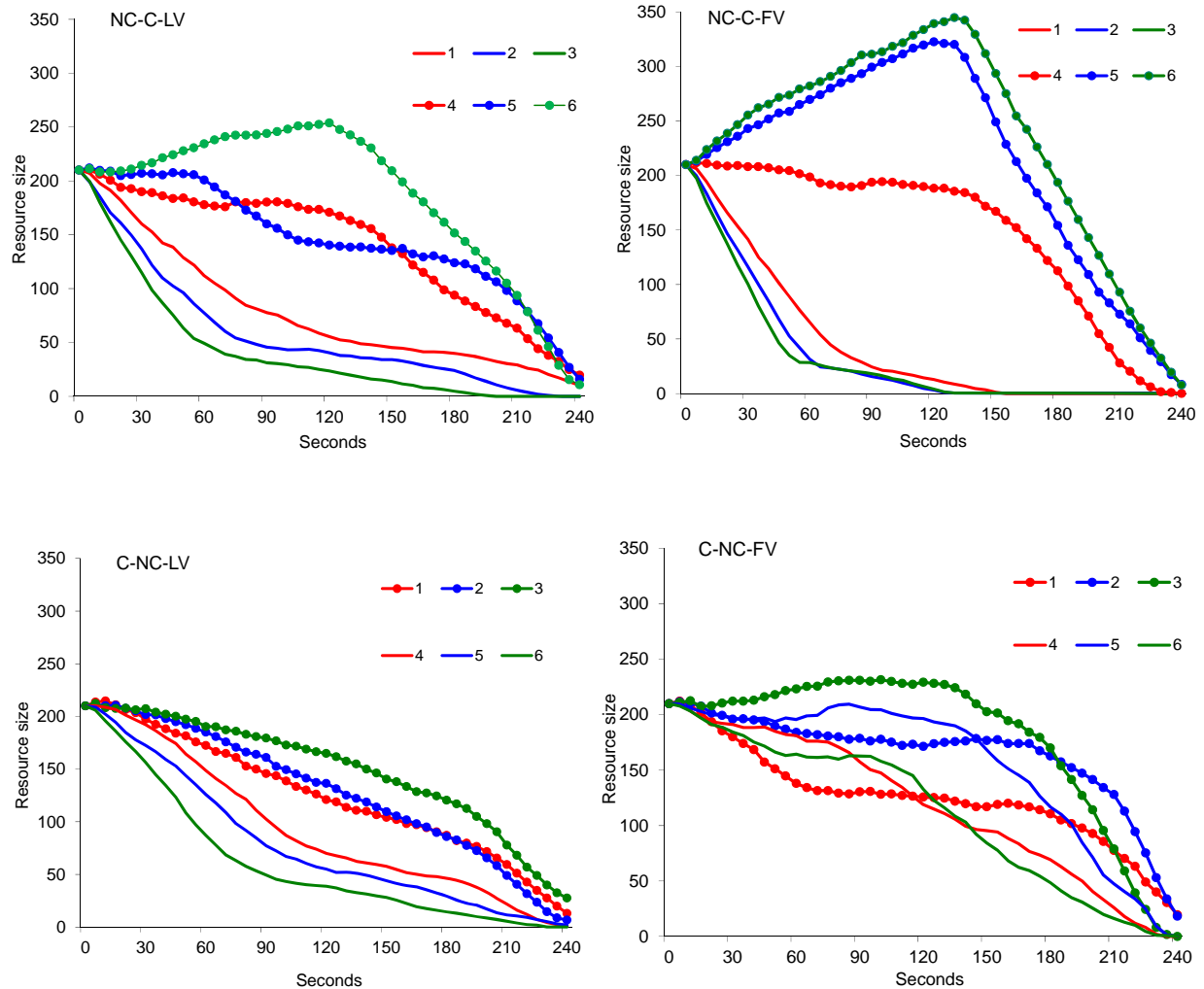
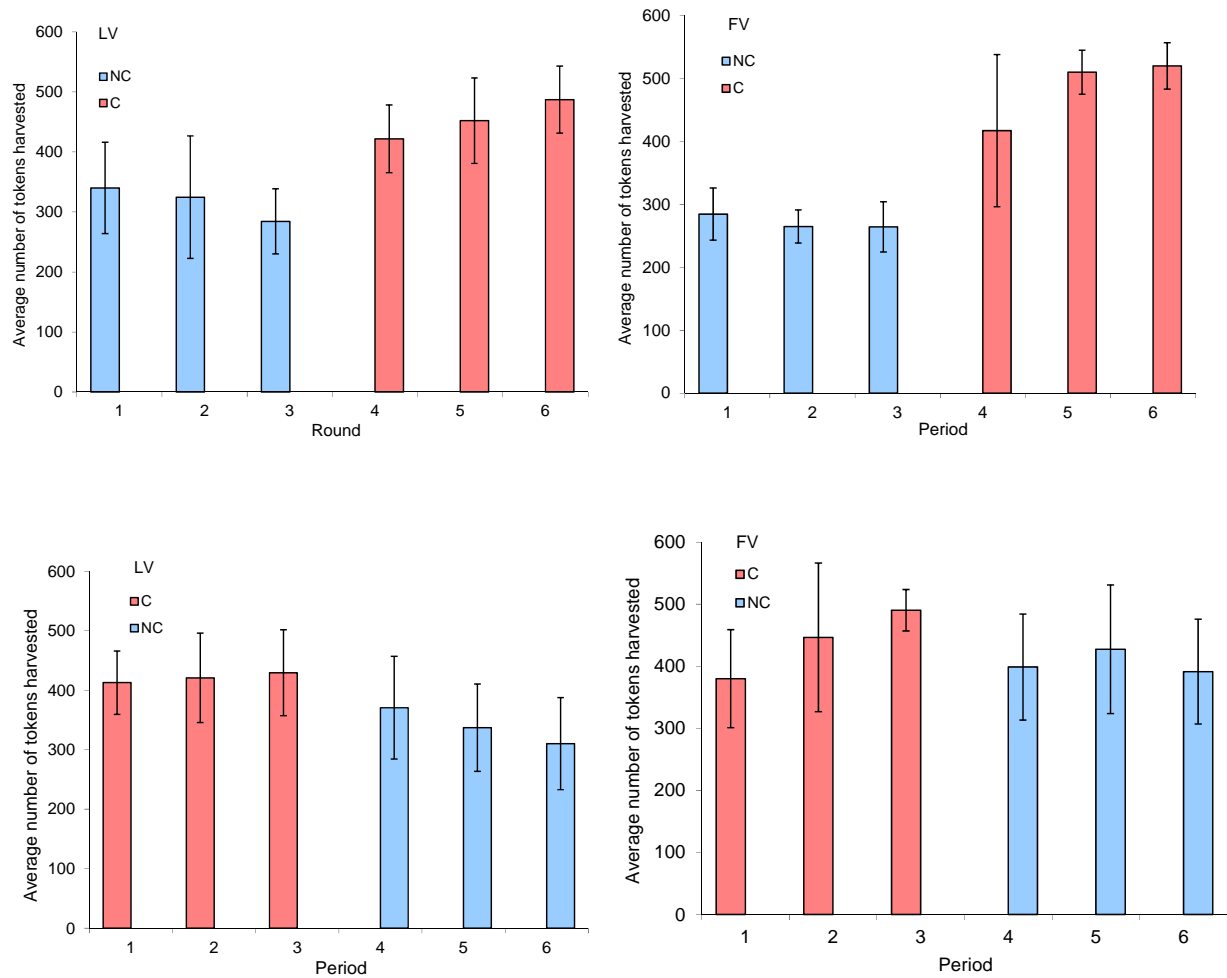


Appendix to “The effect of constrained communication and limited information in governing a common resource”

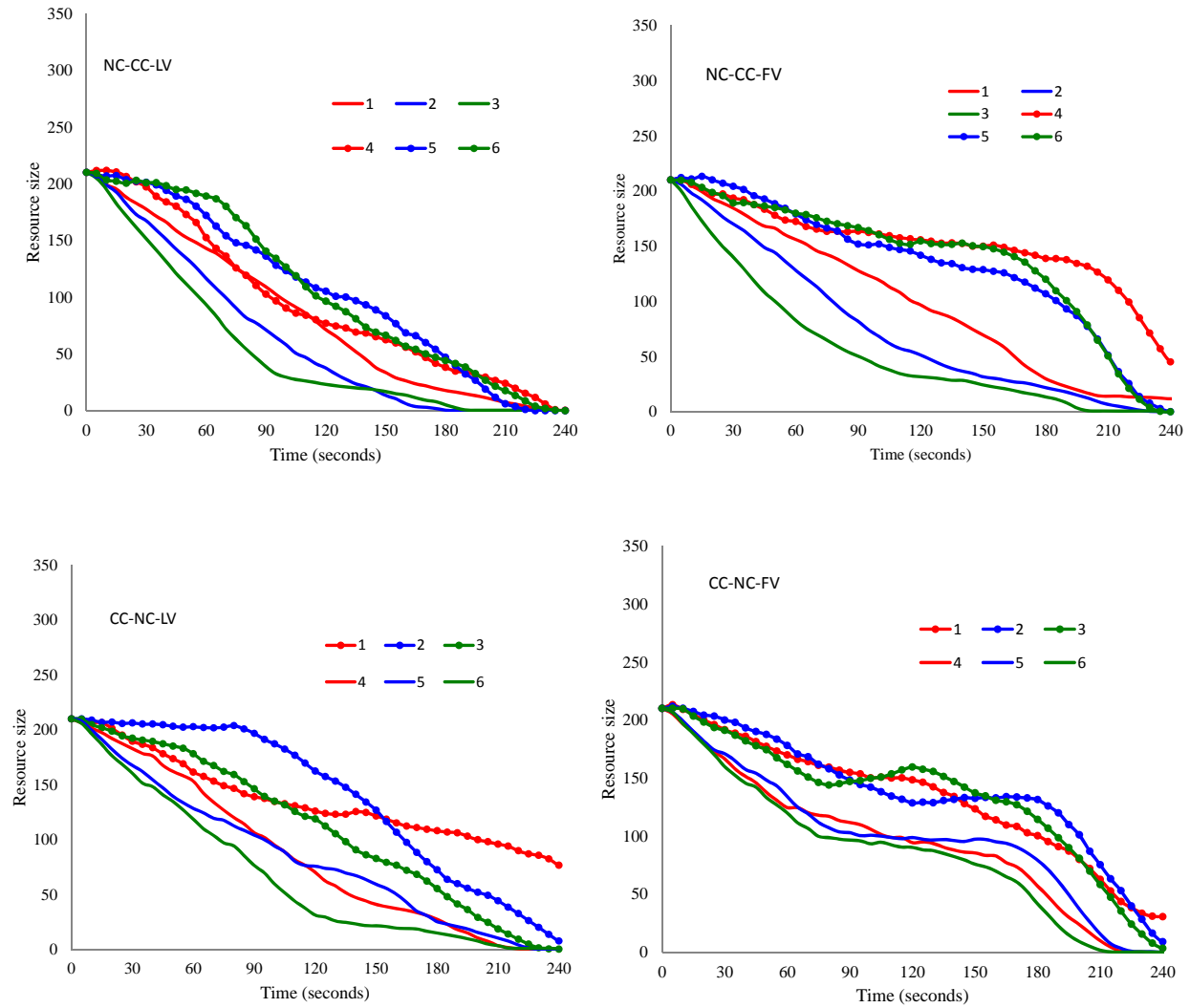
In this appendix you find some additional figures on the results of the experiments. You also find the protocol as used in the experiments.



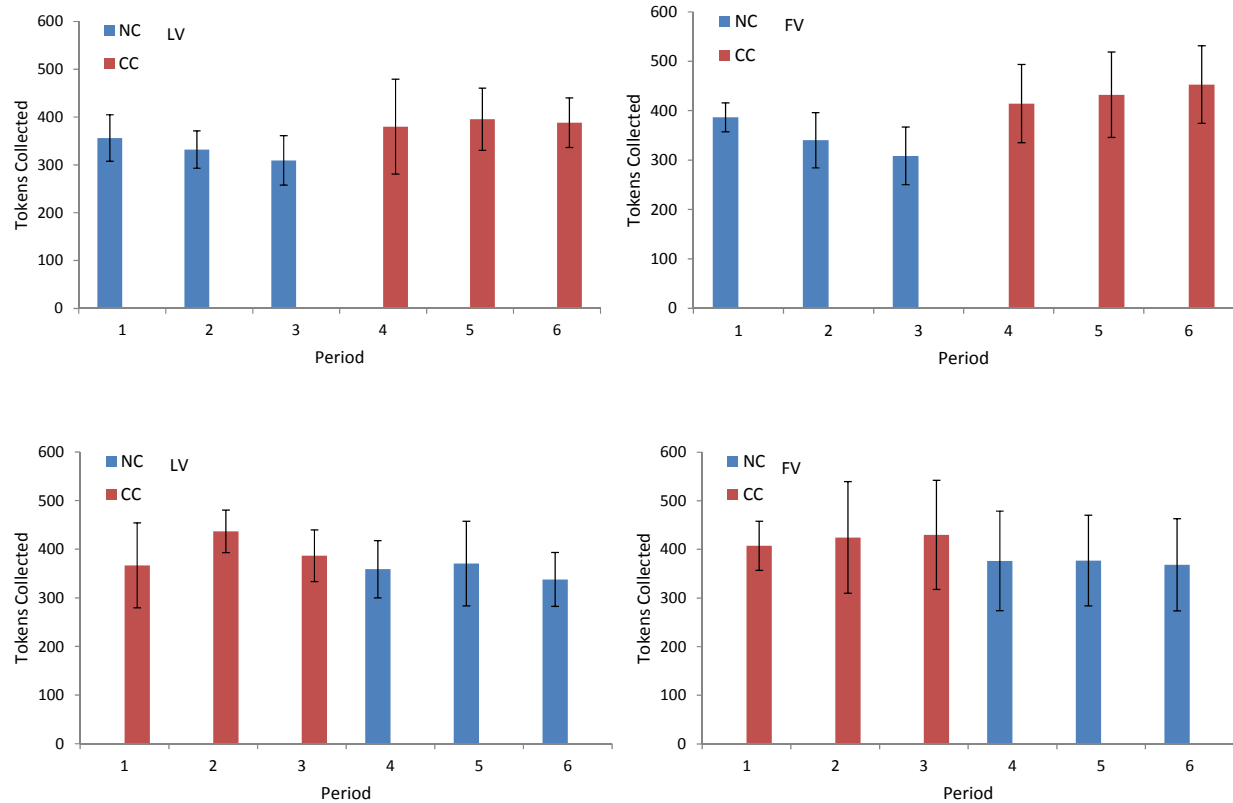
**Figure 1:** Resource availability at given times. The diagrams show the average remaining level of the resource for the groups of each treatment. Each diagram shows a treatment condition, and each line represents a particular period. The treatment is a combination of two sets of three periods of a specific condition. The names for these conditions are noted in the upper left of each display: NC for no communication, C for communication, LV for limited view and FV for full view. A treatment A-B refers to condition A for the first three periods and B for the last three periods. The colors and shapes referring to data of each period are noted in the upper right.



**Figure 2:** Average number of tokens collected by groups per period. Each diagram shows a treatment condition. The treatment is a combination of two sets of three periods of a specific condition. The names for these conditions are noted in the upper left of each display: NC for no communication, C for communication, LV for limited view and FV for full view. The standard deviation of the groups is depicted as error bars.



**Figure 3:** Resource availability at given times. The diagrams show the average remaining level of the resource for the groups of each treatment. Each diagram shows a treatment condition, and each line represents a particular period. The treatment is a combination of two sets of three periods of a specific condition. The names for these conditions are noted in the upper left of each display: NC for no communication, C for communication, LV for limited view and FV for full view. A treatment A-B refers to condition A for the first three periods and B for the last three periods. The colors and shapes referring to data of each period are noted in the upper right.



**Figure 4:** Average number of tokens collected by groups per period. Each diagram shows a treatment condition. The treatment is a combination of two sets of three periods of a specific condition. The names for these conditions are noted in the upper left of each display: NC for no communication, C for communication, LV for limited view and FV for full view. The standard deviation of the groups is depicted as error bars.

Table 1: Summary statistics for the number of tokens collected for period 1-3 and periods 4-6 for all treatments. Five statistics are provided: mean, median, standard deviation, minimum and maximum of the number of tokens collected.

| Name     | Period 1-3                                    | Periods 4–6                                   |
|----------|---|---|
|          | Mean, median, standard deviation, min,<br>max | Mean, median, standard deviation, min,<br>max |
| NC-C-LV  | 948.9; 847; 227.2; 740; 1274                  | 1361; 1323; 130.3; 1222; 1534                 |
| C-NC-LV  | 1262.9; 1280; 1614; 1018; 1482                | 1017.9; 888; 229.3; 822; 1371                 |
| NC-C-FV  | 813.6; 778; 106.6; 739; 1002                  | 1447.2; 1509; 142.6; 1246; 1580               |
| C-NC-FV  | 1269.6; 1395; 225.1; 979; 1493                | 1162.4; 1286; 265.4; 817; 1405                |
| NC-CC-LV | 997.8; 967; 116.6; 902; 1191                  | 1163.8; 1109; 170.5; 985; 1424                |
| CC-NC-LV | 1190; 1207; 84.5; 1056; 1280                  | 1067; 1090; 188.4; 809; 1331                  |
| NC-CC-FV | 1035.9; 979; 132.4; 873; 1265                 | 1299.6; 1354; 227.8; 964; 1571                |
| CC-NC-FV | 1262.2; 1322; 266.8; 912; 1585                | 1136.2; 1244; 298.6; 803; 1493                |

## Experimental protocol

Here you find the information participants receive during the experiments. It includes of text on the screen of the experiments, as well as some screen shots of the software. ). The software used for this experiment is open-source and available at <http://commons.asu.edu>.

## Welcome Screen Instructions



Welcome to the experiment. The experiment will begin shortly after everyone has been assigned a station.

Please **wait quietly and do not close this window or open any other applications.**



## General Instructions

Welcome. You have already earned 5 dollars by showing up at this experiment. You can earn more, up to a maximum of 40 dollars, by participating in this experiment, which will take about an hour to an hour and a half. The amount of money you earn depends on your decisions as well as the decisions of other people in this room during the six rounds of the experiment.

You appear on the screen as a yellow dot . You move by pressing the four arrow keys on your keyboard. You can move up, down, left, or right. You have to press a key for each and every move of your yellow dot. In this experiment you can collect green diamond shaped tokens  and earn two cents for each collected token. To collect a token, move your yellow dot over a green token and press the **space bar**. If you move over a token without pressing the **space bar** you do NOT collect that token.

The tokens that you collect have the potential to regenerate. After you have collected a green token, a new token can re-appear on that empty cell. However, the rate at which new tokens will appear depends on the number of adjacent cells with tokens. The more tokens in the eight cells around an empty cell, the faster a new token will appear on that empty cell. In other words, **existing tokens can generate new tokens**. To illustrate this, please refer to Image 1 and Image 2. The middle cell in Image 1 denoted with an X has a greater chance of regeneration than the middle cell in Image 2. When all neighboring cells are empty, there is **no chance for regeneration**.

Image 1

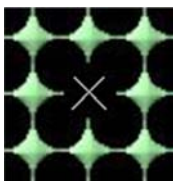
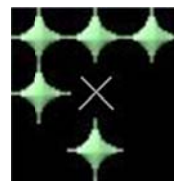


Image 2



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Your vision is limited in this experiment. The area that is not visible to you will be dark.

### **Practice Round Instructions**

You will now have four minutes to practice with the experimental environment. The decisions you make in this round will NOT influence your earnings. At the beginning of the practice round 25% of the cells are occupied with green tokens. The environment is a 13 x 13 grid of cells.

During this practice round, and **only during** this practice round, you are able to reset the tokens displayed on the screen by pressing the **R** key. When you press the **R** key you will reset the resource to its initial distribution, randomly filling half of the cells.

Please do not communicate with any other participant.

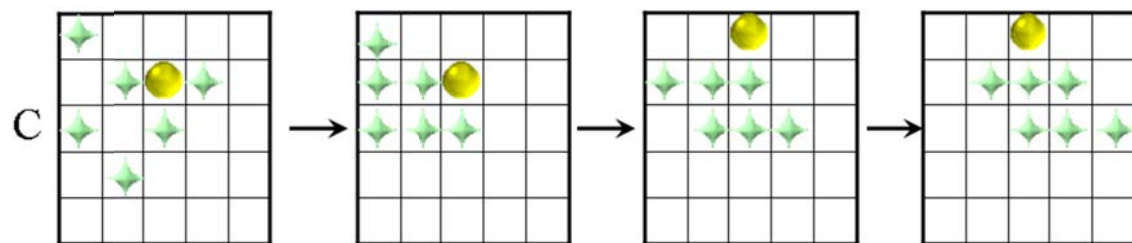
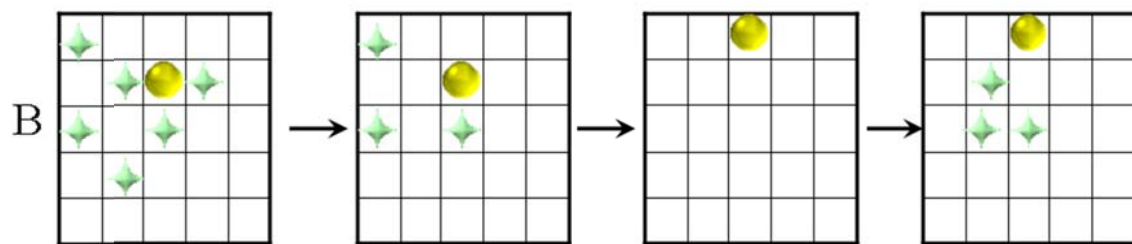
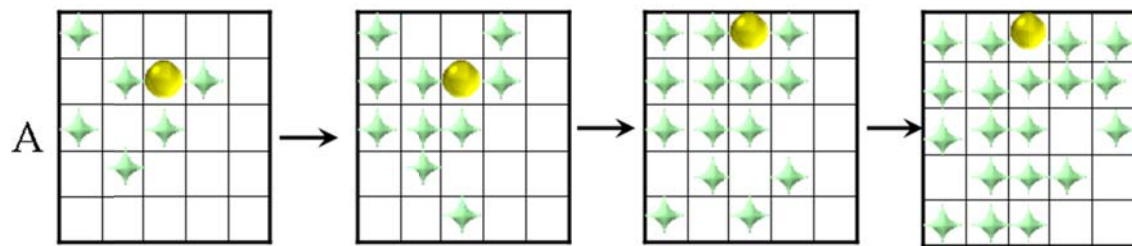
**If you have any questions please raise your hand. Do you have any questions so far?**

Before we begin the practice round you need to answer the following questions correctly. You can only continue when you have answered all questions correctly. If an error is made you will need to answer the questions again.

Which of the statements is **incorrect?**

- A. Your decisions of where to collect tokens affects the regeneration of tokens.
- B. When you have collected all tokens on the screen, no new tokens will appear.
- C. Tokens grow from the middle of the screen.
- D. In order to collect a token you need to press the space bar while your yellow dot is on a cell with a token.

Which sequence of situations is **not possible?**



A  
B  
C


If you have any questions please raise your hand.

## Round 1 instructions

This is the first round of the experiment. The length of the round is 4 minutes. Like in the practice round you can collect green tokens. This time you earn **two cents** for each token collected. This time you **cannot** reset the distribution of green tokens.

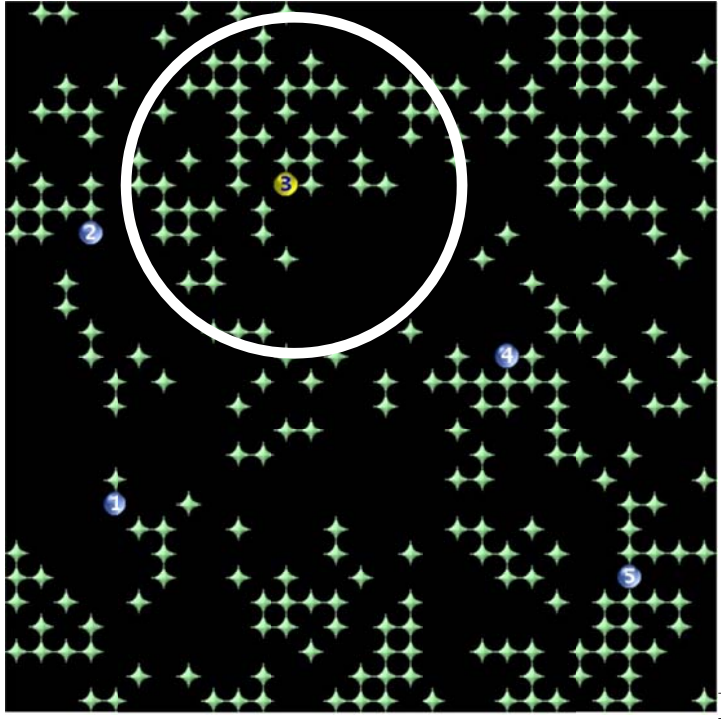
In this round the renewable resource will become five times bigger. You will share this larger environment with four other players in this room that have been randomly selected. One group's resource environment is distinct from the other groups.

Each of you has been assigned a number from 1 to 5. These numbers will remain the same throughout the experiment but you will **not** be able to identify which person in the room has been assigned which number, so your anonymity is guaranteed.

The other four players will appear on the screen as blue dots  with a white number embedded in the dot. On the top right corner of the screen you can see how many tokens each player has collected. On the top left corner of the screen you can see a clock that displays the remaining time in the round.

*[In experiments with limited vision the following is added:]*

Since you can only see the resource within your vision you may neither see all the other participants nor all the resource units. The figure below indicates the vision range compared to the whole environment



**Do you have any questions so far?**

[Rounds 2 and 3 are the same as round 1]

## **Round 4 Instructions**

Round 4 is the same as the previous two rounds with two exceptions.

Before the next round starts you can anonymously communicate by text messages for four minutes with the other participants in your group. You can use this opportunity to discuss the experiment and coordinate your actions to improve your earnings. You may not promise side-payments after the experiment is completed or make any threats. You are also not allowed to reveal your real identity. We are monitoring the chat traffic while you chat.

[If communication is constrained the paragraph above is replaced with:

During the next round you can anonymously communicate by text messages with other participants in your group. To start writing a text message you have to click with the mouse cursor in the text box at the right of the screen. To return to the collection of tokens you have to click with the mouse on the area where tokens appear. You can use this opportunity to discuss the experiment and coordinate your actions to improve your earnings. You may not promise side-payments after the experiment is completed or make any threats. You are also not allowed to reveal your real identity. We are monitoring the chat traffic while you chat.]

[If communication is constrained in an environment with limited vision we add the following sentence:

The messages you write can only be read by those participants within your group who are visible to you when you post your message.]

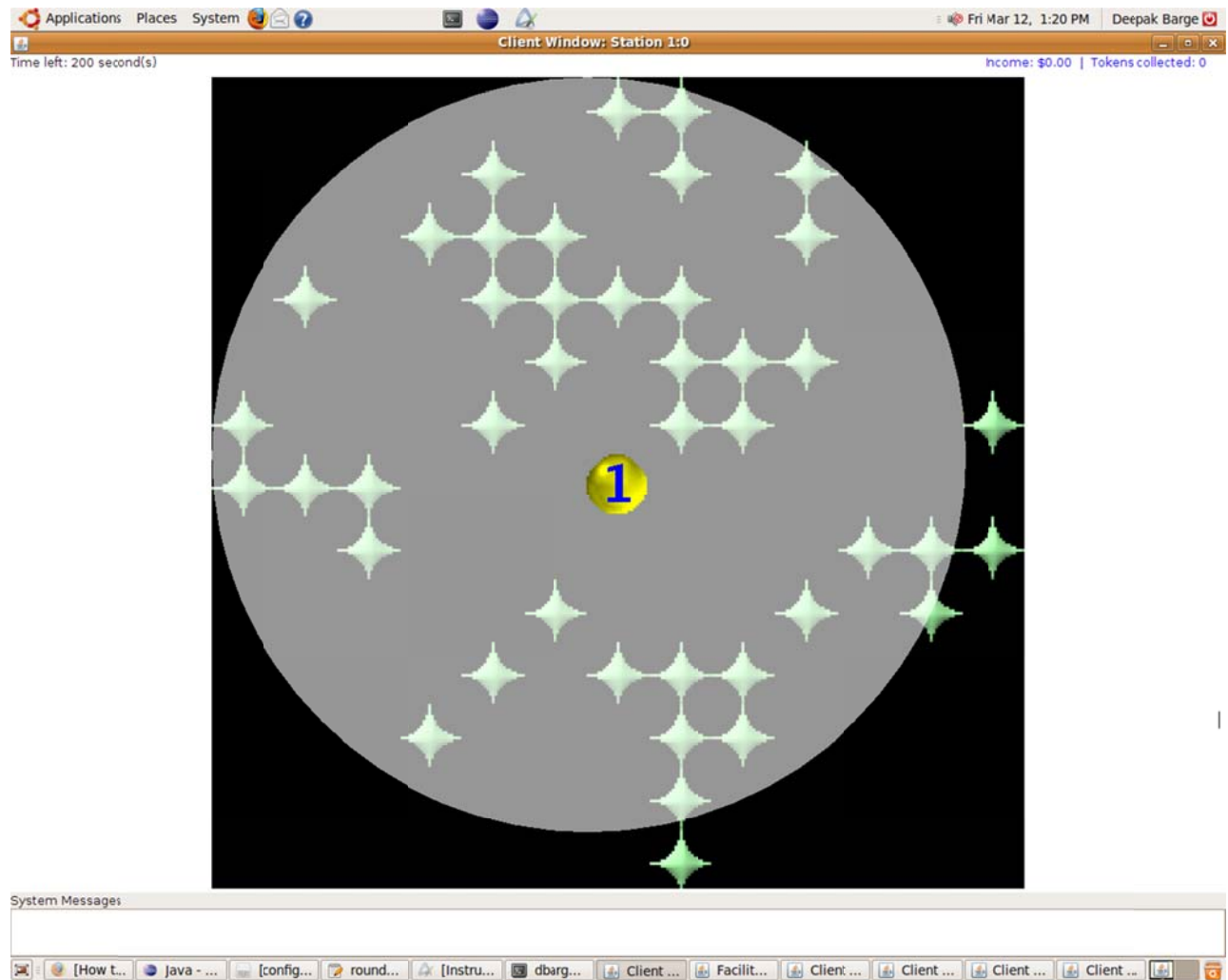
The length of this round is four minutes.

**If you have any questions please raise your hand. Do you have any questions so far?**

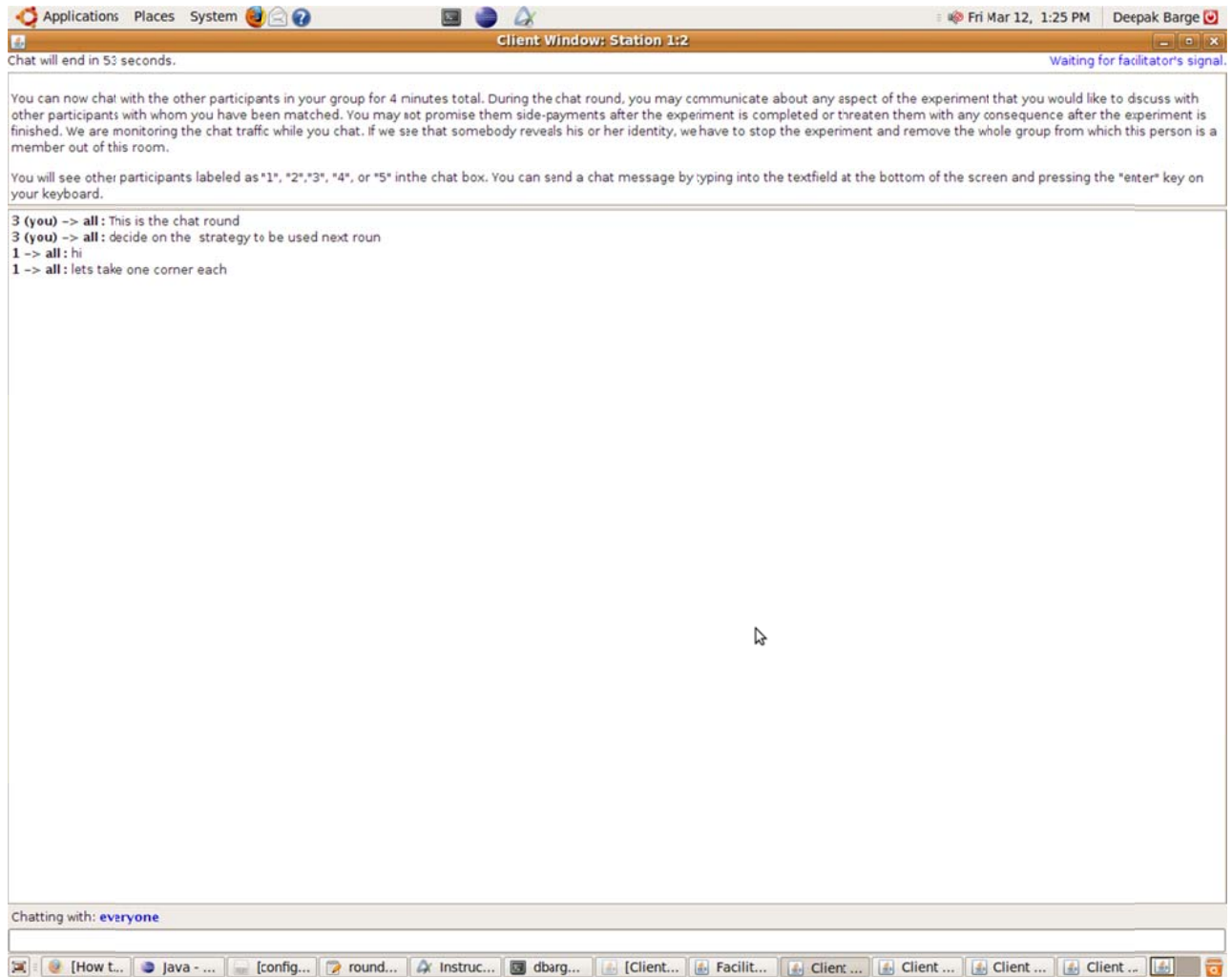
[Rounds 5 and 6 are the same as round 4]

Screenshots of experimental environment with limited vision

Practice round



## Chat screen unconstrained communication





Screen during harvesting of tokens of group with limited vision from perspective of player 5.

