DISCUSSION PAPER SERIES

DP15264

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LABOUR ECONOMICS

ISSN 0265-8003

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Discussion Paper DP15264
Published 09 September 2020
Submitted 03 September 2020

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Abstract

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JEL Classification: C92, D90, D91

Keywords: anger, induced emotions, Strategic Interactions, beauty-contest

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Anger and Strategic Behavior: A Level-k Analysis*

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September 3, 2020

Abstract

Anger is an important driver in shaping economic activities, particularly in instances that involve strategic interactions between individuals. Here we test whether anger impairs the capacity to think strategically, and we analyze the implications of our result on bargaining and cooperation games. Accordingly, with a preregistered experiment (Experiment 1), we externally induce anger to a subgroup of subjects following a standard procedure that we verify by using a novel method of text analysis. We show that anger can impair the capacity to think strategically in a beauty contest game. Angry subjects choose numbers further away from the Nash equilibrium, and earn significantly lower profits. A structural analysis estimates that there is an increase in the share of level-zero players in the treated group compared to the control group. Furthermore, with a second preregistered experiment (Experiment 2), we show that this effect is not common to all negative emotions. Sad subjects do not play significantly further away from the Nash equilibrium than the control group in the same beauty contest game of Experiment 1, and sadness does not lead to more level-zero play.

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*The authors thank several colleagues for discussions on this and related research, in particular Pierpaolo Battigalli, Jan Engelmann, David Gill, Peter Hammond, Thomas Hills, Elliot Ludvig, Tigran Melkonyan, Herve Moulin, Victoria Prowse, Andy Schotter, Daniel Sgroi, and Marc Willinger. University of Warwick Economics Department IRB approval obtained on March 2019. Registration numbers in the AEA Registry: AEARCTR-000426 for Experiment 1 and AEARCTR-0004729 for Experiment 2.

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1 Introduction

Anger is an important emotion that can affect basic interactions among people in daily life. A growing economic literature has examined the effects of anger on economic decisions. The repercussions of anger on economic behavior that have emerged in the literature are generally based on the frustration-aggression hypothesis (Dollard *et al.*, 1939; Selten, 1978), which is based on the idea that anger can lead a person to behave in hostile ways to someone else – regardless of whether the person targeted is the source of the anger.[1] In general, this literature hinges on the hypothesis that anger and frustration generate preferences for punishment.

This paper examines the effects and the issues surrounding the socioeconomic repercussions of anger from another angle: by looking at how such emotion affects *strategic sophistication*. We see our approach as complementary rather than a substitute of the former.

Our work is in line with the literature on cognitive psychology positing that anger may be linked to the impairment of cognitive processes. For example, it has been experimentally shown that anger promotes heuristic processing of information at the expense of more systematic processing.[2] For instance, Tiedens and Linton (2001) find that being angry leads to lower information processing by making individuals rely more on persuasive messages and stereotypes, rather than on the strength of the arguments.[3] Moreover, Gneezy and Imas (2014) show how individuals may sometimes strategically exploit this cognitive impairment of the opponent.

To test our hypothesis that anger decreases the capacity to reason strategically, we conduct two experiments involving a beauty contest game. Prior to the start of the game, we use written exercises to exogenously induce anger in one treatment group, and we compare the play of these subjects with those of a control group, among whom a placebo exercise is conducted (Experiment 1). To evaluate whether any effects on strategic reasoning stem specifically from anger, rather than from negative emotions, we conduct a second, identical experiment in which we instead induce sadness among participants in the treated group (Experiment 2).[4]

[1]For research examining another player in a game as a source of the anger, see, e.g., Xiao and Houser (2005); Rotemberg (2005); Anderson and Simester (2010); Carpenter and Matthews (2012); Winter (2014); Winter *et al.* (2016); Akerlof (2016); Van Leeuwen *et al.* (2017); Passarelli and Tabellini (2017). For research examining the situation in which the other player is not the source of anger, see, e.g., Card and Dahl (2011); Munyo and Rossi (2013). Gurdal *et al.* (2013) conduct research examining a situation in which the other player is probably the source of anger. Battigalli *et al.* (2019) develop a general framework to analyse the frustration-aggression hypothesis in the above-mentioned situations.

[2]For a review, see Litvak *et al.* (2010).

[3]More generally, research in cognitive and affective sciences has emphasized strong interactions between emotions and cognitive processes (see Engelmann *et al.*, 2018, for a review).

[4]According to a common characterization of emotions (Ekman, 1999), the basic negative emotions besides anger are: disgust, fear, and sadness. Among these, we chose sadness because of its closeness with anger; this allows us to maintain the same induction procedure in both experiments.

Our emotion-induction procedures involve asking participants to recall and write about previous experiences that led them to feel angry or sad. These procedures rely on methods and techniques commonly used in and previously validated by the social psychology literature. We underscore that we induce incidental anger rather than provoking a conflict between players; this is designed to achieve our aim of distinguishing our mechanism of interest rather than anger that hinges on social preferences for punishment.[5]

We choose the beauty contest game to test the sophistication of the strategic reasoning because social preferences are unlikely to affect behavior in this game (Eyster, 2019). Consequently, when people fail to play according to the Nash equilibrium, they either commit or expect the others to commit some form of errors. In fact, as Gill and Prowse (2016) show, the capacity to play toward the Nash equilibrium in this game depends on cognitive skills. The beauty contest allows for one to obtain a rather precise characterization of the level a player's level of strategic sophistication, which can be assumed to depend on the player's level of higher-order beliefs (the so-called level-k thinking) (see Nagel, 1995; Duffy and Nagel, 1997; Stahl, 1996). Furthermore, the beauty contest game allows one to assess another cognitive capacity that characterizes strategic behaviour – the *theory of mind*, which can be defined as the ability to think about others' thoughts and mental states to predict their intentions and actions (Coricelli and Nagel, 2009).

Our experimental findings from Experiment 1 show a strong negative effect of anger on strategic sophistication in the beauty contest game. Subjects who participate in the anger-inducing exercises play the game further away from the Nash equilibrium prediction – and significantly so compared to those participants among whom no emotion is induced. Our structural analysis estimates that there is an increase in level-zero players in the anger treatment group relative to the share of these players in the control group. Furthermore, the anger induction leads to significantly lower payoffs for the treated participants, providing evidence that anger negatively affect participants' theory of mind.

Results from Experiment 2 show that sadness has no significant impact on guesses in the game. In the structural analysis we find that, if anything, sadness decreases the number of level-zero players. We also observe that sadness has only a weakly significant negative effect on profits. We thus conclude that anger – rather than negative emotions in general – lowers subjects' capacity of strategic thinking.

Establishing a clear link between anger and strategic reasoning is important at least for two reasons. First, from a theoretical perspective, it provides insights on how to include anger in economic models of behavior. Second, because the effects of incidental emotions are pervasive in many economically relevant decisions (Lerner *et al.*, 2004; Tice *et al.*, 2001), and because such emotions may have an enduring and unconscious impact (Vohs *et al.*, 2007;

[5]Incidental emotions are externally generated and unrelated to the process under consideration. See Loewenstein and Lerner (2003) for a discussion of the distinction between incidental and anticipatory emotions.

Andrade and Ariely, 2009), anger may represent a relevant negative externality for social interactions. This, in turn, represents a potentially important negative externality for a poor economy, who may be more likely to experience negative shocks (see e.g. Koren and Tenreyro, 2007), or among poorest socioeconomic classes, even in an otherwise vibrant economy, likely have little capacity to insure themselves from negative shocks that can generate potentially vicious, widespread cycles of anger and frustration. With this in mind, we illustrate how a reduction of strategic sophistication due to anger may reduce cooperation in a repeated prisoners' dilemma game (see Section 5.1).

As result, this represents a potentially important negative externality for poor economies, who are more subject to negative shocks (see e.g. Koren and Tenreyro, 2007), or among poorest socioeconomic classes, even in an otherwise vibrant economy, likely have little capacity to insure themselves from negative shocks that can potentially vicious, widespread cycles of anger and frustration. With this in mind, we illustrate how a reduction of strategic sophistication due to anger may reduce cooperation in a repeated prisoners' dilemma game (see Section 5.1).

Our results show that anger negatively affects the capacity to think strategically by both decreasing the level-k chosen as a decision rule, and by impairing the theory of mind. These findings are puzzling because anger is pervasive in human behavior. As the literature in psychology argues, a plausible explanation relies on the notion that anger, like other emotions, can serve as a credible commitment device in situations of conflict (e.g. Elster, 1998; Frank, 1987, 1988; Hirshleifer, 1987), and thus can lead to greater evolutionary success in strategic interactions. If angry individuals do not think carefully about the consequences of their actions – as our results suggest – then others have reason to be wary of the angry person, to avoid conflict. We use the standard ultimate game to illustrate this argument (see Section 5.2).

The remainder of the paper is organized as follows. Section 2 describes our experimental design. Section 3 presents our experimental results. Section 4 structurally estimates the proportion of level-k thinking by condition and experiment. Section 5 discusses the implications of our results on cooperative choices in a prisoner's dilemma game, and on bargaining power in an ultimatum game. This section also discusses the underlying mechanism and potential confounding factors that may explain the results. Section 5 offers final remarks and conclusions. The appendix provides supplementary analysis and tables.

2 Experimental Design

To study whether and how anger affects strategic reasoning, and to disentangle the effect of anger from the potential effects of negative emotions more in general, we devise an experiment with the following three features: the ability to exogenously manipulate emotions of participants; to assess the effect of the emotional induction on strategic thinking; and, to compare the effects of the inducement of two different, negative emotions, or the lack of emotional inducement.

Our experimental design is as follows: We set up two experiments with treatment and control groups. Those in the treatment group participated in emotional induction tasks (detailed in Section 2.1.1), which consisted of writing exercises designed to elicit anger (Experiment 1) or sadness (Experiment 2). Those in the control group were asked to complete similar exercises that did not elicit any emotion. Participants representing both treatment and control groups were then matched in groups of three players. They played together the p-beauty contest game for ten rounds. This allowed us to cleanly assess the effects of anger (Experiment 1) and sadness (Experiment 2) on strategic reasoning. In this way, we tested whether any effect of anger on cognitive reasoning is unique to the emotion of anger itself, or whether it is a more general effect of negative emotions.

2.1 The Experiment

At the outset of the experiment, participants were randomly allocated to a computer terminal. The participants, university students, were asked to complete a demographic questionnaire that included information about their age, country of birth, department, year of study, gender, and high school marks. We then asked them to complete the Positive and Negative Affect Schedule (PANAS) questionnaire, (Schamborg *et al.*, 2016; Watson *et al.*, 1988). This questionnaire consists of two ten-item scales that measure positive and negative affect. Each item is rated on a five-point Likert scale. We added three further questions from the PANAS–X questionnaire (Watson and Clark, 1999). Two of these additional questions assess the emotions of interest: anger and sadness.[6] This questionnaire provides us with a measure of their overall emotional state before the induction took place.[7]

2.1.1 Emotional Induction

Participants were randomly assigned to be part of the treatment or control group in both experiments. Those in the treatment group then participated in an induction task designed to elicit the emotion of interest: anger (Experiment 1) or sadness (Experiment 2). Participants in the treatment group were asked to answer two questions about past life experiences. They had 10 minutes to answer the questions, and they could not proceed to the next part of the experiment until this time expired. Before participants read the emotional induction questions, we provided them with two pieces of information. First, we informed them that the exact questions they would be answering were randomized and, therefore, that the questions

[6] We also added a question about happiness as a further control check.

[7] From now on, for the sake of simplicity, we refer to this set of questions as the PANAS questionnaire.

they would read might be different from those that another participant would. Second, we told them that they could answer these questions in their native language.[8]

In the treatment of Experiment 1, the first question asked participants to recall and list up to five events in which they had experienced angry feelings. The second question asked them to carefully describe one of these events. Similarly, in the treatment of Experiment 2, we asked participants to recall up to five events that made them feel sad, and to write in detail about one of these events.[9] By contrast, participants in the control groups of both experiments were asked to recall up to five things they did earlier in the day, and to describe in detail how they typically spend their evenings.

This method to induce emotions is known as "autobiographical recall" in the psychological literature. It is based on the idea that recalling an event that caused an individual to feel a specific emotion will make that individual recreate and relive that emotion.[10] We chose this method for several reasons. First, ample evidence in the psychology literature shows that autobiographical recall effectively induces anger and sadness.[11] Second, as compared to other methods, autobiographical recall more specifically induces the emotion of interest with limited arousal of related but different emotions (Lerner *et al.*, 2003; Strack *et al.*, 1985; Tiedens and Linton, 2001). Finally, this method allows us to ex-post perform text analyses to further assess the effectiveness of the induction.

2.1.2 Matching Protocol

Following the induction procedure, participants were randomly sorted in groups of three. Each group consisted of three subjects that received the two different inductions used in the experiment; that is, each threesome consisted of either one treatment recipient and two members of the control group, or two treatment recipients and one member of the control group. Importantly, participants were told only that they were matched with two other players.[12]

[8] Given the relatively large number of subjects who are not native English speakers, we offered this option to encourage writing. In this way, for instance, we could prevent people from not answering because they were not comfortable with writing in English. Only one subject chose to write in a language other than English.

[9] Appendix B provides the screenshots of the induction task for each experimental condition. The induction questions are based on Small and Lerner (2008).

[10] Other methods, generally referred to as "mood induction procedures," include asking individuals to look at images, watch video excerpts, listen to music, and imagine certain scenarios. Other methods rely on situational procedures, too (e.g., consumption of bitter drink to induce disgust). For a review see Lench *et al.* (2011) and Westermann *et al.* (1996).

[11] For a recent review see Siedlecka and Denson (2019).

[12] As mentioned above, participants did not know the exact questions we asked other participants in the session, and they were not informed about the matching protocol.

2.1.3 The Beauty Contest Game

Subjects played the p-beauty contest (Nagel, 1995) that follows closely the one in Gill and Prowse (2016). Participants in groups of three played the p-beauty contest for ten rounds with fixed-group matching. In each round, participants had to choose an integer between zero and 100. The participants whose chosen number was closer to 70% of the mean of the three numbers earned £10.00, whereas all others earned nothing. If there was more than one winning number, then the winners equally split the £10.00, while the loser earned nothing. In each round of this game, the unique Nash equilibrium is to choose zero.[13] To avoid wealth effects, we told participants that at the end of the session that only one round would be randomly drawn to count for payments.

In each round, participants had to type the number in a given box; they did not face any time constraint. After all participants in a group had made their choices, each participant was shown the following information about the game in that round: 1) the three chosen numbers in the group; 2) the 70% of the mean of the chosen numbers; 3) the winning number(s); and 4) one's own earnings in that round.[14]

2.1.4 Other Tasks

Upon completion of the game, we asked participants to fill in a set of questionnaires. We asked them to complete the PANAS questionnaire again. We could thus assess the induction procedure as the difference in participants' responses to this questionnaire before and after the induction took place. We then asked them to self-report, on a nine-point scale, the degree to which they experienced different discrete emotions while they were writing about their personal past-life experiences (Rottenberg *et al.*, 2007). Third, in Experiment 1, we asked participants to complete the State-Trait Anger Expression Inventory 2 (STAXI-2) questionnaire (Schamborg *et al.*, 2016), which assesses one's disposition to anger (i.e., anger as a trait). We then asked two final questions. The first asked whether they had previously played the p-beauty contest game (prior to participation in our experiment). The second was a non-incentivized general willingness to take risks question (Dohmen *et al.*, 2011).

2.2 Experimental Procedure

The experimental sessions were conducted from May to October 2019 at the economics laboratory of the University of Warwick. Overall, we recruited 351 subjects through the university's SONA System for recruitment of participants in experiments. We conducted 11 sessions with 171 subjects in Experiment 1, and 12 sessions with 180 subjects in Experiment 2. Sessions

[13] See e.g. Gill and Prowse (2016) and López (2001) for the formal proof that takes into account that numbers in the game can only be discrete.

[14] In Appendix B we provide the screenshots of the instructions for the p-beauty contest game.

lasted roughly 35 minutes. Participants earned an average payment of £8.33 including the show-up fee of £5.00. We coded and conducted the experiment using the oTree software (Chen *et al.*, 2016). Tables A.1 and A.2 provide descriptive statistics of the sample. Tables A.3 and A.4 show that there are no significant differences across conditions in observable characteristics in the experiment.

At the onset of each session, subjects were randomly allocated to a computer terminal, and the experimenter read aloud general instructions about the session. After that, detailed instructions about the experimental tasks were shown on the computer screens. A reminder of the instructions for each part of the experiment was shown at the bottom of each page. Participants were encouraged to ask questions to the experimenter at any point.

3 Results

In this section we show that the anger treatment induced subjects to play higher numbers in the beauty contest game, and, consequently, led them to earn lower profits, compared to subjects in the control group. The effects of the sadness treatment on guesses and profits are much less clear. Before presenting these results, we analyze whether the induction procedure itself was successful in inducing the emotions of interest.

3.1 Emotion Induction

To analyse the emotional content of subjects' answers to the induction questions, we use the Linguistic Inquiry and Word Count (LIWC) 2015 software. The LIWC software reads a specific text, and counts each time a word in the text corresponds to a word present in the built-in dictionary.[15] The dictionary matches each word with psychologically relevant categories (e.g., affect word, social word, etc.). For instance, the word "cried" matches the following dictionary categories: Sadness, Negative Emotion, Overall Affect, Verb, and Past Focus. The software then computes the percentage of total words that match one of these categories. Following our example, if the world "cried" were found in the text, the scores for these five categories would increase.

For the purposes of the induction assessment, we look at two categories: Anger and Sadness. Table 1 shows some examples of words in these categories, and the number of words included in each of these.

Figure 1 shows the results of the text analysis. Subjects, on average, followed the instructions of the induction. The difference in the content of anger in the texts for the treated subjects compared to those in the control group is 2.077, and it is statistically different from

[15]The dictionary recognizes about 6,400 English words.

zero (p-value<0.000) (top-left panel).[16] Similarly, the subjects treated with the sadness induction used more words associated with sadness than subjects in the control group ($\Delta = 2.628$, p-value<0.000). Importantly, in Experiment 1, the difference in the anger content of the writings between participants in the treated and control groups is significantly larger than the difference in the sadness content between the treated and control group members ($\Delta = 1.633$, p-value<0.000) (top-left panel compared with bottom-left). Similarly, in Experiment 2, the difference in anger content of the writings between treated and control group subjects in Experiment 2 is significantly larger than the difference in the anger content between them ($\Delta = 2.094$, p-value<0.000) (top-left panel compared with bottom-left).

These results highlight that, at a minimum, participants wrote about the episodes that they had been asked to address in the exercises.[17] This, in turn, should have caused participants to relive the recalled event and experience once again the emotions related to it (see Section 2.1.1). Our data allows us to look further into this link. We thus analyze self-reported measures of the levels of an array of discrete emotions felt in the experiment.

In particular, we now study before and after responses to the PANAS questionnaire. Figure 2 shows the results. There is a significant difference in reported anger before and after the anger treatment, compared to the control ($\Delta = 0.280$, p-value=0.004) (top-left panel), while the difference about sadness is not statistically significant in the same groups ($\Delta = -0.071$, p-value=0.478) (bottom-left panel). The opposite is true in Experiment 2. Here the difference in subjects' reported levels of sadness, before and after the induction, is significantly greater in the treatment compared to the control ($\Delta = 0.263$, p-value=0.014) (bottom-right panel). We also find a positive marginal effect in the difference in reported anger across the two groups ($\Delta = 0.156$, p-value=0.078) (top-right panel).

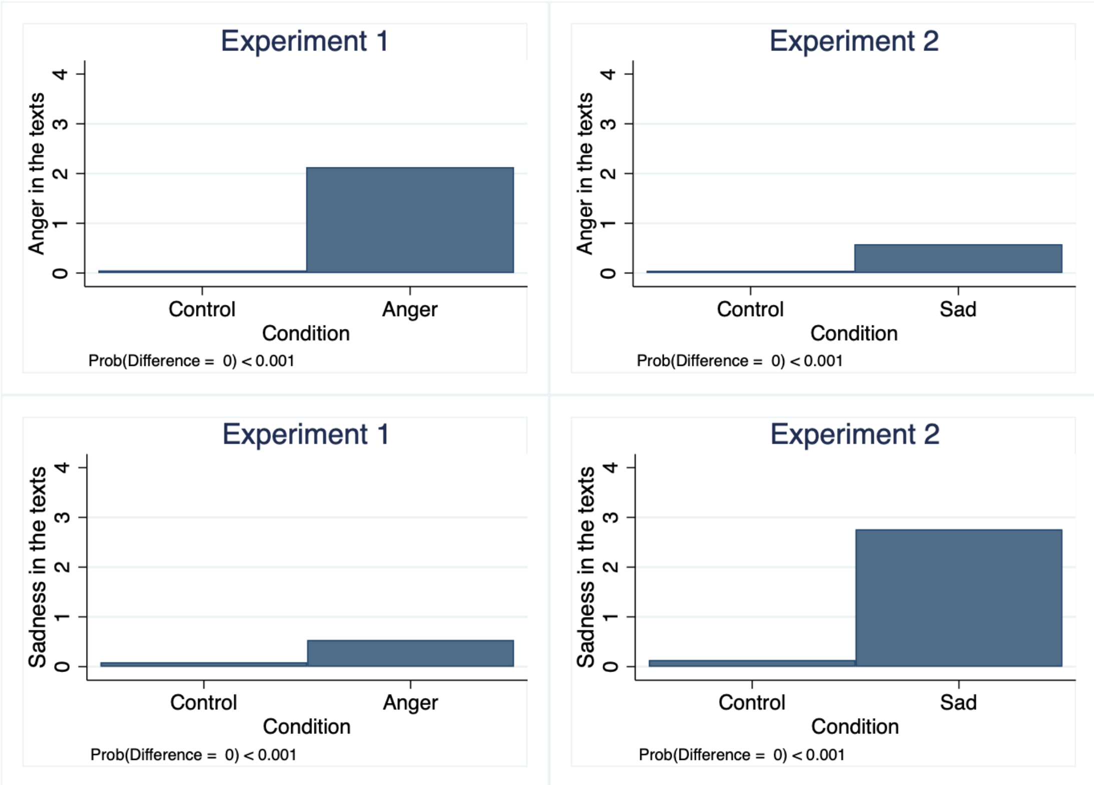
Table 1: Anger and Sadness categories in LIWC

	Example	Words in Category
Anger	Hate, Kill, Annoyed	230
Sadness	Crying, Grief, Sad	136

[16] In this subsection, we compute Mann-Whitney tests to assess the differences in the emotions across conditions and experiments.

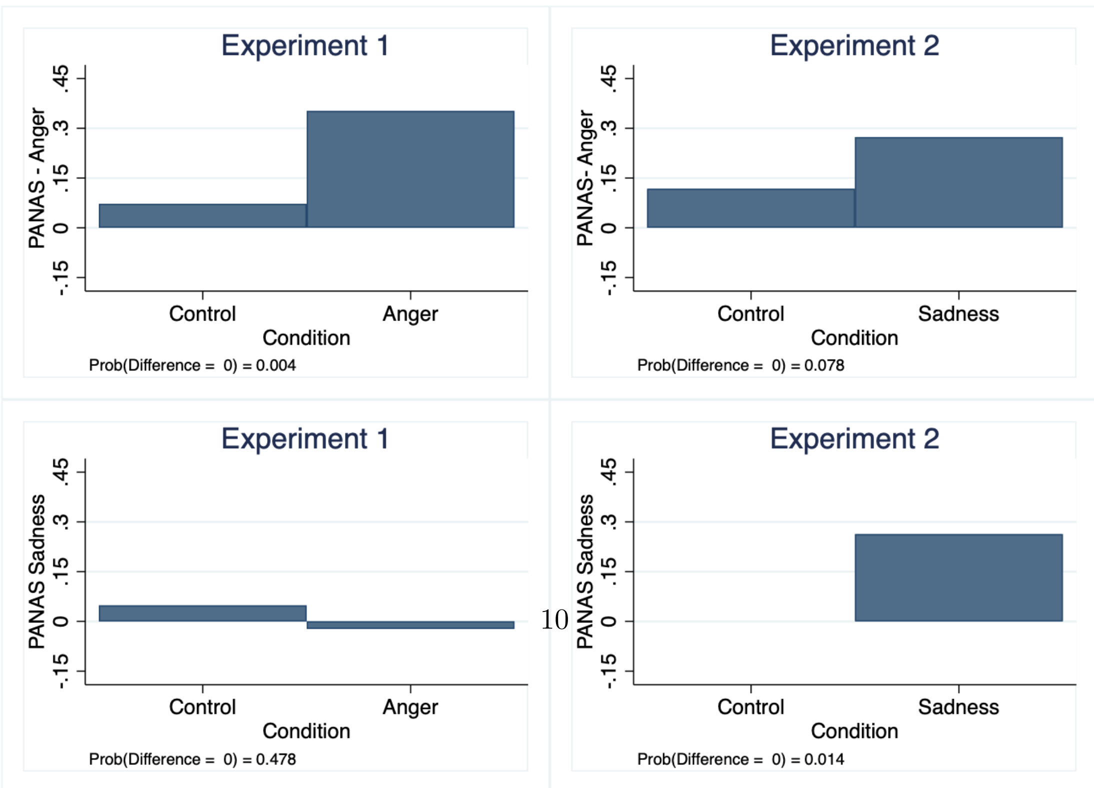
[17] In Appendix C we perform further text analyses by measuring total and negative affect in the texts by condition and experiment. Results are similar. Interestingly, if we look at the presence of words indicative of anxiety in the texts, levels are significantly lower compared to those for anger in the treated group of Experiment 1, and for sadness in the treated group of Experiment 2 (see Figure C.3).

Figure 1: Anger and Sadness measured using text analyses of the inductions



Notes: 1) The bars report the averages of anger and sadness from the subjects' written words for the different inductions. 2) Analysis based on the LIWC2015 (Linguistic Inquiry and Word Count) dictionary (Pennebaker, 2015). 3) The notes report the results of the corresponding Mann-Whitney test.

Figure 2: Anger and Sadness felt before and after the induction



In Appendix D.1 we show that our conclusions of the effectiveness of the induction procedure holds if we look at the answers to the Rottenberg *et al.* (2007)'s questionnaire. Additionally, through the responses to the first PANAS questionnaire, we can check whether participants' general affect was similar at the baseline by condition and experiment. In Appendix D.2 we present the results. We find no differences in either positive or negative affect at the baseline across conditions in the two experiments. This is a further check that randomization into the treatment conditions produced balanced groups. And, more importantly, it shows that our experimental results cannot be driven by differences in affect at the baseline.

3.2 p-beauty Contest Game

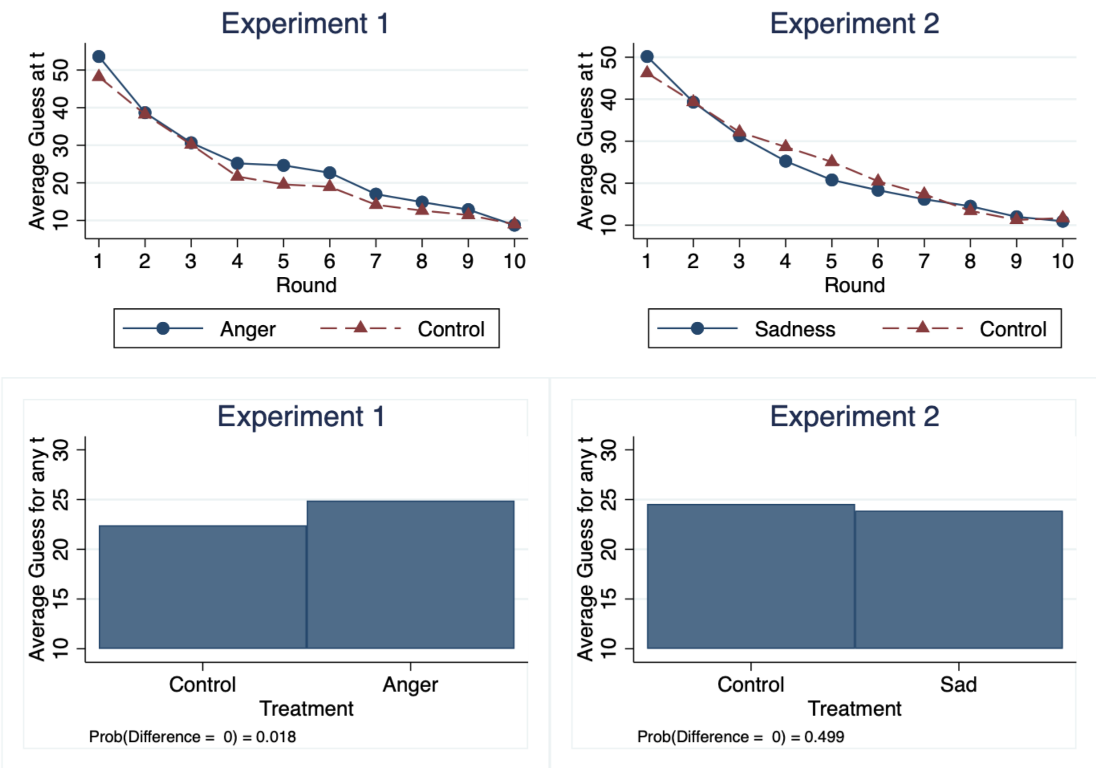
Having shown that the induction procedure was successful in inducing the emotions of interest, we now analyze the effect of anger and sadness in the p-beauty contest game. This game allows us to assess how the treatments affect strategic reasoning in two ways. First, we can study how close to the Nash equilibrium subjects play (i.e., how close their guesses are to zero). This is a proxy for strategic sophistication. Second, the payoffs in the game are a measure of subjects' ability to choose their guesses given others' behavior in the game. In this sense, payoffs are a measure of subjects' theory of mind, the process of mental modeling about others' beliefs and actions (Coricelli and Nagel, 2009). That is, when thinking about others' characteristics and beliefs, people build mental models that change and develop through continuous interactions, and these can be used to anticipate others' behavior.

Our two variables of interest are, therefore, the *guesses* and the *payoffs*.

3.2.1 Guesses

The mean unconditional guess across all rounds is 23.68 (s.d. 0.525) in Experiment 1 and 24.20 (s.d. 0.507) in Experiment 2. As Figure 3 shows, treated subjects in Experiment 1 guessed on average higher numbers than those in the control. This holds true in almost every round and on aggregate (left panels). In Experiment 2, by contrast, no clear pattern emerges. Guesses by treatment are similar across rounds and on aggregate (right panels).

Figure 3: The effect of anger and sadness on the average guess



Notes: 1) The lines in the top panels report the average guess for each round of play by condition and experiment. 2) The bottom panels report the average guess across all rounds by condition and experiment. 3) The notes report the results of the corresponding t-test.

In the first round of Experiment 1, the average guess among those who undertook the anger exercise is 53.60, compared to 48.20 among those in the control group. This difference is marginally significantly different from zero (p-value=0.098).[18] In Experiment 2, this difference is again larger among those in the treatment group compared to those in the control group (50.17 vs. 46.21, Δ=3.96), although not significantly so (p-value=0.242).

We find that the average guess across all rounds among those who experienced the anger treatment is 24.89, while it is 22.40 among those in the control group. The difference (Δ=2.49) is highly significant (p-value=0.018). In contrast, in Experiment 2 the average guess among those in the sadness treatment is lower than the average guess among those in the control group (23.87 vs. 24.56), although the difference is not statistically significant (p-value=0.499).

[18]In Subsections 3.2 and 3.2, we compute t-tests to assess average differences in guesses and payoffs across conditions and experiments.

The previous analysis on average guesses across all rounds does not consider that guesses are influenced by past behavior. Therefore, in order to take into account previous game play and group fixed effects we estimate the following model:

$$Guess_{i,j,t} = \beta_0 + \beta_1 Treatment_i + \beta_2 AverageGuess_{j,t-1} + \beta_3 t + \gamma_j + \epsilon_{i,j,t}; \tag{1}$$

where i indicates the subject in group j, while t is the round of play. Our dependent variable is the guess in the game, $Guess_{i,j,t}$. Our independent variable of interest is $Treatment_i$, which is a dummy variable indicating the emotion treatment individual i received in one of the two experiments. Control variables include: $AverageGuess_{j,t-1}$ that is the average guess in the previous round, t is the round of play, γ_j is the group-level effect, while $\epsilon_{i,j,t}$ is the error term.

We estimate Equation (1) by using an OLS model with group fixed effects. We cluster standard errors at the group level. The results are reported in Table 2. Column (1) reports the results for Experiment 1; Column (2) reports those for Experiment 2; Column (3) reports the combination of the two. The anger treatment has a positive and significant effect on guesses. The guesses of subjects who experienced the anger treatment are more than two units higher on average, compared to subjects' guesses in the control (p-value=0.009). The sadness treatment has an insignificant negative effect on guesses.

Table 2: The effect of the treatment on guesses in both experiments

	Experiment 1 Guess b/se	Experiment 2 Guess b/se	Experiments 1 & 2 Guess b/se
Anger Treatment	2.439**		2.439***
	(0.921)		(0.917)
Sadness Treatment		–0.626	–0.626
		(1.021)	(1.017)
Average Guess at $t-1$	0.092***	0.106***	0.098***
	(0.019)	(0.020)	(0.014)
Round	–2.114***	–2.028***	–2.078***
	(0.304)	(0.307)	(0.216)
Group Exp FE	Yes	Yes	Yes
N	1539	1620	3159
Individuals	171	180	351
R2	0.465	0.445	0.455

Notes: 1) OLS estimator; 2) Standard errors (shown in parentheses) are clustered at the group level. 3) * p-value<0.1, ** p-value<0.05, *** p-value<0.01.

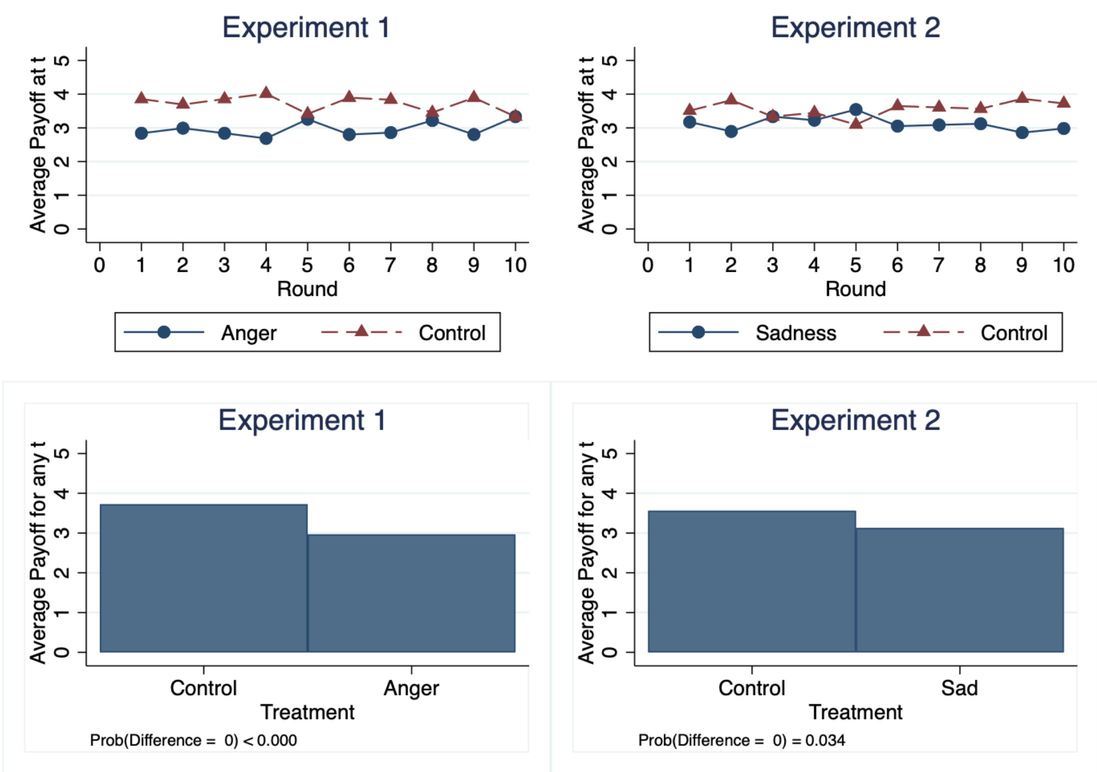
The appendix shows the results of further analyses. In the first analysis (shown in Appendix E.1), we add the individual random effects to the model above; the results are essentially the same. We also estimate Equation (1) by including control variables for each player's guess in the previous round (shown in Appendix F.1); the results show the same effect of anger on guesses.

3.2.2 Payoffs

Next, we analyze the effects of the treatments on payoffs in the two experiments. As argued above, this variable proxies for an individual's capacity to understand other players' behaviors, and to respond optimally by following these beliefs.

The top panels of Figure 4 show that the anger treatment results in lower levels of payoffs in almost every round. The sadness treatment also has a detrimental impact on payoffs, though the results are not as clear cut as those that stem from the anger treatment. As shown by the bottom panels of the figure, both treatments decrease payoffs. The effect of the anger treatment, however, is larger in magnitude.

Figure 4: The effect of anger and sadness on payoffs in both experiments



Notes: 1) The lines in the top panels report average payoffs for each round of play by condition and experiment. 2) The bottom panels report average payoffs across all rounds by condition and experiment. 3) The notes report the results of the corresponding t-test.

In the first round, the average payoff for those who experienced the anger treatment is £2.84, while it is £3.86 in the control group (Δ=£-1.02, p-value=0.139). We also find lower average payoffs for those who experienced the sadness treatment compared to those in the control group (£3.18 vs. £3.51), but the effect is substantially smaller (Δ=£-0.33, p-value=0.628).

Average payoffs across rounds are lower for those in the treatment groups of both experiments. Payoffs for those who experienced the anger treatment were £0.76 lower; their payoffs were £2.96, compared to payoffs of £3.72 for players in the treatment group. This corresponds to a percentage decrease of around 20 percent. If we perform a t-test, we see that the difference is significant (p-value=<0.000). The sadness treatment seems to have the same effect of reducing the payoffs but to a lower extent (control=£3.56, treatment= £3.13, $\Delta = \pounds 0.43$, p-value=0.034).

As before, we perform OLS regressions to analyze the impact of the treatments on payoffs, while also taking into account previous game play. We estimate the following model:

$$\begin{aligned} Payoff_{i,j,t} = \beta_0 + \beta_1 Treatment_i + \beta_2 AverageGuess_{j,t-1} \\ + \beta_3 Guess_{j,t,1} + \beta_4 Guess_{j,t,2} + \gamma_j + \epsilon_{i,j,t}; \end{aligned} \tag{2}$$

This model is the same as in Equation (1) with two further controls: $Guess_{j,t,1}$ and $Guess_{j,t,2}$. These variables are the guesses made by the other two subjects in the same group play in the current round t. We need these variables because the payoffs are influenced by the guesses of the two other players. We cluster standard errors at the group level.

We present the estimation in Table 3: Column (1) reports the results for Experiment 1, Column (2) reports those for Experiment 2. Column (3) combines the two. Column (1) shows that the anger treatment significantly reduces payoffs per round by about £0.65 (p-value=0.047). The coefficient of the sadness treatment is smaller (£0.53) and non-significant in Experiment 2 (p-value=0.147). We find the same results when the two experiments are pooled together in a unique regression (Column (3)).

We also run an individual random effects model (shown in Appendix E.2); the results are essentially the same. We run a variation of Equation (2) in which we control for each player's guess in the previous round (shown in Appendix F.2); the results are similar.

The extent of anger in the text (as measured by the LIWC2015 software) is negatively correlated with the payoffs for those who experienced the anger treatment (see Table E.8 of the appendix). This finding suggests that the effect of anger is proportional to the magnitude of anger induced. By contrast, we do not find a similar effect for sadness (see Table E.7). A similar result can be noted from table E.7 with respect to guesses in the anger treatment, although the respective coefficient is not significant in this case.

Table 3: The effect of the treatment on payoffs in both experiments

	Experiment 1	Experiment 2	Experiments 1 & 2
	Guess	Guess	Guess
	b/se	b/se	b/se
Anger Treatment	–0.659**		–0.700**
	(0.324)		(0.323)
Sadness Treatment		–0.527	–0.530
		(0.359)	(0.358)
Guess other player (1) at t	0.060***	0.042***	0.049***
	(0.009)	(0.007)	(0.006)
Guess other player (2) at t	0.034***	0.051***	0.042***
	(0.007)	(0.006)	(0.005)
Average Guess at t-1	–0.018***	–0.019***	–0.018***
	(0.003)	(0.002)	(0.002)
Group Exp FE	Yes	Yes	Yes
N	1539	1620	3159
Individuals	171	180	351
R2	0.056	0.055	0.054

Notes: 1) OLS estimator; 2) Standard errors (shown in parentheses) are clustered at the group level. 3) * p-value<0.1, ** p-value<0.05, *** p-value<0.01.

4 Structural Level-k Model

In this section, we present a finite mixture model, in which individuals are grouped according to the different latent k-rule chosen. Using this model, we estimate the impact of anger on players' level-k rule. We first describe the model. We then present the estimation strategy and the results.

4.1 The Model

We assume that choices $x_{i,g,t}$, in which i is the subject in group g and round t, are independent draws over rounds and subjects. Let $k_{i,g,t} \in [0, 1, ..\overline{k}]$ be the rule followed by subject i in group g and round t.

When the choice rule is $k = 0$, we assume that individuals choose randomly. Thus, the choice per individual and round is uniformly distributed, with probability:

$$Pr(x \mid k_{i,g,t} = 0) = 1/101. \tag{3}$$

When, on the other hand, the choice rule is $k > 0$, we assume that the choice of subject i in group g and round t follows a normal distribution $g(x \mid \mu_{k,t,g}, \sigma)$, characterized by the mean $\mu_{k,t,g}$ and the variance σ.

- For any round $t > 1$, let $\overline{x}_{g,t-1}$ be the average choice in group g for round $t-1$. We then assume that individuals at round t start their iteration using the mean guess in their group, g, in round $t-1$ (that they directly observe at the end of round $t-1$ of the experiment).[19] Accordingly, because subjects choosing a rule k best respond to $k-1$ choices, we assume that the mean of the distribution of their guesses is $\mu_{k,t,g} = (\frac{7}{10})^k \cdot \overline{x}_{g,t-1}$.
- In round $t = 1$, subjects with $k = 1$ best respond to $k = 0$ by calculating the mean of the uniform distribution of $k = 0$'s choices; hence $\overline{x}_{g,0} = 50$ and $\mu_{1,1,g} = (\frac{7}{10}) \cdot 50$. Subjects $k = 2$ best respond to $k = 1$, with $\mu_{2,1,g} = (\frac{7}{10})^2 \cdot 50$, and so on.

As a result, the probability of choosing any x for an individual i in g at round t and a rule $k_{i,g,t} > 0$ is:

$$Pr(x \mid k_{i,g,t} > 0) = g(x \mid \mu_{k,t,g}, \sigma) \tag{4}$$

[19] Gill and Prowse (2016) find that assuming that subjects do not take into account the effect of their own guesses on the mean leads to a better fit of the estimation. We then follow them in this assumption.

Let $z(k)$ be the distribution of the choice rule among the different subjects in the different rounds. The unconditional probability of any choice x of any i in group g at round t is then:

$$Pr(x) = \sum_{k>0}^{\overline{k}} z(k) g(x \mid \mu_{k,t,g}, \sigma) + z_{k=0}(k)(1/101) \tag{5}$$

4.2 Estimation Strategy

Using the experimental data that includes 351 subjects, who make a total of 3,510 choices across the 10 rounds of play, we estimate the parameter vector $\theta = [\sigma, z(k)]$ for each treatment and experiment.

Here, we assume that there are up to level-4 subjects (hence $\overline{k} = 4$) and that the distributions $g(x \mid \mu_{k,t,g}, \sigma)$ are normally distributed with mean, $\mu_{k,t,g}$, and variance, σ. Thus, θ consists of five parameters (remember that for $k = 0$ the distribution of x is uniform).

Given our assumptions, the probability of all observed choices for any individual and round, $\mathbf{x}$, is $Pr(\mathbf{x}) = \prod_{t=1}^{10} \prod_{g=1}^{N} \prod_{i=1}^{3} Pr(x_{i,g,t})$. The likelihood we maximize is then: $L(\theta, \mathbf{x}) = Pr(\mathbf{x})$; where $\theta = [\sigma, z(k)]$.

We maximize the sample log likelihood function using a standard Matlab routine. Table 4 shows the estimated level-k types by condition in Experiment 1 and Experiment 2.[20] We note that the anger treatment increases the share of level-0 play of about 35 percent (from 0.253 to 0.343) against decreases of about 4 percent (from 0.532 to 0.509) and 50 percent (from 0.177 to 0.089) in the shares of level-1 and level-2 play. Overall, the anger treatment leads to a decrease in the average level-k from 1.001 to 0.864. We do not observe the same patterns in Experiment 2. In fact, the sadness treatment, if anything, leads to a lower share of level-0 choices.

In Table G.12 of the appendix, we present the results using an alternative hypothesis on the distributional form of choices. We assume that choices follow a Poisson distribution. We qualitatively observe similar results.

[20]We omit to report the variances for expositional simplicity, they are presented in Table G.12 of the appendix.

Table 4: Estimated Level-k types by treatment and experiment

	Experiment 1		Experiment 2	
	Anger	Control	Sadness	Control
Level 0	0.343	0.253	0.218	0.302
Level 1	0.509	0.532	0.691	0.538
Level 2	0.089	0.177	0.048	0.118
Level 3	0.059	0.038	0.043	0.039
Level 4	0.000	0.000	0.000	0.002
σ	3.501	3.967	4.806	3.410
Log likelihood	-3,408	-3,114	-3,547	-3,216
Average Level-k	0.864	1.001	0.915	0.901

5 Discussion

In this section we discuss two implications of our results. The first is that the negative effect of incidental anger on strategic sophistication can represent a negative externality because it negatively affects cooperation in social interactions such us the repeated prisoner's dilemma game type. The second is that anger represents a commitment device that can increase one's bargaining power by decreasing her strategic sophistication. Finally, we also discuss the underlying mechanism driving our results.

5.1 Anger and Cooperation

As we mentioned in the introduction, the incidental effect of anger on cognitive abilities may represent a negative externality for those economies in which subjects are more exposed to shocks leading to anger. Here we discuss a possible detrimental effect on cooperation. Proto *et al.* (2019) show that cooperation rates on a non zero-sum complex game, such as the repeated prisoner's dilemma, positively depend on the cognitive abilities of the players. Following this finding and the results obtained in the current article, it is natural to hypothesize that anger has a detrimental effect on cooperation rates in a repeated prisoner's dilemma game. This hypothesis also finds confirmation in Castagnetti *et al.* (2018), in which participants in the treatment were induced to feel anger through the use of a standard video induction procedure.

In what follows, we illustrate how anger negatively affects the cooperation rates with an example using an indefinitely repeated prisoners' dilemma game experiment from Castagnetti *et al.* (2018).

Consider the following payoff matrix in the stage game:

Table 5: **Prisoner's Dilemma.** C: Cooperate, D: Defect.

	C	D
C	c,c	c,t
D	t,c	d,d

with $t > c > d > s$, and let δ be the intertemporal discount rate.

Assume that subjects can adopt only one of three strategies: i) Tit for Tat (TfT) (starting with C), in which the player cooperates and then imitates the opponent's previous action; 2) Grim Trigger (GT), in which cooperation is involved so long as the other player does not defect; if the opponent defects, then the player will defect for the remaining of the interaction; and 3) Always Defect (AD) in which the player always plays defect regardless of the opponent's action.[21]

We further assume that at the beginning of each repeated game, subjects decide the strategy and implement them correctly. A $k = 0$ player chooses randomly among these three strategies, with a uniform probability. Hence, she plays each strategy with probability $1/3$. A $k = 1$ player optimally responds to a $k = 0$ player; her expected payoff from playing the AD strategy is:

$$V(AD) = (1/3)\frac{d}{1-\delta} + (2/3)(t + \delta\frac{d}{1-\delta}); \tag{6}$$

while if she plays either the TfT or GT strategies (which we can define as *Sophisticated Cooperation*, or SC), she expects to earn:

$$V(SC) = (1/3)(s + \delta\frac{d}{1-\delta}) + (2/3)(\frac{c}{1-\delta}) \tag{7}$$

In Castagnetti *et al.* (2018) subjects play a series of indefinitely repeated prisoner's dilemma games with random stranger rematching and continuation probability $\delta = 0.75$, and $c = 48$; $t = 50$; 4s=12; $4d = 25$. Substituting these values in equations 6 and 7, we obtain: $V(AD) = 116.67$ and $V(SC) = 157$. Hence, given these parameters a $k = 1$ subject will always choose SC (i.e. TfT or GT indifferently). Using similar computations, it is possible to show that a $k = 2$ player, that best responds to $k = 1$ subjects, similarly choose SC, and so on for $k > 2$.

Considering the results in Castagnetti *et al.* (2018) (see Table 2 in particular), 90 percent of subjects in the control group in Experiment 1 choose C in the first round of the first repeated game; by contrast, only 78.13 percent of those who experienced the anger treatment

[21]There is overwhelming evidence that those are the most common strategies adopted by subjects in the laboratory. For instance, Dal Bó and Fréchette (2011) and Proto *et al.* (2019) find evidence that these strategies are those mostly played (with a likelihood between 66 and 90 percent).

make this choice. We can then argue that anger increased the proportion of $k = 0$ subjects by about 36.6 percent, in the first repeated game of the experiment. This is roughly consistent if we use the maximum likelihood estimated strategies (reported in Table 4 of Castagnetti *et al.* (2018)) in the first five repeated games. In the anger treatment group, 9 percent more participants playing the AD strategy. Hence, following our argument, the anger treatment group includes 27 percent more k=0 subjects.

5.2 Anger and Bargaining

Because anger negatively affects the level of strategic sophistication, it can represent a powerful commitment device. Here we consider a simple sequential game, the ultimatum game, to illustrate this argument. In the ultimatum game the proposer offers a share of $x \in (0, 100)$ to a responder, who decides whether to accept or reject the offer. If the responder accepts, she earns x and the proposer earns $100 - x$. Otherwise, they respectively receive the outside payoffs of V_R and V_P.

We proceed by following Ho and Su (2013), who analyze a model in which the level-k logic is applied to sequential games and to the ultimatum game in particular.[22] They argue that their model implies that:

- Level-0 players are assumed to choose a number between zero and 100 randomly. For the proposer, this randomly chosen number is the initial demand, while for the responder this number is the acceptance threshold (i.e., only offers that are above this threshold are accepted).
- Level-1 players best respond to level-0 players' randomization strategies. The responder accepts any offer greater than V_R. The proposer chooses x so to maximize the expected payoff:

$$\frac{x}{100}(100 - x) + \frac{100 - x}{100} V_R. \tag{8}$$

- Level k$\geq$ 2 players best respond to level k-1 players. The responder accepts any offer greater than V_R. The proposer offers the minimum acceptable amount to a level k-1 proposer, which is V_P.

The implications of our results in this environment can be appreciated as follows. Assume that there is a threshold $\overline{x} > 0$, such that if any offer $x < \overline{x}$, the responder grows angry,

[22] See pages 456-467.

and thus becomes level-0 player.[23] We also assume that the proposer at the beginning of the process chooses a level k > 1. Finally, for expositional simplicity let $V_R = V_P = 0$.

Therefore, a level $k > 1$ proposer knows that if he offers $x \geq \overline{x}$, this will be accepted for sure by any level k-1 responder. If he offers $x < \overline{x}$, then the responder will use the level-0 rule of decision and will accept the offer with probability $x/100$. As a result, the proposer's expected payoff is:

$$\begin{cases} 100 - x, & x \geq \overline{x} \\ (x/100)(100 - x), & x < \overline{x} \end{cases};$$

and his optimal choice is:

$$\begin{cases} x^* = \overline{x}, & \overline{x} \leq 75 \\ x^* = 50, & \overline{x} > 75 \end{cases};$$

$\overline{x}$ can be thought of as a measure of propensity to anger that can also be affected by external factors. To the extent that $\overline{x} \leq 75$, the higher $\overline{x}$ is, the higher the payoff for the responder.[24] Arguably, a possible strategy for the responder is to try to convince the proposer than he is angry (whether or not this is true), so that $\overline{x}$ is high and he is easy to upset. This strategy hinges on to so-called *madman theory*, where signaling anger is a way to signal irrationality.[25]

The predictions of this model are generally consistent with findings in laboratory experiments, in which negative mood induction increases the probability of rejection of unfair offers (see e.g. Forgas and Tan, 2013). It is important to note than in any sequential game, such as the ultimatum game, it is virtually impossible to distinguish the anger effect of the desire to punish the opponent (i.e., due to negative social preferences) from the effect on strategic sophistication tested in this paper with the beauty contest game. Thus, this is a key factor motivating our experimental strategy.

5.3 Mechanism and Potential Confounding Factors

Our results show that anger negatively affects strategic reasoning and theory of mind. Although we can be agnostic about the exact cognitive mechanism, it is instructive to investigate whether this happens because anger leads to disengagement.

[23]The existence of such a threshold is consistent with the framework of psychological game theory (see e.g. Geanakoplos *et al.*, 1989; Battigalli and Dufwenberg, 2009), in which individuals can become angry when their beliefs about others' choices or beliefs are not fulfilled. Therefore, we can interpret $\overline{x}$ as the minimal offer the responder expects to receive.

[24]Interestingly the effect is not monotonic, if $\overline{x} > 75$. Hence if a responder has a *very* strong propensity toward anger, the proposer will prefer to make her angry, and offer $x = 50$.

[25]Niccolò Machiavelli argued that sometimes it is "a very wise thing to simulate madness" (Machiavelli, 2009, book 3, chapter 2).

To understand whether disengagement may be a relevant mechanism through which anger (but not sadness) influences game play, we can look at response times in the beauty contest game. Response times measure how much time each subject invested into thinking about what number to play. Responses times may thus be thought of as a proxy for engagement in the game. The average time spent per round was 7.52 seconds (s.d. 0.119) overall (across rounds, treatments and experiments). To analyze the impact of the induced emotions on response times we perform the same analysis as in Equation (1) but by using response times instead of guesses as dependent variable. Table F.11 in the appendix shows the results. The estimated coefficients are highly insignificant (p-values equal to 0.470 and 0.954). This suggests that the mechanism through which anger affects reasoning on the beauty contest game is not due to disengagement.

A potential concern is that the induction changed participants' beliefs about the other participants' play in the game. For instance, participants could have anticipated the effects of the induction and adapted their guesses in the game accordingly. We find this prospect unlikely. First, in the instructions of the induction we did not informed the participants about the nature of other subjects' induction, furthermore we explicitly informed participants that the questions they would receive in the inductions were not the same across participants. Second, these second-order beliefs should only matter for first-round guesses. In other words, these beliefs should have no impact once subjects have played the first round and have seen other' guesses.

6 Final Remarks

Our results provide strong evidence that anger impairs the capacity to think strategically. Our findings show that angry participants make significantly worse choices in a p-beauty contest game (i.e., they make choices that move them further away from the Nash equilibrium). The angry players earned lower profits than players who did not participate in the exercise to elicit anger. The angry players also use level-0 thinking more often. Our follow-up experiment, which exposed a group of players to exercises to induce sadness, does not produce the same effects.

The fact that anger is so pervasive in human relationships and has a negative effect on the capacity of strategic thinking and on cooperation between individuals is puzzling. However, recent theoretical and empirical literature have emphasized that anger can serve as an efficient commitment device in strategic interactions. We discuss this implication from our results in a sequential game, in which the propensity to become angry and then less strategically sophisticated can represent an effective commitment device able to increase individuals' bargaining power.

Our results have implications for behavioral policies at the individual level. Ex-post anger is detrimental, so it is optimal to control it. On the other side, ex-ante, showing high anger propensity may represent a bargaining advantage.

We argue that the negative effect of anger on strategic reasoning can represent a negative externality for an economy and a society in aggregate because it can potentially reduce cooperation in situations in which cooperation is likely beneficial. We illustrate this using the prisoner's dilemma. Therefore, anger can generate self-sustaining, vicious cycles, particularly in environments in which anger-producing events are more frequent – such as in poorer countries, during times of negative economic shocks, and among poorer, disadvantaged socioeconomic classes.

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A Summary Statistics

A.1 Descriptive Statistics

Table A.1: Descriptive statistics – demographic variables

Experiment 1	Mean	Std. Dev.	Min	Max	N
Demographics					
Female (Share)	58.48%	0.494	0	1	171
Age (Mean)	21.205	3.352	18	43	171
Culture					
Anglo Cultures	0.263	0.442	0	1	171
Confucian Asia	0.123	0.329	0	0	171
Eastern Europe	0.082	0.275	0	1	171
Germanic Europe	0.023	0.152	0	1	171
Latin America	0.006	0.076	0	1	171
Latin Europe	0.047	0.212	0	1	171
Nordic Europe	0.012	0.108	0	1	171
Southern Asia	0.392	0.490	0	1	171
Other	0.053	0.224	0	1	171
Experiment 2	**Mean**	**Std. Dev.**	**Min**	**Max**	**N**
Demographics					
Female (Share)	52.78%	0.501	0	1	180
Age (Mean)	20.456	2.813	18	33	180
Culture					
Anglo Cultures	0.261	0.440	0	1	180
Confucian Asia	0.094	0.293	0	0	180
Eastern Europe	0.117	0.322	0	1	180
Germanic Europe	0.022	0.148	0	1	180
Latin America	0.011	0.105	0	1	180
Latin Europe	0.072	0.260	0	1	180
Nordic Europe	0.006	0.075	0	1	180
Southern Asia	0.406	0.492	0	1	180
Other	0.011	0.105	0	1	180

Table A.2: Descriptive statistics – education and other variables

Experiment 1	Mean	Std. Dev.	Min	Max	N
Education					
High School Final Mark (Normalized)	85.87%	0.112	0.3	1	169
Degree Quantitative (Share)	66.86%	0.472	0	1	169
Year of Study					
1st Year	0.456	0.500	0	1	171
Other	0.532	0.500	0	1	171
Not a Student	0.012	0.108	0	1	171
Other					
Risk Preferences (Mean)	5.647	1.943	0	10	171
Experience in the Game (Share)	4.09%	0.199	0	1	171
Experiment 2	Mean	Std. Dev.	Min	Max	N
Education					
High School Final Mark (Normalized)	86.26%	0.107	0.4	1	179
Degree Quantitative (Share)	72.22%	0.449	0	1	180
Year of Study					
1st Year	0.444	0.498	0	1	180
Other	0.533	0.500	0	1	180
Not a Student	0.022	0.148	0	1	171
Other					
Risk Preferences (Mean)	6.011	1.894	1	10	180
Experienced in the Game (Share)	3.33%	0.180	0	1	180

A.2 Descriptive Statistics by Condition

Table A.3: Descriptive statistics by condition – demographics

Experiment 1	Anger	Control	Difference	p-value
Demographics				
Female (Share)	63.64%	53.01%	10.62%	0.161
Age (Mean)	21.034	21.386	-0.351	0.495
Culture				
Anglo Cultures	0.284	0.241	0.043	0.525
Confucian Asia	0.136	0.108	0.028	0.581
Eastern Europe	0.080	0.084	-0.005	0.910
Germanic Europe	0.023	0.024	-0.001	0.953
Latin America	0.000	0.012	-0.012	0.304
Latin Europe	0.045	0.048	-0.003	0.933
Nordic Europe	0.000	0.024	-0.024	0.145
Southern Asia	0.398	0.386	0.012	0.871
Other	0.034	0.072	-0.038	0.266
Experiment 2	Sadness	Control	Difference	p-value
Demographics				
Female (Share)	54.12%	51.55%	2.54%	0.735
Age (Mean)	20.718	20.221	0.497	0.238
Culture				
Anglo Cultures	0.247	0.274	-0.027	0.687
Confucian Asia	0.153	0.042	0.111	0.011
Eastern Europe	0.082	0.147	-0.065	0.177
Germanic Europe	0.024	0.021	0.002	0.911
Latin America	0.012	0.011	0.001	0.937
Latin Europe	0.094	0.053	0.041	0.286
Nordic Europe	0.000	0.011	-0.011	0.346
Southern Asia	0.376	0.432	-0.055	0.455
Other	0.012	0.011	0.001	0.937

Table A.4: Descriptive statistics by condition – education and other variables

Experiment 1	Anger	Control	Difference	p-value
Education				
High School Final Mark (Normalized)	84.517%	87.306%	-2.879%	0.107
Degree Quantitative (Share)	69.318%	64.198%	5.121%	0.483
Year of Study				
1st Year	43.181%	48.182%	-0.050%	0.514
Other	56.181%	49.398%	7.421%	0.334
Not a Student	0	2.410%	-2.410%	0.145
Other				
Risk Preferences (Mean)	5.489	5.795	-0.307	0.304
Experienced in the Game (Share)	3.409%	4.819%	-0.141%	0.664
Experiment 2	Sadness	Control	Difference	p-value
Education				
High School Final Mark (Normalized)	86.024%	86.474%	-0.450%	0.779
Degree Quantitative (Share)	74.118%	70.526%	3.591%	0.594
Year of Study				
1st Year	43.529%	45.263%	-1.733%	0.817
Other	55.294%	51.579%	3.715%	0.620
Not a Student	1.176%	3.158%	-1.981%	0.371
Other				
Risk Preferences (Mean)	6.176	5.863	0.313	0.269
Experience in the Game (Share)	3.529%	3.158%	0.372%	0.891

B Screenshots of the Experiment

B.1 Emotional Induction

B.1.1 Anger Treatment

Figure B.1: Anger Induction – Question 1

Task I

Time left to complete this page: **9:28**

Please, answer the questions below. Remember that you have 10 minutes to complete them.

1. What are the three to five things that make you most angry? Please write two-three sentences about each thing that makes you angry. (Examples of things you might write about include: being treated unfairly by someone, being insulted or offended, etc.).

Please, write your answer in the box:

Figure B.2: Anger Induction – Question 2

2. Now we'd like you to describe in more detail the one situation that makes you (or has made you) most angry. This could be something you are presently experiencing or something from the past. Begin by writing down what you remember of the anger-inducing event(s) and continue by writing a description of the event(s) as detailed as is possible. If you can, please write your description so that someone reading this might even get angry just from learning about the situation. What is it like to be in this situation? Why does it make you so angry?

Please, write your answer in the box:

B.1.2 Sadness Treatment

Figure B.3: Sadness Induction – Question 1

Task I

Time left to complete this page: **9:38**

Please, answer the questions below. Remember that you have 10 minutes to complete them.

1. What are the three to five things that make you most sad? Please write two-three sentences about each thing that makes you sad. (Examples of things you might write about include: a failed exam, an illness of a relative, etc.).

Please, write your answer in the box:

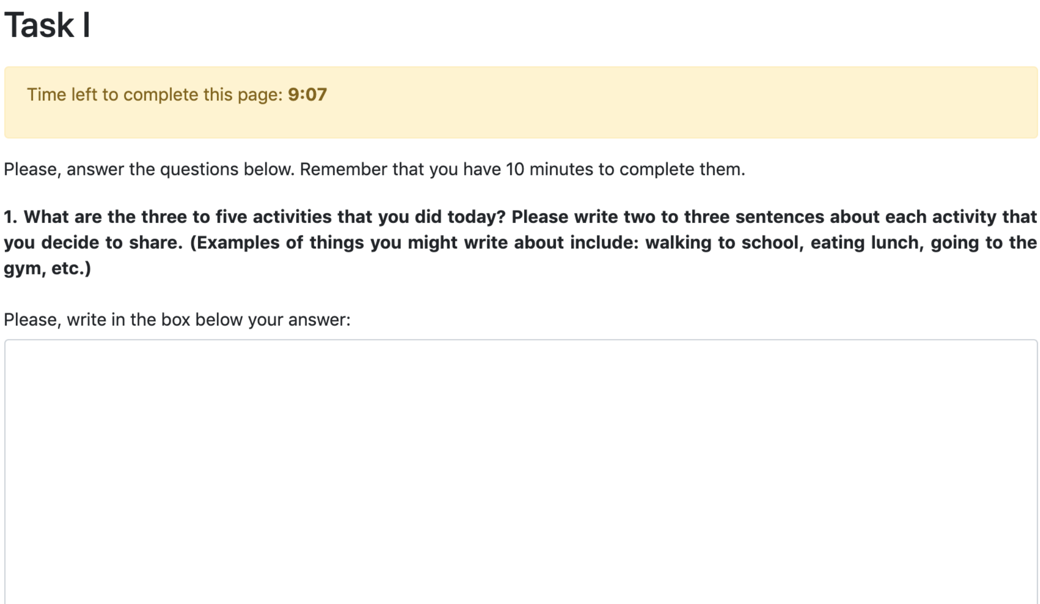
Figure B.4: Sadness Induction – Question 2

2. Now we'd like you to describe in more detail the one situation that makes you (or has made you) most sad. This could be something you are presently experiencing or something from the past. Begin by writing down what you remember of the sadness-inducing event(s) and continue by writing as detailed a description of the event(s) as is possible. If you can, please write your description so that someone reading this might even get sad just from learning about the situation. What is it like to be in this situation? Why does it make you so sad?

Please, write your answer in the box:

B.1.3 Control Treatment

Figure B.5: No Emotion Induction – Question 1



Task I

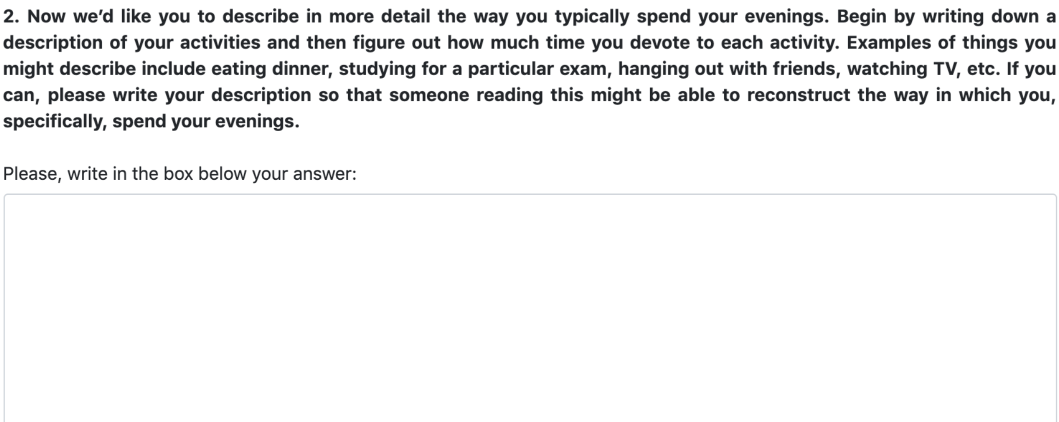
Time left to complete this page: **9:07**

Please, answer the questions below. Remember that you have 10 minutes to complete them.

1. What are the three to five activities that you did today? Please write two to three sentences about each activity that you decide to share. (Examples of things you might write about include: walking to school, eating lunch, going to the gym, etc.)

Please, write in the box below your answer:

Figure B.6: No Emotion Induction – Question 2



2. Now we'd like you to describe in more detail the way you typically spend your evenings. Begin by writing down a description of your activities and then figure out how much time you devote to each activity. Examples of things you might describe include eating dinner, studying for a particular exam, hanging out with friends, watching TV, etc. If you can, please write your description so that someone reading this might be able to reconstruct the way in which you, specifically, spend your evenings.

Please, write in the box below your answer:

B.2 The p-beauty Contest Game

B.2.1 Game Instructions

Figure B.7: p-Beauty Contest Game Instructions

Task 2 - Instructions

We will now describe to you the second part of the experiment. This will be a decision making task.

This part is made up of 10 rounds. You will be anonymously matched into groups of 3 participants. You will never get to know your group members' identity. You will stay in the same group for all 10 rounds.

In each round, you and your other 2 group members will separately choose a whole number between 0 and 100 (0, 100 or any whole number in between is allowed). The group member whose chosen number is closest to 70% of the average of all 3 chosen numbers will earn £10.00 and the other 2 group members will earn nothing in that round. If more than one group member chooses a number which is closest to 70% of the average of all 3 chosen numbers, the £10.00 will be split equally among the group members who chose the closest number (or numbers).

Importantly, at the end of the experiment you will be paid according to your earnings in one randomly drawn round.

At the end of each round, you will discover: (i) the numbers chosen by all your group members; (ii) the average of all 3 chosen numbers; (iii) what 70% of the average of all 3 chosen numbers was; and (iv) how much you earned in that round.

In the next screen you will also find a reminder of the rules of the task (shown at the bottom of this page too).

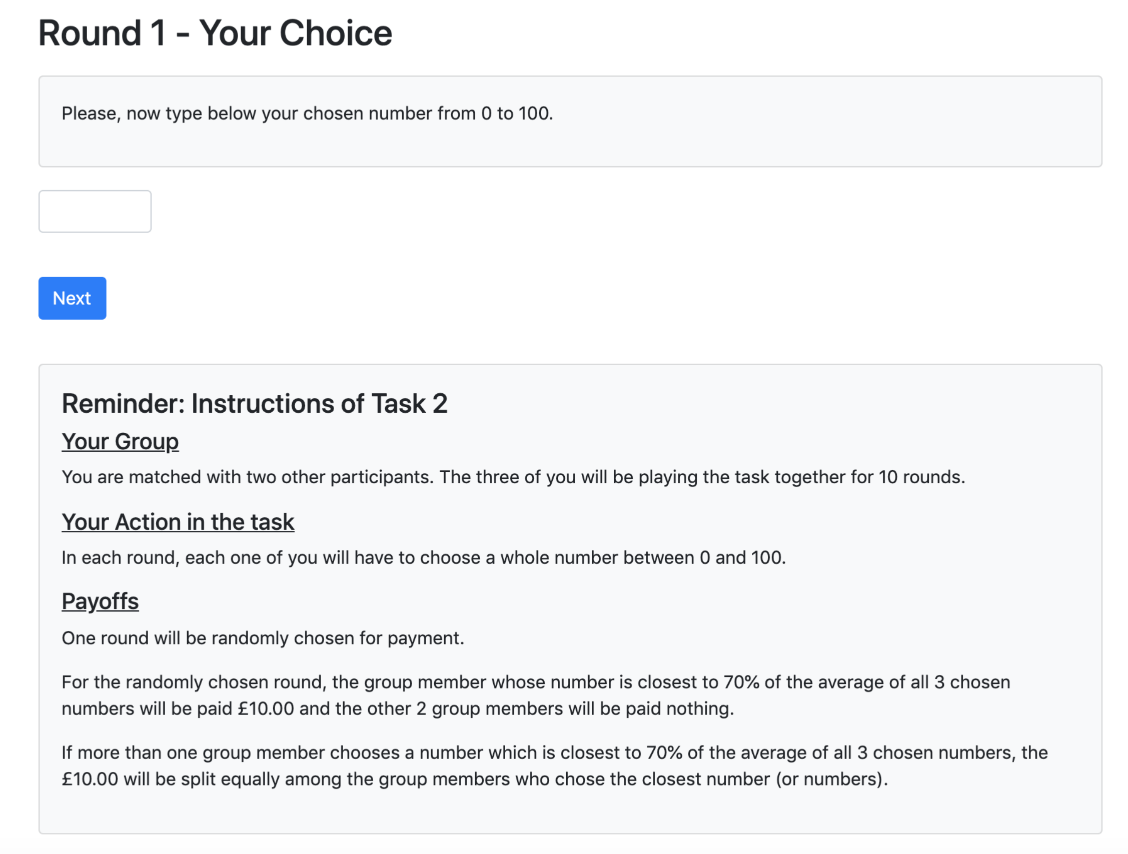
Please raise your hand if you have any questions.

To continue with the task, please type in the cell below the number "20".

Next

B.2.2 Game Play

Figure B.8: p-Beauty Contest Game Play



Round 1 - Your Choice

Please, now type below your chosen number from 0 to 100.

Next

Reminder: Instructions of Task 2

Your Group

You are matched with two other participants. The three of you will be playing the task together for 10 rounds.

Your Action in the task

In each round, each one of you will have to choose a whole number between 0 and 100.

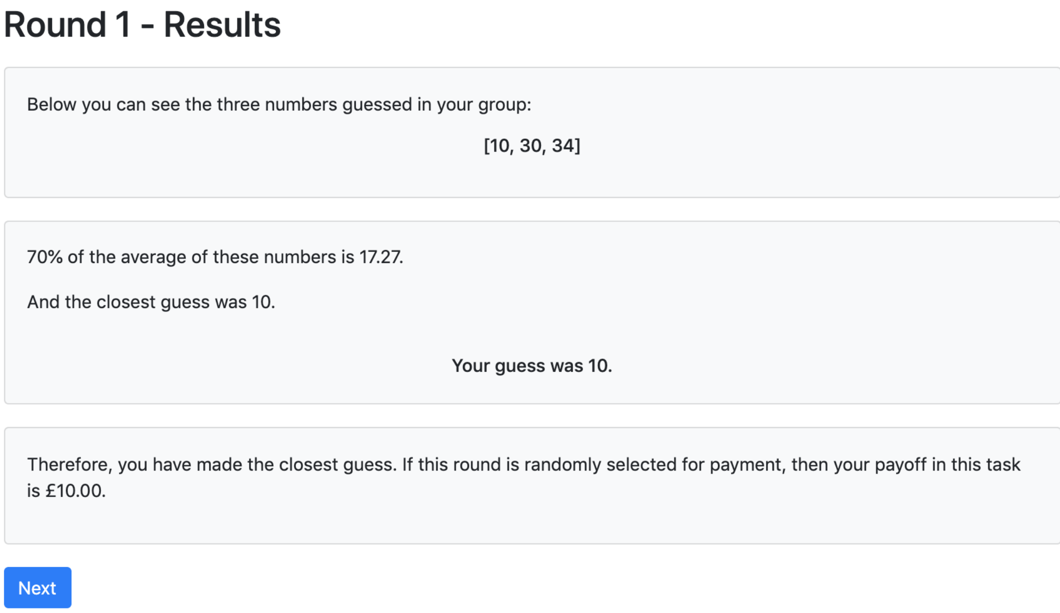
Payoffs

One round will be randomly chosen for payment.

For the randomly chosen round, the group member whose number is closest to 70% of the average of all 3 chosen numbers will be paid £10.00 and the other 2 group members will be paid nothing.

If more than one group member chooses a number which is closest to 70% of the average of all 3 chosen numbers, the £10.00 will be split equally among the group members who chose the closest number (or numbers).

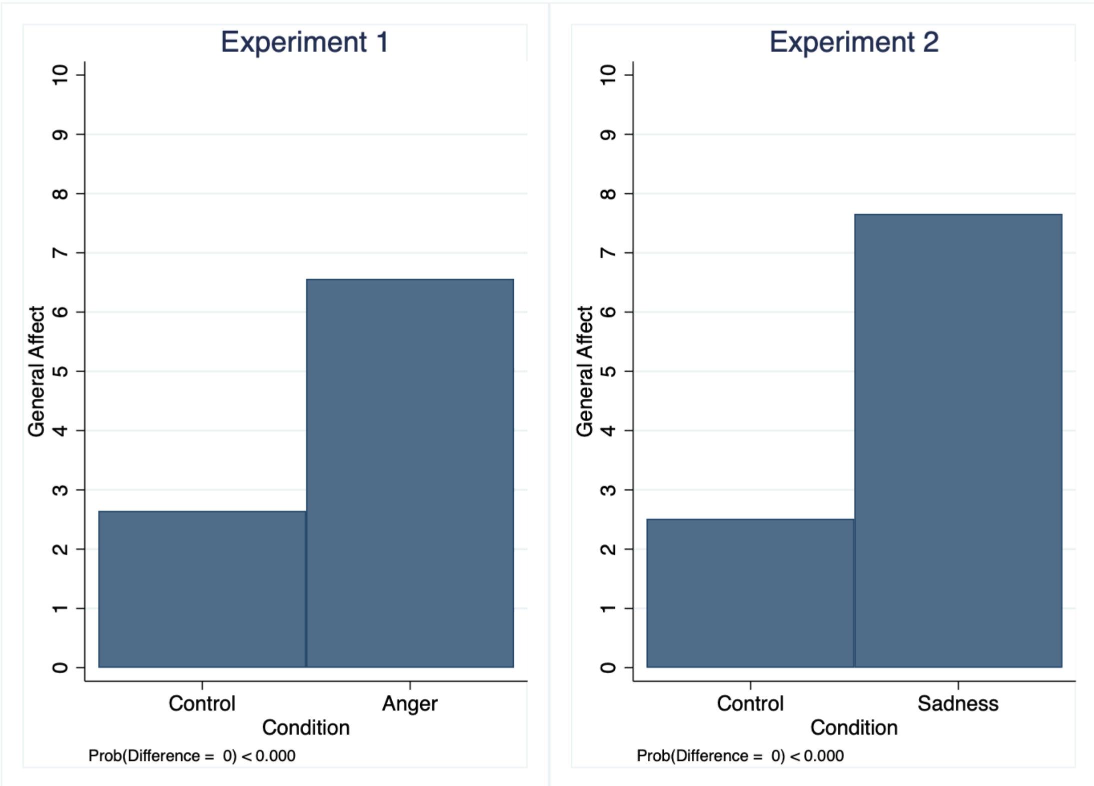
Figure B.9: p-Beauty Contest Game Feedback



C Further Text Analyses

C.1 General Affect

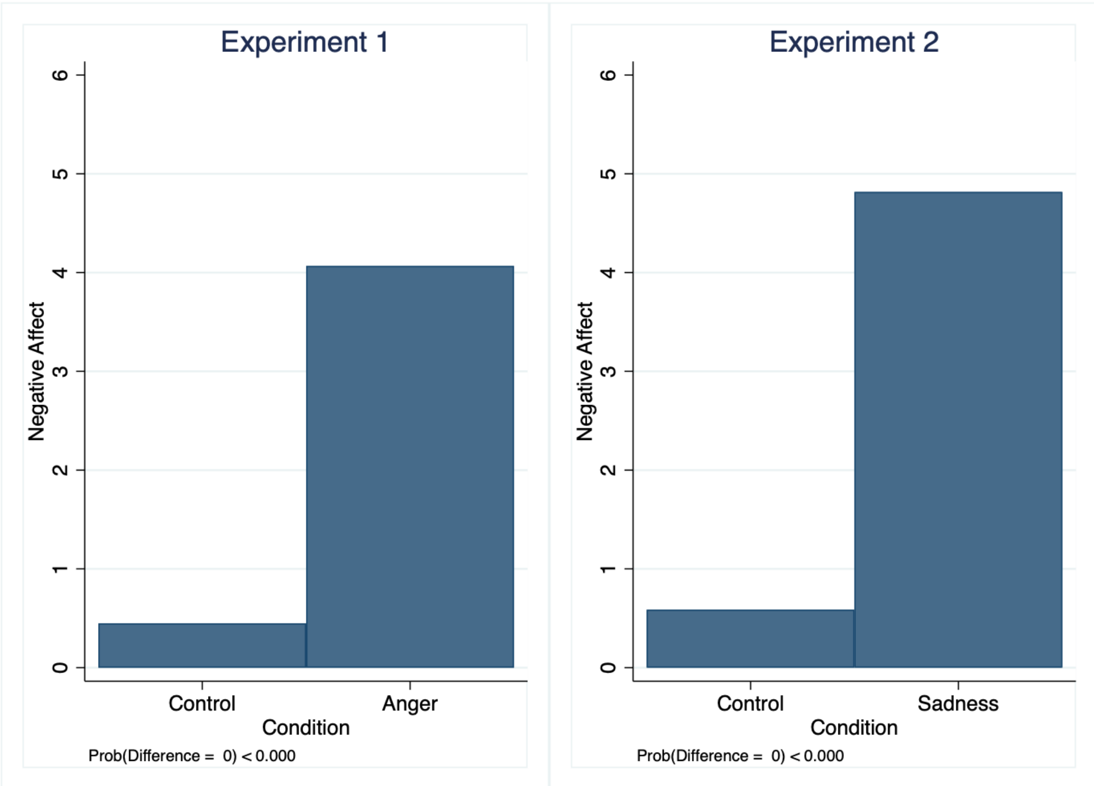
Figure C.10: General affect in the texts



Notes: 1) The bars report the average "affect" in subjects' written words for the different inductions. 2) Analysis based on the LIWC2015 (Linguistic Inquiry and Word Count) dictionary (Pennebaker, 2015). 3) The notes report the results of the corresponding Mann-Whitney test.

C.2 Negative Affect

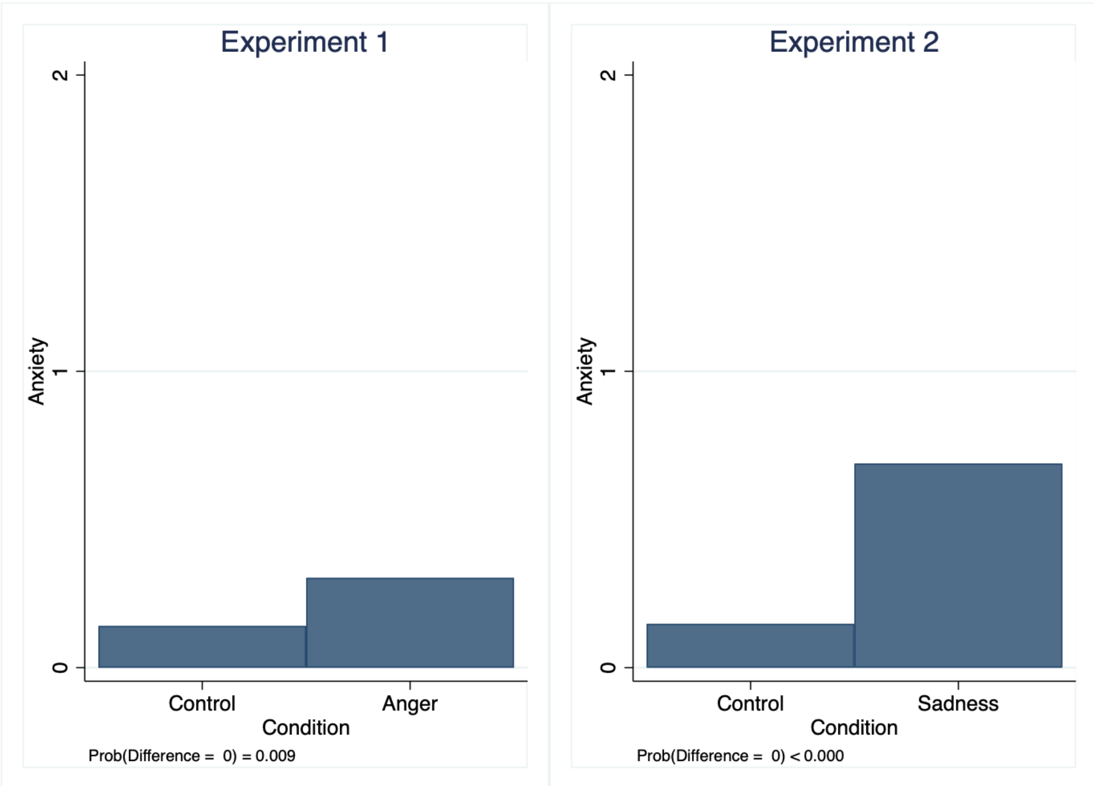
Figure C.11: Negative affect in the texts



Notes: 1) The bars report the average negative affect in subjects' written words for the different inductions. 2) Analysis based on the LIWC2015 (Linguistic Inquiry and Word Count) dictionary (Pennebaker, 2015). 3) The notes report the results of the corresponding Mann-Whitney test.

C.3 Another Negative Emotion: Anxiety

Figure C.12: Anxiety in the texts



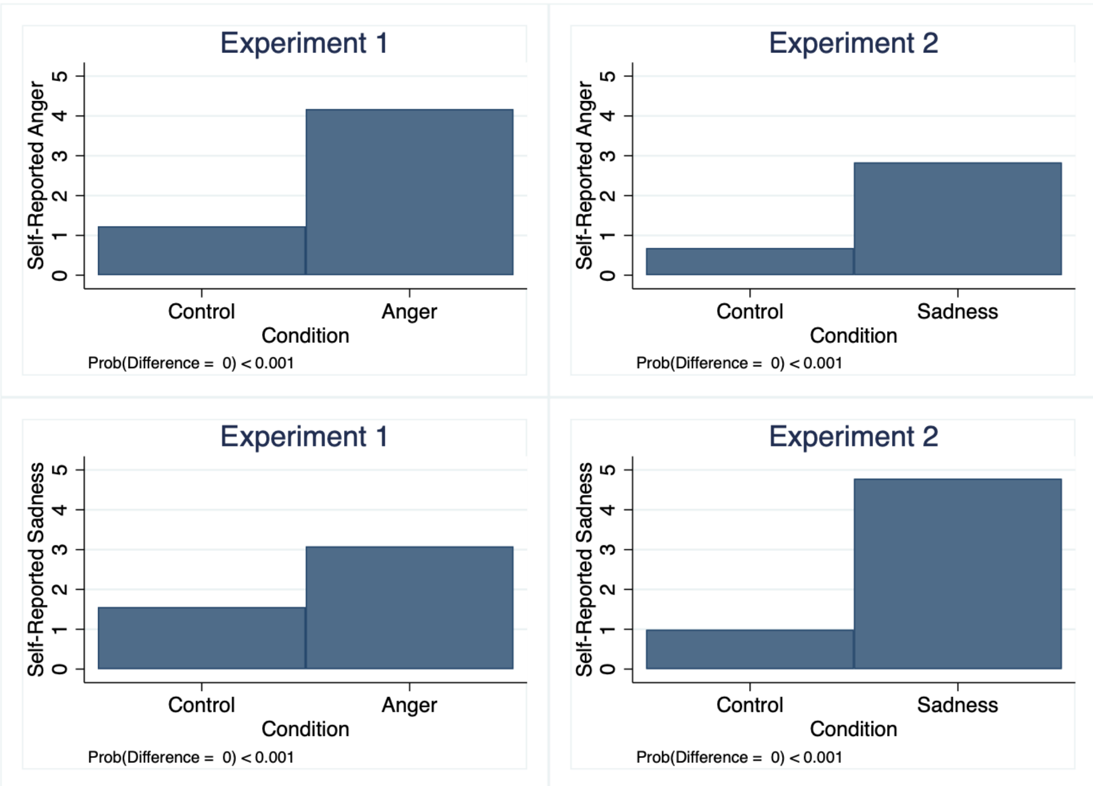
Notes: 1) The bars report the average anxiety in subjects' written words for the different inductions. 2) Analysis based on the LIWC2015 (Linguistic Inquiry and Word Count) dictionary (Pennebaker, 2015). 3) The notes report the results of the corresponding Mann-Whitney test.

D Further Analyses

D.1 Emotional Self-assessment

Figure D.14 shows the effect of the induction using the questionnaire about the self-reported induction effectiveness. There is a significant difference in the levels of anger reported in the anger treatment compared to the control condition ($\Delta = 2.942$, p-value< 0.000) (top-left panel). This is also true for sadness but this difference ($\Delta = 1.525$, p-value< 0.000) is significantly lower (bottom-left panel). As expected, the opposite is true in the sadness experiment (Experiment 2). Here subjects report a significant difference in sadness (bottom-right panel) compared to the control condition ($\Delta = 3.791$, p-value<0.000). They also report a significant difference in reported anger ($\Delta = 2.149$, p-value<0.000) (top-right panel) but this latter difference is significantly lower compared to the former.

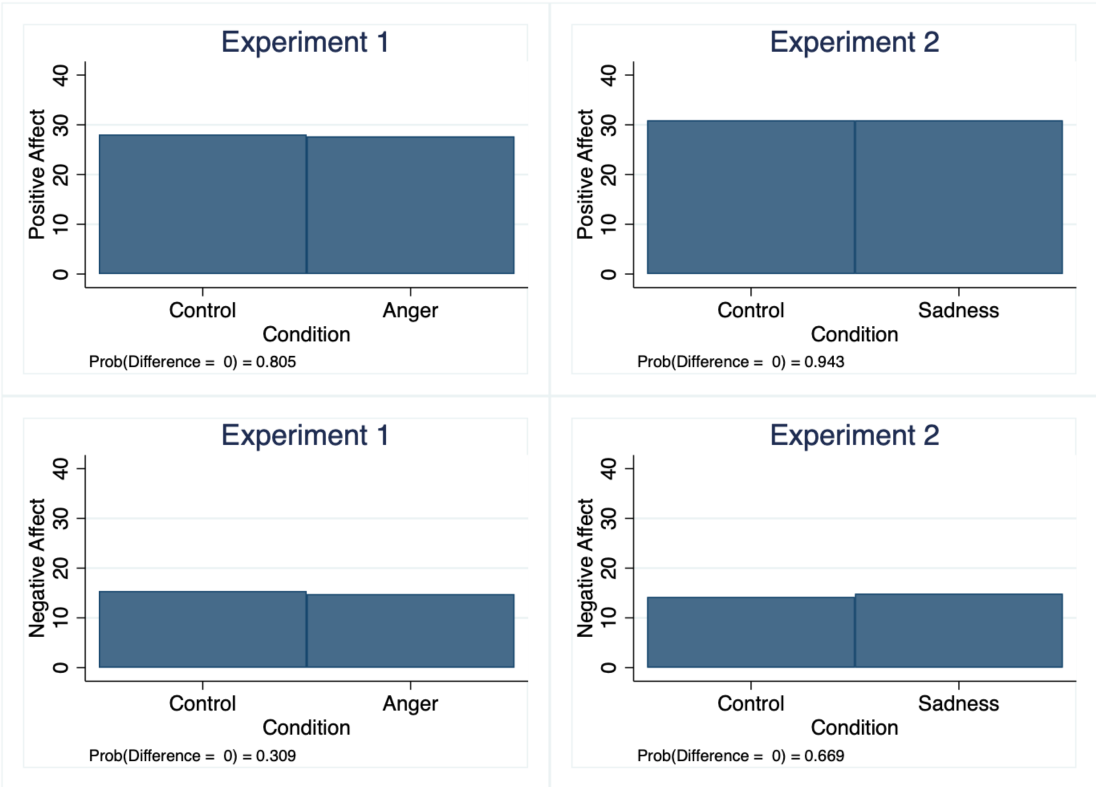
Figure D.13: Self-reported Anger and Sadness felt in the induction



Notes: 1) The bars report the average difference of anger or sadness felt at the end of the sessions. 2) Questions are: "Please indicate the greatest amount of anger (sadness) you experienced while writing about the past life events"; and are coded from 0 (low) to 8 (high). 3) The notes report the results of the corresponding Mann-Whitney test.

D.2 General Affect at the Beginning of the Experiments

Figure D.14: General positive and negative affect at the outset of the experiment



Notes: 1) The bars report the total positive (negative) affect experienced at the outset of the session. 2) Questions are takes from the PANAS questionnaire and ask: "Please, indicate the extent you are feeling this way right now", in terms of 20 scales or emotional states. Each item is rated on a 5-point scale of 1 (not at all) to 5 (very much). 3) Positive affect: Active, Alert, Attentive, Determined, Enthusiastic, Excited,Inspired, Interested, Proud, and Strong. Negative affect: Afraid, Ashamed, Distressed, Guilty, Hostile, Irritable, Jittery, Nervous, Scared, and Upset. 4) The total positive (negative) affect score is the sum of the scores in each positive (negative) emotion. 5) The notes report the results of the corresponding Mann-Whitney test.

E Further Analyses

E.1 The Effect of Anger and Sadness on Guesses in the Two Experiments – Random Effects Estimator

Table E.5: The effect of anger and sadness on guesses in the two experiments – random effects estimator

	Experiment 1 Guess b/se	Experiment 2 Guess b/se	Experiments 1 & 2 Guess b/se
Anger Treatment	2.439***		2.439***
	(0.921)		(0.917)
Sadness Treatment		–0.626	–0.626
		(1.021)	(1.017)
Average Guess at $t-1$	0.092***	0.106***	0.098***
	(0.019)	(0.020)	(0.014)
Round	–2.114***	–2.028***	–2.078***
	(0.304)	(0.307)	(0.216)
Group Exp FE	Yes	Yes	Yes
N	1539	1620	3159
Individuals	171	180	351
R2	0.465	0.445	0.455

Notes: 1) OLS estimator with random effects. 2) Standard errors (shown in parentheses) are clustered at the group level. 3) * p-value<0.1, ** p-value<0.05, *** p-value<0.01.

E.2 The Effect of Anger and Sadness on Payoffs in the Two Experiments – Random Effects estimator

Table E.6: The effect of anger and sadness on payoffs in the two experiments – random effects estimator

	Experiment 1 Payoff b/se	Experiment 2 Payoff b/se	Experiments 1 & 2 Payoff b/se
Anger Treatment	-0.665**		-0.710**
	(0.327)		(0.325)
Sadness Treatment		-0.525	-0.528
		(0.360)	(0.359)
Guess other player (1) at t	0.057***	0.038***	0.045***
	(0.009)	(0.007)	(0.006)
Guess other player (2) at t	0.030***	0.049***	0.039***
	(0.007)	(0.006)	(0.005)
Average Guess at t-1	-0.017***	-0.018***	-0.016***
	(0.002)	(0.002)	(0.002)
Group Exp FE	Yes	Yes	Yes
N	1539	1620	3159
Individuals	171	180	351
R2	0.056	0.054	0.054

Notes: 1) OLS estimator with random effects. 2) Standard errors (shown in parentheses) are clustered at the group level. 3) * p-value<0.1, ** p-value<0.05, *** p-value<0.01.

E.3 The Effect of Anger in the Texts on Guesses in the Anger Treatment of Experiment 1

Table E.7: The effect of anger on guesses in the anger treatment of experiment 1

	Experiment 1	
	Guess	Guess
	b/se	b/se
Anger in the Texts	1.074	
	(0.814)	
Sadness in the Texts		-0.359
		(2.232)
Average Guess at $t-1$	0.071***	0.071***
	(0.025)	(0.025)
Round	-2.436***	-2.436***
	(0.400)	(0.400)
Group FE	Yes	Yes
N	792	792
R2	0.471	0.470

Notes: 1) OLS estimator. 2) Standard errors (shown in parentheses) are clustered at the group level. 3) * p-value<0.1, ** p-value<0.05, *** p-value<0.01.

E.4 The Effect of Anger in the Texts on Payoffs in the Anger Treatment of Experiment 1

Table E.8: The effect of anger on payoffs in the anger treatment of experiment 1

	Experiment 1	
	Payoff	Payoff
	b/se	b/se
Anger in the Texts	-0.669***	
	(0.243)	
Sad in the Texts		-0.091
		(0.557)
Guess Other Player (1) at t	0.041**	0.041**
	(0.016)	(0.016)
Guess Other Player (2) at t	0.024**	0.026**
	(0.011)	(0.011)
Average Guess at $t-1$	-0.012**	-0.013**
	(0.005)	(0.005)
Group FE	Yes	Yes
N	792	792
R2	0.104	0.089

Notes: 1) OLS estimator. 2) Standard errors (shown in parentheses) are clustered at the group level. 3) * p-value<0.1, ** p-value<0.05, *** p-value<0.01.

F Alternative Specifications

F.1 The Effect of Anger and Sadness on Guesses in the Two Experiments

Table F.9: The effect of anger and sadness on guesses in the two experiments

	Experiment 1	Experiment 2	Experiments 1 & 2
	Guess	Guess	Guess
	b/se	b/se	b/se
Anger Treatment	2.014**		2.078***
	(0.795)		(0.812)
Sadness Treatment		-0.587	-0.581
		(0.945)	(0.928)
Guess at $t-1$	0.184***	0.173***	0.177***
	(0.035)	(0.036)	(0.025)
Guess other player (1) at $t-1$	0.043*	0.070**	0.058***
	(0.025)	(0.028)	(0.019)
Guess other player (2) at $t-1$	0.048**	0.073***	0.060***
	(0.023)	(0.026)	(0.018)
Round	-2.120***	-2.028***	-2.079***
	(0.302)	(0.307)	(0.217)
Group FE	Yes	Yes	Yes
N	1539	1620	3159
R2	0.473	0.450	0.461

Notes: 1) OLS estimator. 2) Standard errors (shown in parentheses) are clustered at the group level. 3) * p-value<0.1, ** p-value<0.05, *** p-value<0.01.

F.2 The Effect of Anger and Sadness on Payoffs in the Two Experiments

Table F.10: The effect of anger and sadness on payoffs in the two experiments

	Experiment 1 Payoff b/se	Experiment 2 Payoff b/se	Experiments 1 & 2 Payoff b/se
Anger Treatment	-0.601*		-0.645**
	(0.311)		(0.312)
Sadness Treatment		-0.534	-0.536
		(0.354)	(0.352)
Guess Other Player (1) at t	0.059***	0.042***	0.048***
	(0.010)	(0.007)	(0.006)
Guess Other Player (2) at t	0.032***	0.050***	0.041***
	(0.007)	(0.006)	(0.005)
Guess at $t-1$	-0.034***	-0.030***	-0.031***
	(0.008)	(0.009)	(0.005)
Guess other player (1) at $t-1$	-0.012	-0.012*	-0.011**
	(0.007)	(0.006)	(0.005)
Guess other player (2) at $t-1$	-0.007	-0.013**	-0.009**
	(0.005)	(0.006)	(0.004)
Group FE	Yes	Yes	Yes
N	1539	1620	3159
R2	0.062	0.057	0.058

Notes: 1) OLS estimator. 2) Standard errors (shown in parentheses) are clustered at the group level. 3) * p-value<0.1, ** p-value<0.05, *** p-value<0.01.

F.3 The Effect of Anger and Sadness on Response Times in the Two Experiments

Table F.11: The effect of anger and sadness on response times in the two experiments

	Experiment 1 Response Time b/se	Experiment 2 Response Time b/se	Experiments 1 & 2 Response Time b/se
Anger Treatment	0.339		0.339
	(0.469)		(0.467)
Sadness Treatment		-0.027	-0.027
		(0.462)	(0.460)
Average Guess at $t-1$	0.005	-0.010	-0.002
	(0.005)	(0.009)	(0.005)
Round	0.044	-0.106	-0.024
	(0.077)	(0.121)	(0.724)
Group Exp FE	Yes	Yes	Yes
N	1539	1620	3159
Individuals	171	180	351
R2	0.086	0.159	0.136

Notes: 1) OLS estimator. 2) Standard errors (shown in parentheses) are clustered at the group level. 3) * p-value<0.1, ** p-value<0.05, *** p-value<0.01.

G Different Hypothesis about the Distributional Form in the Structural Analysis

Table G.12: Estimated Level-k types by condition: alternative distribution

	Experiment 1		Experiment 2	
	Anger	Control	Sadness	Control
Poisson Distribution				
Level 0	0.257	0.200	0.197	0.232
Level 1	0.660	0.650	0.735	0.666
Level 2	0.000	0.071	0.000	0.034
Level 3	0.084	0.080	0.067	0.062
Level 4	0.000	0.000	0.001	0.006
Log likelihood	-3,202	-2,942	-3,365	-3,056
Average Level-k	0.910	1.030	0.942	0.946