ELSEVIER

Behavioural Processes 47 (1999) 65–72

BEHAVIOURAL PROCESSES

www.elsevier.com/locate/behavproc

Self-control and social cooperation

Jay Brown, Howard Rachlin *

Department of Psychology, State University of New York at Stony Brook, Stony Brook, NY 11794-2500, USA

Received 9 February 1999; received in revised form 3 May 1999; accepted 19 May 1999

Abstract

Participants repeatedly played a self-control game in which choice of the higher of two monetary rewards on the present trial reduced the overall reward ('alone condition'). Other participants played a prisoner's dilemma (social cooperation) game in which choices alternated so that overall reward-reducing consequences of choosing the higher current amount were experienced by the other player ('together condition'). Participants playing the self-control game chose the lower current amount (and higher overall reward) significantly more frequently than did those playing the social cooperation game. In a second phase, half of the subjects who had played the self-control game played the social cooperation game and vice-versa. Little or no transfer was observed between conditions. In a second experiment, raising the amount of the next-trial reward increased self-control but not social cooperation. Some transfer between self-control and social cooperation was observed. The crucial variable responsible for participants' better performance (closer to optimization) in the self-control game compared to the social cooperation game may have been the higher probability in the former that choice of the lower reward on the present trial would be repeated on subsequent trials.

Keywords: Choice; Cooperation; Prisoner's dilemma; Self-control

1. Introduction

The analogy between self-control and social cooperation has been pointed out by moral philosophers at least since Plato[1]. The fundamental issue addressed by ancient Greek philosophy was the relation between particular objects and abstract entities: abstract ideals, for Plato; abstract categories, for Aristotle (Rachlin, 1994). The problem of self-control is a conflict between particular acts such as eating a caloric dessert, taking an alcoholic drink, or getting high on drugs, and abstract patterns of acts strung out in time such as living a healthy life, functioning in a family, or getting along with friends and relatives (Rachlin, 1995).

In formal terms, suppose two alternative activities are available, a relatively brief activity lasting t units of time, and a longer activity lasting T units of time, where $T = nt$ and n is a positive number greater than one. In other words, the

* Corresponding author. Tel.: +1-516-632-7807.

E-mail address: hrachlin@psych1.psy.sunysb.edu (H. Rachlin)

[1] And many times since, Ainslie (1992) has recently stressed this correspondence.

0376-6357/99/$ - see front matter
PII: S0376-6357(99)00054-6

duration of t is less than that of T, and n of the smaller t's fit into a single T. The ambivalence inherent in a self-control problem depends on two conditions:

1. The whole longer activity is preferred to n repetitions of the brief activity, and
2. The brief activity is preferred to any t-length fraction of the longer activity[2].

For a heroin addict, for example, the act of taking heroin (time $= t$) is always immediately more valuable than not taking it (time $= t = T/n$). But as a long-term pattern, taking heroin (time $= T = nt$) is decidedly not as valuable as not taking it; the addict will feel bad in the long run (time $= T$).

A corresponding problem arises in situations requiring social cooperation (ranging from littering to international arms control). Conflicts often exist between acts benefiting an individual (or a relatively small group) and acts benefiting a (larger) group. The social cooperation problem may be formalized in the same way as the self-control problem: two alternative activities are available; one maximally benefits an individual person, p; the other maximally benefits the group, $P = np$. The classic case of such a conflict is 'the tragedy of the commons' (Hardin, 1968) where overgrazing or overfishing depletes stock and harms the group of farmers or fishermen as a whole (and all individuals in the long run) but, regardless of the level of stock at the moment, maximizes benefits for the individual.

Despite the closeness of the analogy between self-control and social cooperation, it is far from clear that choice of more abstract alternatives in self-control situations will correlate with or generalize to choice of more abstract alternatives in social choice situations. The most salient difference between self-control and social cooperation is that we seem to be able to predict and control our own behavior better than we can predict and control the behavior of others. It is therefore worth examining whether experience in one sphere transfers to the other. The two experiments presented here examined transfer between the two types of tasks using highly corresponding procedures[3].

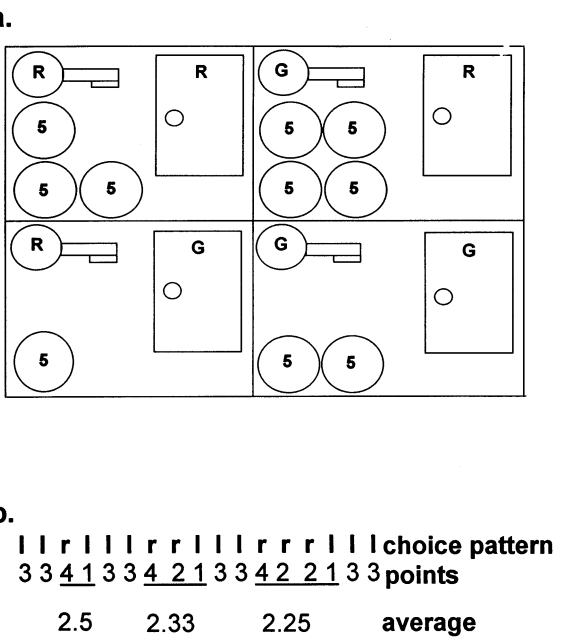

Fig. 1. (a) A model of the apparatus used in this experiment. The top two compartments were red doors and the bottom two compartments were green doors. The left two compartments contained red keys and the right two contained green keys. (b) A demonstration of how breaks in a string of left responses affect the reward outcomes.

[2] A less difficult self-control problem arises when the brief activity is preferred to only the initial t-length fraction of the longer activity. In everyday human life, however, such problems are easily overcome. Serious self-control problems, approaching addictions, arise when a brief period of a longer activity (such as being sober for 10 min) is rarely or never preferred to a brief activity (having a drink).

[3] Recently, Silverstein et al. (1998), studied transfer effects in a prisoner's dilemma game using red and black cards where players first played the game repeatedly with the experimenter, who used a fixed strategy, and then played repeatedly with each other. The main purpose of that experiment was to study the effects of patterning of trials on social cooperation. The present experiments differed from those of Silverstein et al. in two important ways. First, in the present experiment, the apparatus transparently and simultaneously displayed all possible choices and outcomes, thus minimizing the difficulty in understanding the contingencies inherent in prisoner's dilemma procedures and in those self-control procedures that use abstract, temporally extended rewards (see Herrnstein et al., 1993). Second, in the present experiment 2, the rewards were changed (in order to assess their motivational effects)

2. Experiment 1

2.1. Method

2.1.1. Participants

Eighty female undergraduate students from the State University of New York at Stony Brook served as participants. All served in pairs and the actions of one were always clearly visible to the other. Participants were treated in accordance with the American Psychological Association's ethical standards for human participants.

2.1.2. Apparatus

The apparatus used in both self-control and social cooperation tasks (the 'game board') is diagrammed in Fig. 1a. It consisted of a rectangular plastic tray (27 × 17 cm) divided into four compartments ('boxes'). Each box contained three items:

1. A red or green index card with a picture of a door ('red doors' or 'green doors'),
2. A red or green key,
3. A number of nickels (1, 2, 3 or 4 nickels, in experiment 1, as shown in Fig. 1a. In experiment 2, the upper left and right boxes held 5 and 6 nickels, respectively).

The upper boxes both contained red doors; the lower boxes both contained green doors. The left boxes both contained red keys; the right boxes both contained green keys. Note that each right box held one more nickel than the box to its left, and each upper box held two more nickels than the one below it (four more in experiment 2). All the items in the boxes were visible to the players.

2.1.3. The rules of the game

In this experiment, keys were used to 'open a door' of the apparatus. A red key opened one of the two red doors; a green key opened one of the two green doors. Opening a door allowed the player to take both the key and the nickels from that compartment. The key used to open the door was taken from the player and the nickels and appropriate colored key were replaced in the apparatus by the experimenter. That is, after each trial the configuration shown in Fig. 1a was restored.

while keeping the complex contingencies constant whereas in the Silverstein et al. experiment the payoff matrix did not vary.

2.1.4. The self-control game ('alone')

Each trial began with the apparatus as pictured in Fig. 1a. To start, a player was given a red key. The player could use that key to 'open' one or the other red door (to choose either the upper left or upper right box). The used key was then surrendered. If the upper left box was chosen, the player was permitted to take the three nickels and the red key from that box. If the upper right box was chosen the player was permitted to take the four nickels and the green key from that box. Then the nickel(s) and key taken were replaced by the experimenter and the next trial began. If a red key had been received on the previous trial, the player could again choose between the two red doors as before; if a green key had been received on the previous trial, the player could use this key to 'open' one or the other green door (to choose a key and nickels from either the lower left or lower right box).

This is a self-control procedure in the sense that the behavior leading to the higher current reward (choosing the right box) conflicts with the behavior that maximizes overall reward (choosing the left box — the one with the red key). Choosing the right box always earned the player one more nickel than did choosing the left box, but at the cost of obtaining a green key. With the green key the player payed for the 1-point gain (for choosing the right box) on the previous trial with an average 2-point loss (having to choose between the lower boxes) on the present trial. The best overall strategy was to always choose the left box, always receive a red key, and always earn three nickels.

To see this more clearly, consider the choice sequence shown in Fig. 1b. One, two or three right-box choices (r's) are shown in the figure as disturbances in a string of left-box choices (l's). Number of nickels earned on each trial and average for the duration of the disturbance are shown below each string. The more right-box choices, the lower the average[4].

[4] Except if a right box is chosen on the very last trial. But the players in this experiment did not know when the last trial would occur.

2.1.5. The social cooperation task ('together')

Two players, playing on a single game board, as diagrammed in Fig. 1a, made choices on alternate trials. The experimenter arbitrarily designated one player to choose first, and gave that player a red key. After the first player chose one of the upper boxes, the key from that box was handed to the second player who chose between the upper boxes if the key was red (if the first player had chosen the left box) or between the lower boxes if the key was green (if the first player had chosen the right box). The key obtained by the second player was then handed to the first player and the first player made the permitted choice, and so forth. Thus, after the first trial, whether a player chose between the upper boxes or between the lower boxes depended on the other player's choice on the previous trial. This task has the essential properties of a prisoner's dilemma game. However, in the standard prisoner's dilemma (as in Silverstein et al., 1998), pairs of players chose simultaneously on each trial (Rapoport and Chammah, 1965) whereas in this study choices were made sequentially.

In this game, income would be maximized (at three nickels per trial) for each player if both players repeatedly chose the left box (cooperated). However, the individual player would always gain more on the present trial by choosing the right box (defecting). The penalty for defecting, of having to choose between the lower boxes, is suffered not by the player who defects but by the other player, who inherits the green key. Cooperating is the very worst strategy in this game, unless the other player also cooperates. Therefore, the only reason to cooperate (within the demands of the game) is to influence the other player to cooperate subsequently.

2.1.6. Procedure

Four groups of subjects played alone or together for 20 trials in phase I and 20 trials in phase II. The phase I/phase II conditions were: alone/alone; alone/together; together/alone; together/together. Players were asked to judge on a scale from 1 (never met) to 7 (extremely well), how well they knew the other player.

When the game was played alone each player of a pair played on a different game board. Each player in the alone condition was initially given a red key to begin the game. She then used this key to open a compartment. The key in the compartment chosen on a given trial was then used by that player to open a door on the next trial as described above. That is, one player (player 1) made a choice on her game board while player 2 watched. Then player 2 made a choice on her game board while player 1 watched. The phase ended after 20 such alternations.

When players played together a single game board was used. One player (player 1) was given a red key to begin the game. She then used this key to open a compartment containing a red door (one of the upper compartments in Fig. 1). She collected the money in the chosen compartment, but the key was then given to the other player (player 2). Player 2 then used this key on her first trial. The key in the compartment chosen was then given to player 1. This exchanging of keys continued for 20 trials per player in phases in which players played together. After the completion of phase II, players were debriefed about the purpose of the research; the nickels they had earned were counted by the experimenter and paid to the players.

2.2. Results

Each player (including those who played alone) saw the play of her partner. Therefore, unless otherwise noted, the data from the individual players in a pair were averaged for all analyses. However, there was no significant correlation between pairs' stated degree of friendship and their cooperation.

Figure 2 summarizes the performance of all groups over all trials of both phase I and phase II. The trend in cooperation of the group playing alone/alone is significantly positive and linear, $F_{[1,36]} = 15.13$, $P < 0.001$. The trend for those playing together/together is not significant, $F_{[1,36]} = 1.57$, $P > 0.05$.

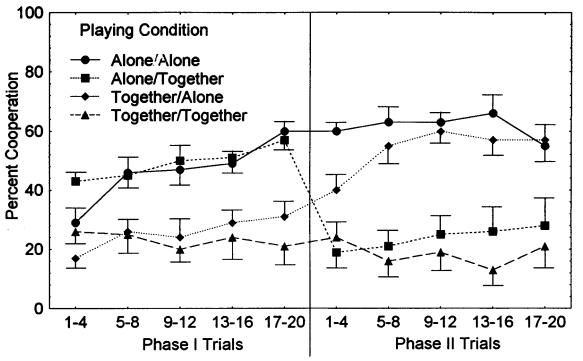

Fig. 2. A summary of the cooperation displayed by all groups during experiment 1. Bars indicate 1 S.E.

2.2.1. Phase I

A 2×5 (phase I $\times$ four-trial blocks) mixed factorial analysis of variance was performed on percent cooperation during phase I. When participants played alone they cooperated significantly more over all trials of this phase ($M = 48\%$) than if they played together ($M = 24\%$), $F_{[1,38]} = 66.5$, $P < 0.001$. In addition to the overall cooperation in phase I, the cooperation across trials was broken into four-trial blocks and analyzed. For participants playing alone, cooperation followed a significant positive linear trend (M's = 36, 46, 49, 50 and 59%), $F_{[1,38]} = 24.13$, $P < 0.001$. The trend for participants playing together was not significant (M's = 22, 26, 22, 26 and 26%), $F_{[1,38]} = 0.83$, $P > 0.05$.

2.2.2. Phase II

A $2 \times 2 \times 5$ (phase I $\times$ phase II $\times$ four-trial blocks) mixed factorial analysis of variance was performed on percent cooperation during phase II. As a whole, participants cooperated significantly more during phase II when playing alone ($M = 58\%$) than when playing together ($M = 21\%$). Participants who played alone in phase I subsequently cooperated more in phase II ($M = 43\%$) than those who played together in phase I ($M = 36\%$), but this difference was not significant.

2.3. Discussion

Despite the clear and discriminable visual representation of the contingencies, only two participants, both playing alone in the first phase, learned to maximize earnings by consistently cooperating over the last four of 20 trials. No other participant cooperated on the last four trials of any phase.

There was no measured transfer of cooperation from the self-control game to the social cooperation game. As soon as the participants playing alone began to play together, their average cooperation dropped to the level of those playing together from the beginning.

Similarly, there was no measured transfer from the social cooperation game to the self-control game. The rise in cooperation during phase II for those participants playing together in phase I and alone in phase II (the together/alone group) was not significantly steeper than the rise in cooperation for those participants playing alone in phase I (the alone/alone and alone/together groups). In other words, experience in the social cooperation game did not seem to aid in the development of self control.

While (the poor) performance in the social cooperation task seemed to depend on the social aspects of the task (cooperation dropped precipitously for the alone–together group as soon as the game became social), one can question whether performance in the self-control task has any motivational component at all. It may be that participants in the alone condition were simply learning a 'satisficing' strategy (Simon, 1956). It may be that unlike experiments on self-control with nonhumans and humans (Logue, 1988, 1995) and in self-control situations of everyday life, where performance depends on amount and delay of reward, performance in the alone conditions of this experiment depends only on experience with the task structure. Experiment 2 was an attempt to address this issue by increasing the amount of the delayed (next-trial) reward. To the extent that the task has the incentive and motivational components of a typical self-control task, this manipulation should increase self-control (left-box choices).

3. Experiment 2

3.1. Method

3.1.1. Participants

Eighty additional female undergraduate students from the State University of New York at Stony Brook served as participants.

3.1.2. Apparatus

The same two game boards used in experiment 1 and shown in Fig. 1a were again employed. In experiment 2, however, the compartments contained 1, 2, 5 or 6 nickels rather than the 1, 2, 3 or 4 used in experiment 1.

3.1.3. Procedure

The procedure of experiment 2 was the same as that of experiment 1 except for the payoff contingencies.

3.2. Results

As in experiment 1, each participant saw the play of her partner, thus making all individual data correlated. As before, the data from the individual participants in a pair were averaged for all analyses unless specifically noted. Again, there was no significant correlation between pairs' stated degree of friendship and their cooperation.

Figure 3 shows the percent cooperation for all groups across trials of both phase I and phase II. As in experiment 1, the trend for the alone/alone group is significantly positively linear, $F_{[1,36]} = 17.76$, $P < 0.001$ and the trend for the together/together group is not significant, $F_{[1,36]} = 1.23$, $P > 0.05$.

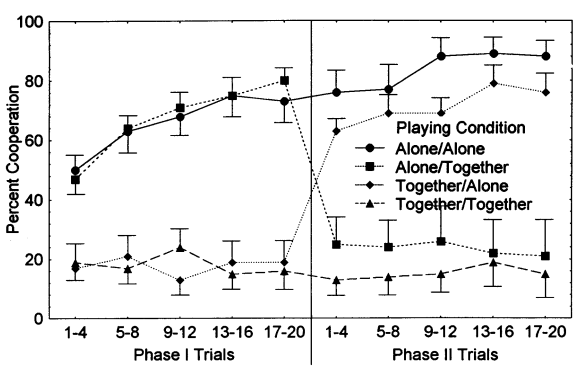

Fig. 3. A summary of the cooperation displayed by all groups during experiment 2. Bars indicate 1 S.E.

3.2.1. Phase I

A 2×5 (phase I $\times$ four-trial blocks) mixed factorial analysis of variance was performed on percent cooperation during phase I of experiment 2. Participants playing alone cooperated significantly more over all trials of this phase ($M = 67\%$) than those who played together ($M = 19\%$), $F_{[1,38]} = 105.07$, $P < 0.001$. In addition to the overall cooperation in phase I, the cooperation across trials was broken into four-trial blocks and analyzed. For participants playing alone, cooperation followed a significant positive linear trend (M's = 49, 63, 69, 75 and 76%), $F_{[1,38]} = 48.09$, $P < 0.001$. The trend for participants playing together was not significant (M's = 23, 19, 18, 17 and 18%), $F_{[1,38]} = 2.03$, $P > 0.05$.

All of the above results are the same as those of the corresponding tests for phase I of experiment 1.

3.2.2. Phase II

A $2 \times 2 \times 5$ (phase I $\times$ phase II $\times$ four-trial blocks) mixed factorial analysis of variance was performed on the percentage cooperation during phase II of experiment 2. As a whole, participants cooperated significantly more during phase II when playing alone ($M = 77\%$) than when playing together ($M = 19\%$). Participants who played alone in phase I subsequently cooperated more in phase II ($M = 54\%$) than those who played together in phase I ($M = 43\%$), but this difference was not significant. Again, these results are the same as those of experiment 1.

3.2.3. Experiments 1 and 2 combined

A $2 \times 4 \times 10$ (experiment $\times$ groups $\times$ four-trial block) was performed to incorporate the data from all participants from both phases of both experiments. This analysis combined the data shown in Figs. 2 and 3. Participants cooperated significantly more in experiment 2 ($M = 46\%$) than in experiment 1 ($M = 38\%$), $F_{[1,72]} = 7.23$, $P < 0.01$. A priori planned comparisons revealed

that the alone/alone group in experiment 1 ($M = 54\%$) cooperated significantly less than the alone/alone group in experiment 2 ($M = 75\%$), $F_{[1,72]} = 12.75$, $P < 0.001$; however, cooperation of the together/together group in experiment 1 ($M = 21\%$) did not significantly differ from that of the together/together group in experiment 2 ($M = 18\%$), $F_{[1,72]} = .313$, $P > 0.05$.

To compare the transition from phase I to phase II of alone/together and together/alone groups, percent cooperation in the last four-trial block of phase I was subtracted from percent cooperation in the first four-trial block of phase II for each pair of participants in these groups. Then, these differences were averaged for both groups in both experiments and corresponding groups were compared across experiments. The drop in cooperation of the alone/together groups was not significantly different between experiment 1 and experiment 2, $t(18) = 1.83$, $P > 0.05$. But the rise of the together/alone group of experiment 2 was significantly greater than that of the alone/together group of experiment 1, $t(18) = -3.81$, $P < 0.01$.

3.3. Discussion

In experiment 2, participants playing alone/alone chose the larger delayed reward (the left box) significantly more frequently than participants playing alone/alone in experiment 1. In the first phase of experiment 2, 17 of 40 participants playing alone consistently chose the left box over the last four trials, as opposed to two of 40 participants in the corresponding condition of experiment 1. Thus, increasing the difference between the present-trial reward and the next-trial reward from two nickels (3 minus 1 or 4 minus 2) to four nickels (5 minus 1 or 6 minus 2) increased choices of the lower current reward and higher overall reward. This is what would be expected if playing alone was at least partly a self-control task.

As in experiment 1, as soon as participants playing alone began to play together, their average cooperation dropped sharply, but not quite to the level of those playing together from the beginning. The rise in cooperation in phase II for those participants playing together in phase I and alone in phase II was steeper in experiment 2 than it was in experiment 1. In other words, experience in the cooperative task, with these higher delayed rewards, enhanced performance in the self-control task.

4. General discussion

In a true self-control task, variations of reward amount, such as those of the present experiments, may be expected to affect behavior directly. Despite the fact that behavior on the alone task was influenced by amount of reward, it may be argued that the alone task is still basically cognitive. Reward amount in the present experiments may have influenced behavior not directly but indirectly through attention to the task. After all, if a participant in the present experiments 'truly knew' the nature of the alone task (perhaps by verbal instruction or extensive training) she would naturally have maximized overall reward (by repeatedly choosing the left box).

But the same may be said of self-control in everyday life (this was Plato's argument). In everyday self-control situations it is impossible to separate 'true knowledge' from self-control. At some point cognition and self-control blend together. All we can say is that self-control in this procedure is sensitive to some of the variables that seem to influence self-control in everyday life. Whether it is sensitive to *all* of the variables, remains to be tested.

Mathematicians and economists notwithstanding (for example, Poundstone, 1992), there is no normatively correct behavior in either the alone or together tasks. Choice in either task depends not on calculation of the maximal return but on subjective discounting of delay (in terms of time or number of trials) and probability (of others cooperating or of cooperating oneself on subsequent trials). Delay and probability discounting, in turn, are highly similar processes (Rachlin et al., 1986; Rachlin and Raineri, 1992). It is futile to consistently cooperate in a prisoner's dilemma

game if the other players will surely defect[5]. It is correspondingly futile to exhibit self-control (say, to refuse a drink) in the context of past, and the certainty of future, impulsive choices (to drink). Realization of abstract rewards depends on consistent rejection of the immediate reward. For example, good health, a better job, better social relations, etc., depend on a consistent pattern of drink avoidance. Sobriety has no meaning at a point in time. Whether it is right or wrong to cooperate *this* time depends on the probability of others cooperating or of oneself showing self-control at other times.

In experiment 2, participants learned something about the contingencies of the game by exposure to either the alone or together task in the initial phase. Behavior in the second phase quickly adjusted to changes of conditions. The important question is, what are the differences in performance on the two tasks due to? The crucial parameter differentiating self-control from social cooperation seems to be the subjective probability of reciprocation — of next-trial cooperation conditional on present-trial cooperation and of next-trial defection conditional on present-trial defection. This parameter may be inferred to be relatively high in the self-control task and relatively low in the social task. Future experiments may test this inference directly.

[5] A vivid instance of the foolhardiness of lonely cooperation is portrayed in Richard Price's novel, *Clockers*. Two brothers living in a drug-ridden New Jersey project cope in different ways: one conforms to the moral standards of the larger society (consistently 'cooperates'); the other adapts to his local environment and behaves as all around him behave (consistently 'defects'). The novel illustrates the disastrous consequences of cooperation and the survival value of defection in such a situation.

Acknowledgements

This research was supported by grants from The National Institute of Mental Health and The National Institute on Drug Abuse.

References

Ainslie, G., 1992. Picoeconomics — The Strategic Interaction of Successive Motivational States within the Person. Cambridge University Press, New York.

Hardin, G., 1968. Tragedy of the commons. Science 162, 1243–1248.

Herrnstein, R.J., Loewenstein, G.F., Vaughan, W. Jr., Prelec, D., 1993. Utility maximization and melioration: internalities in individual choice. J. Behav. Decision Making 6, 149–185.

Logue, A.W., 1988. Research on self-control: an integrating framework. Behav. Brain Sci. 11, 665–710.

Logue, A.W., 1995. Self-Control: Waiting Until Tomorrow for what You Want Today. Prentice Hall, Englewood Cliffs, NJ.

Poundstone, W., 1992. Prisoner's Dilemma. Doubleday, New York.

Rachlin, H., 1994. Behavior and Mind: The Roots of Modern Psychology. Oxford University Press, New York.

Rachlin, H., 1995. Self-control: beyond commitment. Behav. Brain Sci. 18, 109–159.

Rachlin, H., Logue, A.W., Gibbon, J., Frankel, M., 1986. Cognition and behavior in studies of choice. Psych. Rev. 93, 33–45.

Rachlin, H., Raineri, A., 1992. Irrationality, impulsiveness and selfishness as discount reversal effects. In: Loewenstein, G., Elster, J. (Eds.), Choice Over Time. Russel Sage Foundation, New York, pp. 93–118.

Rapoport, A., Chammah, A.M., 1965. Prisoner's Dilemma. University of Michigan Press, Ann Arbor, MI.

Silverstein, A., Cross, D., Brown, J., Rachlin, H., 1998. Prior experience and patterning in a prisoner's dilemma game. J. Behav. Decision Making 11, 123–138.

Simon, H.A., 1956. Rational choice and the structure of the environment. Psych. Rev. 63, 129–138.