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Emil Persson

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Department of Economics
School of Business, Economics and Law at University of Gothenburg
Vasagatan 1, PO Box 640, SE 405 30 Göteborg, Sweden
+46 31 786 0000, +46 31 786 1326 (fax)
www.handels.gu.se   info@handels.gu.se

Frustration and Anger in Games: A First Empirical Test of the Theory

Emil Persson*

Department of Economics, University of Gothenburg, Sweden

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Abstract

Anger can be a strong behavioral force, with important consequences for human interaction. For example, angry individuals may become hostile in their dealings with others, and this has strategic consequences. Battigalli, Dufwenberg, and Smith (2015; BDS) develop a formal framework where frustration and anger affect interaction and shape economic outcomes. This paper designs an experiment testing the predictions based on central concepts of their theory. The focus is on situations where other-responsibility is weak or nonexistent, and in this specific context I find only limited support for the theory: While unfulfilled expectations about material payoffs seem to generate negative emotions in subjects, which is in line with BDS' conceptualization of frustration, behavior is generally not affected by these emotions to the extent predicted by the theory.

Keywords: Emotion, Anger, Blame, Psychological games, Experiment.

JEL Codes: C72, C91, D03.

*Department of Economics, University of Gothenburg, Box 640, SE 405 30 Gothenburg, Sweden; Tel.: +46 31 786 2927; E-mail: emil.persson@economics.gu.se.

1 Introduction

Anger can be a strong behavioral force, with important consequences for human interaction. For example, angry individuals may become hostile in their dealings with others, which could shape interaction and outcomes in, for example, situations involving negotiation and bargaining, contractual holdup, delegated decision making, conflict, and social dilemmas.[1]

Although it seems important to understand the sources of anger, as well as its consequences for strategic interaction, this topic has received relatively little attention in the development of behavioral theory.[2] Battigalli, Dufwenberg, and Smith (2015; henceforth, BDS) contribute to fill this gap in the literature by developing a theory where frustration and anger affect interaction and outcomes, using the framework of psychological game theory (Geanakoplos et al., 1989; Battigalli and Dufwenberg, 2009). The objective of my paper is to investigate the empirical relevance of BDS, and to this end I design an experiment that tests the predictions based on central concepts of their theory. This constitutes the first empirical test of BDS.

In BDS, anger is anchored in frustration, which is the result of unfulfilled expectations about material payoffs.[3] Frustration sometimes makes players hostile toward their co-players. When frustrated, a player may go after other players, but his desire to do so depends on his evaluation of the other players' part in the outcome that frustrates him. BDS develop three different versions of how this evaluation process shapes the actions of frustrated players: With *simple anger*, frustrated players are angry with anyone, regardless of the source of frustration; with *anger from blaming behavior*, players are targeted only if they caused frustration; and with *anger from blaming intentions*, players are targeted only if they intended to cause frustration.

With this paper I develop empirical tests for two key features of the theory: simple anger and anger from blaming behavior. Simple anger (BDS' first anger hypothesis) formalizes a version of the classical Dollard et al. frustration-aggression-displacement hypothesis, where aggression through a displacement effect is directed at substitute targets (Dollard et al., 1939; Berkowitz, 1989). Such displaced aggression could be relevant when the source of frustration

[1] For empirical accounts of negative emotions and anger in similar situations, see e.g., Pillutla and Murnighan (1996), Sanfey et al. (2003), Bosman and van Winden (2002), Bolle et al. (2014), Hopfensitz and Reuben (2009), and Drouvelis and Grosskopf (2014).

[2] This is especially true for the analysis of immediate (as opposed to anticipated) emotions, which focuses on the "action tendency" of emotions experienced by the decision maker (e.g., Elster, 1998; Loewenstein, 2000).

[3] This is based on the notion of frustration as an obstruction to reaching a desired outcome, which is a common conceptualization in psychology; see, e.g., BDS or Potegal and Stemmler (2010) for details and discussion. For alternative ways to model anger, see, e.g., Akerlof (2015) who focuses on rule violations as a source of anger.

is intangible, as in the case of an unexpected loss suffered by a local soccer team, which has been associated with substantial increases in domestic violence and violent crime (Card and Dahl, 2011; Munyo and Rossi, 2013). Dramatic changes in weather and climate could have a similar effect, for instance through strong and correlated income shocks as a source of frustration and anger.[4] With anger from blaming behavior (BDS' second anger hypothesis), frustrated individuals are angry with those who caused frustration through their behavior. Vis-à-vis simple anger, a key ingredient for anger from blaming behavior is the importance of blame attribution and other-responsibility;[5] and vis-à-vis anger from blaming intentions, anger from blaming behavior is more relevant if people focus more on what they can observe (and expect to observe) rather than on intentions, which in many situations are more difficult to discern.

BDS create a rich framework for theoretical analysis. It is, however, quite challenging to develop convincing empirical tests of the theory, partly because people's behavior is shaped both by the emotions they experience themselves and by their anticipation of others' behavior due to the emotions they might experience (it is a psychological game where subjects have belief-dependent utility functions), and partly also because the different versions of the theory may predict similar behavioral patterns in a given situation of interest. Therefore, the empirical strategy in the present paper is to lift up, focus on, and compare key features of the theory in a condensed and specific setting, as simply as possible. The experimental treatments are built around the following situation: A player who had a good chance to earn 100 Swedish kronor (about 12 US dollars at the time of writing) finds himself with only 10 kronor. Is he frustrated? Theory suggests he might be, since he has been obstructed from reaching a desired outcome. Would he punish a passive co-player, who had no chance at all to prevent the misfortune? Simple anger suggests he might. Would he punish an active co-player, who made a "bad" choice in a binary lottery and thereby caused the misfortune? Anger from blaming behavior suggests he might.

I develop specific empirical tests for simple anger and anger from blaming behavior. The tests are quite extreme in that they focus on relatively unsophisticated behavior, such as Pareto-damaging punishment of passive co-players. Theoretically, simple anger is widely applicable to situations involving sophisticated strategic interaction, but the conceptual basis is quite rudimentary: I hit my head on the kitchen shelf and therefore I punish you; I hit my thumb with a hammer and therefore I punish you; or you bring me bad news and therefore I punish you (Frijda, 1993). Focusing on this aspect seems natural for a first empirical

[4]See, e.g., Burke et al. (2015) and Ranson (2014) for a discussion and empirical evidence on climate and interpersonal violence.

[5]See, e.g., Averill (1983), Smith and Ellsworth (1985), and Wranik and Scherer (2010) for a discussion on the role of blame attribution in anger.

test of the theory. Moreover, while anger from blaming behavior admits more sophisticated reasoning (about co-players' blameworthiness), it too can be quite rudimentary. For example, it admits punishment for mistakes or bad luck. Gurdal et al. (2013) document behavior that is consistent with this aspect of anger from blaming behavior. In their experiment, an agent invests money on behalf of a principal. The agent chooses between a safe and a risky prospect, and the principal subsequently decides on remuneration for the agent and a dummy player. Interestingly and in line with anger from blaming behavior, Gurdal et al. find that agents are paid less (relative to the dummy player) following bad realizations of the risky prospect, i.e., they are punished for bad uncontrollable luck.[6] Building on these insights, I specifically test whether aspects of blame, frustration, and punishment in BDS are relevant in situations where other-responsibly is weak or nonexistent. The focus of the paper is thus on emotion and behavior at one end of a spectrum, where there is complete payoff symmetry between players (i.e., no economic inequality) and where frustration is caused by chance moves or bad luck rather than harmful actions with blameworthy intent.

Results from the experiment indicate that unfulfilled expectations about material payoffs generate negative emotions in subjects, which is in line with BDS' conceptualization of frustration. However, these negative emotions do not generally affect subjects' behavior to the extent predicted by the theory. The experiment focuses on situations where other-responsibility is weak or nonexistent, and in this specific context I do not find much support for the simple anger hypothesis or the anger from blaming behavior hypothesis.

The rest of the paper is organized as follows. Section 2 describes relevant aspects of BDS' theory and illustrates the concepts of simple anger and anger from blaming behavior using two examples. Section 3 describes and motivates the experimental design, which is based on operationalized versions of these two examples, and derives hypotheses for the experiment. The results are presented in Section 4, and in the final section I discuss the findings and conclude the paper.

[6] On punishment for mistakes or bad luck, see also Cushman et al. (2009), Gino et al. (2010), and Bartling and Fischbacher (2012); but cf. Rand et al. (2015). Furthermore, Mollerstrom et al. (2015) and Cappelen et al. (2015) find that irrelevant or forced decisions affect how third-party spectators are willing to compensate people for bad luck. In particular, Cappelen et al. (2015) implement an experiment where subjects are allocated money based on a procedure that is very similar to the one used in the present paper, and they find strong effects on redistribution decisions ex post. There is also a related literature on "outcome bias," which examines how negative uncontrollable outcomes affect how other persons are evaluated (e.g., Baron and Hershey, 1988; Tan and Lipe, 1997).

2 Frustration and anger

This section describes BDS' theory (short version) using two examples to illustrate the concepts of *simple anger* (Section 2.1) and *anger from blaming behavior* (Section 2.2). Later on, these examples will be operationalized and implemented as the two main treatments in the experiment (Section 3).

There are two players and two stages. Actions are represented by a sequence $(a^t)_{t=1,2}$, where $a^t = (a_i^t, a_j^t)$ and $i \neq j$. For instance, a^1 represents the actions taken in the first stage such that $h = a^1$ is a history of length one, and a_i^2 represents player i's action in the second stage. Conditional on a history of actions, i's belief about his own action (which is interpreted as his plan) and i's belief about j's action are given by α_i. The material end-game payoff for i depends on actions taken during the course of the game (a^1 and a^2) and is denoted π_i.

Anger is anchored in frustration, which is a key aspect of the theory. It is the result of unfulfilled expectations, i.e., when the best attainable outcome falls short of a person's expectation ex ante (which means that he was obstructed from reaching a desired outcome). At $t = 2$, i's frustration is given by

$$F_i(a^1; \alpha_i) = \left[\mathbb{E}\left[\pi_i; \alpha_i\right] - \max_{a_i^2} \mathbb{E}\left[\pi_i \mid (a^1, a_i^2); \alpha_i\right] \right]^+, \tag{1}$$

where $[x]^+ = \max\{x, 0\}$. That is, it is the difference between the end-game payoff i expected at $t = 1$ (first term) and the maximal end-game payoff i realizes that he can secure for himself at $t = 2$ (second term). Frustration is thus the result of unexpected bad outcomes beyond i's control.

Frustration sometimes makes players hostile toward their co-player. When i is frustrated, he may go after j, but his desire to do so depends on his evaluation of j's part in the outcome that frustrates him. BDS develop three different versions of how this evaluation process shapes the actions of frustrated players: With *simple anger* (SA), player i is angry with j regardless of the source of frustration; in contrast, with *anger from blaming behavior* (ABB), player j will be targeted only if he caused i's frustration, and with *anger from blaming intentions* (ABI), player j will be targeted only if his intention was to frustrate i. The behavior of player i moving at history h is determined by the following general utility function:

$$U_i(h, a_i; \alpha_i) = \mathbb{E}\left[\pi_i \mid (h, a_i); \alpha_i\right] - \theta_i B_{ij}(h; \alpha_i) \mathbb{E}\left[\pi_j \mid (h, a_i); \alpha_i\right], \tag{2}$$

where $\theta_i \geq 0$ is a sensitivity parameter. When i is frustrated and under the impression it is j's fault (which is governed by the blame function $B_{ij} \in [0, F_i]$), he will consider forgoing own material payoff (π_i) in order to reduce j's payoff (π_j). The formula in (2) thus implements punishment as the action tendency of frustration. The three versions of anger are separated by the blame function $B_{ij}(h;\alpha_i)$, which determines what amount of frustration i attributes to j, i.e., to what extent i blames j for his frustration. This function is always less than or equal to i's frustration, $F_i(h;\alpha_i)$.

For simple anger, blame always equals frustration:

$$B_{ij}^{SA}(h;\alpha_i) = F_i(h;\alpha_i). \tag{3}$$

For anger from blaming behavior, i's blame of j depends on j's behavior. BDS consider two different functional forms of the blame function for anger from blaming behavior: With *could-have-been blame*, player i considers what "could have been" (at most) had j chosen a different action, and with *blaming unexpected deviations*, player i considers instead the material payoff he would have obtained had j behaved as i expected him to. The blame function for the former, could-have-been blame, is:

$$B_{ij}^{ABB}(h;\alpha_i) = \min\left\{\left[\max_{h' \prec h, a'_j \in A_j(h')} \mathbb{E}\left[\pi_i \mid (h', a'_j);\alpha_i\right] - \mathbb{E}\left[\pi_i \mid h;\alpha_i\right]\right]^+, F_i(h;\alpha_i)\right\}, \tag{4}$$

thus capturing the difference between the maximal expected payoff j could have given i through his action a'_j (choosing from all possible actions A_j) at history h' (which precedes h) and the payoff that i currently (at h) expects to secure for himself at the end of the game. Turning to the latter functional form of the blame function for anger from blaming behavior, blaming unexpected deviations, the blame function is instead:

$$B_{ij}^{ABB}(h;\alpha_i) = \min\left\{\left[\sum_{h' \prec h, a'_j \in A_j(h')} \alpha_{ij}(a'_j)\mathbb{E}\left[\pi_i \mid (h', a'_j);\alpha_i\right] - \mathbb{E}\left[\pi_i \mid h;\alpha_i\right]\right]^+, F_i(h;\alpha_i)\right\}, \tag{5}$$

such that i considers his expected payoff had j behaved as i expected ($a_{ij}(a'_j)$ is the marginal probability with which i thinks that j chooses action a'_j), and compares it with his current expected payoff (second term).[7]

[7] With BDS' third version of blame, anger from blaming intentions, i takes j's intentions to frustrate i into account: he compares the material payoff resulting from j's action with the material payoff he thinks that j thought would result from his action (blame thus depends on i's belief about j's belief about i's action). I don't test this aspect of BDS' theory and thus the interested reader is referred to BDS for formal treatment and further discussion.

2.1 A game with a correlated income shock

BDS illustrate the difference between blame modulated through simple anger and anger from blaming behavior (and anger from blaming intentions) with an example (Figure 1). A carpenter (Andy) and his co-worker (passive player Bob) are at work. On a good day (G), they both earn a high wage of 2 and thus everything is fine. However, on the occasional bad day (B) Andy accidentally hits his thumb with a hammer. He becomes frustrated and may turn on his co-worker Bob (T) even though he did not cause the upset, or, alternatively, he accepts things as they are (N) and they can move on with their production. Chance determines whether B or G prevails, with probability p and $(1-p)$, respectively.

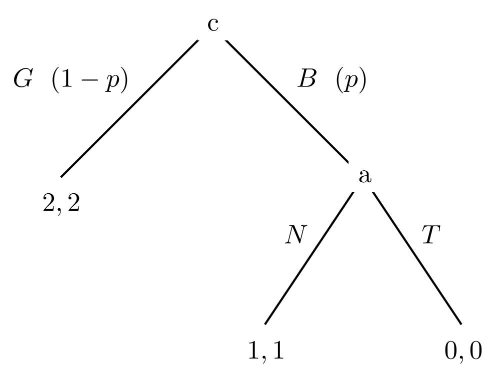

Figure 1: The simple anger game ("Hammering one's thumb")

The bad day thus comes with a correlated income shock, which frustrates Andy if the maximal payoff at $t = 2$ (which is 1) is less than the payoff Andy expected at $t = 1$. Frustration thus depends on p and on Andy's belief at $t = 1$ about his own action in the event of B, i.e., how he plans to react when frustrated due to B. In formal terms, Andy initially expected to earn a material payoff of $\mathbb{E}[\pi_a; \alpha_a] = 2(1-p) + \alpha_a(N|B)p$, where $\alpha_a(N|B) \in [0, 1]$ is Andy's plan for the bad day B, i.e., the probability with which he expects to choose N should B occur. On the bad day B, the maximal payoff Andy can secure for himself (by choosing $a_a^2 = N$) is 1. Thus, using (1), his frustration at $t = 2$ is given by:

$$F_a(B; \alpha_a) = 2(1-p) + \alpha_a(N|B)p - 1 \tag{6}$$

and it is increasing in $\alpha_a(N|B)$ and also in $-p$, since this increases the payoff Andy initially expects.

With simple anger, Andy might punish Bob for the frustrating outcome B. This is Pareto damaging in terms of material payoffs but still preferable to Andy if he is sufficiently "prone to anger" (which is determined by the sensitivity parameter θ_a in the utility function). Using

(2), Andy's utility from N is $1 - \theta_a [2(1-p) + \alpha_a(N|B)p - 1] \cdot 1$, and his utility from T is 0. Thus, Andy will punish Bob (by choosing T) if θ_a is sufficiently large, since then $U_a(T) \geq U_a(N)$. In contrast, neither with anger from blaming behavior nor with anger from blaming intentions does Andy blame Bob for B (so $B_{ab} = 0$), because Bob had no possibility to affect the outcome in the game. Hence, Andy will not punish Bob under these two versions of the theory.

2.1.1 Equilibrium

BDS employ the notion of sequential equilibrium (SE) adapted to psychological games by Battigalli and Dufwenberg (2009).[8] The SE concept requires that action profiles are sequentially rational, such that no gains can be made by deviating from planned actions, and that beliefs are correct. In the game between Andy and Bob above, there are three types of equilibria when frustration is modulated through simple anger (and $p < 1/2$):[9]

(i) If θ_a is large enough, Andy cares a lot about frustration and thus he will punish Bob after B ($a_a^2 = T$). There is an SE with $\alpha_a(N|B) = 0$ and $U_a(B, T; \alpha_a) \geq U_a(B, N; \alpha_a)$, such that $\theta_a \geq \frac{1}{1-2p}$.

(ii) If θ_a is small enough, Andy does not care much about frustration and thus he will not punish Bob after B ($a_a^2 = N$). There is an SE with $\alpha_a(N|B) = 1$ and $U_a(B, T; \alpha_a) \leq U_a(B, N; \alpha_a)$, such that $\theta_a \leq \frac{1}{1-p}$.

(iii) For a small intermediate interval of θ_a, Andy's belief that he will punish Bob after B is increasing in θ_a (i.e, in the extent to which he cares about frustration). There is an SE with $\alpha_a(N|B) = \frac{1}{p\theta_a} - \frac{1-2p}{p}$ and $U_a(B, T; \alpha_a) = U_a(B, N; \alpha_a)$, such that $\theta_a \in (\frac{1}{1-p}, \frac{1}{1-2p})$.

2.2 A game with a correlated income shock and some blame

In order to bring anger from blaming behavior into play and make it comparable with simple anger, consider the following modification of the simple anger game displayed in Figure 1: Chance moves L or R with probability $(1-p)$ and p, respectively, and thereafter Bob chooses between l and r without having observed the chance move. Bob's choice leads to states identical to B and G in the simple anger game, but whether l or r is the "good" choice that

[8] They explore a second solution concept, "polymorphic sequential equilibrium," in order to develop a different conceptualization of players' intentions. A discussion of this concept is therefore beyond the scope of this paper.

[9] We consider $p < 1/2$ since it may generate frustration. (When $p \geq 1/2$, Andy will not be frustrated after B and thus he will always choose N in this case.)

leads to G depends on chance: l leads to G and r to B after L, and vice versa after R. The game is displayed in Figure 2.

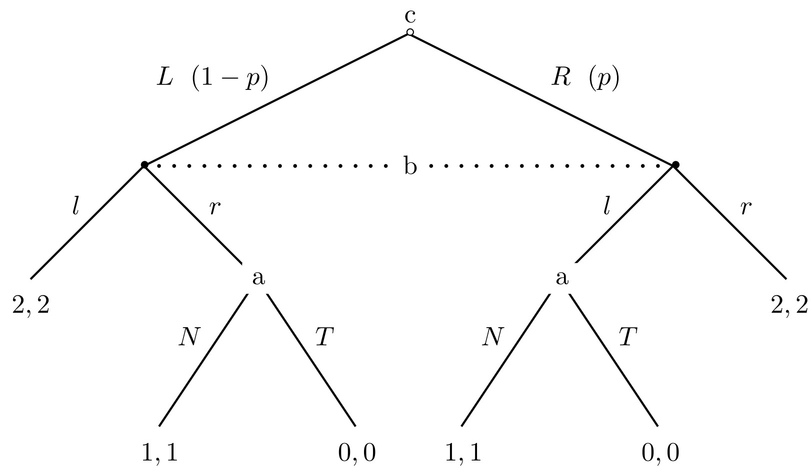

Figure 2: The blame-behavior game

For ease of comparison with the simple anger game, we restrict attention to situations where $p < 1/2$. Andy's frustration depends on his belief (at the root of the game) about Bob's plan, and we let $\alpha_a(l)$ denote the probability with which Andy expects Bob to choose l. If $\alpha_a(l) = 1$, Andy expects l with certainty and his plan for the bad day B is given by $\alpha_a(N|(R, l))$, i.e., the probability with which he expects to choose N in the event of B. Andy's frustration on the bad day is thus given by $F_a((R, l); \alpha_a) = 2(1-p) + \alpha_a(N|(R, l))p - 1$ and it is similar to frustration in the simple anger game, given by (6) above. The equation says that if Andy expects l with certainty, his frustration after B is increasing in the probability of L, i.e. the probability with which l leads to the good day G since this increases his ex-ante expected payoff. With simple anger, there are then equilibria where $\alpha_a(l) = 1$ and, as in the simple anger game above, (i) Andy with $\theta_a \geq \frac{1}{1-2p}$ punishes Bob after B, (ii) Andy with $\theta_a \leq \frac{1}{1-p}$ does not punish Bob after B, and (iii) Andy with $\theta_a \in (\frac{1}{1-p}, \frac{1}{1-2p})$ is indifferent between punishing and not punishing Bob after B.[10]

Bob moves before Andy and this opens for the possibility of Andy blaming and punishing Bob in accordance with anger from blaming behavior. With could-have-been blame (first version of anger from blaming behavior), predictions coincide with simple anger predictions. The reason is that Andy blames Bob for frustrating him, since whenever the bad day occurs it would have been avoided had Bob chosen differently. For example, if the bad day is due to (R, l), it would have been avoided had Bob chosen r instead of l. Even though Bob from

[10]For Bob, l is optimal when $p < 1/2$ since it maximizes the chance of the good day G with the high payoff (and, given Andy's plan, Bob deviating would not affect Andy's aggression on the bad day B).

an ex-ante perspective could not prevent the income shock (beyond choosing the action that maximizes their chance of the good day G, which is l when $p < 1/2$), by (4) Andy fully blames Bob for his frustration. In contrast, with blaming unexpected deviations (second version of anger from blaming behavior), by (5) Andy would not blame Bob and therefore not punish him after (R, l) if l is what he expected at the root of the game, and vice versa for (L, r) if r is what he initially expected.[11] This illustrates the difference between could-have-been blame and blaming unexpected deviations, since only with the former is there an SE where Bob is punished in the blame-behavior game.

In general, Andy is as frustrated on the bad day in the simple anger game (Figure 1) as in the blame-behavior game (Figure 2). Since Bob is always blamed for the bad day in the latter game using could-have-been blame, comparing across games we have exogenous variation in the extent to which Bob can be blamed for a given level of frustration. Simple anger is relevant in both games but anger from blaming behavior is relevant in only one of them, and this constitutes the basic idea for the empirical strategy used in the present paper.

3 Experiment

3.1 Design

The main objective of this paper is to test condensed versions of simple anger and anger from blaming behavior (could-have-been blame). To this end, I operationalize the simple anger game (Figure 1) and the blame-behavior game (Figure 2) in two separate between-subject treatments: a *Simple* treatment (Figure 3) and a *Blame-behavior* treatment (Figure 4).

Henceforth, Andy is called player **a** and Bob player **b**. Two important modifications are made when operationalizing the games: First, since frustration in the bad state B originates in a low p, I increase the outside payoff and set $p = 1/2$ in order to be able to implement the games using the direct-response method rather than the strategy method (with a low p the direct-response method would consume an unreasonable amount of observations). Therefore, frustration in the experimental treatments originates in a high outside payoff rather than in a low p. The choice of p at exactly $1/2$ makes it as easy as possible for subjects to understand and calculate their expected and counterfactual payoffs in each game. It also makes **a**'s frustration in the blame-behavior game independent of his belief about **b**'s behavior, since the bad state B is equally likely whether he chooses l or r (and conversely for the good state

[11] Of course, if Andy initially expected r but Bob deviated by choosing l, Andy would blame Bob for the bad day occurring due to (R, l) since it would have been avoided had Bob behaved as Andy expected. This is the basis for an SE where Andy expects r and Bob chooses r in order to deflect blame, even though l would maximize the chance of the good day G when $p < 1/2$.

G). This removes a potential source of bias in the comparison across the treatments, since otherwise we would have to elicit and condition on **a**'s belief about **b**'s behavior in the *Blame-behavior* treatment. A second modification is that the choice set of **a** is expanded to allow for gradual punishment decisions. It is an implication of BDS that a sufficiently frustrated player i will punish j as much as possible if he blames j for his frustration, and this is due to the linearity of the utility function in (2). Interestingly, Bosman and van Winden (2002) emphasize this aspect of emotional punishment in the context of their power-to-take game, and with the modified choice set of **a** the experimental treatments admit investigation of this aspect in the context of BDS' theory.[12]

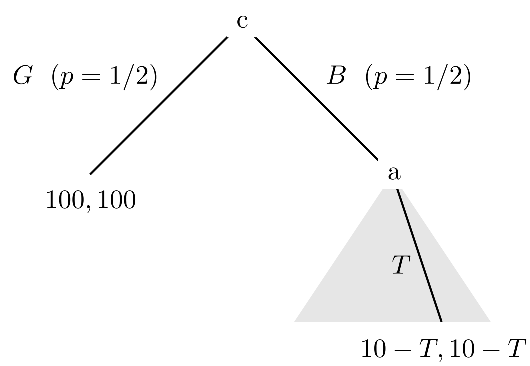

Figure 3: The *Simple* treatment

A third treatment, *Simple-strategy*, implements the *Simple* treatment using the strategy method, such that **a** decides on punishment in the event of the bad state, i.e., before knowing whether B or G obtains (if B occurs the choice is implemented). An interesting aspect of BDS is that preferences are own-plan dependent. In the simple anger game (Figure 1), this means that **a**'s decision utility (2) at $t = 2$ depends on how he planned at $t = 1$ that he would choose at $t = 2$. That is, **a**'s decision utility $t = 2$ depends on the probability with which he expects (at $t = 1$) to choose N should B occur. If **a** plans to choose N, he becomes more frustrated after B (since he plans to avoid costly punishment and thus expects a higher material payoff) and thus more likely to choose T than had he instead planned to choose T from the beginning. Thus, there is a potential conflict between **a**'s plan at $t = 1$ and his action at $t = 2$, since at $t = 1$ he is not frustrated and thus wants to plan for N, which maximizes his material end-game payoff, but at $t = 2$ he is frustrated and thus wants to

[12]In the power-to-take game, the first mover can appropriate part of the responder's income but the responder can retaliate by destroying some or all of his or her income. There seems to be a strong link between negative emotions and appropriation and destruction behavior in this game, and also between unfulfilled expectations and punishment, which is in line with BDS' conceptualization of frustration (Bosman and van Winden, 2002; Ben-Shakhar et al., 2007).

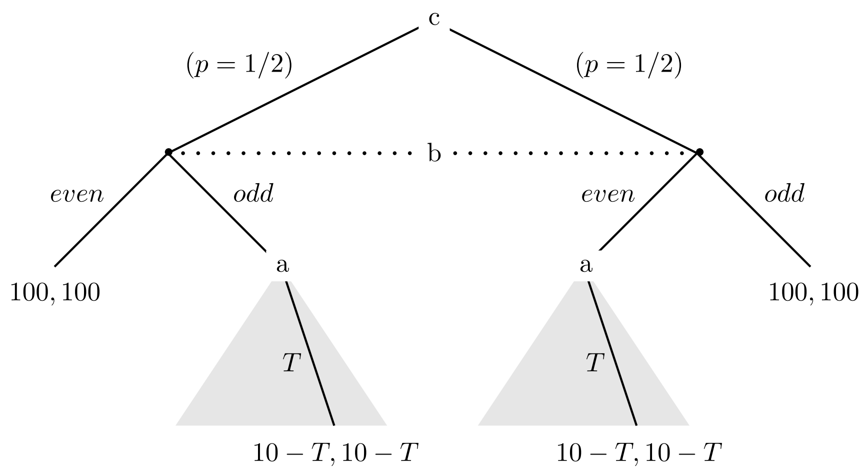

Figure 4: The *Blame-behavior* treatment

punish **b** if sufficiently prone to anger. In equilibrium, **a** takes this plan dependence into account, making a plan that is consistent with him maximizing utility function (2) when frustrated due to B.[13] In light of this, the *Simple-strategy* treatment variation tests whether **a** at the root of the game (in the *Simple-strategy* treatment) seems to have the same goal as **a** has after the frustrating outcome B (in the *Simple* treatment).[14]

In a fourth and final treatment, *Control*, subjects participate in an experiment consisting only of the subgame after B in the *Simple* treatment. The test of the theory (simple anger) is not particularly strong based only on the *Simple* treatment since it rests on rejecting a point prediction at the corner of the choice set, i.e., no punishment. One worry is that some subjects could be influenced by experimenter-demand effects, especially since the game is rather special. With a between-subjects comparison across *Simple* and *Control*, this potential confound is avoided and the test of the theory becomes stronger.

3.2 Procedural details

Subjects are welcomed to the lab and randomly assigned a cubicle workstation. They are given plenty of time to read the instructions (see Appendix) and ask questions (in private) before the beginning of the experiment. They are matched in pairs but decisions are made in private and they never learn the identity of the person they are matched with.

The end-game payoffs in the treatments are as follows (see also Figures 3 and 4): In

[13]This can for example be illustrated with the third SE mentioned on p. 8, where **a** plans for N after B (with probability $\alpha_a(N \mid B) = \frac{1}{p\theta_a} - \frac{1-2p}{p}$) so as to keep himself indifferent between N and T when frustrated due to B.

[14]The between-subject test is in the spirit of BDS' multi-self approach, with one "self" of i moving at each history h of the game. See BDS and Battigalli and Dufwenberg (2009, pp. 28) for details.

the good situation G, **a** and **b** receive 100 Swedish kronor each (around 12 US dollars), and in the bad situation B, they receive 10 Swedish kronor each and **a** decides whether to accept the low payoff or punish **b** at a 1:1 cost. Thus, $(\pi_a, \pi_b) = (100, 100)$ in G, and $(\pi_a, \pi_b) = (10 - T, 10 - T)$ with **a** choosing $T \in \{0, 1, \ldots, 10\}$ in B.

In the *Simple* treatment, the public toss of a six-sided die determines whether the good situation G (with the high income) or bad situation B (with the low income) obtains for any pair of subjects. Each subject-pair is given a group number at the beginning of the experiment, and if there is an even-even or odd-odd match between the number shown on the die and the group number, the subject-pair is assigned the good situation (with the high income); in case of an even-odd or odd-even mismatch, the subject-pair is assigned the bad situation (with the low income). For example, a subject-pair with group number 2 will be assigned the good situation if the die shows 2, 4, or 6, and the bad situation for numbers 1, 3, and 5. In contrast, in the *Blame-behavior* treatment, **b** will guess whether the die will show an even or an odd number and if the guess is correct (an even-even or odd-odd match with the number on the die), the good situation is assigned, and if the guess is wrong the bad situation is assigned. Beyond this, everything is identical across the two treatments. In the *Simple-strategy* treatment, subjects first make their decision (in the event of the bad situation) and then the die toss determines what situation will be payoff relevant. In the *Control* treatment, subjects immediately face a situation identical to the low-income situation in the other three treatments.[15]

In the bad situation and in the *Control* treatment, **b** is asked for her belief about **a**'s decision. If correct, **b** is monetarily rewarded. As a measure of frustration, subjects are asked in a post-experimental questionnaire to describe the intensity of emotions felt when learning whether they would end up in the good situation (with the high income) or in the bad situation (with the low income).[16] They answered this question approximately five minutes after they had learned what outcome would be relevant for them.[17] The experiment was computerized with z-Tree (Fischbacher, 2007) and participants were recruited using ORSEE (Greiner, 2015). Sessions lasted around 30 minutes and subjects were on average paid 107 Swedish kronor (around 12.50 US dollars at the time of the experiment).

[15] In order to keep the expected hourly wage as close as possible across the treatments, subjects in the *Control* treatment were paid for answering an additional survey at the end of the session.

[16] I follow Bosman and van Winden (2002) and let subjects report on a range of emotions and not just the few (negative) emotions of interest in this study. For a discussion on self-reports as an emotion elicitation method, see, e.g., Robinson and Clore (2002).

[17] The exact formulation read as follows: "We will now ask you to describe how you felt at the moment **when** you found out which situation would be assigned your group (i.e., right after the experimenter had tossed the die). Please indicate the **intensity of each of the emotions** listed below. Please note that there is no 'right' or 'wrong' answer."

3.3 Hypotheses

The first hypothesis concerns frustration. By (1), **a** is frustrated when the bad state B obtains since he realizes that his maximal payoff is less than the payoff he expected at the root of the game. Therefore, I investigate whether the correlated income shock generates negative emotions in subjects; i.e., whether those who end up in the bad situation with the low income in the *Simple*, *Blame-behavior*, and *Simple-strategy* treatments on average experience a higher intensity of negative emotions than subjects in the good situation (with the high income):

> **Hypothesis 1.** *Frustration*: Subjects who end up in the bad situation (with the low income) will report a stronger intensity of negative emotions than subjects who end up in the good situation (with the high income).

The second hypothesis concerns simple anger, and thus the comparison between the *Simple* treatment and the *Control* treatment. In the *Simple* treatment, simple anger predicts full punishment ($T = 10$) if **a** is sufficiently prone to anger ($\theta_a \geq \frac{1}{40}$) whereas anger from blaming behavior predicts zero punishment.[18] In the *Control* treatment, both simple anger and anger from blaming behavior predict zero punishment since there is no frustration.

> **Hypothesis 2.** *Simple anger*: A larger fraction of players **a** will punish their co-player **b** in the *Simple* treatment than in the *Control* treatment.

The third hypothesis concerns anger from blaming behavior (could-have-been blame) and thus comparisons across the *Blame-behavior*, *Simple*, and *Control* treatments. In the *Blame-behavior* treatment, simple anger and anger from blaming behavior predictions coincide (full punishment if sufficiently prone to anger; $T = 10$),[19] whereas only simple anger predicts punishment in the *Simple* treatment, and neither simple anger nor anger from blaming behavior predicts punishment in the *Control* treatment.

> **Hypothesis 3.** *Anger from blaming behavior*: A larger fraction of players **a** will punish their co-player **b** in the *Blame-behavior* treatment than in the *Simple* treatment, AND the same fraction of players **a** will punish their co-player **b** in the *Simple* treatment and the *Control* treatment.

[18] There is a simple-anger SE where **a** chooses full punishment at $t = 2$ (and at $t = 1$ he is certain that he will do so), since by (1) his frustration is $F_a = 0.5 \cdot 100 + 0.5 \cdot 0 - 10 = 40$ and thus by (2) we have $U(T = 0) \leq U(T = 10)$ when $10 - \theta_a \cdot 40 \cdot 10 \leq 0$, i.e. when $\theta_a \geq \frac{1}{40}$.

[19] They are identical to the simple-anger prediction in the *Simple* treatment (punish if $\theta_a \geq \frac{1}{40}$), since (i) the level of frustration in the bad state B is the same in both treatments, and (ii) with could-have-been blame **a** fully blames **b** for his frustration, since the good state G would have obtained had **b** made a different choice.

The fourth hypothesis concerns **a**'s plan (at the root of the game) to punish **b**, should the frustrating state B occur. Preferences are own-plan dependent and this creates a potential conflict between **a**'s plan at the root of the game and his action when potentially frustrated due to B. In equilibrium, **a** takes this plan dependence into account (as described on p. 11) and we expect players **a** at the root of the game in the *Simple-strategy* treatment to have the same goal as **a** has after the frustrating outcome B in the *Simple* treatment:

> **Hypothesis 4.** *Consistent planning*: The same fraction of players **a** will punish their co-player **b** in the *Simple* treatment and the *Simple-strategy* treatment.

The fifth and final hypothesis concerns **b**'s belief about **a**'s punishment decision, in each of the four treatments. It is an equilibrium requirement in BDS that players are, at least on average, correct in their beliefs about other players' behavior, and this is what we expect to observe in the experiment:

> **Hypothesis 5.** *Belief about others' punishment*: There is no difference between the fraction of players **a** who punish and the fraction of players **b** who expect to be punished in any of the four treatments.

4 Results

A total of 342 students participated in the experiment. Table 1 displays their participation in the different parts of the experiment (good or bad situation), which depends on the chance move and on **b**'s decision in the *Blame-behavior* treatment. We can see that 52 subjects in

Table 1: Participation in the different parts of the experiment.

Treatment	Sessions	Participants	Situation Good	Situation Bad	Players **a** who can make a punishment decision
Simple	11	98	46	52	26
Blame-behavior	17	142	84	58	29
Simple-strategy	5	54	26	28	27
Control	7	48	–	–	24
Total	40	342	156	138	106

Note: In *Simple* and *Blame-behavior*, one player **a** for every subject-pair (i.e., one **a** and one **b**) who experience the bad situation B can make a punishment decision. For instance, in *Simple*, 52 subjects experience the bad situation and out of these, 26 are a player **a** and another 26 are a player **b**. In *Simple-strategy*, decisions are made before chance determines whether situation B or G obtains, and thus 27 of the 54 participants will decide as **a**.

Simple and 58 subjects in *Blame-behavior* experience the correlated income shock, and thus subsequently make decisions in the bad situation (players **a** decide on punishment and players **b** report their expectation). Additionally, in the *Simple-strategy* treatment, 54 subjects decide in the same situation but before the chance move, and a further 48 subjects make decisions in the *Control* treatment (which is identical except for the income shock). As can be seen in the table, we have 26, 29, 27, and 24 punishment decisions and an equal amount of reported expectations in *Simple*, *Blame-behavior*, *Simple-strategy*, and *Control*, respectively, and we have 156 subjects who end up in the good situation (with the high income) and 138 subjects who instead experience the bad situation (with the low income).

First we will analyze subjects' emotional reactions. In line with Hypothesis 1, we can see in Table 2 that subjects are more angry and more irritated when hit by the income shock (the bad situation). The strongest impact is on irritation, with an average intensity of 3.10 within the full sample on a scale ranging from 1 (no emotion at all) to 7 (high intensity of emotion). This finding is in line with Bosman and van Winden (2002), who also document substantial irritation (average intensity of 4.05) following a positive take rate in the power-to-take game.[20] This result supports BDS' conceptualization of frustration as unfulfilled expectations about material payoffs.

Result 1: The bad situation, where subjects' maximal income from the experiment is substantially lower than the ex-ante expected income, generates negative emotions.

Table 2: Average intensity of negative emotions (by situation, G or B).

	Anger			Irritation		
	Good	Bad	*P-value*	Good	Bad	*P-value*
Simple ($N = 74$)	1.29	1.95	< 0.01	1.26	2.73	< 0.01
Blame-behavior ($N = 142$)	1.12	2.07	< 0.01	1.23	3.21	< 0.01
Simple-strategy ($N = 54$)	1.04	2.07	< 0.01	1.12	3.43	< 0.01

Note: I use two-sided Mann-Whitney U tests. After the experiment, subjects were asked to describe the intensity of eleven different emotions (both positive and negative) felt when learning whether the situation with the high income (good) or the situation with the low income (bad) would obtain (1 = no emotion at all; 7 = high intensity of emotion). Due to technical problems, 24 subjects could not answer the question in *Simple* and thus $N = 74$.

The correlated income shock thus generates negative emotions and the question is whether this has a significant effect on subjects' actions and beliefs, following Hypotheses 2–5. Table 3

[20] Calculated from Table 2 in Bosman and van Winden (2002) as the average irritation intensity reported by all 39 responders in the experiment (the take rate was positive for 36 of them).

displays the fraction of subjects who punish (**a**) and expect to be punished (**b**), respectively, for each of the four treatments.[21] We can see that the results are similar across the treatments: 15%–17% of players **a** chose to punish their co-player, and 24%–37% of players **b** expected to be punished. The similarity in behavior across all four treatments indicates the absence of treatment effects and we verify this in panel A of Table 4. The results for Hypotheses 2–4 are formulated as follows:

> **Result 2:** Subjects do not seem to act in accordance with the simple anger hypothesis in the context of the experiment. (We cannot reject the null hypothesis of no difference in behavior between the two treatments *Simple* and *Control*.)

> **Result 3:** Subjects do not seem to act in accordance with the anger from blaming behavior hypothesis in the context of the experiment. (We cannot reject the null hypothesis of no difference in behavior between the two treatments *Blame-behavior* and *Simple*.)

> **Result 4:** There is no difference between decisions made at the root of the game (about punishment, should the bad situation occur) and decisions made when the bad situation has occurred. (We cannot reject the null hypothesis of no difference in behavior between the two treatments *Simple* and *Simple-strategy*.)

The fifth and final hypothesis concerned subjects' beliefs about others' punishment decisions. This issue is investigated by comparing the fraction of players **a** who punish with the fraction of players **b** who expect to be punished. Comparing across columns in Table 3, we can see that there is a tendency for players **b** to overshoot in their beliefs about the extent to which their matched player **a** will punish them. For instance, in the *Simple* treatment, 35% of players **b** thought that they would be punished after the correlated income shock, but only 15% of players **a** did so. Looking at the bottom panel of Table 4 we can see that the difference between punishment behavior and expected punishment behavior is significant at the 1% level within the full sample (Mann-Whitney U test; $p < 0.01$, $N = 212$).

> **Result 5:** Subjects in the experiment do not seem to hold correct beliefs about other players' punishment decisions.

Taken together, subjects who end up in the bad situation (with the low income) experience negative emotions, but this does not seem to affect their behavior to the extent predicted by the theory. In the context of the experiment, using a minimalistic design and a deliberatively

[21] The raw data for punishment decisions made by all players **a** who participated in the experiment can be found in the Appendix, Table 5.

weak form of blame attribution, I do not find much support for the simple anger or the anger from blaming behavior hypothesis.

Table 3: Fraction of subjects who punish and expect to be punished, respectively.

	Punishment (player **a**)		Expected (player **b**)	
	No	Yes	No	Yes
Simple	22 (85%)	4 (15%)	17 (65%)	9 (35%)
Blame-behavior	24 (83%)	5 (17%)	22 (76%)	7 (24%)
Simple-strategy	23 (85%)	4 (15%)	17 (63%)	10 (37%)
Control	20 (83%)	4 (17%)	15 (63%)	9 (37%)

Note: The table displays the fraction of players **a** who chose not to punish ($T = 0$) and punish ($T > 0$), respectively, and the fraction of players **b** who expected their assigned player **a** to choose not to punish and punish, respectively.

Table 4: Testing Hypotheses 2–5.

Panel A: Punishment	
Null hypothesis	*P-values*
Punish in *Simple* = Punish in *Control*	0.90 ($N = 50$)
Punish in *Blame-behavior* = Punish in *Simple*	0.85 ($N = 55$)
Punish in *Simple* = Punish in *Simple-strategy*	0.95 ($N = 53$)
Panel B: Expectations vs. punishment	
Null hypothesis	*P-values*
Punish = Expected, in *Simple*	0.11 ($N = 52$)
Punish = Expected, in *Blame-behavior*	0.52 ($N = 58$)
Punish = Expected, in *Simple-strategy*	0.06 ($N = 54$)
Punish = Expected, in *Control*	0.11 ($N = 48$)
Punish = Expected, in all treatments	< 0.01 ($N = 212$)

Note: I use two-sided Mann-Whitney U tests based on proportions displayed in Table 3.

5 Conclusion

Anger can be a strong behavioral force, and this has important consequences for human interaction. I design an experiment that tests the predictions based on central concepts in a theory of anger developed by Battigalli, Dufwenberg, and Smith (2015; BDS). Specifically, I test condensed versions of their simple anger and anger from blaming behavior hypotheses in two-player settings, and I investigate aspects of beliefs and compare subjects' planned choices at different stages of the game. The experiment implements a strong and correlated income shock and subsequently tests whether it generates negative emotions in subjects, whether it makes them punish their co-players, and whether they punish their co-players when they can be blamed for the correlated income shock.

The results from the experiment show that the income shock generates negative emotions in subjects; it makes them angry and irritated. This is in line with BDS, who model frustration as a result of unfulfilled expectations about material payoffs. However, these negative emotions do not generally affect punishment decisions to the extent predicted by the theory: Subjects who experience the correlated income shock (the bad situation) do not punish their co-player more than subjects who do not experience the income shock, not even when the co-player can be blamed for the income shock. Thus, in this specific context there is not much support for the notions of simple anger and anger from blaming behavior.

The focus of the paper is on situations where other-responsibility is weak or nonexistent, and where there is complete payoff symmetry between the players. Frustration is caused by chance moves or bad luck rather than harmful actions with blameworthy intent. Focusing on these aspects seems natural for a first empirical test of the theory, since it isolates the relatively unsophisticated punishment behavior that is the essence of simple anger and that also seems to be relevant for anger from blaming behavior, as indicated by data from experiments in Gurdal et al. (2013).

The difference between the results in this study and in Gurdal et al. is interesting. In their experiment, an agent invests money on behalf of a principal. The agent chooses between a safe and a risky prospect, and the principal subsequently decides on remuneration for the agent and a dummy player. They find that agents are blamed and punished for bad uncontrollable outcomes, since they are paid less (relative to the dummy player) following bad realizations of the risky prospect. One important contextual difference between Gurdal et al. and the *Blame-behavior* treatment in the present paper is that the agents in Gurdal et al. do have some ex-ante control over the outcome, in their choice between the safe and the risky prospect, even though they are punished for the bad realization of the risky prospect, which they cannot control. This makes the agent's role in the bad outcome more salient and perhaps this is why anger from blaming behavior seems to be more relevant in this context. Having some form of choice, even if irrelevant, possibly affects how one's responsibility for a bad outcome is evaluated.[22]

Another important aspect of the design is that payoffs are symmetric, which allows for testing the theory in isolation of distributional concerns. However, maybe the influence of frustration and anger would be stronger in contexts with asymmetric payoffs. For example, disastrous income shocks caused by catastrophic events such as extreme weather or natural disasters might well make people angry, but maybe they are more likely to be angry with people who had the means and economic privileges to prevent or limit personal damage rather than with people who also were badly affected by these events. An interesting extension is thus to test the theory in a context where there is payoff inequality, implemented by chance or by other players in the experiment.

Anger and frustration may shape economic outcomes in profound ways. Angry individuals become hostile in their dealings with others and this has strategic consequences. BDS provide a rich framework for theoretical analysis and I have provided a first test of empirical relevance. There are several interesting avenues for future research.

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[22] This is consistent with Mollerstrom et al. (2015) and Cappelen et al. (2015), who find that irrelevant or even forced decisions affect how third-party spectators are willing to compensate people for bad luck.

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Appendix A: Additional data

Table 5: All punishment decisions in the experiment (by treatment).

Punishment (player **a**)	*Simple* (Frequency)	*Blame-behavior* (Frequency)	*Simple-strategy* (Frequency)	*Control* (Frequency)
0	22	24	23	20
1	0	1	0	1
2	3	0	2	0
3	0	1	0	1
4	0	1	0	1
5	0	2	0	0
6	0	0	1	0
7	0	0	0	0
8	0	0	0	1
9	0	0	0	0
10	1	0	1	0
Total (N)	26	29	27	24
Average punishment	0.62	0.62	0.74	0.67

Appendix B: Instructions for the *Simple* treatment

General instructions for participant A

Welcome to the experiment and thank you for participating!

Please do not talk to other participants.

You are about to take part in an economics experiment. If you read the following instructions carefully, you can – depending on your decisions – earn money in addition to the SEK 50 you will receive for being part of the experiment. The amount of money that you earn with your decisions will be added up and paid to you in cash at the end of the experiment. These instructions are solely for your private information. You are not allowed to communicate during the experiment. Violation of this rule will lead to exclusion from the experiment and all payments. If you have questions, please raise your hand and we will come to you. We will only answer your questions in private.

We will not speak in terms of Swedish kronor during the experiment, but rather of points. Your income will first be calculated in points. At the end of the experiment, the total amount of points earned will be converted to kronor at the following rate: 1 point = 1 SEK.

We will explain the exact experimental procedure on the next few pages.

The experiment

At the beginning of the experiment, you will be randomly matched with one other participant in the experiment. You will never find out the identity of this person, not even after the experiment. In the same way, the person matched with you will never find out your identity.

There are two types of participants in this experiment: participants A and B. **You are a participant A.** The person matched with you is a participant B. We will refer to you and your participant B as a **group** and each group will be assigned a specific number (a group number).

There are **two possible situations** in the experiment:

- In situation 1, you receive 100 points and participant B receives 100 points.
- In situation 2, you receive 10 points and participant B receives 10 points.

At the beginning of the experiment, the experimenter will randomly assign your group either situation 1 or situation 2 by tossing a 6-sided die.

- If your group number is an **even** number (2, 4, 6, 8 etc.): situation 1 will be assigned if the thrown number is also an even number (2, 4 or 6) and situation 2 will be assigned if the thrown number is an odd number (1, 3 or 5).
- If your group number is an **odd** number (1, 3, 5, 7 etc.): situation 1 will be assigned if the thrown number is also an odd number (1, 3 or 5) and situation 2 will be assigned if the thrown number is an even number (2, 4 or 6).

This means that situation 1 and situation 2 are equally likely to be assigned (each situation will be assigned with a probability of 50%).

Example 1: If your group number is 8 (an even number) and the number on the die is 4 (also an even number), then situation 1 is assigned.

Example 2: If your group number is 4 (an even number) and the number on the die is 3 (an odd number), then situation 2 is assigned.

Example 3: If your group number is 3 (an odd number) and the number on the die is 1 (also an odd number), then situation 1 is assigned.

If situation 1 is assigned, the experiment is over. Your income is 100 points and participant B' income is 100 points.

If situation 2 is assigned, as participant A you have the possibility to deduct up to a total of 10 points from your participant B. Each point deducted will cost you one point. When you have made your choice, the experiment is over.

Example 1: Situation 2 is assigned and you (as participant A) give up 4 points to deduct 4 points from your participant B. The following payment will then result:

- Your points (as participant A): $10 - 4 = 6$.
- Participant B's points: $10 - 4 = 6$.

Example 2: Situation 2 is assigned and you (as participant A) give up 0 points to deduct 0 points from your participant B. The following payment will then result:

- Your points (as participant A): $10 - 0 = 10$.
- Participant B's points: $10 - 0 = 10$.

[*Only in the instructions for participant B:* **In situation 2 you will be asked to estimate the number of points your participant A will deduct from you. You will be paid for the accuracy of your estimate: If your estimate is exactly right, you will get 5 points in addition to your other income from the experiment. If your estimate is not exactly right, you will not get any additional points.**

Example 1: You estimate that your participant A will deduct 4 points from you and this estimate is correct. The following payment will then result:

- Your points (as participant B): $10 - 4 + 5 = 11$.
- Participant A's points: $10 - 4 = 6$.]

Procedures in chronological order

1. The experiment begins. Your group is randomly assigned situation 1 or situation 2. The experimenter will toss the die and one randomly selected participant will verify the outcome. Together they will enter the number on this participant's computer screen.

2a. If situation 1 is assigned, the experiment is over. Your income is 100 points and participant B's income is 100 points. You will receive payment for the points earned plus your show-up fee in cash.

2b. If situation 2 is assigned, as participant A you have the possibility to deduct up to a total of 10 points from your participant B. Each point you deduct will cost you one point. Once you have made your decision, the experiment is over. Your income is 10 points minus the amount (if anything) you deducted from participant B, and participant B's income is 10 points minus the amount (if anything) you deducted from him or her. You will receive payment for the points earned plus your show-up fee in cash.

[*In the instructions for participant B, 2b instead reads:* If situation 2 is assigned, participant A has the possibility to deduct up to a total of 10 points from you. Each point deducted will cost him or her one point. You will estimate the number of points he or she will deduct from you. Once you have made your decision (and your participant A has made his or her decision), the experiment is over. Your income is 10 points minus the amount (if anything) participant A deducted from you plus 5 points if you estimated this amount correctly, and participant A's income is 10 points minus the amount (if anything) he or she deducted from you. You will receive payment for the points earned plus your show-up fee in cash.]

Do you have any questions?

Appendix C: Instructions for the *Blame-behavior* treatment

General instructions for participant A

Welcome to the experiment and thank you for participating!

Please do not talk to other participants.

You are about to take part in an economics experiment. If you read the following instructions carefully, you can – depending on your decisions – earn money in addition to the SEK 50 you will receive for being part of the experiment. The amount of money that you earn with your decisions will be added up and paid to you in cash at the end of the experiment. These instructions are solely for your private information. You are not allowed to communicate during the experiment. Violation of this rule will lead to exclusion from the experiment and all payments. If you have questions, please raise your hand and we will come to you. We will only answer your questions in private.

We will not speak in terms of Swedish kronor during the experiment, but rather of points. Your income will first be calculated in points. At the end of the experiment, the total amount of points earned will be converted to kronor at the following rate: 1 point = 1 SEK.

We will explain the exact experimental procedure on the next few pages.

The experiment

At the beginning of the experiment, you will be randomly matched with one other participant in the experiment. You will never find out the identity of this person, not even after the experiment. In the same way, the person matched with you will never find out your identity.

There are two types of participants in this experiment: participants A and B. **You are a participant A.** The person matched with you is a participant B. We will refer to you and your participant B as a **group** and each group will be assigned a specific number (a group number).

There are **two possible situations** in the experiment:

- In situation 1, you receive 100 points and participant B receives 100 points.
- In situation 2, you receive 10 points and participant B receives 10 points.

At the beginning of the experiment, the experimenter will randomly assign your group either situation 1 or situation 2 by tossing a 6-sided die. Before the experimenter tosses the die, your participant B will **guess** whether the thrown number will be **even** (2, 4 or 6) or **odd** (1, 3 or 5).

- If the guess is **correct,** situation 1 will be assigned.
- If the guess is **wrong,** situation 2 will be assigned.

This means that situation 1 and situation 2 are equally likely to be assigned (each situation will be assigned with a probability of 50%).

Example 1: If your participant B guessed that the thrown number would be even, and the number on the die is 4 (also an even number so the guess was correct), then situation 1 is assigned.

Example 2: If your participant B guessed that the thrown number would be even, and the number on the die is 3 (an odd number so the guess was wrong), then situation 2 is assigned.

Example 3: If your participant B guessed that the thrown number would be odd, and the number on the die is 1 (also an odd number so the guess was right), then situation 1 is assigned.

If situation 1 is assigned, the experiment is over. Your income is 100 points and participant B' income is 100 points.

If situation 2 is assigned, as participant A you have the possibility to deduct up to a total of 10 points from your participant B. Each point deducted will cost you one point. When you have made your choice, the experiment is over.

Example 1: Situation 2 is assigned and you (as participant A) give up 4 points to deduct 4 points from your participant B. The following payment will then result:

- Your points (as participant A): $10 - 4 = 6$.
- Participant B's points: $10 - 4 = 6$.

Example 2: Situation 2 is assigned and you (as participant A) give up 0 points to deduct 0 points from your participant B. The following payment will then result:

- Your points (as participant A): $10 - 0 = 10$.
- Participant B's points: $10 - 0 = 10$.

[*Only in the instructions for participant B:* **In situation 2 you will be asked to estimate the number of points your participant A will deduct from you. You will be paid for the accuracy of your estimate: If your estimate is exactly right, you will get 5 points in addition to your other income from the experiment. If your estimate is not exactly right, you will not get any additional points.**

Example 1: You estimate that your participant A will deduct 4 points from you and this estimate is correct. The following payment will then result:

- Your points (as participant B): $10 - 4 + 5 = 11$.
- Participant A's points: $10 - 4 = 6$.]

Procedures in chronological order

1. The experiment begins. Your group is randomly assigned situation 1 or situation 2. Your participant B will guess whether the thrown number will be even or odd and the guess will be reported to you (on your computer screen). Then the experimenter will toss the die and one randomly selected participant will verify the outcome. Together they will enter the number on this participant's computer screen.

2a. If situation 1 is assigned, the experiment is over. Your income is 100 points and participant B's income is 100 points. You will receive payment for the points earned plus your show-up fee in cash.

2b. If situation 2 is assigned, as participant A you have the possibility to deduct up to a total of 10 points from your participant B. Each point you deduct will cost you one point. Once you have made your decision, the experiment is over. Your income is 10 points minus the amount (if anything) you deducted from participant B, and participant B's income is 10 points minus the amount (if anything) you deducted from him or her. You will receive payment for the points earned plus your show-up fee in cash.

[*In the instructions for participant B, 2b instead reads:* If situation 2 is assigned, participant A has the possibility to deduct up to a total of 10 points from you. Each point deducted will cost him or her one point. You will estimate the number of points he or she will deduct from you. Once you have made your decision (and your participant A has made his or her decision), the experiment is over. Your income is 10 points minus the amount (if anything) participant A deducted from you plus 5 points if you estimated this amount correctly, and participant A's income is 10 points minus the amount (if anything) he or she deducted from you. You will receive payment for the points earned plus your show-up fee in cash.]

Do you have any questions?

Appendix D: Instructions for the *Simple-strategy* treatment

General instructions for participant A

Welcome to the experiment and thank you for participating!

Please do not talk to other participants.

You are about to take part in an economics experiment. If you read the following instructions carefully, you can – depending on your decisions – earn money in addition to the SEK 50 you will receive for being part of the experiment. The amount of money that you earn with your decisions will be added up and paid to you in cash at the end of the experiment. These instructions are solely for your private information. You are not allowed to communicate during the experiment. Violation of this rule will lead to exclusion from the experiment and all payments. If you have questions, please raise your hand and we will come to you. We will only answer your questions in private.

We will not speak in terms of Swedish kronor during the experiment, but rather of points. Your income will first be calculated in points. At the end of the experiment, the total amount of points earned will be converted to kronor at the following rate: 1 point = 1 SEK.

We will explain the exact experimental procedure on the next few pages.

The experiment

At the beginning of the experiment, you will be randomly matched with one other participant in the experiment. You will never find out the identity of this person, not even after the experiment. In the same way, the person matched with you will never find out your identity.

There are two types of participants in this experiment: participants A and B. **You are a participant A.** The person matched with you is a participant B. We will refer to you and your participant B as a **group** and each group will be assigned a specific number (a group number).

There are **two possible situations** in the experiment:

- In situation 1, you receive 100 points and participant B receives 100 points.
- In situation 2, you receive 10 points and participant B receives 10 points.

At the beginning of the experiment, the experimenter will randomly assign your group either situation 1 or situation 2 by tossing a 6-sided die.

- If your group number is an **even** number (2, 4, 6, 8 etc.): situation 1 will be assigned if the thrown number is also an even number (2, 4 or 6) and situation 2 will be assigned if the thrown number is an odd number (1, 3 or 5).
- If your group number is an **odd** number (1, 3, 5, 7 etc.): situation 1 will be assigned if the thrown number is also an odd number (1, 3 or 5) and situation 2 will be assigned if the thrown number is an even number (2, 4 or 6).

This means that situation 1 and situation 2 are equally likely to be assigned (each situation will be assigned with a probability of 50%).

Example 1: If your group number is 8 (an even number) and the number on the die is 4 (also an even number), then situation 1 is assigned.

Example 2: If your group number is 4 (an even number) and the number on the die is 3 (an odd number), then situation 2 is assigned.

Example 3: If your group number is 3 (an odd number) and the number on the die is 1 (also an odd number), then situation 1 is assigned.

If situation 1 is assigned, the experiment is over. Your income is 100 points and participant B' income is 100 points.

If situation 2 is assigned, as participant A you have the possibility to deduct up to a total of 10 points from your participant B. Each point deducted will cost you one point. When you have made your choice, the experiment is over.

Example 1: Situation 2 is assigned and you (as participant A) give up 4 points to deduct 4 points from your participant B. The following payment will then result:

- Your points (as participant A): $10 - 4 = 6$.
- Participant B's points: $10 - 4 = 6$.

Example 2: Situation 2 is assigned and you (as participant A) give up 0 points to deduct 0 points from your participant B. The following payment will then result:

- Your points (as participant A): $10 - 0 = 10$.
- Participant B's points: $10 - 0 = 10$.

[*Only in the instructions for participant B:* **In situation 2 you will be asked to estimate the number of points your participant A will deduct from you. You will be paid for the accuracy of your estimate: If your estimate is exactly right, you will get 5 points in addition to your other income from the experiment. If your estimate is not exactly right, you will not get any additional points.**

Example 1: You estimate that your participant A will deduct 4 points from you and this estimate is correct. The following payment will then result:

- Your points (as participant B): $10 - 4 + 5 = 11$.
- Participant A's points: $10 - 4 = 6$.]

We will ask you to make your choice (how many points to deduct if situation 2 is assigned) before your group is randomly assigned situation 1 or situation 2 (by the experimenter tossing the die). If situation 2 is assigned, your choice will be implemented (and if situation 1 is assigned your income will be 100 points and participant B's income 100 points regardless of the choice you made).

Example 1: You (as participant A) give up 4 points to deduct 4 points from your participant B in case situation 2 is assigned. It is then randomly determined that situation 1 will apply (your choice is not implemented). The following payment will then result:

- Your points (as participant A): 100.
- Participant B's points: 100.

Example 2: You (as participant A) give up 4 points to deduct 4 points from your participant B in case situation 2 is assigned. It is then randomly determined that situation 2 will apply (your choice is implemented). The following payment will then result:

- Your points (as participant A): $10 - 4 = 6$.
- Participant B's points: $10 - 4 = 6$.

Procedures in chronological order

1. The experiment begins. As participant A you have the possibility to deduct up to a total of 10 points from your participant B if situation 2 is assigned. Each point you deduct will cost you one point. You will make your choice now and it will be implemented if it is randomly determined that situation 2 will apply.

2. Your group is randomly assigned situation 1 or situation 2. The experimenter will toss the die and one randomly selected participant will verify the outcome. Together they will enter the number on this participant's computer screen.

3a. If situation 1 is assigned, your income is 100 points and participant B's income is 100 points. You will receive payment for the points earned plus your show-up fee in cash.

3b. If situation 2 is assigned, your choice will be implemented. Your income is 10 points minus the amount (if anything) you deducted from participant B, and participant B's income is 10 points minus the amount (if anything) you deducted from him or her. You will receive payment for the points earned plus your show-up fee in cash.

[*In the instructions for participant B, 3b instead reads:* If situation 2 is assigned, your choice will be implemented. Your income is 10 points minus the amount (if anything) participant A deducted from you plus 5 points if you estimated this amount correctly, and participant A's income is 10 points minus the amount (if anything) he or she deducted from you. You will receive payment for the points earned plus your show-up fee in cash.]

Do you have any questions?

Appendix E: Instructions for the *Control* treatment

General instructions for participant A

Welcome to the experiment and thank you for participating!
Please do not talk to other participants.

You are about to take part in an economics experiment. If you read the following instructions carefully, you can – depending on your decisions – earn money in addition to the SEK 50 you will receive for being part of the experiment. The amount of money that you earn with your decisions will be added up and paid to you in cash at the end of the experiment. These instructions are solely for your private information. You are not allowed to communicate during the experiment. Violation of this rule will lead to exclusion from the experiment and all payments. If you have questions, please raise your hand and we will come to you. We will only answer your questions in private.

We will not speak in terms of Swedish kronor during the experiment, but rather of points. Your income will first be calculated in points. At the end of the experiment, the total amount of points earned will be converted to kronor at the following rate: 1 point = 1 SEK.

We will explain the exact experimental procedure on the next few pages.

The experiment

At the beginning of the experiment, you will be randomly matched with one other participant in the experiment. You will never find out the identity of this person, not even after the experiment. In the same way, the person matched with you will never find out your identity.

There are two types of participants in this experiment: participants A and B. **You are a participant A.** The person matched with you is a participant B.

At the beginning of the experiment, you receive 10 points and participant B receives 10 points.

As participant A you have the possibility to deduct up to a total of 10 points from your participant B. Each point deducted will cost you one point. When you have made your choice, the experiment is over.

Example 1: You (as participant A) give up 4 points to deduct 4 points from your participant B. The following payment will then result:

- Your points (as participant A): $10 - 4 = 6$.
- Participant B's points: $10 - 4 = 6$.

Example 2: You (as participant A) give up 0 points to deduct 0 points from your participant B. The following payment will then result:

- Your points (as participant A): $10 - 0 = 10$.
- Participant B's points: $10 - 0 = 10$.

[*Only in the instructions for participant B:* **You will be asked to estimate the number of points your participant A will deduct from you. You will be paid for the accuracy of your estimate: If your estimate is exactly right, you will get 5 points in addition to your other income from the experiment. If your estimate is not exactly right, you will not get any additional points.**

Example 1: You estimate that your participant A will deduct 4 points from you and this estimate is correct. The following payment will then result:

- Your points (as participant B): $10 - 4 + 5 = 11$.

- Participant A's points: $10 - 4 = 6$.]

Procedures in chronological order

The experiment begins. You receive 10 points and participant B receives 10 points. As participant A you have the possibility to deduct up to a total of 10 points from your participant B. Each point you deduct will cost you one point. Once you have made your decision, the experiment is over. Your income is 10 points minus the amount (if anything) you deducted from participant B, and participant B's income is 10 points minus the amount (if anything) you deducted from him or her. You will receive payment for the points earned plus your show-up fee in cash.

[*In the instructions for participant B, the above paragraph is replaced by the following:* The experiment begins. You receive 10 points and participant A receives 10 points. Participant A has the possibility to deduct up to a total of 10 points from you. Each point deducted will cost him or her one point. You will estimate the number of points he or she will deduct from you. Once you have made your decision (and your participant A has made his or her decision), the experiment is over. Your income is 10 points minus the amount (if anything) participant A deducted from you plus 5 points if you estimated this amount correctly, and participant A's income is 10 points minus the amount (if anything) he or she deducted from you. You will receive payment for the points earned plus your show-up fee in cash.]

Do you have any questions?