Supplementary Material for:

The biosecurity collective-risk social dilemma: Simulating the prevention of a rapidly spreading pest

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Supplementary Figures

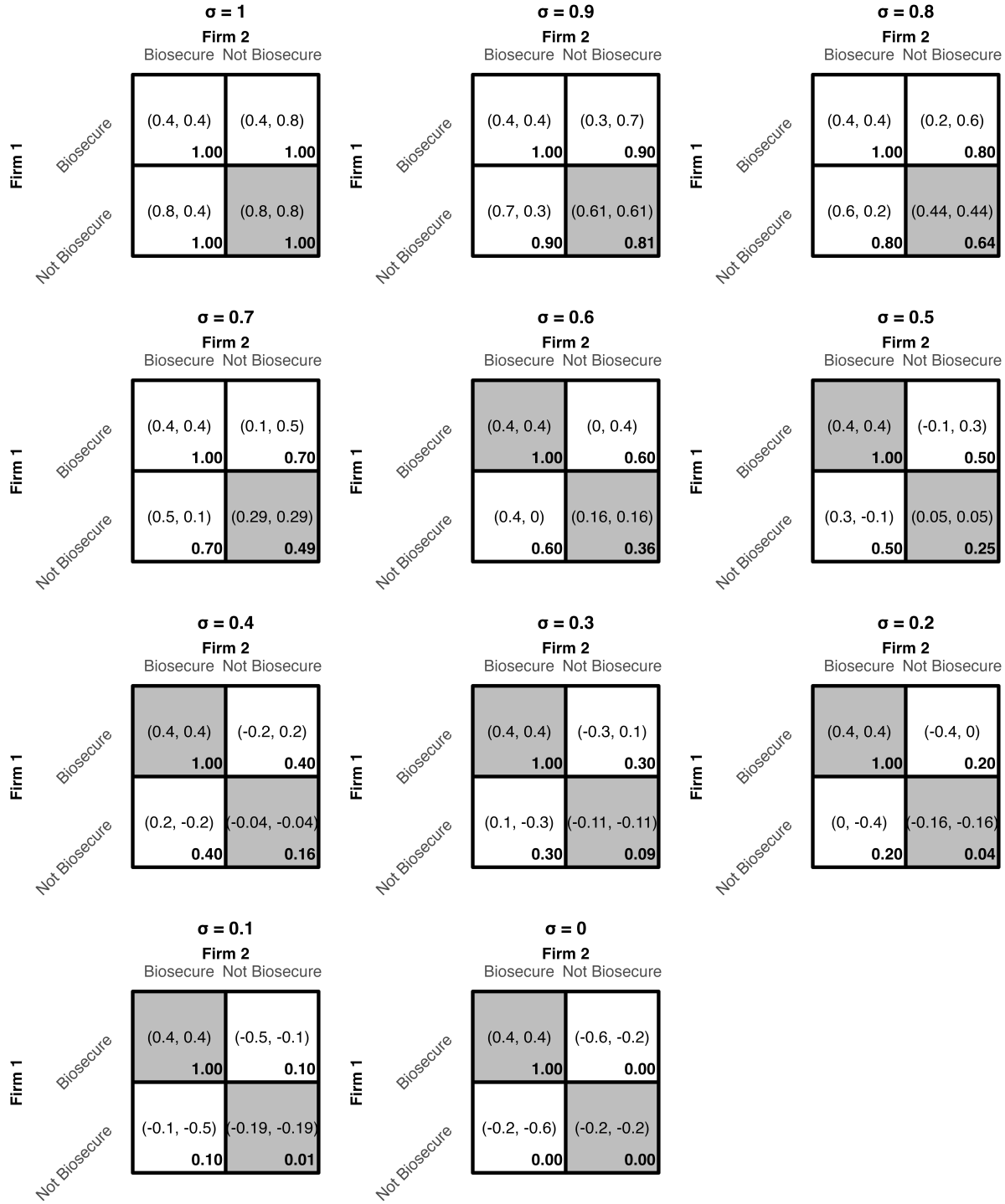

Figure S1

Expected payoffs and protection probabilities for different settings of the entry-threat parameter. Bold-face values represent protection probabilities, and shaded cells represent pure strategy Nash equilibria.

Supplementary Virtual Lottery Game

Prize structure for Play Panel 1 (Games 1–14).

Game	Ball 1–3	Ball 4–10	Choice	Ball 1	Balls 2–10	Choice
	Prize A			Prize B		
1	$40	$10	○	$68	$5	○
2	$40	$10	○	$75	$5	○
3	$40	$10	○	$83	$5	○
4	$40	$10	○	$93	$5	○
5	$40	$10	○	$106	$5	○
6	$40	$10	○	$125	$5	○
7	$40	$10	○	$150	$5	○
8	$40	$10	○	$185	$5	○
9	$40	$10	○	$220	$5	○
10	$40	$10	○	$300	$5	○
11	$40	$10	○	$400	$5	○
12	$40	$10	○	$600	$5	○
13	$40	$10	○	$1000	$5	○
14	$40	$10	○	$1700	$5	○

Prize structure for Play Panel 2 (Games 15–28).

Game	Ball 1–9	Ball 10	Choice	Balls 1–7	Balls 8–10	Choice
	Prize A			Prize B		
15	$40	$30	○	$54	$5	○
16	$40	$30	○	$56	$5	○
17	$40	$30	○	$58	$5	○
18	$40	$30	○	$60	$5	○
19	$40	$30	○	$62	$5	○
20	$40	$30	○	$65	$5	○
21	$40	$30	○	$68	$5	○
22	$40	$30	○	$72	$5	○
23	$40	$30	○	$77	$5	○
24	$40	$30	○	$83	$5	○
25	$40	$30	○	$90	$5	○
26	$40	$30	○	$100	$5	○
27	$40	$30	○	$110	$5	○
28	$40	$30	○	$130	$5	○

Prize structure for Play Panel 3 (Games 29–35).

Game	Balls 1–5	Balls 6–10	Choice	Balls 1–5	Balls 6–10	Choice
	Prize A			Prize B		
29	$25	-$4	○	$30	-$21	○
30	$4	-$4	○	$30	-$21	○
31	$1	-$4	○	$30	-$21	○
32	$1	-$4	○	$30	-$16	○
33	$1	-$8	○	$30	-$16	○
34	$1	-$8	○	$30	-$14	○
35	$1	-$8	○	$30	-$11	○

Supplementary Experimental Instructions

No-Communication Treatment

Welcome to the Experiment!

In this experiment, you can earn money. **For a successful experiment, you must not communicate with other participants or make yourself noticeable to them in any way**. Please read the following instructions carefully. Should you have any questions, please signal us. Thank you for your participation. We hope you enjoy the experiment, and wish you good luck!

After reading please click 

Today's session

Today's session is divided into three parts: (1) a virtual lottery game, (2) a biosecurity game, and (3) a questionnaire. We will begin with the virtual lottery game.

After reading please click  to proceed to the instructions for the virtual lottery game.

Part 1: Virtual Lottery Game

Instructions

Imagine you are taking part in a virtual lottery game where you have a choice between playing for the money amounts in Prize A or Prize B.

The PLAY PANELS contain the odds of each Prize, for each game. Please close the instructions momentarily by clicking on the blue instructions icon to the right of the screen and you will be able to see the first of three PLAY PANELS. Once you have inspected the PLAY PANEL, click on the instructions icon again to return back to these instructions.

In each PLAY PANEL, the default choice is Prize A for each game. If you find the odds in Prize B more appealing at any given game, you can switch to Prize B. However, once you've switched to Prize B, you cannot go back to Prize A for the rest of the PLAY PANEL.

How the game works

Thirty-five balls (numbered 1-35) will be put into a virtual bingo cage and one ball will be randomly picked. This numbered ball will correspond to the GAME NUMBER in one of your PLAY PANELS and determines which out of the 35 games will be played.

All balls are then removed from the bingo cage and ten balls (numbered 1-10) are put back in. The next ball that is picked determines how much money you win (or lose).

For example, if GAME NUMBER 7 was randomly selected out of the 35 games, and you chose Prize A for that game, you will win:

- $40 if the ball number is between 1 and 3, or
- $10 if the ball number is between 4 and 10.

If you chose Prize B, you will win:

- $150 if the ball number is 1, or
- $5 if the ball number is between 2 and 10.

When instructed to do so, please click  to proceed

Part 2: Biosecurity Game

Overview of the game

Please read through these instructions carefully. If you have any questions please raise your hand and one of the administrators will come to you.

You are about to take part in an experiment about collective decision-making related to risky choices. This experiment gives you an opportunity to earn money. How much you earn depends partly on your decisions, partly on the decisions of others, and partly on chance.

In this experiment, you own an apple orchard and you have three neighbours who also grow apples. Each season, your orchard will generate revenue. You will receive this revenue in the seasons where there is ***no outbreak of pests***. When an ***outbreak*** of pests occurs, the pests spread quickly and infect all neighbouring orchards, resulting in the loss of that season's apples. You will generate no revenue in a season where an ***outbreak*** of pests occurs.

You must decide whether to ***protect*** or ***not protect*** against an ***outbreak*** of pests (at the start of) each season. There is a cost associated with choosing to ***protect***. You do not have to pay this cost if you choose to ***not protect***.

The probability of an ***outbreak*** of pests occurring is quite variable and partially dependent on whether your neighbours protect their orchards. Sometimes, if everyone chooses to ***not protect*** there will be ***no outbreak*** of pests. On other occasions, the majority may choose to ***protect***, and an ***outbreak*** of pests will still occur.

After reading please click 

Your anonymity

All decisions you make in the game are anonymous. To ensure this, a pseudonym is assigned to you by the computer, visible at the bottom left of the screen. These pseudonyms correspond to names of moons in our solar system (Leda, Triton, Portia, or Sinope).

Game structure

The game is divided into two blocks of 15 rounds (30 rounds in total), where each round corresponds to a season. Each round is divided into two stages: a contribution stage and a feedback stage.

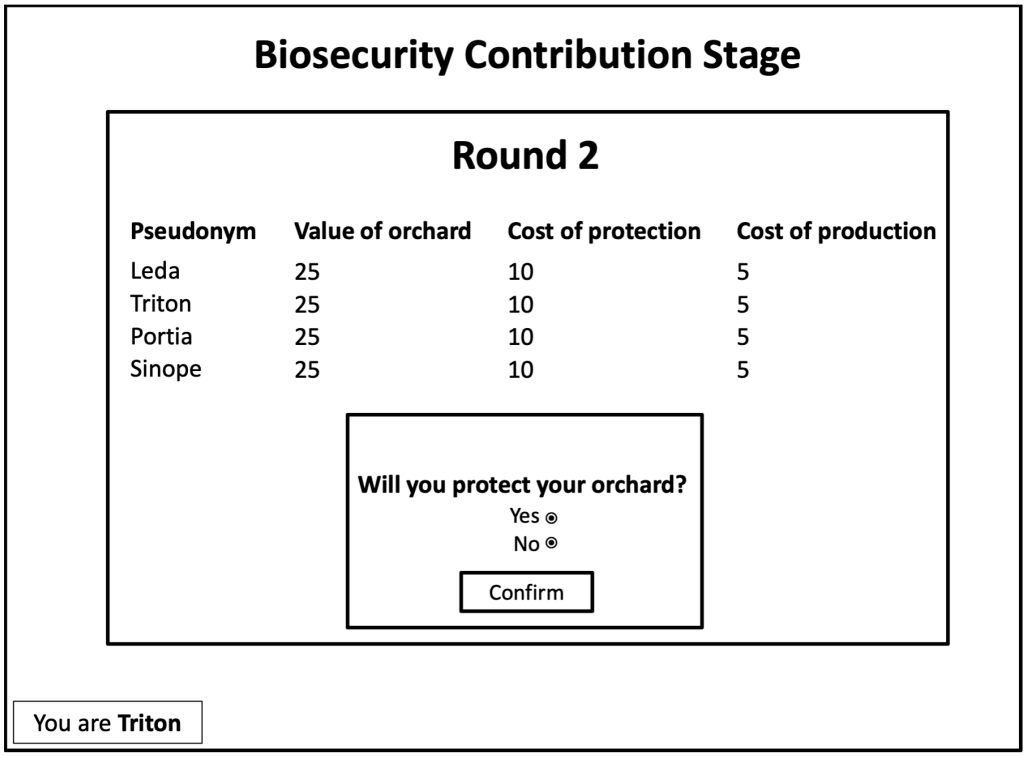

Figure 1. Illustration of the contribution stage of the biosecurity game.

A screenshot of the contribution stage is provided in Figure 1. In this stage, you will be presented with three sources of information about each player for the current playing round: the value of their orchard, their cost of protecting it, and their cost of production.

After reading please click 

The value of each player's orchard represents the amount of revenue it will generate if there is no outbreak of pests. The cost of protection represents each player's cost of protecting their orchard from an outbreak of pests. The cost of production represents each player's cost of producing his or her apples. For simplicity, in today's game, the value of each player's orchard ($25), their cost of protection ($10), and their cost of production ($5) are identical and do not vary across rounds.

In the contribution stage, you must decide whether you will protect your orchard from an outbreak of pests or not. If you select "Yes" then you will be required to pay the cost of protection of $10, whereas if you select "No" then you will not be required to pay this cost.

Note that whilst you can choose on each round whether or not to protect your orchard, you will always be required to pay the $5 cost of production. This will be automatically deducted from any revenue you earn on each round.

Your revenue on each round is determined as follows:

- If you choose to ***protect*** and there is ***no outbreak***, the income you receive is **$10** (value of orchard - cost of protection - cost of production = 25 – 10 – 5 = 10).
- If you choose to ***not protect*** and there is ***no outbreak***, the income you receive is **$20** (value of orchard - cost of production = 25 – 5 = 20).
- If you choose to ***protect*** and there is an ***outbreak***, the loss you receive is **-$15** (0 - cost of protection - cost of production = 0 – 10 – 5 = -15).
- If you choose to ***not protect*** and there is an ***outbreak***, the income you receive is **-$5** (0 – cost of production = 0 – 5 = -5).

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After all players have simultaneously made their decision whether or not to protect their orchards in the contribution stage, the computer will proceed to the feedback stage. A screen shot of this stage is provided in Figure 2.

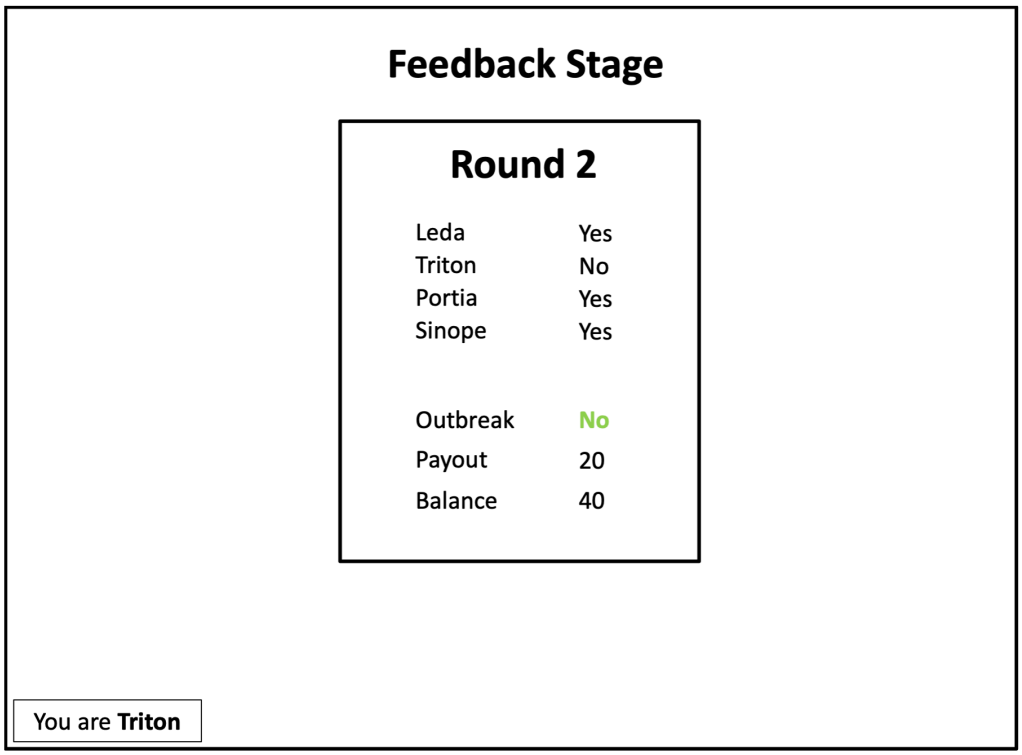

Figure 2. Illustration of the feedback stage of the biosecurity game.

In the feedback stage, you will receive information about the decisions made by each player in the contribution stage. In the example shown in Figure 2, it can be seen that on Round 2 three players decided to incur the cost of protecting their orchards (Leda, Portia, and Sinope) and one player decided not to incur that cost (Triton). You will also receive information about whether an outbreak of pests occurred, your payout for the round, and the balance of your account so far. In the example, an outbreak did not occur and the player (Triton) earned revenue of $20, taking the balance of her account to $40, meaning that she must also have earned revenue of $20 on Round 1.

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Probability of an outbreak of pests

As noted earlier, you will complete two blocks of 15 rounds of the biosecurity game. In one block, the probability of an outbreak of pests will be low (low-risk condition), whereas in the other block the probability of an outbreak of pests will be high (high-risk condition).

Low-risk condition. The table below gives the probability of an outbreak on each round in the low-risk condition, as a function of the number of players choosing to protect, or not protect, their orchards.

Number of players choosing to:		Probability of an ***Outbreak %***
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Number of players choosing to:		Probability of an ***Outbreak %***
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0	4	59%
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Your payout

At the end of the experiment, you will be paid any revenue generated during the biosecurity game, subject to a conversion rate. The conversion rate is your revenue earned $\times$ 0.1. For example, if your revenue earned was \$300 then you would be paid 300 $\times$ 0.1 = \$30.

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Player Strategies

You can choose to play using a number of different strategies.

For example, one strategy would be for each player to choose to protect on every round in both the low- and high-risk blocks. Using this strategy, each player would earn a **total of $30:** $15 in the low-risk block and $15 in the high-risk block.

Another strategy would be for all players to choose to not protect on each round. Using this strategy, each player's earnings would depend upon the number of pest outbreaks that occurred. However, on average, using this strategy each player would earn **less than** if each player chose to protect.

Of course, there are many other strategies you could use aside from these two examples.

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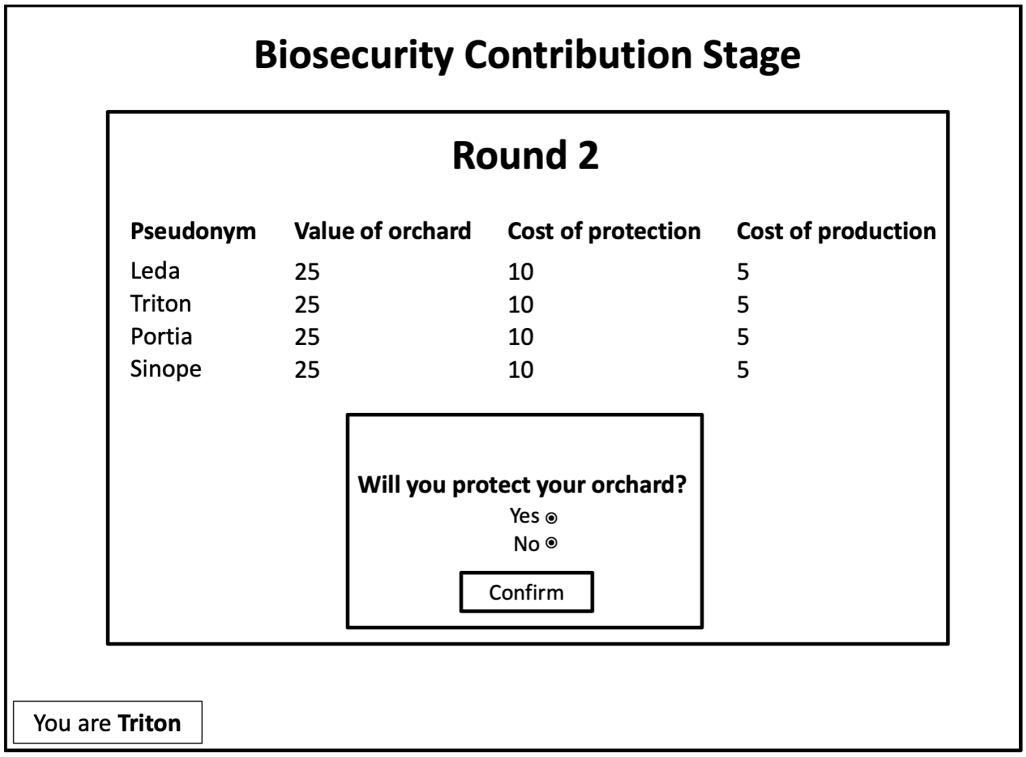

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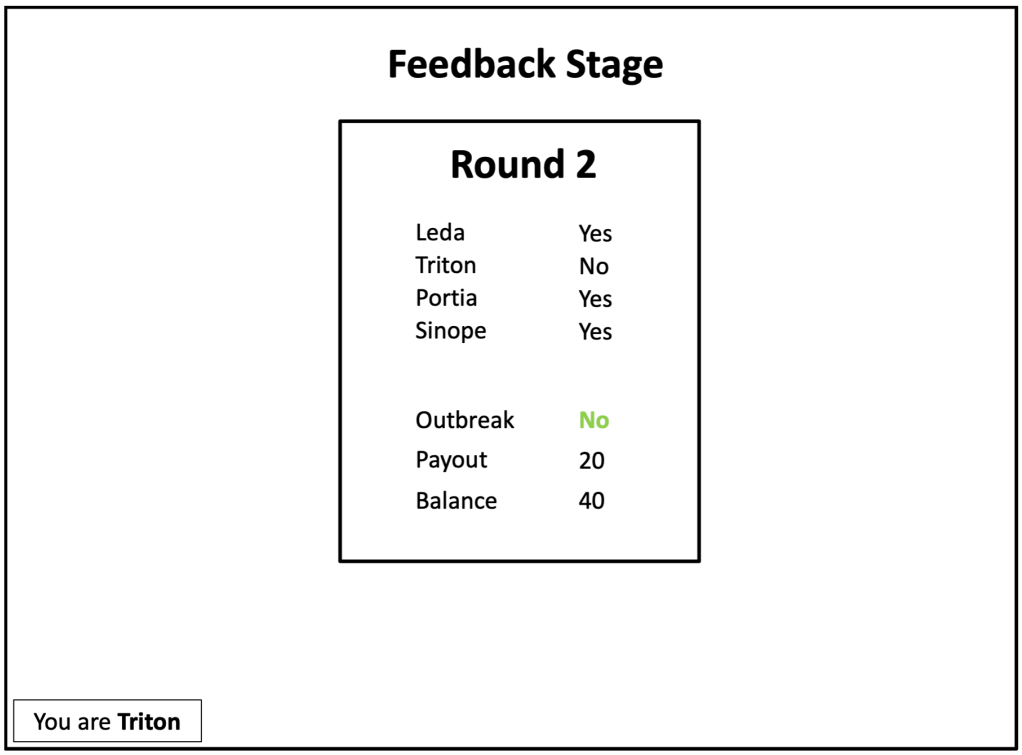

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After reading please click →

Communication Stage

At the beginning of **rounds 1, 6,** and **11** in the low- and high-risk blocks, you will be able to communicate with your co-players via a "chat room" before you enter the biosecurity contribution stage. A screenshot of this chat room is provided in Figure 3.

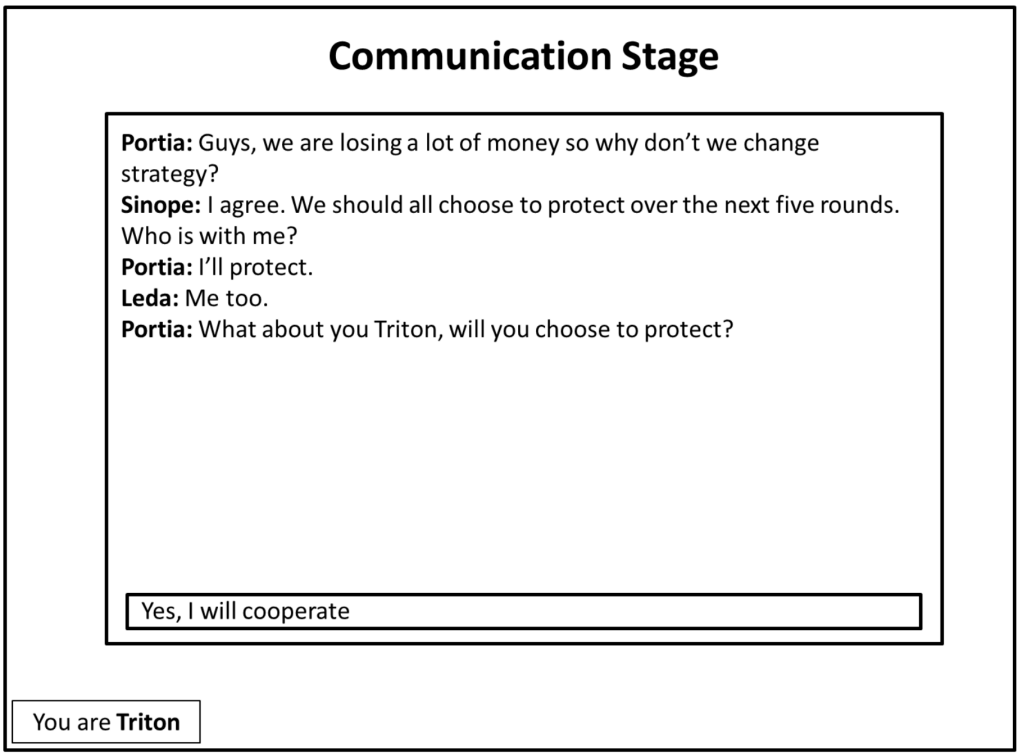

Figure 3. Illustration of the communication stage of the biosecurity game.

The chat room contains a text entry field at the bottom (in the example in Figure 3, this is the field in which the player Triton has typed—but not yet submitted—the message "Yes, I will cooperate"). You can type a message in this field and when you press the enter key on the keyboard it will be displayed in the public window under your assigned pseudonym for the other players to see. In the chat room, you can discuss anything, but please abide by the following rules:

- Refrain from using obscene language and do not threaten other players
- Do not offer side payments. An example of a side payment would be if Portia said:

"Triton, if you choose to protect over the next five rounds, I'll give you $5 of my experimental earnings"

- Keep your real identity private at all times

After reading please click 

Remember that you will only be able to communicate with your co-players through the chat room at the beginning of **rounds 1, 6,** and **11**. On each of these rounds, you will have **exactly 2 minutes** to communicate with one another in the chat room.

After reading please click 

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Supplementary Control Questions

Player Pseudonym: _____ **Condition:** _____ **Group #:** _____

Control Questions

For a successful experiment, it is imperative that each player understands the rules of play. Please answer the following questions so that we can ensure that you have understood the instructions. Please answer all questions, and signal us when you have finished. We will then come to you and check your answers.

1. How many players must protect their orchards in order to prevent an outbreak of pests with certainty (please tick the correct box)?

   ☐ 1 player

   ☐ 2 players

   ☐ 3 players

   ☐ 4 players

2. Assume that you are in the high risk condition. If two players decide to protect and another two players decide not to protect, then what is the probability of an outbreak (please tick the correct box)?

   ☐ 0%

   ☐ 20%

   ☐ 36%

   ☐ 59%

3. Assume that you are in the low risk condition. If one player decides to protect and three players decide not to protect, then what is the probability of an outbreak (please tick the correct box)?

☐ 0%

☐ 19%

☐ 27%

☐ 34%

4. Assume that you decided to protect your orchard and there was an outbreak of pests. What would your revenue be (please tick the correct box)?

☐ -$15

☐ -$5

☐ $10

☐ $20

5. Assume that you decided not to protect your orchard and there was no outbreak of pests. What would your revenue be (please tick the correct box)?

☐ -$15

☐ -$5

☐ $10

☐ $20

When you have finished answering the questions, please signal us so that we can come to you and check your answers.