SUPPLEMENTARY MATERIALS: Sensitivity of collective action to early warning signals of shifting climate tipping points

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This supplementary document reports additional details about the study conducted by Hurlstone, White, and Newell (2025) examining the impact of early warning signals on cooperation under threshold uncertainty in a dangerous climate change game[1]. The document includes an extended experimental methods, the instructions and control questions given to participants, additional methodological information, and supporting statistical analyses. Note that this document is not meant to be self-explanatory—please consult the main paper for further information.

Keywords: Cooperation, Dangerous climate change, Early warning signals, Threshold uncertainty

Supplementary Extended Experimental Methods

Participants

Unlike most economic experiments, which are typically conducted in laboratory settings with student samples, our study was conducted online and recruited participants from a broader demographic background. To our knowledge, this is the first experiment using a dangerous climate change game to employ an online crowdsourced sample rather than a traditional student participant sample.

We recruited participants from the UK using the online participant crowdsourcing platform Prolific (N = 750; mean age = 39.74 years; SD = 12.02; range = 18–79; females = 351, males = 374, missing = 25). Participants received a participation fee of £6 and were informed that they would be playing a game with four other players in which they could earn a bonus payment. Ethical approval to conduct the experiment was granted by the Faculty of Science and Technology Research Ethics Committee at Lancaster University (FST-2025-5156-RECR-2).

Design

The experiment employed a 6 (treatment: 100 vs. 50/150 vs. 150 vs. 100/200 vs. 135/165 vs. 145/155) $\times$ 10 (round: 1–10) mixed design: treatment was a between-groups factor, whereas round was a within-groups factor. Participants were tested in groups of five players. Groups were allocated at random to one of the six treatments, subject to the constraint of equal cell sizes (25 groups per treatment).

Apparatus, Materials, and Procedure

The experiment was executed using oTree[2], an open-source platform for running web-based interactive tasks, and was deployed on the Heroku cloud platform. Participants undertook the experiment using their own internet-enabled devices. To ensure compatibility and reduce the likelihood of technical issues, we restricted access to laptop and PC users by setting the device requirements in the Prolific recruitment interface and by monitoring devices at the experiment landing page. Mobile and tablet users were automatically redirected back to Prolific to return the study.

Although it would have been possible to collect all data in a single day, we instead chose to run the experiment in batches, including an initial pilot session. Sessions were conducted on different days of the week at approximately 9 am, 12 pm, and 3 pm UK time, with a mean of 75 participants per session (range = 26–134). This schedule allowed the experimenter to actively

monitor each session and address any technical difficulties if they arose.

After reading an information sheet and providing electronic informed consent, participants were directed to a waiting page, where they remained until enough others arrived to form a 5-person group. If participants waited longer than 10 minutes without being matched, they were released from the study and compensated with an early-exit fee of £2 for their time. Once grouped, players read the experimental instructions and completed a set of control questions to confirm their understanding of the rules of play. To preserve anonymity, each player was assigned a pseudonym (Ananke, Telesto, Despina, Japetus, or Kallisto). During the game, each player's decisions were communicated to the other players under their designated pseudonyms.

At the start of the game, each player received an endowment of 40 tokens. In each of ten rounds, players simultaneously and independently decided whether to contribute 0, 2, or 4 tokens from their endowment into an account for damage prevention (Fig. S1). Players knew that if the total group contributions by the end of the game equalled or exceeded a threshold amount, then each player would get to keep the remaining balance of their endowment, issued as a bonus payment at a rate of 1 token = £0.50. However, if total contributions fell short of the threshold, then each player would lose 90% of their remaining endowment.

In treatments 100 and 150, the threshold was fixed at 100 or 150 tokens, respectively. In treatments 50/150, 135/165, and 145/155, the threshold was a random amount between 50 and 150 tokens. In treatment 100/200, it was a random amount between 100 and 200 tokens. In all uncertainty treatments, players knew that the exact threshold would be determined at the end of the game by drawing a whole number at random from the specified range, with each value being equally likely.

Before rounds 1 and 6, each player simultaneously and independently submitted two non-binding announcements. First, each player submitted a proposal regarding how many tokens the group should contribute in total over the ten rounds (Fig. S2). They were then informed about their own proposal, the proposals of the other group members, and the average proposal. Players knew that the average group proposal would serve as the agreed collective target. Second, concurrent with receiving this feedback, each player submitted a pledge regarding how many tokens they would personally contribute in total over the ten rounds (Fig. S3). They were then informed about their own pledge, the pledges of the other group members, and the total pledge, alongside the group proposals to facilitate comparison (Fig. S4).

At the end of each round, players were informed about their own contribution, their cumulative contribution, their most recent proposal and pledge, as well as the corresponding decisions made by the other group members (Fig. S5). Summaries of the total round contributions, group total contributions, average group proposal, and total group pledges were also displayed. In this way, as the game progressed, players were able to gauge whether their group members were adhering to their pledges and whether the group contributions were consistent with achieving the agreed collective goal.

Before the second set of non-binding announcements, groups in treatments 135/165 and 145/155 were given an on-screen warning supplying them with updated information about the threshold range (Fig. S6). Specifically, in treatment 135/165, groups were informed that the threshold was now a random amount between 135 and 165 tokens, whereas in treatment 145/155, they were informed that it was now a random amount between 145 and 155 tokens. In all other treatments, the fixed or uncertain threshold range remained as initially specified, and groups in these treatments received no additional information about the threshold. Instead, at the start of round 6, they proceeded directly to submit their second set of non-binding announcements.

At the end of the game, the threshold amount and the contents of the damage prevention account were communicated to the group. In the uncertainty treatments, the computer determined the exact threshold amount by drawing a random number from a uniform distribution either over the interval [50, 150] (treatment 50/150), [100, 200] (treatment 100/200), [135, 165] (treatment 135/165), or [145, 155] (treatment 145/155). To simulate calculation, participants viewed a five-second spinning circular animation before the threshold was revealed (Fig. S7), after which their payoffs were displayed (Fig. S8). They then completed a brief demographics questionnaire and read the debriefing form, before being redirected to Prolific to receive their participation fee. Bonus payments were issued manually by the experimenter within 12 hours of completing the session. The average total payoff per participant, including the participation fee, was £18.73. Experimental sessions had a median completion time of 25 minutes, making the level of compensation both fair and commensurate with participants' time investment.

Supplementary Experimental Instructions

100 Treatment

Experimental Instructions

Welcome to our experiment!

1. General Information

In our experiment, you can earn money. How much you earn depends on the gameplay, or more precisely on the decisions you and your fellow players make. Regardless of the gameplay, you will receive **£6** for your participation. The experiment consists of two parts and takes around 30 minutes in total. In part 1, you will read these instructions and answer a few short questions to check your understanding. This usually takes about 10 minutes. In part 2, after everyone has completed the first part, the game will begin. The game has 10 rounds and takes around 20 minutes. Please read the following rules carefully to ensure you understand how the game works before it begins.

2. Game Rules

There are **five players** in the game, meaning you and four other players. Each player faces the same decision problem. In the beginning of the experiment, you receive a **starting capital of 40 tokens**, which is credited to your personal account. During the experiment, you can use the tokens in your account or let them be. In the end, your current account balance is paid to you at the rate of **1 token = £0.50**. Your decisions are anonymous. For the purpose of anonymity, you will be allocated a pseudonym which will be used for the whole duration of the game. The pseudonyms are chosen from the names of moons in the Solar System (*Ananke, Telesto, Despina, Japetus, or Kallisto*). Once the game begins, you will be able to see your pseudonym in the upper left corner of your display.

The experiment has exactly **ten rounds**. In each round, you can invest your tokens in order to try and prevent damage. The damage will have a considerable negative financial impact on all players. In each round, all five players are asked the following question at the same time:

"How many tokens do you want to invest in damage prevention?"

You can answer with **0, 2, or 4 tokens**. After each player has made their decision, the five decisions are displayed at the same time. After that, all tokens invested by the players are assigned to a special account for damage prevention.

At the end of the game (after exactly ten rounds), the computer calculates the total investments made by all players of the group. **If the total investments are equal to or greater than a threshold amount, the damage is prevented and each player is paid the tokens remaining in their account,** meaning the 40 starting tokens minus the tokens the player has invested in preventing damage over the course of the game. **However, if the total investments are lower than the threshold amount, the damage occurs: All players lose 90% of the remaining tokens in their personal accounts**. The threshold amount to be reached in order to prevent damage is **100 tokens**.

At the end of the game, all players together must have invested at least 100 tokens to prevent the damage. If a single player has invested, say, a total of 10 tokens in damage prevention after ten rounds, they have a credit of 30 tokens in their personal account. If the group of players as a whole has invested 100 or more tokens in damage prevention, the damage will not occur and this player will receive £15 (30 tokens $\times$ £0.50). However, if the group has invested less than 100 tokens, the damage will occur and the player will lose 90% of their remaining tokens—receiving only £1.50 (10% of £15) from the game.

Please note the following feature of the game: Before the players decide how many tokens they want to invest into preventing damage, they make two non-binding announcements. First, each player makes a proposal for how many tokens the group as a whole should invest into preventing damage over the total of ten rounds. Second, each player makes a pledge for how many tokens they intend to invest in total over the ten rounds into preventing damage. Following this, the proposals and pledges made by all players (and an average and total value from all proposals and pledges, respectively) will be shown. After round 5, all players can make a new proposal for the total investments to be made by the group over the ten rounds, and a new pledge for how many tokens they intend to invest in total over the ten rounds.

⏱️ Important Timing Information

On each decision page (proposal, pledge, or investment), the game can only proceed once all five players have submitted their decisions. You will have a maximum of **60 seconds** to make each decision. A countdown timer at the top-left of the screen will show how much time remains.

If you do not respond in time, the computer will make a default decision for you. **If you fail to submit three decisions in a row** (equivalent to 4.5 minutes without responding), you will be removed from the game to allow the other players to continue without delay.

3. An Example

Here, you can see an example of the decisions made by the five players in one round (round 3).

You are: **Ananke**

Round: **3** / 10

Proposals
Rounds 1-10

Player	Proposal
Ananke	100
Telesto	60
Despina	100
Japetus	70
Kallisto	110

Average: 88

Pledges
Rounds 1-10

Player	Pledge
Ananke	20
Telesto	10
Despina	16
Japetus	12
Kallisto	22

Total: 80

Investments
Rounds 1-3

Player	Total
Ananke	8
Telesto	4
Despina	6
Japetus	4
Kallisto	6

Total: 28

Investments
Round 3

Player	Amount
Ananke	2
Telesto	0
Despina	4
Japetus	2
Kallisto	4

Total Round 3: 12

The first panel shows the proposals made by each player regarding how many tokens the group as a whole should invest into preventing damage over the ten rounds in total. For example, Kallisto suggests that the group should invest 110 tokens. The average of all proposals is 88 tokens. The second panel shows the pledges made by each player regarding how many tokens they will personally invest in the damage prevention account over the ten rounds in total. For example, over the ten rounds, Ananke has pledged to personally invest 20 tokens in total. The total of all pledges is 80 tokens.

The third panel shows the cumulative investments made by each player from the first to the current round (rounds 1–3). Despina and Kallisto have invested 6 tokens each, while Telesto and Japetus each invested 4 tokens. Ananke has invested 8 tokens. In total, 28 tokens were invested across the first three rounds. The fourth panel shows the investments made in the current round (round 3). The players Ananke and Japetus have invested 2 tokens each, the players Despina and Kallisto have invested 4 tokens each, and Telesto has not made any investments. In total, 12 tokens were invested in this round. In the game, you will see this information after each round.

4. Control Questions

Please answer the following control questions.

True or False: At the start of the game, and once again at the end of round 5, each player makes: (I) a non-binding proposal of how many tokens the group should collectively invest in damage prevention over the ten rounds, and (II) a non-binding pledge of how many tokens they will personally invest in damage prevention over the ten rounds.

◯ True ◯ False

Assume you invested a total of 16 tokens over the ten rounds, and the threshold amount to prevent damage was not reached by your group. How much money do you get at the end of the game (excluding the £6 participation fee)?

◯ £0 ◯ £0.50 ◯ £1.20 ◯ £12

Assume the group has invested the threshold amount to prevent damage, and that you have invested a total of 20 tokens over the ten rounds. How much money do you get at the end of the game (excluding the £6 participation fee)?

◯ £1 ◯ £10 ◯ £16 ◯ £20

Assume that the group has invested a total of £80 over the ten rounds. Does the damage occur in this case?

◯ Yes ◯ No

Assume that the group has invested a total of £105 over the ten rounds. Does the damage occur in this case?

◯ Yes ◯ No

50/150, 135/165, and 145/155 Treatments

Experimental Instructions

Welcome to our experiment!

1. General Information

In our experiment, you can earn money. How much you earn depends on the gameplay, or more precisely on the decisions you and your fellow players make. Regardless of the gameplay, you will receive **£6** for your participation. The experiment consists of two parts and takes around 30 minutes in total. In part 1, you will read these instructions and answer a few short questions to check your understanding. This usually takes about 10 minutes. In part 2, after everyone has completed the first part, the game will begin. The game has 10 rounds and takes around 20 minutes. Please read the following rules carefully to ensure you understand how the game works before it begins.

2. Game Rules

There are **five players** in the game, meaning you and four other players. Each player faces the same decision problem. In the beginning of the experiment, you receive a **starting capital of 40 tokens**, which is credited to your personal account. During the experiment, you can use the tokens in your account or let them be. In the end, your current account balance is paid to you at the rate of **1 token = £0.50**. Your decisions are anonymous. For the purpose of anonymity, you will be allocated a pseudonym which will be used for the whole duration of the game. The pseudonyms are chosen from the names of moons in the Solar System (*Ananke, Telesto, Despina, Japetus, or Kallisto*). Once the game begins, you will be able to see your pseudonym in the upper left corner of your display.

The experiment has exactly **ten rounds**. In each round, you can invest your tokens in order to try and prevent damage. The damage will have a considerable negative financial impact on all players. In each round, all five players are asked the following question at the same time:

"How many tokens do you want to invest in damage prevention?"

You can answer with **0, 2, or 4 tokens**. After each player has made their decision, the five decisions are displayed at the same time. After that, all tokens invested by the players are assigned to a special account for damage prevention.

At the end of the game (after exactly ten rounds), the computer calculates the total investments made by all players of the group. **If the total investments are equal to or greater than a threshold amount, the damage is prevented and each player is paid the tokens remaining in their account,** meaning the 40 starting tokens minus the tokens the player has invested in preventing damage over the course of the game. **However, if the total investments are lower than the threshold amount, the damage occurs: All players lose 90% of the remaining tokens in their personal accounts**. The threshold amount to be reached in order to prevent damage is **some amount between 50 and 150 tokens**, but you will not know the exact amount until the conclusion of the game. At the end of the experiment, the exact threshold amount will be drawn randomly. The draw is programmed so that each whole number between 50 and 150 tokens has an equal probability of being selected.

Suppose at the end of the game that the randomly drawn threshold amount is 74. All players together must have invested at least 74 tokens to prevent the damage. If a single player has invested, say, a total of 10 tokens in damage prevention after ten rounds, they have a credit of 30 tokens in their personal account. If the group of players as a whole has invested 74 tokens or more in damage prevention, the damage will not occur and this player will receive £15 (30 tokens $\times$ £0.50). However, if the group has invested less than 74 tokens, the damage will occur and the player will lose 90% of their remaining tokens—receiving only £1.50 (10% of £15) from the game.

Please note the following feature of the game: Before the players decide how much they want to invest into preventing damage, they make two non-binding announcements. First, each player makes a proposal for how many tokens the group as a whole should invest into preventing damage over the total of ten rounds. Second, each player makes a pledge for how many tokens they intend to invest in total over the ten rounds into preventing damage. Following this, the proposals and pledges made by all players (and an average and total value from all proposals and pledges, respectively) will be shown. After round 5, all players can make a new proposal for the total investments to be made by the group over the ten rounds, and a new pledge for how many tokens they intend to invest in total over the ten rounds.

⏱️ Important Timing Information

On each decision page (proposal, pledge, or investment), the game can only proceed once all five players have submitted their decisions. You will have a maximum of **60 seconds** to make each decision. A countdown timer at the top-left of the screen will show how much time remains.

If you do not respond in time, the computer will make a default decision for you. **If you fail to submit three decisions in a row** (equivalent to 4.5 minutes without responding), you will be removed from the game to allow the other players to continue without delay.

3. An Example

Here, you can see an example of the decisions made by the five players in one round (round 3).

You are: **Ananke**

Round: **3** / 10

Proposals
Rounds 1-10

Player	Proposal
Ananke	100
Telesto	60
Despina	100
Japetus	70
Kallisto	110

Average: 88

Pledges
Rounds 1-10

Player	Pledge
Ananke	20
Telesto	10
Despina	16
Japetus	12
Kallisto	22

Total: 80

Investments
Rounds 1-3

Player	Total
Ananke	8
Telesto	4
Despina	6
Japetus	4
Kallisto	6

Total: 28

Investments
Round 3

Player	Amount
Ananke	2
Telesto	0
Despina	4
Japetus	2
Kallisto	4

Total Round 3: 12

The first panel shows the proposals made by each player regarding how many tokens the group as a whole should invest into preventing damage over the ten rounds in total. For example, Kallisto suggests that the group should invest 110 tokens. The average of all proposals is 88 tokens. The second panel shows the pledges made by each player regarding how many tokens they will personally invest in the damage prevention account over the ten rounds in total. For example, over the ten rounds, Ananke has pledged to personally invest 20 tokens in total. The total of all pledges is 80 tokens.

The third panel shows the cumulative investments made by each player from the first to the current round (rounds 1–3). Despina and Kallisto have invested 6 tokens each, while Telesto and Japetus each invested 4 tokens. Ananke has invested 8 tokens. In total, 28 tokens were invested across the first three rounds. The fourth panel shows the investments made in the current round (round 3). The players Ananke and Japetus have invested 2 tokens each, the players Despina and Kallisto have invested 4 tokens each, and Telesto has not made any investments. In total, 12 tokens were invested in this round. In the game, you will see this information after each round.

4. Control Questions

Please answer the following control questions.

True or False: At the start of the game, and once again at the end of round 5, each player makes: (I) a non-binding proposal of how many tokens the group should collectively invest in damage prevention over the ten rounds, and (II) a non-binding pledge of how many tokens they will personally invest in damage prevention over the ten rounds.

◯ True ◯ False

True or False: In the random draw to determine the threshold amount at the end of the game, each whole token amount between 50 and 150 has the same probability of being selected.

◯ True ◯ False

Assume you invested a total of 16 tokens over the ten rounds, and the threshold amount to prevent damage was not reached by your group. How much money do you get at the end of the game (excluding the £6 participation fee)?

◯ £0 ◯ £0.50 ◯ £1.20 ◯ £12

Assume the group has invested the threshold amount to prevent damage, and that you have invested a total of 20 tokens over the ten rounds. How much money do you get at the end of the game (excluding the £6 participation fee)?

◯ £1 ◯ £10 ◯ £16 ◯ £20

Assume that the group has invested a total of 80 tokens over the ten rounds. The draw shows that the threshold amount to avoid damage is 120 tokens. Does the damage occur in this case?

◯ Yes ◯ No

Assume that the group has invested a total of 100 tokens over the ten rounds. The draw shows that the threshold amount to avoid damage is 60 tokens. Does the damage occur in this case?

◯ Yes ◯ No

What is the probability of the threshold amount to prevent damage being greater than 100 tokens?

◯ 10% ◯ 30% ◯ 50% ◯ 90%

150 Treatment

Experimental Instructions

Welcome to our experiment!

1. General Information

In our experiment, you can earn money. How much you earn depends on the gameplay, or more precisely on the decisions you and your fellow players make. Regardless of the gameplay, you will receive **£6** for your participation. The experiment consists of two parts and takes around 30 minutes in total. In part 1, you will read these instructions and answer a few short questions to check your understanding. This usually takes about 10 minutes. In part 2, after everyone has completed the first part, the game will begin. The game has 10 rounds and takes around 20 minutes. Please read the following rules carefully to ensure you understand how the game works before it begins.

2. Game Rules

There are **five players** in the game, meaning you and four other players. Each player faces the same decision problem. In the beginning of the experiment, you receive a **starting capital of 40 tokens**, which is credited to your personal account. During the experiment, you can use the tokens in your account or let them be. In the end, your current account balance is paid to you at the rate of **1 token = £0.50**. Your decisions are anonymous. For the purpose of anonymity, you will be allocated a pseudonym which will be used for the whole duration of the game. The pseudonyms are chosen from the names of moons in the Solar System (*Ananke, Telesto, Despina, Japetus, or Kallisto*). Once the game begins, you will be able to see your pseudonym in the upper left corner of your display.

The experiment has exactly **ten rounds**. In each round, you can invest your tokens in order to try and prevent damage. The damage will have a considerable negative financial impact on all players. In each round, all five players are asked the following question at the same time:

"How many tokens do you want to invest in damage prevention?"

You can answer with **0, 2, or 4 tokens**. After each player has made their decision, the five decisions are displayed at the same time. After that, all tokens invested by the players are assigned to a special account for damage prevention.

At the end of the game (after exactly ten rounds), the computer calculates the total investments made by all players of the group. **If the total investments are equal to or greater than a threshold amount, the damage is prevented and each player is paid the tokens remaining in their account,** meaning the 40 starting tokens minus the tokens the player has invested in preventing damage over the course of the game. **However, if the total investments are lower than the threshold amount, the damage occurs: All players lose 90% of the remaining tokens in their personal accounts**. The threshold amount to be reached in order to prevent damage is **150 tokens**.

Suppose at the end of the game that the threshold amount is 150. All players together must have invested at least 150 tokens to prevent the damage. If a single player has invested, say, a total of 20 tokens in damage prevention after ten rounds, they have a credit of 20 tokens in their personal account. If the group of players as a whole has invested 150 tokens or more in damage prevention, the damage will not occur and this player will receive £10 (20 tokens $\times$ £0.50). However, if the group has invested less than 150 tokens, the damage will occur and the player will lose 90% of their remaining tokens—receiving only £1.00 (10% of £10) from the game.

Please note the following feature of the game: Before the players decide how much they want to invest into preventing damage, they make two non-binding announcements. First, each player makes a proposal for how many tokens the group as a whole should invest into preventing damage over the total of ten rounds. Second, each player makes a pledge for how many tokens they intend to invest in total over the ten rounds into preventing damage. Following this, the proposals and pledges made by all players (and an average and total value from all proposals and pledges, respectively) will be shown. After round 5, all players can make a new proposal for the total investments to be made by the group over the ten rounds, and a new pledge for how many tokens they intend to invest in total over the ten rounds.

⏱️ Important Timing Information

On each decision page (proposal, pledge, or investment), the game can only proceed once all five players have submitted their decisions. You will have a maximum of **60 seconds** to make each decision. A countdown timer at the top-left of the screen will show how much time remains.

If you do not respond in time, the computer will make a default decision for you. **If you fail to submit three decisions in a row** (equivalent to 4.5 minutes without responding), you will be removed from the game to allow the other players to continue without delay.

3. An Example

Here, you can see an example of the decisions made by the five players in one round (round 3).

You are: **Ananke**

Round: **3** / 10

Proposals
Rounds 1-10

Player	Proposal
Ananke	150
Telesto	110
Despina	150
Japetus	120
Kallisto	160

Average: 138

Pledges
Rounds 1-10

Player	Pledge
Ananke	30
Telesto	20
Despina	26
Japetus	22
Kallisto	32

Total: 130

Investments
Rounds 1-3

Player	Total
Ananke	12
Telesto	6
Despina	10
Japetus	6
Kallisto	8

Total: 42

Investments
Round 3

Player	Amount
Ananke	4
Telesto	0
Despina	2
Japetus	2
Kallisto	4

Total Round 3: 12

The first panel shows the proposals made by each player regarding how many tokens the group as a whole should invest into preventing damage over the ten rounds in total. For example, Kallisto suggests that the group should invest 160 tokens. The average of all proposals is 138 tokens. The second panel shows the pledges made by each player regarding how many tokens they will personally invest in the damage prevention account over the ten rounds in total. For example, over the ten rounds, Ananke has pledged to personally invest 30 tokens in total. The total of all pledges is 130 tokens.

The third panel shows the cumulative investments made by each player from the first to the current round (rounds 1–3). Ananke has invested 12 tokens, Despina 10 tokens, Kallisto 8 tokens, and Telesto and Japetus 6 tokens each. In total, 42 tokens were invested across the first three rounds. The fourth panel shows the investments made in the current round (round 3). The players Ananke and Kallisto have invested 4 tokens each, the players Despina and Japetus have invested 2 tokens each, and Telesto has not made any investments. In total, 12 tokens were invested in this round. In the game, you will see this information after each round.

4. Control Questions

Please answer the following control questions.

True or False: At the start of the game, and once again at the end of round 5, each player makes: (I) a non-binding proposal of how many tokens the group should collectively invest in damage prevention over the ten rounds, and (II) a non-binding pledge of how many tokens they will personally invest in damage prevention over the ten rounds.

◯ True ◯ False

Assume you invested a total of 24 tokens over the ten rounds, and the threshold amount to prevent damage was not reached by your group. How much money do you get at the end of the game (excluding the £6 participation fee)?

◯ £0 ◯ £0.50 ◯ £0.80 ◯ £8

Assume the group has invested the threshold amount to prevent damage, and that you have invested a total of 30 tokens over the ten rounds. How much money do you get at the end of the game (excluding the £6 participation fee)?

◯ £0.50 ◯ £5 ◯ £7.50 ◯ £10

Assume that the group has invested a total of 130 tokens over the ten rounds. Does the damage occur in this case?

◯ Yes ◯ No

Assume that the group has invested a total of 155 tokens over the ten rounds. Does the damage occur in this case?

◯ Yes ◯ No

100/200 Treatment

Experimental Instructions

Welcome to our experiment!

1. General Information

In our experiment, you can earn money. How much you earn depends on the gameplay, or more precisely on the decisions you and your fellow players make. Regardless of the gameplay, you will receive **£6** for your participation. The experiment consists of two parts and takes around 30 minutes in total. In part 1, you will read these instructions and answer a few short questions to check your understanding. This usually takes about 10 minutes. In part 2, after everyone has completed the first part, the game will begin. The game has 10 rounds and takes around 20 minutes. Please read the following rules carefully to ensure you understand how the game works before it begins.

2. Game Rules

There are **five players** in the game, meaning you and four other players. Each player faces the same decision problem. In the beginning of the experiment, you receive a **starting capital of 40 tokens**, which is credited to your personal account. During the experiment, you can use the tokens in your account or let them be. In the end, your current account balance is paid to you at the rate of **1 token = £0.50**. Your decisions are anonymous. For the purpose of anonymity, you will be allocated a pseudonym which will be used for the whole duration of the game. The pseudonyms are chosen from the names of moons in the Solar System (*Ananke, Telesto, Despina, Japetus, or Kallisto*). Once the game begins, you will be able to see your pseudonym in the upper left corner of your display.

The experiment has exactly **ten rounds**. In each round, you can invest your tokens in order to try and prevent damage. The damage will have a considerable negative financial impact on all players. In each round, all five players are asked the following question at the same time:

"How many tokens do you want to invest in damage prevention?"

You can answer with **0, 2, or 4 tokens**. After each player has made their decision, the five decisions are displayed at the same time. After that, all tokens invested by the players are assigned to a special account for damage prevention.

At the end of the game (after exactly ten rounds), the computer calculates the total investments made by all players of the group. **If the total investments are equal to or greater than a threshold amount, the damage is prevented and each player is paid the tokens remaining in their account**, meaning the 40 starting tokens minus the tokens the player has invested in preventing damage over the course of the game. **However, if the total investments are lower than the threshold amount, the damage occurs: All players lose 90% of the remaining tokens in their personal accounts**. The threshold amount to be reached in order to prevent damage is **some amount between 100 and 200 tokens**, but you will not know the exact amount until the conclusion of the game. At the end of the experiment, the exact threshold amount will be drawn randomly. The draw is programmed so that each whole number between 100 and 200 tokens has an equal probability of being selected.

Suppose at the end of the game that the randomly drawn threshold amount is 174. All players together must have invested at least 174 tokens to prevent the damage. If a single player has invested, say, a total of 10 tokens in damage prevention after ten rounds, they have a credit of 30 tokens in their personal account. If the group of players as a whole has invested 174 tokens or more in damage prevention, the damage will not occur and this player will receive £15 (30 tokens £0.50). However, if the group has invested less than 174 tokens, the damage will occur and the player will lose 90% of their remaining tokens — receiving only £1.50 (10% of £15) from the game.

Please note the following feature of the game: Before the players decide how much they want to invest into preventing damage, they make two non-binding announcements. First, each player makes a proposal for how many tokens the group as a whole should invest into preventing damage over the total of ten rounds. Second, each player makes a pledge for how many tokens they intend to invest in total over the ten rounds into preventing damage. Following this, the proposals and pledges made by all players (and an average and total value from all proposals and pledges, respectively) will be shown. After round 5, all players can make a new proposal for the total investments to be made by the group over the ten rounds, and a new pledge for how many tokens they intend to invest in total over the ten rounds.

⏱️ Important Timing Information

On each decision page (proposal, pledge, or investment), the game can only proceed once all five players have submitted their decisions. You will have a maximum of **60 seconds** to make each decision. A countdown timer at the top-left of the screen will show how much time remains.

If you do not respond in time, the computer will make a default decision for you. **If you fail to submit three decisions in a row** (equivalent to 4.5 minutes without responding), you will be removed from the game to allow the other players to continue without delay.

3. An Example

Here, you can see an example of the decisions made by the five players in one round (round 3).

You are: **Ananke**

Round: **3** / 10

Proposals
Rounds 1-10

Player	Proposal
Ananke	150
Telesto	110
Despina	150
Japetus	120
Kallisto	160

Average: 138

Pledges
Rounds 1-10

Player	Pledge
Ananke	30
Telesto	20
Despina	26
Japetus	22
Kallisto	32

Total: 130

Investments
Rounds 1-3

Player	Total
Ananke	12
Telesto	6
Despina	10
Japetus	6
Kallisto	8

Total: 42

Investments
Round 3

Player	Amount
Ananke	4
Telesto	0
Despina	2
Japetus	2
Kallisto	4

Total Round 3: 12

The first panel shows the proposals made by each player regarding how many tokens the group as a whole should invest into preventing damage over the ten rounds in total. For example, Kallisto suggests that the group should invest 160 tokens. The average of all proposals is 138 tokens. The second panel shows the pledges made by each player regarding how many tokens they will personally invest in the damage prevention account over the ten rounds in total. For example, over the ten rounds, Ananke has pledged to personally invest 30 tokens in total. The total of all pledges is 130 tokens.

The third panel shows the cumulative investments made by each player from the first to the current round (rounds 1–3). Ananke has invested 12 tokens, Despina 10 tokens, Kallisto 8 tokens, and Telesto and Japetus 6 tokens each. In total, 42 tokens were invested across the first three rounds. The fourth panel shows the investments made in the current round (round 3). The players Ananke and Kallisto have invested 4 tokens each, the players Despina and Japetus have invested 2 tokens each, and Telesto has not made any investments. In total, 12 tokens were invested in this round. In the game, you will see this information after each round.

4. Control Questions

Please answer the following control questions.

True or False: At the start of the game, and once again at the end of round 5, each player makes: (I) a non-binding proposal of how many tokens the group should collectively invest in damage prevention over the ten rounds, and (II) a non-binding pledge of how many tokens they will personally invest in damage prevention over the ten rounds.

◯ True ◯ False

True or False: In the random draw to determine the threshold amount at the end of the game, each whole token amount between 100 and 200 has the same probability of being selected.

◯ True ◯ False

Assume you invested a total of 24 tokens over the ten rounds, and the threshold amount to prevent damage was not reached by your group. How much money do you get at the end of the game (excluding the £6 participation fee)?

◯ £0 ◯ £0.50 ◯ £0.80 ◯ £8

Assume the group has invested the threshold amount to prevent damage, and that you have invested a total of 30 tokens over the ten rounds. How much money do you get at the end of the game (excluding the £6 participation fee)?

◯ £0.50 ◯ £5 ◯ £7.50 ◯ £10

Assume that the group has invested a total of 120 tokens over the ten rounds. The draw shows that the threshold amount to avoid damage is 180 tokens. Does the damage occur in this case?

◯ Yes ◯ No

Assume that the group has invested a total of 160 tokens over the ten rounds. The draw shows that the threshold amount to avoid damage is 120 tokens. Does the damage occur in this case?

◯ Yes ◯ No

What is the probability of the threshold amount to prevent damage being greater than 150 tokens?

◯ 25% ◯ 50% ◯ 75% ◯ 100%

Supplementary Methodological Information

Running a group-based decision-making experiment using an online participant recruitment platform such as Prolific poses several logistical and technical challenges. Here we consider these challenges and how we overcame them.

Group Formation and Participant Sampling

One key challenge is ensuring that participants are sampled at a sufficient rate to allow the timely formation of groups. To address this, we requested that Prolific disable the platform's rate-limiting mechanism, also known as the naivety distribution mechanism. This mechanism is normally used to distribute study invitations more equitably across the participant pool by prioritising less experienced users. Disabling it increases the sampling rate and is recommended by Prolific for studies requiring real-time group formation. One consequence of this change is that most participants tend to be experienced users with many prior approvals and correspondingly high approval ratings.

Group formation was handled in oTree using the `group_by_arrival_time` method. In oTree versions 5.8 and above, only participants with an active and focused browser window are eligible to be grouped. If a participant switches focus to another window or tab, they become temporarily ineligible. To facilitate grouping, oTree displays an indicator light above the participant's browser window: a green light signifies that the participant is active and eligible for grouping, while an amber light indicates that they must return to the experiment window to resume eligibility.

To mitigate the risk of delayed grouping due to browser inactivity, participants were first shown a *group formation notice page*, which explained the importance of remaining on the page and keeping the browser window focused. Having given their consent and read this notice, participants were then directed to the waiting page, where the `group_by_arrival_time` mechanism was implemented. This mechanism formed groups dynamically as soon as five active and focused participants were available. To prevent excessive delays, we implemented a timeout mechanism: if a participant remained on the waiting page for more than 10 minutes without being matched, they were released from the study and compensated with an early-exit fee of £2 for their time.

Server Setup and Participant Access

With Prolific's naivety distribution mechanism disabled, the participant sampling rate increases markedly—in our experiment, the sampling rate was 3.63 participants per minute, equating to one participant arriving at the experiment every 16.5 seconds. This allows for faster recruitment, which is essential for real-time group formation, but it also places additional demands on server performance. It is therefore important to have a server configuration capable of handling the resulting load efficiently and reliably.

The experiment was deployed using the Heroku cloud platform recommended by oTree. We selected the most powerful server configuration available to us—namely, a single `Standard-2X` web dyno to serve the application and a `Standard-0` Postgres database plan to store session data. This setup provided sufficient computing power and memory to accommodate multiple simultaneously active five-player groups, while also supporting the database queries required for dynamic group formation and live interaction.

To prevent performance bottlenecks, we also capped the number of concurrent participants via the Prolific recruitment interface. Specifically, access was limited to a maximum of 100 participants at any given time. This cap ensured that group formation could proceed without excessive delays or system slowdowns, while maintaining steady throughput across multiple sessions.

Pilot testing confirmed that this server configuration was able to support the demands of the experiment without crashing or timing out. Participant traffic was monitored throughout the data collection period to ensure stable operation.

Timing Controls and Auto-Submission

Because all participants in a group progressed through the game simultaneously, it was important to prevent any single participant from unduly delaying the others. To address this, we implemented countdown timers across all stages of the experiment. Decision-making pages (used to submit proposals, pledges, and contributions) each had a 60-second visible countdown timer displayed in the top-left corner of the screen. If a participant failed to respond within the allotted time, the software automatically submitted a default response on their behalf:

- For proposals, the default was the expected value of the threshold for that treatment (100 tokens in treatments 100 and 50/150 and for first proposals in treatments 135/165 and 145/155; 150 tokens in treatments 150 and 100/200 and for second

proposals in treatments 135/165 and 145/155).

- For pledges, the default was the participant's fair-share contribution to reach the expected value of the threshold for that treatment (20 tokens if the expected threshold value was 100 tokens and 30 tokens if the expected threshold value was 150 tokens).

- For contributions, a value was randomly selected from the set {0, 2, 4}, with probabilities based on the distribution of responses from a previous experiment[3] to reflect typical participant behaviour (weights: 0 = 0.238, 2 = 0.579, 4 = 0.183).

Feedback pages used to display group decisions included a 30-second timer and automatically advanced once the timer expired. The instructions page also had a 10-minute limit, based on pilot testing. If the timer elapsed, the software autofilled the control questions with the correct answers and submitted them, allowing the group to proceed without delay.

Dropout Detection and Response Automation

These auto-submission features were also designed to maintain the integrity of the experiment in the event of participant dropout. While decision pages included a 60-second countdown timer that ensured responses were auto-submitted even if a participant failed to respond, repeated delays across multiple pages could significantly slow the progression of the game for the rest of the group. To mitigate this, we classified a participant as a dropout if they failed to submit responses on three consecutive decision pages—a period of inactivity lasting 4.5 minutes. From that point onward, their decisions were automatically submitted within 1 second of each page loading, preventing further delays for the remaining group members.

Supplementary Statistical Analyses

Equilibrium Comparisons

We compared observed total group contributions against the cooperative and Nash equilibrium predictions for each treatment using two-sided Wilcoxon signed-rank tests with Holm corrections.

In the low-threshold baseline treatments, contributions were consistent with the common cooperative and Nash equilibrium under certainty, but shifted toward the cooperative equilibrium under uncertainty. In treatment 100 (*Mdn* = 108), contributions were significantly higher than the equilibrium prediction of 100 ($W = 276$, $z = 4.20$, $p_{\text{holm}} < .001$). In treatment 50/150 (*Mdn* = 114), contributions did not differ significantly from the cooperative equilibrium prediction of 119.44 ($W = 103$, $z = -1.60$, $p_{\text{holm}} = 1.00$), but were significantly higher than the Nash equilibrium prediction of 65.74 ($W = 325$, $z = 4.37$, $p_{\text{holm}} < .001$).

In the high-threshold baseline treatments, contributions were consistent with the common cooperative and Nash equilibrium under certainty, but were more closely aligned with the cooperative equilibrium under uncertainty. In treatment 150 (*Mdn* = 152), contributions did not differ significantly from the equilibrium prediction of 150 ($W = 122$, $z = -0.13$, $p_{\text{holm}} = 1.00$). In treatment 100/200 (*Mdn* = 142), contributions did not differ significantly from the cooperative equilibrium prediction of 144.44 ($W = 106$, $z = -1.52$, $p_{\text{holm}} = 1.00$), but were significantly higher than the Nash equilibrium prediction of 107.41 ($W = 302$, $z = 3.75$, $p_{\text{holm}} = .0027$).

In the early-warning treatments, contributions were evaluated against both the old cooperative and Nash equilibria associated with the original threshold range and the new equilibria associated with the revised threshold ranges announced mid-game. In treatment 135/165 (*Mdn* = 140), contributions were significantly higher than both the old cooperative equilibrium prediction of 119.44 ($W = 293$, $z = 3.51$, $p_{\text{Holm}} = .0074$) and the old Nash equilibrium prediction of 65.74 ($W = 325$, $z = 4.37$, $p_{\text{Holm}} < .001$). Compared to the new equilibria, contributions were significantly below the cooperative equilibrium prediction of 165 ($W = 0$, $z = -4.37$, $p_{\text{Holm}} < .001$), but did not differ significantly from the Nash equilibrium prediction of 143.06 ($W = 115$, $z = -1.28$, $p_{\text{Holm}} = 1.00$). In treatment 145/155 (*Mdn* = 148), contributions were again significantly higher than both the old cooperative equilibrium prediction of 119.44 ($W = 322$, $z = 4.29$, $p_{\text{Holm}} < .001$) and the old Nash equilibrium prediction of 65.74 ($W = 325$, $z = 4.37$, $p_{\text{Holm}} < .001$). Compared to the new equilibria, contributions were significantly below the cooperative equilibrium prediction of 155 ($W = 42.5$, $z = -3.23$, $p_{\text{Holm}} = .019$), but did not differ significantly from the Nash equilibrium prediction of 153.24 ($W = 62$, $z = -2.70$, $p_{\text{Holm}} = .092$).

In summary, these results suggest that in the low-threshold baseline treatments, groups coordinated on the common equilibrium under certainty, albeit with contributions overshooting the prediction somewhat, whereas under uncertainty they coordinated on the cooperative equilibrium. In the high-threshold baseline treatments, groups coordinated closely around the common

equilibrium under certainty, while under uncertainty they again coordinated on the cooperative equilibrium. In the early-warning treatments, contributions are most consistent with the notion that groups coordinated on the new Nash equilibrium associated with the revised threshold ranges.

Proposals and Pledges

The impact of the mid-game warnings on contributions was mirrored broadly in average group proposals and total group pledges. Starting with proposals (see Fig. 3a in the main article), first proposals were approximately 100 tokens in treatments 100, 50/150, 135/165, and 145/155. Accordingly, for the low-threshold comparison, first proposals did not differ significantly by treatment (Kruskal-Wallis, $\chi^2_{df=3}$ = 1.13, p = .771). In contrast, first proposals were higher in treatments 150 and 100/200 than the other treatments, although they still fell short of 150 tokens. For the high-threshold comparison, first proposals differed significantly by treatment (Kruskal-Wallis, $\chi^2_{df=3}$ = 55.71, $p < .001$). There was no significant difference between treatments 150 and 100/200 (Mann-Whitney U = 240.50, p = .165). However, compared to treatment 100/200, first proposals were significantly lower in treatment 135/165 (Mann-Whitney U = 35.00, $p < .001$) and treatment 145/155 (Mann-Whitney U = 33.00, $p < .001$).

Turning to second proposals, those in treatments 100 and 50/150 were again close to 100 tokens—although somewhat higher in treatment 50/150 than in treatment 100. By contrast, second proposals were markedly higher in treatments 135/165 and 145/155 following the announcement of the mid-game warnings, but still short of 150 tokens. For the low-threshold comparison, there was a significant effect of treatment (Kruskal-Wallis, $\chi^2_{df=3}$ = 62.03 $p < .001$). Second proposals were significantly higher in treatment 50/150 than in treatment 100 (Mann-Whitney U = 134.00, $p < .001$). Importantly, compared to treatment 50/150, second proposals were significantly higher in treatment 135/165 (Mann-Whitney U = 58.50, $p < .001$) and treatment 145/155 (Mann-Whitney U = 49.50, $p < .001$). Second proposals in treatments 150 and 100/200 were at a comparable level to those in treatments 135/165 and 145/155. Thus, for the high-threshold comparison, the effect of treatment was not significant (Kruskal-Wallis, $\chi^2_{df=3}$ = 0.73 p = .866), indicating that the mid-game warnings in treatments 135/165 and 145/155 elevated second proposals to the same level as in the high-threshold baseline treatments.

The pattern was broadly similar for pledges (see Fig. 3b in the main article). In treatments 100, 50/150, 135/165, and 145/155 first pledges were again close to 100 tokens. Accordingly, for the low-threshold comparison, first pledges did not differ significantly by treatment (Kruskal-Wallis, $\chi^2_{df=3}$ = 0.25 p = .970). In contrast, first pledges were noticeably higher in treatments 150 and 100/200 than the other treatments, although, as with first proposals, they still fell short of 150 tokens. For the high-threshold comparison, there was a significant effect of treatment on first pledges (Kruskal-Wallis, $\chi^2_{df=3}$ = 44.09, $p < .001$). There was no significant difference between treatments 150 and 100/200 (Mann-Whitney U = 272.50, p = .443). However, compared to treatment 100/200, first pledges were significantly lower in treatment 135/165 (Mann-Whitney U = 94.50, $p <$ .001) and treatment 145/155 (Mann-Whitney U = 100.50, $p < .001$).

Turning to second pledges, those in treatments 100 and 50/150 were just above 100 tokens. By contrast, second pledges were higher in treatments 135/165 and 145/155 in response to the mid-game warnings, although they still fell short of 150 tokens. For the low-threshold comparison, there was a significant effect of treatment (Kruskal-Wallis, $\chi^2_{df=3}$ = 27.69 $p <$ .001). Second pledges did not differ significantly between treatments 100 and 50/50 (Mann-Whitney U = 275.00, p = .472). Importantly, compared to treatment 50/150, second pledges were significantly higher in treatment 135/165 (Mann-Whitney U = 160.00, p = .003) and treatment 145/155 (Mann-Whitney U = 119.00, $p < .001$). Second pledges in treatments 150 and 100/200 were at a comparable level to those in treatments 135/165 and 145/155. Accordingly, there was no effect of treatment for the high-threshold comparison (Kruskal-Wallis, $\chi^2_{df=3}$ = 4.12 p = .249), confirming that the mid-game warnings in treatments 135/165 and 145/155 elevated second pledges to a comparable level as in the high-threshold baseline treatments.

Relationship of Proposals and Pledges to Contributions

The degree to which average group proposals and total group pledges served as reliable signals of total group contributions varied according to the timing of these non-binding communications (see Fig. 4 in the main article). First proposal and pledge amounts were generally weak and inconsistent predictors of total group contributions across treatments. By contrast, second proposal and pledge amounts were consistently and positively associated with total contributions across treatments. The one exception was the absence of an association between second pledges and contributions in treatment 145/155, which reflected the restricted range of pledges and contributions resulting from the extreme narrowing of the threshold range mid-game in this treatment. These trends were statistically confirmed by a linear regression examining whether treatment, first and second average group proposals, and first and second total group pledges predicted total contributions across all rounds. Treatment was dummy coded using five contrasts: (1) 100 vs. 50/150, (2) 50/150 vs. (135/165, 145/155), (3) 150 vs. 100/200, (4) 100/200 vs. (135/165, 145/155), and (5) 135/165 vs. 145/155. The overall model was significant, $F(9, 140) = 21.04$, $p < .001$, with

an R^2 of .57 (adjusted $R^2 = .55$), indicating that the predictors collectively explained 57% of the variance in total group contributions (Table S1).

Of the five treatment contrasts, only one reached statistical significance. Contributions were significantly higher in treatments 135/165 and 145/155 than in treatment 50/150 ($\beta = -15.98$, SE = 4.30, $t = -3.72$, $p < .001$). All other treatment contrasts were non-significant ($ps \geq .080$). Among the continuous predictors, there was no significant effect of first proposal amount ($\beta = -0.05$, SE = 0.07, $t = -0.70$, $p = .492$) or first pledge amount ($\beta = 0.06$, SE = 0.07, $t = 0.79$, $p = .431$). By contrast, second proposal amount was a significant positive predictor of contributions ($\beta = 0.31$, SE = 0.11, $t = 2.77$, $p = .006$), as was second pledge amount ($\beta = 0.21$, SE = 0.09, $t = 2.32$, $p = .022$). Thus, while initial proposals and pledges were inconsistent indicators of subsequent contributions, second proposals and pledges provided reliable signals of group behaviour across treatments.

Tables

Table S1. Linear regression predicting group contributions.

Predictor	Estimate	SE	t	p
(Intercept)	65.08	11.97	5.44	**<.001**
Treatment				
100 vs. 50/150	2.17	4.25	0.51	.611
50/150 vs. (135/165 + 145/155)	–15.98	4.30	–3.72	**<.001**
150 vs. 100/200	7.23	4.09	1.77	*.080*
100/200 vs. (135/165 + 145/155)	–4.35	4.76	–0.91	.363
135/165 vs. 145/155	–6.22	4.05	–1.54	.127
First proposal	–0.05	0.07	–0.69	.492
Second proposal	0.31	0.11	2.77	**.006**
First pledge	0.06	0.07	0.79	.431
Second pledge	0.21	0.09	2.32	**.022**

Figures

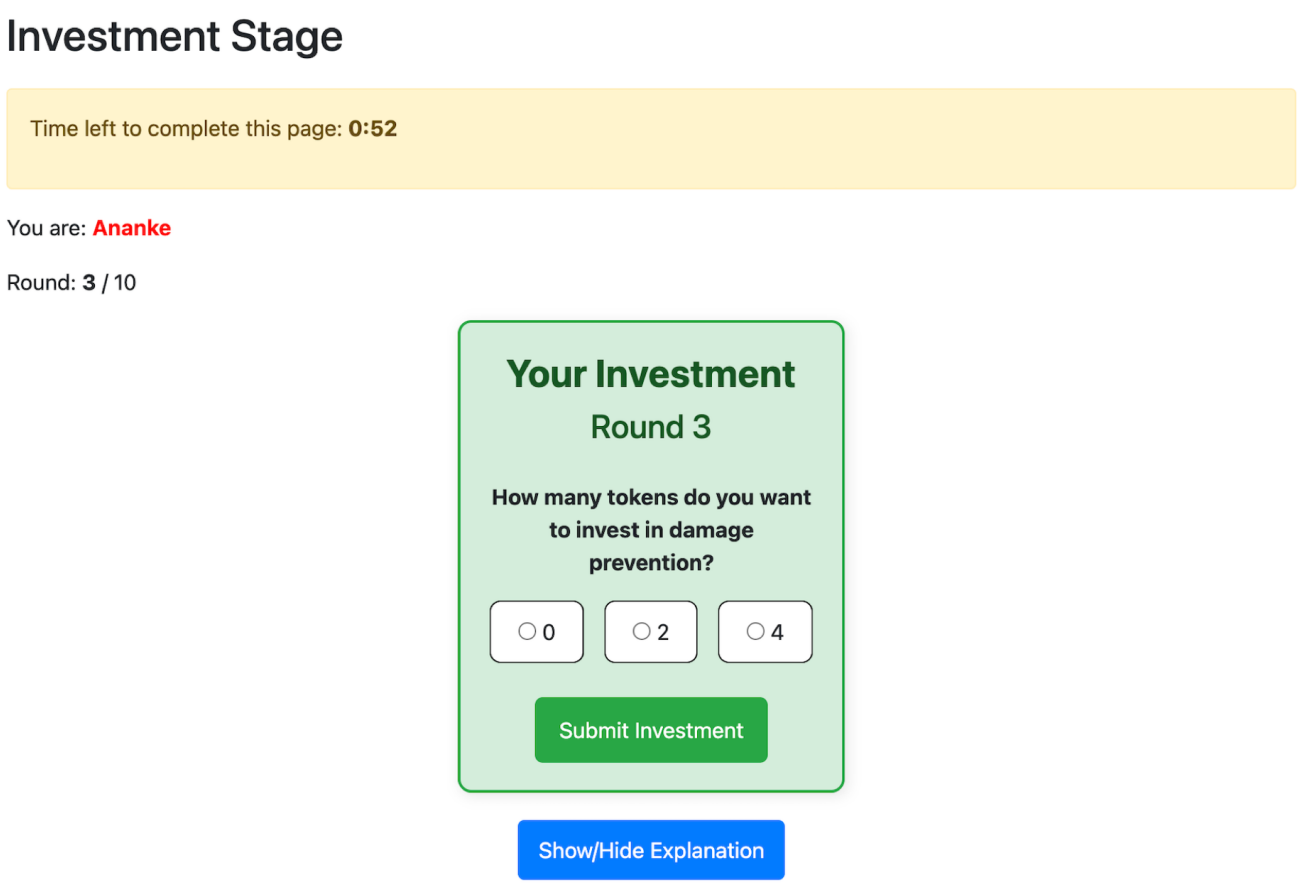
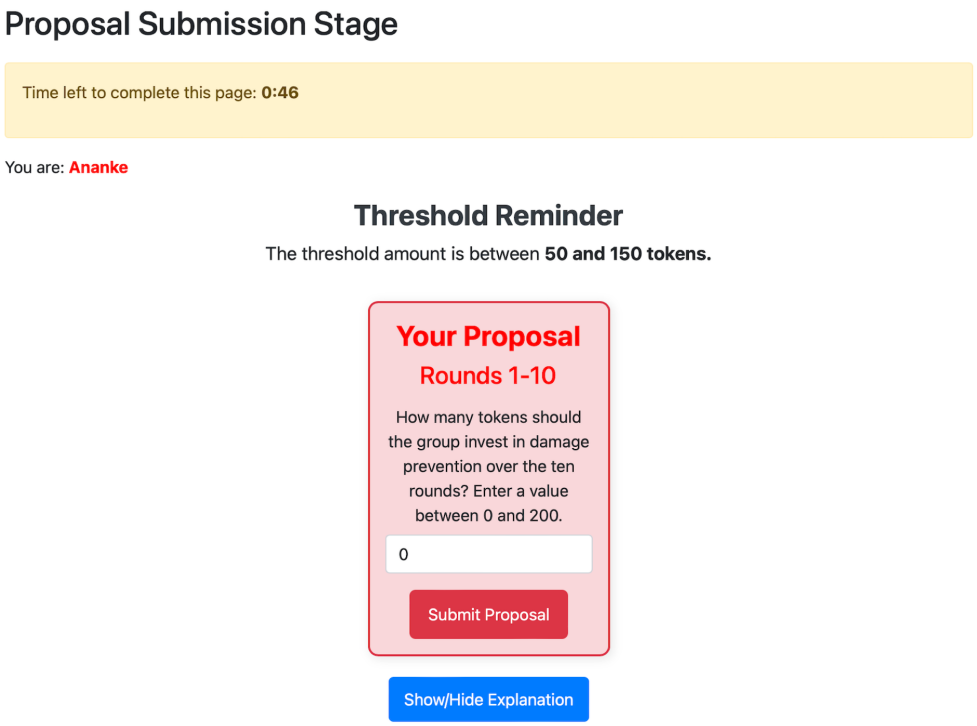


Figure S1. Screenshot of the contribution stage.

a



b

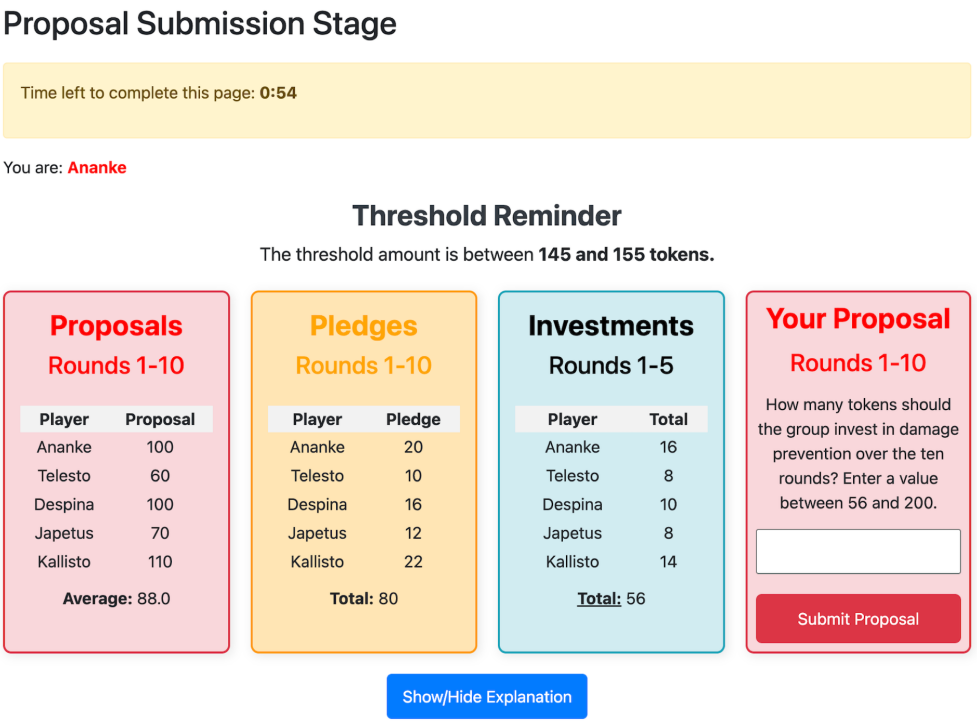


Figure S2. Screenshot of the proposal submission stage. **a,** Proposal submission page before round 1. **b,** Proposal submission page before round 6. Note that the threshold range in the threshold reminder in **b** is different from **a** because the screenshots are taken from treatment 145/155 where the threshold range changes at the mid-point of the game.

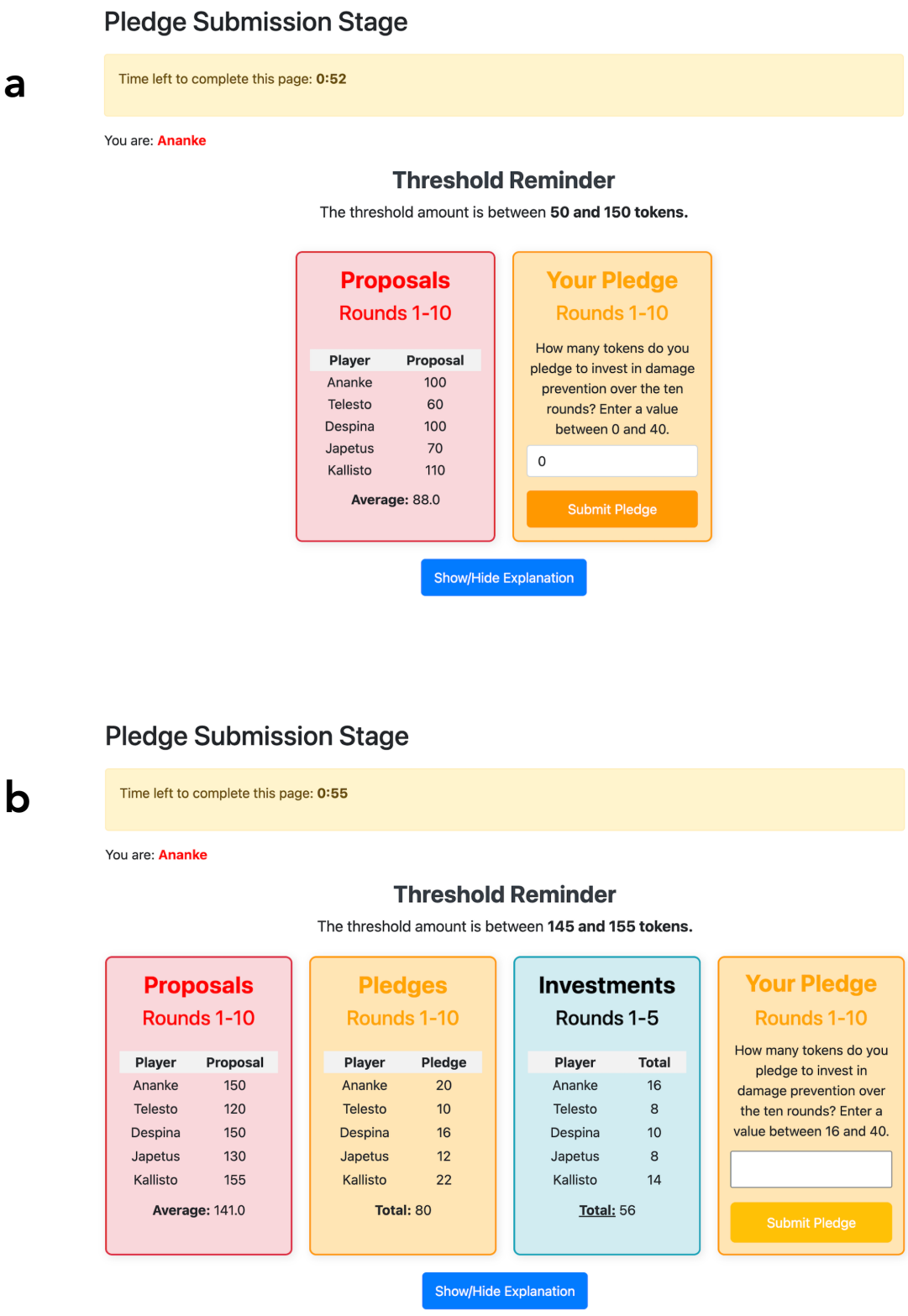
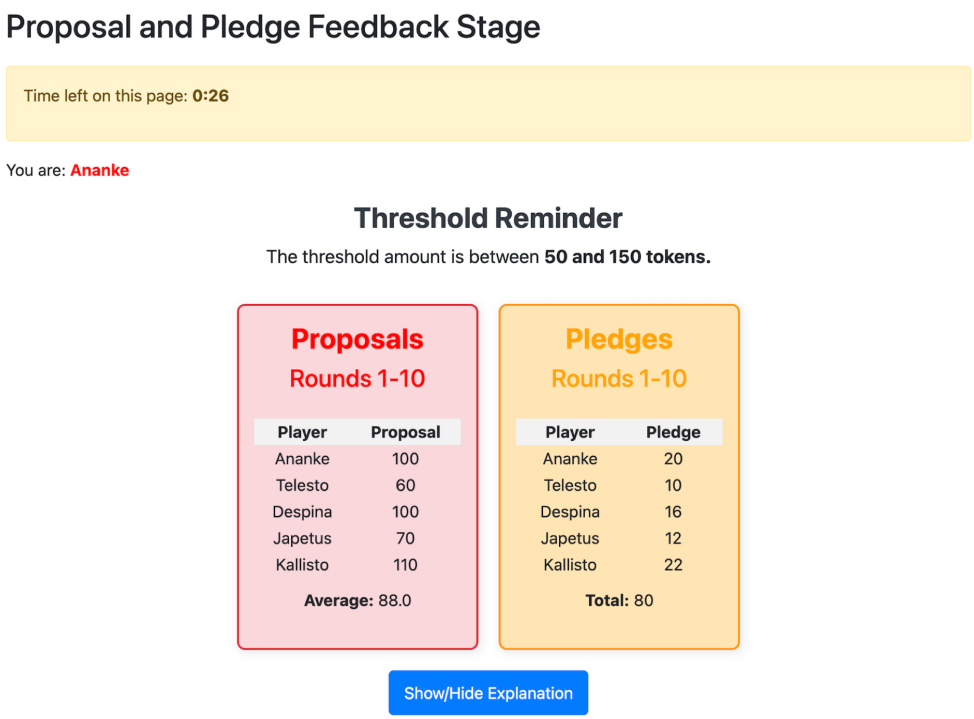


Figure S3. Screenshot of the pledge submission stage. a, Pledge submission page before round 1. **b,** Pledge submission page before round 6. Note that the threshold range in the threshold reminder in **b** is different from **a** because the screenshots are taken from treatment 145/155 where the threshold range changes at the mid-point of the game.

a



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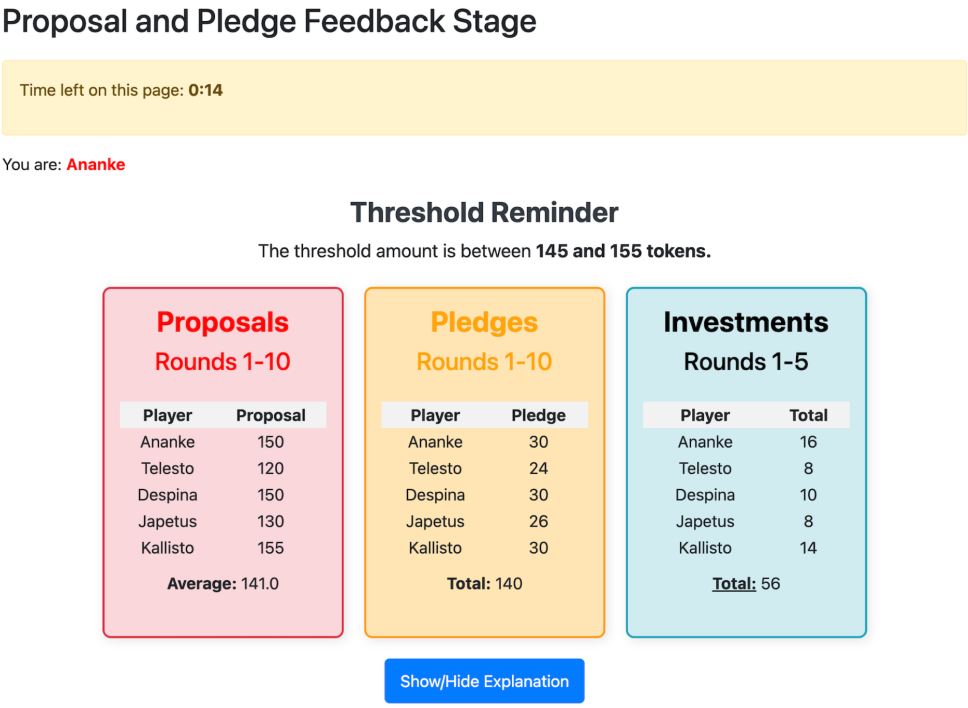

Figure S4. Screenshot of the proposal and pledge feedback stage. a, Feedback page before round 1. **b,** Feedback page before round 6. Note that the threshold range in the threshold reminder in **b** is different from **a** because the screenshots are taken from treatment 145/155 where the threshold range changes at the mid-point of the game.

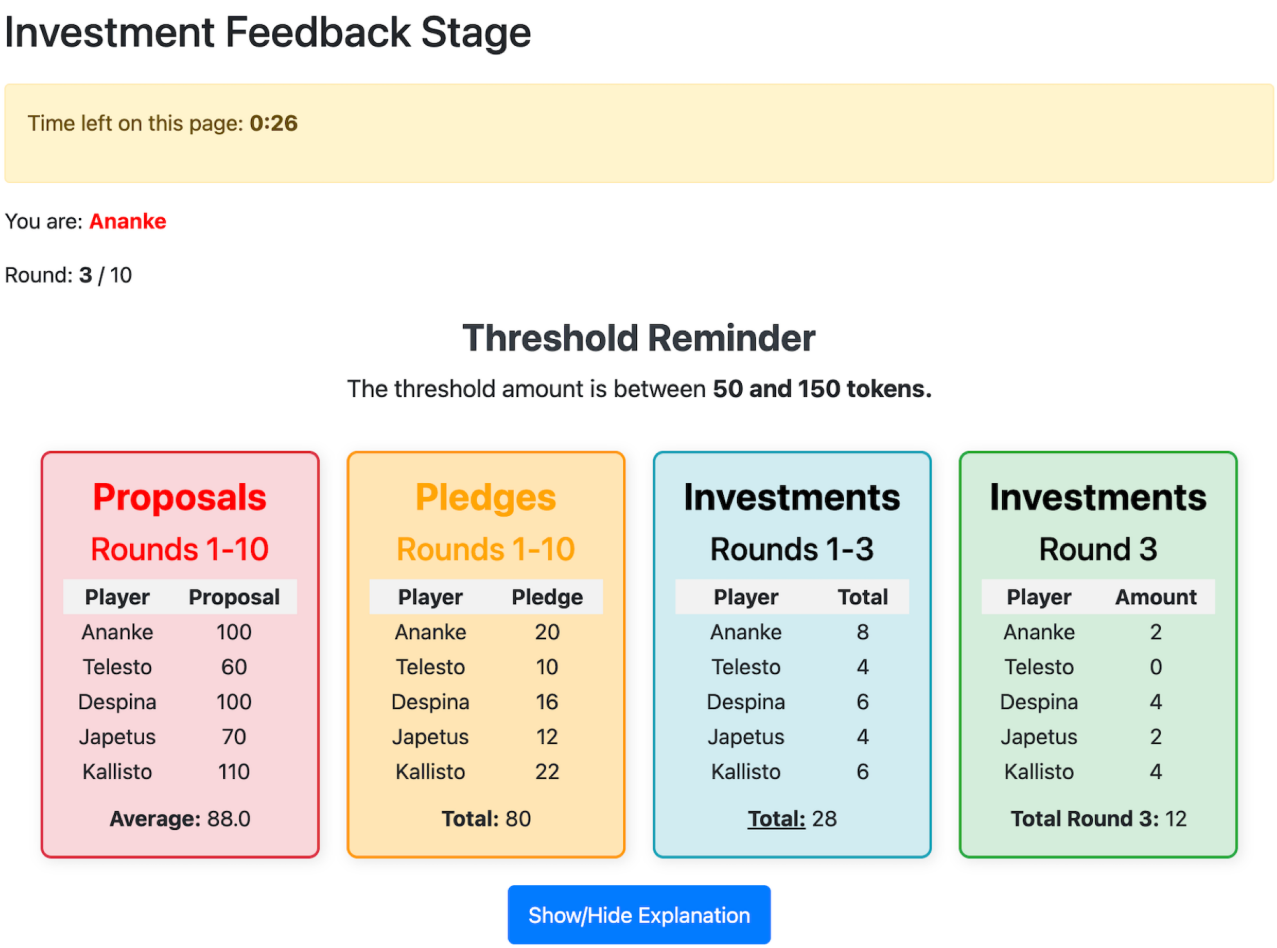

Figure S5. **Screenshot of the contribution feedback stage.**

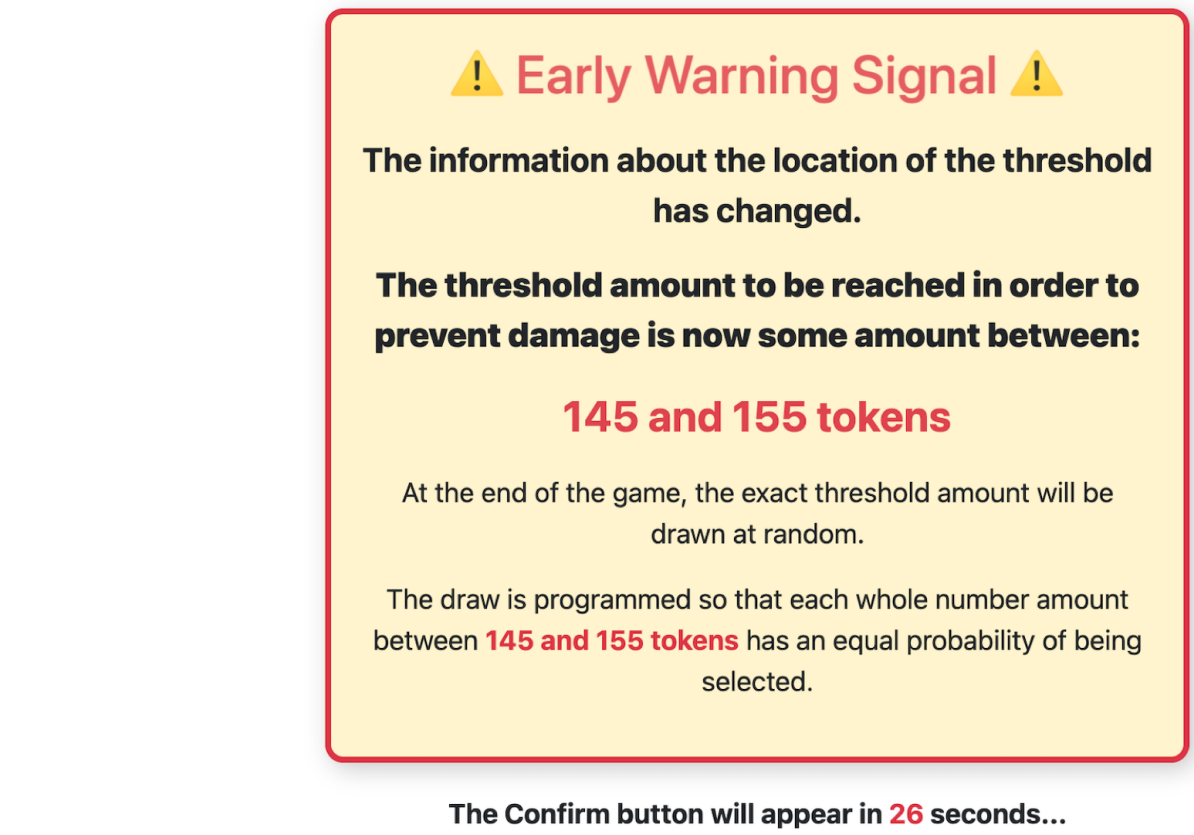

Figure S6. Screenshot of the early warning announcement stage.

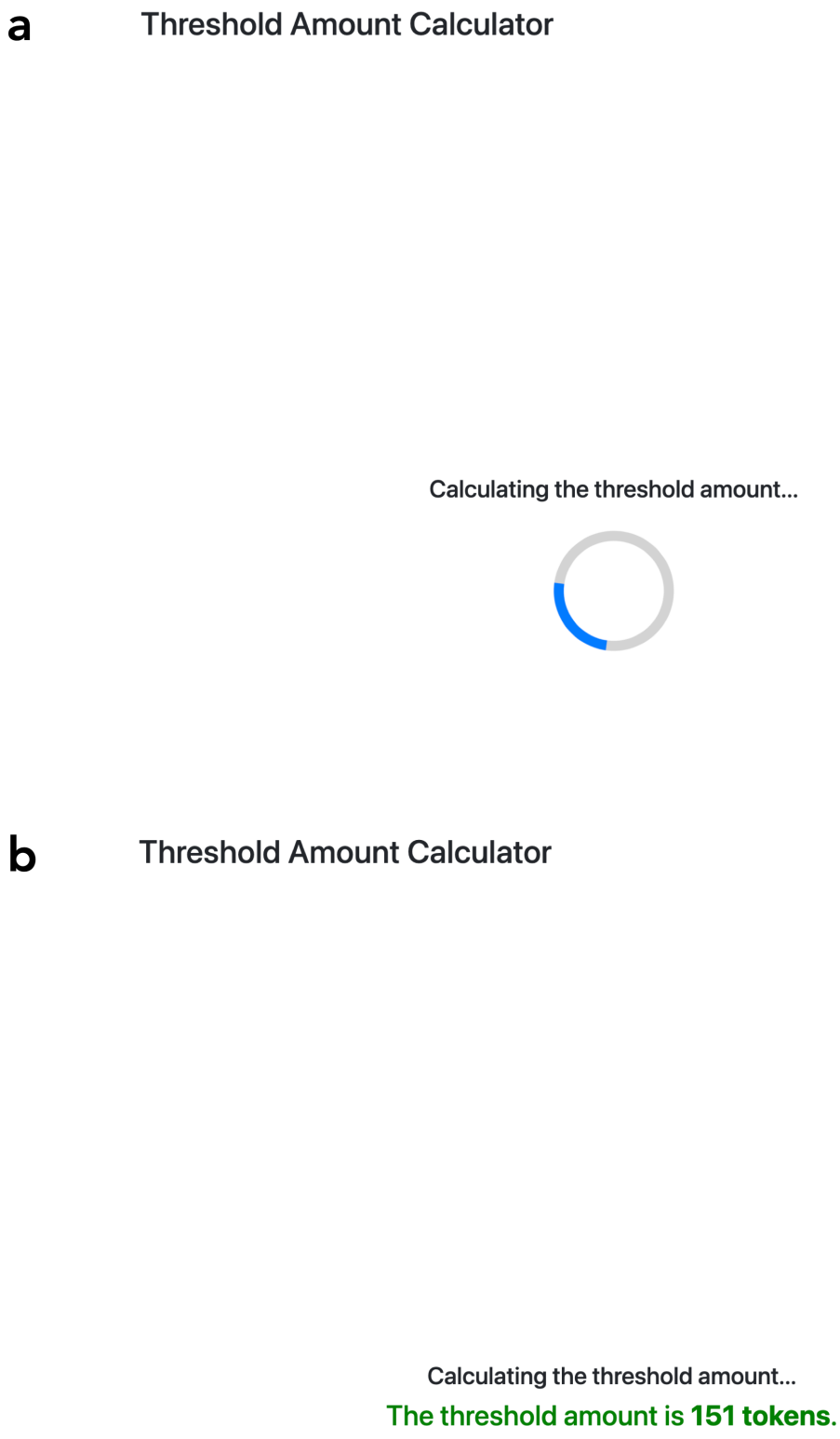

Figure S7. Screenshot of the threshold animation stage. a, Rotating circular animation, created by spinning a grey circle with a single blue segment to emulate the process of selecting the threshold. **b,** Revelation of the randomly determined threshold value once the animation completes.

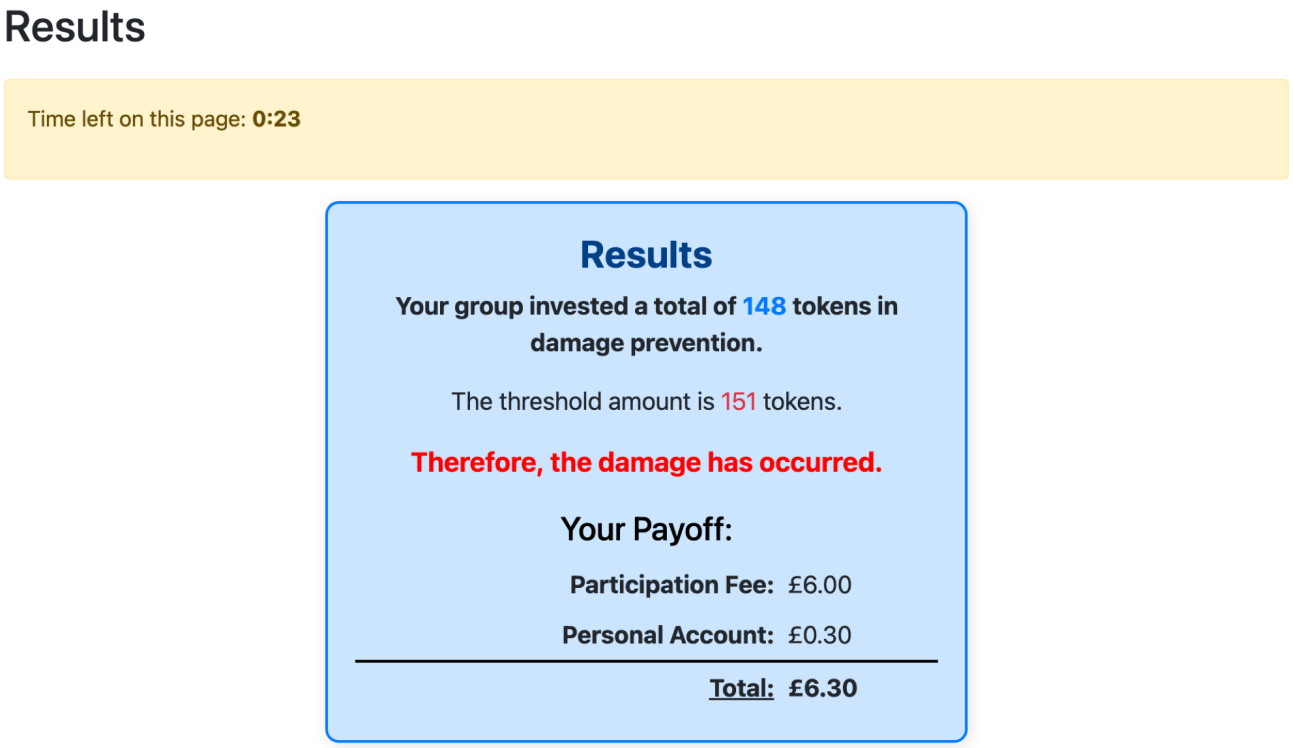

Figure S8. Screenshot of the payoff stage.

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1. Hurlstone, M. J., White, B. & Newell, B. R. Sensitivity of collective action to early warning signals of shifting climate tipping points (2025).
2. Chen, D. L., Schonger, M. & Wickens, C. oTree: An open-source platform for laboratory, online, and field experiments. *J. Behav. Exp. Finance* **9**, 88–97 (2016).
3. Hurlstone, M. J., White, B. & Newell, B. R. Threshold uncertainty, early warning signals and the prevention of dangerous climate change. *Royal Soc. Open Sci.* **12**, 240425 (2025).