Is Reciprocity Really Outcome-Based? A Second Look at Gift-Exchange with Random Shocks

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Abstract

By means of a laboratory experiment, Rubin and Sheremeta (2016) study a bonus-version of the gift-exchange game, including two treatment variations. First they vary whether the effort provided by the agent directly translates into output for the principal, or whether it is distorted by a shock. Second, for the condition with a shock they vary whether the shock is observed by the principal, or not. The authors' main findings are that (i) the introduction of an unobservable shock significantly reduces welfare; and (ii) informing the principal about the size of the shock does not restore gift-exchange. In a replication study we largely reproduce finding (i), but we fail to confirm finding (ii). Our data suggests that small behavioral differences in the initial rounds lead to a hysteresis effect that is responsible for the differences in results across studies.

Keywords: Gift-exchange, principal agent model, incomplete contracts, random shocks, outcome-based reciprocity, replication study, laboratory experiment

JEL: C72, C91, D63, D81, H50

1 Introduction

Reciprocity has been shown to have the power to increase efficiency in labor-market relations governed by incomplete contracts – see Akerlof (1982) and Akerlof and Yellen (1988, 1990). In experimental economics, an important workhorse model to study reciprocity in labor-market relations is the gift-exchange game introduced by Fehr et al. (1993). The basic version of this game has two stages. In stage 1, a firm offers a contract – consisting of a wage and a desired effort – to a worker. In stage 2, the worker observes the contract chosen by the firm and makes an unverifiable effort choice, knowing that effort increases the firm's revenue but is personally costly to him. The game ends with the payoff of the firm increasing in the worker's effort and

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decreasing in the wage, and the payoff of the worker increasing in the wage and decreasing in the effort.

Numerous studies have investigated variants of the gift-exchange game in lab experiments – see Fehr et al. (1993), Fehr et al. (1997), Fehr and Falk (1999), Charness (2000), and Gächter and Falk (2002), among others. Typically, workers provide more than the minimum effort, and effort is positively related to the wage (Fehr and Schmidt, 2006; Charness and Kuhn, 2011). As there is no direct material incentive for exerting more than the minimum effort in the one-shot version of the game, this finding is typically interpreted as evidence for reciprocity – workers reward the gift of a generous wage by giving a gift in the form of higher effort.

The impact of reciprocity has been shown to be even more pronounced in the bonus-version of the gift-exchange game. This version adds to the basic version an 'adjustment' stage, where the firm can reward or punish the worker for his performance at an own material cost. Now both sides of the market have opportunities for reciprocal responses; this produces large and persistent increases in effort and thereby considerable efficiency gains – see Fehr et al. (1997, 2007).[1]

In the experiments by Fehr et al. (1997) and Fehr et al. (2007), the worker's effort is perfectly observable by the firm. In a recent experiment, Rubin and Sheremeta (2016) – RS16 in the following – distort the worker's effort choice in the bonus-version of the gift-exchange game by a random shock.

RS16 provide two hypotheses regarding the adjustment of the principal, namely 'effort-based reciprocity' (H_1) and 'outcome-based reciprocity' (H_2). H_1 implies that 'good' actions are rewarded and 'bad' actions are punished, while H_2 implies that adjustments are based on the outcome – which is a function of the action of the agent and a random shock. In the treatment with an observable shock, effort-based reciprocity is in line with intention-based reciprocity – where second-order beliefs are used to assess the intentions of the other, and adjustments are based on attributed intentions – while outcome-based reciprocity is not.[2] This is so because higher effort increases the payoff of the principal independently of her second-order belief and

[1]Throughout the paper we follow large parts of the experimental economics literature in using the terms 'efficiency' and 'welfare' interchangeably for the sum of the material payoffs of the two parties involved.

[2]Intention-based reciprocity has been modeled – among others – by Rabin (1993), Dufwenberg and Kirchsteiger (2004), and Falk and Fischbacher (2006). Experimental evidence in line with intention-based reciprocity is presented – among others – by Blount (1995), Charness (2004), Charness and Levine (2007), Cox and Deck (2006), McCabe et al. (2003) and Rand et al. (2015).

because with outcome-based reciprocity a negative shock is punished although the principal knows that it is outside the agent's control.

RS16 find that (i) the introduction of an unobservable shock significantly reduces welfare; and (ii) informing the principal about the size of the shock does not restore gift-exchange. These findings are inconsistent with H_1 but consistent with H_2: If the principal's adjustment is mainly motivated by outcome-based reciprocity, then the effort choice of the agent should be the same in the treatment with an observable shock as in the setting with an unobservable shock, as exerting more effort has the same consequences in both environments. Moreover, under some plausible conditions, the effort in these two environments is lower than in the treatment without a shock. On the other hand, if the principal's adjustment is mainly based of effort, then the agent's effort choice should be the same in the treatment with an observable shock as in the setting without a shock, as exerting more effort has – on average – the same consequences in both environments. Moreover, under some plausible conditions, the effort in these two environments is higher than in the treatment with an unobservable shock.[3]

In our replication study, we implement the same three treatments as RS16: In the 'Effort-Only' treatment, the worker's effort is not distorted by a shock. In the 'Effort-Shock' treatment, the worker's effort is distorted by a random shock; the principal observes both the effort and the shock before making her decision of how much to reward or punish the worker. The 'Outcome-Only' treatment is like the Effort-Shock treatment, except that the principal only observes the outcome, which corresponds to the sum of effort plus shock.

We largely reproduce RS16's finding (i), but we fail to reproduce finding (ii): Welfare is larger in the Effort-Shock than in the Outcome-Only treatment, and it is statistically indistinguishable between the Effort-Shock and the Effort-Only treatment. Also, while the principal's adjustment in the Effort-Shock treatment is increasing in the shock (in line with the hypothesis that reciprocity is at least partly outcome-based), the impact of the agent's effort on the adjustment is more pronounced and more robust than that of the shock (consistent with the hypothesis that reciprocity is mainly effort-based). Finally, an increase in effort has the same effect on the adjustment in the Effort-Only and the Effort-Shock treatment – as predicted by H_1. Overall, our evidence from the adjustment stage of the game is consistent with the following hypothesis: With observable effort, reciprocity is mainly effort-based, and on top of that, there is some

[3] See RS16, p. 990, for details.

forgiving on the side of the principal in cases where the consequences of a negative deviation of the agent's effort choice from desired effort are cushioned by a positive shock.

While our finding that an observable random shock does not impair gift-exchange is in line with results in some recent work (Kocher and Strasser, 2011; Gerhards and Heinz, 2017), it is not in line with the main result of RS16. We address the question of what drives this difference in the discussion section, commenting on differences in the subject pool, differences in learning dynamics, and behavioral differences in initial rounds, leading to a hysteresis effect. It seems that the last-mentioned mechanism is the main driver for the differences in results between us and RS16.

2 Experimental design

Our design replicates that of RS16. The game consists of 10 periods, each period having three stages. In stage one, the principal (she) offers a contract $(w, \underline{e})$, consisting of a wage $w \in \{1, 2, \ldots, 100\}$ and an (unenforceable) desired effort $\underline{e} \in \{0, 1, \ldots, 14\}$ that she would like the agent to undertake. In stage two, the agent (he) observes the contract chosen by the principal and decides about the effort level $e \in \{0, 1, \ldots, 14\}$, knowing that the cost of effort, $c(e)$, is $e^2/2$, rounded to the next highest integer. Higher effort translates into higher outcome, y. In the Effort-Only treatment the outcome is simply the effort ($y = e$), while in the treatments with a shock (Effort-Shock and Outcome-Only) the outcome is the effort plus an integer component ϵ (i.e., $y = e + \epsilon$), which is uniformly distributed on $\{-2, -1, 0, 1, 2\}$. In stage three, the principal observes either only the effort (Effort-Only), or only the outcome (Outcome-Only), or both (Effort-Shock), and chooses an adjustment a from the set $\{-50, -40, \ldots, 0, \ldots, 40, 50\}$. Payoffs are $\pi^P = 10y - w - \frac{|a|}{10}$ for the principal and $\pi^A = w - c(e) + a$ for the agent. Details are common knowledge among all participants; i.e. they know the payoff structure, the set of actions available to each player at each stage, and in the treatments with shock they know the size and the probabilities of all possible shock levels.

The experiment was programmed in z-Tree (Fischbacher, 2007); participants were recruited via hroot (Bock et al., 2014). Roles were fixed and participants were randomly re-matched each period. Sessions were run in 2016 at the Innsbruck EconLab, lasting around 70 minutes. On average, participants earned €12.96.

We ran three sessions per treatment; with three matching groups of eight per session (four principals, four agents), creating nine independent observations per treatment.[4] Given the difference in the mean effort between the Effort-Only and the Effort-Shock treatment – the two treatments where effort is observable – in RS16's data, and given the respective standard deviations, with a sample size of nine observations in each condition and an α of 5%, we have a power of 88% (t-test).[5]

3 Results

We are mainly interested in welfare – defined as the sum of the payoffs of the two parties. Since effort and adjustment are the variables determining welfare, we start by presenting the main result in terms of welfare, and then present the evidence regarding the two components of welfare in backward induction order (i.e., starting with stage 3). In the online-appendix, we extend the analysis by also including wage and desired effort and by displaying the corresponding values of RS16.

Table 1: Summary statistics

	Effort		Adjustment		Welfare	
Effort-Only	5.81		6.96		39.96	
	(0.49)		(2.97)		(5.00)	
Effort-Shock	5.48	**	8.31	*	38.77	**
	(0.55)	**	(3.35)	**	(4.60)	**
Outcome-Only	4.20		-1.28		23.81	
	(0.43)		(2.20)		(3.70)	

Standard errors in parenthesis are based on 9 indep. observations; stars for significance according to Mann-Whitney U-tests, based on 9 indep. observations: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.1 Welfare

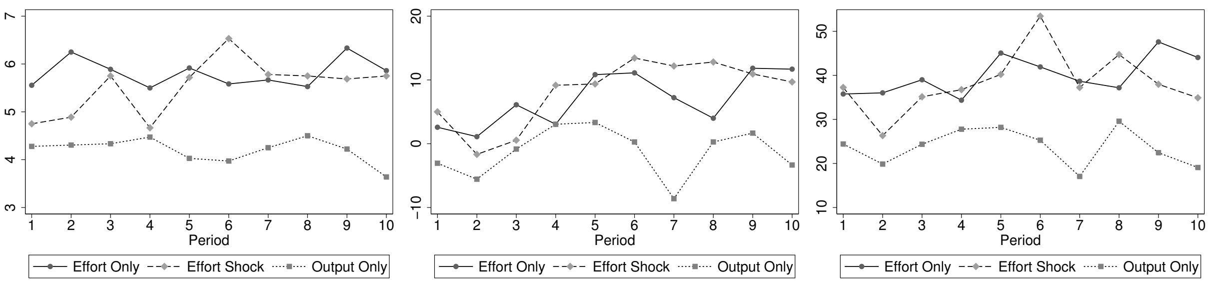
Average welfare is higher in the Effort-Only than in the Outcome-Only treatment (MWU-test, based on 9 independent observations in each condition: $p = 0.05$) and it is higher in the Effort-

[4]In one session of the Effort-Shock treatment, we had a virus appearing at one computer in period five. For the affected group, observations for periods five to ten and demographic information was not stored.

[5]Since each of the nine observations is an average of 40 observations, the sample mean is asymptotically normal distributed, which allows us to use the t-test for the power calculation. An alternative way of calculating the power of our Mann Whitney U-tests (MWU-tests) is the following bootstrap procedure: We draw randomly from the RS16 data 40 observations from each of the nine matching groups from each treatment, and apply the MWU-test to the resulting data. Repeating this protocol 10.000 times and calculating the frequency of cases where the p-value is below 5%, we get a power of 92%.

Figure 1: Averages per period

(a) Effort (b) Adjustment (c) Welfare



Shock than in the Outcome-Only treatment (MWU-test: $p = 0.04$). However, it does not differ between the Effort-Only and the Effort-Shock treatment (MWU-test: $p = 0.96$). Panel (c) of Figure 1 and a panel regression controlling for period effects (see Table 5 in the online-appendix) confirm these results.[6]

Result 1 *In line with findings of RS16, the introduction of an unobservable shock significantly reduces welfare compared to the treatment without shock. In contrast to the findings of RS16, welfare is significantly larger when the shock is observable rather than unobservable, and statistically indistinguishable between the treatment with observable shock and the one without shock.*

3.2 Adjustment

Table 2: Adjustment across the Effort-Only and Effort-Shock treatment

	Av. adjustment and # of obs.			MWU-tests across deviations, p-values		
	Effort < des. ef.	Effort = des. ef.	Effort > des. ef.	Ef. < des. ef. vs. ef. > des. ef.	Ef. < des. ef. vs. ef. = des. ef.	Ef. > des. ef. vs. ef. = des. ef.
Effort-Only	-5.42	19.97	22.26	< 0.01	< 0.01	0.66
N	189	121	50			
Effort-Shock	-4.09	24.48	23.57	< 0.01	< 0.01	0.69
N	193	87	56			
	MWU-tests across treatments					
P-values	0.90	0.15	0.54			

Table 2 shows the average adjustment for given differences between effort and desired effort for

[6] Following RS16, we estimate panel models with individual participants representing random effects and standard errors clustered at the matching group level and calculated via bootstrap. We have also estimated these panel models controlling for gender, age, and risk aversion; results remain unaffected.

the two treatments where effort is observable. In both treatments, effort choices that negatively deviate from the desired effort are punished. By contrast, positive deviations of effort from desired effort are hardly rewarded more than exact fulfillment. This is in line with findings in the literature, indicating that with observable effort, reciprocity is effort-based and that negative reciprocity is a more powerful and robust behavioral phenomena than positive reciprocity – see Abbink et al. (2000), Fehr and Gächter (2000), Baumeister et al. (2001), and Charness and Kuhn (2011).

We find no significant difference between the Effort-Only and the Effort-Shock treatment in adjustment for effort being greater, equal, or lower to desired effort (MWU-tests: all p-values ≥ 0.15). This suggests that matching the desired effort and deviating from it is rewarded or punished similarly in the two treatments – which would be in line with H_1. Panel regressions controlling for period effects and demographic variables confirm these results – see Table 6 in the online-appendix.

Table 3: Effort-Shock treatment: Adjustment for a given shock level

	Average adjustment and # of obs			MWU-tests across deviations, p-values		
Shock	Effort $<$ des. ef.	Effort $=$ des. ef.	Effort $>$ des. ef.	Ef. $<$ des. ef. vs. ef. $>$ des. ef.	Ef. $<$ des. ef. vs. ef. $=$ des. ef.	Ef. $>$ des. ef. vs. ef. $=$ des. ef.
Negative	-7.00	21.95	16.36	< 0.01	< 0.01	0.33
N	80	41	22			
Zero	-8.37	26.43	24.55	< 0.01	< 0.01	0.98
N	43	14	11			
Positive	1.86	26.88	30.00	< 0.01	< 0.01	0.85
N	70	32	23			
	MWU-tests across shocks, p-values					
Neg. shock vs. pos. shock	0.02	0.48	0.06			
Neg. shock vs. zero Shock	0.98	0.62	0.22			
Zero shock vs. pos. shock	0.07	0.99	0.81			

Table 3 dis-aggregates the average adjustment in the Effort-Shock treatment in the effects of negative, zero, or positive deviations of effort from desired effort for different shock levels; it provides support for the hypothesis that the adjustment is influenced by the size of the shock. The effect is most pronounced for positive and negative deviations of effort from desired effort, but (even there) the overall impact seems moderate: When effort exceeds the desired effort, the average adjustment is 16.36 after a negative shock but 30.00 after a positive shock (MWU-test: $p = 0.06$). When effort is below the desired effort, the adjustment is -7.00 after a negative shock, but 1.86 after a positive shock (MWU-test: $p = 0.02$). Importantly, although these two differences are significant at conventional levels when considered in isolation, none of the significant results in the bottom part of Table 3 survives a Bonferroni correction for the simultaneous testing of 18 (or even only 9) hypotheses.[7]

We also searched in other ways for evidence in support of H_2. For instance, given that we mainly find evidence for negative reciprocity, H_2 would imply that punishments that are unjustified when reciprocity is effort-based (i.e., negative adjustments for effort $\geq$ desired effort) occur more frequently in the Effort-Shock than in the Effort-Only treatment – simply because negative shocks happen in the former but are impossible in the latter treatment. This is not what we find, though: When effort is (weakly) larger than desired effort, the frequency of punishments is 4% in the Effort-Only but only 2% in the Effort-Shock treatment (two-sample test of proportions: $p = 0.32$). By contrast, in environments where unjustified punishments are unavoidable even under effort-based reciprocity (because effort is not observable in the Outcome-Only treatment), they happen more frequently. The frequency of negative adjustments for positive deviations of effort from desired effort in the Outcome-Only treatment is 8%, and the difference in frequencies between the Outcome-Only and the Effort-Shock treatment is significant (two-sample test of proportions: $p = 0.02$).

Turning to the impact of the agent's effort on the adjustment, we find economically more pronounced and statistically more robust results: The differences in adjustments between negative deviations of effort from desired effort and zero deviations exceed 20 units for all shock levels and all significant differences displayed in the right part of Table 3 remain significant even when correcting them for the simultaneous testing of 18 hypotheses.

Overall, the evidence presented in Table 3 seems to be consistent with effort-based negative reciprocity, plus some forgiving when the effect of the negative deviation of effort from desired effort is cushioned by a positive shock: When effort is lower than desired effort, the principal punishes the agent with a negative adjustment, except for the case when the negative deviation comes together with a positive random shock. We summarize our findings to the following

[7] In panel regressions controlling for period effects and demographic variables the shock has a significant impact, yet it is much lower than the impact of an additional unit of effort (see Table 7 in the online-appendix).

result:

Result 2 *While the adjustment in the Effort-Shock treatment is influenced by the size of the shock, the impact of effort on the adjustment is more pronounced and more robust than that of the shock. Also, the impact of effort on the adjustment is similar in the Effort-Shock and the Effort-Only treatment.*

3.3 Effort

Average effort is higher in the Effort-Only than in the Outcome-Only treatment (MWU-test: $p = 0.02$), and it is higher in the Effort-Shock than in the Outcome-Only treatment (MWU-test: $p = 0.03$). It does not differ between the Effort-Only and the Effort-Shock treatment (MWU-test: $p = 0.83$). Panel (a) of Figure 1 and a panel regression including period effects (see Table 8 in the online-appendix) confirm these results.[8]

Result 3 *In line with our findings for welfare, average effort is higher in the Effort-Only than in the Outcome-Only treatment, and higher in the Effort-Shock than in the Outcome-Only treatment. It is statistically indistinguishable between the treatment with observable shock and the one without shock, however.*

4 Discussion

We have reproduced RS16's finding that the introduction of shocks reduces efforts when shocks are unobserved. However, we failed to confirm the result that observable shocks have the same impact on behavior as unobservable shocks. Indeed, our evidence from the adjustment stage of the game is consistent with the hypothesis that with observable shocks, reciprocity is mainly effort-based, and that on the top of effort-based reciprocal responses principals share part of the windfall profits (or losses) generated by the shock with the agent. Participants seem to anticipate that the behavior in the last stage of the game is qualitatively similar in the Effort-Shock and the Effort-Only treatment. They therefore behave similarly in these two treatments also earlier in the game.

[8]Panel (a) of Figure 1 suggests that in the first four periods average effort is lower in the Effort-Shock than in the Effort-Only treatment. The difference between the two treatments is not significant, however. This is true for each single period (MWU-tests: all p-values > 0.16) and for the average of the first four periods (MWU-test: $p = 0.25$).

Our finding that the consequences of observable shocks are in part shared without impairing gift-exchange is consistent with recent evidence from laboratory experiments analyzing employer-employee relationships in the face of exogenous shocks (Kocher and Strasser, 2011; Gerhards and Heinz, 2017). However, it is not in line with the main result of RS16. What drives the differences in results?

One candidate explanation is subject pool effects: While RS16 have conducted their study in the US, our sessions have taken place in Austria. If factors such as culture and experience affect gift-exchange – as suggested by the results in Charness et al. (2004), for instance – then reciprocity might be more outcome-based in the subject pool investigated by RS16 than in ours; this tendency could potentially explain the differences in results. We searched for evidence that points in that direction, but failed to find such evidence. Indeed, when we reconstruct our Table 3 using RS16's data, we find results that are very similar to those reported in Subsection 3.2, and reconstructing the panel regression gives similar results that we find in our data – see Table 10 in the online-appendix.

A second candidate explanation is differences in learning dynamics across studies. Comparing the time trends in the Effort-Shock treatment across studies, we find that the difference in average effort is small in the first round but increases steadily in later rounds – for the sake of comparison, we have included RS16's figures in the online-appendix (Figure 3). The following differences in dynamics are responsible for the increasing gap: In our study, the effort in the Effort-Shock treatment is initially between the corresponding values in the Effort-Only and the Outcome-Only treatment. However, after some 'learning rounds', average effort in the Effort-Shock treatment converges to the increasing path in the Effort-Only treatment, while in the Outcome-Only treatment it stays rather constant at a lower level – see panel (a) of Figure 1. By contrast, in RS16, the effort in all the treatments is initially roughly the same. After the initial round, the average effort in the Effort-Only treatment increases over the rounds, while it stays rather constant at a lower level in the Effort-Shock and the Outcome-Only treatment – see panel (a) of Figure 3 in the online-appendix.

The differences in the time trends of effort provision in the Effort-Shock treatment are confirmed by panel regressions controlling for wage, desired effort and 'inverse period' – see Table 9 in the online-appendix. While the effects of wage and desired effort on effort are comparable across studies for all the treatments – and the effect of 'inverse period' on effort is comparable across studies for the Effort-Only and the Outcome-Only treatment – there is a different time trend in the Effort-Shock treatment: While effort is significantly increasing over periods in our study, the variable 'inverse period' is insignificant in RS16's data.

What causes these differences in dynamics across studies? To address this question we investigated the behavior of participants in the initial round. While negative adjustments for cases where effort weakly exceeds desired effort are *generally* rather rare (2% in Effort-Shock, 4% in Effort-Only, and 8% in Outcome-Only in our data), they occur quite frequently in *round one* of the Effort-Shock treatment in RS16. Specifically, in round one of the Effort-Shock treatment the frequency of such 'unjustified punishments' is 33% in RS16's data, but only 7% in our data (two sample test of proportions: $p = 0.08$). This high frequency of unjustified punishments in round one in RS16 might have led agents to believe that exerting high effort is not an adequate shelter against punishment. Such beliefs might have reduced their effort in subsequent rounds. With lower effort in subsequent rounds agents forgo the opportunity to learn that principal behavior is very similar in the Effort-Shock and the Effort-Only treatment.

We conclude that in settings characterized by strategic complementarities small differences in the behavior in initial rounds (caused by subject pool effects or by pure chance) might lead to differences in learning dynamics and thereby to path dependent outcomes in the long run. This insight is not specific to the context under consideration or to lab experiments more generally – it is rather a well-known phenomenon (often called 'hysteresis') in many branches in economics and beyond. Turning back to the specific context of gift-exchange with random shocks, we conclude that although our results are plausible and in line with the results of Kocher and Strasser (2011) and Gerhards and Heinz (2017), their robustness has to be verified in future experiments before policy conclusions can be drawn from existing evidence.

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A Online-appendix

Table 4: Averages of all decision variables and payoffs, our and RS16's data

	Wage	Desired effort	Effort	Adjustment	Principal's payoff	Agent's payoff	Welfare
				Our data			
Effort-Only	35.19	8.08	5.81	6.96	20.68	19.28	39.96
	(3.07)	(0.52)	(0.49)	(2.97)	(2.47)	(3.49)	(5.00)
Effort-Shock	37.31	7.66 **	5.48 **	8.31 *	14.92 **	23.85	38.77 **
	(3.29) **	(0.34) **	(0.55) **	(3.35) **	(2.94)	(3.43) *	(4.60) **
Outcome-Only	29.21	6.44	4.20	−1.28	10.10	13.71	23.81
	(3.00)	(0.44)	(0.43)	(2.20)	(3.18)	(2.66)	(3.70)
				RS16's data			
Effort-Only	41.14	8.95	6.40	1.44	20.91	17.01	37.92
	(3.22) *	(0.31) **	(0.43) *	(3.41)	(3.11) **	(2.77)	(4.28) *
Effort-Shock	33.45	7.63	4.69	−1.81	11.23	14.78	26.01
	(2.98)	(0.34) **	(0.34) **	(2.21)	(3.46) *	(3.28)	(3.41) **
Outcome-Only	33.85	7.63	4.69	−4.97	12.04	13.16	25.19
	(2.28)	(0.25)	(0.41)	(1.32)	(2.85)	(1.95)	(2.33)

Standard errors in parenthesis are based on 9 indep. observations; stars for significance according to Mann-Whitney U-tests, based on 9 indep. observations: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 2: Average per period, first stage behavior

(a) Wage (b) Desired effort

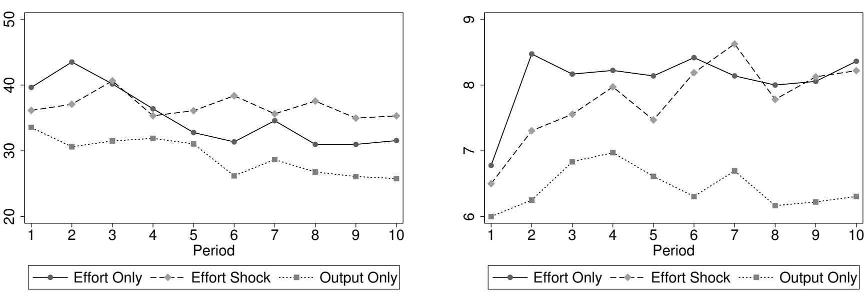


Figure 3: Average per period – RS16's data

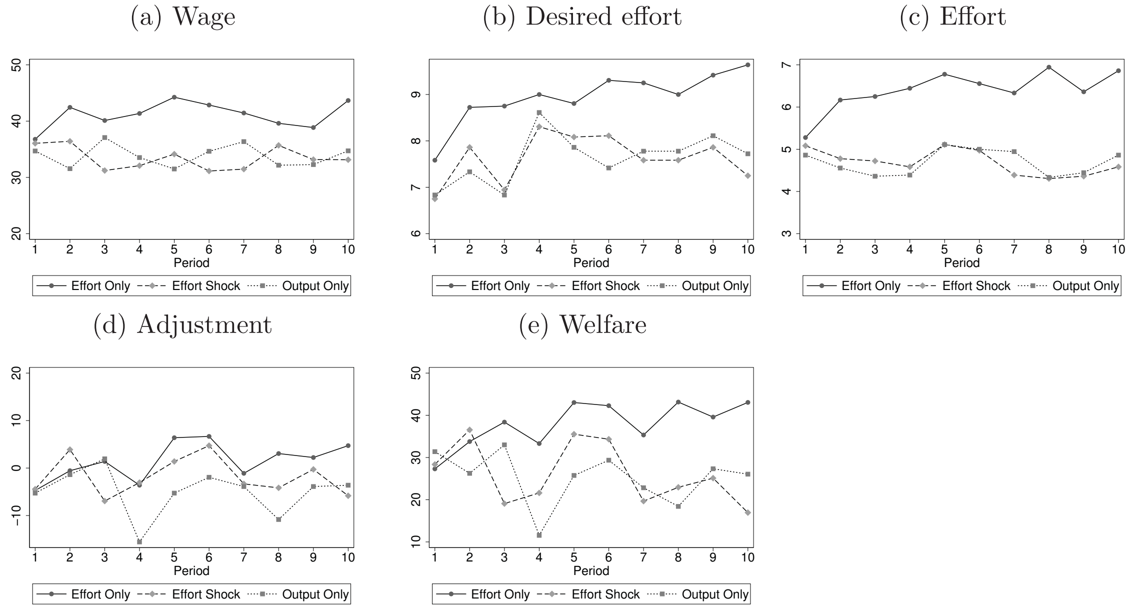


Table 5: Panel model of welfare, controlling for differences between treatments

	(1) All treatments Dep. var.: welfare	
Effort-Shock	−1.37	(8.40)
Outcome-Only	−18.65***	(7.20)
Inverse period	−8.40	(7.92)
Effort-Shock x inv. period	−0.11	(12.08)
Outcome-Only x inv. period	8.51	(10.57)
Constant	42.42***	(5.57)
Observations	1056	

Standard errors in parentheses are clustered on the group level and calculated via bootstrap; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Effort-Shock = 1 if treatment = 'Effort-Shock', zero otherwise. Outcome-Only = 1 if treatment = 'Outcome-Only' and zero otherwise. Inv. period runs from 1 to 1/10. χ^2-test on difference between the treatment dummies: $p = 0.03$.

Table 6: Panel models of adjustment, controlling for differences between treatments

	(1) Effort-Only & Effort-Shock		(2) Effort-Only & Effort-Shock		(3) Effort-Only & Effort-Shock		(4) Effort-Only & Effort-Shock	
	Dependent variable: adjustment							
Effort-Only (EO)	−0.60	(4.24)	−2.13	(3.75)	0.79	(4.31)	−0.70	(3.87)
Effort − des. effort	3.28***	(0.88)	1.70**	(0.76)	3.34***	(0.89)	1.84**	(0.80)
EO x Effort − des. effort	0.17	(1.05)	−0.08	(0.96)	0.40	(1.03)	0.14	(0.93)
Effort > des. effort			0.15	(3.69)			1.00	(3.66)
Effort < des. effort			−19.07***	(3.14)			−17.81***	(3.24)
Inverse period					−13.99***	(4.72)	−13.32***	(4.71)
Gender					4.27	(3.34)	3.50	(3.23)
Age					0.54	(0.36)	0.49	(0.38)
Constant	15.37***	(3.01)	22.75***	(3.15)	4.62	(9.27)	12.55	(10.73)
Observations	696		696		670		670	

Standard errors in parentheses are clustered on the group level and calculated via bootstrap; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 'Effort > des. effort' is a dummy = 1 if effort > des. effort, zero otherwise; 'Effort < des. effort' is a dummy = 1 if effort < des. effort, zero otherwise. Effort-Only (EO) is a dummy if treatment = 'Effort-Only', zero otherwise. Inv. period runs from 1 to 1/10.

Table 7: Panel models of adjustment, investigating importance of shock and effort

	(1) Effort-Shock		(2) Effort-Shock		(3) Effort-Shock		(4) Effort-Shock	
	Dependent variable: adjustment							
Effort − des. effort	3.27***	(0.87)	1.67**	(0.81)	3.35***	(0.84)	1.92**	(0.90)
Shock	2.65***	(0.72)	2.56***	(0.68)	3.34***	(0.55)	3.24***	(0.56)
Effort > des. effort			−1.82	(6.74)			2.36	(6.11)
Effort < des. effort			−19.78***	(4.67)			−15.87***	(3.90)
Inverse period					−16.43***	(5.98)	−14.69***	(5.17)
Gender					5.98	(4.05)	5.45	(3.86)
Age					0.97	(0.60)	0.96	(0.73)
Constant	15.53***	(2.96)	23.59***	(4.52)	−5.49	(15.37)	−0.09	(18.30)
Observations	336		336		320		320	

Standard errors in parentheses are clustered on the group level and calculated via bootstrap; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 'Effort > des. effort' is a dummy = 1 if effort > des. effort, zero otherwise; 'Effort < des. effort' is a dummy = 1 if effort < des. effort, zero otherwise. Effort-Only (EO) is a dummy if treatment = 'Effort-Only', zero otherwise. Inv. period runs from 1 to 1/10.

Table 8: Panel model of effort, controlling for differences between treatments

	(1) All treatments	
	Dep. var.: effort	
Effort-Shock	0.05	(0.89)
Outcome-Only	−1.71**	(0.76)
Inverse period	−0.13	(0.55)
Effort-Shock x inv. period	−1.18	(0.82)
Outcome-Only x inv. period	0.36	(0.70)
Constant	5.85***	(0.55)
Observations	1056	

Standard errors in parentheses are clustered on the group level and calculated via bootstrap; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Effort-Shock = 1 if treatment = 'Effort-Shock', zero otherwise. Outcome-Only = 1 if treatment = 'Outcome-Only' and zero otherwise. Inv. period runs from 1 to 1/10. χ^2-test on difference between the treatment dummies: $p = 0.05$.

Table 9: Panel model of effort, our data and RS16 data

	(1)	(2)	(3)	(4)	(5)	(6)
		Our Data			RS16 Data	
	Effort-Only	Effort-Shock	Outcome-Only	Effort-Only	Effort-Shock	Outcome-Only
	Dependent variable: effort					
Wage	0.07***	0.07***	0.07***	0.09***	0.07***	0.06***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Desired effort	0.11**	0.05	0.05	0.10**	0.07	0.09
	(0.05)	(0.05)	(0.03)	(0.04)	(0.06)	(0.06)
Inverse period	−0.80**	−1.20**	−0.32	−0.93**	0.39	0.15
	(0.34)	(0.52)	(0.43)	(0.36)	(0.65)	(0.47)
Constant	2.69***	2.88***	1.77***	2.06***	1.59***	1.85***
	(0.38)	(0.66)	(0.39)	(0.34)	(0.35)	(0.41)
Observations	360	336	360	360	360	360

Standard errors in parentheses are clustered on the group level and calculated via bootstrap; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Inv. period runs from 1 to 1/10.

Table 10: Panel models of adjustment, investigating importance of shock and effort – RS16's data

	(1)		(2)		(3)		(4)	
	Effort-Shock		Effort-Shock		Effort-Shock		Effort-Shock	
	Dependent variable: adjustment							
Effort – des. effort	2.22***	(0.53)	1.47***	(0.50)	2.24***	(0.55)	1.52***	(0.48)
Shock	2.24***	(0.80)	2.33***	(0.78)	2.35***	(0.80)	2.42***	(0.79)
Effort > des. effort			−1.56	(4.88)			−1.28	(4.50)
Effort < des. effort			−10.97***	(3.32)			−10.37***	(3.24)
Inverse period					−5.40	(3.83)	−4.11	(3.62)
Gender					−2.95	(4.57)	−3.03	(4.38)
Age					1.49	(1.30)	1.18	(1.31)
Constant	4.87*	(2.91)	10.54***	(3.88)	−17.46	(27.39)	−6.41	(26.89)
Observations	360		360		360		360	

Standard errors in parentheses are clustered on the group level and calculated via bootstrap; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 'Effort > des. effort' is a dummy = 1 if effort > des. effort, zero otherwise; 'Effort < des. effort' is a dummy = 1 if effort < des. effort, zero otherwise. Effort-Only (EO) is a dummy if treatment = 'Effort-Only', zero otherwise. Inv. period runs from 1 to 1/10.

B Instructions

[[[These are the instructions for the Effort-Shock treatment. When instructions are adapted to the Effort-Only or the Outcome-Only treatment, we mark the respective parts with squared brackets.]]]

Dear participants,

welcome to today's experiment. For today's experiment, funds are provided by the Austrian Science fund.

Please read the instructions for the experiment carefully. All statements in the instructions are true, and all participants receive exactly the same instructions. Your earnings in the experiment depend on your decisions and potentially the decisions of others. If you have a question, please raise your hand. Your question will then be answered privately. The experiment as well as the data analysis is anonymous. For a better understanding, in the following we will only use male designations. Those should be understood gender neutral.

We ask you to not talk to other participants and to use only the resources and devices that are provided by the conductors of the experiment. Please switch off all electronic devices. In addition, at the computer you are only allowed to use features that are necessary for the experiment. If you do not comply with these rules, you won't be paid in this experiment and you are not allowed to participate in any further experiments.

The currency used in the experiment is tokens. Tokens will be converted to Euros at a rate of 10 tokens to 1 Euro. You have already received a €11.00 participation fee. Your earnings from the experiment will be incorporated into your participation fee. At the end of today's experiment, you will be paid in private and in cash.

The experiment consists of two parts. Together, both parts will last for around 75 minutes. The two parts of the experiment are completely independent from each other. That is, your payment for part x only depends on decisions that you take in part x, and does not depend on decisions you take in the other part of the experiment. At the beginning of each part you receive the corresponding instructions. We will read the instructions out loud and will give you time for questions.

Thank you a lot for your attention and for participating in today's experiment.

Part 1

YOUR ROLE ASSIGNMENT

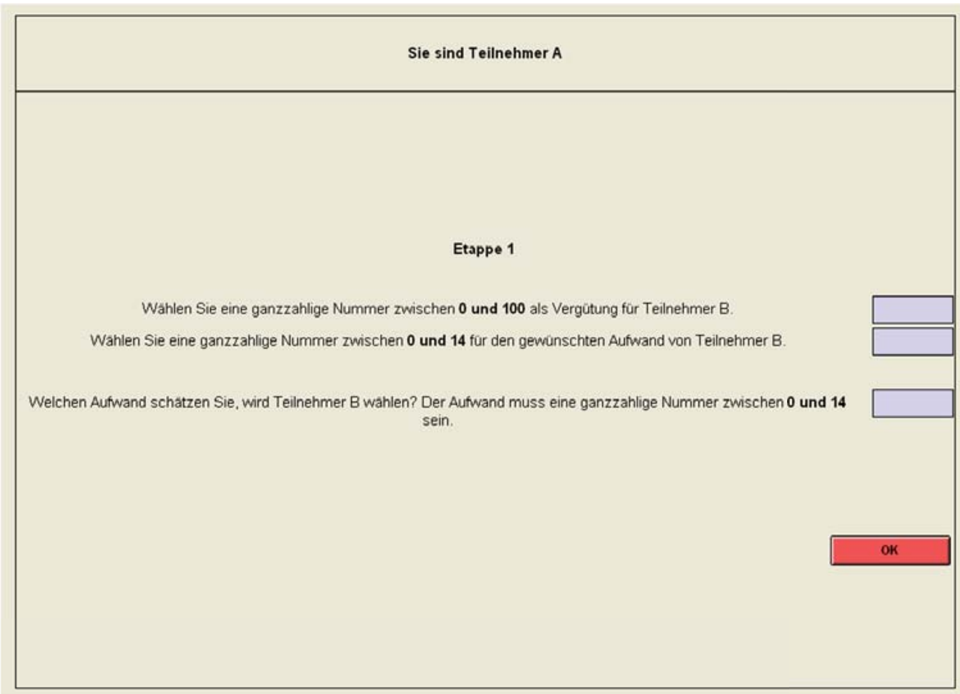
This part consists of 10 periods. Each period, you will be randomly and anonymously placed into a group which consists of two participants: participant A and participant B. At the beginning of the first period you will be randomly assigned either as participant A or participant B. You will remain in the same role throughout part 1 of the experiment. So, if you are assigned as participant B then you will stay as participant B throughout the entire part 1. Each consecutive period you will be randomly re-grouped with another participant of opposite assignment. So, if you are participant B, each period you will be randomly re-grouped with another participant A.

Each period will proceed in three stages.

STAGE 1

In stage 1, participant A will choose a reward (any integer number between 0 and 100) and a desired effort (any integer number between 0 and 14) for participant B.

An example of the stage 1 decision screen for participant A is shown below.



STAGE 2

On the screen, participant B is shown the reward and the desired effort chosen by participant A. Then, participant B will choose an effort level (any integer number between 0 and 14).

An example of the stage 2 decision screen for participant B is shown below.

For each effort level chosen by participant B there is an associated cost of effort. The cost of effort can be found in the following table: Note that as effort rises from 0 to 14, costs rise

Effort	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Cost of effort	0	1	2	5	8	13	18	25	32	41	50	61	72	85	98

exponentially.

STAGE 3

After participant B chooses the effort level, the computer will add to effort a random number to determine the performance of participant B:

Participant B's performance = effort + random number.

The random number chosen by the computer can take a value of -2, -1, 0, 1, or 2. Each number is equally likely to be drawn. After the computer makes the draw of a random number, it will display to participant A the performance of participant B on the screen, as well as the effort chosen by participant B and the random number chosen by the computer.

[[[Effort-Only treatment: After participant B chooses the effort level, the performance of participant B is determined as follows: Participant B's performance = effort of participant B. Then the computer will display to participant A the performance of participant B on the screen.]]]

[[[Outcome-Only treatment: After participant B chooses the effort level, the computer will add to effort a random number to determine the performance of participant B: Participant B's performance = effort + random number. The random number chosen by the computer can take a value of -2, -1, 0, 1, or 2. Each number is equally likely to be drawn. Following the draw of the random number Participants B's performance will be shown to Participant A. Participant A will not know Participant B's actual effort or the random number drawn by the computer. Then, in the third stage, participants 1 will choose an adjustment level. The adjustment level must be a multiple of 10, between -50 and 50.]]]

An example of the stage 3 decision screen for participant A is shown below.

For each adjustment level chosen by participant A there is an associated cost of adjustment. The cost of adjustment can be found in the following table:

Adjustment	-50	-40	-30	-20	-10	0	10	20	30	40	50
Cost of adjustment	5	4	3	2	1	0	1	2	3	4	5

EARNINGS OF PARTICIPANT A

The earnings of participant A depend on the reward chosen by participant A in the first stage, the performance of participant B in the second stage and the adjustment chosen by participant A in the third stage. Specifically, the participant A's earnings are calculated by the following formula:

Participant A's earnings = 10*(performance participant B) − (reward) − (cost of adjustment)
= 10*(effort of participant B + random number) − (reward) − (cost of adj.)

[[[Effort-Only
Participant A's earnings = 10*(performance participant B) − (reward) − (cost of adjustment)]]]

[[[Outcome-Only
Participant A's earnings = 10*(performance participant B) − (reward) − (cost of adjustment)
= 10*(effort of participant B + random number) − (reward) − (cost of adj.)]]]

Note that higher participant B's effort implies higher participant B's performance, and thus higher participant A's earnings. On the other hand, a higher reward or a higher cost of adjustment implies lower participant A's earnings.

EARNINGS OF PARTICIPANT B

The earnings of participant B depend on the reward chosen by participant A in the first stage, the cost of the effort chosen by participant B in the second stage and the adjustment chosen by participant A in the third stage. Specifically, participant B's earnings are calculated by the following formula:

Participant B's earnings = (reward) − (cost of effort) + (adjustment)

Note that a higher reward chosen by participant A implies higher participant B's earnings. On the other hand, a higher effort implies higher effort costs and therefore lower participant B's earnings. If participant A chooses a positive adjustment level for participant B then participant B's earnings increase by that adjustment level. However, if participant A chooses a negative adjustment level then participant B's earnings decrease by that adjustment level.

Example 1

Assume the following scenario. In the first stage, participant A chooses a reward of 50 and a desired effort of 7. In the second stage, participant B chooses an effort of 6. Then the computer randomly selects 2 as a random number, so the performance of participant B is 8 (6+2). Then the computer displays to participant A that participant B's performance is 8, participant B's effort is 6 and the random number chosen by the computer is 2. After observing this information, in the third stage, participant A chooses an adjustment of -40.

Therefore, participant A's earnings = 10*8 − 50 − 4 = 26, since participant B's performance is 8, the reward is 50, and the cost of adjustment of -40 is 4. Finally, participant B's earnings = 50 − 18 − 40 = -8, since the reward is 50, the cost of effort of 6 is 18, and the adjustment is -40.

Example 2

Assume the following scenario. In the first stage, participant A chooses a reward of 40 and a desired effort of 6. In the second stage, participant B chooses an effort of 9. Then the computer randomly selects -2 as a random number, so the performance of participant B is 7 (9-2). Then the computer displays to participant A that participant B's performance is 7, participant B's effort is 9 and the random number chosen by the computer is -2. After observing this information, in the third stage, participant A chooses an adjustment of 30. Therefore, participant A's earnings = 10*7 − 40 − 3 = 27, since participant B's performance is 7, the reward is 40, and the cost of adjustment of 30 is 3. Finally, participant B's earnings = 40 − 41 + 30 = 29, since the reward is 40, the cost of effort of 9 is 41, and the adjustment is 30.

[[[The examples are accordingly adjusted for the Effort-Only and Outcome-Only treatments.]]]

END OF THE PERIOD

The computer will display to both participants the following information: the reward chosen by participant A, the desired effort chosen by participant A, the performance of participant B, the effort chosen by participant B, the random number chosen by the computer, the adjustment chosen by participant A, as well as individual earnings for that period.

[[[Effort-Only: At the end of each period, the computer will display to both participants the following information: the reward chosen by participant A, the desired effort chosen by participant A, the performance of participant B, the adjustment chosen by participant A, as well as individual earnings for that period. An example of the outcome screen is shown below.]]]

[[[Outcome-Only: The computer will display to both participants the following information: the reward chosen by participant A, the desired effort chosen by participant A, the performance of participant B, the effort chosen by participant B, the random number chosen by the computer, the adjustment chosen by participant A, as well as individual earnings for that period.]]]

At the end of each period, the computer will calculate individual earnings.

An example is shown on the following picture.

Once your earnings are displayed on the outcome screen as shown below you should record your earnings for the period on your Personal Record Sheet under the appropriate heading.

IMPORTANT NOTES

Remember you have already received a €11.00 participation fee. In part 1 of the experiment, depending

on a period, you may receive either positive or negative earnings. At the end of part 1 we will randomly select 1 out of 10 periods for actual payment and convert the income thereof to a payment in Euros. If the earnings are negative, we will subtract them from your total earnings. If the earnings are positive, we will add them to your total earnings. Are there any questions?

Control questions (implemented in z-Tree)

Question 1: Assume the following scenario. In the first stage, participant A chooses a reward of 90 and a desired effort of 12. In the second stage, participant B chooses an effort of 13. Then the computer randomly selects -2 as a random number, so the performance of participant B is 11 (13 -2). Then the computer displays to participant A that participant B's performance is 11, participant B's effort is 13 and the random number chosen by the computer is 2. After observing this information, in the third stage, participant A chooses an adjustment of 50. What are participant A's earnings? _____(correct: 10*11-90-5 = 15) What are participant B's earnings? _____ (correct: 90-85+5 = 10)

Question 2: Assume the following scenario. In the first stage, participant A chooses a reward of 20 and a desired effort of 14. In the second stage, participant B chooses an effort of 4. Then the computer randomly selects 2 as a random number, so the performance of participant B is 6 (4 +2). Then the computer displays to participant A that participant B's performance is 6, participant B's effort is 4 and the random number chosen by the computer is 2. After observing this information, in the third stage, participant A chooses an adjustment of 0. What are participant A's earnings? ______(correct: 10*6-20+0 = 40) What are participant B's earnings? ______ (correct: 20-8+0 = 12)

[[[Effort-Only, Question 1: Assume the following scenario. In the first stage, participant A chooses a reward of 90 and a desired effort of 12. In the second stage, participant B chooses an effort of 13, so the performance of participant B is 13. Then the computer displays to participant A that participant B's performance is 13. After observing this information, in the third stage, participant A chooses an adjustment of 50. What are participant A's earnings? ______(correct: 10*13-90-5 = 35) What are participant B's earnings? ______ (correct: 90-85+5 = 10)

Question 2: Assume the following scenario. In the first stage, participant A chooses a reward of 20 and a desired effort of 14. In the second stage, participant B chooses an effort of 4, so the performance of participant B is 4. Then the computer displays to participant A that participant B's performance is 4. After observing this information, in the third stage, participant A chooses an adjustment of 0. What are participant A's earnings? ______(correct: 10*4-20+0 = 20) What are participant B's earnings? ______ (correct: 20-8+0 = 12)]]]

[[[Outcome-Only, Question 1: Assume the following scenario. In the first stage, participant A chooses a reward of 90 and a desired effort of 12. In the second stage, participant B chooses an effort of 13. Then the computer randomly selects -2 as a random number, so the performance of participant B is 11 (13 -2). Then the computer displays to participant A that participant B's performance is 11. After observing this information, in the third stage, participant A chooses an adjustment of 50. What are participant A's earnings? ______(correct: 10*11-90-5 = 15) What are participant B's earnings? ______ (correct: 90-85+5 = 10)

Question 2: Assume the following scenario. In the first stage, participant A chooses a reward of 20 and a desired effort of 14. In the second stage, participant B chooses an effort of 4. Then the computer randomly selects 2 as a random number, so the performance of participant B is 6 (4 +2). Then the computer displays to participant A that participant B's performance is 6. After observing this information, in the third stage, participant A chooses an adjustment of 0. What are participant A's earnings? ______(correct: 10*6-20+0 = 40) What are participant B's earnings? ______ (correct: 20-8+0 = 12)]]]

Personal Record Sheet

This sheet is for yourself, to record the earnings you have for each period.

You are participant A / B (circle one)

Period	Step 1 Wage	Step 1 Desired effort	Step 2 Perform.	Step 2 Effort	Step 2 Random number	Step 3 Adj.	Income from decisions/beliefs	Income period
1								
2								
3								
. . .								

Total income:
Payment of part 1:
Income of the chosen period in token:
Income of the chosen period in Euro: ______ (1)
Participation fee: ______ (2)
Payment of part 2: ______ (3)
Total payment: (1) + (2) + (3) ____

Part 2

On your computer screen you will see a square composed of 100 numbered boxes, like shown below.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Behind one of these boxes hides a mine; all the other 99 boxes are free from mines. You do not know where this mine lies. You only know that the mine can be in any place with equal probability.

Your task is to decide how many boxes to collect. Boxes will be collected in numerical order. So you will be asked to choose a number between 1 and 100.

At the end of the experiment we will randomly determine the number of the box containing the mine. If you happen to have harvested the box where the mine is located – i.e. if your chosen number is greater than or equal to the drawn number – you will earn zero. If the mine is located in a box that you did not harvest – i.e. if your chosen number is smaller than the drawn number – you will earn in euro an amount equivalent to the number you have chosen.

In the next screen we will ask you to indicate how many boxes you would like to collect. You confirm your choice by hitting 'OK'.

Extra Sheet

Effort participant B	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Cost of effort	0	1	2	5	8	13	18	25	32	41	50	61	72	85	98

Adjustment participant A	-50	-40	-30	-20	-10	0	10	20	30	40	50
Cost of adjustment	5	4	3	2	1	0	1	2	3	4	5

Participant B's performance = effort + random number.

Participant A's earnings = 10*(performance participant B) − (reward) − (cost of adjustment)

= 10*(effort of participant B + random number) − (reward) − (cost of adj.)

[[[Effort-Only

Participant A's earnings = 10*(performance participant B) − (reward) − (cost of adjustment)]]]

[[[Outcome-Only

Participant A's earnings = 10*(performance participant B) − (reward) − (cost of adjustment)

= 10*(effort of participant B + random number) − (reward) − (cost of adj.)]]]

Participant B's earnings = (reward) − (cost of effort) + (adjustment)