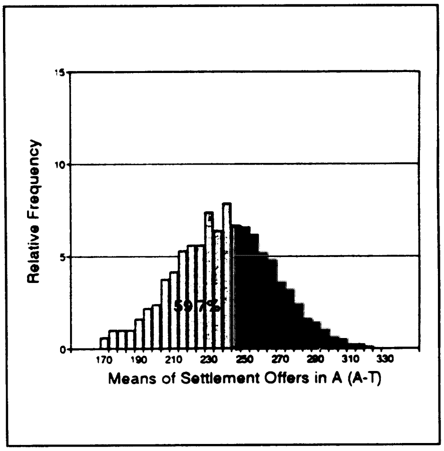

Figure 7.18: Distribution of means of settlement offers in A in the third part of the model of the simple alternative theory (10,000 runs)

7.3.2 Results of the Scoring Rule

In this subsection we report the results of the scoring rule in the third play. We denote the scoring rule of observation i in the final period of the third play as $K_{i,3}$ where

$$K_{i,3} = 2p_{i,3} - \sum_{j=1}^{n} p_{j,3}^2 \qquad (39)$$

The probability $p_{i,3}$ refers to the predicted probability of observation i in the third play. Again, we look for each observation of the six groups which probability is assigned to the observation by the theory. We multiply the predicted probability of the respective theory by two and then subtract the aggregated sum of squared probabilities. Table 7.3 reports the values of the six groups in the third play for the two theories.

Group	Alternative Theory				Learning Direction Theory			
	A	Offer A	Offer B	S	A	Offer A	Offer B	S
1	0.431	0.514	0.653	1.597	0.873	0.501	0.087	1.460
2	0.732	0.801	0.537	2.070	1.382	0.885	0.127	2.393
3	0.422	1.394	0.301	2.117	0.620	0.747	-0.213	0.540
4	0.511	1.190	1.458	3.159	1.418	1.266	1.900	4.583
5	1.287	0.741	-0.306	1.722	1.311	0.761	0.527	2.599
6	0.079	0.287	0.370	0.737	0.829	0.087	0.061	0.977

Table 7.3: *Overview of the values that we obtain from the scoring rule for the two alternative theories in the three bargaining positions in the third play where A refers to the acceptance limits, Offer A to the settlement offers in the defendant's good bargaining position and Offer B to the settlement offers in the defendant's bad bargaining position*

In the third play we cannot reject the null hypothesis that the two alternative theories predict the observed values in period 15 equally well for the scoring rule. Our decision is again based on a one-tailed Wilcoxon matched-pairs signed-ranks test. The significance level for the scoring rule in the third play is 28.13%.

Different from our previous results, both the scoring rule and the distributions of means do not establish a difference between learning direction theory and the naive theory in the third play. This result is not surprising if we consider that subjects throughout the entire third play are reluctant to adjust values. Behaviour has stablelized and subjects only rarely change to different values. The learning curve flattens and new information on the behaviour of other players does not give rise to major changes either.

7.4 Summary of the Simulations and the Comparison of the Two Theories

As a general result, the **direction learning theory** has turned out to be more powerful in the prediction of observed values in the final period of the three plays than the alternative theory. For the assessment of the two theories we have pursued two approaches: The *Distribution of Means* and the *Application of Proper Scoring Rule.* For the distribution of means we compute the mean of all simulated values in one bargaining position in the final period of the respective play. Hereby, we do not distinguish between the individual subject groups. For the scoring rule we assess the probability predictions of the nine observed values of each group individually.

The results on the distribution of means show that the simulation model of direction learning can better account for the downward trend of settlement offers of inexperienced defendants than the simple alternative theory. Subjects tend to offer less in the defendant's good and bad bargaining position within the first play. The mean of settlement offers in the defendant's good bargaining position goes steadily downwards from 309.37 in period 11 to 243.78 in period 14 until it goes up to 282.29 in period 15.[11] Some sort of end-game behaviour might be the reason for this reversal. Certainly, our simulation model of direction learning cannot account for this end-game effect and this might explain why the significance level is around 39%.

The simple alternative model that randomly selects the values with probabilities equal to past relative frequencies naturally fails to predict the downward trend and, therefore, can strongly be rejected. As far as the acceptance limit A is concerned, we do not observe any significant differences. One reason for this might be that acceptance limits are more spread in a bell-shaped distribution over the entire interval from 0 to 1000. The mean of acceptance limits does not show any significant trend over time. In the first play the 47.25% probability of winning a court case does not force the mean of acceptance limits into any specific direction. We have already

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[11] The regression analysis shows that the time variable is significant at the 0.001% significance level for the mean of settlement offers of the defendant of type g. For the mean of settlement offers of the defendant of type b we have a significance level of 0.003%, whereas for the mean of acceptance limits the significance level is 74.7%. All results reported here refer to the first play.

discussed in earlier chapters that subjects tend to follow direction learning. Since most bargaining rounds end in court, the number of plaintiffs who put up their acceptance limit is about the same as the number of subjects who ask for less after they have lost the court case. In the second and third play the choice of above "medium" acceptance limits is counterbalanced by below "medium" acceptance limits. Altogether, the means of acceptance limits do not change significantly in the second and third play. Therefore, we cannot expect the adjustment rule to perform better than the alternative theory.

The results that are displayed by our scoring rule clearly favour direction learning in the first and second play. In the third play the scoring rule cannot reject the null hypothesis of no difference in the prediction between the two theories either. The result, however, is not surprising if we consider that subjects drastically reduce the tendency to adjust their values. In the first play, subjects adjust in 81.53% of the cases their values - if we only consider subjects who repeat the game, we observe an adjustment in 80.85% of the cases - , whereas in the third play this proportion reduces to 27.67%.

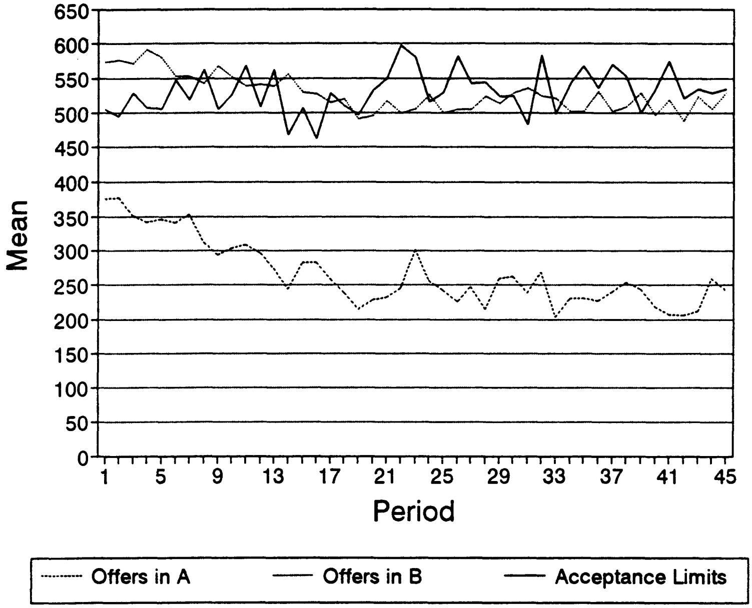
In Table 7.4 we give an overview of the significance levels of the observed acceptance limits and settlement offers of the defendant of type b and g. We look if the observed means fall into the rejection region of our distributions of means that we obtain from the Monte-Carlo simulations and the alternative theory. The cases in which the observed mean falls below or above 5% of the 1,000, 5,000 or 10,000 simulated means of our two alternative theories are written in bold letters. In Figure 7.19 we graph the observed means of all three plays.

	Play	1,000 Runs		5,000 Runs		10,000 Runs	
		Monte-Carlo	Alternative	Monte-Carlo	Alternative	Monte-Carlo	Alternative
Offer A	First Play	0.160	**0.001** (*)	0.194	**0.006** (*)	0.198	**0.004** (*)
	Second Play	0.337	0.446	0.346	0.446	0.340	0.445
	Third Play	0.192	0.396	0.197	0.408	0.194	0.403
Offer B	First Play	0.486	**0.042** (**)	0.481	**0.038** (**)	0.472	**0.035** (**)
	Second Play	0.216	0.194	0.208	0.183	0.214	0.181
	Third Play	0.266	0.090	0.261	0.089	0.266	0.089
A	First Play	0.168	0.306	0.1515	0.312	0.149	0.314
	Second Play	0.271	0.357	0.281	0.367	0.281	0.366
	Third Play	0.325	0.453	0.348	0.439	0.333	0.440

Table 7.4: *Overview of the significance levels (one-sided) of the observed means of settlement offers and acceptance limits with respect to the distribution of means based on the Monte-Carlo simulations and the alternative model for 1,000, 5,000 and 10,000 runs*

Offer A := Settlement offer in the defendant's good bargaining position
Offer B := Settlement offer in the defendant's bad bargaining position
A := Acceptance Limit
(*) := Significant at the 2.5% significance level for a two-sided test
(**) := Significant at the 10% significance level for a two-sided test

Figure 7.19: *Graphic presentation of the observed means in the three bargaining positions (defendant of type g (=Offers in A), defendant of type b (=Offers in B) and plaintiff (=Acceptance Limits)) from period 1 to 45*



8. SUMMARY

In the experimental investigation of our game model with incomplete information we have found two learning processes. One learning process pertains to the way of how subjects adjust their values. Subjects tend to offer less in the defendant's position and ask for more in the plaintiff's position if they have been successful, whereas they tend to put up their settlement offers in the defendant's bargaining position and go down with their acceptance limit in the plaintiff's bargaining position if they have been unsuccessful. The other learning process refers to the polarization of acceptance limits when subjects repeat the game for the first time. The litigation experience in the first play has such a dominant influence on subjects' behaviour in the plaintiff's position that we observe a strong shift in the distribution of acceptance limits.

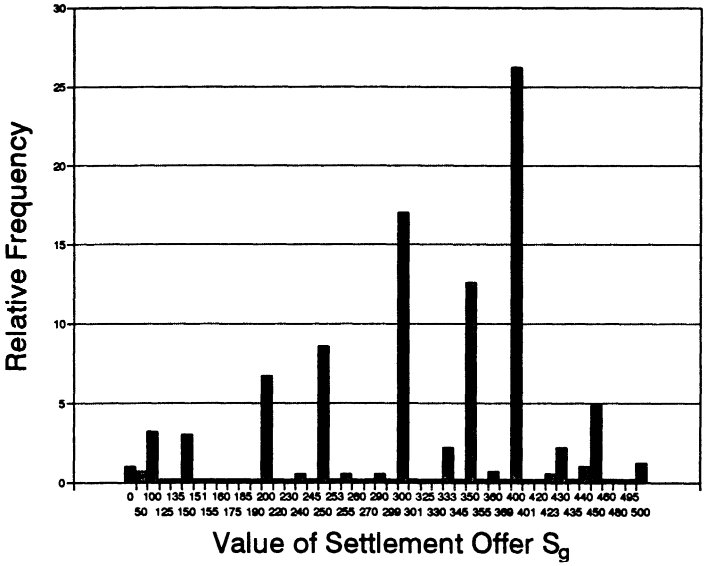
We have built a model based on direction learning and the theory of prominent numbers. We have stated a simple alternative model that assumes that subjects choose their values with past observed relative frequencies. The simulations have shown that the values that are generated by direction learning in the Monte-Carlo simulations come closer to the observed values than the simulated values of the simple alternative theory in the first and second play. We have applied the distribution of means and a scoring rule as assessment rules. We have found out that the distribution of means is a weaker method that can only discriminate between the two theories if we observe major changes in the behaviour of subjects. Our scoring rule, however, evaluates the probability prediction of each observation individually and is, therefore, more precise and powerful. In the third play, however, the behaviour of subjects is too stationary for any theory to be more powerful in the prediction of observed behaviour in the final period.

From our results we can conclude that the adjustment of values is strongly guided by the ex-post bargaining assessment. Dependent upon the bargaining outcome, subjects think about how they could have improved their action. Our experimental results have shown that this ex-post decision processing exercises an influence on the behaviour of subsequent periods. However, we have also seen that direction learning by itself cannot satisfactorily explain the change of behaviour from the first play to the second play in the plaintiff's bargaining position. The litigation experience helps to explain how subjects change their behaviour when they are experienced.

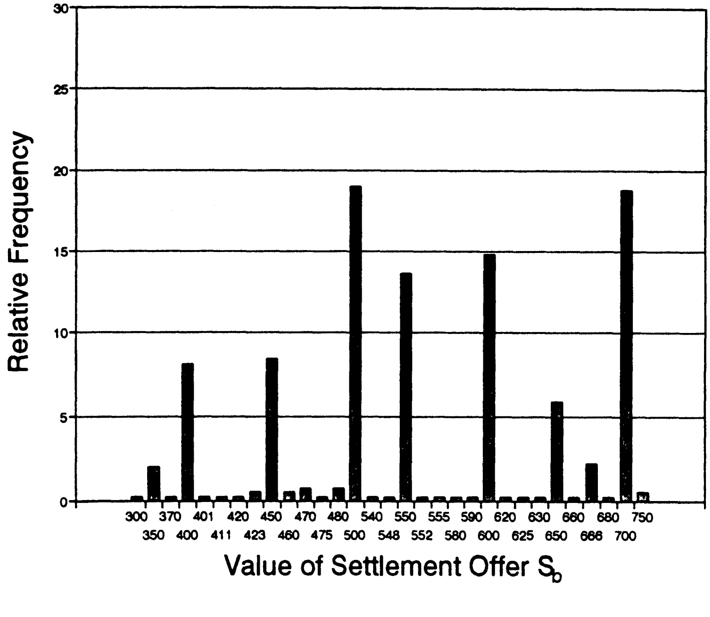
For future research the existing model can be further improved by additional verifiable assumptions such as subjects' deviant behaviour. Also, it will be of interest to find other bargaining models where direction learning can predict the observed behaviour in a similarly precise manner as in our game. In this context, it might be worth investigating the underlying determinants of direction learning. The question to which type of bargaining model learning direction theory can be applied naturally arises. Another course of research is the derivation of new alternative models that might even turn out to be more powerful and applicable than direction learning. Further research will hopefully bring more insights into these issues.

APPENDIX A

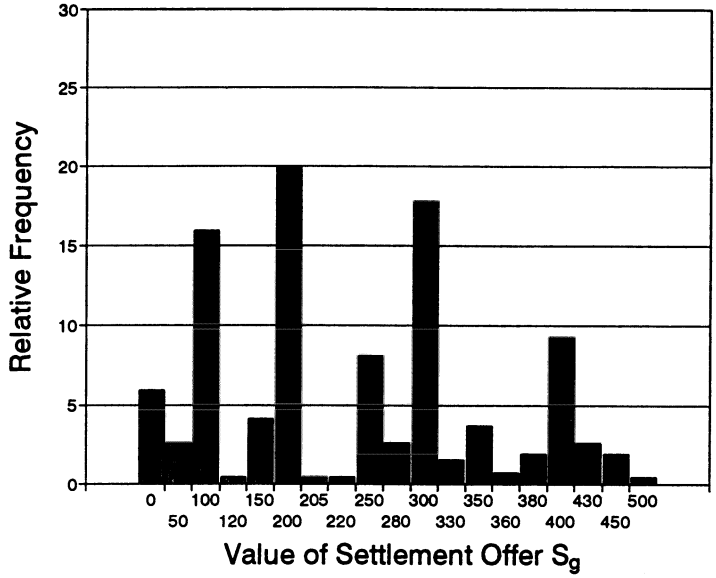
Distribution of settlement offers of inexperienced subjects in the defendant's good bargaining position



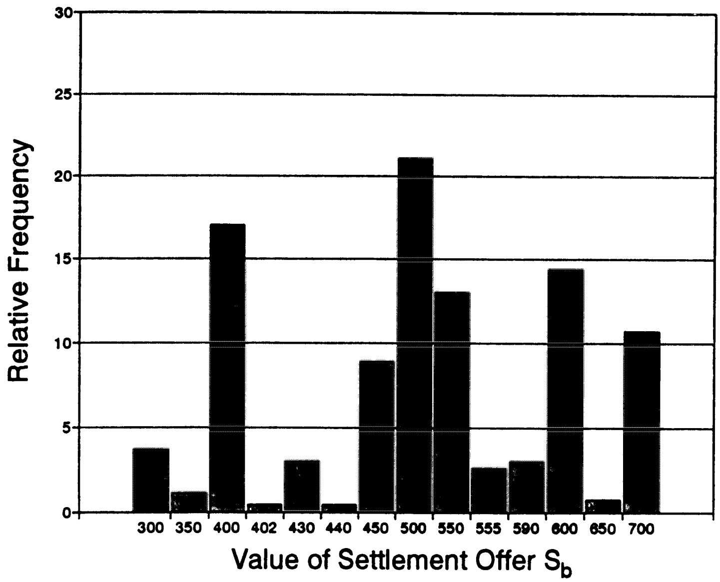
Distribution of settlement offers of inexperienced subjects in the defendant's bad bargaining position



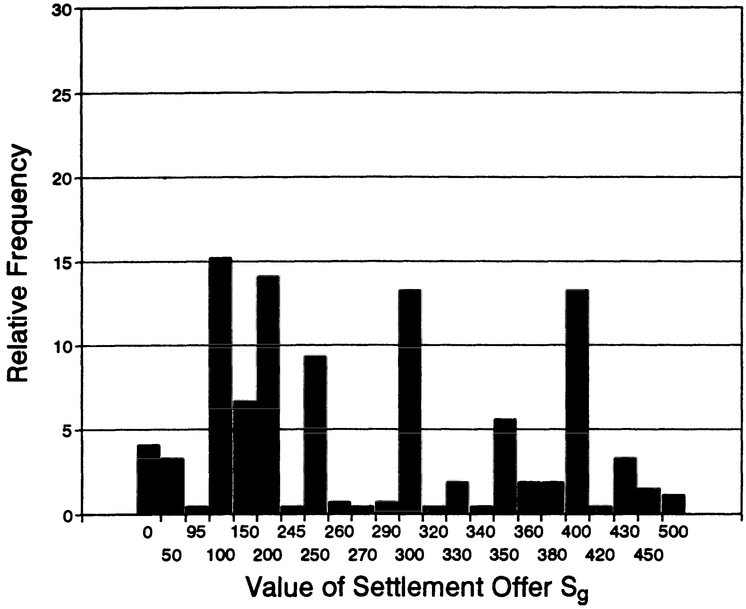
Distribution of settlement offers of first-level experienced subjects in the defendant's good bargaining position



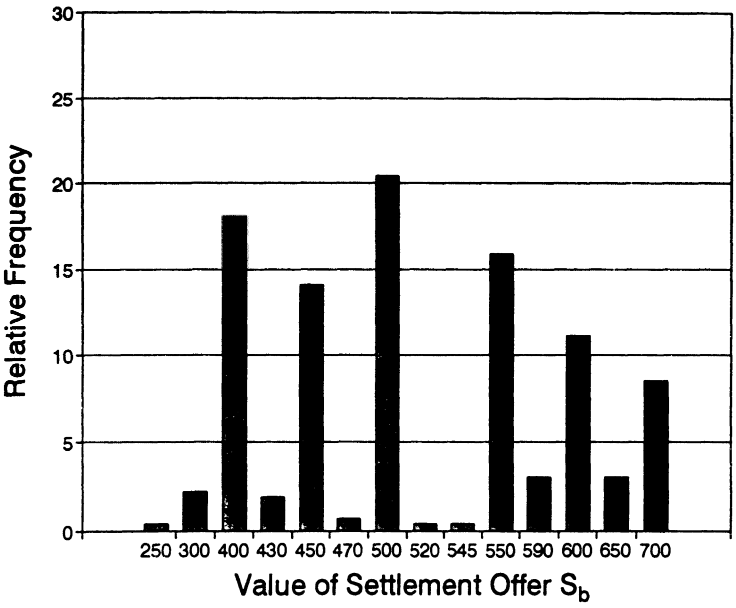
Distribution of settlement offers of first-level experienced subjects in the defendant's bad bargaining position



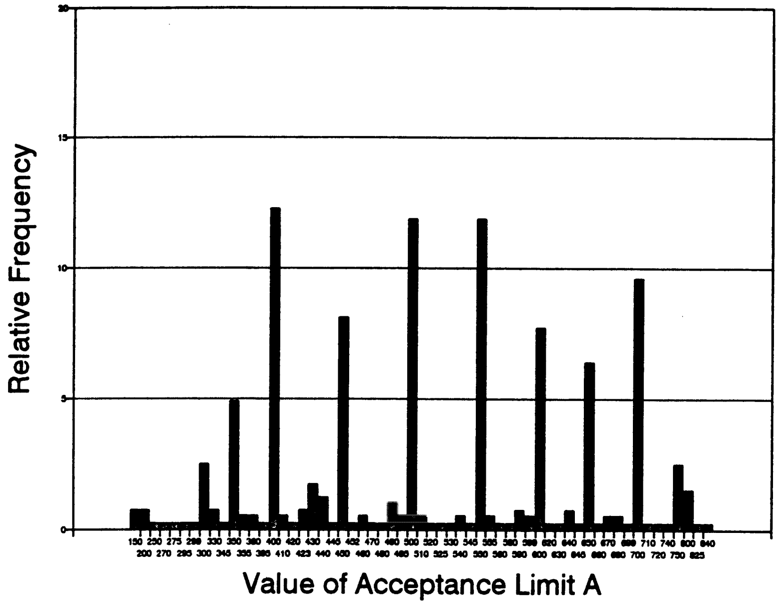
Distribution of settlement offers of second-level experienced subjects in the defendant's good bargaining position



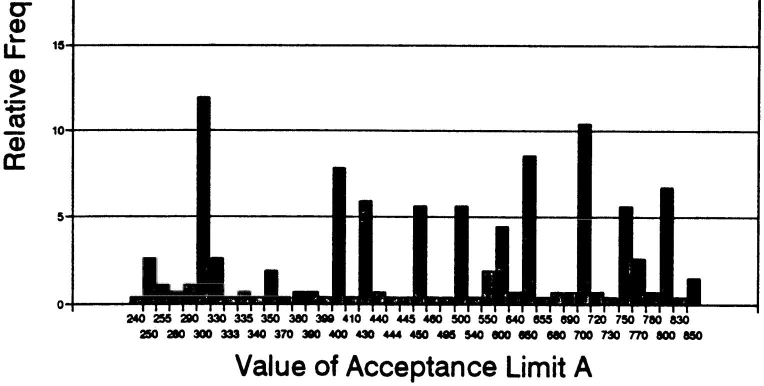
Distribution of settlement offers of second-level experienced subjects in the defendant's bad bargaining position



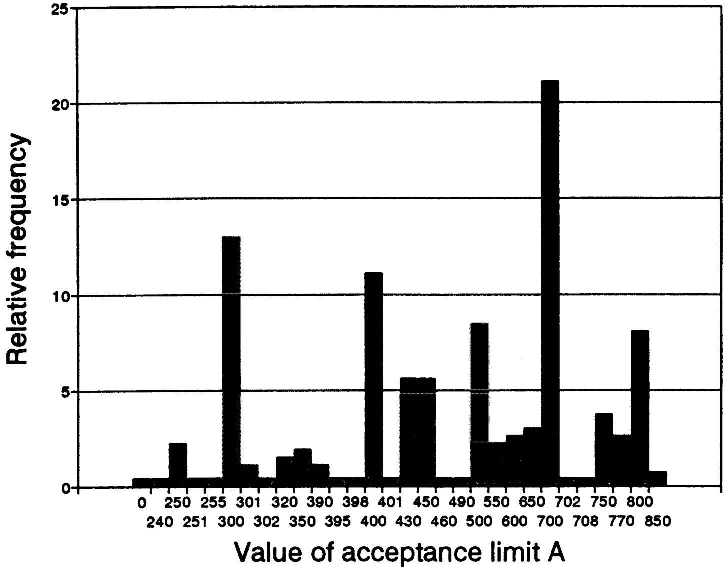
Distribution of acceptance limits of inexperienced subjects



Distribution of acceptance limits of first-level experienced subjects



Distribution of acceptance limits of second-level experienced subjects



APPENDIX B

Round	I	II	III	IV	V
Subject D:P	1:2 5:3 6:4	3:1 2:4 6:5	1:4 5:2 3:6	5:1 2:6 4:3	1:6 3:2 4:5
Round	VI	VII	VIII	IX	X
Subject D:P	1:2 5:3 6:4	3:1 2:4 6:5	1:4 5:2 3:6	5:1 2:6 4:3	1:6 3:2 4:5
Round	XI	XII	XIII	XIV	XV
Subject D:P	1:2 5:3 6:4	3:1 2:4 6:5	1:4 5:2 3:6	5:1 2:6 4:3	1:6 3:2 4:5

Table B.1: *Matching table of inexperienced subjects in the experiment and the simulation model of direction learning. One independent group consists of six players. In each bargaining round three players are assigned to the plaintiff's bargaining position; the other three players are in the defendant's position*

Round	I	II	III	IV	V
Subject D:P	2:6 4:5 3:1	3:2 6:4 5:1	4:1 2:5 6:3	2:4 1:6 5:3	1:2 4:3 6:5
Round	VI	VII	VIII	IX	X
Subject D:P	3:1 4:2 5:6	4:3 1:5 6:2	3:6 5:2 1:4	2:1 3:5 6:4	1:6 5:4 2:3
Round	XI	XII	XIII	XIV	XV
Subject D:P	4:2 5:3 6:1	5:4 2:6 1:3	6:3 4:1 2:5	1:5 3:2 4:6	3:4 2:1 6:5

Table B.2: *Matching Table of first-level experienced and second-level experienced subjects in the experiment and the simulation model of direction learning*

APPENDIX C

I	Position in period 11	Period in which I is in Q' [12]	I_Accept	I_Offer_A	I_Offer_B
1	D	12	510	350	500
2	P	12	750	350	650
3	P	12	600	350	550
4	P	14	700	230	700
5	D	12	600	495	550
6	D	13	500	400	500
7	D	12	600	250	500
8	P	12	700	450	700
9	P	12	600	100	500
10	P	14	550	200	600
11	D	12	700	150	500
12	D	13	450	350	550
13	P	12	275	350	600
14	P	12	300	300	600
15	P	12	400	200	400
16	P	14	500	300	550
17	D	12	395	125	400
18	D	13	350	175	450
19	D	12	601	400	700
20	P	12	555	160	600
21	P	12	495	100	350
22	P	14	550	100	700
23	D	12	150	150	600
24	D	13	350	400	600
25	D	12	330	200	500
26	P	12	440	300	500
27	P	12	520	300	500
28	P	14	590	400	700

Table C.1: *Starting values of inexperienced subjects in the plaintiff's bargaining position (I_Accept), defendant's good bargaining position (I_Offer_A) and the defendant's bad bargaining position (I_Offer_B) in the simulation model of direction learning needed for the Monte-Carlo study*

[12] Q' denotes the bargaining position opposite to the one in period 11.

I	Position in period 11	Period in which I is in Q'	I_Accept	I_Offer_A	I_Offer_B
29	D	12	600	200	400
30	D	13	700	300	700
31	D	12	423	440	480
32	P	12	750	150	500
33	P	12	700	250	600
34	P	14	700	250	400
35	D	12	400	333	666
36	D	13	500	400	550
37	D	12	400	350	500
38	P	12	700	250	450
39	P	12	500	250	550
40	P	14	800	300	550
41	D	12	500	400	700
42	D	13	300	300	400
43	D	12	500	240	450
44	P	12	700	250	400
45	P	12	398	400	700
46	P	14	550	202	448
47	D	12	649	260	500
48	D	13	550	400	700
49	P	12	430	430	500
50	P	12	500	250	400
51	P	12	299	400	550
52	P	14	500	300	550
53	D	12	650	150	500
54	D	13	400	400	550

Table C.1, cont.: *Starting values of inexperienced subjects in the simulation model of direction learning needed for the Monte-Carlo study*

I	Position in period 11	Period in which I is in Q'	I_Accept	I_Offer_A	I_Offer_B
1	P	12	750	250	550
2	P	12	770	330	590
3	P	12	700	400	550
4	D	14	850	200	650
5	D	12	650	500	550
6	P	13	800	250	500
7	D	12	500	100	500
8	D	12	640	200	650
9	D	12	650	50	500
10	P	14	300	250	600
11	P	12	450	300	550
12	P	13	400	400	600
15	P	12	650	150	700
16	D	12	430	380	430
17	D	12	350	150	550
18	P	14	410	360	500
22	P	12	500	100	700
26	D	13	340	300	400
27	D	12	290	100	400
29	P	12	400	200	400
32	D	12	500	100	450
34	P	14	770	200	400
36	D	12	650	300	550
42	D	13	300	300	400
43	P	12	450	350	450
44	P	12	800	100	400
45	P	12	400	400	700
46	D	14	750	50	450
47	D	12	350	250	450
48	D	13	400	300	600
49	P	12	430	430	500
50	P	12	805	100	400
51	P	12	700	350	600
52	D	14	550	200	500
53	D	12	650	220	550
54	D	13	400	400	500

Table C.2: *Initial values of first-level inexperienced subjects in the plaintiff's and defendant's bargaining position in the simulation model of direction learning used for the Monte Carlo study*

I	Position in period 11	Period in which I is in Q'	I_Accept	I_Offer_A	I_Offer_B
1	P	12	650	300	500
2	P	12	770	285	590
3	P	12	700	350	550
4	D	14	750	200	700
5	D	12	700	450	555
6	P	13	750	200	500
7	D	12	400	200	500
8	D	12	700	250	700
9	D	12	600	0	600
10	P	14	300	250	600
11	P	12	450	300	500
12	P	13	400	400	600
15	P	12	700	150	300
16	D	12	430	330	430
17	D	12	400	100	550
18	P	14	500	350	500
22	P	12	500	100	700
26	D	13	390	300	500
27	D	12	240	100	400
29	P	12	400	200	400
32	D	12	500	100	450
34	P	14	700	200	400
36	D	12	700	200	550
42	D	13	300	300	400
43	P	12	400	300	400
44	P	12	700	100	300
45	P	12	400	400	700
46	D	14	700	0	400
47	D	12	400	150	450
48	D	13	400	300	600
49	P	12	430	430	500
50	P	12	800	50	400
51	P	12	800	300	600
52	D	14	500	250	500
53	D	12	700	100	500
54	D	13	400	400	550

<u>Table C.3:</u> *Initial values of second-level inexperienced subjects in the plaintiff's and defendant's bargaining position in the simulation model of direction learning used for the Monte Carlo study*

APPENDIX D

In Appendix D we print the introductory explanation to the game, the pre-experimental questionaire, an extract of the questionaire that subjects are asked to answer during the experiment and a third questionaire that assesses subjects' Machiavellianism.

Introduction

I welcome you to a 2-person bargaining game. In the introduction you receive information

1. on the course of the game,
2. on the computer screen and the use of the keyboard and
3. on the answering of the questionaires.

1. Course of the game.

The bargaining situation is as follows:

The defendant incurs a damage of 1000 Taler upon the plaintiff. The defendant submits an out-of-court offer to the plaintiff, whereas the plaintiff makes a claim, i.e. a minimum acceptance limit.

The offer is compared with the plaintiff's acceptance limit. If the offer is greater than or equal to the acceptance limit, the plaintiff receives the out-of-court offer. If the offer is less than the acceptance limit, the conflict will be solved by the court. The court decision is uncertain and depends upon the defendant's information set.

If the plaintiff wins the court case, the defendant has to pay 1000 Taler. In addition, the defendant has to bear the litigation costs of 100 Taler.

If the defendant wins the court case, the plaintiff receives no compensation and has to pay the litigation costs.

Each participant plays the game 15 rounds. At the beginning of each round the player is assigned to one of the two bargaining positions randomly. The game is anonymous and the players do not know the identity of their opponents.

Ethical or moral aspects are not to be taken into consideration! It is the player's goal to achieve a maximum number of Taler which will determine the final payoff.

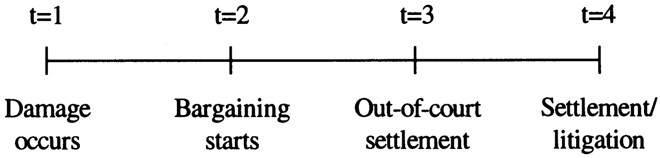
How is the final payoff determined?

Each participant starts off with 7500 Taler. After each round the winnings/losses are added/deducted. The state of the account is converted to German Marks after the end of the experiment. The conversion rate is

180 Taler = 1 German Mark

After the fifth round each player is asked to decribe how he arrived at his acceptance limit and settlement offers.

Course of the game in chronological order:



Schematic arrangement of the game

Personal bargaining position and opponent are assigned

If the player is in the defendant's position, he continues in this column. His opponent is the plaintiff. He incurs a loss of 1000 Taler to the plaintiff and receives 100 Taler.

If the player is in the plaintiff's position, he continues in this column. The defendant is his opponent. He suffers a loss of 1000 Taler and 1000 Taler are deducted from his account.

There are two information sets.

Information set A: More favourable to the defendant. In case of litigation she wins with a probability of 60%.

Information set B: In this case the defendant wins with a probability of 30%.

Information set A: Disadvantageous to the plaintiff. In case of litigation he wins with a probability of 70%.

Information set B: If litigation occurs, the plaintiff wins with a probability of 70%.

The player does not know which information set is drawn. However the player knows that information set A comes with a probability of 75% and information set B with a probability of 25%.

The defendant makes two settlement offers, one for information set A and another one for information set B.

The plaintiff submits an acceptance limit.

After the defendant/plaintiff has made her/his choice, the information set is randomly chosen. Information set A is chosen with a probability of 75% and information set B with a probability of 25%.

The defendant's offer for the respective information set is compared with the plaintiff's acceptance limit.

Offer $\geq$ Acceptance limit $\Rightarrow$ Out-of-court settlement

Offer $<$ Acceptance limit $\Rightarrow$ Litigation

If the two parties cannot settle the conflict out-of-court, the winner is decided by drawing. The probability of winning depends on the information set.

Settlement: The defendant pays the settlement offer as compensation to the plaintiff.
Outcome: 1000 - Offer.

Defendant loses suit: She pays 1000 Taler as compensation and, in addition, 100 Taler litigation costs.
Outcome: -100 Taler.

Defendant wins suit: She does not have to pay anything.
Outcome: 1000 Taler.

Settlement: The plaintiff receives the defendant's offer for the respective information set.
Outcome: -1000 + Offer.

Plaintiff wins suit: He receives 1000 Taler from the defendant irrespective of the information set.
Outcome: 0 Taler.

Plaintiff loses suit. He does not receive any compensation payment, but has to pay the litigation costs.
Outcome: -1100 Taler.

Survey of the probability sampling

Information set A is drawn with a probability of 75%.

The plaintiff wins the suit with a probability of 40%, whereas the defendant wins with a probability of 60%.

The information set B is drawn with a probability of 25%.

The plaintiff wins the law case with a probability of 70%. The defendant wins with a probability of 30%.

The ex-ante probabilities of winning, i.e. the probability of winning a court case before the information set is chosen, are for the defendant and plaintiff as follows:

Defendant:	52.5%.
Plaintiff:	47.5%.

After each round, the players are given information on the bargaining outcome, the outcome of the law suit, their bargaining position, the defendant's information set, their Taler outcome and the state of their account. After each round, the player can derive from the last column in the outcome table his earnings in the i-th round. After each round the earnings/losses are added to/deducted from their account.

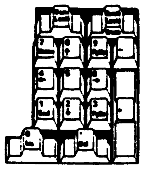
2. Computer screen and use of the keyboard:

Take a seat in the cubicle that has the same number you have drawn prior to the beginning of the game. You will find the computer program already loaded. The computer set-up is always the same. In the bottom line you will find the command line which gives you information on which keys are available. The remaining screen contains information and questions to be answered by the player. The cursor gives you the possibility if required to choose among different alternatives.
The keyboard has the following layout:

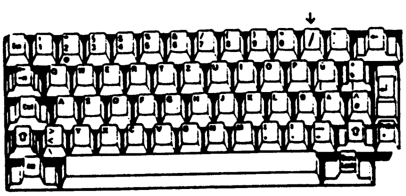
a) Function keys b) Numeric keys c) (Typewriting machine) bank

a)

b)



c)



The calculator computes with maximum 11 places after the decimal point. The calculator only accepts decimal points for numbers, e.g. 2.5 or 1.25.

TASCHENRECHNER IN UMGEKEHRTER POLNISCHER NOTATION

BEFEHLSÜBERSICHT

<—┘ : Abschicken und neue Zahl
+ : addieren (S1 + WORK)
- : subtrahieren(S 1 - WORK)
*** : Multiplizieren(S 1*WORK)**
/ : dividieren (S 1 / WORK)

M : WORK-Register speichern
R : Speicher auslesen

	A=3/4	B=1/4
Schädiger	0.60	0.30
Geschädigter	0.40	0.70

C : WORK - Register löschen
E : Alles löschen

MELDUNGEN

S

WORK **Zahl eingeben!**

<ESC> : verläßt den Taschenrechner **<—┘ : Zahl in den Speicher schreiber**

In the following you will find the relevant computer screens for the bargaining game.

Computer screen for the defendant:

Geben Sie nun an, welchen Betrag Sie (i) für Beweislage A und (ii) für Beweislage B dem Geschädigten in einem außergerichtlichen Vergleich anzu - bieten, um einen Zivilprozeß zu vermeiden. Durch Drücken der F1-Taste, kön-nen Sie eine Hilfestellung zu jedem Menüpunkt aufrufen.
Wenn Sie fertig sind, wählen Sie "Werte senden", um Ihre Angaben abzuschicken

Beweislage A	:	0	T
Beweislage B	:	0	T

	A=3/4	B=1/4
Schädiger	0.60	0.30
Geschädigter	0.40	0.70
Schaden	:	1 000 T
Prozeßkosten	:	100 T

Was möchten Sie als nächstes tun?

——> Taschenrechner benutzen
Wert für Beweislage A
Wert für Beweislage B
Spielbeschreibung
Werte senden

Taschenrechner
0.00

F1 : Hilfe ↑,↓ : anwählen <┘ : Ausführen

Computer screen for the plaintiff:

Akzeptanzwert ab:	0	T

Was möchten Sie als nächstes tun?

——> Taschenrechner benutzen
Meinen Wert eingeben
Spielbeschreibung
Wert senden

	A=3/4	B=1/4
Schädiger	0.60	0.30
Geschädigter	0.40	0.70
Schaden	:	1 000 T
Prozeßkosten	:	100 T

Taschenrechner
0.00

F1 : Hilfe ↑,↓ : anwählen <┘ : Ausführen

3. Answering of the questionaires:

Every player gets three questionaires. The first questionaire includes questions on the player participating in the game and will be handed out after the introduction to the game. The second questionaire can be found next to the computer in the cubicle and includes questions referring to the bargaining game. After the fifth round each player will be asked to comment on his strategy and his line of proceeding. The third questionaire will be handed out after the last round of the game. For this reason, each player is asked to stay in his cubicle until the experimentator arrives.

In the following, we present the **first questionaire** that is handed out to the subjects prior to the experiments.

Number:

Date:

Please answer the following questions. All answers will be treated confidentially.

Please mark with a tick as applies to you. If more than one answer holds true, tick the answer that applies most to you.

1. Have you already attended a game-theoretic lecture?

2. Do you participate in an experiment for the first time?

3. How do you judge your knowledge in statistics?

High ____ Medium _____ Low ____ None ____

4. How do you behave in everyday life?
   I proceed tactically and leave other people in the dark.
   I put immediately my cards on the table.

5. Personal success and failure can be imputed in general to my own behaviour

True ____ Not true ____

6. Do you like to try something new or do you rather stick to well-established traditions and prefer to be steadfast in your principles?

Try something new.

Hold on to well-established actions.

7. Do you fight for your rights even if you have to encounter that this might lead to heavy losses?

Yes ____ No ____

Further questions on personal data

8. Semester at university:
9. Major:
10. Age:
11. Sex: Male ____ Female ____

Extract from the second questionaire that subjects answer parallel to the experiment.

Date:_____ Terminal-Number:_____

Round 1

1.1 How did you arrive at your offer/acceptance limit? Did you choose your value(s) out of the whole cloth or did you make use of calculations and active considerations?

After the announcement of the bargaining outcome

1.2 Are you satisfied with your behaviour?

1.3 Do you think your choice was right? Please tick only one answer!

Yes ____ No ____ Neither nor ____

Write a short comment on your answer!

1.4 Is there anything you would have done different ex-post?

1.5 Would you choose the same value(s) again in the next bargaining round?

Yes ____ No ____

1.6 Do you have any further comments on the course of the game in the first round?

Extract from the **second questionaire** that subjects answer parallel to the experiment.

Date: Terminal-Number:

Round 1

How did you arrive at your offers/acceptance limit? Did you choose your value(s) out of the whole cloth, or did you make use of calculations and active considerations?

After the announcement of the bargaining outcome

1.2 Are you satisfied with your behaviour?

1.3 Do you think your choice was right? Please tick!

Yes ____ No ____ Neither nor ____

Write a short comment on your answer!

1.4 Is there anything you would have done different ex-post?

1.5 Would you choose the same value(s) again in the next bargaining round?

Yes ____ No ____ I do not know ____

1.6 Further comments on the course of the game in the first round?

Finally, we present the Machiavelli-questionaire that subjects have to answer after the end of the first play.

Post-experimental questionaire

In the following you will be asked your opinion on a sequence of statements. The statements can be classified as 'Strongly disagree', 'Disagree some', 'Disagree little', 'Indifferent', 'Agree little', 'Agree some' and 'Agree strongly'.

If you sometimes disagree with the statement, but in general agree a little bit, then cross the answer 'Agree a little'. However, if you are indifferent to a large extent, then cross the answer indifferent.

Please pay attention to the following aspects:

i) Do not cross the answer that you might think imparts the best impression. Do always cross the answer that fits you best. Always remember that your answers will be treated strictly anonymously and confidentially.
ii) Give the answer that come right to your mind. Do only cross one answer which fits best.

Questions 1-20

1. Most men get over the death of their fathers more easily than the loss of their property.

Disagree			**Indifferent**	**Agree**		
Strongly	some	little	indifferent	little	some	strongly

2. People suffering from incurable diseases should have the choice of being put painlessly to death.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

3. Never tell anyone the real reason you did something unless it is useful to do so.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

4. The best way to handle people is to tell them what they want to hear.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

5. Most men are basically good and nice.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

6. Most men who get ahead in their life, lead a morally sound life.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

7. If you ask someone a favour a favour, it is better to tell the real reasons behind it rather than use some reasons that might be of great importance.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

8. One should take action only when sure it is morally right.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

9. It is wise to flatter important people.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

10. The largest difference between criminals and other people is that criminals are stupid enough to get caught.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

11. All in all it is better to be modest and honest rather than important and dishonest.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

12. It is inexcusable to deceive or lie to another person.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

13. In general men only do not work hard unless forced to do so.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

14. Most men are brave and courageous.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

15. It is difficult to get ahead without cutting corners.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

16. Honesty is always the best way.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

17. It is possible to be a good man in all respects.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

18. Barnum was probably right in saying that every minute there is born a sucker.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

19. It is safest to assume that everybody has a vicious streak that will become apparent if you provide an opportunity.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

20. Someone who completely trusts in someone else is looking for trouble and problems.

Disagree			**Indifferent**	**Agree**		
Strongly	little	some	indifferent	little	some	strongly

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