Appendix A (not for publication)

Details and Proofs of Propositions

1 The model

A group is composed of $N = 2n$ identical players. On the initial period $t = 1$, the population is randomly divided into $n \geq 2$ *consumers* (="blue," in the experiment) and n *producers* ("red"); each player has equal probability of being assigned either role. In all subsequent periods players deterministically alternate between these two roles; producers in period t become consumers in $t + 1$, and vice-versa.

Matching in a period: An exogenous matching process randomly partitions the population into n consumer-producer pairs in each period t. Pairings are random, equally likely, and independent over time. Given that there is an equal number n of consumers and producers, there are $n!$ ways to create n consumer-producer pairs. Let $o_i(t)$ be player i's opponent in period t. Fixing some player $j \neq i$, it holds that $o_i = j$ in $(n-1)!$ of all possible pairs. Hence, in each period any given consumer is matched to any of the n producers with probability $1/n$ (and vice-versa).

Interaction in a pair: In Baseline, only the producer has a choice to make, either Z or Y. If Z is the outcome, then g is the payoff to the consumer and 0 is the payoff to the producer. If Y is the outcome, then d is the payoff to the consumer, while the producer obtains $d - l$ with $-l \leq 0 \leq d < g$; see Figure 1. The outcome Z is called *cooperation* because it generates $g - 2d + l > 0$ surplus, where $g - (d - l)$ is the consumer's share and $-d$ is the producer's share. The outcome Y is called *defection*, as it generates no surplus. The interpretation is that there are gains from specialization and trade: producers have a specialized perishable good, which gives more consumption utility to consumers than producers. Define the (socially) efficient outcome in a match as the one in which total surplus is maximized. Cooperation is efficient but is *not* mutually beneficial. Defection is the unique Nash equilibrium of a one-shot interaction.

The supergame: consider an infinite repetition of the interaction, indexing time $t = 1, 2, \ldots$. Period payoffs are geometrically discounted at rate $\beta = 0.75$ starting from period

$T = 20$. Histories are private information, but at the end of each period, players can observe the actions of their opponent and if outcome are identical in all meetings. We call this anonymous public monitoring because it allows public detection of defections on the equilibrium path but it does not allow players to identify opponents. These assumptions imply that players can neither build a reputation nor engage in relational contracting. Payoffs in the repeated game are the sum of expected period-payoffs, discounted starting on period T. In the repeated game, the efficient outcome corresponds to cooperation in each meeting of every period.

Matching across supergames: In each experimental session we created five supergames ensuring that no two subjects could be paired in more than one supergame. Groups are created as follows. In each supergame there are three groups with eight subjects each. Four are of type 1 (beginning producer) and four of type 2 (beginning consumer). Type 1 subjects can only meet type 2 subjects and viceversa. The 24 subjects are partitioned in 6 sets of 4 each: $A = \{1, 2, 3, 4\}$, $B = \{5, 6, 7, 8\}$, ..., $F = \{21, 22, 23, 24\}$. The sets A through F are fixed for the duration of the session and are paired in each supergame to form groups. During the session subjects are matched to subjects from other sets. The groups can be read in the table below.

	Pair this set...					
	A	B	C	D	E	F
...to this set in supergame 1	C	E	A	F	B	D
...to this set in supergame 2	B	A	F	E	D	C
...to this set in supergame 3	D	C	B	A	F	E
...to this set in supergame 4	E	F	D	C	A	B
...to this set in supergame 5	F	D	E	B	C	A

That is in supergame 1, group 1 is composed of sets $\{A, C\}$, group 2 of sets $\{B, E\}$ and group 3 of sets $\{D, F\}$, and so on.

2 Existence of a cooperative equilibrium

To support full cooperation as an equilibrium outcome we consider a grim trigger strategy described by a two-state automaton.

Definition 1 (**Cooperative strategy**). *At the start of any period t, player i can be "active" or "idle," and takes actions only as a producer. As an active producer, player i selects Z, and as an idle producer selects Y. The player starts active on the initial date $t = 1$; in all $t \geq 1$*

(i) *if player i is active, then i becomes idle in $t + 1$ only if some producer in the group—not necessarily the producer in $\{i, o_i(t)\}$—chooses Y. Otherwise, player i remains active;*

(ii) *There is no exit from the idle condition.*

We call (full) cooperation the outcome that results when everyone adopts the strategy in Definition 1. If everyone adopts this strategy, then this strategy is called a **social norm**. Intuitively, this norm consists of a rule of cooperation and rule for punishment: (i) Cooperation: if the player is a producer, then he selects Z; (ii) Punishment: if an outcome Y is observed in the group, then the player will always select Y whenever he is a producer. The central feature of this norm is that the entire group participates in enforcing defections but in equilibrium no one ever defects. In what follows we show that, under this social norm, cooperation is a sequential equilibrium if β is sufficiently large.

Proposition 3. *if $\beta \geq \beta^* := \dfrac{d}{g - d + l}$, then the strategy in Definition 1 supports full cooperation in equilibrium.*

The proof is contained in the remainder of this section. Start by calculating equilibrium payoffs. Recall that players deterministically alternate between the two roles of producer and consumer. Hence, in equilibrium players earn g every other period. Discounting kicks in on date T, hence, only payoffs from periods $t = T + 1$ (included) are discounted at rate β. Let $v_s(t)$ denote the equilibrium payoff at the start of $t = 1, 2, \ldots$ to a player who is in state $s = 0, 1$, where $0 =$producer and $1 =$consumer.

Lemma 1. *Fix $T \geq 1$ and $\beta \in (0,1)$. In cooperative equilibrium we have $v_1(t) > v_0(t)$ for all $t = 1, 2, \ldots$, where*

$$v_s(t) := \begin{cases} g \times \dfrac{T-t}{2} + v_s, & \text{if } \ T-t = 2k \\ g \times \dfrac{T-t+1}{2} + \beta v_s, & \text{if } \ T-t = 2k-1, \\ v_s, & \text{if } \ T-t \leq 0, \end{cases} \tag{1}$$

and

$$v_s := \frac{\beta^{1-s}}{1-\beta^2} \times g \qquad \text{for } s = 0, 1.$$

Proof of Lemma 1. To prove the result we consider the two cases $t \geq T$ and $t < T$ separately.

Let v_s denote the equilibrium payoff at the start of period $t \geq T$ to a player who is in state $s = 0, 1$ (0 identifies a producer). It holds that

$$v_s := \frac{\beta^{1-s}}{1-\beta^2} \times g \qquad \text{for } s = 0, 1.$$

The payoff is time invariant because of the stationary alternation between states.

Now consider period $t < T$. According to the proposed strategy those who are initial consumers earn g on odd dates ($t = 1, 3, \ldots$) and zero otherwise, while initial producers earn g on even dates ($t = 2, 4, \ldots$) and zero otherwise. Hence, knowing whether $T - t$ is odd or even matters. For $j, k = 1, 2 \ldots$ and $s = 0, 1$ it holds that

$$v_s(t) = \begin{cases} g \times \dfrac{T-t}{2} + v_s & \text{if } \ T-t = 2k \\ g \times \dfrac{T-t+1}{2} + \beta v_s & \text{if } \ T-t = 2k-1. \end{cases}$$

The continuation payoff $v_s(t)$ has two components. The first sums up the period payoffs for all $t \leq T-1$. The second sums up the period payoffs for all $t \geq T$. It should be clear that $v_s(t)$ is increasing in T for $s = 0, 1$ and it achieves a minimum when $T - t = 1$.

The equilibrium payoff to a player in state $s = 0, 1$ on any date $t \geq 1$ is given by (1). We have $v_1(t) > v_0(t)$ for all t because $v_1 > v_0$ for all $\beta \in (0, 1)$. $\square$

The equilibrium payoff is found simply by substituting $t = 1$ in (1).

2.1 Incentives in and off equilibrium

To determine the optimality of the cooperative strategy we must check two items: (i) In equilibrium no producer has an incentive to defect; (ii) out of equilibrium no producer has an incentive to cooperate. We let $\hat{v}_s(t)$ denote the continuation payoff to a player in state s on date t, off equilibrium.

In equilibrium no producer defects: Conjecture that the strategy in Definition 1 is a social norm. Consider a generic producer in a period $t \geq 1$; choosing Z is a best response if

$$v_0(t) \geq \hat{v}_0(t). \tag{2}$$

The left-hand-side of the inequality denotes the payoff to a producer who cooperates in the period, choosing Z. The right-hand-side denotes the continuation payoff on date t if the producer defects in equilibrium (reverting back to playing the social norm in the following period), given that off-equilibrium everyone follows the group punishment rule prescribed by the social norm. Hence, if a defection occurs on t, then every producer selects Y from $t+1$ because equilibrium defections are public.

It should be clear that

$$\hat{v}_0(t) = \hat{v}_0 := \frac{d + \beta(d-l)}{1-\beta^2} \qquad \text{if } t \geq T.$$

For $k = 1, 2, \ldots$, the continuation payoff off-equilibrium satisfies

$$\hat{v}_0(t) := \begin{cases} (d + d - l) \times \dfrac{T-t}{2} + \hat{v}_0 & \text{if } \ T - t = 2k \\ (d + d - l) \times \dfrac{T-t+1}{2} + \beta\hat{v}_0 & \text{if } \ T - t = 2k-1, \\ \hat{v}_0 & \text{if } \ T - t \leq 0. \end{cases} \tag{3}$$

Off equilibrium payoffs are independent of the size of the group N since producers defect forever after seeing a defection.

Lemma 2. *Fix $T \geq 1$ and $\beta \in (0,1)$. If*

$$\beta \geq \beta^* := \frac{d}{g-d+l},$$

then $v_0(t) \geq \hat{v}_0(t)$ for all $t = 1, 2, \ldots$.

Proof of Lemma 2. The result is obtained by manipulation of the equations in (3). Note that

$$v_0 - \hat{v}_0 = \frac{\beta}{1-\beta^2} \times g - \frac{d + \beta(d-l)}{1-\beta^2} = \frac{\beta}{1-\beta^2} \times (g - 2d + l) - \frac{d}{1+\beta}$$

Now define

$$\begin{aligned} \Delta_0(t) &= v_0(t) - \hat{v}_0(t) \\ &= \begin{cases} (g-2d+l) \times \dfrac{T-t}{2} + v_0 - \hat{v}_0 & \text{if } \ T-t = 2k \\ (g-2d+l) \times \dfrac{T-t+1}{2} + \beta(v_0 - \hat{v}_0) & \text{if } \ T-t = 2k-1, \\ v_0 - \hat{v}_0 & \text{if } \ T-t \leq 0. \end{cases} \end{aligned}$$

It is immediate that $\Delta_0(t = T-2k) > \Delta_0(t \geq T)$; simply note that $g - 2d + l > 0$ by assumption. Also, $\Delta_0(t = T - 2k + 1) > \Delta_0(t \geq T)$; to prove it insert $k = 1$ (the most stringent case), rearrange the inequality, and then insert the expression for $v_0 - \hat{v}_0$, to obtain the inequality $g - 2d + l > -d$.

Given that the minimum value of $\Delta_0(t)$ is achieved for $T - t \leq 0$, then (2) holds for all t whenever

$$\begin{aligned} 0 &\leq v_0 - \hat{v}_0 = \frac{\beta}{1-\beta^2} \times (g-2d+l) - \frac{d}{1+\beta} \\ &\Leftrightarrow \beta \geq \beta^* := \frac{d}{g-d+l}. \end{aligned}$$

Note that $\beta^* < 1$ because $g - 2d + l > 0$ by assumption.[1] □

Out of equilibrium no producer cooperates: given that everyone else follows the candidate strategy in Definition 1, it is always individually optimal to punish out of equilibrium.

[1] The producer's payoff from cooperating is normalized to zero. For generality, let it be $c < d$, instead. In this case it is easy to demonstrate that we have $\beta^* := \dfrac{d-c}{g-d+l}$ because $v_0 = \dfrac{c+\beta g}{1-\beta^2}$.

A producer optimally selects Y out of equilibrium, since Y is the dominant action when everyone forever defects. If a producer selects Z instead of Y out of equilibrium—and reverts to play Y afterward—he earns 0 and the continuation payoff is $\beta\hat{v}_1(t)$, because he starts next period as a producer, off-equilibrium. By selecting Y this period, as required by the social norm, he earns $d > 0$ and the continuation payoff is $\beta\hat{v}_1(t)$.

Note that $\hat{v}_s(1)$ is the payoff associated to infinite repetition of the static Nash equilibrium (every producer always chooses Y), which is always an equilibrium of the repeated game. The condition $\beta \geq \beta^*$ is therefore necessary and sufficient for existence of a cooperative equilibrium because it ensures that players earn payoffs above those guaranteed by defecting at any point in time. The condition $\beta \geq \beta^*$ does not guarantee that cooperation will be realized because many equilibria exist in the game. Given the experimental parameters, we have $\beta^* = 3/8 = 0.375$. It follows that the fully cooperative equilibrium exists in the Baseline condition because in the experiment $\beta = 0.75$. Furthermore, this equilibrium exists in all treatments because tokens and balances are intrinsically worthless, do not restrict the action set, and can always be ignored.

3 Existence of monetary equilibrium

Consider the Money treatment. Each of the $N/2$ initial consumers is initially endowed with one indivisible, intrinsically worthless token. The supply of tokens is fixed at $M = N/2$. It is assumed that token holdings are partially observable by the opponent: in each pair, each player can verify whether the opponent has either 0 or at least one token; the exact number is unobservable. Consider the following strategy.

Definition 2 (**Monetary trade strategy**)**.** *In any period t, after any history, if the player is*

- *without tokens: she has no action to take as a producer; chooses Z conditional on receiving a token, as a consumer;*
- *with tokens: as a consumer she transfers one token to the producer conditional on Z*

being the outcome; as a producer she selects Y.

We call *monetary trade* the outcome that results when everyone adopts the strategy in Definition 2. Under monetary trade help is given quid-pro-quo in exchange for a token. Otherwise, help is not given and each player exits the match with their initial endowment. Monetary trade is an equilibrium that sustains the socially efficient allocation on the same parameter set as the use of the social norm. The reason is that in monetary equilibrium all meetings lead to a trade due to the deterministic alternation between consumption and production opportunities. This is demonstrated in what follows.

Proposition 4. *If $\beta \geq \beta^*$, then the monetary trade strategy in Definition 2 supports full cooperation in equilibrium.*

Proof of Proposition 2. Conjecture that monetary trade is an equilibrium. Consider a player with token balance $s = 0, 1$ at the start of a period. In equilibrium, a consumer has a token and a producer has none. Hence, the probability that a consumer with a token meets a producer without tokens is 1. Denote by $v_s(t)$ the equilibrium continuation payoff. Because the consumption pattern is the same as under the social norm, in monetary equilibrium it holds that $v_s(t)$ corresponds to the functions defined in (1).

Now consider deviations. We start by proving that a consumer does not deviate in equilibrium, refusing quid-pro-quo exchange for Z. In period $t \geq 1$ let $\beta_t = 1$ if $t < T$ and $\beta_t = \beta$ otherwise. Denote by $\tilde{v}_1(t)$ the payoff in t to a consumer who defects by refusing to spend money in t.

Deviations from the trading strategy alter the distribution of tokens, whose evolution depends on the outcome of the random matching process. Here, for simplicity, we consider only the case in which the incentive to deviate is the strongest, which is when the distribution of tokens reverts to equilibrium two periods after the defection. For this to occur, in the period following the initial deviation, the deviator must be matched again to his previous counterpart. This implies that the deviator is punished just for one period.

Using recursive arguments we have

$$
\begin{aligned}
\tilde{v}_1(t) &= d - l + \beta_t[d + \beta_{t+1} v_1(t+2)] \\
&< g + \beta_t[0 + \beta_{t+1} v_1(t+2)] = v_1(t).
\end{aligned}
$$

The inequality holds for any β_t because $g > d + d - l$ by assumption. To understand the inequality, consider the first line. Defecting in t generates payoff $d - l$ instead of g, and in $t+1$ the player will be a producer *with* money, reverting back to playing the monetary strategy (unimprovability criterion). Hence, she will refuse to sell for another token because she already has one; this is optimal because (i) acquiring an additional token costs her d and (ii) she has already one token to spend. hence, in $t+2$ the player becomes a consumer with money and the distribution of tokens is back at equilibrium. In summary, following a unilateral deviation in t by a consumer, the group is back on the equilibrium path in period $t+2$.

Now we prove that if $\beta \geq \beta^*$, then a producer in equilibrium would not want to deviate in any t, refusing to help for a token. Let $\tilde{v}_0(t)$ be the payoff in t to a producer who defects by refusing to accept money in t:

$$
\begin{aligned}
\tilde{v}_0(t) &= d + \beta_t[d - l + \beta_{t+1} v_0(t+2)] \\
&< 0 + \beta_t[g + \beta_{t+1} v_0(t+2)] = v_0(t).
\end{aligned}
$$

The inequality holds for any $\beta_t \geq \beta^*$ because $g > d + d - l$ (if $\beta_t = 1$) and if $\beta_t = \beta$ then we need $\beta \geq \beta^*$. The first line of the inequality shows that defecting in t gives payoff d instead of 0. In $t+1$ the player is a consumer *without* money, thus unable to buy help—since everyone follows the monetary strategy—and earns $d - l$. In $t+2$ she is a producer without money and the distribution of tokens is back at equilibrium. Hence, after a unilateral deviation in t by a producer, the group is back in equilibrium in period $t+2$. □

4 Equilibrium with record-keeping

Consider Memory. Each player is initially assigned a balance, "1" if consumer and "0" if producer, which is automatically updated at the end of each period. The player's balance may rise or fall by one unit, or may remain the same, depending on the outcome in the pair. Balances in a pair are unchanged if Y is the outcome. Otherwise, if Z is selected, then the producer's balance increases by 1 and the consumer's balance falls by 1. Hence, the sum of all balances is fixed at $N/2$ in each period and over the course of the game the individual balance may take negative or positive integer values. It is assumed that player sees whether the opponent's balance is L (="0 or below") or H (="1 or above"). The exact balance is private information. Balances allow players to replicate monetary trade without the need to exchange objects.

Definition 3 (Trade strategy). *At the start of any period t and after any history, if player i is a consumer, then he has no action to take. If player i is a producer with balance L, then she chooses Z only if the consumer has a balance H; she selects Y in all other circumstances.*

Hence, if $\beta \geq \beta^*$ then the strategy in Definition 3 supports the fully cooperative equilibrium. The same analysis done for the monetary trade strategy can be used here. As in the case of monetary trade, if a producer deviates from equilibrium, then in the best-case scenario the group recovers the equilibrium distribution of balances in two period of play, as seen before.[2]

5 Why liquidity constraints matter

Here, we provide a simple theoretical explanation for why liquidity constraints can make money superior to memory. Consider any treatment in which each of the $N/2$ initial consumers is initially endowed with a unit of balances, either in terms of tokens, or of record-keeping. We say that a treatment in which the trading strategy is available supports trading

[2]To see this, suppose player j on period t is a producer who deviates, in equilibrium. As a consequence, his balance remains zero. Next period, player j is a consumer with 0 balance and has no action to take. The producer who meets j on date $t+1$ does not cooperate, so j enters next period still with 0 balance, as a producer. On $t+2$ player j, having reverted to playing the equilibrium strategy, cooperates. We are thus back on the equilibrium path.

equilibrium with liquidity constraints if players' balances cannot become negative. It follows that trading equilibrium with liquidity constraints can be supported only in Money, through the exchange of tokens. By contrast, there are no liquidity constraints in Memory and Money Unconstrained.

To explain why removing liquidity constraints may harm cooperation and efficiency, we add a behavioral component to the theory. Suppose the population is composed of two types of players: a share $1-p$ of players is *rational*, and a share p is *behavioral.* Rational players maximize earnings by choosing between two strategies: free-riding—i.e., always defecting by never helping as a producer—or the trade strategy, i.e., help only consumers with balance H when the player is a producer with a balance L. Rational players, adopt the trading strategy if it delivers a higher payoff than "always defect." By contrast, behavioral players follow a fixed rule: as consumers they always give a token in exchange for help, when this is possible; as producers they fall into two classes: altruistic or quid-pro-quo. Specifically, *altruistic* players unconditionally help consumers because of pro-social preferences. *Quid-pro-quo* players help as long as this increases their balance.

A first important observation is that in fully cooperative equilibrium the presence of behavioral types is irrelevant. All players act identically because all producers have balance L, while consumers have balance H. Because the consumption pattern is the same as under the social norm, it holds that in equilibrium a producer with balance 0 has long-run payoff v_0^p while a consumer with balance 1 has payoff v_1^c where these payoffs correspond to[3]:

$$v_0^p = v_0 = \frac{\beta}{1-\beta^2} \times g \quad \text{and} \quad v_1^c = v_1 = \frac{g}{1-\beta^2}.$$

The presence of behavioral types matters off-equilibrium, so it affects the incentives to deviate from the equilibrium path, refusing to help. The crucial difference between altruists and quid-pro-quo players is that the former help any consumer who has balance L, even if doing so does not increase the altruist's balance. A quid-pro-quo player does not behave like traders because she helps whenever she can increase her balance (even if the consumer's balance is L). As a consequence, the presence of quid-pro-quo players only matters when

[3]Here, for simplicity, each round is discounted at rate β (i.e., there are no fixed rounds).

balances can go negative. To see why this is so, we calculate the long-run payoff for a producer who has balance L at the start of a period.[4]

Recall that, without behavioral types, in monetary equilibrium if $\beta \geq \beta^* = \dfrac{d}{g-d+l}$, then a producer with balance L would not deviate and free-ride: free-riding is suboptimal because it prevents the player from obtaining a token from traders. A free-rider will thus never obtain help from anyone.

With behavioral types this is no longer true, because a consumer with a balance L can obtain help from altruists (always) and from quid-pro-quo players (when the balance can go negative). Consider a situation in which balances can go negative: one can prove that the incentive to free-ride for a rational player is higher than in the case without behavioral types. The player would choose to trade only if $\beta \geq \hat{\beta}(p) > \beta^*$. To see this, notice that someone who chooses to free ride will constantly have a balance L. Let $\tilde{v}_0^p$ be the payoff to a producer who has a balance L. Using recursive arguments, we have

$$\tilde{v}_0^p = d + \beta[pg + (1-p)(d-l) + \beta\tilde{v}_0^p] \quad \Rightarrow \quad \tilde{v}_0^p = \frac{d + \beta[pg + (1-p)(d-l)]}{1-\beta^2}$$

On the right-hand side of the first expression, d corresponds to the producer's current payoff from refusing to help. The following period the player is a consumer with balance L. If she meets a behavioral type (with probability p) she earns g because both quid-pro-quo and altruists will help a consumer when balances can go negative. Instead, she earns $d-l$ if she meets a trader (who does not help). The continuation payoff remains $\beta\tilde{v}_0^p$ as the player's balance is constantly L.

It follows that if $\tilde{v}_0^p \leq v_0$, then the payoff from free-riding is lower than the payoff from choosing the trading strategy which implies

$$\beta \geq \hat{\beta}(p) := \frac{d}{(1-p)(g-d+l)}.$$

Instead, when balances cannot go negative, quid-pro-quo players behave identically to

[4]We can simply focus on the actions of producers because—following the proof of existence of monetary equilibrium—consumers with tokens are at least weakly better off by offering one token to producers (while they have no action to take otherwise).

traders so they do not help a consumer with balances L. Since $\hat{\beta}(p)$ is increasing in p, it follows that the incentives to free-ride are smaller in this case, as compared to when balances can go negative, where p is bigger as it includes both altruists and quid-pro-quo players. Given our parametrization, this simple theory suggests that a rational player should free-ride when at least half of the population is composed of behavioral types.

Appendix B (not for publication)

Design and Results: Additional Information

1 Design specifics in Money and Memory

We call Token an electronic object that is intrinsically worthless because holding it yields no extra points or dollars, and it cannot be redeemed for points or dollars at the end of any supergame. Tokens can be carried over to the next period but not to the next supergame. Tokens can be transferred from consumer to producer, one at a time. There is no upper bound on token balances and there is a lower bound of zero. Because outcome and actions are observed only at the end of each meeting, subjects cannot signal their desire to cooperate by requesting or offering a token. These same considerations apply to Memory with the difference that there is no lower bound on balances and that consumers are always passive.

The spontaneous use of tokens as money

In a meeting, consumer and producer make simultaneous selections from their choices sets, without prior communication. Choices are observable at the end of the meeting, to speed up learning in the game. Choices that are incompatible lead to the status quo. This design ensures that subjects can neither incur involuntary losses, nor can garnish their opponent's token holdings or earnings. If subjects choose to conditionally trade help for a token, then this would suggest that tokens have acquired value endogenously.

Second, to avoid biasing the results in favor of the emergence of monetary exchange the design includes actions that are antithetical to monetary exchange. By choosing Z *for* 0, the producer commits to execute Z only if the consumer chooses *give* 0. By choosing 1 *for* Y, the consumer commits to transfer a token if the producer *avoids* the choice Z. Hence, tokens may take on a negative connotation as subjects could use them to tag producers who do not provide unconditional help. Given this richer action set, the addition of tokens might increase coordination problems relative to Baseline.

The actions Z *for* 0 and 1 *for* Y are antithetical to monetary exchange. The outcome function specifies that a producer executes Z only if the consumer keeps her token, while the consumer keeps her token only if the producer unconditionally helps. These actions are consistent with money having a negative connotation because they allow subjects to tag opponents as defectors. To see this consider that there are two types of players in each period, A (who starts the supergame as consumers with one token) and B (who starts as a producer without a token). A-consumers can tag as defectors B-producers by giving them a token if they do not help. Consequently, B-producers "help" only if their opponent keeps her token. On the other hand, A-consumers are identified as cooperators only if they *do* have a token, hence would ask for a token if they are producers without one; in that match, a B-consumer would gladly get rid of her token. Within this richer choice set, subjects have more trouble in discovering the potential use of tokens as money.

	Token holdings	
Period	**Producer**	**Consumer**
t=1	0	1
t=2	1	0
t=3	0	1
t=4	1	0
⋮	⋮	⋮

Table B.1: Using tokens to tag defectors

Possible and impossible trades

Token transfers could not take place in every circumstance off equilibrium. Trade is possible when the consumer has at least 1 token. Otherwise, trade is impossible, in which case consumer and producer have a restricted choice set. In the experiment, a consumer with 0 tokens had no action to take (=do nothing), and his producer opponent could only choose between Y and Z. Subjects were informed whether trade was possible before making a choice in a way that minimized the chance that such information would indirectly reveal identities. Each player observed whether his opponent had either 0 or "1 or more tokens." Providing information about token holdings reduces the cognitive load for participants when making a decision and when interpreting the outcome.

Monitoring of past actions

In all treatments subjects could observe on their screens the results of every past period of the supergame. The information included the outcome of the encounter, Y or Z, and whether the outcomes were identical in every pair of the group. In Money, subjects also observed whether a token was transferred in the encounter. This information was also visible at all times on the screen and included all past periods. Each subject had also a pen and a sheet of paper to fill in with the results. Requiring manual writing is a standard procedure in experimental economics for the purpose of maintaining participants alert to the ongoing session and to make sure that subjects are aware of the outcome of interactions as the experiment unfolds. The same procedure was followed in all treatments. If subjects wanted to rely on history-dependent strategies, such as trigger strategies, they could easily access information about past outcomes either on the screen or on paper. This design feature could have biased the results against the use of tokens as money.

2 Additional Tables and Figures

In the experiment, producers conditioned help on the opponent's balance, L or H (Table B.2). In Money and Memory treatments consumers with a balance H receive more help than those with balance L. However, in Money producers with a positive balance helped less frequently than producers with a balance of 0 or less. On the other hand, in Memory this gap is less pronounced.

	Consumers' balance		
Producers' balance	L	H	Total
Money			
L	0.299	0.774	0.634
H	0.169	0.491	0.337
Total	0.258	0.726	0.569
Memory			
L	0.477	0.592	0.567
H	0.486	0.683	0.605
Total	0.482	0.623	0.583

Notes: The percentages show the share of subjects in each category by treatment.

Table B.2: Frequency of cooperation by subjects' balance (inexperienced sessions).

2.1 Experienced subjects

Dependent variable: *Individual frequency of cooperation*	(All treatments) Estimate	S.E.
Supergame	-0.031**	0.013
Money	-0.275***	0.068
Money x Supergame	0.106***	0.018
Memory	-0.104*	0.061
Memory x Supergame	0.045***	0.016
Money+Memory	-0.340***	0.063
Money+Memory x Supergame	0.080***	0.016
Unconstrained	-0.185***	0.056
Unconstrained x Supergame	0.030**	0.013
Constant	0.411***	0.086
N. of obs. (N. of subjects)	1800 (360)	
R-squared within	0.116	
R-squared between	0.197	
R-squared overall	0.157	

Notes: One observation per subject per supergame. All supergames included. Panel regression with random effects at the individual level and robust standard errors (S.E.) adjusted for clustering at the session level. The estimated coefficients for *Money* and *Memory* are significantly different at the 1% level (p- value= 0.002). The estimated coefficients for *Money x supergame* and *Memory x supergame* are significantly different at the 5% level (p- value= 0.017). The sum of the coefficients *Supergame* and *Memory x supergame* is significant at the 1% level (p-value = 0.005). The sum of the coefficients *Supergame* and *Money x supergame* is not significant (p-value > 0.1). *Controls* include the following individual characteristics: gender, major, two measures of understanding of the instructions (response time and number of wrong answers in the quiz) and session location (Purdue, Chapman).

Table B.3: Cooperation frequency (experienced sessions).

Dependent variable: *Individual frequency of cooperation*	Supergame 1		Supergame 5	
	Estimate	S.E.	Estimate	S.E.
Money	0.577***	0.026	0.651***	0.018
Memory	0.261***	0.038	0.237***	0.031
Money+Memory	0.286**	0.053	0.528***	0.042
Constant	0.440*	0.178	0.307**	0.076
Controls	Yes		Yes	
N. of obs.	96		96	
R-squared	0.471		0.722	

Table B.4: Treatment Effects on Cooperation in Supergames 1 & 5 (experienced sessions).

Notes: One observation per subject. Experienced sessions. Robust standard errors (S.E.) adjusted for clustering at the session level. In supergame 1 the estimated coefficients for *Money* and *Memory* are significantly different at the 5% level (p-value: 0.042). In supergame 5 the estimated coefficients for *Money* and *Memory* are significantly different at the 1% level (p-value: 0.005). *Controls* include the following individual characteristics: gender, major, and two measures of understanding of the instructions (response time and number of wrong answers in the quiz).

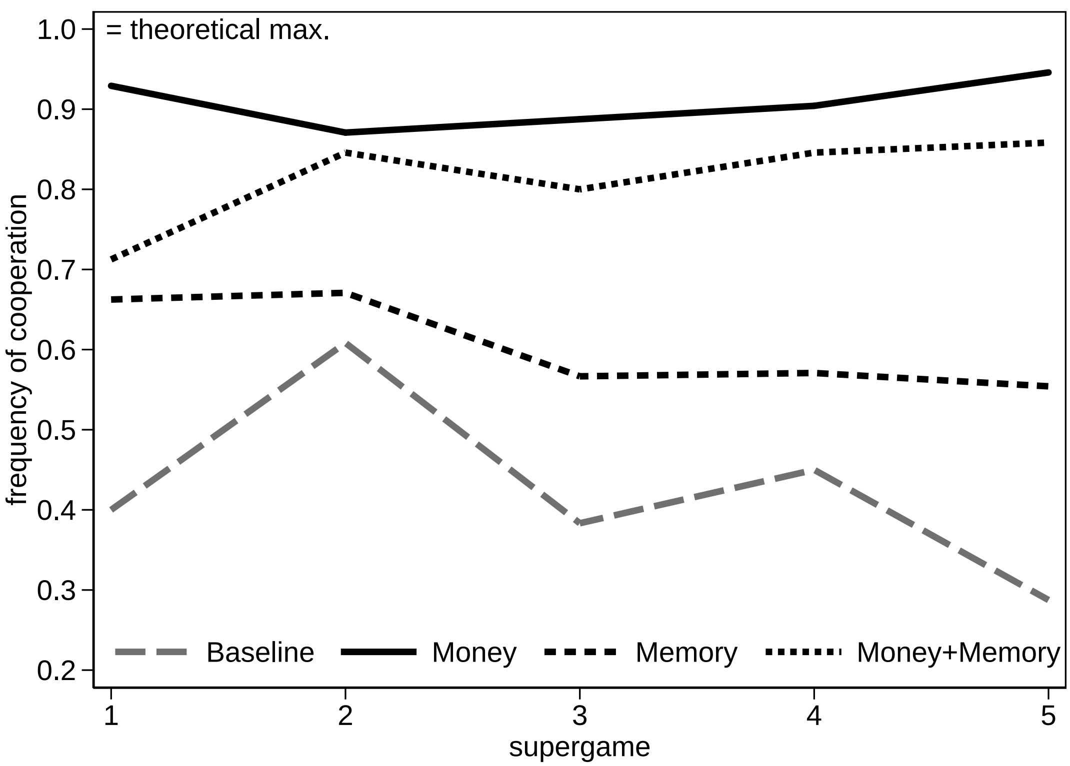


Figure B.1: Cooperation frequency by treatment (experienced sessions)

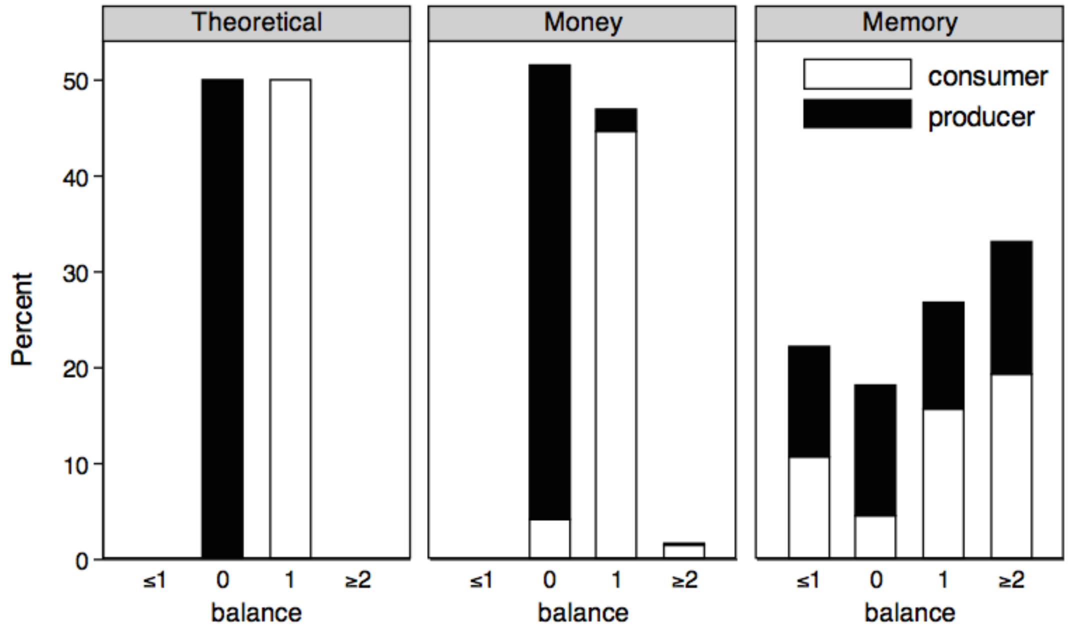


Figure B.2: Distribution of balances in Money and Memory (experienced sessions)

Figure B.3: Trade emerges in Money but not in Memory.

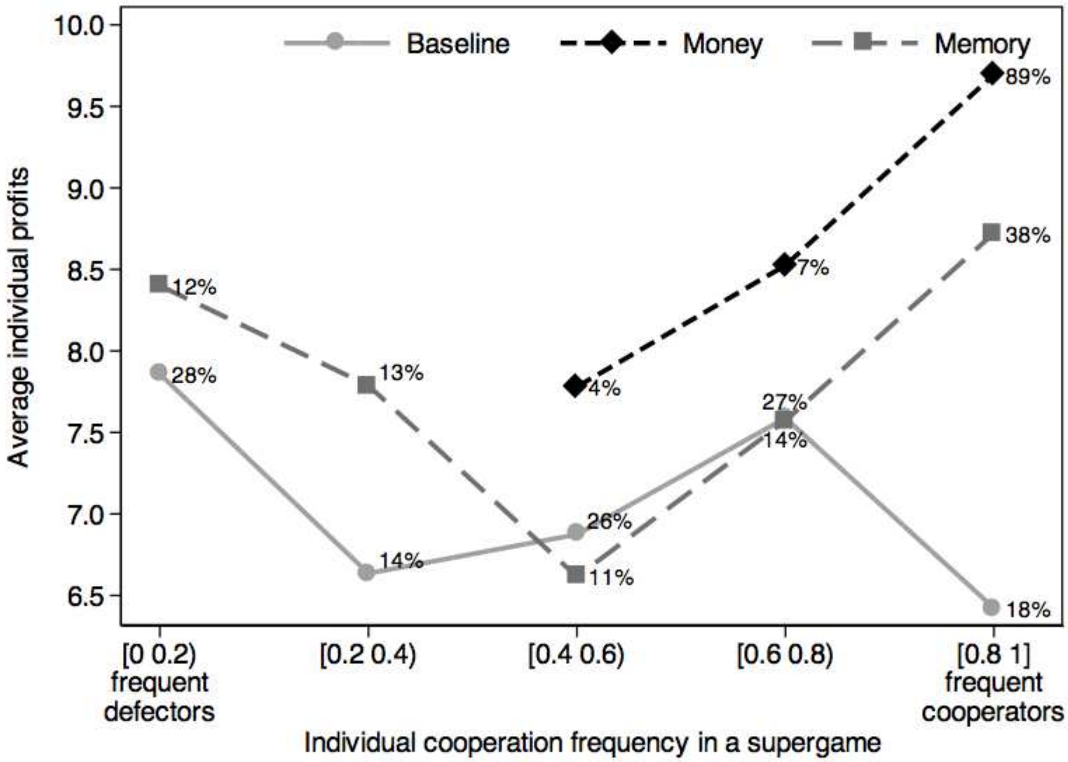


Figure B.4: Cooperation frequency and profits (experienced sessions)

2.2 Additional treatments

Dependent variable:	(All treatments)	
Individual frequency of coop.	Estimate	S.E.
Treatment effects at supergame 1		
Constant	0.411***	0.086
Money	-0.275***	0.068
Memory	-0.104*	0.061
Money+Memory	-0.340***	0.063
Unconstrained	-0.185***	0.056
Trend by treatment		
Supergame	-0.031**	0.013
Money x Supergame	0.106***	0.018
Memory x Supergame	0.045***	0.016
Money+Memory x Supergame	0.080***	0.016
Unconstrained x Supergame	0.030**	0.013
Controls	Yes	
N. of obs. (N. of subjects)	1800 (360)	
R-squared within	0.116	
R-squared between	0.197	
R-squared overall	0.157	
Wald tests on estimated coefficients (only p-values< 0.1**)**		
Treatment effects at supergame 1		
Money vs. Memory	p-value=0.000	
Money vs. Unconstrained	p-value=0.029	
Money vs. Money+Memory	p-value=0.000	
Memory vs. Unconstrained	p-value=0.011	
Trend by treatment		
Money x Sup. vs. Memory x Sup.	p-value=0.000	
Money x Sup. vs. Unconstrained x Sup.	p-value=0.000	
Money x Sup. vs. Money+Memory x Sup.	p-value=0.088	
Memory x Sup. vs. Money+Memory x Sup.	p-value=0.003	
Memory x Sup. vs. Unconstrained x Sup.	p-value=0.088	

Table B.5: Cooperation frequency.

Notes: One observation per subject per supergame. Inexperienced sessions, all supergames. Panel regression with random effects at the individual level and robust standard errors adjusted for clustering at the session level. *Controls* include the following individual characteristics: gender, major, two measures of understanding of the instructions (response time and number of wrong answers in the quiz) and session location (Purdue, Chapman).

Dependent variable:	Money+Memory		Money Unconst.	
Cooperation outcome in a pair	Estimate	S. E.	Estimate	S. E.
Supergame	0.027***	0.007	0.141***	0.041
Period	-0.000	0.000	-0.007***	0.002
Balance				
Producer, Consumer				
L, H	0.499***	0.061	0.057***	0.016
H, L	-0.032	0.027	0.001	0.012
H, H	0.330***	0.072	0.220***	0.068
Controls	Yes		Yes	
N. of obs. (N. of subjects)	3600 (72)		2400 (48)	

Table B.6: How balances in a meeting affect cooperation.

Notes: One observation per subject per period. Inexperienced sessions. Marginal effects from a logit regression. Robust standard errors (S.E.) adjusted for clustering at the session level. *Controls* include the following individual characteristics: gender, major, and two measures of understanding of the instructions (response time and number of wrong answers in the quiz).

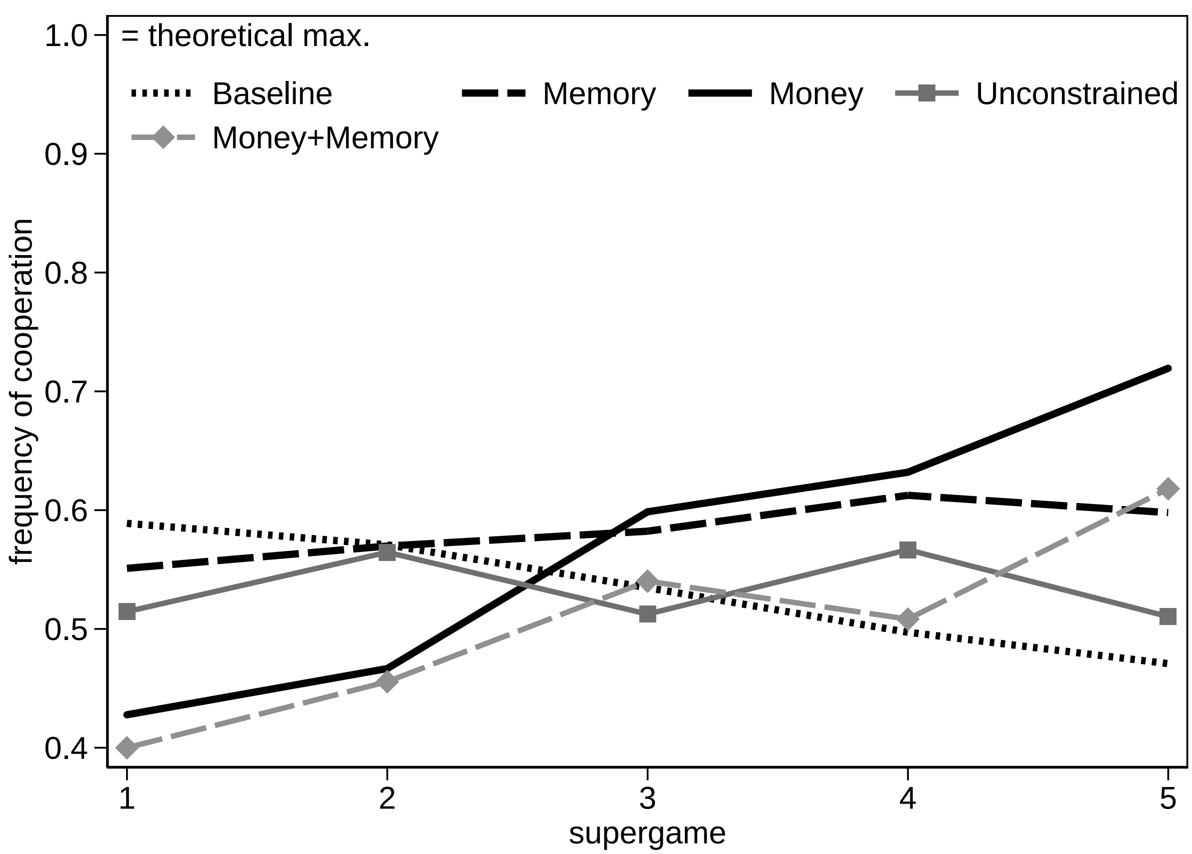


Figure B.5: Cooperation frequency in all treatments.

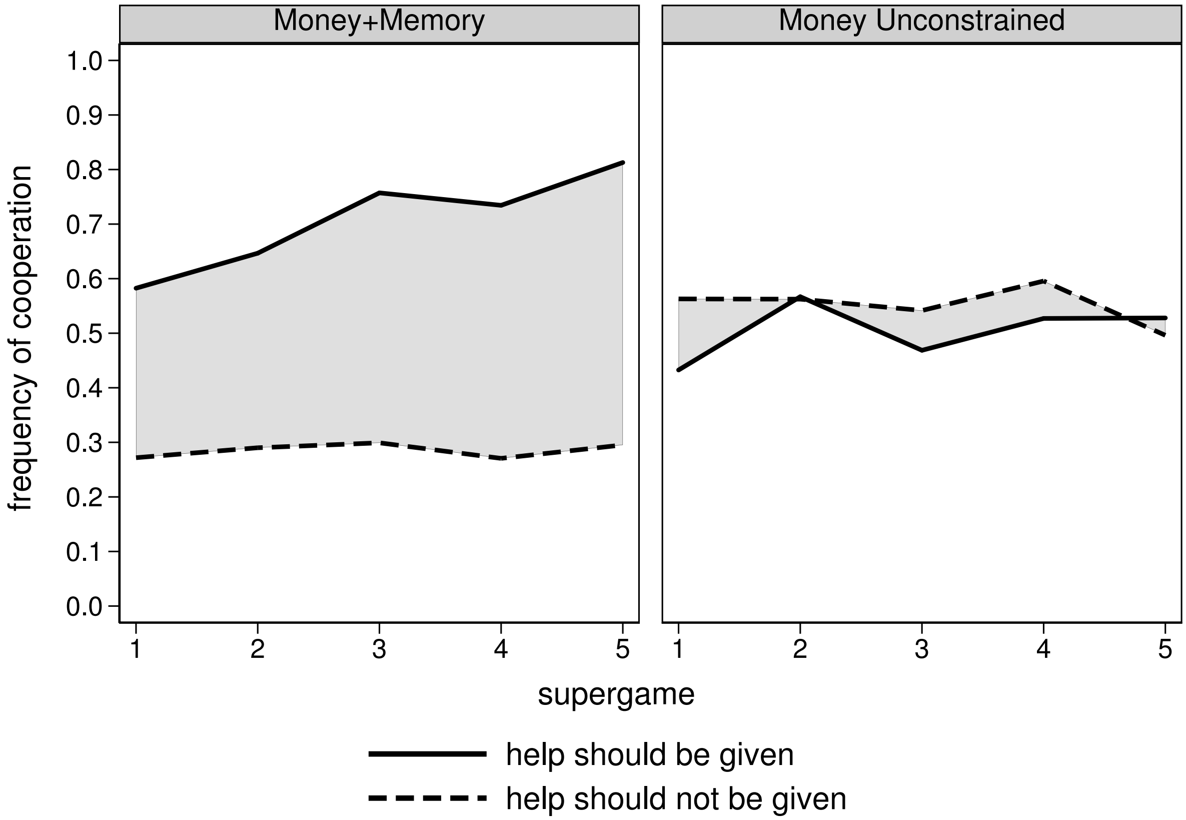


Figure B.6: Trade emerges in MONEY+MEMORY but not in MONEY UNCONSTRAINED.

Appendix C -- Instructions

Instructions Baseline Treatment

This is an experiment in decision-making. The National Science Foundation has provided funds for this research. You will earn money depending on the decisions you and others make in the experiment. Please turn off your cell-phones, do not talk to others and do not look at their screens. These instructions are a detailed description of the procedures we will follow.

How do you earn money?

You will earn points that will be converted into dollars. For every point you earn, you will receive 3 cents ($.03). You will also receive the show-up fee and, in addition, $3 for your participation. All earnings will be paid to you in cash at the end of the experiment.

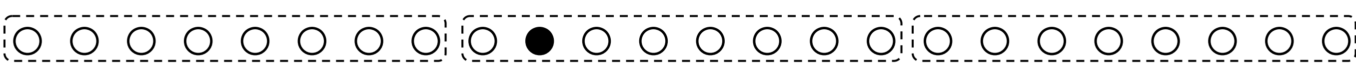
The experiment is composed of **many periods**. In each period you will be in a pair with another person selected at random, called your **"match."** In every pair, one participant will be **red** and the other **blue**:

- If you are **red**, then you can choose to execute either **outcome Y** or **Z**:
  - under outcome **Y**, you earn ***6*** points and your **blue** match earns ***4*** points.
  - under outcome **Z**, you earn ***0*** points and your **blue** match earns ***20*** points.

- If you are **blue**, then you have no choice to make.

Who will be your match in the pair?

There are twenty-four participants. Each participant will be assigned to a **set** composed of **eight persons**:



your set

Your match is a person **picked at random** from those **in your set.** Your match is a participant in this room but you will neither see her actual identity nor her experimental identification number. Your match may be the same as in the previous period, or may change: you have one chance out of four of being matched with the same person in two consecutive periods. You will not know if you repeatedly interact with the same participant.

What color will you be?

In every set of eight, four persons are **red** and the other four are **blue**. Your initial color assignment is random and then your color will alternate from period to period.

Initially, you have a 50% chance to be **red** and 50% chance to be **blue**. In the following periods, your color will change. If you are **blue**, then next period you will be **red**. If you are **red**, then next period you will be **blue**.

Recall that your match has always a color different than yours.

How many periods will the experiment last?

The experiment consists of **five cycles**. Each cycle involves many **periods** |||||| :

The number of periods in a cycle is **random** and so it is **unknown** to us. A cycle will have at least twenty periods. From period twenty on, at the end of each period, the computer program randomly selects an integer number between 1 and 100. Each number is equally likely to be selected. This random number is the same for everyone in the room.
If this random number is 1, 2,…, or 75, then the cycle will continue.
If this random number is 76, 77,…, or 100, then the cycle will end.
This means that:

- We never know for sure which period will be the last in a cycle.
- Some cycles may be longer and others may be shorter, but we cannot know this in advance.
- A cycle has twenty periods for sure. From period twenty on, after each period there is a 75% chance that the cycle continues and a 25% chance that the cycle ends.

The computer will select the random number in the same way a ball is drawn from a container of one-hundred balls, numbered 1 to 100. After each draw, the ball is placed back into the container. Hence, the chance that a cycle will end, say, after period twenty-eight, is 25%, which is exactly the same as the chance that the cycle will end after period twenty.

Because of this random rule, after period twenty we **expect three additional periods.** No matter what period is reached after period twenty, we always expect three additional periods. The number of past periods does not influence the chance that a cycle will end because the random procedure is exactly the same in every period.

After each cycle, new sets of persons will be formed. **You will never interact with another participant for more than one cycle.**

What exactly do you need to do in each period?

Each **period** has the following timeline:

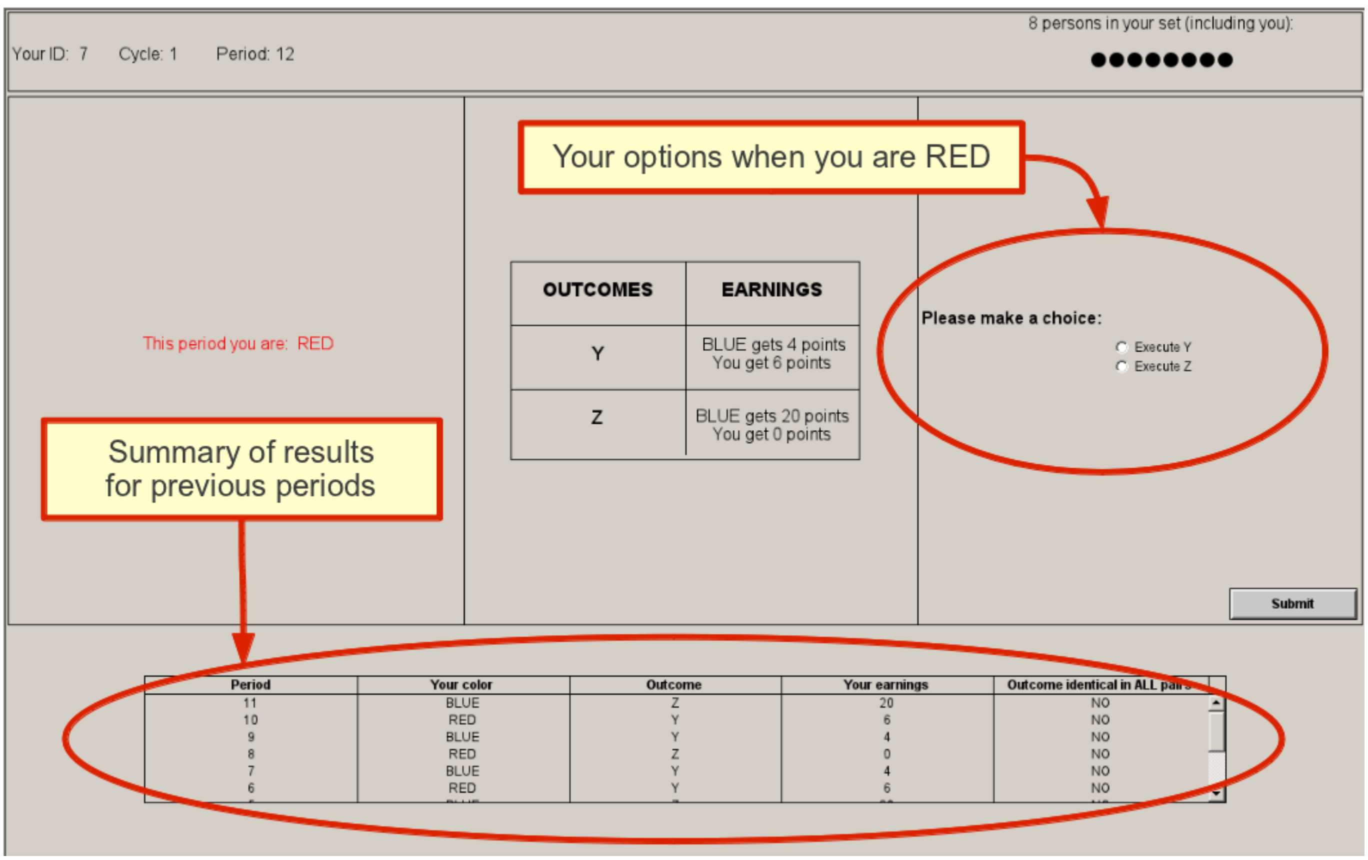
1. You are assigned a color (**red** or **blue**)
2. You are randomly paired to a participant from your set.
3. You may be called to make a choice (see below).
4. You and your match see the outcome of your choices.
5. The cycle may continue or may end.

The choices you may make in each period depend on your color, **red** or **blue**. If you are **red**, then your match is **blue** (and vice versa).

- If you are **red**, then you can select one of the following two options (**Figure A**):
  - **<u>Execute Y</u>:** you earn ***6*** points and **blue** earns ***4*** points.
  - **<u>Execute Z</u>:** you earn ***0*** points and **blue** earns ***20*** points.

  To make your choice, click the button next to the option you wish to select. You may change your mind at any time prior to clicking the "Submit" button. You are free to make any choice you like in each period.

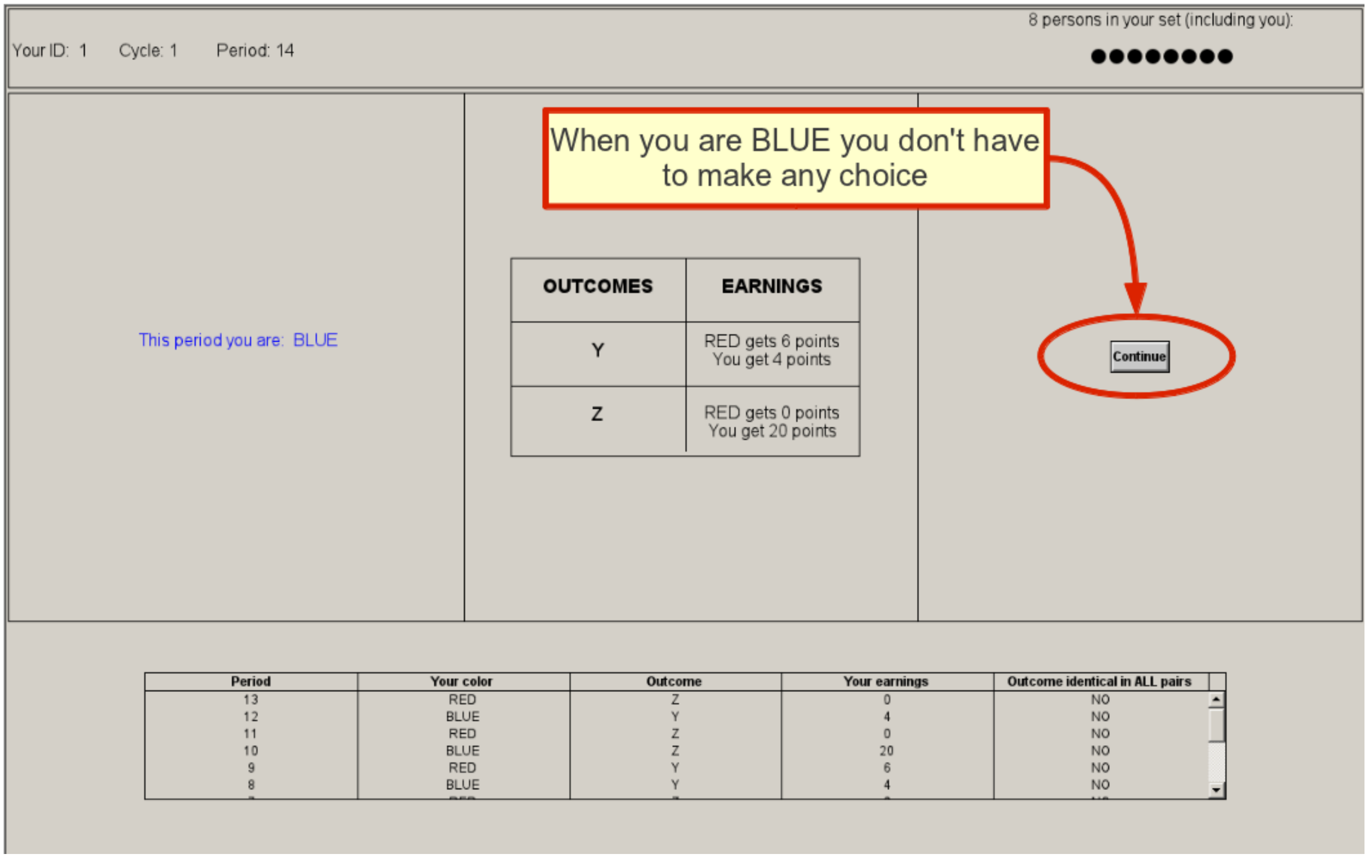
<u>Figure A: Choice screen for red</u>



Before making your choice, you can also review outcomes in previous periods of the cycle by scrolling down the "Summary of Results" table at the bottom of the screen. Each line includes: period number, your color for the period, and the outcome **Y** or **Z**. The column "Your earnings" displays the points you have earned. The last column reports whether the outcome was the same in all pairs of your set.

- If you are **blue**, then you have no choice to make.

Figure B: Choice screen for blue

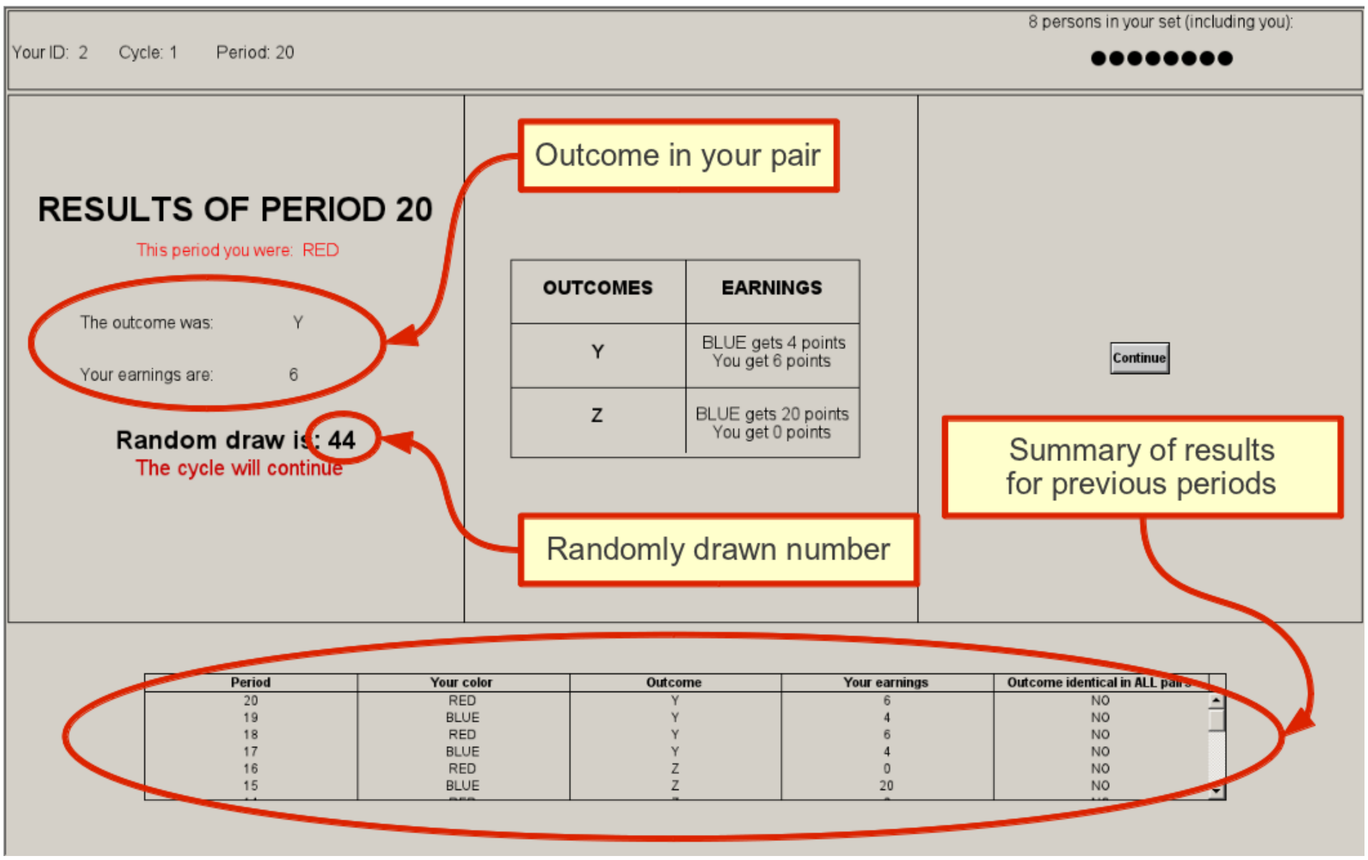


After all participants have made their choice, the results for the period will appear on your screen. The results screen (**Figure C**) will display your earnings in points for the period. You can see if the outcome was **Y** or **Z**. You can also see the outcome of the random draw that determines whether the cycle continues.

At the bottom of the screen you can once again find the "Summary of Results" table.

Please write the results on your record sheet under the appropriate headings.

<u>Figure C: Screen for the results of the period</u>:



Final Comments

- Do not talk to others and do not look at their screens.
- You will be in a set of eight participants. At the end of each cycle, new sets will be formed, so that you will never interact with another participant for more than one cycle.
- Your match for the period is a person picked at random among those in your set who have a color different than yours.
- If you are **red**, then you always make a choice. If you are **blue**, then you have no choice to make.
- A cycle has twenty periods for sure. From period twenty on, there is a 75% chance of an additional period in the cycle, and a 25% chance that the cycle ends.
- The points you earn will be redeemed for dollars at the end of this session.

Do you have any questions before we begin?

Instructions Money Treatment

This is an experiment in decision-making. The National Science Foundation has provided funds for this research. You will earn money depending on the decisions you and others make in the experiment. Please turn off your cell-phones, do not talk to others and do not look at their screens. These instructions are a detailed description of the procedures we will follow.

How do you earn money?

You will earn points that will be converted into dollars. For every point you earn, you will receive 3 cents ($.03). You will also receive the show-up fee. All earnings will be paid to you in cash at the end of the experiment.

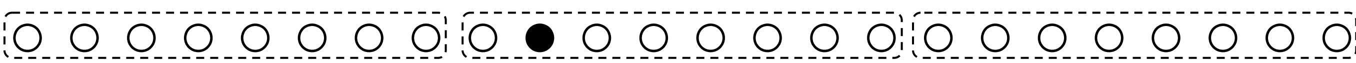
The experiment is composed of **many periods**. In each period you will be in a pair with another person selected at random, called your **"match."** In every pair, one participant will be **red** and the other **blue**:

- If you are **red**, then you can choose to execute either **outcome Y** or **Z**:
  - under outcome **Y**, you earn ***6*** points and your **blue** match earns ***4*** points.
  - under outcome **Z**, you earn ***0*** points and your **blue** match earns ***20*** points.

- If you are **blue**, then you may choose to give a **"ticket"** to your **red** match or not, as discussed below.

Who will be your match in the pair?

There are twenty-four participants. Each participant will be assigned to a **set** composed of **eight persons**:



your set

Your match is a person **picked at random** from those **in your set.** Your match is a participant in this room but you will neither see her actual identity nor her experimental identification number. Your match may be the same as in the previous period, or may change: you have one chance out of four of being matched with the same person in two consecutive periods. You will not know if you repeatedly interact with the same participant.

What color will you be?

In every set of eight, four persons are **red** and the other four are **blue**. Your initial color assignment is random and then your color will alternate from period to period.

Initially, you have a 50% chance to be **red** and 50% chance to be **blue**. In the following periods, your color will change. If you are **blue**, then next period you will be **red**. If you are **red**, then next period you will be **blue**.

Recall that your match has always a color different than yours.

How many periods will the experiment last?

The experiment consists of **five cycles**. Each cycle involves many **periods** ||||| :

The number of periods in a cycle is **random** and so it is **unknown** to us. A cycle will have at least twenty periods. From period twenty on, at the end of each period, the computer program randomly selects an integer number between 1 and 100. Each number is equally likely to be selected. This random number is the same for everyone in the room.
If this random number is 1, 2,…, or 75, then the cycle will continue.
If this random number is 76, 77,…, or 100, then the cycle will end.
This means that:

- We never know for sure which period will be the last in a cycle.
- Some cycles may be longer and others may be shorter, but we cannot know this in advance.
- A cycle has twenty periods for sure. From period twenty on, after each period there is a 75% chance that the cycle continues and a 25% chance that the cycle ends.

The computer will select the random number in the same way a ball is drawn from a container of one-hundred balls, numbered 1 to 100. After each draw, the ball is placed back into the container. Hence, the chance that a cycle will end, say, after period twenty-eight, is 25%, which is exactly the same as the chance that the cycle will end after period twenty.

Because of this random rule, after period twenty we **expect three additional periods.** No matter what period is reached after period twenty, we always expect three additional periods. The number of past periods does not influence the chance that a cycle will end because the random procedure is exactly the same in every period.

After each cycle, new sets of persons will be formed. **You will never interact with another participant for more than one cycle.**

<u>Tickets</u>

In the first period of each cycle every participant who is **blue** will receive **one ticket:**

- Tickets can neither be redeemed for dollars nor can be carried over to the next cycle.
- Tickets can be exchanged as explained below.

<u>What exactly do you need to do in each period?</u>

Each **period** has the following timeline:

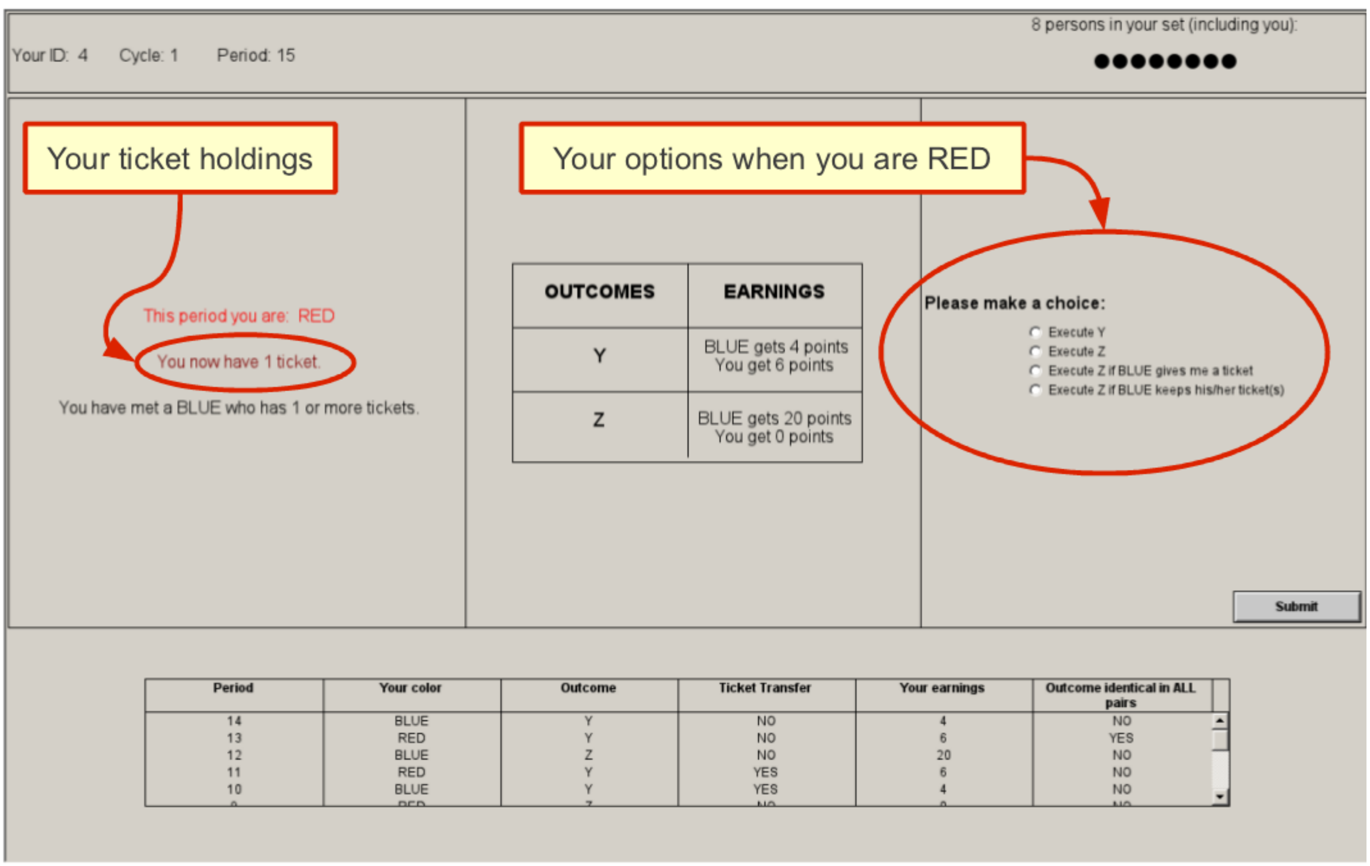
1. You are assigned a color (**red** or **blue**)
2. You are randomly paired to a participant from your set.
3. You may be called to make a choice (see below).
4. You and your match see the outcome of your choices.
5. The cycle may continue or may end.

The choices you may make in each period depend on your color, **red** or **blue**, and on whether **blue** has tickets. If you are **red**, then your match is **blue** (and vice versa).

- If you are **red** and your **blue** match has some tickets, then you can select one of the following four options (**Figure A**):
  - **<u>Execute Y</u>:** you earn ***6*** points and **blue** earns ***4*** points.
  - **<u>Execute Z</u>:** you earn ***0*** points and **blue** earns ***20*** points.
  - **<u>Execute Z if BLUE gives me a ticket</u>:**
    - If **blue** chooses "Give a ticket to RED" or "Give a ticket to RED if RED executes Z,", then the outcome is **Z** and you get a ticket.
    - Otherwise, the outcome is **Y**; whether you get a ticket depends on the choice of **blue**.
  - **<u>Execute Z if BLUE keeps his/her ticket(s)</u>:**
    - If **blue** chooses "Keep your ticket(s)," then the outcome is **Z** and you do not get a ticket.
    - Otherwise, the outcome is **Y**; whether you get a ticket depends on the choice of **blue**.

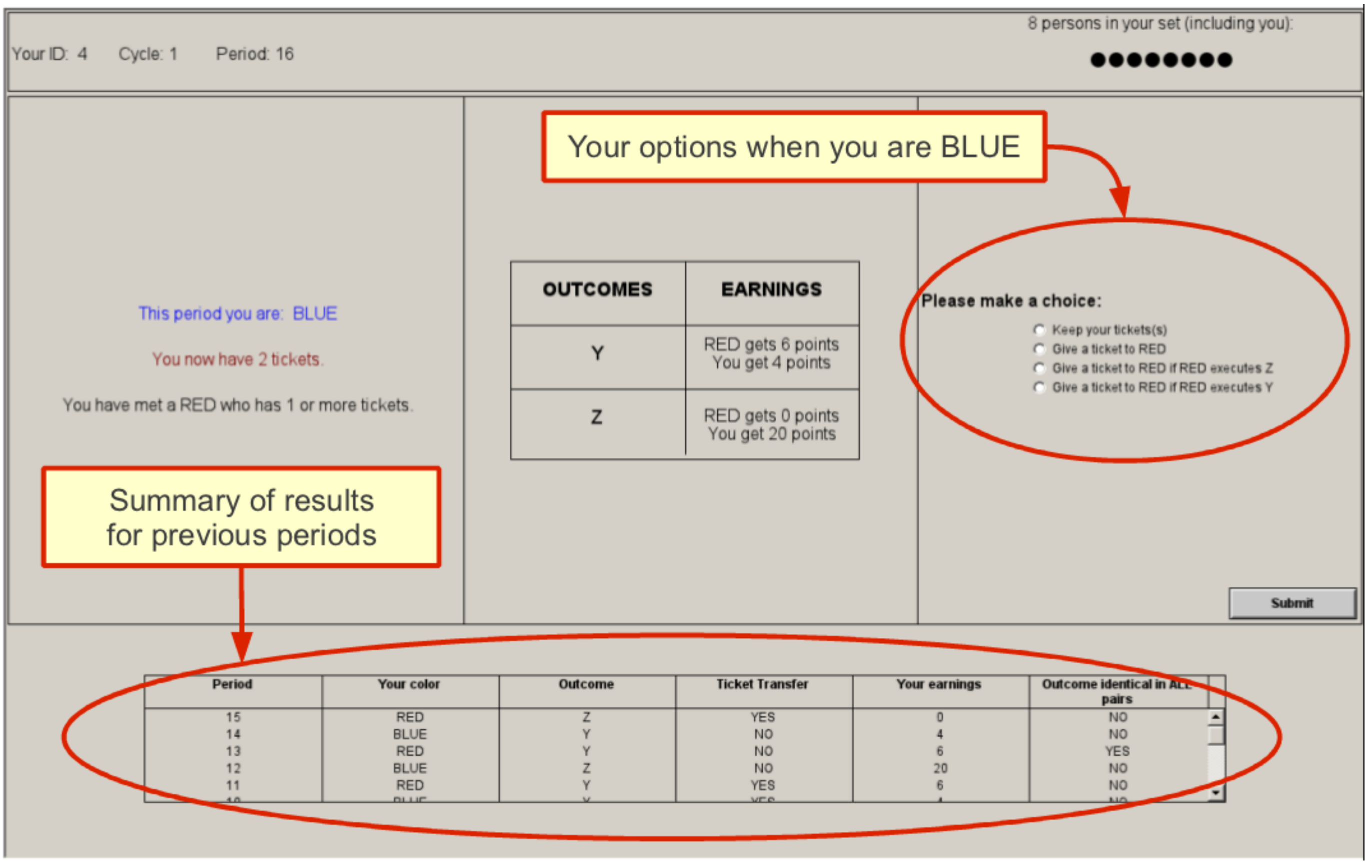
Note: If **blue** has no tickets, then you can only choose between "Execute Y" and "Execute Z."

<u>Figure A: Choice screen for red</u>



- If you are **blue** and do not have a ticket, you have no choice to make.
  Otherwise, you may select one of the following four options (**Figure B**):
  - **Keep your ticket(s)**
  - **Give a ticket to RED**
  - **Give a ticket to RED if RED executes Z**:
    - If **red** chooses "Execute Z" or "Execute Z if BLUE gives me a ticket," then the outcome is **Z** and you transfer a ticket to **red**.
    - Otherwise, the outcome is **Y** and you keep your ticket**.**
  - **Give a ticket to RED if RED executes Y**:
    - If **red** chooses "Execute Z," then the outcome is **Z** and you keep your ticket.
    - Otherwise, the outcome is **Y** and you transfer a ticket to **red**.

Figure B: Choice screen for blue



To make your choice, click the button next to the option you wish to select. You may change your mind at any time prior to clicking the "Submit" button. You are free to make any choice you like in each period. Your match cannot see which one of the four options you select before she makes her choice.

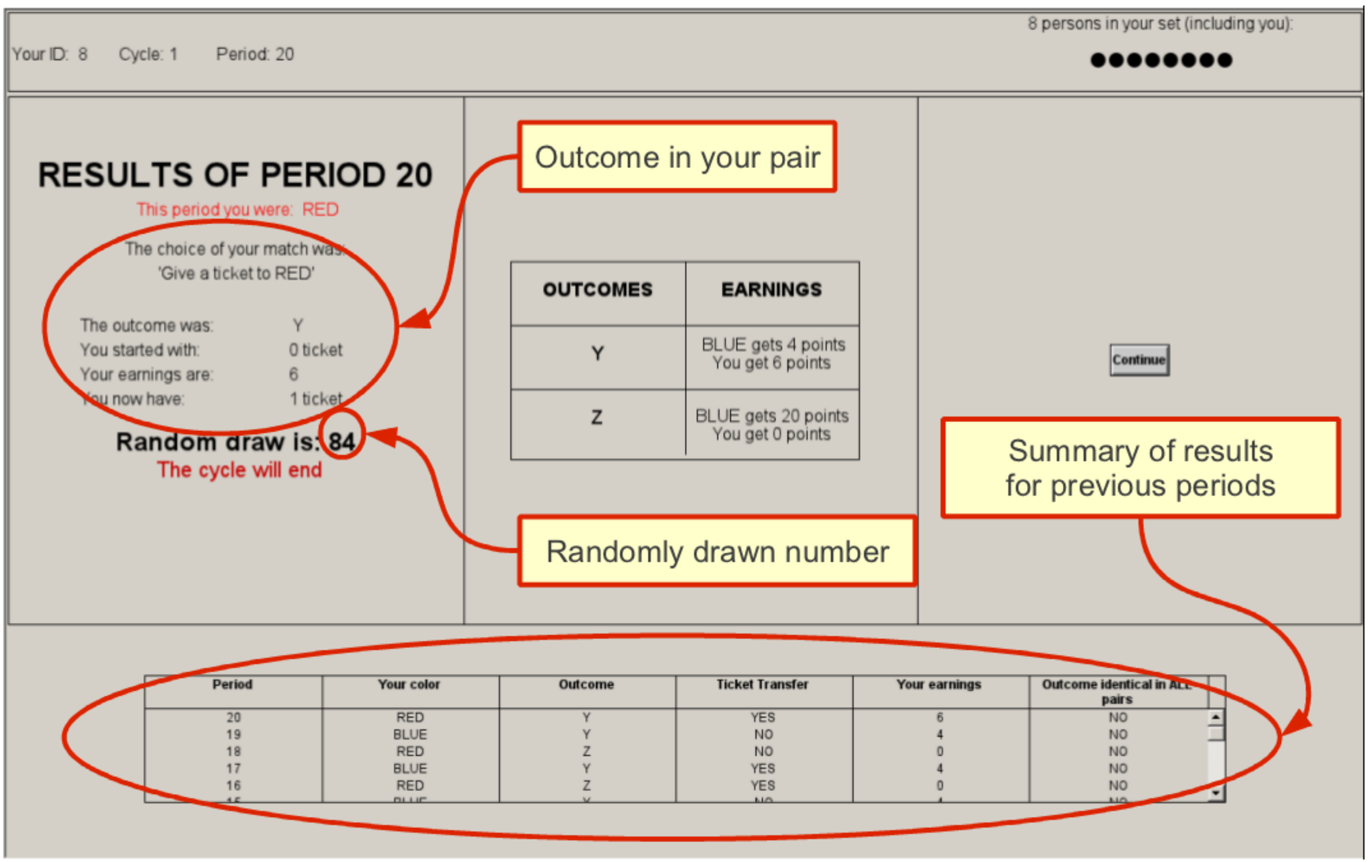
Before making your choice, you can also review outcomes in previous periods of the cycle by scrolling down the "Summary of Results" table at the bottom of the screen. Each line includes: period number, your color for the period, the outcome **Y** or **Z** and if there was a ticket transfer. The column "Your earnings" displays the points you have earned. The last column reports whether the outcome was the same in all pairs of your set.

After all participants have made their choice, the results for the period will appear on your screen. The results screen (**Figure C**) will display your earnings in points for the period. You can see the choice of your match, if the outcome was **Y** or **Z**, and if a ticket was transferred. You can also see the outcome of the random draw that determines whether the cycle continues.

At the bottom of the screen you can once again find the "Summary of Results" table.

Please write the results on your record sheet under the appropriate headings.

<u>Figure C: Screen for the results of the period</u>:



Final Comments

- Do not talk to others and do not look at their screens.
- You will be in a set of eight participants. At the end of each cycle, new sets will be formed, so that you will never interact with another participant for more than one cycle.
- Your match for the period is a person picked at random among those in your set who have a color different than yours.
- If you are **red**, then you always make a choice. If you are **blue**, then you make a choice only if you have a ticket.
- A cycle has twenty periods for sure. From period twenty on, there is a 75% chance of an additional period in the cycle, and a 25% chance that the cycle ends.
- The points you earn will be redeemed for dollars at the end of this session. Tickets will not be redeemed for dollars.

Do you have any questions before we begin?

Instructions Memory Treatment

This is an experiment in decision-making. The National Science Foundation has provided funds for this research. You will earn money depending on the decisions you and others make in the experiment. Please turn off your cell-phones, do not talk to others and do not look at their screens. These instructions are a detailed description of the procedures we will follow.

How do you earn money?

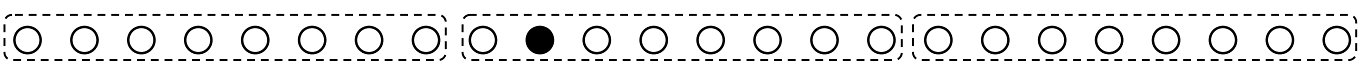
You will earn points that will be converted into dollars. For every point you earn, you will receive 3 cents ($.03). You will also receive the show-up fee. All earnings will be paid to you in cash at the end of the experiment.

The experiment is composed of **many periods**. In each period you will be in a pair with another person selected at random, called your **"match."** In every pair, one participant will be **red** and the other **blue**:

- If you are **red**, then you can choose to execute either **outcome Y** or **Z**:
  - under outcome **Y**, you earn ***6*** points and your **blue** match earns ***4*** points.
  - under outcome **Z**, you earn ***0*** points and your **blue** match earns ***20*** points.
- If you are **blue**, then you have no choice to make.

Who will be your match in the pair?

There are twenty-four participants. Each participant will be assigned to a **set** composed of **eight persons**:



your set

Your match is a person **picked at random** from those **in your set.** Your match is a participant in this room but you will neither see her actual identity nor her experimental identification number. Your match may be the same as in the previous period, or may change: you have one chance out of four of being matched with the same person in two consecutive periods. You will not know if you repeatedly interact with the same participant.

What color will you be?

In every set of eight, four persons are **red** and the other four are **blue**. Your initial color assignment is random and then your color will alternate from period to period.

Initially, you have a 50% chance to be **red** and 50% chance to be **blue**. In the following periods, your color will change. If you are **blue**, then next period you will be **red**. If you are **red**, then next period you will be **blue**.

Recall that your match has always a color different than yours.

How many periods will the experiment last?

The experiment consists of **five cycles**. Each cycle involves many **periods |||||** :

The number of periods in a cycle is **random** and so it is **unknown** to us. A cycle will have at least twenty periods. From period twenty on, at the end of each period, the computer program randomly selects an integer number between 1 and 100. Each number is equally likely to be selected. This random number is the same for everyone in the room.
If this random number is 1, 2,…, or 75, then the cycle will continue.
If this random number is 76, 77,…, or 100, then the cycle will end.
This means that:

- We never know for sure which period will be the last in a cycle.
- Some cycles may be longer and others may be shorter, but we cannot know this in advance.
- A cycle has twenty periods for sure. From period twenty on, after each period there is a 75% chance that the cycle continues and a 25% chance that the cycle ends.

The computer will select the random number in the same way a ball is drawn from a container of one-hundred balls, numbered 1 to 100. After each draw, the ball is placed back into the container. Hence, the chance that a cycle will end, say, after period twenty-eight, is 25%, which is exactly the same as the chance that the cycle will end after period twenty.

Because of this random rule, after period twenty we **expect three additional periods.** No matter what period is reached after period twenty, we always expect three additional periods. The number of past periods does not influence the chance that a cycle will end because the random procedure is exactly the same in every period.

After each cycle, new sets of persons will be formed. **You will never interact with another participant for more than one cycle.**

Personal Index (PI)

Every participant has a "Personal Index" denoted PI.

When a cycle starts, the PI of each **red** participant is 0 while the PI of each **blue** participant is 1.

At the end of each period, your PI may increase or decrease by one unit, or may remain the same, depending on the outcome in your pair. Hence, during the course of the cycle your PI may take negative or positive values, such as …,-2,-1,0,1,2,…, and so on.

You can always see your PI. You can only see whether the PI of your match is "0 or below" or "1 or above."

What exactly do you need to do in each period?

Each **period** has the following timeline:

1. You are assigned a color (**red** or **blue**)
2. You are randomly paired to a participant from your set.
3. You may be called to make a choice (see below).
4. You and your match see the outcome of your choices.
5. The cycle may continue or may end.

The choices you may make in each period depend on your color, **red** or **blue**. If you are **red**, then your match is **blue** (and vice versa).

- If you are **red**, then you can select one of the following two options (**Figure A**):

    - **Execute Y:** you earn ***6*** points and **blue** earns ***4*** points.

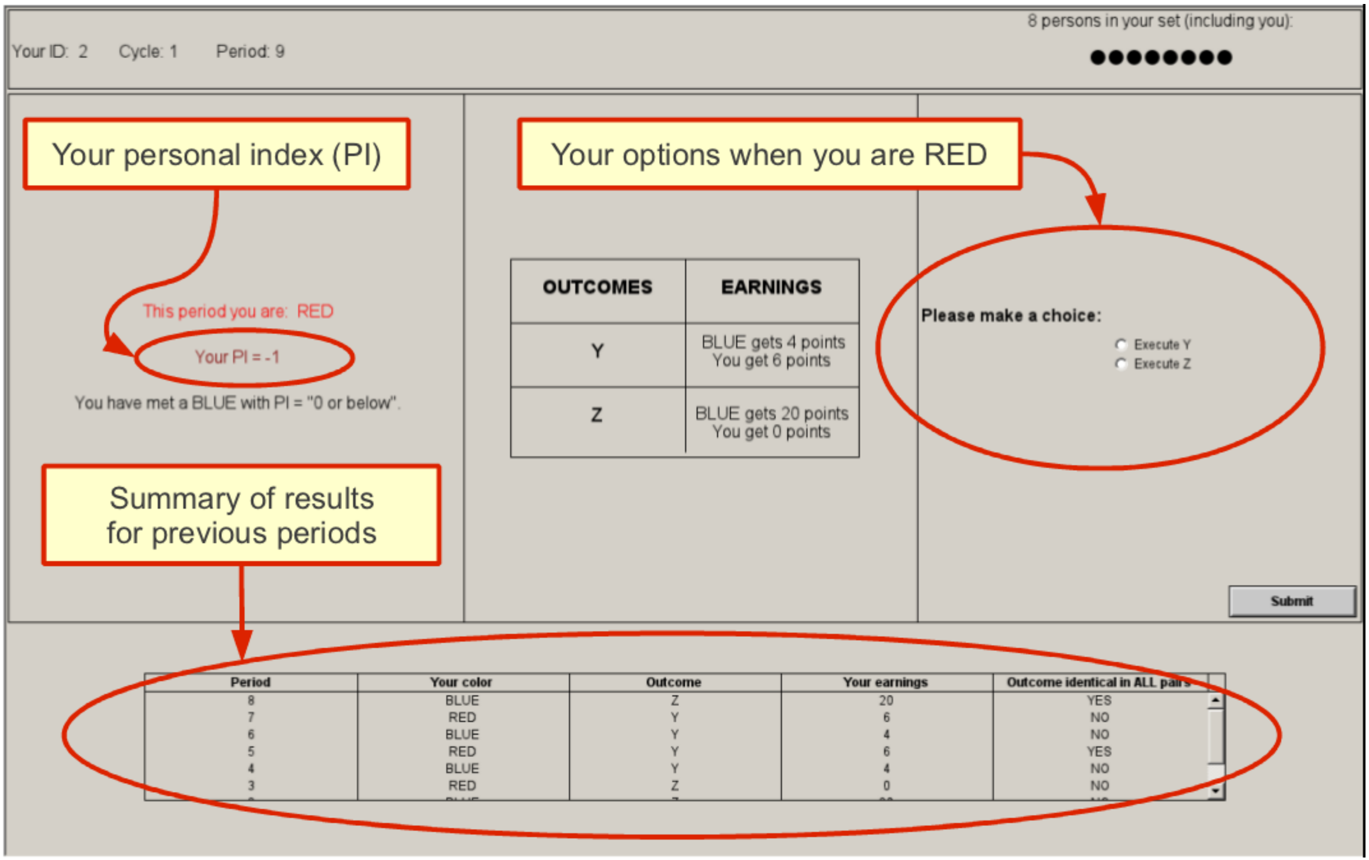
      Here your PI does not change and the PI of **blue** does not change, also.

    - **Execute Z:** you earn ***0*** points and **blue** earns ***20*** points.

      Here your PI increases by one and the PI of **blue** decreases by one.

To make your choice, click the button next to the option you wish to select. You may change your mind at any time prior to clicking the "Submit" button. You are free to make any choice you like in each period.

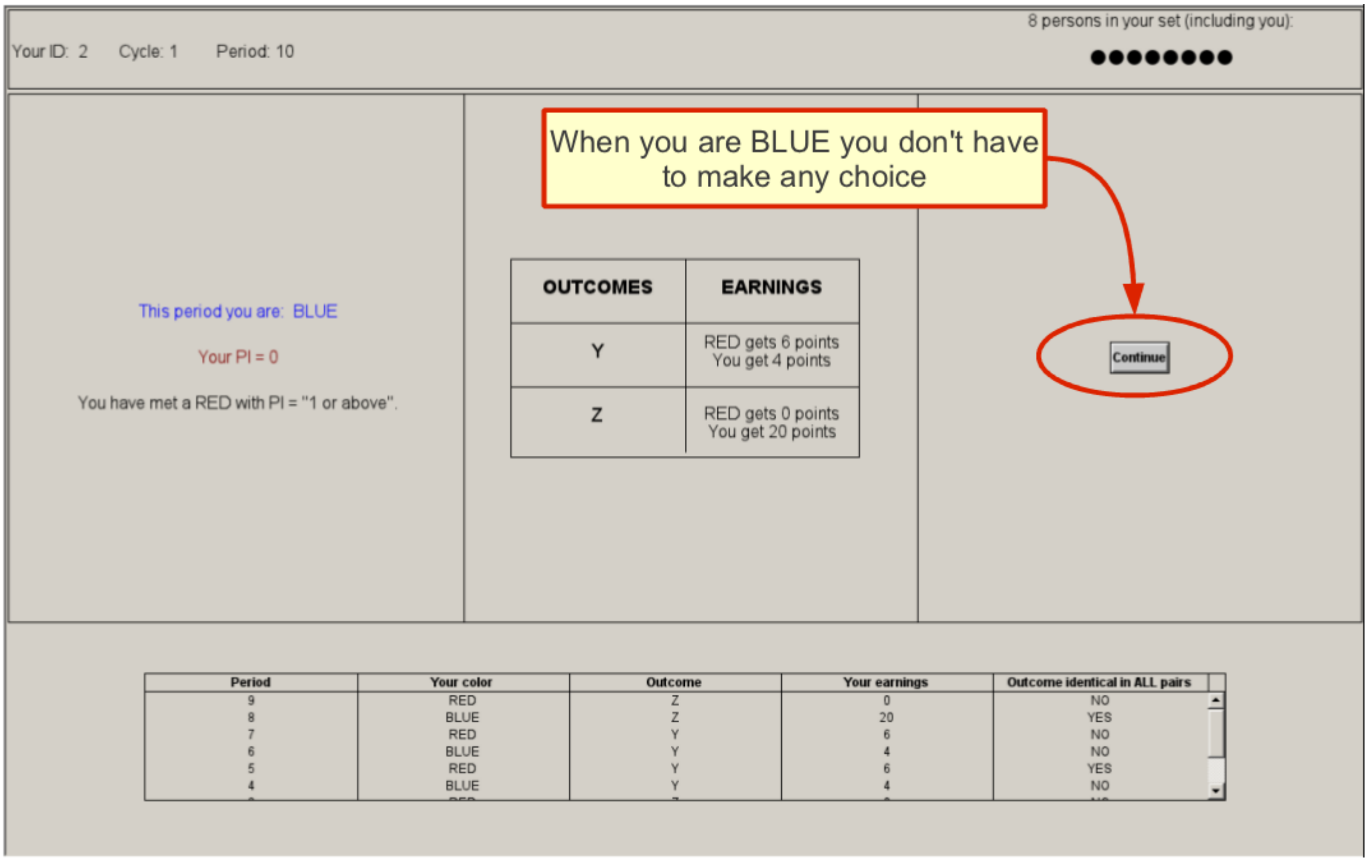
Figure A: Choice screen for red



Before making your choice, you can see whether you match as a PI "0 or below" or "1 or above." You can also review outcomes in previous periods of the cycle by scrolling down the "Summary of Results" table at the bottom of the screen. Each line includes: period number, your color for the period, and the outcome **Y** or **Z**. The column "Your earnings" displays the points you have earned. The last column reports whether the outcome was the same in all pairs of your set.

- If you are **blue**, then you have no choice to make.

Figure B: Choice screen for blue

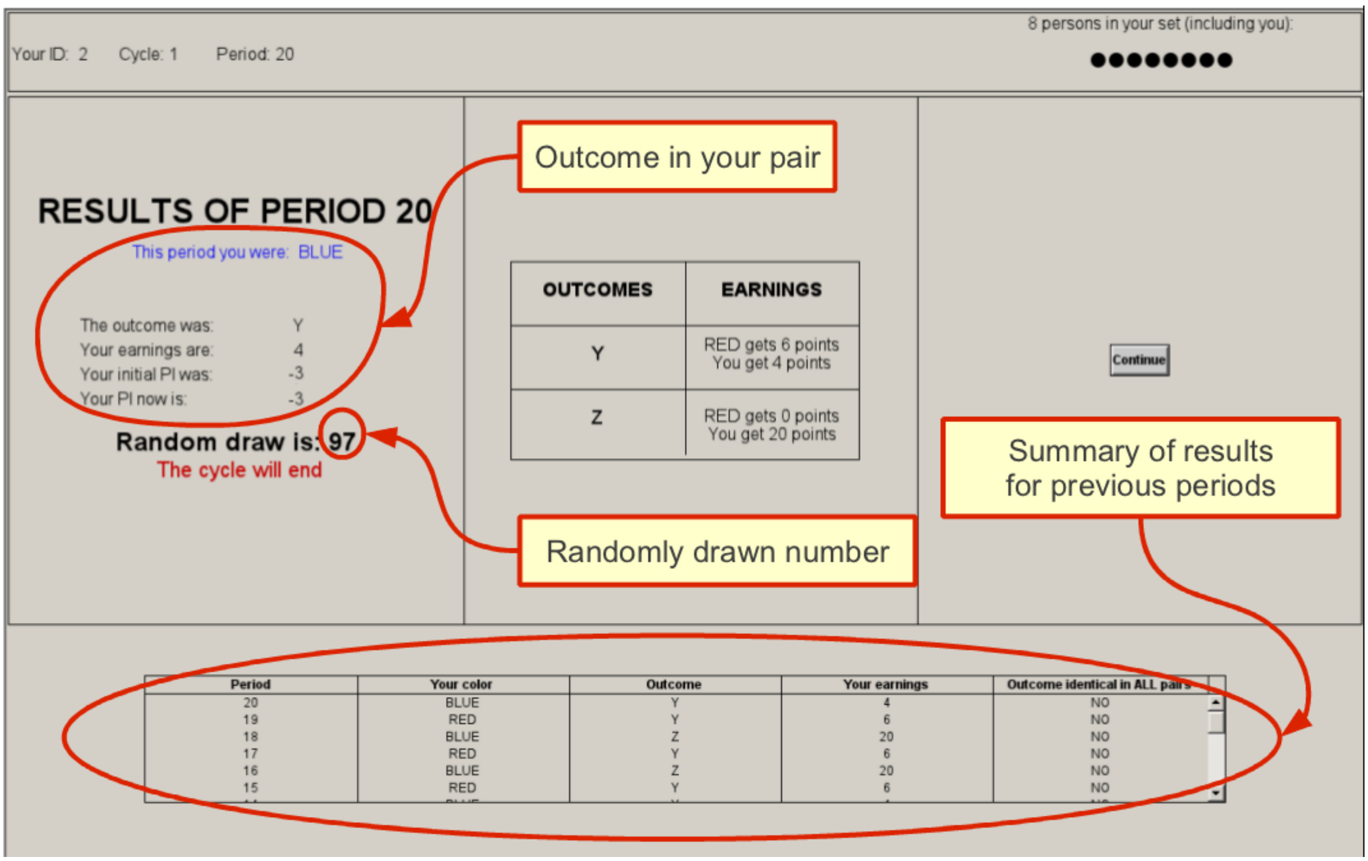

Your ID: 2 Cycle: 1 Period: 10
8 persons in your set (including you):
When you are BLUE you don't have to make any choice
This period you are: BLUE
Your PI = 0
You have met a RED with PI = "1 or above".
OUTCOMES
EARNINGS
Y
RED gets 6 points You get 4 points
Z
RED gets 0 points You get 20 points
Continue
Period
Your color
Outcome
Your earnings
Outcome identical in ALL pairs
9 RED Z 0 NO
8 BLUE Z 20 YES
7 RED Y 6 NO
6 BLUE Y 4 NO
5 RED Y 6 YES
4 BLUE Y 4 NO

After all participants have made their choice, the results for the period will appear on your screen. The results screen (**Figure C**) will display your earnings in points for the period. You can see if the outcome was **Y** or **Z**, and whether your PI has changed. You can also see the outcome of the random draw that determines whether the cycle continues.

At the bottom of the screen you can once again find the "Summary of Results" table.

Please write the results on your record sheet under the appropriate headings.

Figure C: Screen for the results of the period:



Final Comments

- Do not talk to others and do not look at their screens.

- You will be in a set of eight participants. At the end of each cycle, new sets will be formed, so that you will never interact with another participant for more than one cycle.

- Your match for the period is a person picked at random among those in your set who have a color different than yours.

- If you are **red**, then you always make a choice. If you are **blue**, then you have no choice to make.

- A cycle has twenty periods for sure. From period twenty on, there is a 75% chance of an additional period in the cycle, and a 25% chance that the cycle ends.

- Before making a choice, you will be able to see whether your match has a PI of "0 or below" or "1 or above."

- The points you earn will be redeemed for dollars at the end of this session.

Do you have any questions before we begin?

Comprehension Quiz

(Correct answers in bold)

1. The total number of cycles is:

A) 5
B) 10
C) not predetermined

2. You are in period 1 of a cycle. What is the probability that the cycle will continue?

A) 75%
B) 90%
C) 100%

3. What is the minimum number of periods a cycle will last?

A) 1
B) 20
C) 70

4. You are in period 20 of a cycle. What is the probability that the cycle will continue?

A) 75%
B) 90%
C) 100%

5. You are in period 20 of a cycle. How many additional periods do we expect?

A) 0
B) 3
C) 9

6. The number of participants in the experiment (total in the room) is:

A) 8
B) 16
C) 24

7. In each cycle, how many participants are in your set (including yourself)?

A) 8
B) 16
C) 24

8. In each period how many participants do you interact with?

A) 1
B) 7
C) 15

9. Will you ever see the ID of your match?

A) YES
B) NO

10. Can you see the choices of your match in previous periods?

A) YES

B) NO

11. Will you know at the end of the period whether the outcome in all other pairs from your set was the same as in your pair?

A) Yes

B) No

12. Suppose that ID 10 is your match in period 7 of cycle 1. Can ID 10 be your match in future cycles?

A) Yes, the sets never change.

B) No, I can never interact with the same participant for more than one cycle.

13. You are BLUE and the outcome is Y; how many points do you earn?

A) 4

B) 6

C) 20

14. Suppose you are BLUE this period. Will you be BLUE next period?

A) Yes

B) No

15. You are RED and the outcome is Z; how many points do you earn?

A) 0

B) 6

C) 20

16. Suppose you are RED this period. Will you be RED next period?

A) Yes

B) No

17. Before making her choice, will your match be able to see which one of the four options you select?

A) Yes, my match can see my choice before making his/her choice

B) **No, my match can only see my choice at the end of the period**

18. What is the total number of tickets in each set of eight persons?

A) 4

B) 8

C) 24

19. Can be tickets redeemed for dollars or carried over to the next cycle?

A) Yes

B) No

20. You are RED and your BLUE match has a ticket. You choose “Execute Z if BLUE gives me a ticket.” Suppose BLUE chooses “Give a ticket to RED if RED executes Z.? What is the outcome?

A) The outcome is Y. I do not receive a ticket.

B) The outcome is Z. I receive a ticket.

C) The outcome is Z. I do not receive a ticket.

21. You are RED and your BLUE match has a ticket. You choose "Execute Z if BLUE keeps his/her ticket(s)." Suppose BLUE chooses "Give a ticket to RED if RED executes Z." What is the outcome?"
A) The outcome is Y. I do not receive a ticket.
B) The outcome is Y. I receive a ticket.
C) The outcome is Z. I do not receive a ticket.

22. You are BLUE and you have a ticket. You choose "Keep your ticket(s)." Suppose RED chooses "Execute Z if BLUE gives me a ticket." What is the outcome?
A) The outcome is Y. I keep my ticket.
B) The outcome is Z. I transfer my ticket to RED.
C) The outcome is Z. I keep my ticket.

23. You are BLUE and you have a ticket. You choose "Give a ticket to RED if RED executes Y" Suppose RED chooses something other than "Execute Z." What is the outcome?
A) The outcome is Y. I transfer my ticket to RED.
B) The outcome is Z. I transfer my ticket to RED.
C) The outcome is Z. I keep my ticket.

24. Suppose that the experiment lasts 120 periods, the outcome is always Y, and you are RED half of the periods and BLUE half of the periods. How many dollars will you earn?
A) $18.00
B) $27.00
C) $36.00

25. Suppose that the experiment lasts 120 periods, the outcome is always Z, and you are RED half of the periods and BLUE half of the periods. How many dollars will you earn?
A) $18.00
B) $27.00
C) $36.00