Humans reciprocate intentional harm by discriminating against group peers

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Sometimes humans take revenge, not on the person who harmed them, but on other people from that person's group. This can lead to cycles of intergroup conflict and violence. We designed a laboratory experiment to test the hypothesis that humans practice group-based reciprocity: if someone harms or helps them, they harm or help other members of that person's group. We find that artificial and arbitrary groups trigger such group reciprocity when the original perpetrator's act was deliberate and unequivocal. In contrast, acts that are harmful, but are not clear norm violations, are reciprocated towards the actor, but have no effect on her group peers. Our results can help us understand the psychology and evolutionary mechanisms behind intergroup revenge.

Human society is organized in groups, including families, clans, firms and nations. This structure is reflected in individual behaviour and cognition. Humans identify with their ingroup and are altruistic and prosocial towards ingroup members; towards outgroup members, they display stereotyping and prejudice [1, 7, 8, 10, 33, 37]. Group structure provides the backdrop for intergroup conflict—from economic and political competition to inter-ethnic violence and war—which is pervasive in the species [36].

Intergroup conflicts often follow a tit-for-tat logic, in which one group's violence leads to revenge from the other side [6, 19, 20, 21, 29]. This suggests that humans practice intergroup *reciprocity*. Reciprocity is a well-known mechanism that may underlie the evolution of cooperation [25, 26]. While in direct reciprocity, individuals help those who have helped them in the past (and similarly for harm), in indirect reciprocity, individuals help or harm other people

than those who have helped them. Indirect reciprocity comes in two flavours: *downstream* reciprocity follows the maxim 'do unto thy neighbour as they have done to others', whereas *upstream* reciprocity follows the maxim 'do unto thy neighbour as others have done unto you'.

Compared to downstream reciprocity, upstream reciprocity is cognitively easier to implement, as it does not require tracking individual reputations, but is more difficult to understand from an evolutionary point of view [5, 28]. Nonetheless, upstream reciprocity can co-evolve with direct or spatial reciprocity [27]. Furthermore, laboratory experiments provide positive evidence for upstream reciprocity: individuals are more generous to others if a third party was generous to them [11, 16, 18], and the mere possibility of being harmed by a third party reduces cooperation in a social dilemma [35].

In this paper we examine group-based upstream reciprocity, or *group reciprocity*. That is, an individual who is harmed (helped) by a member of an outgroup becomes more likely to harm (help) others from that group. Whereas group-based downstream reciprocity [3, 4] follows the maxim 'do unto others as they have done to members of *my* tribe', group-based upstream reciprocity follows the maxim 'do unto others as members of *their* tribe have done to me' (Figure 1). Both up- and downstream group reciprocity can expand the scope of conflict, from individual level to group level. While (group-based) downstream reciprocity can bring a victim's groupmates into a conflict as new aggressors, upstream reciprocity can bring in an aggressor's groupmates, as new victims.

Upstream group reciprocity has different cognitive requirements from related phenomena. While ingroup altruism and group-based downstream reciprocity require people to differentiate their own group from outsiders—"us" from "them"—upstream group reciprocity requires them to differentiate between different outgroups—between "them and them"—and to keep a mental account of outgroups' reputation. Upstream group reciprocity could thus provide an evolutionary basis for outgroup stereotyping.

We ran a laboratory experiment to test the hypothesis that people reciprocate towards groups. Although field observations from conflict are highly suggestive, they are loaded with individual and group context and history. Ob-

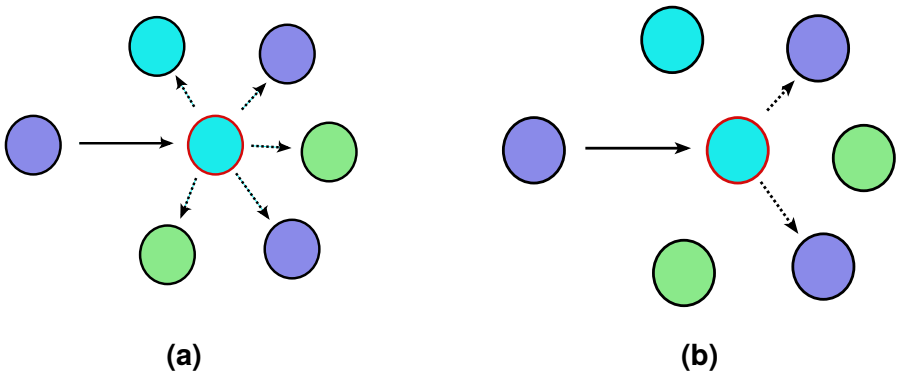

Figure 1: Upstream reciprocity. (*a*) Someone who was helped or harmed becomes more likely to help or harm others. (*b*) Upstream group reciprocity targets people who belong to the same group as the initial partner.

serving group reciprocity under controlled laboratory conditions with artifical groups identifies group reciprocity as an innate human tendency. Cleanly identifying group reciprocity requires controlling for three confounds: individual level reciprocity, e.g. if subjects' actions affect an entire group including the original actor who helped or harmed them; generalized reciprocity, where subjects reciprocate not specifically towards the original actor's group, but towards other people in general; and strategic interactions, where apparent reciprocity is driven by reputation-building. While previous work has not satisfied all three conditions simultaneously [14, 22, 32], our experiment fulfils all three: subjects can differentiate the original actor from his or her group members, they interact both with these group members and with members of other groups, and we minimize strategic concerns by not giving feedback about subjects' actions.

After an initial group-formation stage, participants interacted in two strategic stages. The upstream action, in which the individual could be helped or harmed by another person, was represented by a Trust Game (TG) [2]. In this game, the Sender (S) receives 150 money-equivalent tokens, and chooses how many of them to send to the Responder (R). The amount sent is multiplied by a factor of 3, so that R receives between 0 and 450 tokens, of which he can send any number back to S. The TG enables us to model two types of interactions.

Whereas R is clearly kind when returning money (and nasty when exploiting a generous proposer by keeping the received amount), S's intentions are equivocal. Sending money can be driven by selfish expectations of reciprocity, while not sending can be driven by caution. Thus, while all subjects experience helpful or harmful actions, only senders experience actions that clearly reflect their counterpart's preferences and intentions [17, 23].

The upstream action was followed by the reciprocal action, in which the individual could help others. We implemented this as an Allocation Game in which subjects divided a fixed amount between two recipients. In Direct Reciprocity rounds, the recipients included the TG partner; in Group Reciprocity rounds, a member of the TG partner's group; and in Ingroup Favoritism rounds, a member of the allocator's group. The other recipient was always a member of a third, neutral, group. Baseline rounds included two neutral recipients, to test whether the TG experience leads to arbitrary discrimination in the absence of any reciprocal or group motivations.

We report results on allocations, discrimination between recipients (measured as the absolute difference between the two recipients' allocations), and direct and group reciprocity. All reported statistical tests are based on mixed-effects regressions with bootstrapped standard errors clustered on subjects. See the supplementary material for the full specification and results.

The first column in Table 1 presents the mean allocations. Participants gave significantly more to members of their own team at the expense of the neutral recipient ($z = 3.63, p < 0.001$ for senders, $z = 3.59, p < 0.001$ for responders), establishing that our group formation manipulation was successful in inducing group identity and triggering ingroup favouritism. Allocations to the TG partner and his team mates were not significantly different to the baseline 35 ($p > 0.47$ for all comparisons). Nonetheless, as the second column of Table 1 shows, allocators discriminated significantly more than in the baseline both when interacting with their TG partner ($z = 9.08, p < 0.001$) and with his team mates ($z = 3.93, p < 0.001$). This effect was not significantly different between TG senders and receivers (F test $0.50, p = 0.68$).

The third column of Table 1, *Reciprocity*, reports the slope of allocations regressed on the *kindness* of subjects' TG partners. The kindness of the sender

Table 1: Allocations and Discrimination

	Allocation	Discrimination	Reciprocity
Senders			
Baseline	35.00 (—)	4.15 (0.97)	—
Direct Reciprocity	33.98 (2.30)	22.00 (1.51) ***	15.64 (5.12)**
Group Reciprocity	34.39 (0.77)	8.08 (1.61) ***	7.78 (2.37)**
In-Group	38.98 (1.11) ***	15.46 (2.99) ***	0.20 (5.50)
Responders			
Baseline	35.00 (—)	2.25 (0.51)	—
Direct Reciprocity	35.38 (1.08)	22.17 (2.30) ***	20.87 (6.04)***
Group Reciprocity	34.79 (0.62)	6.12 (1.51) **	1.20 (2.08)
In-Group	42.13 (1.99) ***	17.20 (3.40) ***	4.72 (7.62)

Mean allocation (out of 70), mean discrimination, and reciprocity (marginal effect of TG partner's kindness on allocation) by condition. Robust standard errors clustered on sessions. Significance of comparison to Baseline is marked.*, **, and *** indicate p < 0.05, p < 0.01, and p < 0.001, respectively.

was measured as the share of the endowment sent, and that of the responder as the share of the received amount sent back. Responder's kindness was not defined for six (out of 96) responders whose partner did not send any money.

There is strong direct reciprocity: allocations to the TG partners increase with that partner's kindness both for senders ($z = 3.06, p < 0.01$) and for responders ($z = 3.46, p < 0.001$).

Group reciprocity, however, is only observed for senders, who allocate less to team mates of a responder who sent less—an intentionally harmful action. Responders, on the other hand, although directly reciprocating the TG partner, do not systematically discriminate against team mates of a sender who sent little—a harmful action that does not unequivocally signal a bad intention. The regression analysis shows no significant effect of sender kindness on responder's allocation to the sender's team mates ($z = 0.58, p = 0.56$). The responder's kindness, on the other hand, significantly increases sender's allocations made to the responder's team mates ($z = 3.29, p < 0.01$). The estimated ratio of the group and direct reciprocity coefficients is 50%, so that for every allocation dollar a responder loses due to an unkind action in the TG, his team mates lose 50 cents.

Senders' group reciprocity was related to their social value orientation. The slope of kindness on allocations was 15.97 for those with less than median SVO, and -1.06 for those with median or greater SVO (interaction, $p = 0.061$).These results should be interpreted cautiously, since both scores were affected by the kindness of subjects' partners.

Our results show that upstream reciprocity is moderated by social boundaries. Humans respond to harms from outgroup members by discriminating against others in that specific outgroup. Unlike parochial altruism and within-group reciprocity, this phenomenon requires humans to differentiate between outgroups, possibly providing a cognitive basis for discrimination and prejudice targeted against specific minorities.

We distinguish between reciprocity towards harm and towards intentional harm [31]. People discriminate against others who harm them even if the harmful action does not necessarily indicate bad intentions. However, they only generalize to the perpetrator's group members if the intentions behind the harmful actions are unequivocally bad.

This observation raises new questions regarding the nature of reciprocity and the role of intentions (or perceptions thereof). One possible interpretation stems from the distinction between intention-based and outcome-based motives in reciprocal behaviour [12]. It is possible that humans generalize intentions across group members more than they generalize actions across group members. So, if (e.g.) group member 1 wishes to harm them, they are prone to infer that group member 2 also wishes to do so; but if group member 1 takes an action that harms them, they do not necessarily infer that group member 2 would also have done so. Indeed, the conjecture 'One member of the Blue group is a bad person, therefore all Blue members are bad' is plausible. The conjecture 'One member of the Blue group did not send any money, therefore other Blue members did not send money' is not—as, given subjects' knowledge, the other Blue members were not even necessarily senders.

Upstream reciprocity is notoriously difficult to understand in evolutionary terms [5, 27]. Group reciprocity may provide another piece of the puzzle, as it provides two new channels by which upstream reciprocity may evolve. First, group members are interdependent, especially in the small groups that were

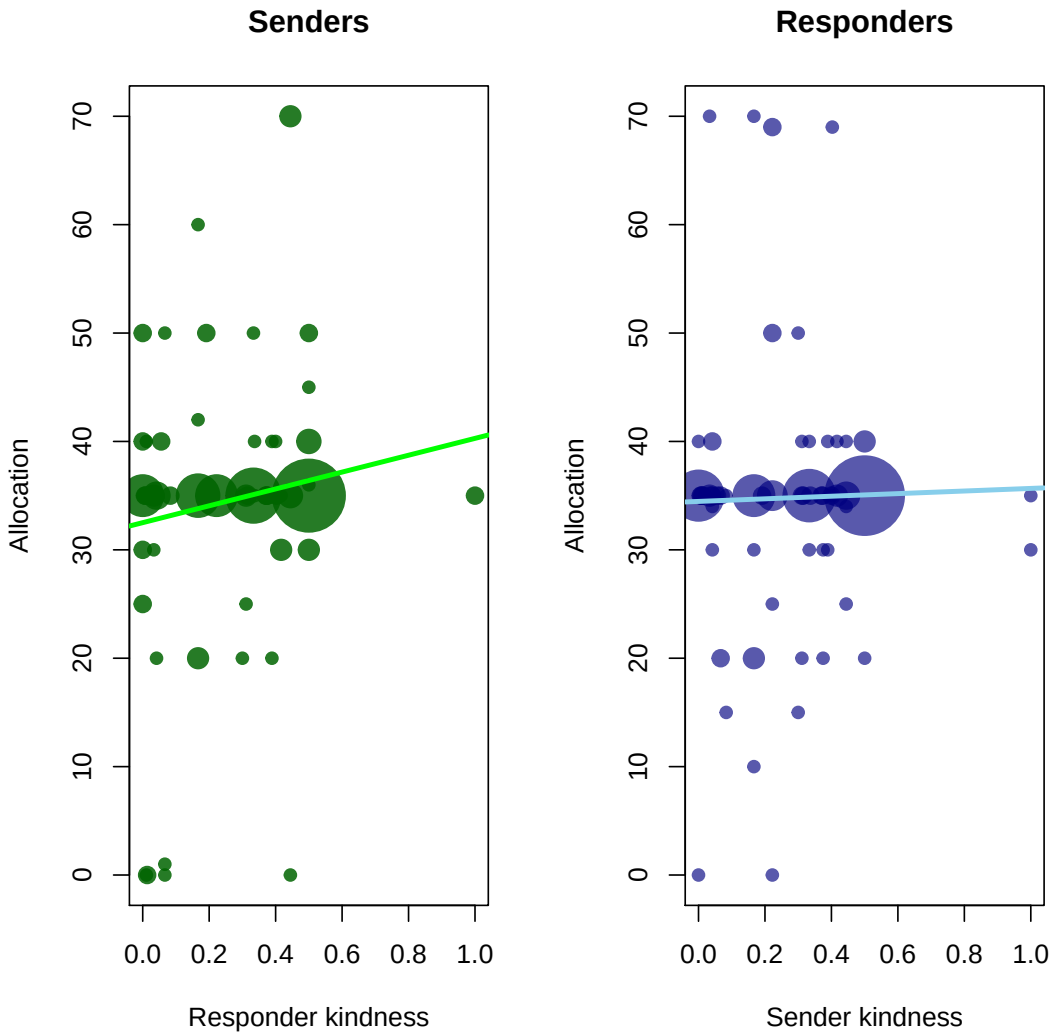

Figure 2: Allocations in the Group Reciprocity condition versus partner's kindness in the TG. Circles show individual data points (circle size proportional to number of observations). Lines show linear regressions.

the norm during most of human evolutionary history. Punishing a perpetrator's group member therefore indirectly harms the perpetrator, who is dependent on his peers for, e.g., public goods provision. Thus, group reciprocity may bridge upstream indirect reciprocity and direct reciprocity.

Second, the evolution of indirect reciprocity acts by way of chains of reciprocal actions, which return with some probability to the original instigator of the chain [27]. In a population organised in groups, such that people interact more frequently with their own group members, group reciprocity may increase the likelihood of successful reciprocal chains, facilitating the evolution of upstream reciprocity. These ideas could be formalized in future work.

Methods

Each session consisted of 24 participants, randomly allocated into six *teams* of four. Each participant was identified throughout the experiment by team colour and individual number (1–4) within the team. At the beginning of the experiment, participants were informed that the experiment had five distinct stages, and that they might interact with the same people in different stages. Specific instructions for each stage were distributed and read aloud at the beginning of the stage. The five stage were a group formation stage, the TG stage, the AG stage, a social value orientation elicitation [24] stage and a collectivism scale measurement [adapted from the horizontal collectivism scale in 30].

Following [8], we created group identity in the first stage by allowing participants to consult each other by anonymous chat while solving a simple task. Participants solved five Raven matrices (see supplementary material). Each matrix was presented on screen for 120 seconds, during which each participant could both send written messages to the team and update her own answer. The final answer submitted at the end of the 120 seconds determined payoffs, with 10 tokens paid for each correct answer. To further boost group identity through a common goal, team members each earned an additional bonus of 5 tokens if all four team members answered correctly.

Next, participants were rematched into pairs to play the one-shot TG. To fa-

cilitate understanding, participants played five practice rounds, in which they entered decisions both as S and as R. In the actual interaction, participants could see their TG partner's team colour and individual number.

The third stage Allocation Game consisted of six rounds. In each round, participants interacted in groups of three. Individuals in each group were identified to each other by team colour and number. Each round consisted of a random dictator game, as follows. Each player in the group of three had to allocate 100 tokens within the group. The allocator received a fixed 30 tokens, and could freely allocate the remaining 70 tokens between the other two players. Previous research has found that people do not harm, but refrain from helping negatively perceived outgroups [34]. Accordingly, we set the parameters of the game so that, compared to the reference point of the allocator's own share, an equal division benefits both other players. Table 2 shows the matching scheme over the six rouds. Each participant was in the same group of three in one of the six rounds with a member of her own team (*ingroup* condition), in one round with her TG partner (*direct reciprocity* condition), and in two rounds with other members of the TG partner's team (*group reciprocity* condition). The remaining two rounds served as the baseline condition. No feedback was provided between rounds. Stage payoffs were determined by one randomly chosen round of the six rounds, and the allocation decision of one randomly chosen player in each group. Note that the matching is not independent. For example, if one player is in the direct reciprocity condition, then one other player is in the direct reciprocity condition and the third player is in either the baseline or group reciprocity condition.

The fourth stage implemented the slider measure of social value orientation [9, 24], in which participants choose nine allocations between themselves and another person. For consistency with the previous stages, the team identity of the partner was known. To keep the decision independent of previous experience with the different teams, we matched participants within teams. Therefore, this measure captures within-group social value orientation. Payoffs were determined by one randomly chosen decision of the nine decisions made by one randomly chosen player in each dyad. The decisions yielded a social orientation angle for each participant, with 0° corresponding to selfish-

Table 2: Matching example

Round	Allocates to			Treatment
1	Red 1	/	Yellow 1	Group reciprocity (GR)
2	Yellow 4	/	Brown 2	Group reciprocity (GR)
3	Green 3	/	Yellow 2	Direct reciprocity (DR)
4	Red 1	/	Brown 1	Baseline (B)
5	Brown 2	/	Brown 4	Baseline (B)
6	Blue 3	/	Green 2	Ingroup (IG)

Note: Example treatments shown for player Blue 2, who played the TG with Yellow 2 (see the supplementary material for the full matching scheme).

ness, 45° to pure altruism, and negative angles to spitefulness.

After the fifth and final stage (a non-strategic and non-incentivised collectivism measurement), participants learned their cumulative payoff in tokens and were paid in private. One hundred and ninety two participants, recruited using ORSEE [15] participated in eight sessions conducted between June 2014 and January 2015. The experiment was programmed in z-Tree [13]. The average payment was approximately $18 for a duration of 70 minutes.

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Competing interests

The authors declare no competing interests.

Appendix A: Complete matching scheme

Period	Group 1	2	3	4	5	6	7	8
1	Blue 2 (GR) Red 1 (B) Yellow 1 (GR)	Blue 1 (GR) Yellow 2 (GR) Purple 2 (B)	Green 4 (GR) Brown 4 (B) Purple 3 (GR)	Blue 3 (B) Green 3 (GR) Purple 4 (GR)	Red 2 (DR) Brown 2 (DR) Purple 1 (B)	Blue 4 (B) Red 3 (DR) Brown 3 (DR)	Green 1 (IG) Green 2 (IG) Brown 1 (B)	Red 4 (B) Yellow 3 (IG) Yellow 4 (IG)
2	Green 3 (GR) Yellow 1 (B) Purple 1 (GR)	Red 3 (B) Green 1 (GR) Purple 3 (GR)	Blue 4 (GR) Green 4 (B) Yellow 2 (GR)	Blue 2 (GR) Yellow 4 (GR) Brown 2 (B)	Blue 3 (DR) Red 1 (B) Yellow 3 (DR)	Green 2 (DR) Brown 4 (B) Purple 2 (DR)	Blue 1 (B) Brown 1 (IG) Brown 3 (IG)	Red 2 (IG) Red 4 (IG) Purple 4 (B)
3	Red 1 (GR) Brown 4 (GR) Purple 1 (B)	Red 4 (GR) Yellow 4 (B) Brown 1 (GR)	Blue 3 (B) Red 2 (GR) Brown 3 (GR)	Red 3 (GR) Green 2 (B) Brown 2 (GR)	Green 4 (DR) Yellow 1 (B) Purple 4 (DR)	Blue 2 (DR) Green 3 (B) Yellow 2 (DR)	Blue 1 (IG) Blue 4 (IG) Green 1 (B)	Yellow 3 (B) Purple 2 (IG) Purple 3 (IG)
4	Blue 4 (GR) Red 3 (B) Yellow 3 (GR)	Blue 3 (GR) Yellow 4 (GR) Purple 4 (B)	Green 2 (GR) Brown 2 (B) Purple 1 (GR)	Blue 1 (B) Green 1 (GR) Purple 2 (GR)	Red 4 (DR) Brown 4 (DR) Purple 3 (B)	Blue 2 (B) Red 1 (DR) Brown 1 (DR)	Green 3 (IG) Green 4 (IG) Brown 3 (B)	Red 2 (B) Yellow 1 (IG) Yellow 2 (IG)
5	Green 4 (GR) Yellow 2 (B) Purple 2 (GR)	Red 4 (B) Green 2 (GR) Purple 4 (GR)	Blue 3 (GR) Green 3 (B) Yellow 1 (GR)	Blue 1 (GR) Yellow 3 (GR) Brown 1 (B)	Blue 4 (DR) Red 2 (B) Yellow 4 (DR)	Green 1 (DR) Brown 3 (B) Purple 1 (DR)	Blue 2 (B) Brown 2 (IG) Brown 4 (IG)	Red 1 (IG) Red 3 (IG) Purple 3 (B)
6	Red 2 (GR) Brown 3 (GR) Purple 2 (B)	Red 3 (GR) Yellow 3 (B) Brown 2 (GR)	Blue 4 (B) Red 1 (GR) Brown 4 (GR)	Red 4 (GR) Green 1 (B) Brown 1 (GR)	Green 3 (DR) Yellow 2 (B) Purple 3 (DR)	Blue 1 (DR) Green 4 (B) Yellow 1 (DR)	Blue 2 (IG) Blue 3 (IG) Green 2 (B)	Yellow 4 (B) Purple 1 (IG) Purple 4 (IG)

Appendix B: Experimental instructions

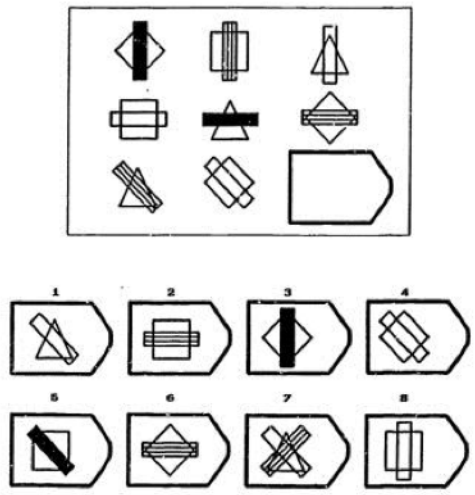
Instructions for the experiment

<Presented as a pdf document and available throughout the experiment>

These instructions are identical to all the participants.
The experiment is composed of five separate and different phases. At the beginning of the experiment, all participants will be allocated into **teams of four**. Each team has a unique **colour**. These teams will remain fixed throughout the experiment.
Before each part, we will distribute and read the relevant instructions for that part. In each part the participants will be reallocated into groups. The number of participants in a group can change from part to part. The payments in the part will be determined according to the decisions of the participants in the team. It is possible, but not necessary, that another participant will be in the same group as you in two different parts. In each part of the experiment you will be able to know which team each of the participants in your group belongs to.
Your final payment in the experiment will be the total of your gain in all of the parts.
At the end of the experiment, you will be presented with the payments in each part and your total payment, in points and in shekels. Please remain seated until the experimenter calls you for payment.
If you have any questions, please raise your hand now and the experimenter will come to you.

Experiments for the first part

In this part, you and the members of your team perform a pattern completion task. The computer will present you with five questions. Each question is comprised of eight pictures, and the team members wil be asked to choose a ninth picture out of eight possible pictures to complete the pattern. For example:

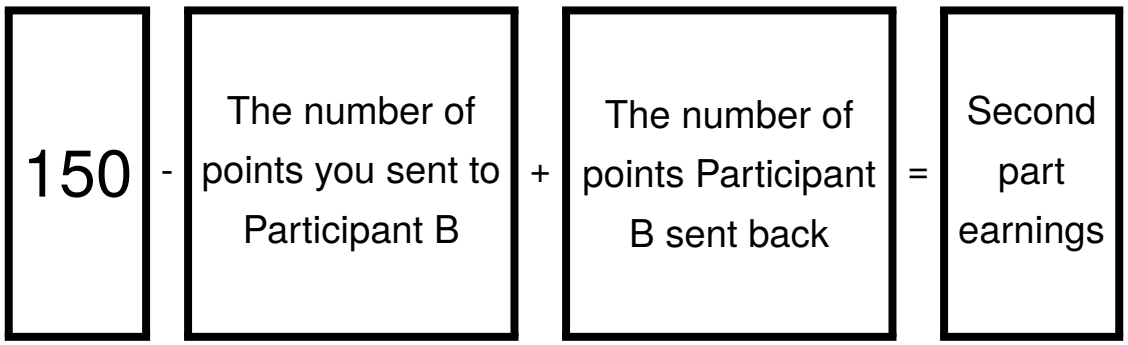


Each team member must answer all of the questions. For each correct answer, the team member will receive **10 points**. Additionally, if all of the team members answer correctly, the whole team will receive a **team bonus of 20 points, to be equally divided among the team members**.
Each question will be allocated two minutes. During this time, the team members can **consult each other** using electronic chat. Enter your answer and click Confirm. You can change your answer and click Confirm again at any point during the two minutes. The last answer to be entered is the final answer.
Attention: Do not reveal any identifying information. If any participant in the session identifies themselves, we will stop the experiment and release all participants with only the showup fee.
If you have any questions, please raise your hand now and the experimenter will come to you.

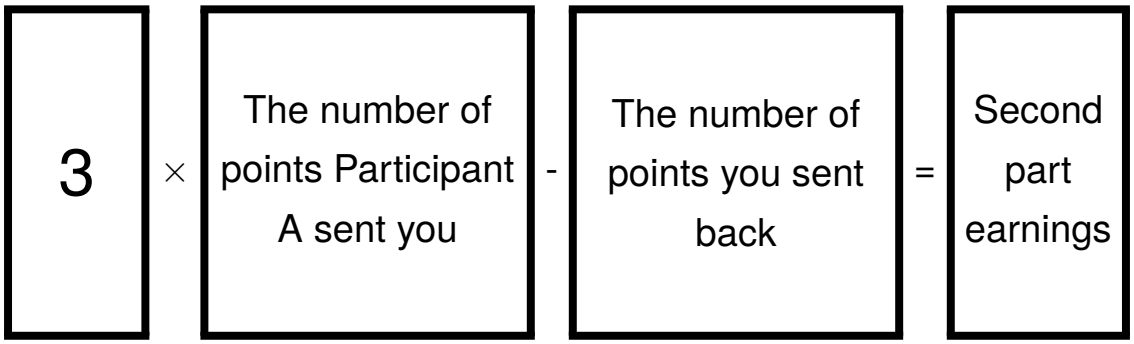
Instructions for the second part

In this part participants will be matched in **pairs**. In each pair, one participant will be in role A and the other participant in role B. Participant A receives an allocation of **150 points** and decides how many of the 150 points to **send to Participant B**. The amount is **tripled**. Next, Participant B will decide how many points out of the points received to **send back to to Participant A**. These points will not be multiplied.

If you are allocated to role A, your payment in this part will be:



If you are allocated to role B, your payment in this part will be:



Before making your decision, you will be able to test the payment calculation in a **practice phase**, in which you will be able to make decisions as both **Participant A** and as **Participant B**. In this stage, you will enter decisions in both roles, and see the final payments. The practice will repeat five times.

If you have any questions, please raise your hand now and the experimenter will come to you.

Instructions for the third part

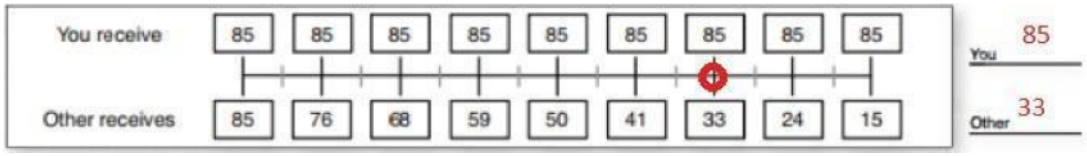
In the third part, all participants will be matched in **groups of three**. Each of the three participants in the group will choose how to **divide 100 points** between the three group members, such that he himself receives **30 points**, and **freely allocates** the remaining **70 points** between the other two group members. This stage has **6 rounds**, and you will be **rematched in a new group**.

Payment calculation in the part

At the end of the experiment, the computer will randomly choose one of the six rounds, and one participant in each group. The payment for this part will be determined according to the decision of the randomly chosen participant in the randomly chosen round.
If you have any questions, please raise your hand now and the experimenter will come to you.

Instructions for the fourth part

In this part, participant will be matched in **pairs**.
Each participant will be presented with **6 rulers** that include nine possible allocations of money to the two participants. The amount you chose to **keep for yourself** is indicated above each ruler, and the amount you choose to **give to the other participant** is indicated below the ruler. You are to choose your preferred allocation of the nine possible allocations. For example,



You can choose any point on the ruler. For example, assume you chose the point marked in red. You will receive 85 points and the other participant will receive 33 points.
At the end of the part, the computer will randomly choose on of the two participants in the pair and one of the nine rulers. your payment in this part will be determined by the decision of the randomly chosen participant for the randomly chosen ruler.
If you have any questions, please raise your hand now and the experimenter will come to you.

Instructions for the fifth part

In this part you will be asked to answer several questions. The questions have to do with the way one sees himself and his surroundings in different situations. Your task is to indicate how much you agree or disagree with each statement, using the following scale:

1. Strongly disagree.
2. Disagree.
3. Neither agree nor disagree.
4. Agree.
5. Strongly agree.

Note: there are no right and wrong answers. Please indicate the answer that best reflects your character with respect to the statement. Take your time and think about your answer.