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Development of Cooperation Between Children in the Minimal Social Situation

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DEVELOPMENT OF COOPERATION BETWEEN CHILDREN IN THE MINIMAL SOCIAL SITUATION

by

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Janice V. Siegel

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

ABSTRACT

Development of Cooperation Between Children

in the Minimal Social Situation

by

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The purpose of this study was to determine whether children can learn to cooperate in what has been described as the "minimal social situation." The research also compared the effectiveness of verbal instructions and a training task for teaching subjects the "win-stay, lose-change" rule. This rule has been used to explain the development of cooperation in the minimal social situation.

Subjects were 19 teams of first-, second-, and third-graders. Five teams were composed of two girls; six were girl-boy teams; and eight were boy-boy teams. Ten of the 19 teams learned to cooperate in the minimal social situation without treatment. Two of four teams given the rule training procedure learned to cooperate after having failed to learn under typical minimal social conditions. Of five teams given verbal instructions, four learned to cooperate immediately.

The probability of following the win-stay, lose-change rule was approximately 50% initially and did not increase significantly in later sessions. It is not clear then that following this rule is a

prerequisite for the development of a cooperative exchange. Explanations in the literature which suggest subjects learn a single rule, i.e., win-stay, lose-change, may be misleading since children evidenced a variety of rules, any of which might have been reinforced or punished over the course of the experiment.

(139 pages)

Introduction

Although there has been much research dealing with the topic of cooperation, there have been relatively few studies dealing specifically with cooperation in what has been called the "minimal social situation." Study of the minimal social situation began with Sidowski, Wyckoff, and Tabory in 1956. The research was an attempt to explain social interaction entirely within an operant conditioning framework, avoiding the use of concepts such as "awareness" and "understanding" which have traditionally been used to explain social interaction. Assuming the main factors controlling social interactions to be reinforcement and punishment, Sidowski et al. (1956) defined the essential features of a social situation as follows:

> (a) Two or more Ss have at their disposal responses which result in reinforcing or punishing effects on other Ss. (b) The principal sources of reinforcement and punishment for any S depend on responses made by other Ss. (c) The responses controlling reinforcement and punishment are subject to learning through trial and error. (p. 115)

The purpose of the Sidowski et al. research was to determine whether two subjects could learn to cooperate (consistently give each other positive reinforcement) under the minimal social conditions previously defined. In this experiment pairs of college students were placed in isolated booths. Each subject had before him a panel with two buttons and a counter, and a pair of electrodes was attached to one of his hands. The subjects were instructed that the object of the experimental task was to make as many points as possible

by pushing the buttons on the panel in front of them. Each subject was led to believe at all times that he was the only person involved in the experiment. Although they were unaware of it, the subjects were not working independently. Each subject controlled the other's reinforcement and punishment. When a subject pushed one button on his panel, he gave a point to his partner; when he pushed the other button, his partner received a shock. Results of the study indicated that subjects did learn to cooperate, i.e., to give each other points (at a greater than chance level).

The development of cooperation in the minimal social situation has been attributed to subjects' following a "win-stay, lose-change" rule. This rule suggests that when two subjects are responding in the minimal social situation, a subject receiving a reward will tend to repeat his previous response (he will push again the button he pushed last); a subject receiving punishment will change responses. Indeed, if both subjects of a team followed this rule perfectly, the team would lock into a mutually rewarding interchange, i.e., learn to cooperate, within three trials.

Since Sidowski's original experiment, there have been eight other minimal social studies. These studies have dealt with a variety of independent variables such as the effects of informing subjects that their reinforcement was controlled by another subject (Sidowski, 1957; Kelley, Thibaut, Radloff, & Mundy, 1962), the effects of using different intensities of shock (Sidowski, 1957), the effect of the sex of partners responding in the minimal social situation (Sidowski

& Smith, 1961), and the effects of offering monetary incentive to subjects for cooperation or competition (Crawford & Sidowski, 1964). The minimal social research has also been extended to triads and quartets (Kelley et al., 1962; Smith & Murdock, 1970; Fry, Hopkins, & Hoge, 1970; Powers, Riddle, & Phillips, 1976).

All studies up to now have used adults, specifically college students, as subjects. It seemed that a reasonable next step in the extension of the minimal social literature would be to determine whether or not children could learn to cooperate under conditions which have led to cooperation in adults.

A pilot study done earlier by this author indicated that children did not learn to cooperate in the minimal social situation. (See Appendix for complete results of the pilot study.) The children tended to exhibit certain error patterns which made the possibility of their locking into a mutually rewarding pattern of responding rather remote. For example, children tended to alternate from one response to the other or to persistently repeat one response, regardless of the consequences. Similar behavior has been reported in several studies (Sidman & Stoddard, 1967; Stoddard & Sidman, 1967; Gerjouy & Winters, 1968; and Gholson, Levine, & Phillips, 1972) when children were required to perform a difficult discrimination task. Harlow (1950) reported that monkeys, too, exhibit specific error patterns.

The error patterns exhibited by the children are probably traceable to reinforcement contingencies not under the control of the

experimenter. The probability of adventitiously reinforced response patterns would seem to be rather high in the minimal social situation, since the subject has no direct control over the outcomes he receives (this is controlled by his partner). On one trial a subject may be reinforced for a response, and on the next trial punished for the same response, depending on how his partner responds. In most cases win-stay, lose-change behavior was not consistently reinforced; often it was punished. It seemed that failure to learn in the minimal social situation was mainly due to the ambiguous feedback received by the subjects. If both subjects had followed a win-stay, lose-change rule, eventually a mutually rewarding state would have been reached. However, at least in the case of the children in the pilot research, complex behavior patterns developed which interfered with the development of rule-following behavior.

The preliminary research indicated the need for a method of teaching win-stay, lose-change behavior. The present study attempted to teach win-stay, lose-change behavior in the minimal social situation by two methods: 1) verbal instruction and 2) a rule training task.

The purpose of the research then was three-fold: 1) to establish whether children would learn to cooperate under the minimal social conditions described by Sidowski; 2) to determine the effectiveness of a training task developed to teach the rule, win-stay, lose-change, and 3) to compare the effectiveness of verbal instructions to the training procedure in teaching the rule.

Review of the Literature

The study of the minimal social situation began with Sidowski et al. in 1956. The effects of two levels of shock used as punishment were also measured in this experiment. Half of the subjects received a strong shock (200% of their absolute threshold value) and the other half received weak shock (110% of their absolute threshold value).

Results of the experiment indicated that subjects in dyads using strong shock as a punisher learned to cooperate, while subjects receiving weak shock did not. By the end of the session subjects in the strong shock group gave each other positive reinforcement on approximately 65% of the responses. This increase in positive responses was not seen in the weak-shock groups.

Theoretical Explanation of the Development of Cooperation

Sidowski used an operant conditioning analysis to explain the development of cooperation in the minimal social situation. Subjects tend to repeat responses for which they are rewarded and change responses that are punished. Thus, it appears subjects follow a win-stay, lose-change rule. By following this rule, subjects eventually lock into a pattern of mutually rewarding responding.

Figure 1 illustrates the possible routes to cooperation in the minimal social situation. In Case I both team members, A and B, give positive reinforcement on the first trial. If both follow the

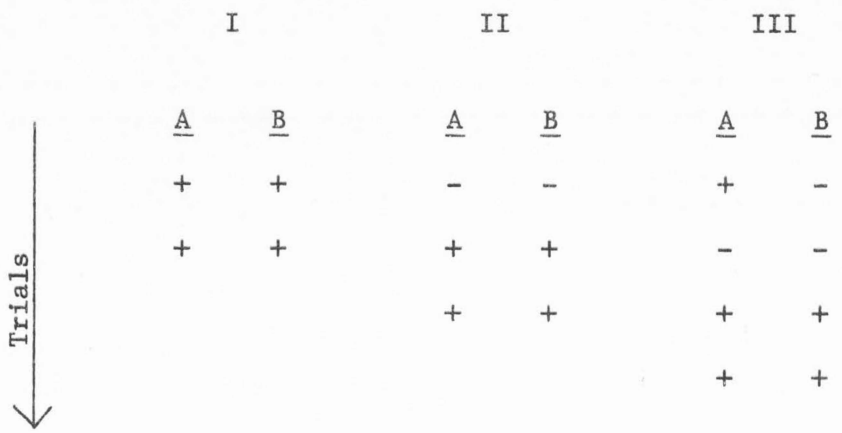


Figure 1. Three possible routes leading to mutually rewarding interchange in the minimal social situation. (Plus and minus signs in each column represent responses made by each subject.)

win-stay, lose-change rule, they will repeat this positive response, thus locking into a mutually rewarding interchange. If team members give each other punishment on the first trial (Case II), according to the rule, both should change responses on the second trial. Both team members would receive positive reinforcement on the second trial, and again, they would lock into a mutually rewarding interchange. The analysis is somewhat more complex in the situation where one team member gives reinforcement on the first trial and the other gives punishment. Following the diagram for Case III, Subject A gave reinforcement on Trial 1 and changes responses on Trial 2 because he was punished by subject B on Trial 1. Subject B who gave punishment on the first trial was reinforced by his partner and so repeats this response on Trial 2. This brings the team to a situation where both members are punished for their response, as in Case II. If both team members follow the rule, they will change responses and lock into a mutually rewarding interchange.

In view of the win-stay, lose-change rule, Sidowski et al. explained the greater effectiveness of strong shock as due to subjects more often shifting from one response button to another following a strong shock than following a weak shock. Weakly punished behavior may be sustained by intermittent reinforcement. Because subjects receiving strong shock change responses, they are more likely to lock into a mutually rewarding pattern of responding.

Both Sidowski (1957) and Kelley et al. found evidence of "win-stay" behavior in subjects, but neither found evidence of "lose-change"

behavior. Analysis of data gathered in the Kelley et al. experiment indicated that subjects did not exhibit win-stay behavior initially, but rather learned it over the course of the experiment.

Rabinowitz, Kelley, and Rosenblatt (1966) did an investigation of win-stay, lose-change behavior in the minimal social situation. When overall responding on both response buttons on the subjects' panels was analyzed, it was found that subjects exhibited win-stay behavior significantly more often than chance. Lose-change rate did not differ from chance. In contrast to the Kelley et al. study, there was no change in win-stay rate over the course of the study. Subjects showed the difference initially.

When responding was analyzed on each button separately, however, it was found that the win-stay rate on one button (that which gave reward to the partner) was significantly greater than the win-stay rate on the other button. Lose-change behavior occurred significantly more often on the second button. The authors concluded that subjects did not learn undifferentiated win-stay, lose-change behavior but rather different rules for responding on the different response buttons.

Fry et al. (1970) and Smith and Murdoch (1970) examined win-stay, lose-change behavior with triads in the minimal social situation. Both groups of researchers found data suggesting that subjects exhibited win-stay behavior, but neither found data supporting a lose-change tendency. However, they did not analyze the responding on each response button separately as was done by Rabinowitz et al.

Instructions and Incentive Conditions

As was reported earlier, the first minimal social experiment used points as a reinforcer and shock as a punisher. Sidowski (1957) investigated the necessity of using both reward and punishment in the minimal social situation. Three different reward-punishment conditions were studied. One-third of the pairs of subjects could give each other points, but no shock; one-third could give each other only shock; the remainder of the subjects could give both shock and points. The importance of being informed of the social nature of the experiment was also evaluated in this experiment and will be discussed later. Results indicated that the shock-score subjects and the score-only subjects significantly increased their use of the score button. The shock-only group did not increase their use of the score button. The shock-score groups were superior to both the score-only and the shock-only groups, but the difference between shock-score groups and score-only groups was not statistically significant.

In most later minimal social studies (Crawford & Sidowski, 1964; Kelley et al., 1962; Fry et al., 1970; and Smith & Murdoch, 1970) shock was no longer used. In these experiments, points were subtracted for incorrect responses. No analysis has been done to indicate whether the use of shock and score leads to more effective learning than the addition and subtraction of points.

In 1964, Sidowski and Crawford investigated the effects of monetary incentive and instructions to cooperate or to compete in the

minimal social situation. Subjects were given a 20-trial demonstration of how buttons on the panel in front of them worked, i.e., how the buttons on one subject's panel controlled the other's outcomes. Points were added or subtracted on counters in front of subjects for correct and incorrect responses. Subjects within each dyad were instructed either to compete with or to cooperate with their partner. Monetary incentive was offered to one-half the subjects. In the Competition/Monetary Incentive group subjects were told that the subject with the highest score would receive $10; the second highest scoring subject would receive $7; and the third highest, $5. The Cooperation/Monetary Incentive subjects were offered the same monetary rewards for high team scores (combined scores of the dyad members). There was no significant difference between groups due to monetary incentive, but different instructions did affect the results. Subjects in dyads instructed to cooperate earned significantly more points than subjects in dyads that were instructed to compete.

The results of this study must be accepted with caution. The 20-trial demonstration given to subjects made them aware of how the reinforcement contingencies worked in the minimal social situation and, of course, made them aware of the social nature of the situation. Thus, it might be argued that this was not a "true" minimal social situation.

Sidowski and Smith (1961) investigated the effects of various instructions and sex of subjects on behavior in the minimal social situation. Equal numbers of male-male, female-female, and female-male

teams were used in the study. Subjects were told they were playing a game (trying to win points) with no opponent, with a machine opponent, with the experimenter as an opponent, or with another subject as an opponent. Results indicated no significant effects due to sex or to the various instructions. The study was useful, however, in that it eliminated these as important variables in the minimal social situation.

Free Operant Versus Trials Procedure

Sidowski's first two minimal social studies were free operant in nature, meaning subjects could respond at any time. Although learning was shown in this setting, a free operant situation does lead to some difficulties. For example a subject might be rewarded or punished when he is not responding at all. In Sidowski's second experiment (1957) subjects in the shock-only condition, instead of learning to cooperate, decreased their rate of responding (thus were not shocked so frequently). Almost all minimal social studies since these original two have used a trials procedure (an exception being Rabinowitz et al., 1966, which will be discussed later). In most cases the onset of a light signals the beginning of the trial; each subject's response is locked into a memory system, and the outcomes are delivered after both have responded.

Kelley et al. (1962) studied the effects of simultaneous versus alternated trials in the minimal social situation. In the simultaneous situation subjects simultaneously made responses and received feedback

after each response; in the alternated trials situation, subjects alternated turns making responses. Since subjects in the alternated trial condition would have a longer delay before feedback after a response, a control (simultaneous trials with a delay in feedback) was run to account for this; however, this delay did not seem to affect the rate of learning for this control group. Results of the study indicated that dyads working under "minimal conditions" (without knowledge of their partners or the reinforcement contingencies) did better under simultaneous conditions. Where subjects knew that they were working with a partner and how the reinforcement contingencies worked, those with alternated trials attained solution as often as those with simultaneous trials, but took more trials to do so. The reason solution was not as readily attained in the alternation situation was explained rather clearly in Jones and Gerard (1967) (refer to Figure 2):

> In the alternation case, when A responds, then B, then A, ... the dyad cannot move to a mutually reinforcing (plus-plus) state by following the win-stick lose-shift rules. Assume, for example, that A begins by helping B and is punished in return. A changes his response, thus punishing B. B changes his response, thus rewarding A, who therefore continues to punish B. This constitutes a cycle, then, which starts and ends with B being punished for helping A. (pp. 553-554)

Knowledge of the Social Nature of the Experiment

By definition, persons working in a minimal social situation do not know of the presence of their partners in the experimental setting. In his 1957 study Sidowski investigated the effects of

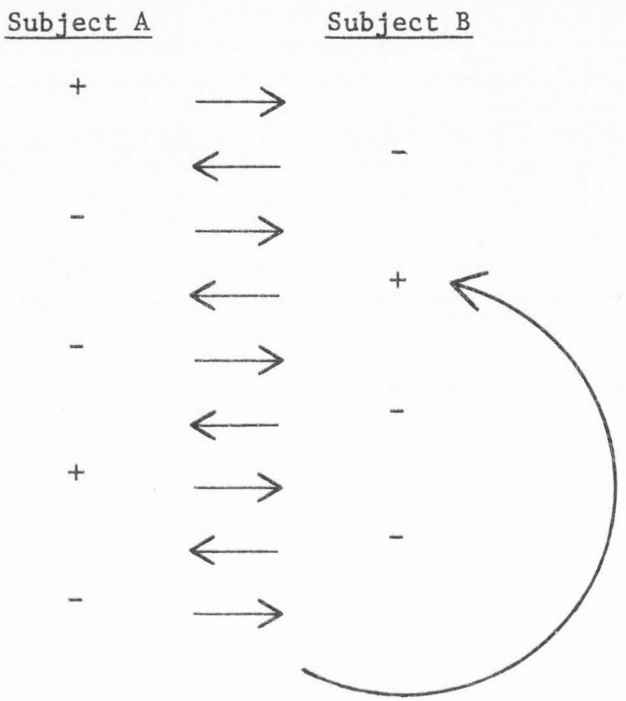


Figure 2. The predicted sequence of plays, beginning with the case where A reinforces B and B punishes A under alternated trials conditions.

informing subjects of the social nature of the minimal social situation. Subjects in one-half of the dyads were told that their rewards and punishments were controlled by another person and that they in turn controlled the rewards and punishments of that other person. The other half of the subjects were led to believe that they were participating alone in the experiment. Results indicated no difference between informed and uninformed dyads.

Sidowski and Smith (1961) measured the effects of giving subjects different game instructions--subjects were told that they were working with no opponent, with a machine opponent, with the experimenter as an opponent, or with another subject. The finding that there was no difference in performance between subjects who were told they were opposing another subject and those who were told they had no opponent lends support to the earlier Sidowski (1957) findings.

Kelley et al. (1962) also studied the effect of informing subjects of the social nature of the situation. The instructions in this experiment were probably more explicit than those given by Sidowski (1957). Subjects were brought into a room together and introduced. Then they were shown how to use the control box. The experimenter diagrammed for subjects how the experimental arrangements worked, i.e., that one response by a subject gave a point to his partner and the other response subtracted a point. Subjects were not told which switches delivered the reward and punishment, however. Results of this study indicated that dyads under informed conditions did clearly better than those under uninformed conditions--significantly

more dyads reached solution ($p<.001$), and there were significantly more dyads in which both members increased the frequency of positive scores ($p<.001$). Kelley et al. explained the differences between their findings and the earlier Sidowski findings as due to the more explicit explanation they gave about the reinforcement contingencies in the situation.

Fry et al. (1970), working with triads in the minimal social situation, studied the effects of informing subjects about the social nature of the situation. Members of one-third of the triads were told how they controlled each other's reinforcement and were shown a diagram of the interactions (without being told which buttons delivered punishment and reward). One-third of the subjects were uninformed, i.e., led to believe they were working alone. In the remaining one-third of the triads, one member of the triad was informed and the other two members were uninformed. In this latter situation, the informed member of the triad was told that he was the only informed member. Results of the experiment indicated that in informed triads subjects learned to reinforce each other at a significantly greater than chance level. The subjects in the uninformed conditions did not learn to cooperate above a chance level. Initially the triads in which only one member was informed performed below a chance level; throughout the session, however, their performance increased to a chance level.

Smith and Murdoch (1970) studied the effects of informing subjects of the social nature of the task with triads and quartets.

Informed subjects were told that one of their buttons gave positive points to another person and that the other gave negative points. In this experiment no quartets reached solution. Eleven of 32 triads reached solution, but there was no significant difference in the number of informed and uninformed triads. The same authors measured the effect of informing dyads. Informed dyads reached solution significantly more often; eight out of nine informed dyads reached solution, while only three out of seven uninformed dyads did so.

The above studies indicate that in most cases information about the minimal social task does significantly improve the performance of the subjects working in the situation.

Triads and Quartets in the Minimal Social Situation

Kelley et al. (1962) did the first work with triads and quartets in the minimal social situation. The procedure used was the same as that used in other minimal social studies (subjects isolated from each other; one subject's responses affecting the outcomes of the other; signalled trials procedure). With triads, Subject A controlled the reinforcement of C, and C controlled the reinforcement of A. The quartet situation worked similarly, but with a fourth member added. By consistently following a win-stay, lose-change rule, the authors predicted that triads would not learn a mutually reinforcing pattern of responding, but that quartets would. Figure 3 illustrates the patterns of responding that would be expected with triads and quartets.

TRIAD			QUARTET			
A	B	C	A	B	C	D
-	-	+	+	+	-	-
-	+	-	-	+	-	+
+	-	-	-	-	-	-
-	-	+	+	+	+	+

Figure 3. Predicted sequence of play in triads and quartets following the win-stay, lose-change rule. (A delivers outcomes to B, B to C, and C to A; with quartets, C to D and D to A.)

It is clear that triads should not lock into a cooperative relationship if they begin out of phase.

Results indicated that neither triads nor quartets showed a significant increase in positive scores over trials, but quartets tended to do slightly better than triads. When the first block of 30 trials was compared to the last block of 30 trials, 10 out of 14 quartets showed some increase in positive responding while only 16 out of 28 triads showed some increase. This difference was significant at the .06 level of confidence for a one-tailed test. The authors explained the failure of the quartets to reach solution as due to a number of members in each quartet not adhering to the win-stay, lose-change rule.

Smith and Murdoch (1970) did work similar to Kelley et al. with triads and quartets. The experimental arrangement was the same in that Subject A determined Subject B's outcomes, B controlled Subject C's outcomes, and C controlled A's. One-half of the triads and quartets were informed of the social nature of the situation; the remainder of the groups were uninformed. The authors of this study, however, predicted that triads would be more successful than quartets. The rationale for this prediction was as follows:

> The group decision is correct if and only if all the individual members respond correctly. Under a unanimity decision scheme, with fixed individual response probabilities less than one, the probability of a correct group decision decreases as group size increases. (p. 392)

Groups who delivered 35 mutually rewarding responses were said to have solved the problem. Eleven out of 32 triads reached solution

while none of the 32 quartets reached solution. This difference was significant at the .001 level of confidence. Informing subjects did not affect outcomes; six informed triads compared to five uninformed reached solution. Results also indicated that although triads reached solution more often, quartets showed presolution improvement more often. More positive responses were delivered by 25 quartets (out of 32) in the second half of the trials than in the first half, while only 14 triads showed presolution improvement. These latter results support the Kelley et al. results that quartets showed greater improvement when comparing the first 30 trials to the last. The main results of the experiment, though, are in disagreement with the results of Kelley et al. It is not clear why Murdoch and Smith were able to get cooperation in triads where Kelley et al. were not able to do so.

Fry et al. (1970), also working with triads, used an experimental arrangement that was quite different from the one used in the previous studies--each subject in the triad controlled the positive reinforcement to one other subject and the punishment to the third member of the triad. In some triads all members were informed of the social nature of the experiment; in some triads only one person was informed; and the remainder of the triads was uninformed. Results indicated that some learning occurred in the fully informed triads. The percentage of positive responses for the informed triads increased from approximately 52% in the first 30 trials to approximately 63% in the last 30 trials. The uninformed groups showed no learning. Triads in

which only one member was informed initially performed below a chance level; however, their responding increased to a chance level throughout the session (150 trials).

Powers, Riddle, and Phillips (1976) have pointed out that the type of dependency established among members of triads and quartets in previous studies is quite different from the reciprocal dependency that existed between subjects in the previous dyad studies. In Experiment I of Powers et al. a reciprocal relationship was established among all members of the triad. Thus, when Subject A pushed a button on his panel, he gave either reinforcement or punishment to both B and C; B gave reward or punishment to both A and C; and C gave reward or punishment to A and B. Each member of the triad thus received two outcomes. Six triads were run under these conditions, and none reached the criterion for solution (10 consecutive cooperative exchanges).

The failure of the triads in this study is easily understood. It was possible for a subject to receive mixed outcomes from his partners, i.e., positive points from one partner and negative from the other. Following a win-stay, lose-change rule, a subject would not know how to respond if the outcomes from the two other members were not in agreement.

Experiment II of this study attempted to deal with this problem by assigning different weights to the response outcomes. Six triads were run under conditions where point loss was twice point gain, and six triads were run under conditions where point gain was twice point

loss. Under these conditions it was predicted that a subject could follow the win-stay, lose-change rule, even if outcomes were mixed. Results were not as predicted, however; only one of the 12 triads reached the criterion level performance.

In Experiment III of the study a different procedure was implemented. In this phase subjects did not receive positive or negative points until outcomes from all three triad members were in agreement; either all positive or all negative. If outcomes were not in agreement, a red light flashed on each subject's panel, and another trial began. Six triads were run under these conditions, and all met the criterion of 10 consecutive cooperative exchanges. Six dyads were run under the conditions of Experiment III and results were similar, suggesting that there were no differences in the rate of acquisition of a cooperative exchange between dyads and triads.

When Does Learning Occur?

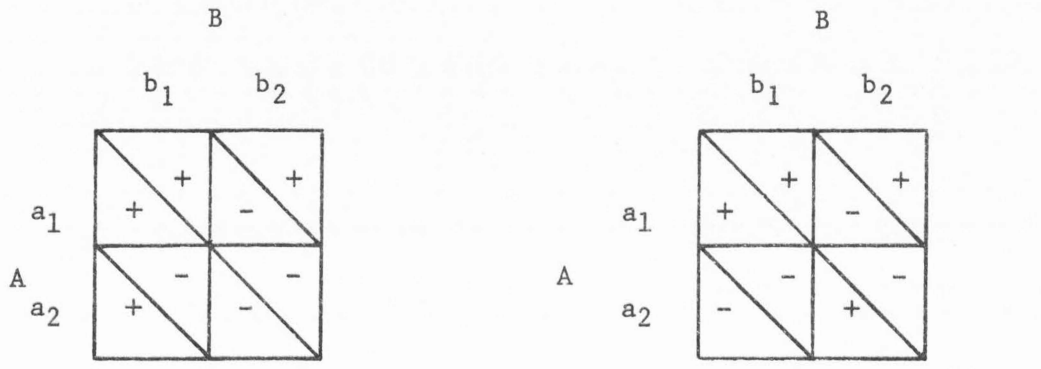
Sidowski et al. (1956) indicated in their analysis of the minimal social situation that learning occurred very early in the session. Analysis of the data for the full 25-minute session indicated no significant increase in the number of score (correct) responses over shock (incorrect) responses, but analysis of the data for the first five minutes of the session indicated the number of score responses increased significantly over the number of shock responses. This was confirmed in Sidowski's 1957 study. Rabinowitz et al. (Experiment I, 1966) reported that only 4 out of 36 dyads actually reached solution. In all four cases this happened very rapidly near the

beginning of the session. (This experiment will be discussed in detail later.)

Mutual Fate Control Versus Fate Control-Behavior Control

Rabinowitz et al. (1966) compared two types of interdependence in the minimal social situation--mutual fate control and fate control-behavior control. Figure 4 illustrates the two types of dependency. Mutual fate control implies that each subject has complete control over the other subject's outcomes. This is a symmetrical relationship in that subjects are dependent upon each other in the same way. Subject A's response a_1 gives Subject B positive reinforcement, regardless of B's response; a_2 gives B punishment. B has the same kind of control over A: b_1 gives A reinforcement; b_2 gives A punishment. Sidowski's original study and all other studies prior to Rabinowitz et al. used a mutual fate control relationship.

In the fate control-behavior control situation (see Figure 4), Subject A has fate control (absolute control) over Subject B's outcomes, but B does not have this type of control over A. B's response b_1 gives A reinforcement if A plays a_1 (which gives B positive reinforcement); if A plays a_2, b_1 gives A punishment. B's response b_2 gives A punishment if A plays a_1; if A plays a_2, b_2 gives A reinforcement. B has behavior control over A, but he does not have complete control as in the mutual fate control relationship. As long as A adjusts his behavior to B's, A can maintain positive outcomes.



Mutual Fate Control

Fate Control-Behavior Control

Figure 4. The two types of interdependence. (Rabinowitz et al., p. 171)

The purpose of their experiment was to determine whether learning would occur in both the mutual fate control and the fate control-behavior control conditions. Applying the win-stay, lose-change rule, it was predicted that cooperation would not develop in the fate control-behavior control situation when simultaneous trials were given.

Rabinowitz et al. changed the task in this minimal social situation slightly. In earlier studies subjects had been told to try to earn points; in this study the experimenter told subjects that they were performing a binary prediction task. Each subject had a panel in front of him with a large center light and two smaller lights on either side of the center. Subjects were told to predict, by pressing one of two small buttons, which small light would come on following each onset of the center light. Actually, each subject was controlling which light came on on the other's panel.

Rabinowitz et al. found that only 3 dyads out of 20 in the mutual-fate control condition and 1 dyad out of 20 in the fate control-behavior control condition reached solution. Under comparable mutual fate control conditions in Kelley et al. (1962) 11 out of 30 dyads in one case, and 12 out of 22 in another, reached solution. In the words of the authors: "Different criteria for solution make it difficult to compare the results, but they seem to indicate that solutions are somewhat less probable in the present experimental conditions" (p. 175).

In analyzing the data of the nonsolution dyads, it was found that in the final 120 trials, dyads in the mutual-fate control

condition gave a significantly greater number of rewarding responses than would have been expected on a chance basis. Dyads in the fate control-behavior control condition showed no improvement in performance.

In Experiment II of the same study, Rabinowitz et al. compared mutual-fate control and fate control-behavior control conditions under ad lib response conditions. This was similar to Sidowski's free operant situation since the subject could respond at any time; however, he did not have the option of not responding. Each response produced a "state" which was in effect until another response changed it. The authors predicted subjects under fate control-behavior control conditions would do better under ad lib responding arrangements. In the mutual-fate control condition subjects had to change responses simultaneously to reach solution. In the fate control-behavior control condition solution can be reached without simultaneous responding. Under ad lib conditions synchronized shifts are not as likely. Therefore, fate control-behavior control groups should reach solution more often.

An avoidance task was used in this experiment. On each subject's panel there was a center red light with a white light and button on either side of this red light. Subjects were told to try to turn off the red light by pressing one of the buttons. The white light beside a button came on to indicate to the subject which response he had made last. Actually, each subject controlled his partner's red light, i.e., one of his buttons turned it on and the other turned it off. Cooperation was defined as both red lights being off during a trial.

The effects of different levels of aversive stimuli were also studied in this experiment. One-half of the mutual-fate control and fate control-behavior control dyads received shock when the red light was activated on their panel; the other half received only the red light. One group of mutual fate control subjects received asymetrical aversive stimuli--one partner in the dyad received only red light while the other received red light and shock.

Results indicated fate control-behavior control groups were superior--significantly more attained solution on every trial; more attained solution on eight or more of 15 trials; and more used fewer than the median number of button presses (8.8) per trial. The presence of shock did not affect the percentage of dyads reaching solution. According to the authors, shock tended to hasten solution in both types of relationships by increasing response rate.

Hypothesis-Testing Behavior in Children

The minimal social situation may be viewed as a discrimination learning task. Subjects placed in the minimal social situation usually try many strategies before arriving at the correct one, i.e., win-stay, lose-change, which will lead to immediate solution. Although there have been no studies using children in a minimal social situation, there is a body of research on the hypothesis testing behavior of children.

Learning theorists have assumed that discrimination learning is accomplished by the strengthening of a correct stimulus-response

pair via reinforcement and the weakening of incorrect stimulus-response pairs via extinction. Other theorists (Restle, 1962; Bower & Trabasso, 1963; Levine, 1959) suggested that in a discrimination learning task subjects are actually testing various "hypotheses." This theory implies that learning in this situation is "all-or-none," rather than a gradual strengthening process.

Levine (1963) suggested a method of determining what particular hypothesis a subject was testing at a given moment. Subjects were given multi-dimensional (size, shape, position, etc.) problems and asked to choose the relevant cue. By inserting a series of blank trials in which no feedback was given following a feedback trial, the experimenter could infer which one of eight possible hypotheses a subject was testing (each hypothesis yielded a unique pattern of responses). This proved to be a useful method for studying hypothesis testing behavior. Various experiments have shown that adult subjects yield patterns of responses consistent with one of the unique hypothesis patterns on 90 to 95% of the hypothesis probes. The effect of feedback about the correctness of a response on a subject's next response has also been measured. Levine (1966) indicated that adult subjects maintained the same hypothesis on 95% of the trials following affirmation (thus, they were exhibiting win-stay behavior). When an hypothesis was disconfirmed, subjects maintained the same response on only 2% of the trials (thus, they were exhibiting lose-change behavior).

The most efficient process by which subjects arrive at a solution in a hypothesis testing situation is called focusing. Focusing involves using outcome information to its fullest advantage, i.e., eliminating all logically disconfirmed hypotheses following each feedback trial.

Eimas (1969) extended Levine's procedure to children. Subjects were second-, fourth-, sixth-, and eighth-graders and college students. Eimas found that the ability to form consistent hypotheses increased with age. Eighth-graders performed significantly better than younger children, and college students performed significantly better than all groups. College students tended to repeat an hypothesis after confirmation on 90% of the trials. This tendency decreased significantly with age to about 60% with second-graders. College students retained a disconfirmed hypothesis on only 8% of the trials; fourth-, sixth-, and eighth-graders on 15% of the trials; and second-graders on 18%. These differences were not statistically significant, however. Younger children were not as efficient in eliminating logically disconfirmed hypotheses either; i.e., they did not use the focusing strategy as well as adults. Eimas suggested that younger children are not as efficient at coding, recoding, and retaining coded material. Ingalls and Dickerson (1969) confirmed Eimas' major findings using college-level, tenth-, eighth-, and fifth-grade students. Eimas (1970), using second-graders, showed that children can learn to focus or efficiently test the various hypotheses if they are given memory aids.

Gholson et al. (1972) pointed out an important issue in studying hypothesis testing in children, i.e., that children's behavior in the laboratory situation is influenced by various "preferences." Gerjuoy and Winters (1968) reviewed the literature on the preferences exhibited by both normal and retarded children on binary-choice tasks. They suggest that children exhibit three types of preferences: stimulus preferences, response preferences, and choice-sequence responses. Stimulus preferences are noted when a subject responds most frequently to one of a number of available stimuli. A response preference is indicated when a child "responds to a stimulus on the basis of its location without regard for the differential characteristics of the stimuli" (p. 32). The most common example of this is position preference. Choice-sequence preferences are "exhibited by a pattern of responses over a series of trials" (p. 32). Perseveration and alternation are examples of choice-sequence preferences. These preferences can interact to influence the child's response.

In summary, the research indicates that for children ages 3 1/2 to approximately 5 the most common strategy in a binary-choice task is perseveration (or win-stay, lose-stay). This behavior does not seem to be affected greatly by the reinforcement schedule at hand. From age 5 up to approximately age 7 the most common strategy is invariant alternation (or win-change, lose-change behavior). Again, reinforcement schedules seem not to alter this behavior. After age 7 the authors conclude that children are more under the control of the reinforcement schedule (thus, exhibit win-stay, lose-change

behavior). The tendency to use these various response patterns is affected by a number of variables such as age, intelligence, difficulty of the task, length of intertrial interval, and presence of absence of feedback.

One way that the Gholson et al. (1972) study differed from previous studies was that position (left or right) was not a relevant cue. Subjects in the study were second-, fourth-, sixth-, and college-level students. The results of this study were similar to the findings of Eimas (1969) and Ingalls and Dickerson (1969) in that consistent hypothesis behavior decreased with age, the tendency to switch hypotheses following confirmation (win-change) decreased significantly with age, and the tendency to retain hypotheses after disconfirmation (lose-stay) decreased with age. Examining the individual data of the children, Gholson et al. found that a few of the younger children exhibited a more primitive style of responding, i.e., a preference for one stimulus, which accounted for higher lose-stay rate of the group.

In a second part of the study Gholson et al. looked at the behavior of kindergartners. They found that kindergarten-aged children exhibited consistent hypotheses below a chance level. The kindergartners responses were almost exclusively governed by preferences. Position preference and position alternation accounted for most of the inconsistent probes. Rieber (1969) compared kindergartners, second-, and fourth-graders in a discrimination learning task and found that kindergartners showed an increase in position alternation over trials, not seen in the remaining groups.

Gholson, Phillips, and Levine (1973) studied the effect of various delays in feedback in a discrimination learning task. Looking at the data of second-graders, they found that a delay in feedback causes an increase in the amount of stereotyped behavior that the children exhibited. Gholson and McConville (1974), using kindergartners in a discrimination learning task, gave the experimental group a pretraining treatment with feedback, while a control group received the same pretraining without feedback. The kindergartners who received feedback during pretraining were superior in performance to the control group. They did not exhibit the stereotyped pattern of responding discussed above.

Offenbach (1974) using first-, third-, and fifth-graders, college students, and elderly adults as subjects, developed another method for determining which hypothesis a subject was testing. Subjects again were given multi-dimensional problems. Instead of using blank trials to determine the hypothesis being tested, however, subjects were instructed to point to a single cue they were testing in a set of decomposed cues from the problem. Results were in agreement with other studies, with the exception that elderly adults performed worse than the youngest children.

Children appear to perform differently from adults in a discrimination learning task. The tendency to exhibit more consistent hypotheses on blank trial probes, the ability to use more efficient methods of information processing, the tendency to retain an hypothesis after confirmation (win-stay), and the tendency to drop a disconfirmed

hypothesis (lose-change) all increase with age. Research (Gholson et al., 1972; Rieber, 1969) indicates that kindergartners and second-graders perform very differently on a discrimination learning task. Kindergartners exhibit predominantly stereotyped patterns of responses such as perseveration and alternation. This is in line with research reviewed by Gerjuoy and Winters (1968). Their review indicates that at about age 7, children tend to abandon more stereotyped patterns of responding, and their behavior comes more under the control of the schedule of reinforcement.

All previous minimal social studies reported have used college students as subjects. It would seem to be of interest to determine whether or not children can learn under similar conditions.

The previous minimal social studies also leave some questions to be answered, particularly in the area of how solution (or a cooperative state) is reached in the minimal social situation: Do subjects follow a win-stay, lose-change rule? Do they, as some studies suggest, follow only one part of this rule? Research with children may help in the solution of some of these problems since children have not had as extensive a history of problem solving as college students have. The research to be described is an attempt to answer some of the questions about the minimal social situation, using children as subjects.

Method

Subjects

Forty-two first-, second-, and third-graders served as subjects. The subjects' ages ranged from 6 years 3 months to 10 years 2 months. Thirty-six of the children attended the Edith Bowen Laboratory School on the campus of Utah State University. Letters were sent to the parents of all children attending the first, second, and third grades of the school, asking permission for their child to participate in the study. All children whose parents gave consent for their participation were used in the study. The six remaining children who were used in the study were children of acquaintances of the experimenter and attended other local elementary schools. Children were randomly divided into two-member teams, with the exception that in most cases subjects were paired with a partner of their own grade level. Two teams of children were dropped from the study; in the case of one team, one of the partners moved away, and in the second case, one team member failed to learn a rule-training task which was necessary for her team's continuation in the study. Data from 19 teams were used in the study: five teams were composed of two girls; six were boy-girl teams; and eight were two-boy teams.

Apparatus

The research was conducted in two rooms of the Exceptional Child Center located on the campus of Utah State University.

Apparatus for typical minimal social conditions. The apparatus used under the typical minimal social conditions was similar to apparatus used in other minimal social studies and is shown in Figure 5. Each subject's panel had a three-position response switch, three small stimulus lights (green, red, and white), and two counters (one registering "points lost;" the other, "points earned"). The white light indicated to the child when to respond. When a subject pushed his response switch up or down (depending on the wiring of his panel) he added a point to one of his partner's counters, either "points earned" or "points lost." When the "points earned" counter was operated, the small green light flashed; when the "points lost" counter operated, the red light flashed. Both subjects' panels were wired to the experimenter's control panel. The control panel had lights which indicated each subject's responses (for data keeping purposes). Switches allowed the experimenter to activate subjects' counters once both had responded and to control the trial light. An assistant recorded data during the experimental sessions, leaving the experimenter free to manipulate the control panel.

Rule-training apparatus. In the rule-training task each subject had before him a panel divided into two sections; each section looked like the panel used under typical minimal social conditions. See Figure 6. Each section had three small stimulus lights (red, green, and white), two counters (one labeled "points earned;" the other, "points lost"), and a three-position response switch. The white light on each section of the subject's panel, when activated, indicated

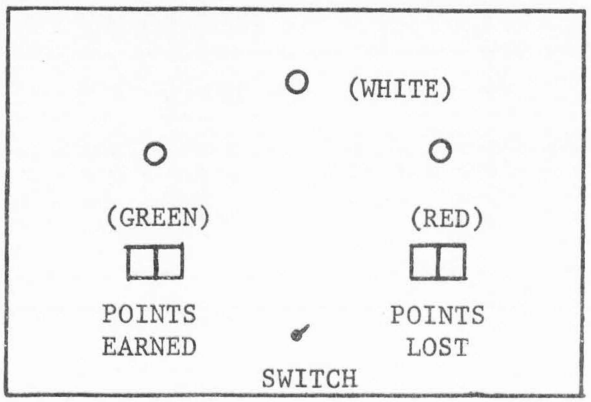


Figure 5. Response panel used by subjects under typical minimal social conditions.

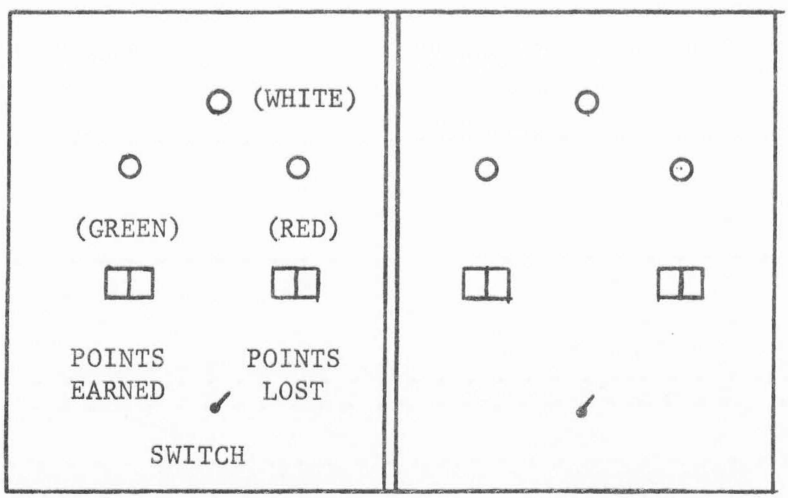


Figure 6. Response panel used by subjects in the rule training task.

to the subject when and on which section of the panel he was to respond. The subject responded by pushing the response switch either up or down (the middle position being neutral). After his response, a point was registered on one of the two counters. When a point was registered on the "points earned" counter, the green light flashed; when the "points lost" counter was activated, the red light flashed.

Each subject's panel was wired to a control box operated by the experimenter from another room. The experimenter's panel had lights which indicated which way the response switches had been pushed by the child and switches which allowed the experimenter to activate lights and counters on the child's panel.

Small toys and candy were used as reinforcers. Children were given a poker chip for each point they earned and chips could be exchanged for small toys and/or candy at the end of the session. Chips were worth approximately one-half cent each.

Procedure

Sixteen teams of subjects were first placed under typical minimal social conditions. Teams who failed to learn under typical minimal social conditions were then given either the rule-training task to teach them the rule "win-stay, lose-change" or verbal instructions to follow this rule. If a team failed to learn after one of these treatments, it was given the other treatment. Three teams (a control group) were given the rule-training treatment before being placed into typical minimal social conditions to control for the possibility that the rule-training treatment was effective only

after extensive training under typical minimal social conditions.

After they learned to cooperate under the typical minimal social conditions, all subjects were given a reversal treatment (to be described later).

Children were taken from their classrooms to the experimental room by the experimenter and an assistant. Each child was taken through a brief familiarization procedure on the first day that he came to a session. The experimenter explained how poker chips could be earned and exchanged for candy or toys. Each child was given ten chips which he was allowed to spend immediately, so that the child could sample the reinforcers.

Typical minimal social conditions. The two subjects in each team were led to separate rooms and seated in front of a panel (as described under "Apparatus"). The children were told that the experimenter had two "games," one for each of them, to conceal the fact that the children were working together. The following instructions were read to each subject:

> We're going to play a game where you can make as many points as you want. At the end of the game I will give you a chip for every point that you win. Then you can go down to the candy store and spend them like we did earlier.
>
> Now, I'll tell you how you play this game--When the white light (the experimenter pointed to the light) comes on, you push this button on your box either up or down (the experimenter demonstrated). Can you do that? (The

experimenter waited for the child's response.)

If you win a point this green light (the experimenter pointed to light) will flash and a number will pop up on this counter (the experimenter pointed to "points earned" counter). Sometimes you will get a point taken away--if the red light flashes and a number pops up on this counter (the experimenter pointed to "points lost" counter), you will lose a point.

When you push the button, leave it they way you pushed it. After you see if you win or lose a point, then put the button back to the middle position (the experimenter demonstrated) and wait for the white light to come on again.

When you are finished I will come and get you, and we will go to the store to buy something. Try to make as many points as you can. Everytime the green light goes on and this counter (the experimenter pointed to "points earned" counter) goes, you get a point. Do not play with the knobs (reset knobs) on the counters or you will lose your points.

The experimenter activated both subjects' white lights simultaneously to begin a trial. The light remained on until both subjects had responded. The experimenter then pushed a switch which registered points on both subjects' counters and activated either their red or green light. There was a 3-second (approximately) intertrial interval. If a subject forgot to reset his switch to the neutral position, the experimenter reminded him to do so.

It was judged that a cooperative state had been reached when subjects had played 14 consecutive mutually rewarding trials. Children were run approximately 100 trials each day. If a team was in a potential criterion run (i.e., if both team members gave reinforcement) on the 100th trial, play was continued until one team member switched responses or until the team reached criterion. If criterion had not been reached by the end of 400 trials, the team was given either the rule training task or verbal instructions. If children failed to earn any points or ended a daily session with a negative score, they were given 20 chips for attendance.

Verbal instructions. This condition was identical to the typical minimal social condition described above except that the children were verbally instructed at the beginning of the session to exhibit "win-stay, lose-change" behavior. The following instructions were read to each child:

> I'll tell you how you can really win a lot of points in this game. Everytime you win a point, push the button again the same way you did before. If you lose a point, push the button the other way.

The child was then asked to repeat the instructions (general content). If a child could not repeat the instructions or repeated them incorrectly, the instructions were read to him again.

Rule-training task. In the rule-training task each child worked independently. The treatment was designed to teach the child to use his previous response and the outcomes from it to discriminate what his next response should be.

Each trial consisted of two responses by the subject (refer to Figure 6). A trial began when the white light on the left panel was activated. The subject responded by pushing the response switch on that side of the panel either up or down. All of the subject's outcomes on the left side of the panel were randomly predetermined by the experimenter using a table of random numbers. The outcomes were random with the exception that no more than three consecutive winning or losing trials were allowed. Approximately one-half of the child's responses on that side of the panel resulted in point gain; one-half, in point loss. If the outcome (randomly selected) was positive, the "points earned" counter and the green light were activated; if the outcome was negative, the "points lost" counter and the red light were activated. The experimenter then activated the white light on the right side of the panel. On this part of the trial, the subject was required to exhibit "win-stay, lose-change" behavior to receive reinforcement. If the child had <u>won</u> on the left side of the panel, he had to make the same response on the right panel to win again, i.e., if he pushed the response switch on the left panel <u>up</u> and won, he had to push the response switch on the right panel <u>up</u> to win again. If the subject <u>lost</u> on the left side of the panel, he was required to <u>change</u> his response on the right side of the panel to win a point. Figure 7 shows the possible outcomes of a subject who randomly made response R_1 on the left panel.

The following instructions were read to the subject before he began the rule-training task:

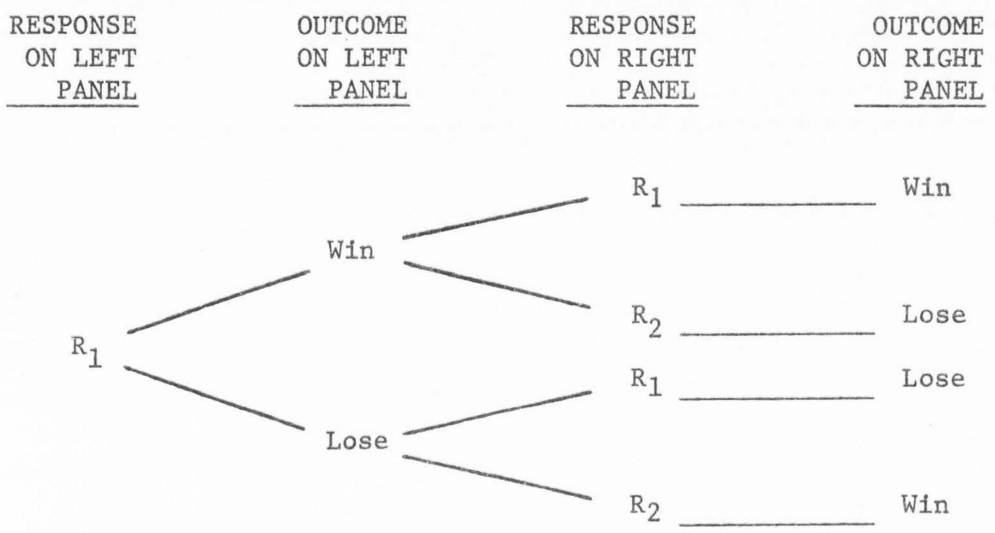


Figure 7. Possible outcomes of subject making response R_1 on the left side of the panel.

We're going to play a game where you can make as many points as you want. At the end of the game I will give you a chip for every point that you win. Then you can go down to the candy store and spend them like we did earlier.

Now, I'll tell you how you play this game--When this white light (the experimenter pointed to white light on left panel) comes on, you push this button on your box either up or down. (The experimenter demonstrated.) Can you do that? (The experimenter waited for the child to respond.)

If you win a point, this green light will go on and a point will pop up on this counter (the experimenter pointed to green light and "points earned" counter). Sometimes you will get a point taken away--if that happens, the red light will go on and this counter (the experimenter pointed to "points lost" counter) will go.

When this white light (the experimenter pointed to light on right panel) comes on, you push this switch either up or down (the experimenter demonstrated with the switch on the right panel). If you win a point, the green light will come on and this counter will move (the experimenter pointed). If you lose a point, the red light will come on, and this counter will move (the experimenter pointed). When both white lights go off, put the switches back in the middle position (the experimenter demonstrated) and wait for the white lights to come on again.

When you are finished, I will come and get you, and we will go to the store to buy something. Try to make as many points as you can. Everytime the green light comes on you win a point.

It was judged that win-stay, lose-change behavior had been learned when a subject made the correct response on the second part of the trial (right panel) on 12 consecutive trials. Each daily session was approximately 50 trials long. Again, if a subject was in a potential criterion run at the end of 50 trials, the session was continued until he made an incorrect response or until he reached criterion.

When both subjects in a team had reached criterion on the rule-training task, they were returned to the typical minimal social conditions described earlier.

If one child in a team reached criterion level performance on the rule-training task before his partner did so, the child was given 25 trials on the task each day until his partner reached criterion. This was done mainly because the children tended to complain to the experimenter and to their teacher if their partner got to go and "play the game" when they did not.

Reversal condition. The response panels that the subjects used under the typical minimal social conditions were wired so that the switch that gave positive points to the partner was in the up position on one panel and in the down position on the other. When a team had reached criterion once, the partners switched panels, and the team

was brought to criterion again. This was done to determine whether the children had simply learned a position response (for example, "up is correct") or whether they could follow the win-stay, lose-change rule to reach criterion on another panel which worked the opposite way.

Observations and reliability. Under typical minimal social conditions an observer recorded only the subjects' responses, since the experimenter's switch (because of the wiring) automatically delivered correct consequences to the children. On the rule-training task, however, the observer recorded the responses of both the subject and the experimenter, because the experimenter had to make different responses, depending on how the child responded. A second observer was brought in to check reliability on a number of occasions. For 12 out of the 19 teams used in the study, a reliability check was made on at least one entire session's data. Reliability was computed by dividing the number of agreements between the two observers by the total number of agreements and disagreements. Reliability on both the training and the typical minimal social tasks ranged from 98 to 100%.

A possible problem with this type of research is that subjects may communicate with each other outside the experimental sessions. To minimize the possibility of this occurring, second- and third-graders were paired with a partner from another second- or third-grade classroom. Since there was only one first grade classroom in the school, first-graders had to be paired with a fellow classmate. All children

were reminded after each session not to talk about the experiment with their classmates.

Each subject was asked the following question after the last session in the typical minimal social conditions (including the verbal instruction condition) and in the rule-training task: "How do you think this game works? How did you decide which way to push your button?"

Results

Groups Reaching Criterion Without Treatment

The results of this study differed considerably from the preliminary research findings (Appendix A). Ten of the 19 teams of children reached the criterion of 14 mutually rewarding trials without treatment (i.e., rule-training or verbal instructions). None of the teams of children used in the preliminary research reached criterion. Significantly more second- and third-grade teams learned to cooperate without treatment than did first-grade teams, χ^2 (1) = 4.89, $p < .05$ (with Yates' correction for continuity). All seven teams composed of second- and third-graders learned to cooperate without special treatment, while only three of nine first-grade teams cooperated without treatment. The data of the control teams was excluded from this analysis.

Figures 8 through 17 show the percentage of cooperative (mutually rewarding) trials played by each team per block of 10 trials. The small arrows on the graphs indicate the block of trials in which the criterion run began. Note that in some cases (Figures 12, 13, 15) the teams had blocks in which there were 10 mutually rewarding trials prior to the start of the criterion run. In these cases one partner switched responses (giving his partner a minus point) just before the team reached the criterion of 14 mutually rewarding trials, making it necessary to begin the count of mutually rewarding trials again.

Figure 8. Percentage of cooperative (mutually rewarding) trials played by SC and ES per block of 10 trials.

*Percentage based on fewer than 10 trials.

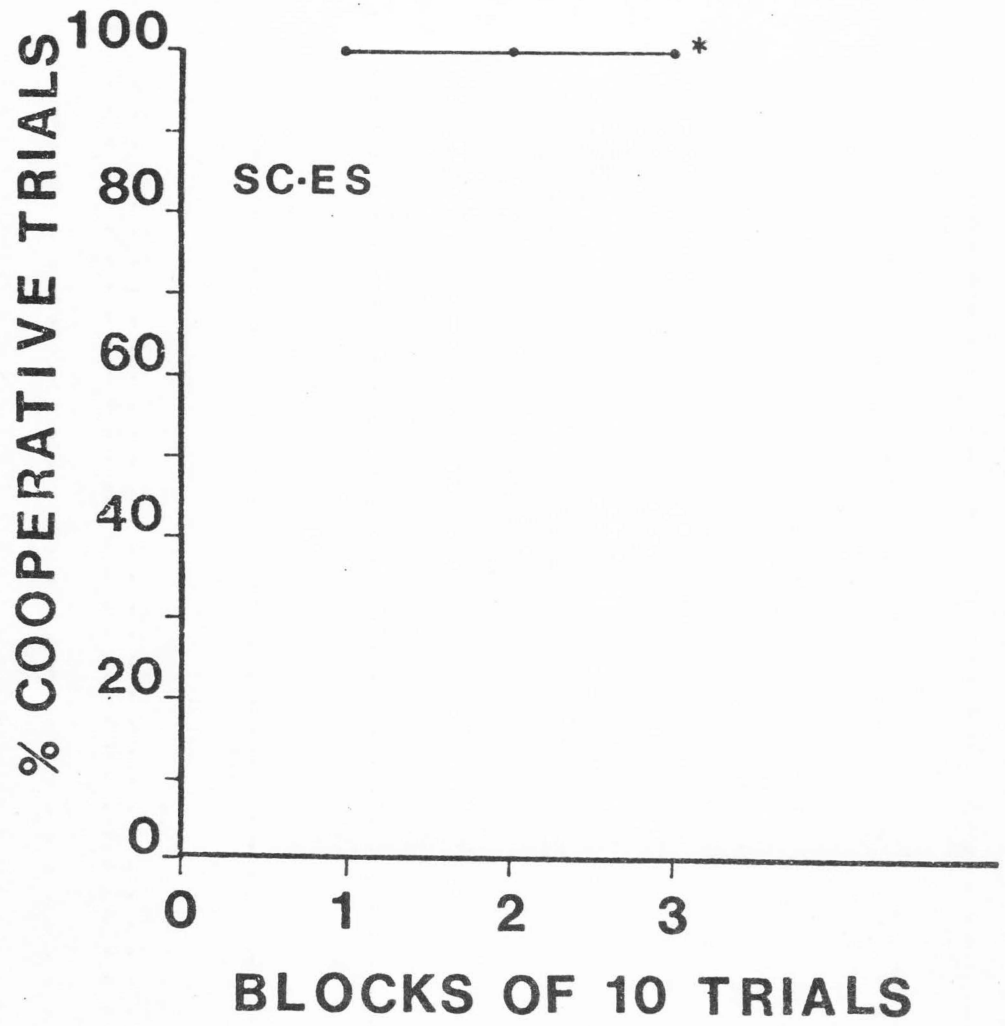

% COOPERATIVE TRIALS
100
80
60
40
20
0
SC·ES
*
0
1
2
3
BLOCKS OF 10 TRIALS

Figure 9. Percentage of cooperative (mutually rewarding) trials played by JD and JT per block of 10 trials.

*Percentage based on fewer than 10 trials.

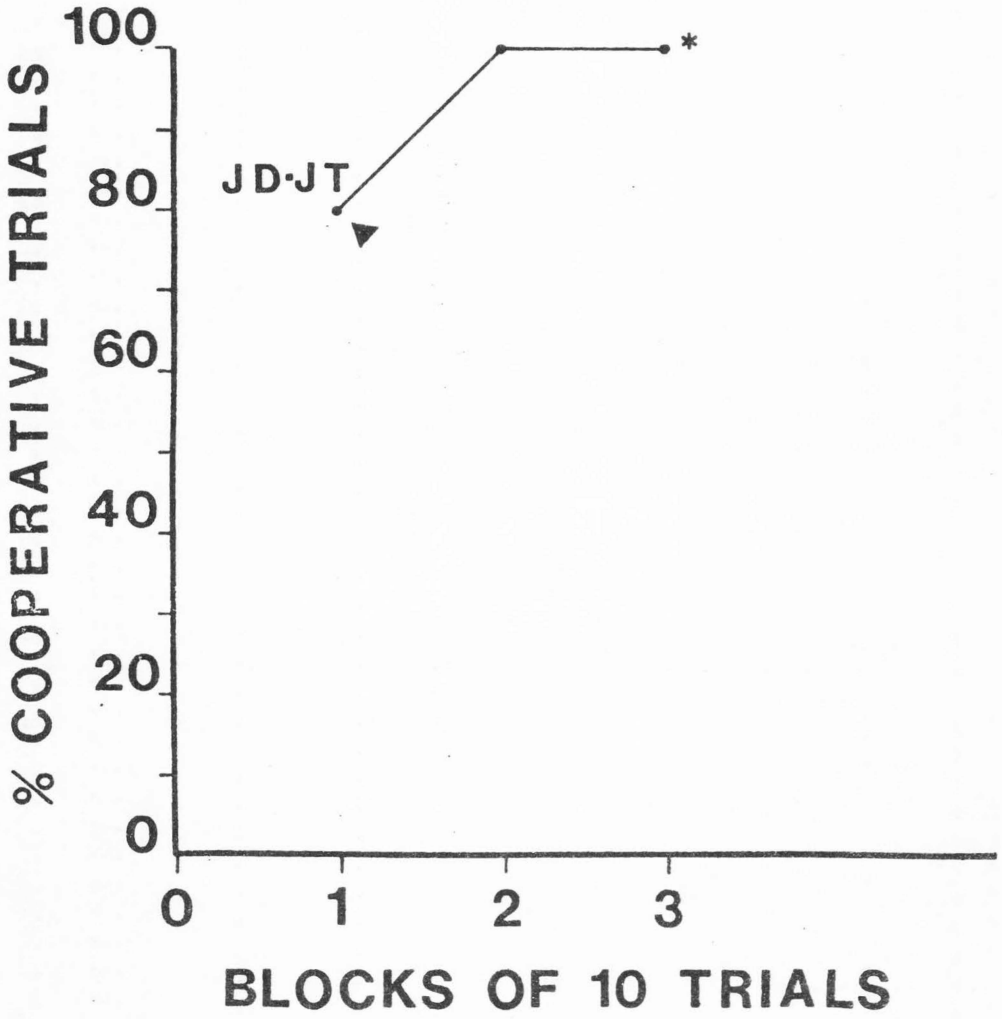

100
80
60
40
20
0
% COOPERATIVE TRIALS
JD·JT
*
0
1
2
3
BLOCKS OF 10 TRIALS

Figure 10. Percentage of cooperative (mutually rewarding) trials played by PB and JP per block of 10 trials.

*Percentage based on fewer than 10 trials.

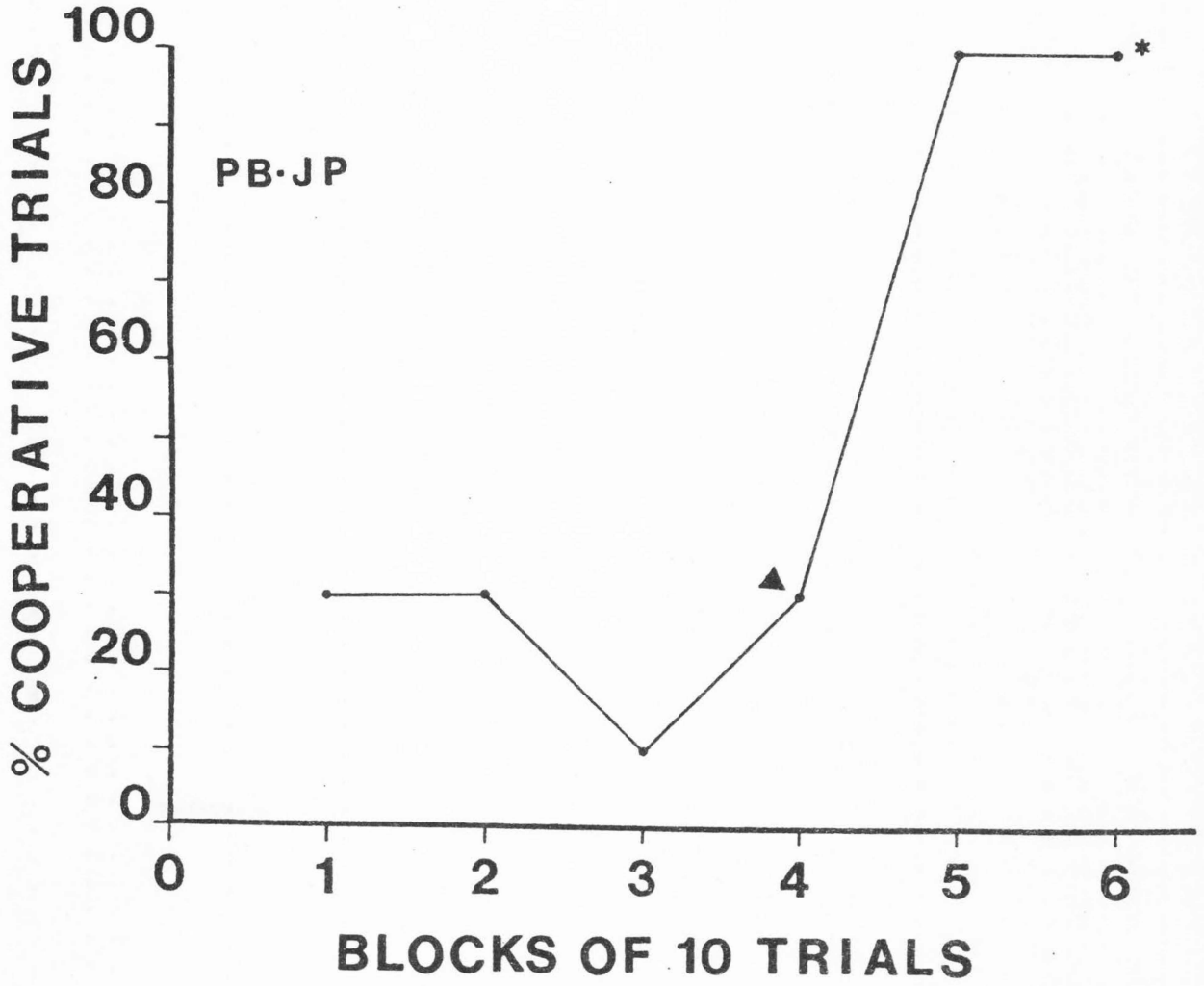

100
80
60
40
20
0
% COOPERATIVE TRIALS
PB·JP
*
0
1
2
3
4
5
6
BLOCKS OF 10 TRIALS

Figure 11. Percentage of cooperative (mutually rewarding) trials played by CS and BN per block of 10 trials.

*Percentage based on fewer than 10 trials.

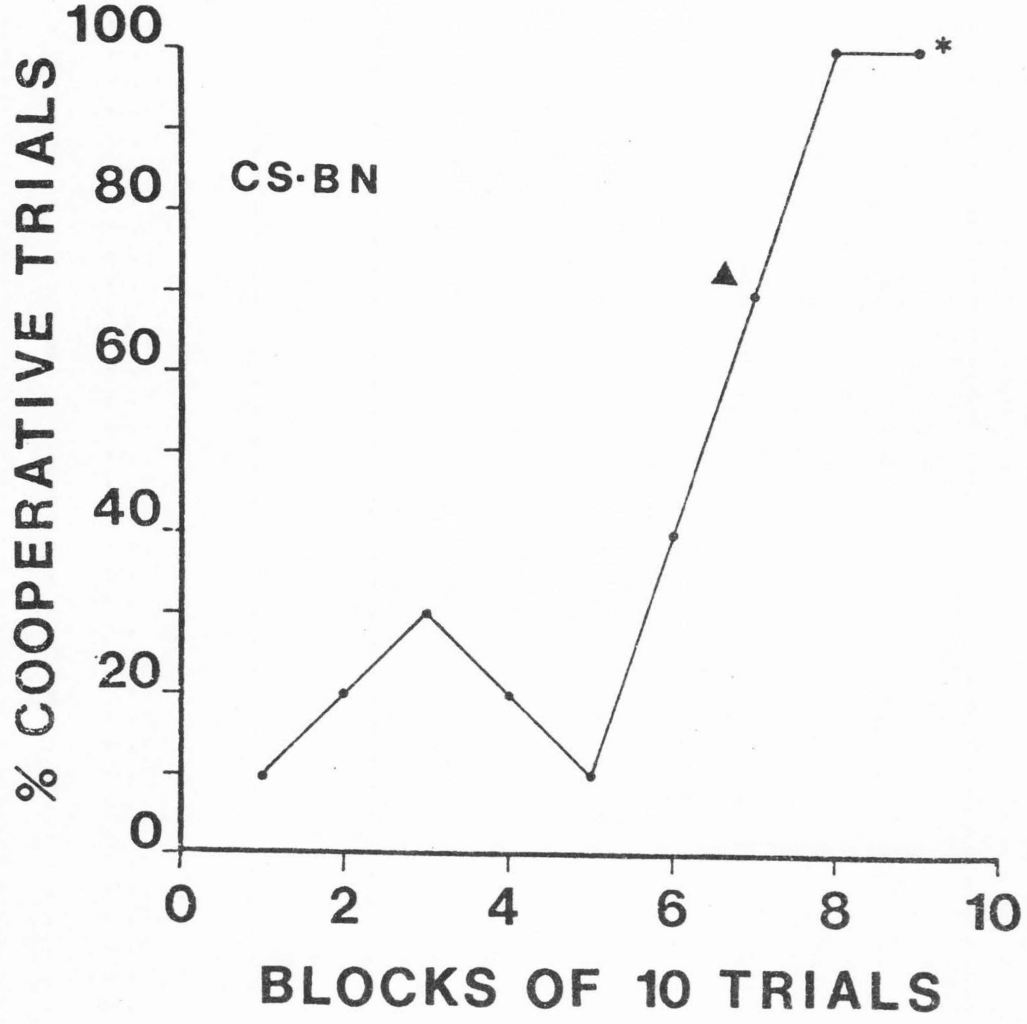

100
80
60
40
20
0
% COOPERATIVE TRIALS
CS·BN
*
▲
0
2
4
6
8
10
BLOCKS OF 10 TRIALS

Figure 12. Percentage of cooperative (mutually rewarding) trials played by KN and YM per block of 10 trials.

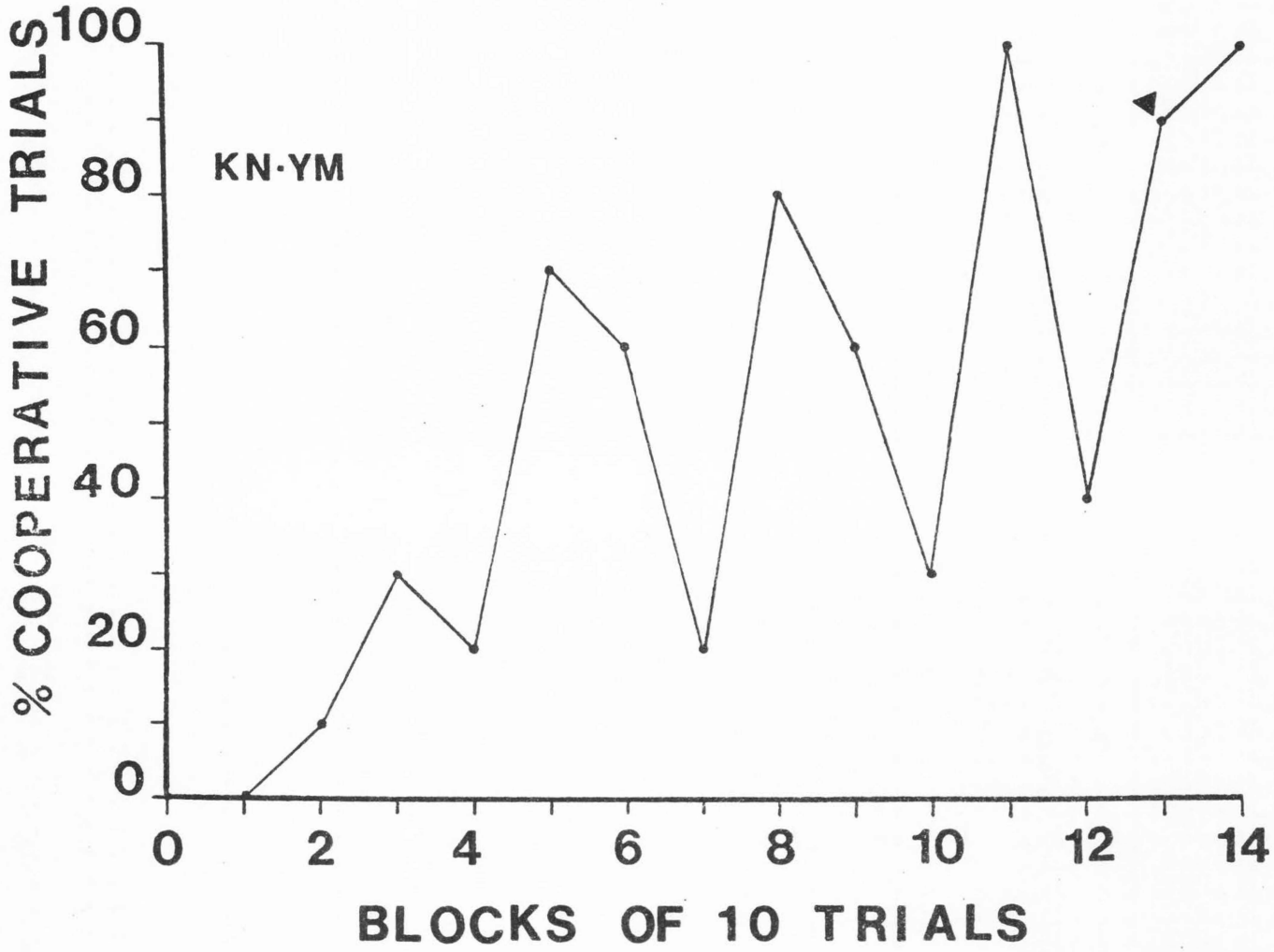

% COOPERATIVE TRIALS
100
80
60
40
20
0
KN·YM
0
2
4
6
8
10
12
14
BLOCKS OF 10 TRIALS

Figure 13. Percentage of cooperative (mutually rewarding) trials played by TJ and SM per block of 10 trials.

*Percentage based on fewer than 10 trials.

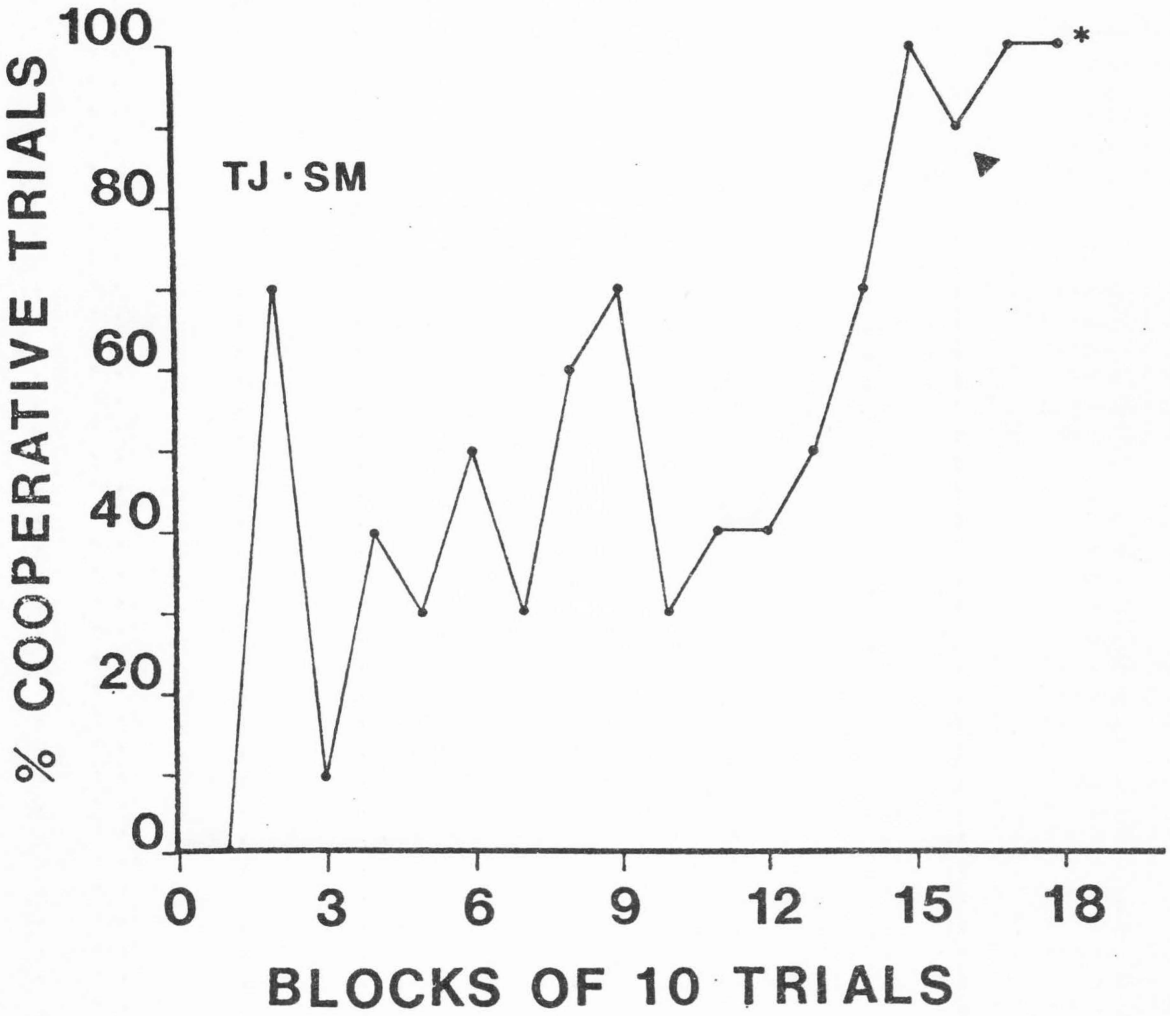

100
80
60
40
20
0
% COOPERATIVE TRIALS
TJ · SM
*
0
3
6
9
12
15
18
BLOCKS OF 10 TRIALS

Figure 14. Percentage of cooperative (mutually rewarding) trials played by CM and SP per block of 10 trials.

*Percentage based on fewer than 10 trials.

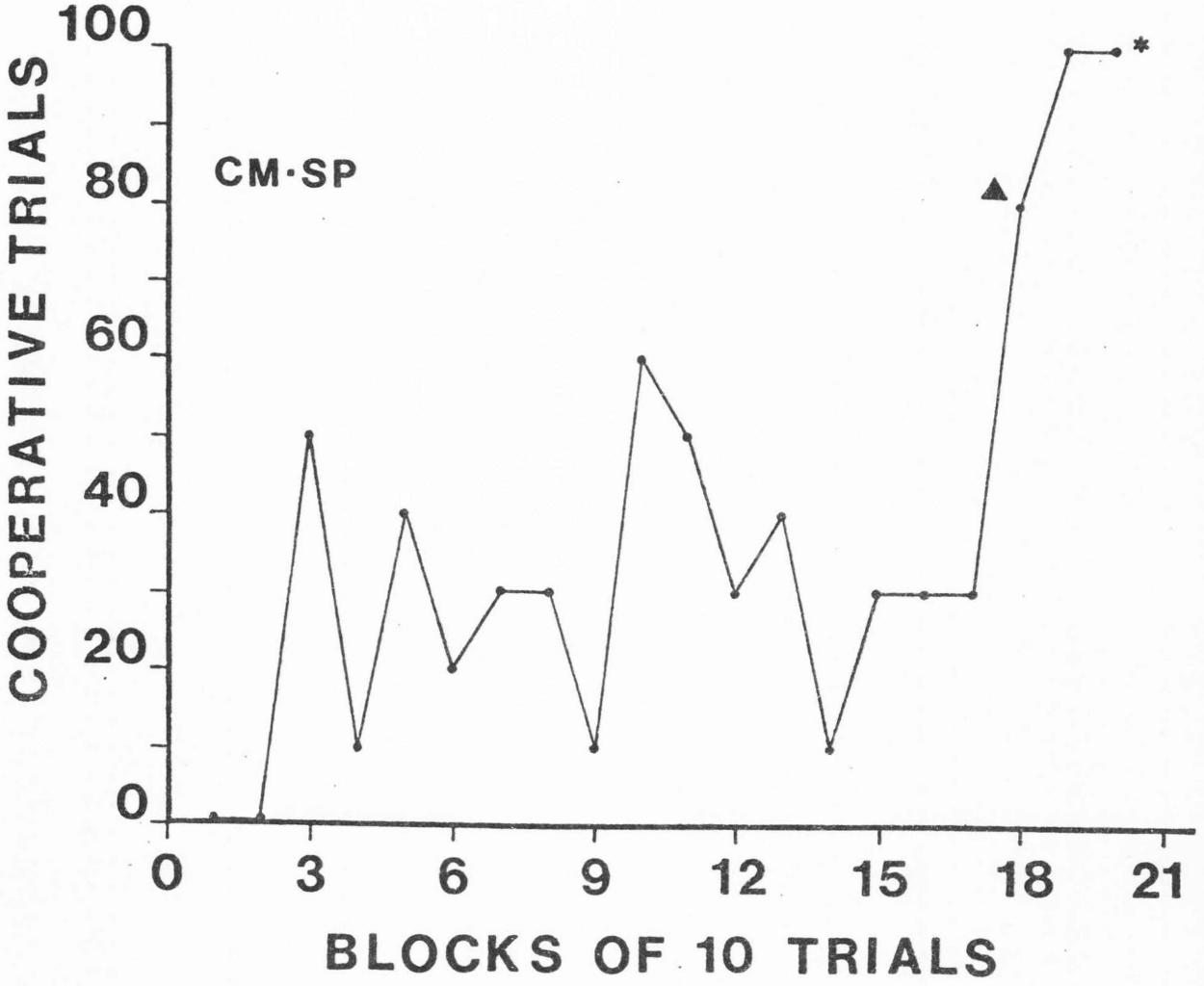

100
80
60
40
20
0
COOPERATIVE TRIALS
CM·SP
▲
*
0
3
6
9
12
15
18
21
BLOCKS OF 10 TRIALS

Figure 15. Percentage of cooperative (mutually rewarding) trials played by LM and HK per block of 10 trials.

*Percentage based on fewer than 10 trials.

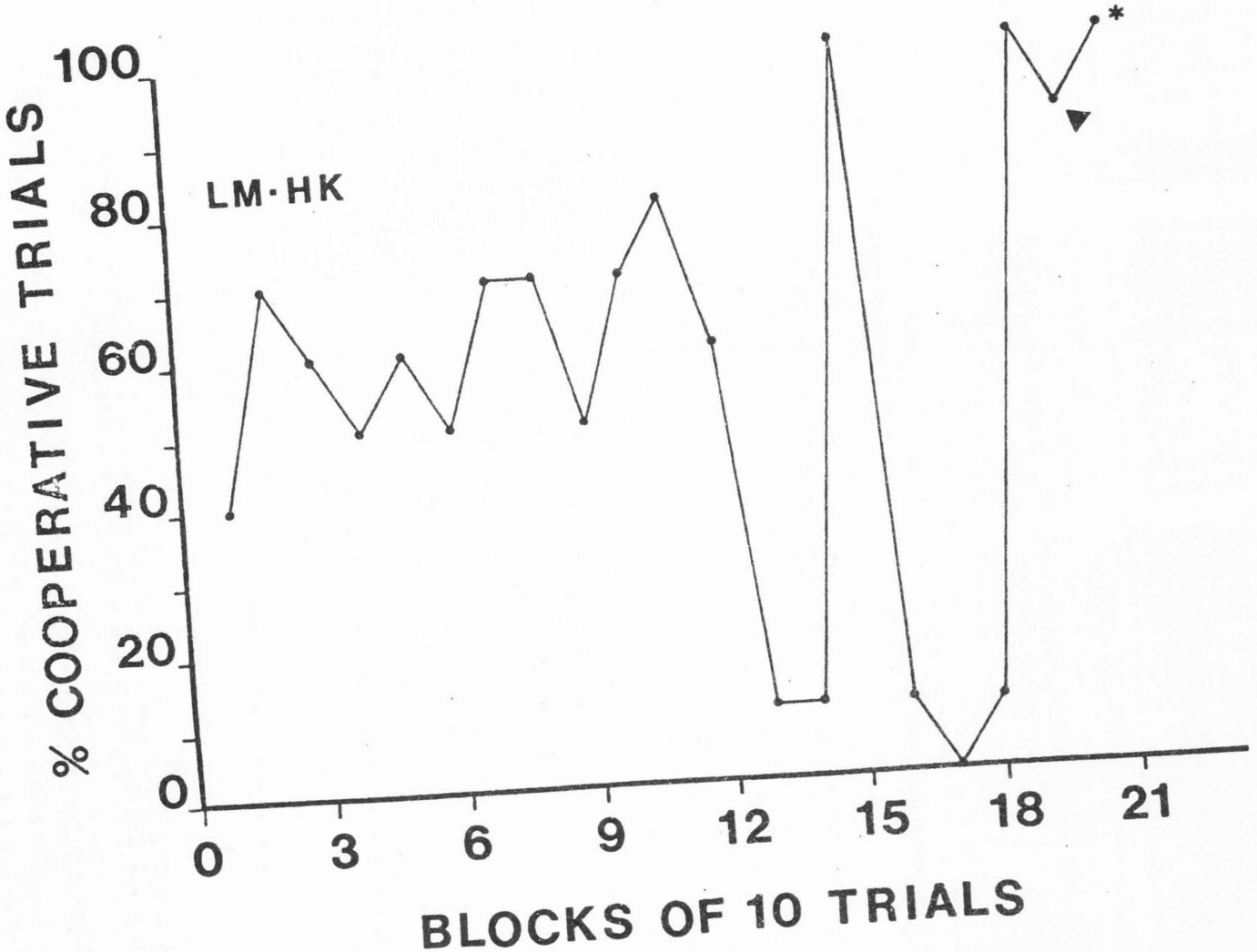

LM·HK
% COOPERATIVE TRIALS
100
80
60
40
20
0
0
3
6
9
12
15
18
21
BLOCKS OF 10 TRIALS
*

Figure 16. Percentage of cooperative (mutually rewarding) trials played by PO and SG per block of 10 trials.

*Percentage based on fewer than 10 trials.

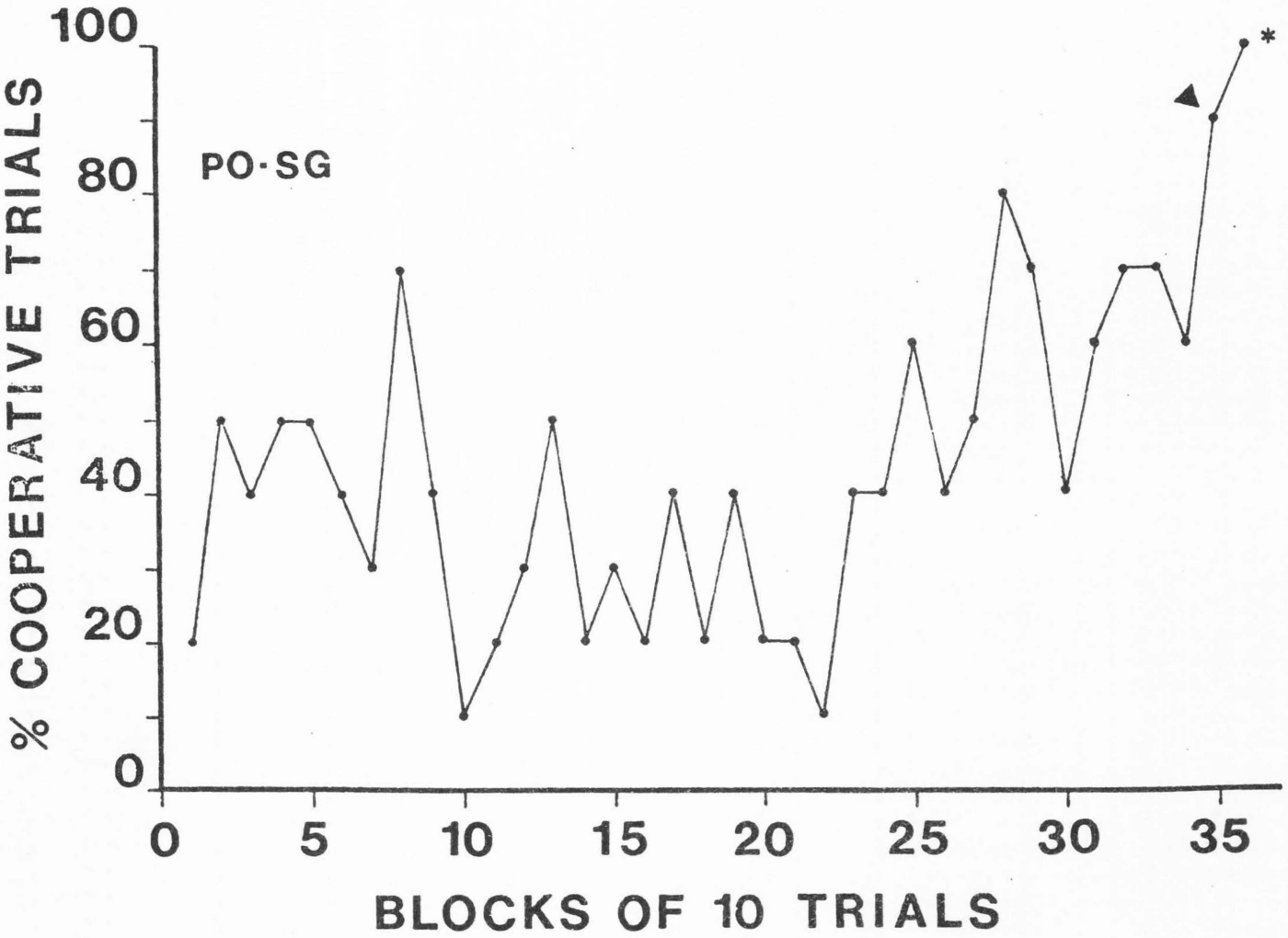
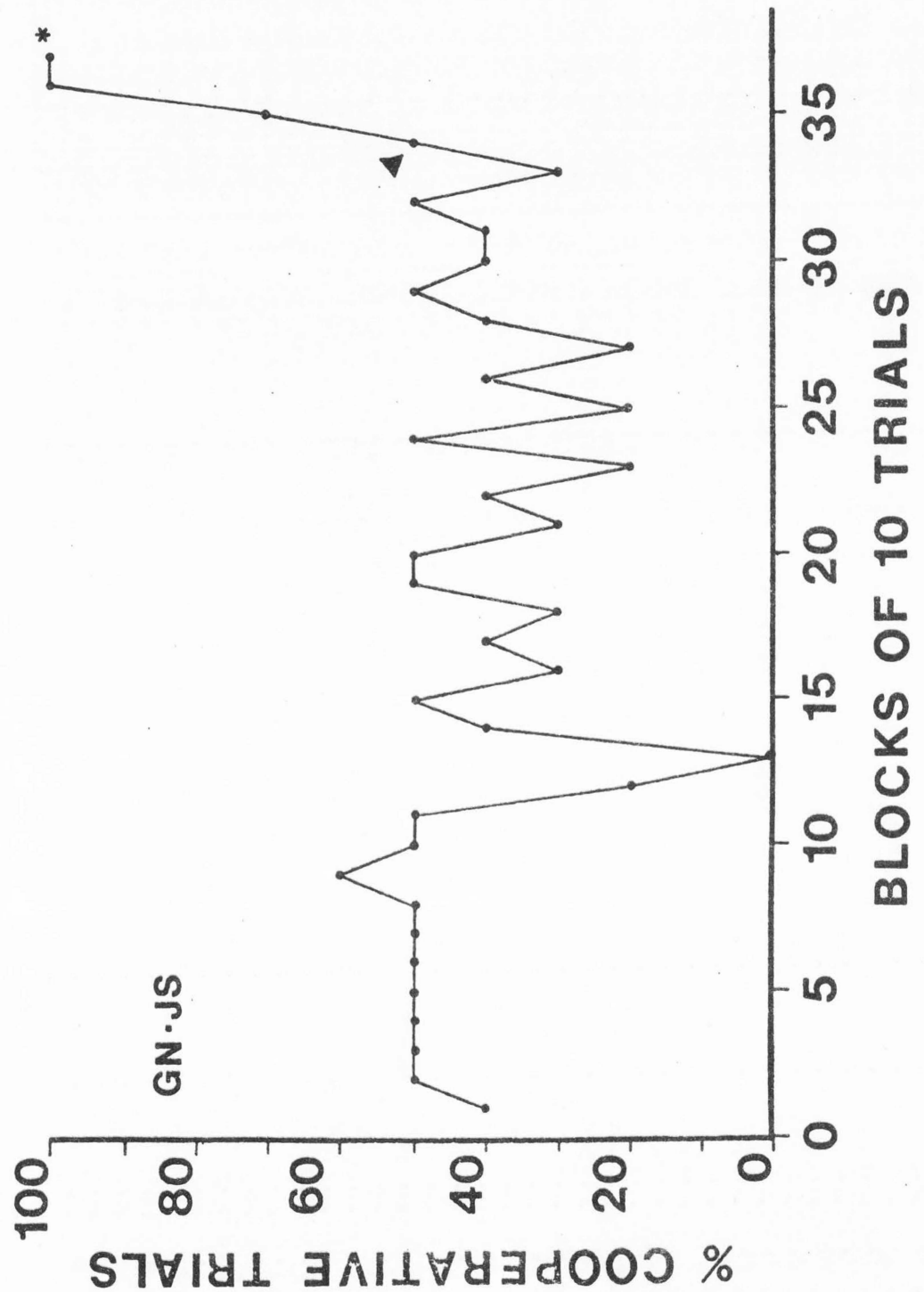

100
80
60
40
20
0
% COOPERATIVE TRIALS
PO·SG
*
0
5
10
15
20
25
30
35
BLOCKS OF 10 TRIALS

Figure 17. Percentage of cooperative (mutually rewarding) trials played by GN and JS per block of 10 trials.

*Percentage based on fewer than 10 trials.

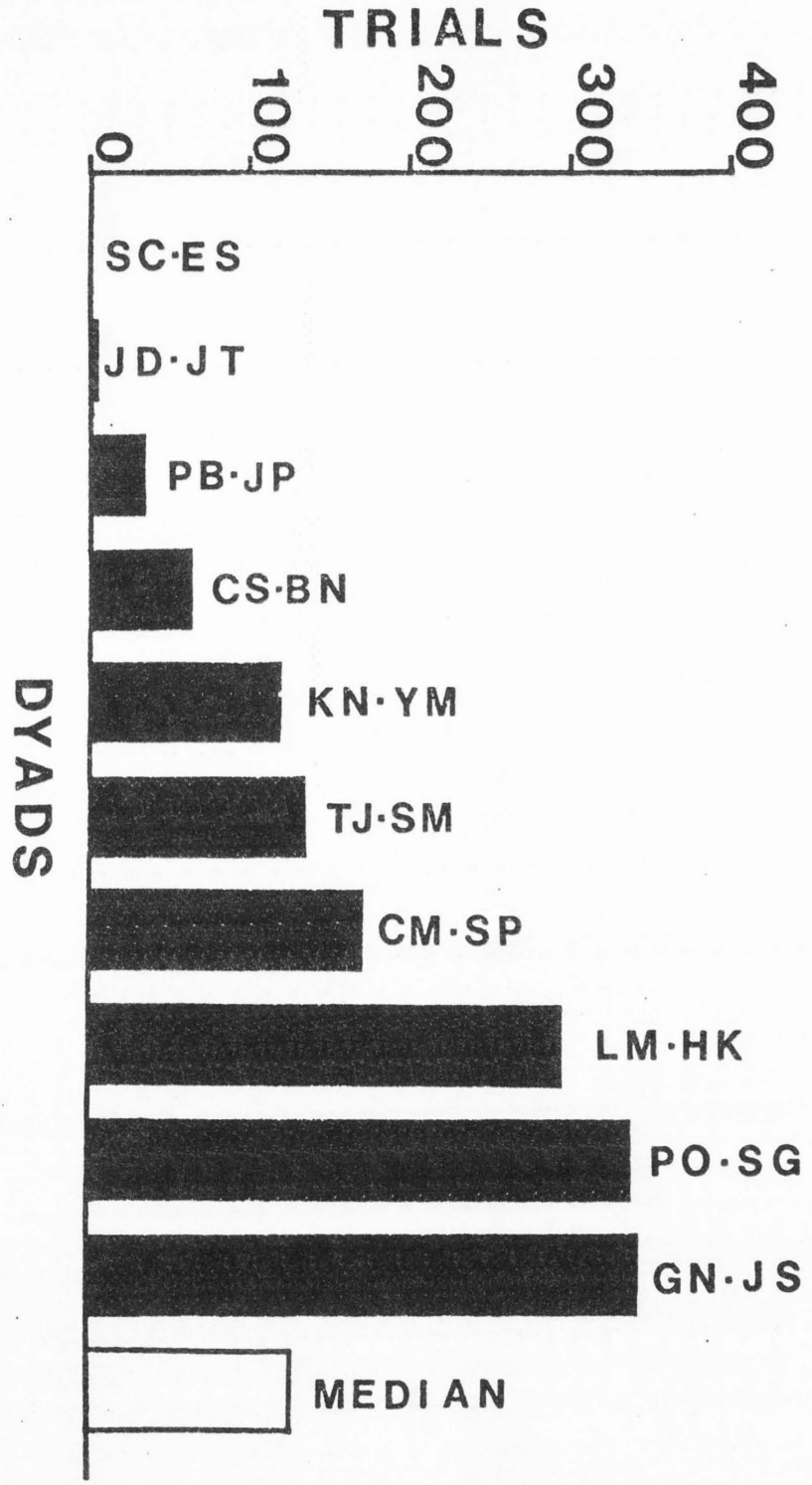

GN-JS
% COOPERATIVE TRIALS
100
80
60
40
20
0
0
5
10
15
20
25
30
35
BLOCKS OF 10 TRIALS
*

Looking at each individual graph, one can see a great deal of variability within each team's data (intrasubject variability). Teams generally did not show a gradual learning curve; in most cases the criterion run began very abruptly. Prior to the criterion run, the data points show many sudden increases and decreases in the number of mutually rewarding trials. If subjects were performing randomly, on one-fourth of the trials both partners would make plus responses; on one-fourth both would make minus responses; and on the remainder of the trials one of the partners would play a plus and the other, a minus. It is clear from the graphs that most of the time subjects were not randomly responding.

There was a great deal of variability among the different teams in the number of trials required to reach criterion. Figure 8 (SC and ES) shows a team of children who played a plus-plus combination initially and continued that pattern for 25 trials, thus reaching criterion without ever switching responses. Figure 17 (GN and JS), on the other hand, shows data from two children who played 344 trials before beginning the run of mutually rewarding trials. Figure 18 is a summary graph showing the number of trials played by each team before they began the run of trials to criterion. The last column on the graph shows the median number of trials (128.5) played by the teams before they began a criterion run. Team SC and ES is at zero because they began the criterion run on the first trial.

Analysis of adherence to win-stay, lose-change rule. Since learning in the minimal social situation has been attributed to subjects

Figure 18. Number of trials played by each team before beginning the criterion run.


TRIALS
0
100
200
300
400
DYADS
SC·ES
JD·JT
PB·JP
CS·BN
KN·YM
TJ·SM
CM·SP
LM·HK
PO·SG
GN·JS
MEDIAN

following a win-stay, lose-change rule, the probability that subjects followed that rule was computed and examined. For each team the percentage of rule adherence on the first 20 trials was compared to rule adherence on the last 20 trials before the criterion run. There was a slight, but not statistically significant increase in rule adherence from the first 20 trials to the last. Mean rule adherence for the teams increased from an average of 56.4% to 60.6% (the data of teams SC and ES and JD and JT was excluded from the analysis--the former team began the criterion run on trial one; the latter, on trial seven). Table 1 shows the mean percentage of rule adherence for the individual teams on the first 20 trials and on the last 20 trials prior to the criterion run. It appears that with the possible exception of teams 8 (LM and HK) and 10 (GN and JS), there were no large changes in rule-following behavior by the various teams. If subjects were performing at chance level, one would expect rule adherence to occur on 50% of the trials. Statistical analysis confirmed that on the first 20 trials subjects as a group were performing at approximately chance level.

As was reported previously, several past studies have reported that subjects showed an increase in win-stay behavior, but not in lose-change behavior. When the percentage of win-stay and lose-change responses per opportunity in the first 20 trials was compared to the last 20 trials prior to the criterion run, no statistically significant increase in either win-stay or lose-change behavior was found. Win-stay responses increased from a mean of 52.1% to a mean

Table 1

Adherence to the "Win-Stay, Lose-Change" Rule for Teams Reaching Criterion without Treatment

Team	Total trials prior to criterion run	Mean rule adherence: first 20 trials (per cent)	Mean rule adherence: last 20 trials (per cent)
SC & ES	0	100	--
JD & JT	7	79[a]	--
PB & JP	37	53	56[a]
CS & BN	65	65	63
KN & YM	121	55	53
TJ & SM	136	75	73
CM & SP	173	65	60
LM & HK	295	44	57
PO & SG	341	57	50
GN & JS	344	37	73
Group mean		56.4	60.6

[a]Percentage based on fewer than 20 trials.

of 56.6%. Lose-change behavior increased from a mean of 63.2% to a mean of 65.0% (again, data from teams SC and ES and JD and JT was excluded from the analysis).

Rabinowitz et al. (1966) found that their subjects learned different rates of responding on the different response buttons. Initially their subjects exhibited significantly more win-stay responses on the button which gave points to the partner than on the button which punished the partner. This difference increased throughout the course of the experiment, but not significantly so. Lose-change behavior occurred at about the same rate on both response buttons, initially. By the end of the experiment, however, lose-change behavior occurred significantly more often on the response button which gave punishment to the partner. A similar analysis was done with the data from the current study. The percentage of win-stay responses per opportunity to perform that response (win-stay responses divided by the total of win-stay and win-change responses) was calculated for each response position, up and down, on the first 40 trials and on the last 40 trials prior to criterion run. Similar calculations were done with lose-change responses for each response position. Tests were done to determine the statistical significance of the following comparisons: (a) Was the percentage of win-stay responses greater on the plus-response (response-switch position which gave positive points to the partner) than on the minus-response (response-switch position which gave negative points to the partner) on the first 40 trials? (b) Was the percentage of lose-change responses

greater on the minus-response than on the plus-response on the first 40 trials? (c) Was the percentage of win-stay responses greater on the plus-response than on the minus-response on the last 40 trials? (d) Was the percentage of lose-change responses greater on the minus-response than on the plus-response on the last 40 trials? (e) Did win-stay responses increase from the first 40 trials to the last on the plus-response? (f) Did lose-change responses increase significantly from the first 40 trials to the last on the minus response? In a number of cases the differences were in the same direction as the Rabinowitz et al. findings; however, none of the differences were statistically significant.

In view of past studies which indicated that subjects did show an increase in rule following behavior, it was not clear why teams in the present study showed no such improvement. An analysis to determine whether subjects were actually being reinforced for rule-following behavior seemed to be indicated. A computer analysis was done to determine how frequently subjects were given correct consequences by their partners for exhibiting rule-following behavior--more specifically, how often win-stay and lose-change responses were reinforced and lose-stay and win-change responses were punished. The mean percentage of correct consequation on the first 20 trials for all teams (excluding SC and ES and JD and JT) was compared to the percentage of correct consequation on the last 20 trials before the criterion run. The mean percentage of correct consequation increased from 45.6 to 59.5 which was significant, $\underline{t}$ (7) = 2.37, $\underline{p} < .05$ (test for

difference between means for correlated samples). This analysis was repeated using a larger sample of trials (comparing the first 40 trials to the last 40 trials), and the results derived were the same.

For each team the percentage of responses that was correctly consequated per block of 20 trials was plotted on a graph with team members' mean adherence to the rule, win-stay, lose-change. Examining these graphs it was clear in a number of cases that rule adherence and correct consequation are related in that the curves on the graph tended to change together. Figure 19 shows the data for a team where rule adherence and correct consequation seemed to be positively correlated. In other teams' data this positive correlation was not evident; Figure 20 is an example of one of these cases. In some cases, it was difficult to determine whether or not a relationship existed; Figure 21 shows some of the more questionable data. Figures 19, 20, and 21 are representative of all teams (not only those who learned without treatment).

A Spearman coefficient of rank correlation was computed to determine whether there was a significant correlation between rule adherence and correct consequation. For the group of teams who learned to cooperate without treatment, there was a significant correlation between correct consequation and rule adherence on the first 20 trials, $\rho = .57$, $\underline{t}\ (14) = 2.58$, $\underline{p} < .05$. However, the correlation between rule adherence and correct consequation was not significant on the last 20 trials before the criterion run.

Figure 19. Percentage of correct consequation by team PO and SG and team rule adherence plotted by blocks of 20 trials.

*Percentage based on fewer than 20 trials.

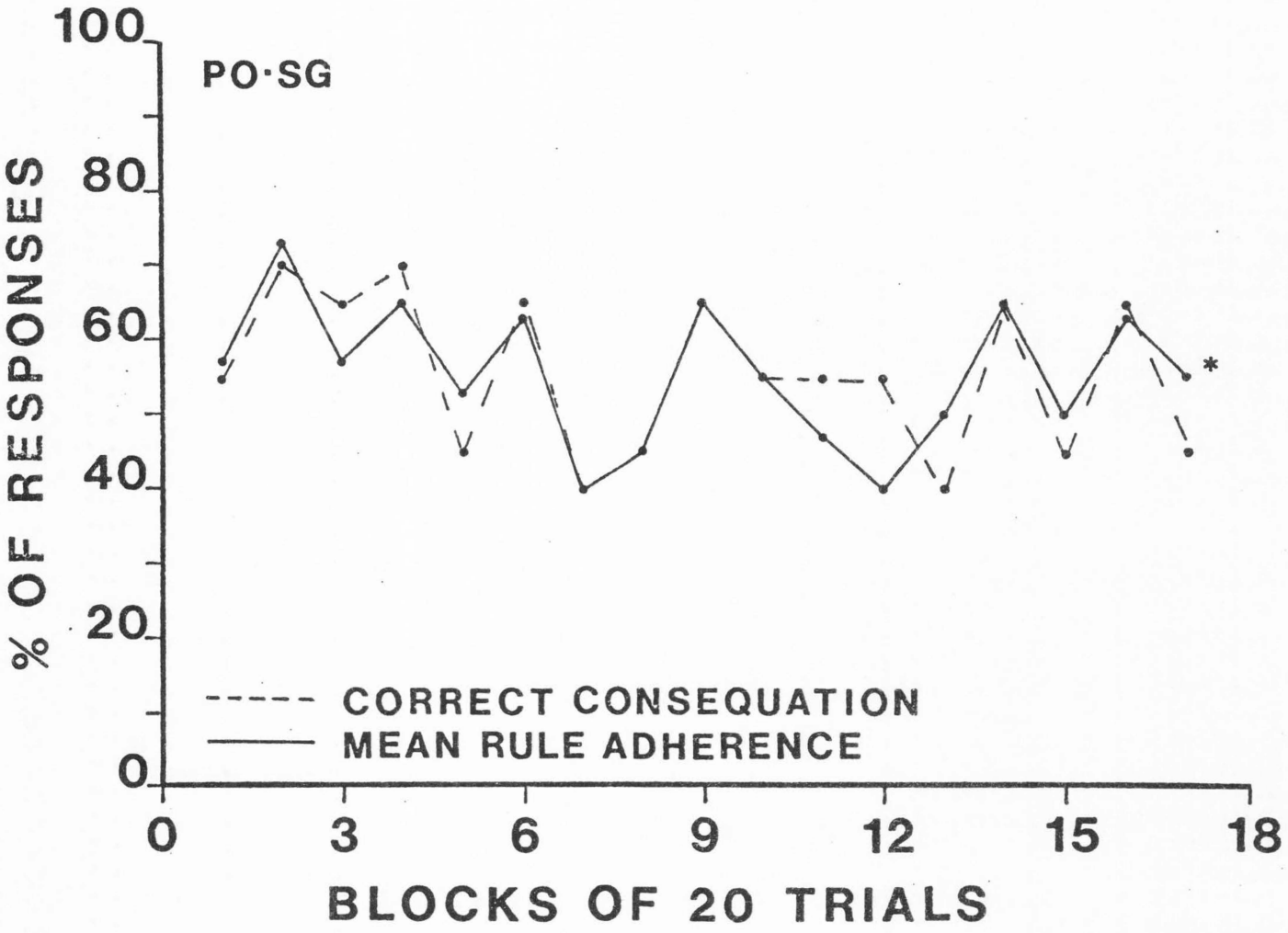

PO·SG
% OF RESPONSES
100
80
60
40
20
0
0
3
6
9
12
15
18
BLOCKS OF 20 TRIALS
CORRECT CONSEQUATION
MEAN RULE ADHERENCE
*

Figure 20. Percentage of correct consequation by team KJ and CK and team rule adherence plotted by blocks of 20 trials.

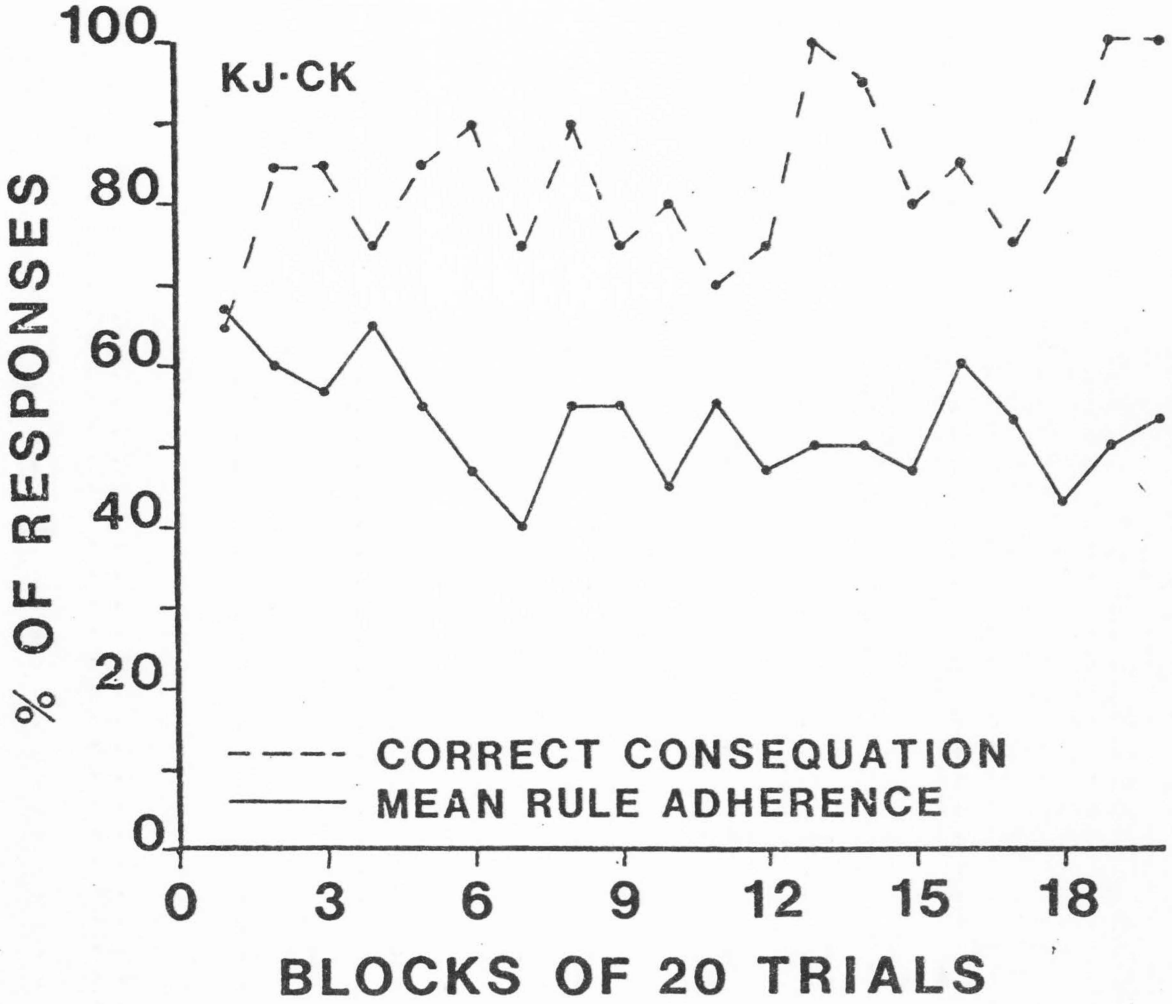
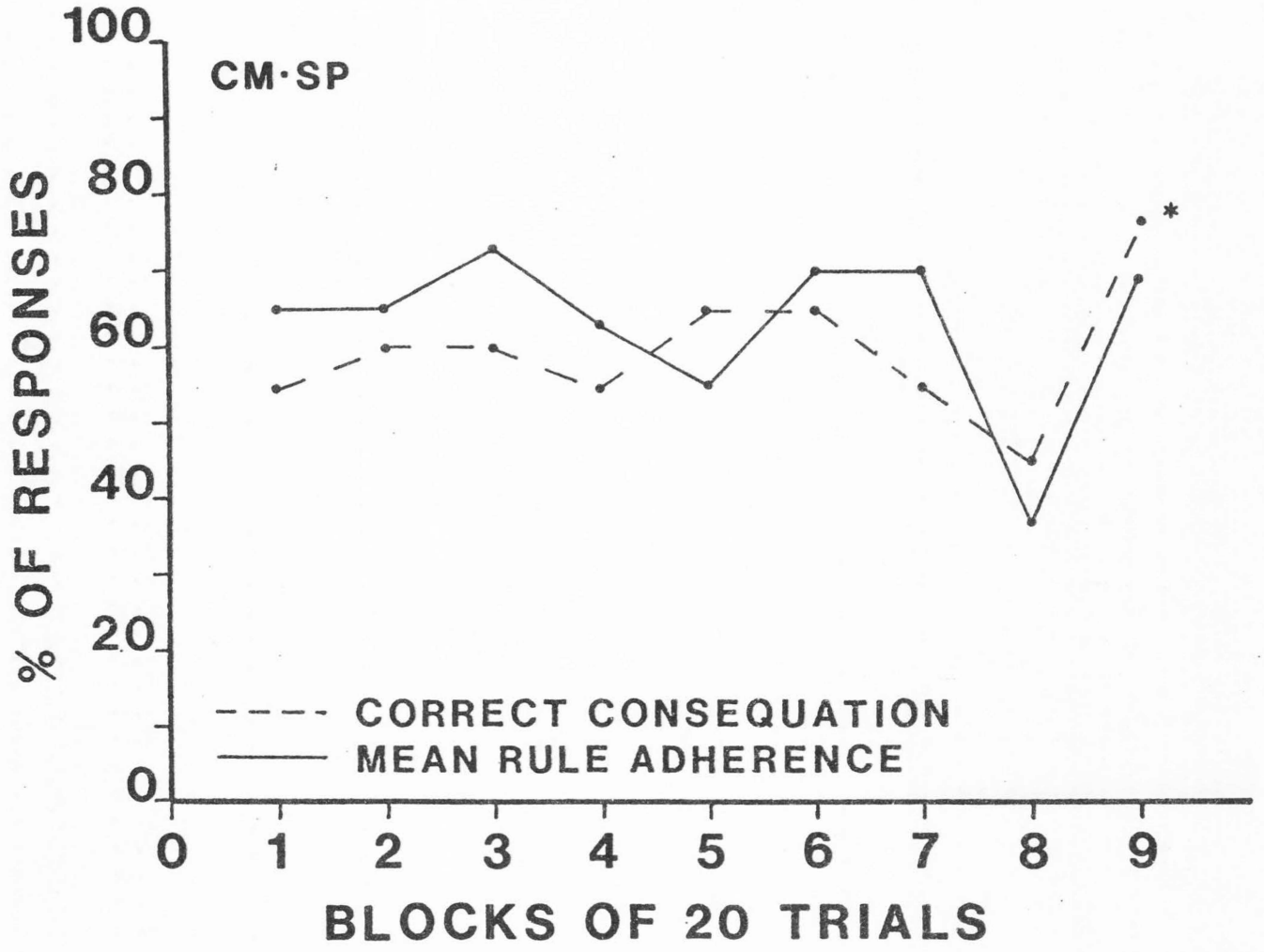

KJ·CK
100
80
60
40
20
0
% OF RESPONSES
CORRECT CONSEQUATION
MEAN RULE ADHERENCE
0
3
6
9
12
15
18
BLOCKS OF 20 TRIALS

Figure 21. Percentage of correct consequation by team CM and SP and team rule adherence plotted by blocks of 20 trials.

*Percentage based on fewer than 20 trials.


CM·SP
% OF RESPONSES
100
80
60
40
20
0
*
CORRECT CONSEQUATION
MEAN RULE ADHERENCE
0 1 2 3 4 5 6 7 8 9
BLOCKS OF 20 TRIALS

Comparisons were done to determine whether the correlation between correct consequation and rule adherence was related to age. The correlation between rule adherence and correct consequation on the first and last 20 trials was calculated for all first-grade teams and then for all second- and third-grade teams. Rule adherence and correct consequation were not significantly correlated for either first- or second- and third-grade teams (on either the first or last 20 trials).

Treatment Groups

Rule-training task. Of 18 children given the rule-training task only one failed to perform to criterion in the task. The number of trials required to reach the criterion of 12 consecutive correct responses ranged from 12 to 340. The median number of trials prior to the criterion run was 54.5; the mean was 78.

Four teams of subjects were given the rule-training task after having failed to reach criterion level performance in 400 trials under typical minimal social conditions. When the subjects were returned to the typical minimal social conditions, two teams showed rapid improvement and reached criterion almost immediately. Figures 22 and 23 show the mutually rewarding trials played by these teams. The broken line dividing each graph indicates the point at which the rule-training task was given. Note that in Figure 22 NM and FG actually reached criterion level performance near trial 200; however, the cooperative interchange was lost very quickly and did not recover in the next 200 trials. After the rule-training task the team began

Figure 22. Percentage of cooperative (mutually rewarding) trials played by NM and FG per block of 10 trials.

*Percentage based on fewer than 10 trials.

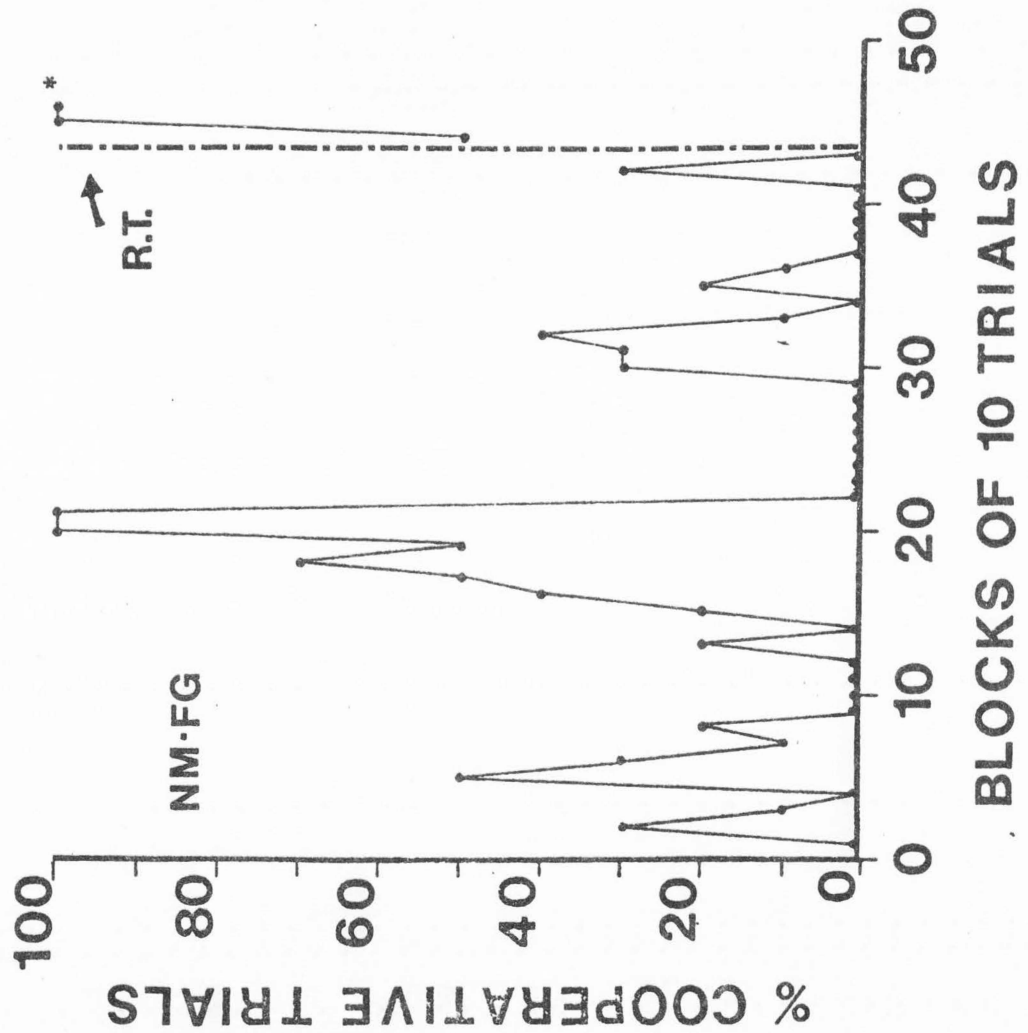
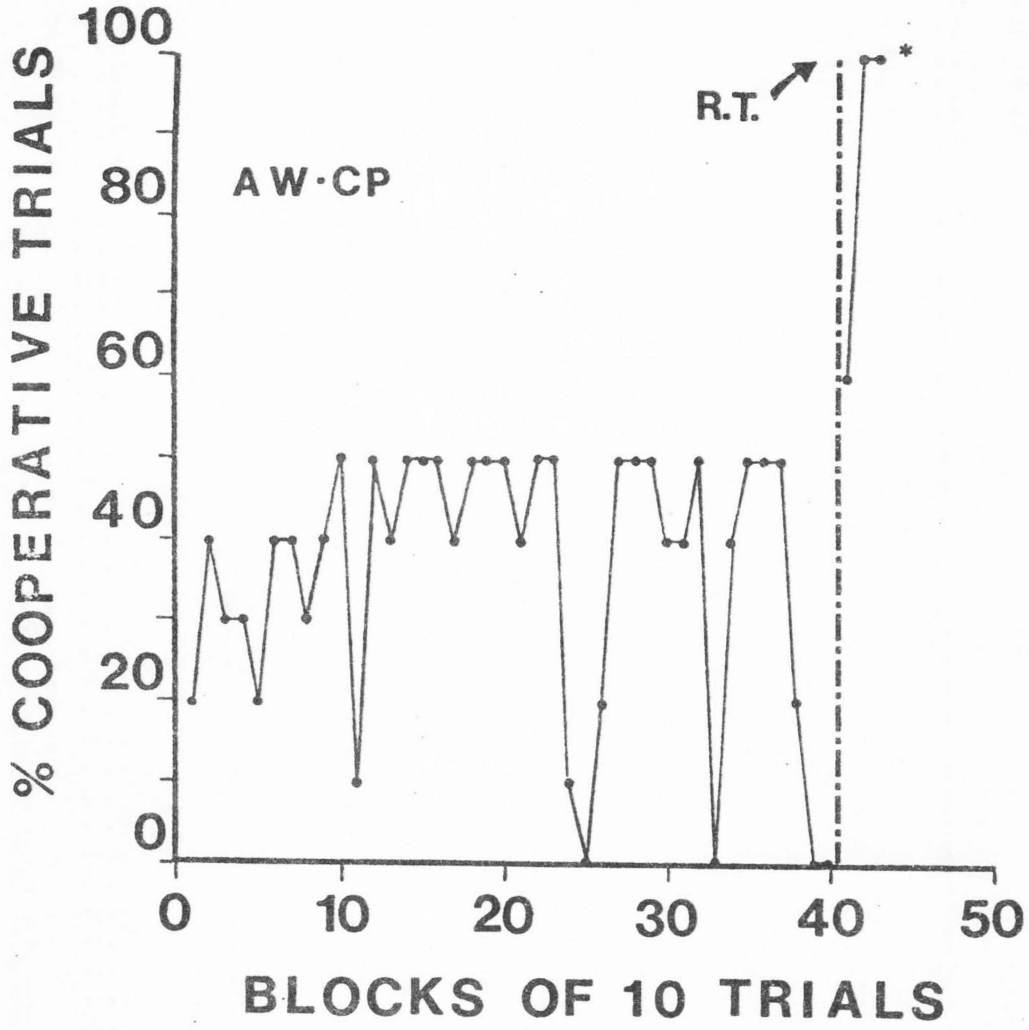

% COOPERATIVE TRIALS
100
80
60
40
20
0
NM·FG
R.T.
*
0
10
20
30
40
50
BLOCKS OF 10 TRIALS

Figure 23. Percentage of cooperative (mutually rewarding) trials played by AW and CP per block of 10 trials.

*Percentage based on fewer than 10 trials.


100
80
60
40
20
0
% COOPERATIVE TRIALS
AW·CP
R.T.
*
0
10
20
30
40
50
BLOCKS OF 10 TRIALS

the criterion run on trial 5. The team AW and CP (Figure 23) began the criterion run on trial 8 after rule training. The remaining two teams who were given the rule-training task after having played under typical minimal social conditions showed no improvement. Their data will be shown under the section "Verbal Instructions."

Verbal instructions. Verbal instructions were given to one team (SR and MF) after 110 trials in the typical minimal social situation and to another team after 400 trials (CS and AG). Both teams immediately locked into a mutually rewarding interchange, as can be seen in Figures 24 and 25. The broken line dividing the graphs indicates the point at which verbal instructions were introduced.

As was mentioned previously, two teams who were given the rule-training task failed to learn when they were returned to the typical minimal social situation for 100 trials. One of these teams, RR and DS, began the criterion run on the first trial after being given verbal instructions. The data for this team is shown in Figure 26. As Figure 27 indicates, the other team KJ and CK failed to reach a mutually rewarding interchange until verbal instructions were given a second time 90 trials later.

Analysis of adherence to win-stay, lose-change rule. In analyzing the win-stay, lose-change behavior of the subjects who received treatment (either the rule-training task or verbal instructions), the mean percentage of rule adherence on the first 20 trials was compared to rule adherence on the last 20 trials before treatment was given. Rule adherence increased slightly from 58.8% to 62.1%,

Figure 24. Percentage of cooperative (mutually rewarding) trials played by SR & MF per block of 10 trials.

*Percentage based on fewer than 10 trials.

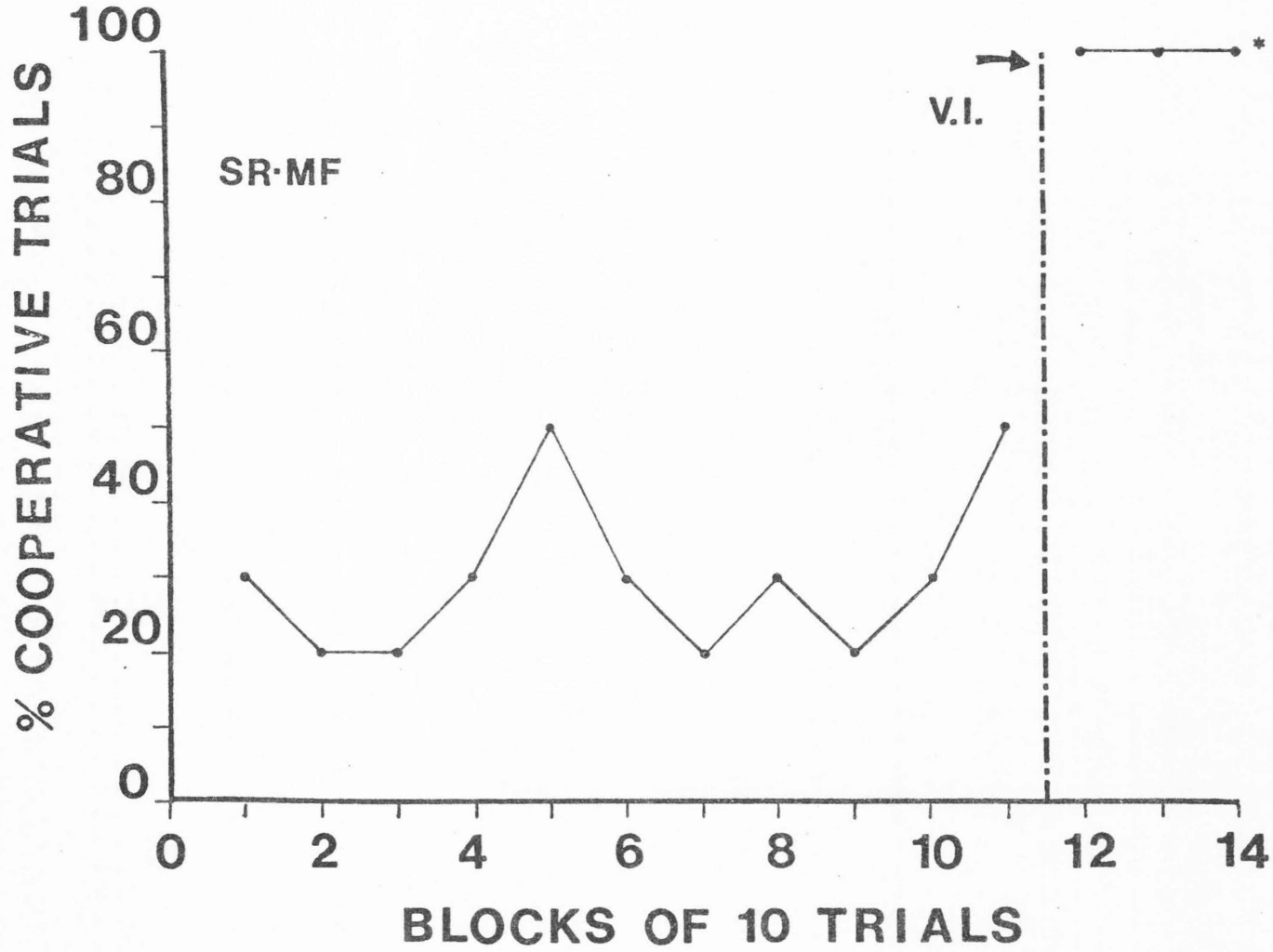

100
80
60
40
20
0
% COOPERATIVE TRIALS
SR·MF
V.I.
*
0
2
4
6
8
10
12
14
BLOCKS OF 10 TRIALS

Figure 25. Percentage of cooperative (mutually rewarding) trials played by CS & AG per block of 10 trials.

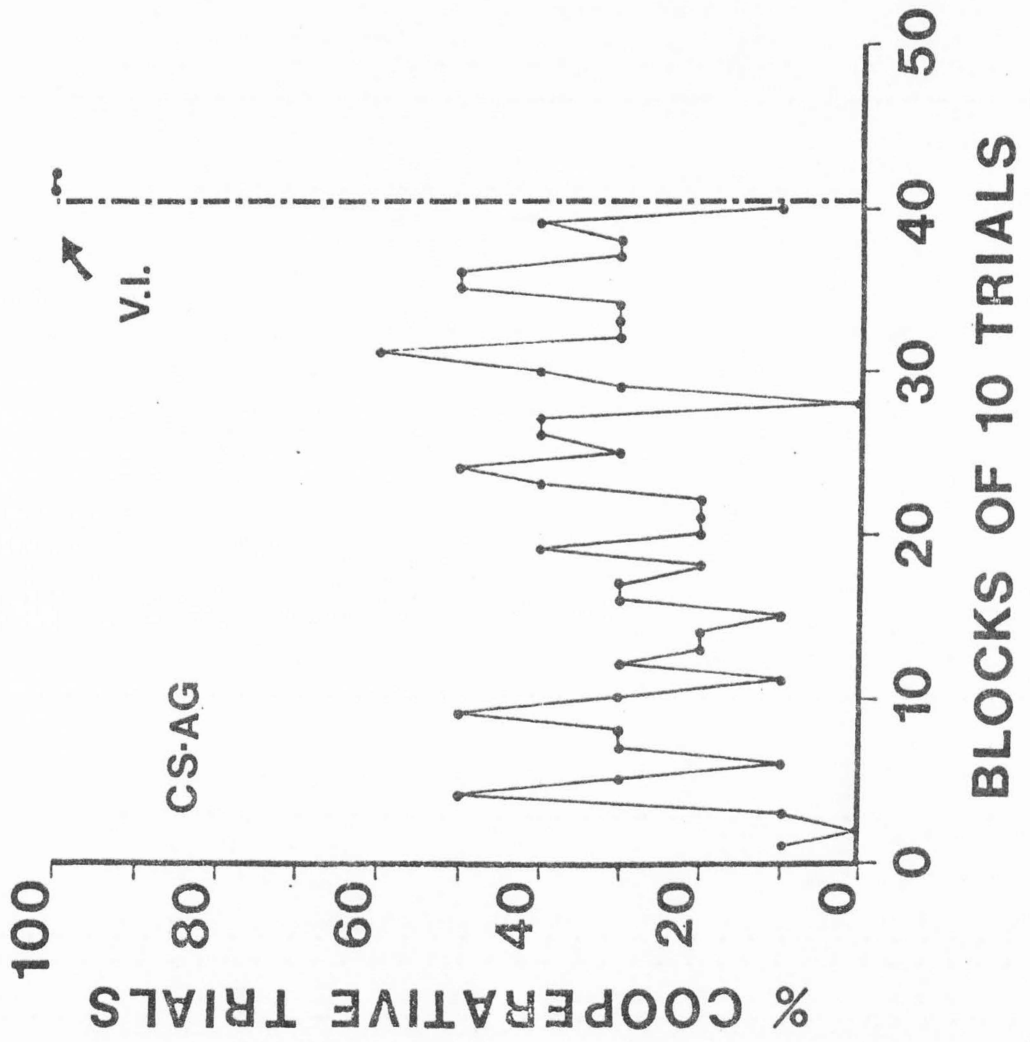

% COOPERATIVE TRIALS
100
80
60
40
20
0
CS-AG
V.I.
0
10
20
30
40
50
BLOCKS OF 10 TRIALS

Figure 26. Percentage of cooperative (mutually rewarding) trials played by RR and DS per block of 10 trials.

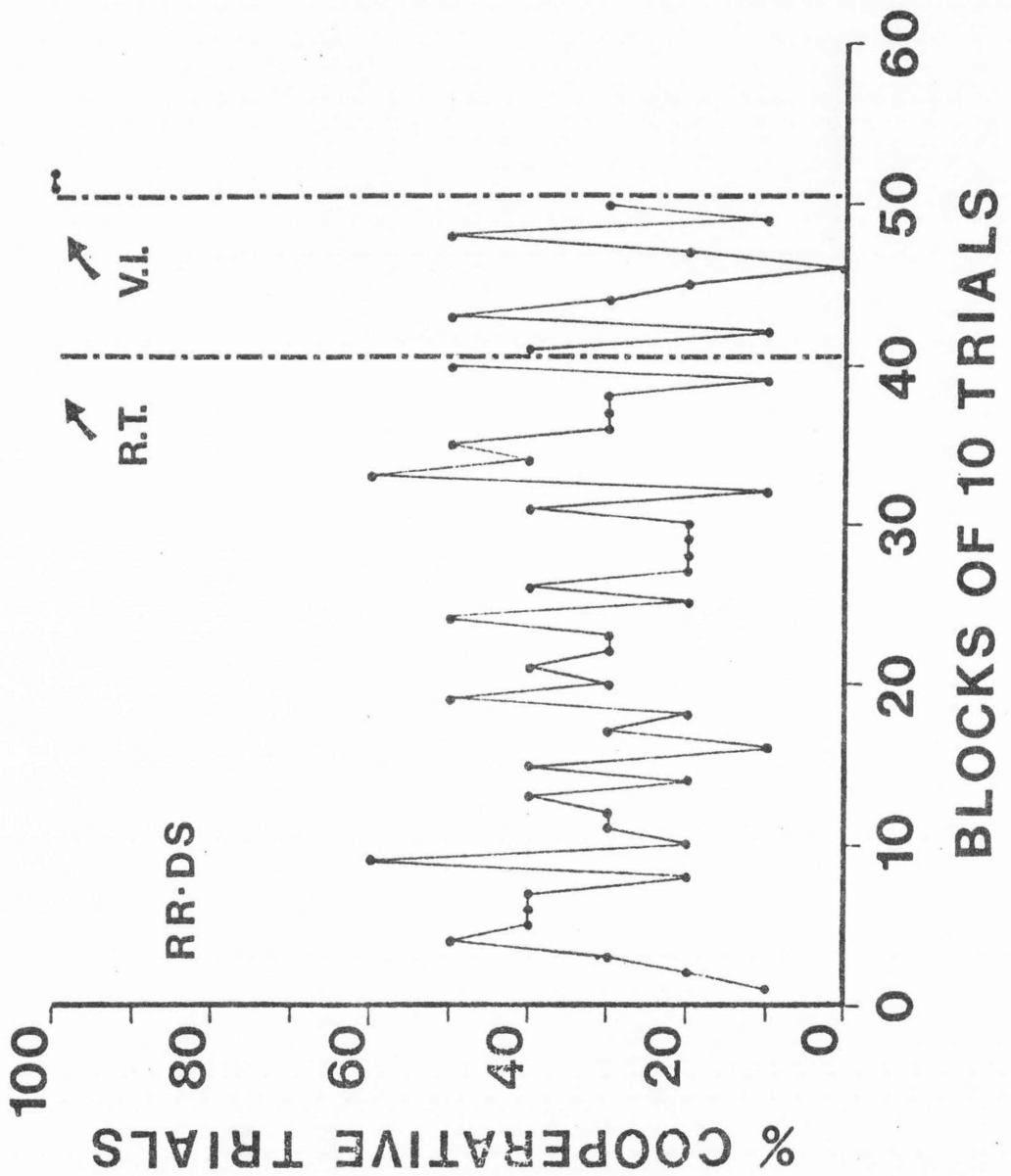
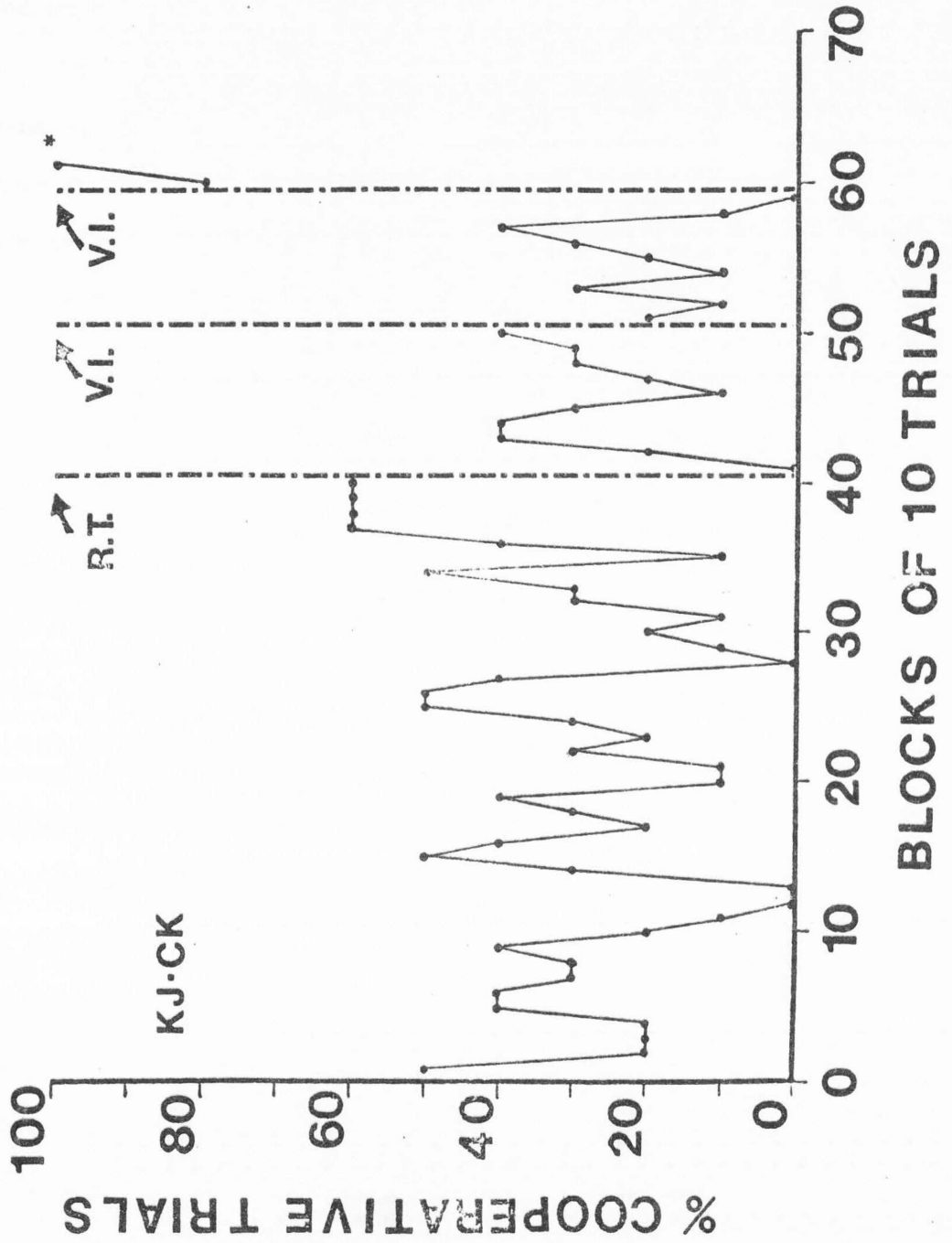

% COOPERATIVE TRIALS
100
80
60
40
20
0
RR·DS
R.T.
V.I.
0
10
20
30
40
50
60
BLOCKS OF 10 TRIALS

Figure 27. Percentage of cooperative (mutually rewarding) trials played by KJ and CK per block of 10 trials.

*Percentage based on fewer than 10 trials.


% COOPERATIVE TRIALS
100
80
60
40
20
0
KJ-CK
R.T.
V.I.
V.I.
V.I.
*
0
10
20
30
40
50
60
70
BLOCKS OF 10 TRIALS

but this difference was not statistically significant. Table 2 gives mean rule adherence for each team individually on the first 20 trials and on the last 20 trials prior to treatment.

Statistical tests were done to determine whether or not subjects were adhering to the rule win-stay, lose-change at a level different from chance. The analysis indicated that on the first 20 trials subjects were adhering to the rule at a significantly greater than chance level, t (5) = 4.35, $p < .01$. Note that subjects who reached solution without special treatment were adhering to the rule only at a chance level.

Win-stay and lose-change responses were also analyzed separately. The percentage of win-stay responses per opportunity in the first 20 trials was compared to those in the last 20 trials prior to treatment. The same analysis was made on lose-change responses. Win-stay responses increased from a mean of 38.6% to 44.9% and lose-change responses increased from 79.5% to 82.9%; these differences were not statistically significant.

As was reported for the teams who learned without treatment, an analysis was done to determine whether, as Rabinowitz et al. reported, subjects were learning to respond differently on the different response switch positions (up and down). The same comparisons were made as were reported for teams who learned without treatment and again no significant results were obtained.

The percentage of correct consequation of win-stay and lose-change responses was computed on the first 20 trials and on the last

Table 2

Adherence to the "Win-Stay, Lose-Change" Rule

for Teams Given Treatment

Team	Type treatment received[a]	Mean rule adherence: first 20 trials (per cent)	Mean rule adherence: last 20 trials (per cent)
NM & FG	MSS; RT; MSS	57	70
AW & CP	MSS; RT; MSS	55	70
SR & MF	MSS; VI; MSS	55	75
CS & AG	MSS; VI; MSS	60	57
RR & DS	MSS; RT; MSS; VI; MSS	57	50
KJ & CK	MSS; RT; MSS; VI; MSS; VI; MSS	67	50
	Group mean	58.8	62.1

[a]Treatments were given to each team in the order listed in the table.

MSS = typical minimal social conditions
RT = rule-training task
VI = verbal instructions

20 trials before treatment was given. The mean for all the teams showed a slight but not statistically significant decrease from 59.2% to 57.7%. Note that the teams who learned to cooperate without treatment showed a significant increase in correct consequation from the first 20 trials to the last.

A Spearman coefficient of rank correlation was computed to determine whether there was a significant correlation between rule adherence and correct consequation for teams who required special treatment. The correlation between rule adherence and correct consequation was not significant on either the first 20 trials ($\rho = .18$) or the last 20 trials before treatment ($\rho = -.33$).

Control group. The rule-training task was given to three teams of children prior to their being placed into the typical minimal social situation. One team (JB and AL) learned to cooperate in 154 trials; however, it is not clear whether this cooperation was due to the rule-training procedure or whether it would have occurred without any previous training.

The experimental history given the remaining two control teams was more complex. These two teams failed to learn to cooperate when they were placed into the minimal social situation after rule training. In both teams one subject was consistently adhering to the rule "win-stay, lose-change" better than his partner. As a next step, the two children (VS and MG) that were following the rule were placed as partners in the minimal social situation; and the remaining two children (DS and BB) who were not adhering to the rule were made

partners. The team VS and MG learned to cooperate within 161 trials. The rule-training task was repeated with the remaining two children; however, they did not learn to cooperate in the minimal social situation until they were given verbal instructions.

Reversal Data

When the teams had reached criterion level performance in the minimal social situation, the partners switched panels, and the teams were again brought to criterion. Subjects' panels were wired differently so that if an up response gave positive points on one box, the down response on the other box gave positive points. Seventeen of the 19 teams learned to cooperate fairly readily in reversal. The remaining two teams required special treatment before learning to cooperate again. The training task was repeated with members of one team (AW and CP), and they cooperated within 15 trials. Verbal instructions were repeated to members of the other team (CS and AG) which led to cooperation on the first trial.

Again, there was considerable variability in the number of trials teams required before beginning the criterion run. Two teams began the criterion run on the first trial, while another team required 374 trials. The mean number of trials to criterion was 60; the median was 37.

Responses to Questions

Following the last session in the typical minimal social conditions and in the rule-training task, each subject was asked the

following questions: "How do you think this game works? How did you decide which way to push your button?" The children's answers to the questions tended to fit under one of three categories. After the minimal social task 64% of the children responded that they did not know how the game worked; 25% responded that the button should be pushed one particular way (for example, up) to win; and 4% responded with an answer that was essentially the win-stay, lose-change rule. The data from the children who were given verbal instructions were excluded from this analysis since all, except one child, responded with the win-stay, lose-change rule. There were no differences in the answers of the children who learned without training and those who required special training.

Following the rule-training task, only 14% of the subjects responded that they did not know how the game worked. The remainder of the children stated the win-stay, lose-change rule correctly.

Discussion

The present research indicates that children can learn to cooperate in the minimal social situation. It is not clear why the results differed from the pilot research. There are a number of possible explanations for this. The teams of children in the pilot research were run from 120 to 300 trials. It is possible that this may not have been enough trials; however, this does not seem to be a likely explanation since five out of the ten teams who reached criterion without treatment did so within 121 trials. There were also at least two procedural changes in the present research. First, children in the pilot research were run for no longer than 60 trials per day, whereas the children in the present study were run at least 100 trials each day. Sometimes they were run for longer sessions if they were in a potential criterion run at the end of 100 trials. Second, in the pilot research there was no red light when the child lost a point as was the case in the present research. A number was registered on the child's minus counter when he/she lost a point, but this may not have been sufficiently clear feedback.

The current procedure was similar to some of the conditions studied by Kelley et al. (1962). Comparing the data from the two studies it appears that children placed under minimal social conditions learn to cooperate as often as college students do when they are placed under similar conditions. Fifty-three percent (10 out of 19) of the teams of children used in the present study reached

solution without instruction. The Kelley et al. study was divided into two experiments. In one experiment 37% (11 out of 30) of the teams of college students reached solution; in the second study 54% (12 out of 22) reached solution. The large difference in the percentage of teams reaching criterion in the first Kelley et al. experiment as compared to the second may be due to the different criterion for solution used. In the first experiment criterion for solution was 35 consecutive mutually rewarding trials; in the second only 12 consecutive cooperative trials were required.

The finding that second- and third-grade teams learned to cooperate more often than did first-grade teams is probably best explained by data from studies of children's hypothesis testing behavior (as was discussed in the "Review of the Literature"). Gholson et al. (1972) and Rieber (1969) indicate that second-graders exhibit fewer stereotyped patterns of responding such as alternation and perseveration than do kindergartners. It was noted that at least one member of several of the teams who did not learn to cooperate in the present study showed a predominant pattern of responding, such as alternation or perseveration, which did not change regardless of the consequences for that behavior. These persistent error patterns made the chance that the team would lock into a mutually rewarding pattern of responding rather remote.

This finding that performance improves with age is also supported by other developmental literature. Kendler and Kendler (1962) in studying concept formation found differences between four-year-olds

and seven-year-olds in their ability to make reversal and nonreversal shifts. Odom (1966) found that five-year-olds made three times as many errors on a discrimination task as did eleven- and thirteen-year-olds. Cronin (1967) found that first-graders could discriminate mirror-image reversals significantly better than kindergartners. Maccoby and Konrad (1966) found that errors decreased on a listening task as age increased when comparing kindergartners, second-, and fourth-graders. Gladstone (1969) found that 3 1/2-year-olds made fewer responses in extinction on a switch-pulling task than did 2 1/2-year-olds.

The results of the statistical analysis done to determine whether teams were adhering to the rule win-stay, lose-change at a level different from chance was confusing at first. The analysis indicated that subjects who reached solution in the minimal social task without treatment initially were adhering to the rule at chance level, while the teams which required treatment were performing at a greater than chance level initially. (Neither group showed a significant increase in rule adherence throughout the sessions.) Again, one possible explanation for this apparent discrepancy deals with the error patterns that children were found to exhibit. Certain error patterns that the children exhibited can give the appearance that children are adhering to the win-stay, lose-change rule, but when the data is qualitatively examined, it is clear that the children are following some other "rule" (rather than the win-stay, lose-change rule). For example, if one team member plays all minus (or punishing) responses and the

In the present research the percentage of rule-following behavior was calculated by totaling the number of trials on which a subject exhibited either win-stay or lose-change behavior. Two plays were required of the subject to determine each incidence of rule-following behavior. The recent literature on hypothesis testing makes a distinction between rule-following behavior and hypothesis-testing behavior. When an individual receives positive feedback (or negative feedback) on two consecutive trials, he can test an hypothesis such as win-stay and/or win-change; but, he cannot exhibit rule-following behavior unless at some point he receives on two consecutive trials both positive and negative feedback. It takes three trials to determine each incidence of rule-following behavior.

The data from both the treatment and non-treatment groups were re-analyzed in light of this different definition of rule-following. Comparing the first and last 20 trials, there was no significant increase in the following of the win-stay, lose-change rule for either group of children. On the first 20 trials children who learned to cooperate in the minimal social situation without treatment exhibited win-stay, lose-change behavior on 28% of the opportunities available to them to make the response. Win-stay, lose-change responses per opportunity decreased to 24% on the last 20 trials. The group of children who required special treatment before learning to cooperate followed the win-stay, lose-change rule on 27% of the opportunities available on the first 20 trials. This decreased to 22% on the last 20 trials.

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Appendix

Preliminary Research with Children in the Minimal Social Situation

The following research was done as a pilot study to determine whether or not children can learn to cooperate in a minimal social situation.

EXPERIMENT I

Subjects

Two dyads composed of third-grade girls from Edith Bowen Lab School were selected from a group of children whose parents consented to their participation in a research project. Subjects earned points which could be exchanged for small toys and candy following each session.

Apparatus

Each S's response panel was equipped with three small lights (red, green, and yellow), two counters, and a three-position response switch. The response switch could be moved either up or down (the center position being neutral). A subject caused points to be added to one of the counters (either "points lost" or "points gained" counter) on his partner's response panel, depending on which way he pushed the switch. When a subject received positive points from his partner, the green light on his panel flashed. The yellow light served to indicate trials. (The red light was not used in this experiment.)

Both subjects' response panels were connected to a control box, operated by the experimenter in another

room. The control box indicated to the experimenter what response each child had made and allowed the experimenter to signal trials and to activate the subjects' counters once responses had been made.

Procedure

The children were taken from their classroom by the experimenter and an assistant and conducted to separate rooms. Each subject was read the following instructions:

> We're going to play a game where you are supposed to make as many points as you can. At the end of the game I will give you one of these poker chips (E showed chip to S) for every point that you win, and you can buy candy or toys with them at our store.
>
> Now, I'll tell you how you play the game--When this yellow light comes on (E pointed to light) you push this button on your box either up or down (E demonstrated). Can you do that? (E waited for child to respond).
>
> If you win a point this green light (E pointed to light) will flash and a number will pop up on this counter (E pointed to counter). Sometimes you will get a point taken away--if a number pops up on this counter (E pointed to "points lost" counter) you will lose a point.
>
> After you see if you win or lose a point, put the button back to the middle position (E demonstrated) and wait for the yellow light to come on again.
>
> When you are finished, I will come and get you and we will go to the store to buy something. Try to make as many points as you can. Everytime the green light goes on and this counter (E pointed to "points gained" counter) moves you get a point. Do not play with the knobs on the counters--if you move them, I will not know how many points to give you.

A trial began when the yellow light was turned on; the light remained on until both subjects had made a response.

When both subjects had responded, the experimenter pushed a switch which registered points on the counters according to the child's responses and activated the green light on the panel of subjects who received positive points. An assistant recorded what response each child made. There was a 5-second inter-trial interval. If a subject forgot to reset his response switch, the experimenter went to the door and reminded him to reset it.

Solution (a cooperative state) was said to have been reached after 10 consecutive mutually rewarding trials. Each team was run for 30 trials on the first two sessions; the remainder of the sessions consisted of 60 trials. One dyad was run for a total of 300 trials and the other for a total of 240 trials. If subjects failed to earn any points or ended the session with a negative score, they were given a few chips for coming to the session.

Results

Data indicated that neither dyad reached the criterion for solution. Table 3 shows the number of cooperative responses (mutually rewarding) made by each dyad across blocks of 30 trials. By chance one would expect approximately 7.5 cooperative trials per block of 30 trials. A statistical analysis indicated that subjects were not responding randomly throughout the sessions, χ^2 (2) = 220.7, $p < .001$ for dyad I; χ^2 (2) = 13.32, $p < .01$ for dyad II). Qualitative analysis of the data indicated that the children tended to exhibit certain error patterns

Table 3

Number of Cooperative

Trials per Block of 30 Trials

Subjects	Blocks									
	1	2	3	4	5	6	7	8	9	10
Dyad I	5	0	1	0	0	0	0	0	0	0
Dyad II	15	0	3	1	0	6	9	10		

such as alternating from one response to the other or repeating the same response regardless of the consequences.

Discussion

Looking at the data, it must be concluded that the two dyads composed of third-graders did not learn to cooperate under conditions which have brought about cooperation in college students. Dyad II showed a gradual increase in cooperative responses; although it is possible that the dyad may eventually have reached a cooperative state, previous research (Sidowski, Wyckoff, & Tabory, 1956; Sidowski, 1957; and Rabinowitz, Kelley, & Rosenblatt, 1966) indicates that learning occurs very rapidly, near the beginning of the session, in the minimal social situation. One difference between the present study and previous minimal social research is the number of trials per session. In previous studies all trials have been executed in one session; in the present study children were given no more than 60 trials per session (approximately one-half hour sessions). It was felt that children would have difficulty remaining attentive for longer periods.

The error patterns exhibited by the children in the present study do not seem unique to the experimental literature. Similar behavior was reported by Sidman and Stoddard (1967) and by Stoddard and Sidman (1967). These authors report that children exhibited specific classifiable error patterns when required to perform a difficult discrimination task. The errors were classified as adventitiously reinforced response sequences,

selecting the most frequently reinforced response key, selecting a response key that was correct on the preceding trial, and initial position preferences. Harlow (1950) reported that monkeys, also, exhibit specific error patterns.

The error patterns reported in the present study, as well as those reported in earlier studies, are probably traceable to reinforcement contingencies not under the control of the experimenter. Since a subject in the minimal social situation has no direct control over the reinforcement which he receives (his partner determines this) the possibility of adventitiously reinforced response patterns seems relatively high. For example, in the present experiment, one subject (A) in a dyad pushed her button in the direction which delivered reinforcement to her partner (B) everytime; B alternated her responses and was reinforced every time by A's responses. A received positive and negative points alternately, but was reinforced on an intermittent schedule so the behavior of both subjects persisted.

It would appear that the major reason for failure to learn in the minimal social situation is the ambiguity of the feedback received by the subject. On one trial a subject may be reinforced for a response, and on the next trial punished for the same response, depending on how his partner is responding. If both subjects followed a win-stay, lose-change rule a mutually rewarding state would eventually be reached. However, it seems that often, at least in children, complex behavior patterns develop or are present which interfere with the development of a mutually rewarding state.

EXPERIMENT II

The results of Experiment I raised at least two questions: 1) How can feedback in the minimal social situation be made less ambiguous? and 2) How can children be taught to follow a win-stay, lose-change rule?

Powers (unpublished study) discussed the problem of ambiguous feedback in his work with triads in the minimal social situation. Placing triads in the minimal social situation creates special problems not encountered with dyads. In the triad sitaution, Subject A would deliver outcomes (positive or negative points) to Subjects B and C; B would deliver outcomes to A and C; and C would give outcomes to B and A. With this type of arrangement a subject might receive conflicting outcomes--positive points from one partner and negative points from the other. In this situation, following a win-stay, lose-change rule, a subject would not know whether to repeat his previous response or to change responses. In the Powers study, subjects did not receive reward or punishment unless the responses of all three members were in agreement; i.e., either all positive or all negative. If outcomes were mixed, a red light flashed on all subjects' panels and another trial was begun. Both triads and dyads placed in the above situation quickly learned to cooperate.

The present experiment attempted to train children to use the win-stay, lose-change rule by using a method similar to

Powers' to avoid ambiguous feedback. One group of dyads was taught "win-stay" behavior; another group was taught "lose-change" behavior; and a final group of dyads was taught both "win-stay" and "lose-change" behavior. Then all groups were placed in the traditional minimal social situation to determine the effectiveness of each training procedure.

Subjects

Subjects were second and third grade boys and girls.

Apparatus

Same as Experiment I, except that the red light was used in this experiment.

Procedure

Subjects were taken from their classroom by E and an assistant and seated in separate rooms. Instructions were read according to the particular experimental group of the subject.

"Win-stay" condition. One dyad was run under this condition. Subjects were read the following instructions:

> We're going to play a game where you are supposed to make as many points as you can. At the end of the game I will give you one of these poker chips (E showed chip to S) for every point that you win, and you can buy candy or toys with them at our store.
>
> Now I'll tell you how you play the game--When this yellow light comes on (E pointed to light) you push this button on your box either up or down (E demonstrated). Can you do that? (E waited for the child to respond).
>
> If you win a point this green light (E pointed to light) will flash and a number will pop up on this counter (E pointed to counter). Sometimes this red light will come on--that means you didn't win a point. After you see if you win a point, put the button back to the middle position (E demonstrated) and wait for the yellow light

light to come on again.

> When you are finished, I will come and get you and we will go to the store to buy something.

The negative counter was covered for this group. Under this condition children received points only if both partners gave positive points; if outcomes were mixed or both negative, a red light was flashed on both subjects' panels. Criteria for learning in this phase was 10 consecutive mutually rewarding trials. Then the group was placed into the regular minimal social conditions described in Experiment I. In the regular minimal social phase, subjects were given a response switch which worked opposite to the one they had used in the training session (i.e., if the up-position had given points to the partner, now the down-position gave points to the partner). Subjects were run 120 trials in the regular minimal social condition or until they reached a criterion of 10 consecutive mutually rewarding responses.

"Lose-change" condition. One dyad was run under this condition. Instructions were similar to the "win-stay" dyad, except that Ss were told that they had 30 points, but they would lose one point every time the counter moved. Subjects were instructed that the red light meant they did not lose a point on that trial. The positive point counter was covered. Subjects received negative points only when both partners gave negative points; if outcomes were mixed or if both gave positive points, a red light flashed on both subjects' panels. Criterion for learning in this phase was 10 consecutive trials

where subjects did not lose points, but rather got a red light. The dyad was then placed into the regular minimal social situation for 120 trials or until criterion of 10 mutually rewarding trials was met.

"Win-stay, lose-change" condition. Two dyads were run under this condition. Subjects were instructed that they could win points, lose points, or that sometimes a red light would come on. In this condition both subjects received positive points if both played positive; both received negative points if both played negative. If outcomes were mixed, the red light on both subjects' panels flashed. Subjects were to be run under these conditions until a criterion of 10 mutually rewarding responses was met and were then to be placed into the regular minimal social situation; however, neither dyad reached criteria. One dyad was run for 120 trials and the other for 150.

Results

Subjects in both the "win-stay" condition and the "lose-change" condition performed to criterion within the first 30 trials. (Results of the "win-stay" dyad must be accepted with caution; both subjects played positive responses on the first trial.) However, results indicate that these training procedures did not affect behavior when subjects were placed in a regular minimal social situation; neither dyad learned to cooperate to criterion. The number of cooperative (both partners giving positive points) responses per block of 10 trials is shown in Table 4. As the data indicates,

Table 4

Number of Cooperative

Trials per Block of 10 Trials

Subjects	Blocks 1	2	3	4	5	6	7	8	9	10	11	12
Dyad I[a]	0	0	0	0	0	0	0	0	0	0	0	0
Dyad II[b]	4	5	4	5	7	2	3	4	0	5	3	1

[a]"Win-stay" training

[b]"Lose-change" training

Dyad I which received "win-stay" training showed no cooperative responses. This dyad was performing worse than would be expected by chance (chance level is approximately 2.5 cooperative responses per block of 10 trials). This below-chance-level performance was due to one child's giving her partner negative points on each trial.

Dyad II receiving "lose-change" training showed more variation in performance, and at one point subjects gave five consecutive cooperative responses. Criterion was never reached, however, and perfromance deteriorated to some degree after that point.

As was stated previously the two dyads in the "win-stay, lose-change" condition never reached criterion level performance in the training session. The performance of those two dyads is shown in Table 5. The data indicates that Dyad III perfromed fairly close to chance level with a slight increase on the last block of trials. Dyad IV performed at the 50 per cent level (five cooperative trials out of 10) throughout most of the trials. This performance was due to one partner giving positive points on every trial whereas the other partner alternated.

Discussion

As was found in the previous experiment, children did not learn to cooperate under conditions where college students have performed successfully. Powers found that dyads and triads learned to cooperate under the condition described as "win-stay, lose-change" above. And, again, children did not learn to

Table 5

Number of Cooperative

Trials per Block of 10 Trials

	Blocks														
Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dyad III	3	4	3	3	2	2	3	4	4	3	2	5			
Dyad IV	2	4	4	5	5	5	5	6	4	6	6	6	6	6	8

cooperate in the regular minimal social situation.

It appears from the above results that the training conditions described were not helpful to the subjects. It was thought that the use of the red lights in the present study would remove ambiguity in feedback and also train certain parts of the win-stay, lose-change rule. In retrospect, however, it appears that the logic was not complete. The red light did not completely remove the ambiguity in feedback. Although unlike the regular minimal social situation a subject could not receive points and lose points for the same response, he could receive two types of feedback for the same response. For example, in the conditions described as "win-stay" above, the subjects received positive points if both played the switch in the position which gave points to the partner (the positive position); however, a subject might receive a red light for the same response if his partner did not play positive on the trial. The case was similar in the conditions described as "lose-change" above. Subjects received negative points if both partners played negative; however, a subject might receive a red light for the same negative response if his partner played positive. The "win-stay," lose-change" condition works similarly.

It should be noted in conclusion that the work described was a pilot study using a very limited sample; however, the results seem to indicate that a more effective training procedure is necessary to teach the win-stay, lose-change rule if children are to learn in the minimal social situation.

VITA

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September, 1974 - June, 1975	Graduate Teaching Assistant, General Psychology, Utah State University. Duties included preparation of class materials, supervision of student interviewing and testing, and maintenance of student records for the course, which was taught by programmed instruction.
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Publications and Presentations

Siegel, J., and Powers, R. B. Learning of a "win-stay, lose-change" rule by children as an aid to cooperation in the minimal social situation. Paper presented at Rocky Mountain Psychological Association, May, 1975.

Veach, J., and Witters, D. Effects of study question placement and incentive conditions on learning prose material. Paper presented at Virginia Academy of Science, May, 1973.

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