stage and the repeated trials are represented by "x" marks on the horizontal axis. Moreover, there is little evidence that participants attempted other mechanisms to increase efficiency (such as rotating contributions).

To summarize, the notion of a cut point appears to organize behavior well in this context, and the data from one-shot games are quite close to the prediction of a symmetric Nash equilibrium. Moreover, the low rate of contributions consistent with the Nash equilibrium indicates that, as in experiments with the voluntary contributions mechanism, the free-rider problem is pervasive in this environment.

The failure of repetition to raise contribution rates by a large amount was of some concern to Palfrey and Rosenthal, who conclude that the absence of cooperation is "not encouraging news for those who might wish to interpret as gospel the oftspoken suggestion that repeated play with discount rates close to 1 leads to more cooperative behavior" (Palfrey and Rosenthal, 1992, p. 4). However, we do not find the absence of cooperation either particularly troublesome or surprising in this context. Given the privacy of value draws, it is difficult to distinguish free-riding from a high-value draw. Thus, it is hard to assess when a punishment should be administered. In terms of the meeting example used to motivate this problem, one can never tell if you skipped the meeting because your daughter was in the hospital or because you wanted to go fishing!

A6.2 Instructions: The Voluntary Contributions Mechanism

This is an experiment in the economics of group decision-making.[41] You have already earned $3.00 for showing up at the appointed time. If you follow the instructions closely and make decisions carefully, you can substantially add to this total.

There will be ten decision-making periods in this experiment. In each period, you are given an endowment of tokens. Your problem is to decide how to divide these tokens into either or both of two accounts: a private account and a group account. Each token you place in the private account generates a cash return to you (and to you alone) of one cent. Tokens placed in the group account yield a lower return. However, every member of the group also receives that same return for each token you place in the group account. Similarly, you receive a return for every token that other members of the group place in the group account. Thus, earnings in a decision period are the number of tokens you place in your private account, plus the return from all tokens you and other members of the group place in the group account.

[41] Brock (1991) contains an alternative set of instructions tailored for classroom use, along with some suggestions for associated classroom exercises.

Returns to the group account are listed in table entitled Return from the Group Account. The table is divided into four columns. In each row of a column, the left entry denotes a total number of tokens that the group may place in the group account. The right entry lists your earnings for that total.[42]

Decision Periods

Your token endowment information for each period, as well as your decisions and earnings, will be recorded on the Decision and Earnings Sheet. As indicated by the numbers in the left column of this sheet, each row represents a single decision period. Endowment information is presented in the second column from the left.

Each period proceeds as follows:

First, decide on the number of tokens to place in the private and in the group accounts by entering numbers in column (a) and/or in column (b) of the Decision Sheet. Your entries in columns (a) and (b) must sum to your endowment. While you make your decision, the ___ other members in your group will also divide their token endowments between private and group accounts.

Second, after everyone has made a decision, one of us will come around and total the number of tokens placed in the group account by all participants. We will write this total (but not the individual decisions) on the blackboard. Write this number in column (c).

Third, your earnings in a decision period are the sum of the tokens you placed in your private account, and the return from the total of tokens placed in the group account. To determine your earnings in the group account, find the earnings number listed opposite the appropriate entry on the Returns for the Group Account table. Write this number in column (d). Your earnings in a period are the sum of your entries in columns (a) and (d). Write this total in column (e).

In each subsequent period, move down to the next row on the Decision Sheet. Note your endowment for that period, make a decision, and record entries in columns (a) and/or (b).

After calculating your earnings for the last period, calculate your total earnings for the session by summing all entries in column (e). Write this sum next to the Total Earnings entry at the bottom of column (e) on your Decision Sheet.

Are there any questions?

[42] The Return from Group Account table presents the relationship between group contributions and earnings for the simple case where the MPCR is constant (.3) and the same for all participants. Note that for brevity the table includes only aggregate contributions up to 100. An implementation of this environment for groups larger than five (or endowments larger than twenty tokens) should include payoff options for all contingencies. Use of the table format allows for a general variety of treatments. With appropriate modifications, it is possible to implement treatments with diminishing and/or asymmetric returns from the group account. The effects of asymmetric token endowments can be evaluated even more simply, with no changes in the table.

Starting the Experiment

At this time, we begin the experiment. Notice your endowment for period 1 in the second column of your Decision Sheet. Please divide this endowment between the group and private accounts by writing entries in column (a) and/or in column (b). The sum of the two amounts that you write in columns (a) and (b) should equal your endowment for the period. Write *only* in the first row at this time. Also, please do not look at others' Decision Sheets, and please do not talk.

Now, one of us will come around and record your decisions, and check to see that the amounts in columns (a) and (b) sum to your endowment. Then we will sum the individual contributions to the group account and write this total on the blackboard.

After the First Period

____ tokens were placed in the group account this period. Please write this number in column (c) on the first row of your Decision Sheet at this time. Now convert this total into earnings by referring to the Returns to Group Account table. Write this number in column (d). Finally, sum (c) and (d) to determine your total earnings. Write this total in column (e).

We will now begin period 2. Notice your token endowment for period 2, on the second row of your Decision and Earnings Sheet. At this time, divide this endowment between the private account and/or the group account by writing entries in column (a) and/or in column (b). (An analogous statement should be read prior to each subsequent period.)

After the Last Period

The experiment is ended. To determine your payment for the experiment, please sum your earnings from each period, in column (e) of your Decision Sheet. Add to this total your initial $3.00 payment and record the sum in the Total Earnings entry at the bottom of column (e). Round this total up to the nearest quarter to determine you payment (e.g,. $3.56 becomes $3.75). Record this sum in the Payment entry.

Please write this total, as you would a check on the receipt form at the bottom of the Earnings and Decision Sheet. Also, please sign and date the receipt form, and record your social security number on it. In a moment, one of us verify your calculations and pay you. You will then be free to go, but please leave all experiment materials in this room. Finally, please remain silent, and do not look on others' Decision Sheets. Thank you for your participation.

Returns from the Group Account

Tokens in Group Account	Your Earnings	Tokens in Group Account	Your Earnings	Tokens in Group Account	Your Earnings	Tokens in Group Account	Your Earnings
1	0	26	8	51	15	76	23
2	1	27	8	52	16	77	23
3	1	28	8	53	16	78	23
4	1	29	9	54	16	79	24
5	2	30	9	55	17	80	24
6	2	31	9	56	17	81	24
7	2	32	10	57	17	82	25
8	2	33	10	58	17	83	25
9	3	34	10	59	18	84	25
10	3	35	11	60	18	85	26
11	3	36	11	61	18	86	26
12	4	37	11	62	19	87	26
13	4	38	11	63	19	88	26
14	4	39	12	64	19	89	27
15	5	40	12	65	20	90	27
16	5	41	12	66	20	91	27
17	5	42	13	67	20	92	28
18	5	43	13	68	20	93	28
19	6	44	13	69	21	94	28
20	6	45	14	70	21	95	29
21	6	46	14	71	21	96	29
22	7	47	14	72	22	97	29
23	7	48	14	73	22	98	29
24	7	49	15	74	22	99	30
25	8	50	15	75	23	100	30

Decision and Earnings Sheet

Pd.	Endow-ment	Your Decision		(c) Total Tokens in Group Account	(d) Value of Tokens in Group Account	(e) Earnings (a) + (d)
		(a) Private Account	(b) Group Account			($3.00)
1	20					
2	20					
3	20					
4	20					
5	20					
6	20					
7	20					
8	20					
9	20					
10	20					

Total Earnings: ($3.00 + earnings) ______

Payment: (Earnings Rounded up to nearest $.25) ______

Receipt Form

Received: ______________________ dollars and ____ cents

Signature: ______________

SSN: ______________

Date: ______________

A6.3 Incentive Compatibility in the Groves–Ledyard Mechanism*

Although not particularly intuitive, it is relatively straightforward to show that the Groves–Ledyard mechanism results in an optimal level of the public good, where the sum of the individual marginal valuations equals the marginal cost, mc, of producing the public good. Each person will choose a quantity increment, x_i, to maximize the difference between the individual's value of the public good and the cost determined by the Groves–Ledyard mechanism. Individual i should increase the quantity increment until the marginal individual valuation is equal to the individual marginal cost, that is, until $V_i' = C'(x_i|S_i)$, where S_i is the sum of the quantity increments of the other individuals. As before, let X denote the sum of the quantity increments for all n individuals. It is straightforward to show that the derivative of the cost function in equation (6.5) with respect to x_i is the term on the far right side of (6.14):

$$V_i'(x_i|S_i) = C_i'(x_i|S_i) = \frac{mc}{n} - nS_i + (n-1)(x_i + S_i), \tag{6.14}$$

for $i = 1, \ldots n$. Since equation (6.14) determines the optimal quality increment for each individual, we can sum these conditions to obtain

$$\begin{aligned} \sum V_i' = \sum C'(x_i|S_i) &= mc - n\sum S_i + n(n-1)X \\ &= mc - n[\sum S_i - (n-1)X] \\ &= mc, \end{aligned} \tag{6.15}$$

where the final step follows from the fact that $\Sigma S_i = (n-1)X$. But equation (6.15) is equivalent to the optimality condition in (6.4), that the marginal cost of producing the public good equal the sum of the individual marginal valuations.

* The material in this section is somewhat more advanced.