Cooperation among Strangers under the Shadow of the Future: Appendix

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Appendix A

Proofs of Propositions

Proof of Proposition 1. We start by discussing payoffs, given a deviation. A player deviates from desired play in two instances: In- or off-equilibrium, if she has not observed a deviation in the past but chooses *Z*, currently. Off-equilibrium, if he has observed a deviation in the past but plays Y, currently. Since the environment is stationary, by the unimprovability criterion we restrict attention to one-time deviations. We also consider only single-player deviations. While this simplifies the analysis, deriving off-equilibrium payoffs still requires a bit of work (which is why we include the proof in the appendix). The problem is that players observe only the actions in their pair; in order to calculate expected values, we must know how uncooperative behavior spreads to the economy after a defection is observed.

A1. The diffusion of sanctions in the economy

Consider a representative period *t* and recall that there are 3 possible ways to pair four players. Thus, if $d = 1,\cdots,4$ is the number of players who choose *Z* currently, then $d' = d,\cdots,4$ is the number of deviators tomorrow, which depends on the current realization of the random pair.[1] As noted above, the central concern of a player is the likelihood that her/his opponent does not cooperate. Thus, we report the probabilities ρ_d that a player who selects *Z* today will meet a cooperator today, given that d players choose Z today. We also calculate $\Pr[d' \mid d]$ (i.e., the probability that tomorrow there are d' individuals who play Z, given that today there are d agents).

The first set of probabilities is needed to determine the expected current utility to a player who is

[1] If $d = 0$, then $d' = 0$ with certainty.

aware of a deviation or that deviates, selecting *Z*. The second set of probabilities is needed to calculate the continuation payoff for a player who is aware of a deviation or that deviates, selecting *Z*. Indeed, they will give us *transition matrices*, allowing us to calculate the various probabilities that the sanction spreads to the rest of the economy. Notice that there will be two contingencies to consider. In one case we calculate probabilities under the conjecture that every player follows the sanctioning behavior specified by the social norm; the other is derived under the conjecture that one player deviates from the sanctioning behavior, once.

Case 1. Off-equilibrium, everyone sanctions. Consider a player who currently selects *Z*. Let $\rho = (\rho_1, \rho_2, \rho_3, \rho_4)$ with ρ_d being the probability that he meets a cooperator given that $d = 1, \cdots, 4$ players currently select *Z*. Clearly, the probability that he meets someone who chooses *Z* is $1 - \rho$. Recall that each player can be paired to three other players, with equal probability. Therefore, we have

$$\rho = (1, \frac{2}{3}, \frac{1}{3}, 0)$$

Here, the transition matrix is:

$$\mathbf{A} = \begin{bmatrix} & \mathbf{1} & \mathbf{2} & \mathbf{3} & \mathbf{4} \\ \mathbf{1} & 0 & 1 & 0 & 0 \\ \mathbf{2} & 0 & 1/3 & 0 & 2/3 \\ \mathbf{3} & 0 & 0 & 0 & 1 \\ \mathbf{4} & 0 & 0 & 0 & 1 \end{bmatrix}$$

The bold numbers in the rows (columns) indicate the number D_t (D_{t+1}) of players who currently (next period) play *Z*. Each cell represents the corresponding conditional probability $\Pr[D_{t+1} | D_t]$. Clearly, Pr [2|1] = Pr [4|3] = 1 since if an odd number of players plays *Z* today, then at least one of them is paired to a cooperator. The latter will choose *Z* in $t + 1$. Also, Pr [4|4] = 1, since the

social norm does not specify reversion to cooperation. To see why Pr [2|2] = 1/3 and Pr [4|2] = 2/3 recall that there are three possible pairings. One of those involves the two players who currently choose *Z*. So, with probability 1/3 the sanctioning behavior does not spread further. If that pairing is not realized, then *Z* will be necessarily seen by the remaining two cooperators. So, with probability 2/3, next period everyone will choose the sanction, *Z*.

Case 2. Off equilibrium, one player does not use the prescribed sanction.

Suppose, off-equilibrium, a player who observed a deviation in the past chooses to deviate from the sanctioning rule and plays *Y* this period. Instead, everybody else follows the social norm. Consider this player. Again, ρ_d is the probability that he meets a cooperator given that $d = 1, \cdots, 4$ players have observed *Z* in the past. The probability that this player meets someone who chooses Z is $1 - \rho$.

However, since this player chooses *Y* instead of *Z*, the transition matrix is now different:

$$\tilde{A} = \begin{bmatrix} & \mathbf{1} & \mathbf{2} & \mathbf{3} & \mathbf{4} \\ \mathbf{1} & 0 & 1 & 0 & 0 \\ \mathbf{2} & 0 & 1/3 & 2/3 & 0 \\ \mathbf{3} & 0 & 0 & 1/3 & 2/3 \\ \mathbf{4} & 0 & 0 & 0 & 1 \end{bmatrix}$$

Again, Pr [2|1] = 1, since this is the case when no one observed a deviation in the past but someone chooses to play *Z* today. Also, Pr [4|4] = 1 since the player who deviates today by choosing cooperation will revert back to playing *Z*, in the next period (onetime deviation). Now, consider the second row, i.e., the case when two players observed a deviation, but only one of them plays *Z* today (reverting to playing *Z*, tomorrow). Here, only one of the three possible pairings includes both players who observed a deviation. In this case the sanctioning behavior does not spread further. In the other two pairings, it spreads only to one more player, since only one player plays *Z* today. Hence, we have Pr [2|2] = 1/3 and Pr [3|2] = 2/3. The third line is

similarly explained.

A2. Off-equilibrium payoffs

Using the matrices above, we can now construct off-equilibrium payoffs in two contingencies. The first is in equilibrium, when the player deviates for the first time, choosing *Z*. The second is off equilibrium, when the player has observed uncooperative behavior in the previous date (i.e., has seen *Z* for the first time) and now deviates by cooperating, choosing *Y*.

Payoff from a deviation, when everyone follows the sanctioning rule. Suppose that every player follows the social norm. Define the column vector:

$$\boldsymbol{V} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix}$$

where V_d denotes the expected lifetime utility at the start of a period, before pairing takes place, to a player who selects Z currently, given that $d = 1, \cdots, 4$ players choose Z currently.[2] Using the vector of probabilities ρ and the transition matrix $\boldsymbol{A}$, where we denote $\boldsymbol{A}_d$ the d^{th} row of matrix $\boldsymbol{A}$, we have:

$$V_d = z + \rho_d (h - z) + \delta \boldsymbol{A}_d \boldsymbol{V}$$

That is, the expected current utility depends on the probability of encountering a cooperator. When he meets a cooperator the player earns h, and otherwise he earns z. The continuation payoff is 0 with probability $1-\delta$, and it is $\boldsymbol{A}_d \boldsymbol{V}$ with probability δ. The latter component tells us that current play may lead to different numbers of cooperators tomorrow, depending on the

[2] Clearly, the agent selects Z as a deviation from equilibrium when d = 1. In this case the agent is the initial deviator. If d = 2, instead, the agent may select Z simply because he observed Z in the past and now follows the sanctioning rule.

outcome of the pairing process. Specifically, we have:

$$\begin{aligned} V_1 &= h + \delta V_2 \\ V_2 &= z + \frac{2}{3}(h - z) + \delta \left(\frac{1}{3} V_2 + \frac{2}{3} V_4 \right) \\ V_3 &= z + \frac{1}{3}(h - z) + \delta V_4 \\ V_4 &= z + \delta V_4 \end{aligned} \qquad (1)$$

To see how we derive them, we discuss the first two lines. Consider the first line. If a player is the initial deviator, then he is certainly paired to a cooperator, i.e., $\rho_1 = 1$ and earns current payoff h. The current cooperator will choose *Z* in the future. Thus, the current deviator's continuation payoff is δV_2. Consider the second line. Since the player chooses Z currently, he earns z if he meets the other only player who chooses *Z* (with probability $\frac{1}{3}$) and earns h if he meets a cooperator (with probability $\frac{2}{3}$). This gives expected current utility $z + \frac{2}{3}(h - z)$. The continuation payoff depends on which one of these pairs took place. If he met the other deviator, no cooperator observes *Z* today, so tomorrow there will still be two players who select Z. Otherwise, both cooperators observe Z today and tomorrow select Z as well. Simple manipulations of (1) give:

$$\begin{aligned} V_1 &= \frac{h(3 + \delta)}{3 - \delta} + \frac{z\delta(1 + \delta)}{(3 - \delta)(1 + \delta)} \\ V_2 &= \frac{2h}{3 - \delta} + \frac{z(1 + \delta)}{(3 - \delta)(1 - \delta)} \\ V_3 &= z + \frac{1}{3}(h - z) + \delta \frac{z}{1 - \delta} \\ V_4 &= \frac{z}{1 - \delta} \end{aligned} \qquad (2)$$

Payoff from a deviation, when a player does not follow the sanctioning rule. Suppose d players have observed a deviation in the past, and everyone follows the social norm except one

of these players. This player defects from the sanctioning rule and cooperates. Let $\tilde{V}_d$ denote the expected lifetime utility at the start of a period, before pairing takes place, to the player that has observed a deviation in the past but selects Y currently, given d. Using the vector of probabilities ρ and the transition matrix $\tilde{\boldsymbol{A}}$, where we denote $\tilde{\boldsymbol{A}}_d$ its d^{th} row, we have:

$$\tilde{V}_d = \begin{cases} V_1 & \text{if } d = 1 \\ l + \rho_d (y - l) + \delta\, \tilde{\boldsymbol{A}}_d \boldsymbol{V} & \text{if } d = 2 \end{cases}$$

When $d = 1$, this means that no deviation was observed previously but someone chooses to deviate today. Therefore $\tilde{V}_1 = V_1$, since it is the first period in which a deviation is observed. For the case $d \geq 2$ notice that only $d - 1$ players choose *Z* currently, the remaining one choosing *Y*. Therefore we must use the matrix $\tilde{\boldsymbol{A}}$.

In that case, we see that $l + \rho_d (y - l)$ is the expected current utility from meeting either a cooperator or not. Since the player cooperates, when he meets a cooperator, he earns y, and otherwise he earns l. Again, the continuation payoff is 0 with probability $1 - \delta$, and it is $\tilde{\boldsymbol{A}}_d \boldsymbol{V}$ with probability δ. We use $\boldsymbol{V}$ and not $\tilde{\boldsymbol{V}}$ in the continuation payoff, since everyone reverts to the sanctioning rule specified by the social norm, from tomorrow on.

As done for the case above, simple calculations generate:

$$\begin{aligned} \tilde{V}_2 &= l + \frac{2}{3}(y - l) + \delta\left(\frac{1}{3}V_2 + \frac{2}{3}V_3\right) \\ \tilde{V}_3 &= l + \frac{1}{3}(y - l) + \delta\left(\frac{1}{3}V_3 + \frac{2}{3}V_4\right) \\ \tilde{V}_4 &= l + \delta V_4 \end{aligned} \quad (3)$$

A3. Requirements for individual optimality

In this section we check that the actions recommended by the social norm are best responses after any history of play. To do so we consider two issues. First, we derive a condition ensuring that choosing *Z* is not a best response on the equilibrium path. Second, we check that playing *Y* instead of *Z*, after having observed a deviation, is never optimal.

Suboptimality of a deviation, in equilibrium. We must check that deviating by choosing *Z* is suboptimal, relative to cooperating. That is:

$$\frac{y}{1-\delta} \geq V_1 = \frac{h(3+\delta)}{3-\delta} + \frac{z\delta(1+\delta)}{(3-\delta)(1-\delta)}$$

an inequality that is rearranged as:

$$\delta^2(h-z) + \delta(2h-y-z) - 3(h-y) \geq 0$$

Let $f(\delta)$ define the expression on the RHS of the inequality. Notice that since $h > y > z$ and $\delta \in (0,1)$, then $f(\delta) \geq 0$ for all $\delta \geq \delta^*$ where $\delta^* \in (0,1)$ is the unique value of δ that solves $f(\delta) = 0$. We have $\delta^* > 0$ since $f(0) < 0$ and $f'(\delta) > 0$. Also, $\delta^* < 1$ since $f'(\delta) > 0$ for $\delta > 0$ and $f(1) = 2(y-z) > 0$. The parameterization of our experiment implies $\delta^* = 0.443$.

Suboptimality of a deviation, off-equilibrium. Here, we check that if a player has observed *Z* in the past, then *Y* today is suboptimal. That is, since we have shown that choosing *Z* is never optimal, when $d = 1$, we must find conditions such that $V_d \geq \tilde{V}_d$ for all $d \geq 2$. To do so, use (1), (2) and (3). Clearly, $V_4 \geq \tilde{V}_4$ since $z \geq l$. Now consider the inequality $V_3 \geq \tilde{V}_3$. Rearranging:

$$\tilde{V}_3 = l + \frac{1}{3}(y-l) + \delta\frac{1}{3}(V_3 - V_4) + \delta V_4,$$

we have $V_3 \geq \tilde{V}_3$, if:

$$z + \frac{1}{3}(h - z) - [l + \frac{1}{3}(y - l)] \geq \delta \frac{1}{3}(V_3 - V_4)$$
$$\Rightarrow \delta \leq 3 \times \frac{2(z - l) + (h - y)}{h - z}$$

since from (1) we have $V_3 - V_4 = \frac{1}{3}(h - z)$. It is easy to see that for our parameterization this is

satisfied by all $\delta \in (0,1)$ since $\frac{2(z - l) + (h - y)}{h - z} = 34.$

Finally, consider $V_2 \geq \tilde{V}_2$. This inequality is immediately rewritten as:

$$z + \frac{2}{3}(h - z) - [l + \frac{2}{3}(y - l)] \geq \delta \frac{2}{3}(V_3 - V_4)$$
$$\Rightarrow \delta \leq \frac{3}{2} \times \frac{z - l + 2(h - y)}{h - z}$$

which always holds for all parameters since $\frac{z - l + 2(h - y)}{h - z} = 34$.

The intuition is simple. Cooperating instead of sanctioning after observing a defection may be helpful to the player, since it delays the spread of the sanction. However, doing so generates a current loss to the player since he earns y (instead of h) if he meets a cooperator, and l (instead of z) if he meets a deviator. Therefore, the player must be sufficiently impatient to prefer play of Z to Y—clearly, the smaller l and y , the greater the incentive to follow with the sanction. Our parameterization insures that this incentive exists for all $\delta \in (0,1)$.

Appendix B

Example of strategy coding

Period	ID	choice	**opponent choice (*)**	Reactive strategies are based on (*)			**opponent and other pair choices (**)**	Global strategies are based on (**)			**opponent's ID (***)**	Targeted strategies are based on (*) and on (***)		
				Grim trig.	TfT lag 1	TfT lag 2		Grim trig.	TfT lag 1	TfT lag 2		Grim trig.	TfT lag 1	TfT lag 2
1	7	0	**1**	0	0	0	**1**	0	0	0	**16**	0	0	0
2	7	1	**0**	0	0	0	**0**	0	0	0	**18**	0	0	0
3	7	1	**1**	1	1	0	**1**	1	1	0	**9**	0	0	0
4	7	1	**0**	1	0	1	**0**	1	0	1	**16**	0	0	0
5	7	0	**1**	1	1	0	**1**	1	1	0	**16**	1	1	0
6	7	1	**1**	1	0	1	**1**	1	0	1	**18**	1	1	0
7	7	1	**1**	1	0	0	**0**	1	0	0	**18**	1	0	1
8	7	1	**1**	1	0	0	**0**	1	1	0	**9**	0	0	0
9	7	1	**1**	1	0	0	**1**	1	0	1	**9**	0	0	0
10	7	1	**1**	1	0	0	**0**	1	0	0	**18**	1	0	0
11	7	1	**1**	1	0	0	**1**	1	1	0	**9**	0	0	0
12	7	1	**1**	1	0	0	**1**	1	0	1	**18**	1	0	0
13	7	1	**0**	1	0	0	**0**	1	0	0	**16**	1	0	1
14	7	1	**1**	1	1	0	**0**	1	1	0	**18**	1	0	0
15	7	1	**1**	1	0	1	**0**	1	0	1	**9**	0	0	0
16	7	0	**0**	1	0	0	**0**	1	0	0	**16**	1	1	0
17	7	0	**0**	1	1	0	**0**	1	0	0	**16**	1	0	1
18	7	0	**1**	1	0	1	**1**	1	0	0	**16**	1	0	0
19	7	1	**1**	1	0	0	**1**	1	0	0	**9**	0	0	0
20	7	1	**1**	1	0	0	**1**	1	0	0	**18**	1	0	0
21	7	1	**1**	1	0	0	**1**	1	0	0	**18**	1	0	0
22	7	1	**0**	1	0	0	**0**	1	0	0	**16**	1	0	0
23	7	0	**0**	1	1	0	**0**	1	1	0	**16**	1	1	0
24	7	1	**1**	1	0	1	**0**	1	0	1	**18**	1	0	0
25	7	0	**1**	1	0	0	**0**	1	0	0	**9**	0	0	0

Notes: (*) 1=cooperation, 0=defection, (**) 1=3 persons cooperated, 0=less than 3 persons cooperated; TfT=tit-for-tat regressor. Experimental data from session 8, cycle 1, periods 1-25 (non-anonymous public monitoring treatment).

Appendix C

Instructions for all treatments

Instructions for the private monitoring treatment

Overview

This is an experiment in decision-making. Purdue University has provided funds for this research. The instructions are simple. If you follow them carefully and make good decisions, you can earn an appreciable amount of money. These earnings will be paid to you in cash at the end of the experiment.

We ask that you not talk with one another for the duration of the experiment. Please turn off your cell-phones. Do not use e-mail.

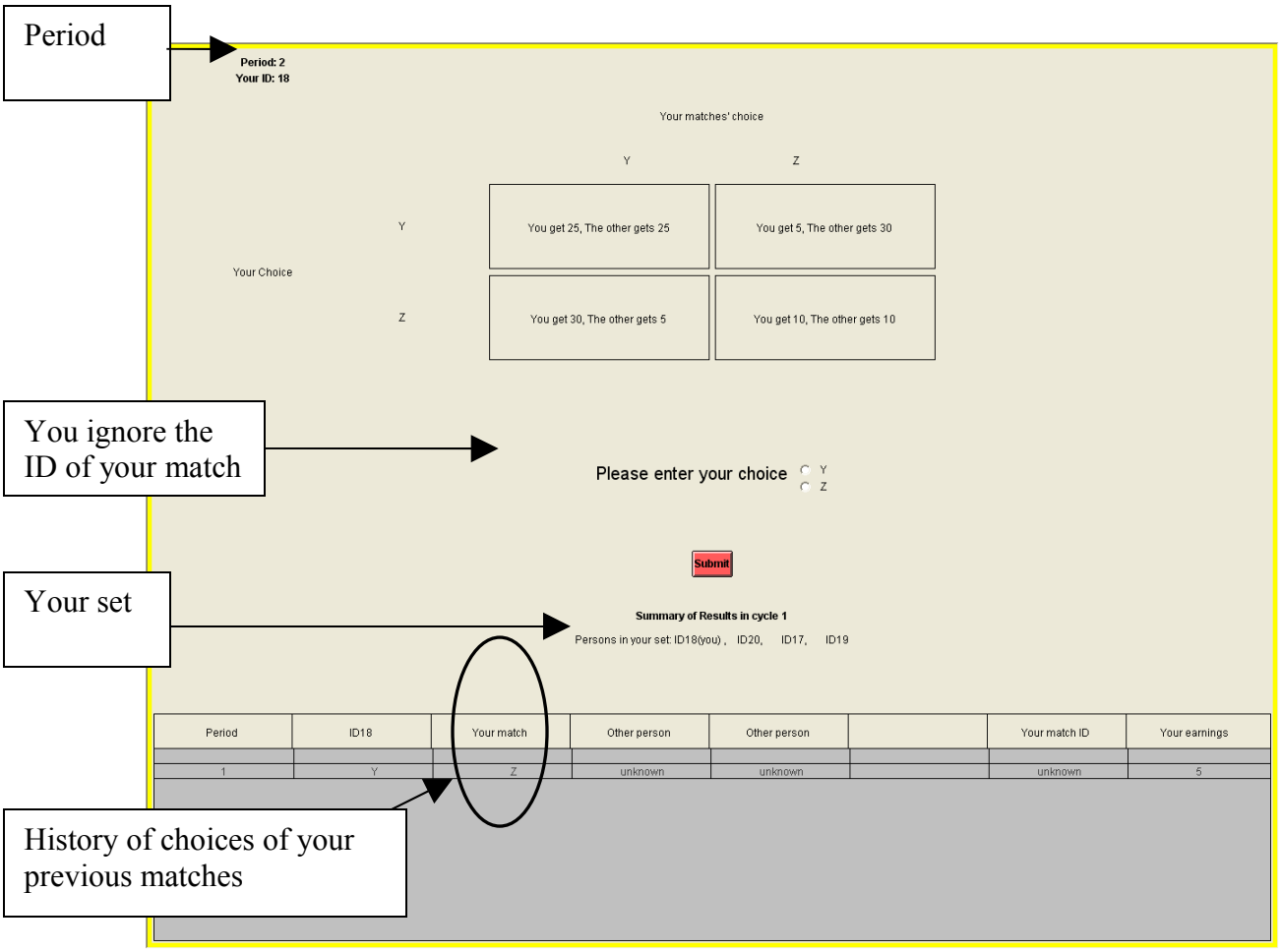
During the course of this experiment, you will be called upon to make decisions in several periods. The experiment is divided into **five** sequences of periods and each sequence is referred to as a **cycle**.

- At the beginning of a cycle, each participant in this room will be randomly assigned to a **set**.
- In each set there will be **four** persons**.**
- For the whole duration of a cycle, you will interact exclusively with the three other participants in that set and nobody else.
- You will never meet again these participants in the following cycles.

In each **period** of a cycle:

- In each period you will be matched to one other participant selected at random from the set you are assigned to. We will refer to this person as "**your match**."
- You will not be informed of the identity of your match. Hence, you do not know when you have already interacted with that person in previous periods of the same cycle.
- You and your match will interact according to the rules described in the upper portion of your screen. The rules will be explained in a moment.

- After each period you will be re-matched to a participant chosen at random from the set you are assigned to. There is one chance out of three that you will be matched with any given person in your set.



Interaction rules

In a period you and your match can make either of two choices, Y or Z. The points you earn in a period depend upon both the choice you make and the choice made by your match in that period. As the payoff table on your screen (above) indicates, there are four possible outcomes:

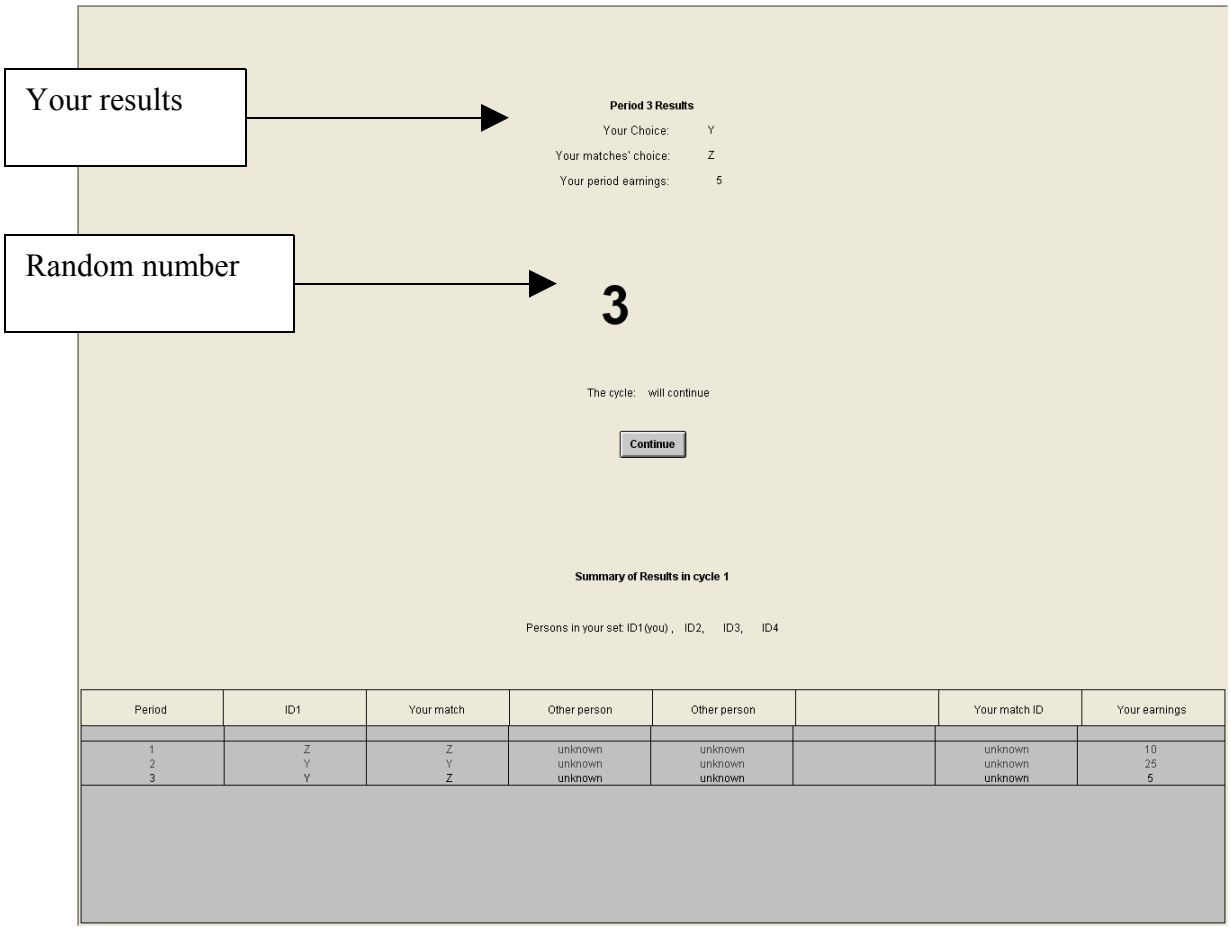
1. If both of you choose Y this period then: you both earn ***25*** points.

2. If you choose Y this period and your match chooses Z then: you earn ***5*** points and your match earns ***30*** points.

3. If you choose Z this period and your match chooses Y then: you earn ***30*** points and your match earns ***5*** points.

4. If you both choose Z then: you both earn ***10*** points.

To make your choice in each period, click the button next to either Y or Z. You may change your mind at any time prior to clicking the "Submit" button by simply clicking on the button next to Y or Z. You are free to choose Y or Z in every period. When you are satisfied with your choice, click the "Submit" button. After all persons have made their choices, the results of the period will appear on your screen.



The result screen (above) will display the number of points you have earned for the period along with **your choice and the choice of your match.** The first column of the 'Summary of Results' table contains your past choices. The second column concerns the choices of your previous matches. Notice that **choices in the second column were most likely made by different persons in different periods. You are not given information on the choices made by the other two persons in your set**. Please record your results for the period on your RECORD SHEET under the appropriate headings.

At this stage a ball will be drawn from an urn containing one hundred balls numbered from 1 to 100. Each ball is equally likely to be selected. The computer program will randomly draw a ball and show the number on the result screen (above). If this random number is less than or equal to 95, then the cycle will continue into the next period. If this number is greater than 95, then the cycle ends. Therefore, **after each period there is a 95% chance that there will be another period of interactions in the cycle and a 5% chance that the cycle will end**.

Suppose that a number less than or equal to 95 has been drawn. Then you press the "Continue" button to proceed. You will face the same decisional situation as in the previous period, but **with a person selected at random from the set of participants you were assigned to**. Remember that there are four participants in each set.

Before making your choice, you may review all the outcomes in previous periods of the cycle by scrolling down the "Summary of Results" table. The table shows your history and the past choices of the persons who happened to be your match in the period. You then choose either Y or Z. Your choice and the choice of your match this period are recorded and added to the Summary of Results table in the lower portion of your screen. You record the outcome and your point earnings for the period.

If the number drawn is greater than 95 then the cycle ends. When a cycle ends, you will be notified in a new screen. There will be a total of five cycles. The rules in the following cycles are the same as in the first, but you will interact with different persons. More precisely, after each cycle, new sets of persons will be formed. This assignment does not depend on actual choices. **A participant will never interact with a person for more than one cycle.**

<u>Earnings</u>

The points you earned in each period are added up. For every 10 points that you earn you will receive 13 cents ($.13). Therefore, the more points you earn the more money you earn. In addition, you will receive a $10 show-up fee. You will be paid your earnings in cash and in private at the end of today's session.

Final Comments

First, do not discuss your choices or your results with anyone at any time during the experiment.

Second, your ID# is private. Do not reveal it to anyone.

Third, since there is a 95% chance that at the end of a period the cycle will continue, you can expect, on average, to interact for 20 periods in a given cycle. However, since the stopping decision is made randomly, some cycles may be much longer than 20 periods and some others may be much shorter.

Fourth, remember that after each period you will be matched randomly to someone in the set you were assigned to. As there are four people in the set, the probability of you being matched with the same person in two consecutive periods of a cycle is 1/3. You are not told the identity of your match.

Fifth, the rules are the same in all five cycles. After a cycle, you will never meet again the same participants.

Questions?

Now is the time for questions. Does anyone have any questions before we begin?

Instructions for the private monitoring with personal punishment treatment

Overview

This is an experiment in decision-making. Purdue University has provided funds for this research. The instructions are simple. If you follow them carefully and make good decisions, you can earn an appreciable amount of money. These earnings will be paid to you in cash at the end of the experiment.

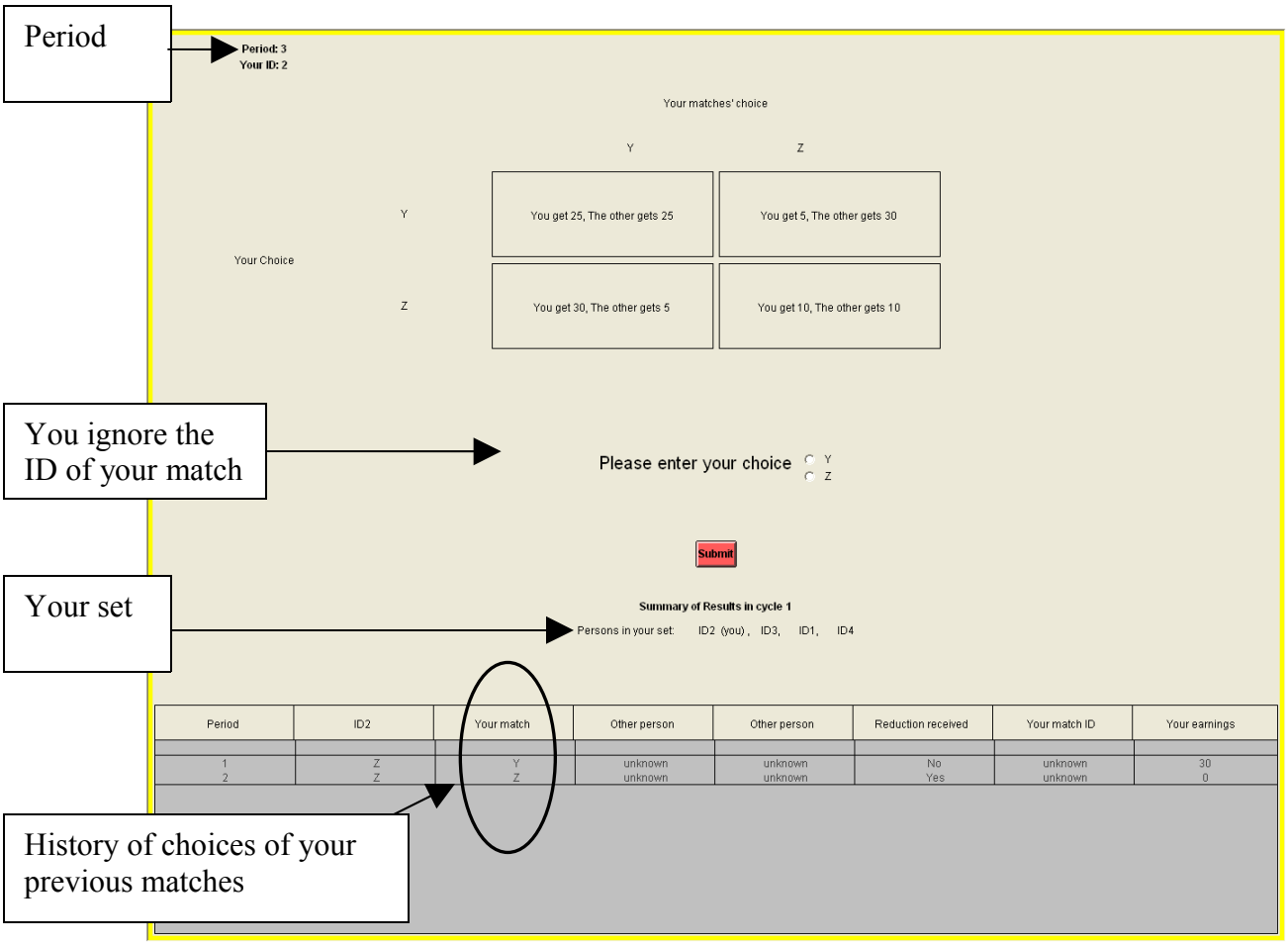
We ask that you not talk with one another for the duration of the experiment. Please turn off your cell-phones. Do not use e-mail.

During the course of this experiment, you will be called upon to make decisions in several periods. The experiment is divided into **five** sequences of periods and each sequence is referred to as a **cycle**.

- At the beginning of a cycle, each participant in this room will be randomly assigned to a **set**.
- In each set there will be **four** persons**.**
- For the whole duration of a cycle, you will interact exclusively with the three other participants in that set and nobody else.
- You will never meet again these participants in the following cycles.

In each **period** of a cycle:

- In each period you will be matched to one other participant selected at random from the set you are assigned to. We will refer to this person as "**your match**."
- You will not be informed of the identity of your match. Hence, you do not know when you have already interacted with that person in previous periods of the same cycle.
- You and your match will interact according to the rules described in the upper portion of your screen. The rules will be explained in a moment.
- After each period you will be re-matched to a participant chosen at random from the set you are assigned to. There is one chance out of three that you will be matched with any given person in your set.



Interaction rules

Each period is divided into two stages. In stage 1 you and your match can make either of two choices, Y or Z. The points you earn depend upon both the choice you make and the choice made by your match in that period. As the payoff table on your screen (above) indicates, there are four possible outcomes for stage 1:

1. If both of you choose Y this period then: you both earn ***25*** points.

2. If you choose Y this period and your match chooses Z then: you earn ***5*** points and your match earns ***30*** points.

3. If you choose Z this period and your match chooses Y then: you earn ***30*** points and your match earns ***5*** points.

4. If you both choose Z then: you both earn ***10*** points.

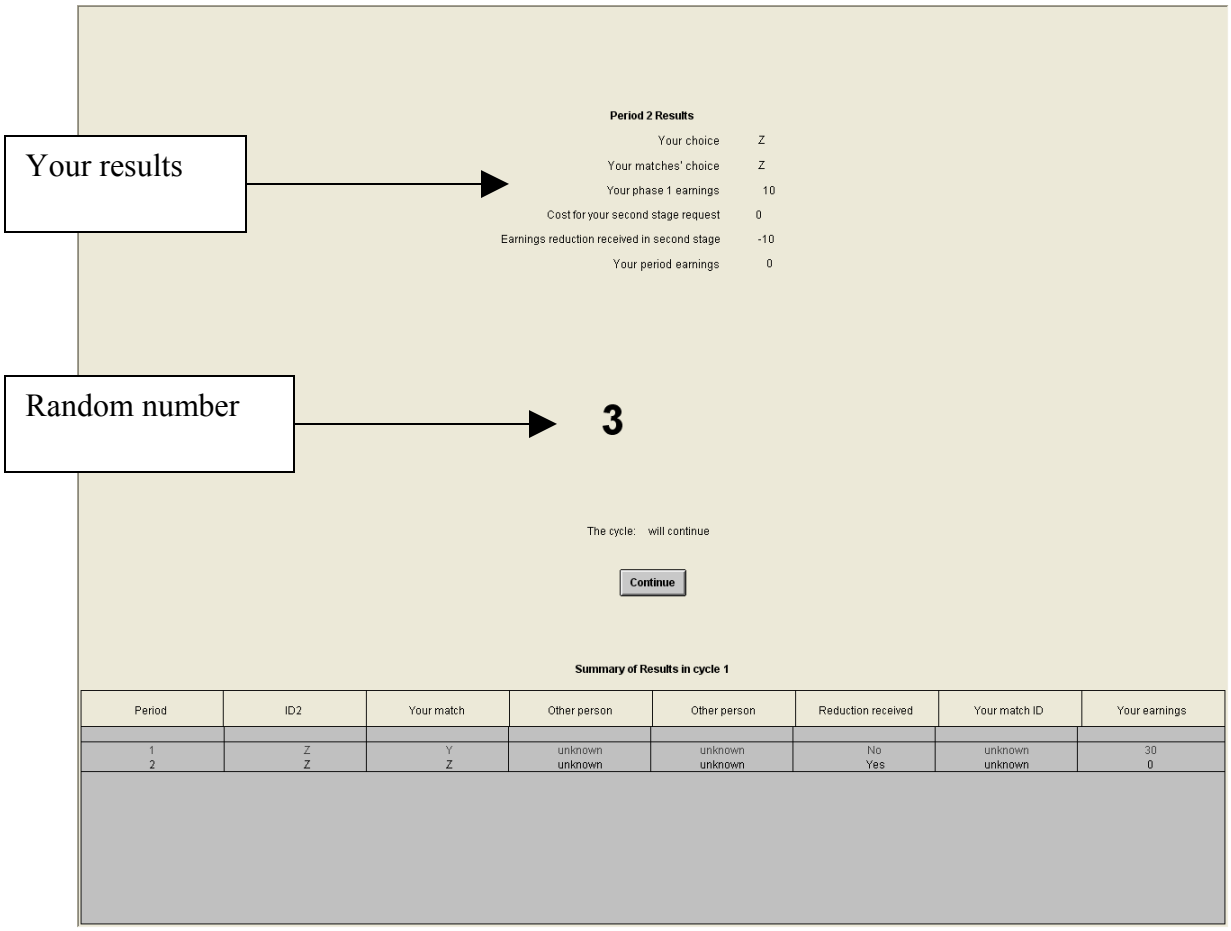
To make your choice in stage 1, click the button next to either Y or Z. You may change your mind at any time prior to clicking the "Submit" button by simply clicking on the button next to Y or Z. You are free to choose Y or Z in every period. When you are satisfied with your choice, click the "Submit" button. After all persons have made their choices, the results of stage 1 will appear on your screen (below).

Before moving to another period, you have the opportunity to pay a cost to lower the earnings of your match (stage 2). You can click the button next to either NO or YES and then click submit when satisfied with your choice.

If you choose NO, no points will be subtracted from the earnings of your match.

If you choose YES, 5 points will be subtracted from your earnings and 10 points will be subtracted from the earnings of your match.

After all persons have made their choices for stage 2, the final results of the period will appear on the lower portion of your screen (see screen below). Please notice that your period earnings can be negative. If your earnings in the period are negative, they will reduce your cumulative earnings.



The result screen (above) will display the number of points you have earned for the period along with **your choices and the choices of your match** for both stage 1 and stage 2**.** The first column of the 'Summary of Results' table contains your past choices in stage 1. The second column concerns the choices in stage 1 of your previous matches. Notice that **choices in the second column were most likely made by different persons in different periods. You are not given information on the choices made by the other two persons in your set**. One of the columns lists the "Reduction received" in each period. It is marked "Yes" when your match requested to lower your earning and "No" otherwise. Please record your results for the period on your RECORD SHEET under the appropriate headings.

At this stage a ball will be drawn from an urn containing one hundred balls numbered from 1 to 100. Each ball is equally likely to be selected. The computer program will randomly draw a ball and show the number on the result screen (above). If this random number is less than or equal to 95, then the cycle will continue into the next period. If this number is greater than 95, then the cycle ends. Therefore, **after each period there is a 95% chance that there will be another period of interactions in the cycle and a 5% chance that the cycle will end**.

Suppose that a number less than or equal to 95 has been drawn. Then you press the "Continue" button to proceed. You will face the same decisional situation as in the previous period, but **with a person selected at random from the set of participants you were assigned to**. Remember that there are four participants in each set.

Before making your choice, you may review all the outcomes in previous periods of the cycle by scrolling down the "Summary of Results" table. The table shows your history and the past choices of the persons who happened to be your match in the period. You then choose either Y or Z in stage 1 and NO or YES in stage 2. Your choice and the choices of your match this period are recorded and added to the Summary of Results table in the lower portion of your screen. You record the outcome and your point earnings for the period.

If the number drawn is greater than 95 then the cycle ends. When a cycle ends, you will be notified in a new screen. There will be a total of five cycles. The rules in the following cycles are the same as in the first, but you will interact with different persons. More precisely, after each cycle, new sets of persons will be formed. This assignment does not depend on actual choices. **A participant will never interact with a person for more than one cycle.**

<u>Earnings</u>

The points you earned in each period are added up. For every 10 points that you earn you will receive 13 cents ($.13). Therefore, the more points you earn the more money you earn. In addition, you will receive a $5 show-up fee. You will be paid your earnings in cash and in private at the end of today's session.

Final Comments

First, do not discuss your choices or your results with anyone at any time during the experiment.

Second, your ID# is private. Do not reveal it to anyone.

Third, since there is a 95% chance that at the end of a period the cycle will continue, you can expect, on average, to interact for 20 periods in a given cycle. However, since the stopping decision is made randomly, some cycles may be much longer than 20 periods and some others may be much shorter.

Fourth, remember that after each period you will be matched randomly to someone in the set you were assigned to. As there are four people in the set, the probability of you being matched with the same person in two consecutive periods of a cycle is 1/3. You are not told the identity of your match.

Fifth, the rules are the same in all five cycles. After a cycle, you will never meet again the same participants.

Questions?

Now is the time for questions. Does anyone have any questions before we begin?

Instructions for the anonymous public monitoring treatment

Overview

This is an experiment in decision-making. Purdue University has provided funds for this research. The instructions are simple. If you follow them carefully and make good decisions, you can earn an appreciable amount of money. These earnings will be paid to you in cash at the end of the experiment.

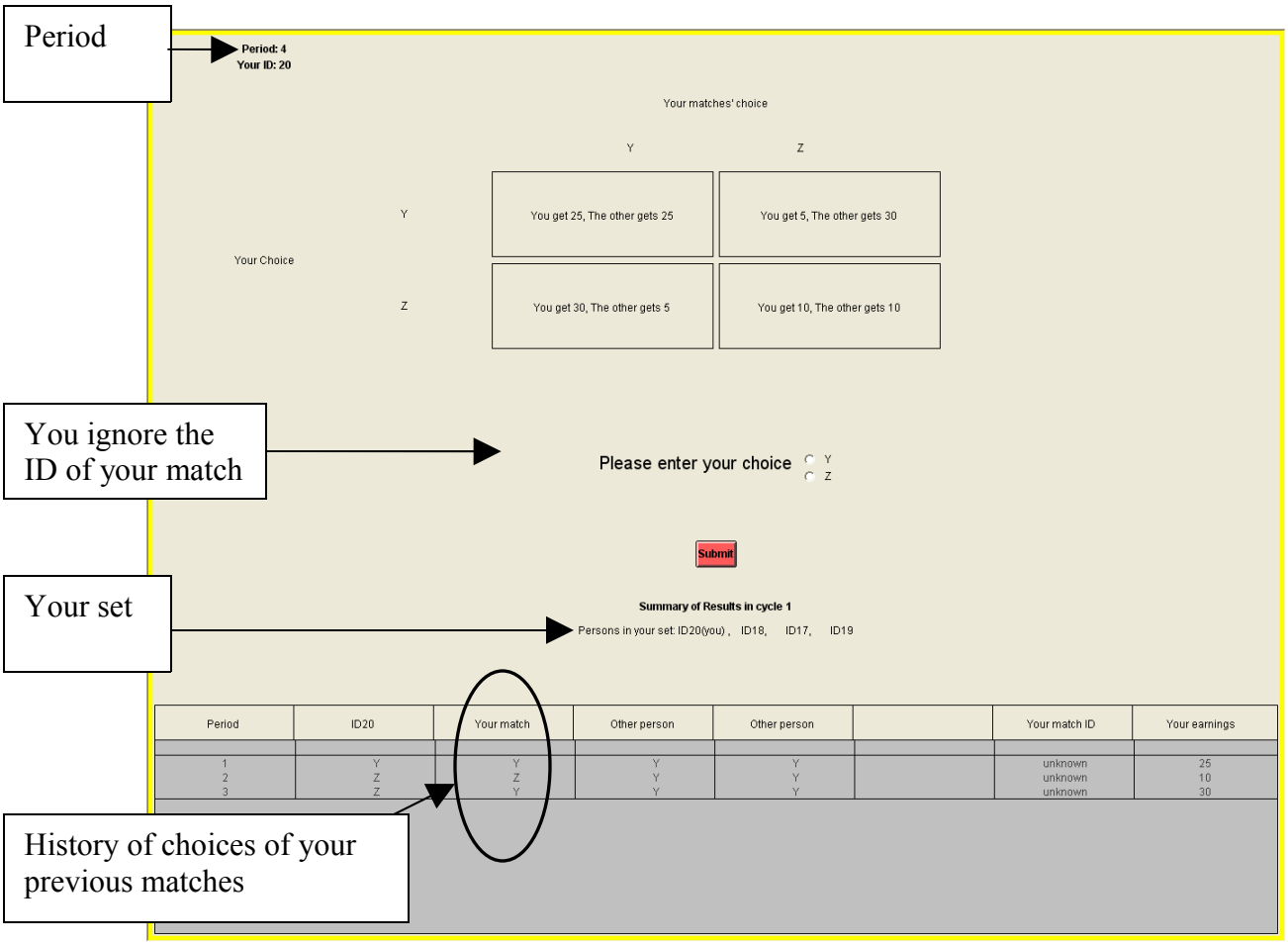
We ask that you not talk with one another for the duration of the experiment. Please turn off your cell-phones. Do not use e-mail.

During the course of this experiment, you will be called upon to make decisions in several periods. The experiment is divided into **five** sequences of periods and each sequence is referred to as a **cycle**.

- At the beginning of a cycle, each participant in this room will be randomly assigned to a **set**.
- In each set there will be **four** persons**.**
- For the whole duration of a cycle, you will interact exclusively with the three other participants in that set and nobody else.
- You will never meet again these participants in following cycles.

In each **period** of a cycle:

- In each period you will be matched to one other participant selected at random from the set you are assigned to. We will refer to this person as "**your match**."
- You will not be informed of the identity of your match. Hence, you do not know when you have already interacted with that person in previous periods of the same cycle.
- You and your match will interact according to the rules described in the upper portion of your screen. The rules will be explained in a moment.
- After each period you will be re-matched to a participant chosen at random from the set you are assigned to. There is one chance out of three that you will be matched with any given person in your set.



Interaction rules

In a period you and your match can make either of two choices, Y or Z. The points you earn in a period depend upon both the choice you make and the choice made by your match in that period. As the payoff table on your screen (above) indicates, there are four possible outcomes:

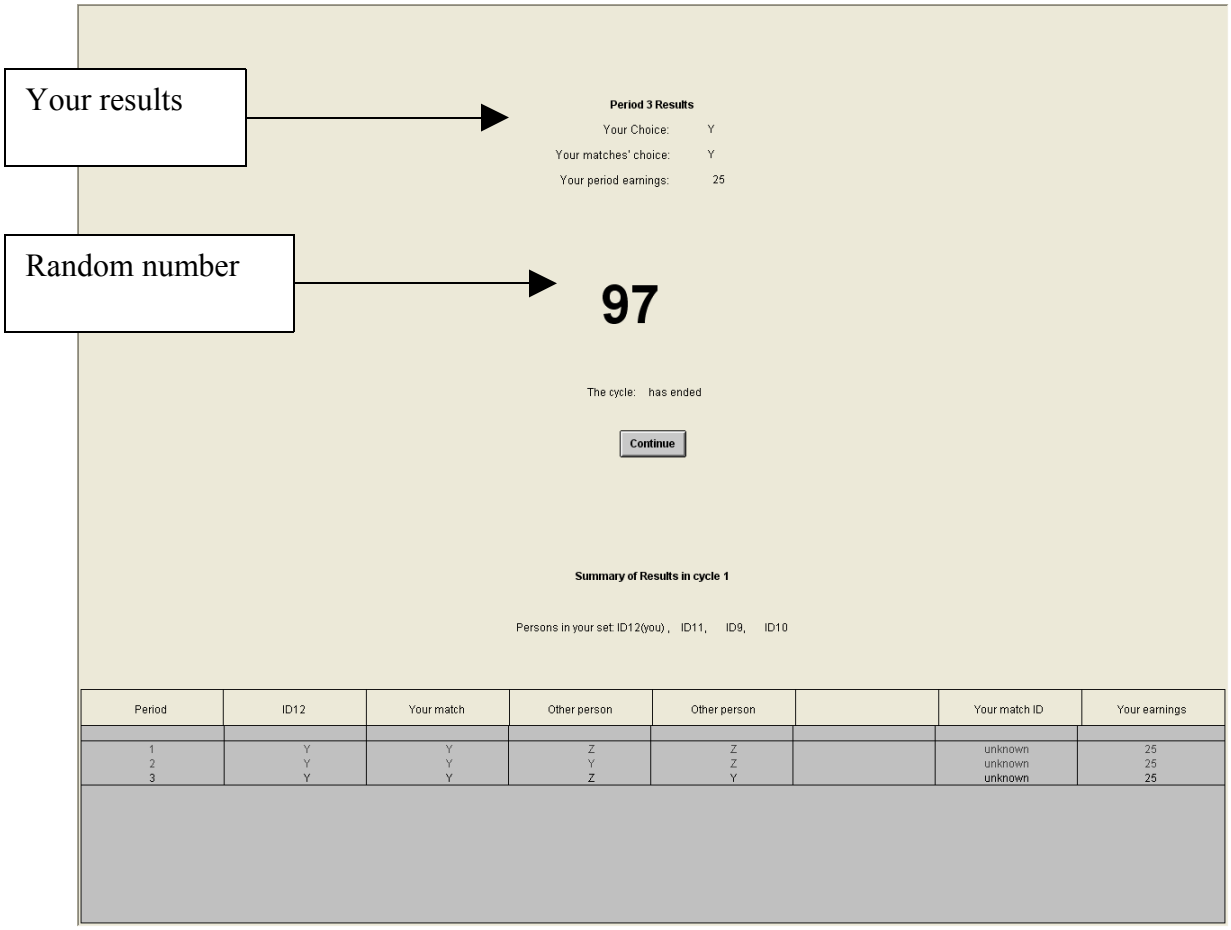
1. If both of you choose Y this period then: you both earn ***25*** points.

2. If you choose Y this period and your match chooses Z then: you earn ***5*** points and your match earns ***30*** points.

3. If you choose Z this period and your match chooses Y then: you earn ***30*** points and your match earns ***5*** points.

4. If you both choose Z then: you both earn ***10*** points.

To make your choice in each period, click the button next to either Y or Z. You may change your mind any time prior to clicking the "Submit" button by simply clicking on the button next to Y or Z. You are free to choose Y or Z in every period. When you are satisfied with your choice, click the "Submit" button. After all persons have made their choices, the results of the period will appear on your screen.



The result screen (above) will display the number of points you have earned for the period as well as **the choices of all four persons in your set**. The first column of the 'Summary of Results' table contains your past choices. The second column concerns the choices of your previous matches. The third and fourth columns list the choices of the other two persons in your set. Notice that **choices in column two were most likely made by different persons in different periods. The same can be said for columns three and four.** Please record your results for the period on your RECORD SHEET under the appropriate headings.

At this stage a ball will be drawn from an urn containing one hundred balls numbered from 1 to 100. Each ball is equally likely to be selected. The computer program will randomly draw a ball and show the number on the result screen (above). If this random number is less than

or equal to 95, then the cycle will continue into the next period. If this number is greater than 95, then the cycle ends. Therefore, **after each period there is a 95% chance that there will be another period of interactions in the cycle and a 5% chance that the cycle will end**.

Suppose that a number less than or equal to 95 has been drawn. Then you press the "Continue" button to proceed. You will face the same decisional situation as in the previous period, but **with a person selected at random from the set of participants you were assigned to**. Remember that there are four participants in each set.

Before making your choice, you may review all the outcomes in previous periods of the cycle by scrolling down the "Summary of Results" table. The table shows your history and the past choices of all persons in your set. You then choose either Y or Z. All choices for this period are recorded and added to the Summary of Results table in the lower portion of your screen. You record the outcome and your point earnings for the period.

If the number drawn is greater than 95 then the cycle ends. When a cycle ends, you will be notified in a new screen. There will be a total of five cycles. The rules in the following cycles are the same as in the first, but you will interact with different persons. More precisely, after each cycle, new sets of persons will be formed. This assignment does not depend on actual choices. **A participant will never interact with a person for more than one cycle.**

Earnings

The points you earned in each period are added up. For every 10 points that you earn you will receive 13 cents ($.13). Therefore, the more points you earn the more money you earn. In addition, you will receive a $3 show-up fee. You will be paid your earnings in cash and in private at the end of today's session.

Final Comments

First, do not discuss your choices or your results with anyone at any time during the experiment.

Second, your ID# is private. Do not reveal it to anyone.

Third, since there is a 95% chance that at the end of a period the cycle will continue, you can expect, on average, to interact for 20 periods in a given cycle. However, since the stopping decision is made randomly, some cycles may be much longer than 20 periods and some others may be much shorter.

Fourth, remember that after each period you will be matched randomly to someone in the set you were assigned to. As there are four people in the set, the probability of you being matched with the same person in two consecutive periods of a cycle is 1/3. You are not told the identity of your match.

Fifth, the rules are the same in all five cycles. After a cycle, you will never meet again the same participants.

Questions?

Now is the time for questions. Does anyone have any questions before we begin?

Instructions for the non-anonymous public monitoring treatment

Overview

This is an experiment in decision-making. Purdue University has provided funds for this research. The instructions are simple. If you follow them carefully and make good decisions, you can earn an appreciable amount of money. These earnings will be paid to you in cash at the end of the experiment.

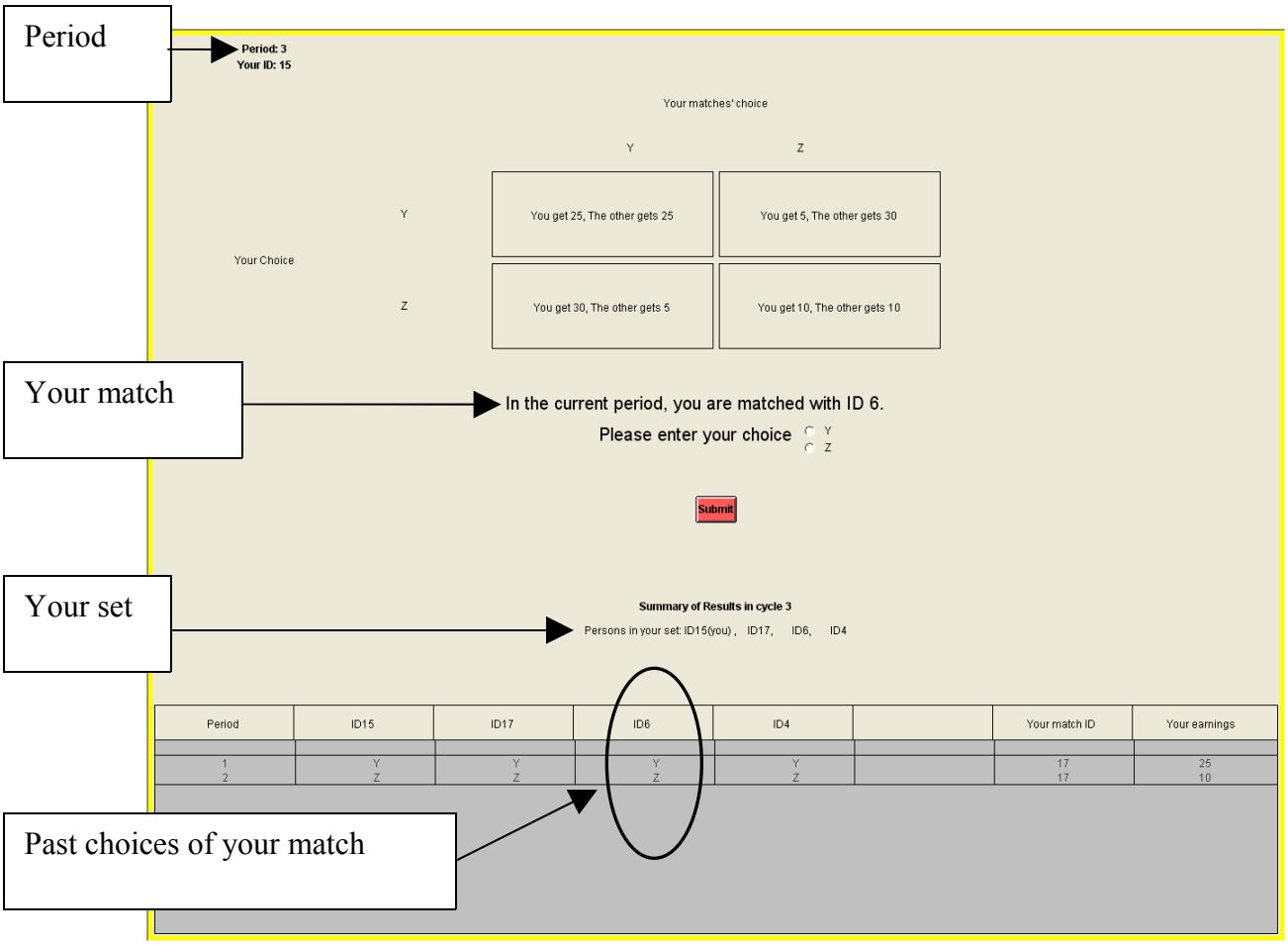
We ask that you not talk with one another for the duration of the experiment.

During the course of this experiment, you will be called upon to make decisions in several periods. The experiment is divided into **five** sequences of periods and each sequence is referred to as a **cycle**.

- At the beginning of a cycle, each participant in this room will be randomly assigned to a set.
- In each set there will be **four** persons**.**
- For the whole duration of a cycle, you will interact exclusively with the three other participants in that set and nobody else.
- You will never meet again these participants in following cycles.

In each **period** of a cycle

- In each period you will be matched with one other participant selected at random from the set you are assigned to. We will refer to this person as "**your match**."
- You know the identification number (ID) of your match and hence know if and when you have already interacted with that person in previous periods.
- You will interact according to the rules described in the upper portion of your screen. The rules will be explained in a moment.
- After each period you will be re-matched to a participant chosen at random from the set you are assigned to.



Interaction rules

In a period each of you can make either of two choices, Y or Z. The points you earn in a period depends upon both the choice you make and the choice made by your match in that period. As the payoff table on your screen (above) indicates:

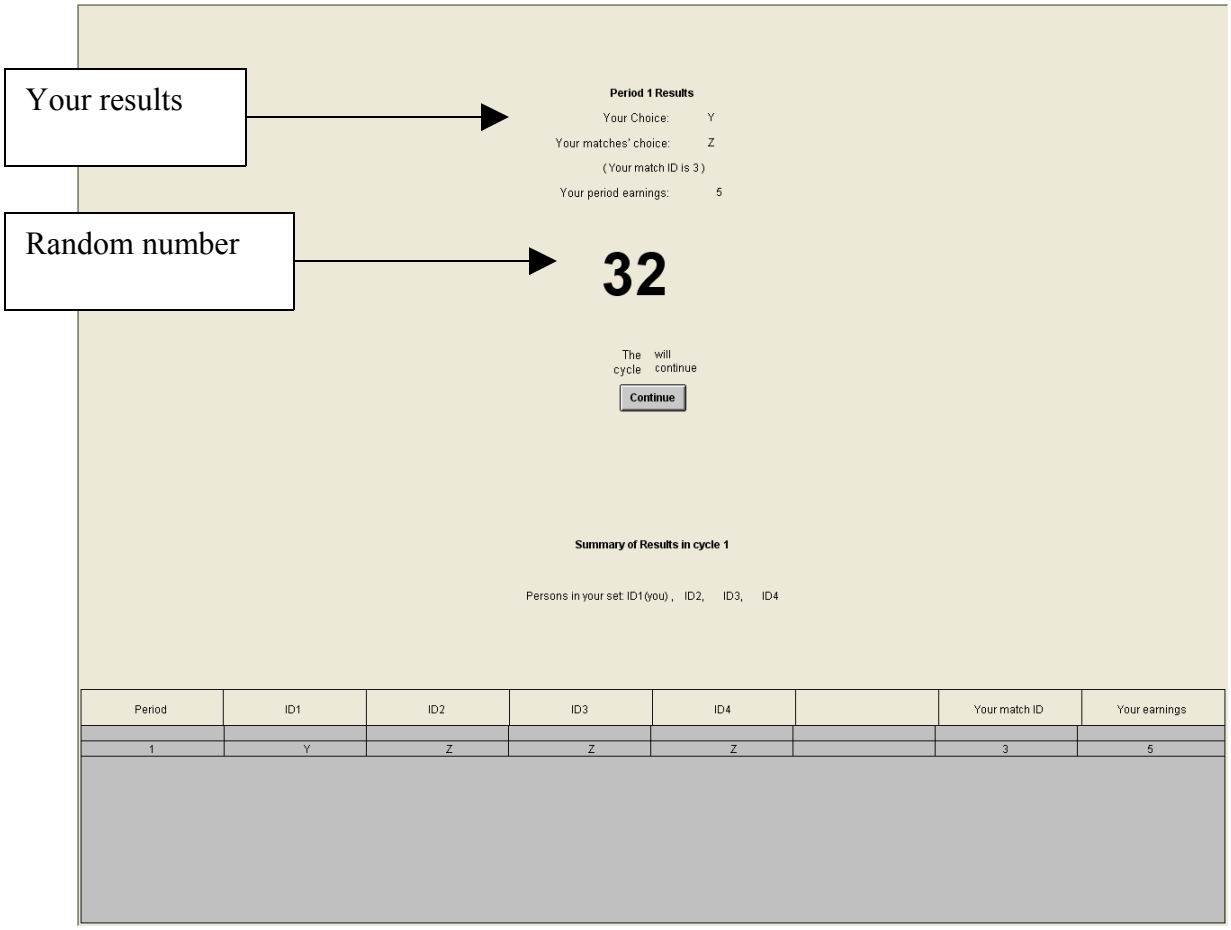
If both of you choose Y this period then: you both earn ***25*** points.

If you choose Y this period and your match chooses Z then: you earn ***5*** points and your match earns ***30*** points.

If you choose Z this period and your match chooses Y then: you earn ***30*** points and your match earns ***5*** points.

If you both choose Z then: you both earn ***10*** points.

To make your choice in each period, click the button next to either Y or Z. You may change your mind any time prior to clicking the "Submit" button by simply clicking on the button next to Y or Z. You are free to choose Y or Z in every period. When you are satisfied with your choice, click the "Submit" button. After all persons have made their choices, the results of the period will appear on your screen.



The result screen (above) will display the number of points you have earned for the period as well as **the choices of all four persons in your set with their corresponding IDs**. Please record your results for the period on your RECORD SHEET under the appropriate headings.

At this stage a ball will be drawn from an urn containing hundred balls numbered from 1 to 100. Each ball is equally likely to be selected. The computer program will randomly draw a ball and show the number on the result screen (above). If this random number is less than 96, the cycle will continue into the next period. If this number is greater than 95 the sequence is over. Therefore, **after each period there is a 95% chance that there will be another period of interactions in the cycle and a 5% chance that the cycle will end**.

Suppose that a number less than 96 has been drawn. Then you press the "Continue" button to proceed. You will face the same decisional situation as in the previous period, but **with**

a person selected at random from the set of participants you were assigned to. Remember that there are four participants in each set.

Before making your choice, you may review all the outcomes in the cycle by scrolling down the "Summary of Results" table. The table shows the individual histories of each person in your set. You then choose either Y or Z. Your choice and the choice of the person with whom you are matched this period are recorded and added to the Summary of Results table at the lower portion of your screen. You record the outcome and your point earnings for the period.

If the number drawn is greater than 95 then the cycle ends. When a cycle ends, you will be notify in a new screen. There will be a total of five cycles. The rules in the following cycles are the same than in the first but the identity of the persons you will interact with will change. After each cycle, participants will be assigned to a new set of persons. This assignment is random and does not depend on actual choices. **A participant will never interact with a person for more than one cycle.**

Earnings

The points you earned in each period are added up. For every 10 points that you earn you will receive 13 cents ($.13). Therefore, the more points you earn the more money you earn. You will be paid your earnings in cash and in private at the end of today's session.

Final Comments

First, do not discuss your choices or your results with anyone at any time during the experiment.

Second, your ID# is private. Do not reveal it to anyone.

Third, since there is a 95% chance that at the end of a period the cycle will continue, you can expect, on average, to interact for 20 periods in a given cycle. However, since the stopping decision is made randomly, some cycles may be much longer than 20 periods and some anothers may be much shorter.

Fourth, remember that after each period you will be matched randomly to someone in the set you were assigned to. You know the ID # of the participants with whom you are matched to.

Fifth, the rules are the same in all five cycles. After a cycle, you will never meet again the same participants.

Questions?

Now is the time for questions. Does anyone have any questions before we begin?

QUIZ

1. The total number of **cycles** is _____

2. You are at the beginning of the cycle. How many **periods** do you expect the cycle will last, on average? _____

3. You are in period 15 of the cycle. How many additional **periods** do you expect, on average? _____

4. The number of **participants** in the experiment (total in the room) is_____

5. In a given **cycle** with how many participants could you interact with (i.e. number of people in a set)? _____

6. In a given **period** with how many participants do you interact with? _____

7. Other than your match, will you know at the end of the period the actions taken by people **in your set**? _____

8. Will you know at the end of the period the actions taken by participants **outside your set**? _____

9. Before choosing an action, will you know the **ID** of your match? _____

10. If ID 5 is in your set this cycle, is there any chance that ID 5 will be your match in future cycles? _____

11. How many points do you earn if both you and your match choose **Y**? _____

12. If the experiment lasts 100 periods and everybody always chooses **Y**, how many dollars are your going to earn? _____

13. How many points do you earn if you and your match choose **Z**? _____

14. If the experiment lasts 100 periods and everybody always chooses **Z**, how many dollars are your going to earn? _____

ID ____ DATE _______________

RECORD SHEET

Cycle	Period	Stage 1		Stage 2		Your earnings	Cumulative earnings
		Your choice (Y/Z)	Choice of your match (Y/Z)	Your choice (no/yes)	Choice of your match (no/yes)		

Instructions for the private monitoring treatment, n=14

Overview

This is an experiment in decision-making. Purdue University has provided funds for this research. The instructions are simple. If you follow them carefully and make good decisions, you can earn an appreciable amount of money. These earnings will be paid to you in cash at the end of the experiment.

We ask that you not talk with one another for the duration of the experiment. Please turn off your cell-phones. Do not use e-mail.

During the course of this experiment, you will be called upon to make decisions in each of several periods.

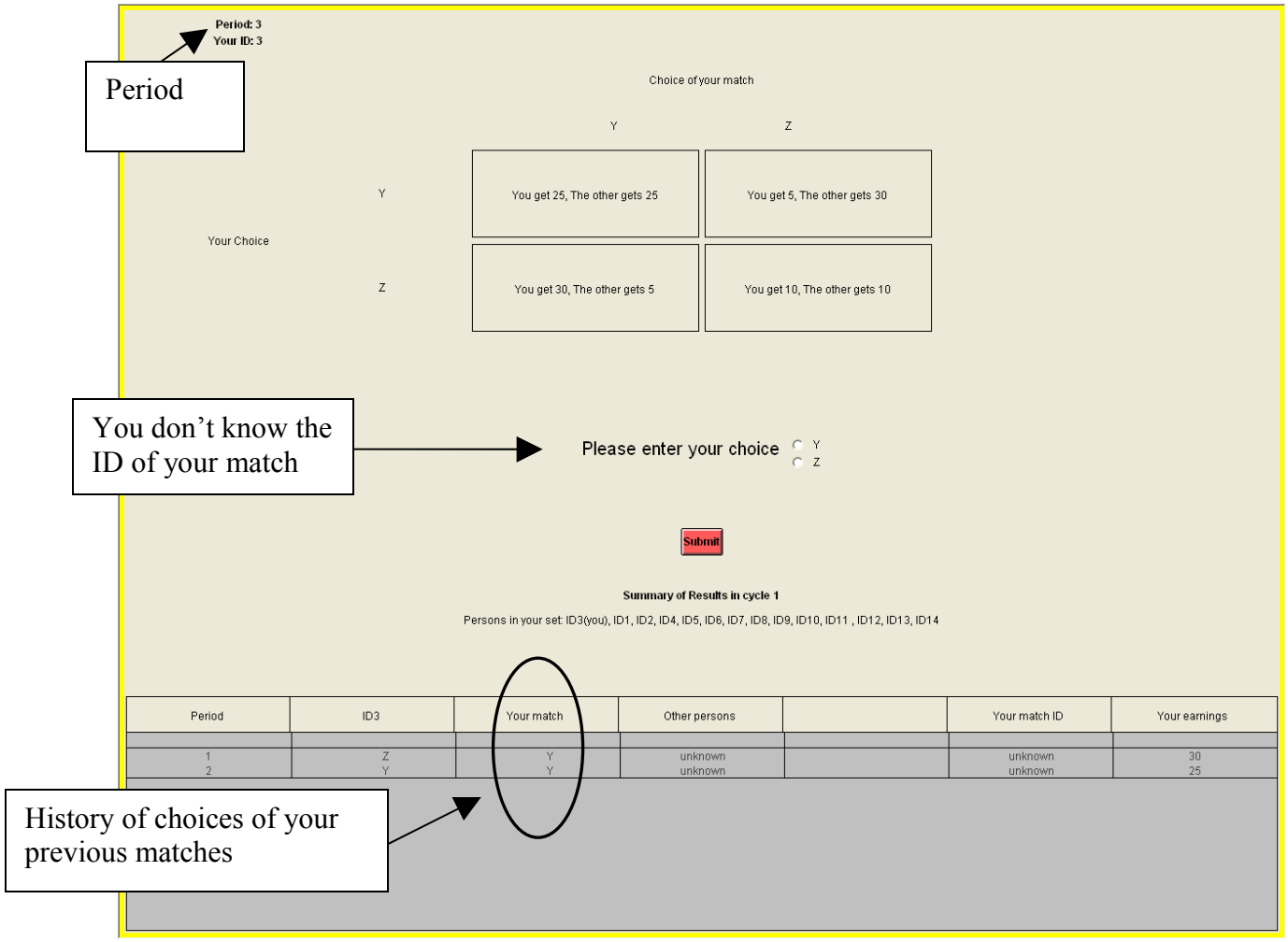
In each period, you may interact with any participant in the room. There are 14 participants in the room.

- In each period you will be matched to one other participant selected at random from the room. We will refer to this person as "**your match**."

- You will not be informed of the identity of your match. Hence, you do not know when you have already interacted with that person in previous periods.

- You and your match will interact according to the rules described in the upper portion of your screen. The rules will be explained in a moment.

- After each period you will be re-matched to a participant chosen at random from the room. There is one chance out of thirteen that you will be matched with any given person in the room.



Interaction rules

In a period you and your match can make either of two choices, Y or Z. The points you earn in a period depend upon both the choice you make and the choice made by your match in that period. As the payoff table on your screen (above) indicates, there are four possible outcomes:

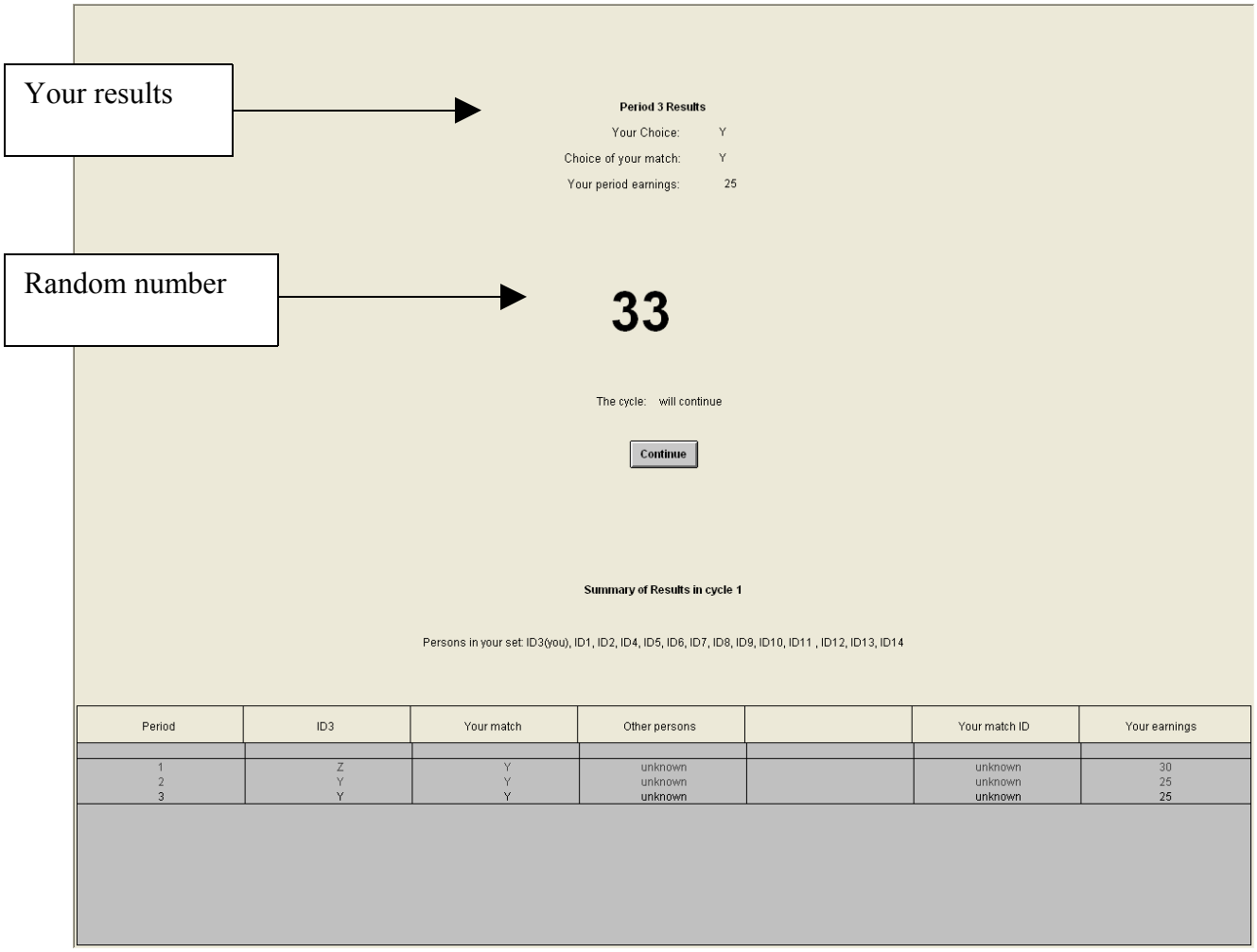
1. If both of you choose Y this period then: you both earn ***25*** points.

2. If you choose Y this period and your match chooses Z then: you earn ***5*** points and your match earns ***30*** points.

3. If you choose Z this period and your match chooses Y then: you earn ***30*** points and your match earns ***5*** points.

4. If you both choose Z then: you both earn ***10*** points.

To make your choice in each period, click the button next to either Y or Z. You may change your mind at any time prior to clicking the "Submit" button by simply clicking on the button next to Y or Z. You are free to choose Y or Z in every period. When you are satisfied with your choice, click the "Submit" button. After all persons have made their choices, the results of the period will appear on your screen.



The result screen (above) will display the number of points you have earned for the period along with **your choice and the choice of your match.** The first column of the 'Summary of Results' table contains your past choices. The second column concerns the choices of your previous matches. Notice that **choices in the second column were most likely made by different persons in different periods. You are not given information on the choices made by the other persons in the room**. Please record your results for the period on your RECORD SHEET under the appropriate headings.

At this stage a ball will be drawn from an urn containing one hundred balls numbered from 1 to 100. Each ball is equally likely to be selected. The computer program will randomly draw a ball and show the number on the result screen (above). If this random number is less than or equal to 95, then the experiment will continue into the next period. If this number is greater than 95, then the experiment ends. Therefore, **after each period there is a 95% chance that there will be another period of interactions and a 5% chance that the experiment will end**.

Suppose that a number less than or equal to 95 has been drawn. Then you press the "Continue" button to proceed. You will face the same decisional situation as in the previous period, but **with a person selected at random from the participants in the room**. Remember that there are fourteen participants in the room.

Before making your choice, you may review all the outcomes in previous periods by scrolling down the "Summary of Results" table. The table shows your history and the past choices of the persons who happened to be your match in the period. You then choose either Y or Z. Your choice and the choice of your match this period are recorded and added to the Summary of Results table in the lower portion of your screen. You record the outcome and your point earnings for the period.

If the number drawn is greater than 95 then the experiment ends.

Earnings

The points you earned in each period are added up. For every 10 points that you earn you will receive 13 cents ($.13). Therefore, the more points you earn the more money you earn. In addition, you will receive a $10 show-up fee. You will be paid your earnings in cash and in private at the end of today's session.

Final Comments

First, do not discuss your choices or your results with anyone at any time during the experiment.

Second, your ID# is private. Do not reveal it to anyone.

Third, since there is a 95% chance that at the end of a period the experiment will continue, you can expect, on average, to interact for 20 periods. However, since the stopping decision is made randomly, the experiment may be much longer than 20 periods or may be much shorter.

Fourth, remember that after each period you will be matched randomly to someone in the room. As there are fourteen people in the room, the probability of you being matched with the same person in two consecutive periods is 1/13. You are not told the identity of your match.

Questions?

Now is the time for questions. Does anyone have any questions before we begin?