ANALYSIS OF THE CONTROL EXERTED BY A COMPLEX COOPERATION PROCEDURE¹

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The study examined the effects of the availability of a non-cooperative response on cooperative responding when cooperation did not have to result in an equal distribution of work or reinforcers. Also, an attempt was made to determine if the cooperative responding was under the control of the cooperation procedure. Pairs of institutionalized retardates were tested in full view of each other. For each subject, reinforcers (money) were contingent upon responses on each of two panels: (1) a matching panel for working matching-to-sample problems, and (2) a sample panel for producing the sample stimulus. The matching panels of the two subjects were 6 m apart, but a subject's sample panel could be placed at different distances from his matching panel. For each subject, either his own or his partner's sample panel could be nearest his matching panel such that less walking was required to reach one sample panel than the other. Subjects could work either individually, by producing their own sample stimulus, or cooperatively, by producing the sample stimulus for their partner. Subjects selected whichever solution involved the least amount of walking. The importance of testing for control by the cooperation procedure was indicated by the findings that cooperative-like responses were not always under the control of the cooperation procedure.

The essential aspects of a cooperation procedure are (1) that the reinforcers of both individuals are at least in part dependent upon the responses of the other individual and (2) that the procedure allows such responses, designated as cooperative responses, to result in an equitable division of responses and reinforcers (Hake and Vukelich, 1972). The cooperation literature illustrates the range of variations possible on these basic procedural requirements.

A recent review of the cooperation literature classified cooperation procedures at the extremes of four procedural dimensions (Hake and Vukelich, 1972). The procedures at the two extremes of three of the dimensions may

be differentiated in terms of complexity, which is defined here as the number of variables operative. The more complex end of each dimension seems also to approximate aspects of cooperation procedures that are most common to humans. The first dimension, for example, is the extent to which the partner is a social stimulus. In non-social procedures, subjects are given no indication of the existence of a partner, *e.g.*, Sidowski, Wyckoff, and Tabor (1956), Sidowski (1957); but, cooperation between humans is typically complicated by the presence of a partner and may be designated as social. The second dimension is the extent to which the cooperation procedure also allows non-cooperative responses that result in the same reinforcer as cooperative responding. In natural settings, cooperation is not typically the only method of obtaining the reinforcer. The third dimension is the extent to which the cooperation procedure allows deviations from an equitable distribution of the work load or the reinforcers, *e.g.*, Boren (1966). Cooperation procedures in natural settings ordinarily allow at least momentary deviations from reciprocity, as may be seen in common cooperative ventures, such as neighbors taking one another's children to school or borrowing food items such as a cup of sugar.

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All of the procedures at the complex end of the dimensions have been studied, but there are few social procedures that have also allowed a non-cooperative response, and only one study has also allowed deviations from reciprocity (Hollis, 1966). Yet, deviations from reciprocity during cooperative responding would seem to be an important factor affecting the choice between cooperative and non-cooperative responses. Hollis (1966, Experiment I) combined all three procedures to study the cooperative behavior of retarded children. Sessions consisted of trials during which a subject had the option of delivering a baited cart only to himself, or working the task cooperatively by extending a baited cart to his partner as well as to himself. There were deviations from reciprocity during cooperative responding since the partner did not have an opportunity to respond or reciprocate until the next day. During this procedure, only three of nine pairs of subjects demonstrated reciprocal cooperative responding. Subsequent procedures that (1) did not have a day between the responses of the subjects, and (2) did not have an alternative response resulted in more cooperative responding (Hollis, 1966). The present experiment evaluated the effects of an alternative, non-cooperative response during a social cooperation procedure that allowed deviations from reciprocity during cooperative responding.

If cooperative responding develops under a complex cooperation procedure, can that behavior be attributed to the cooperation procedure? Few studies have evaluated control by the cooperation procedure, and several studies have been weakened because of this (Brotzky and Thomas, 1967; Vogler, 1968; Schmitt and Marwell, 1968). The present experiment attempted to determine if the observed cooperative behavior was, in fact, under the control of the cooperation procedure.

Demonstration of control by a cooperation procedure requires demonstration of control by (1) the reinforcer resulting from the cooperation procedure and (2) the specified procedural relation between responses and reinforcers. First, in procedures allowing verbal interaction, the cooperative-like responding of one subject could be under the instructional control of his partner. It is therefore important to demonstrate that the scheduled reinforcer is controlling behavior and not instructions.

Second, when the cooperation procedure is social and allows deviations from reciprocity, the procedural relationship between responses and reinforcers would be reciprocal reinforcement. The minimal indications of control by reciprocal reinforcement appear to be (1) that the cooperative behavior of each subject is under the control of the cooperative behavior of the other subject and (2) that the cooperation procedure increases the correspondence of the relative frequency of the responses and/or the reinforcers of the two subjects (Hake and Vukelich, 1972). These two types of control would indicate the social and reciprocal nature of the cooperative behavior.

EXPERIMENT I

METHOD

Subjects

The six male and four female subjects, students in special education classes at Anna State Hospital, were all between 20 to 26 yr of age with IQs ranging from 46 to 78, except for S-7 who was 15 yr old with an IQ of 102. With the exception of S-7, who was diagnosed as emotionally disturbed, all subjects were diagnosed as mentally retarded. The subjects were selected on the basis of willingness to participate, absence of physical and medical problems, and passing scores on pre-tests described in the procedure section.

Apparatus

Figure 1 shows the matching-to-sample apparatus of each subject. One subject's apparatus is labelled "A", and the other's "B". Each matching-to-sample apparatus consisted of two parts: a sample panel where the sample stimulus was produced, and a matching panel where the problem could be worked. The sample panel could be placed at different distances from the matching panel. In the diagram, each subject's sample panel is beside the other subject's matching panel, 6 m from his own matching panel. The sample and matching panels were color coded, blue for Subject A and yellow for Subject B. Each matching panel, approximately 14 by 12 in. (35 by 30 cm), was affixed to a table. The panel consisted of a counter that recorded a point for every third correct response; a 0.25-in. (0.7 cm) diameter light that flashed after each correct

Fig. 1. Diagram of the matching-to-sample apparatus of each subject. Apparatus labelled "A" belongs to one subject and apparatus labelled "B" belongs to the other subject.

response; and three 0.5-in. (1.3-cm) diameter colored response buttons that were used to match the sample stimulus. The matching-response buttons were green, red, and yellow. The 8 by 8 in. (20 by 20 cm) sample panel, on a 1-m high stand, consisted of a 1 in. (2.5-cm) diameter opening for the sample stimulus and a 0.25-in. (0.7-cm) diameter button directly below the sample stimulus. A press on this sample-response button produced in a random order either a green, red, or yellow sample stimulus for 0.5 sec. Pressing the correct matching-response button on the matching panel produced the feedback stimulus and every third correct response produced a point on the counter. A matching response had to be emitted before another sample stimulus could be produced.

A 12 by 12 in. (30 by 30 cm) timer, located in the middle of one wall, indicated the number of minutes remaining in the session and produced a "buzz" when no time remained. A closed-circuit television camera and a microphone, in full view of the subjects, permitted continuous visual and auditory monitoring. The experiment took place in a well-ventilated and well-lighted room in the special education department of the hospital. The electromechanical scheduling and recording

equipment, the video monitor, and the speaker were in an adjacent room.

Procedure

Pre-tests. Pre-tests were given to identify individuals who could discriminate between the sample stimulus colors and count pennies, abilities that seemed essential to use color matching as the task and pennies as the reinforcer. Individuals were tested for color discrimination while seated at one of the matching panels with the sample panel at arm's length (0 m) and then at 6 m. The experimenter presented the sample stimulus for 0.5 sec and asked the name of the color. If the color was named correctly on nine of 10 sample presentations at both distances, the individual proceeded to the counting test. During this test, each person was given 46 pennies and asked to count them. Responses of "45", "46", or "47" were accepted. All subjects could accurately read the numbers on their counter.

The 10 subjects who passed both pre-tests were paired in terms of approximately equal IQs except for one pair (S-7 and S-8) that had one subject (S-7) with a normal IQ.

Training sessions. Training sessions were provided to ensure that the subjects could work the task. During the first training session, each subject's sample panel was to the left of his matching panel at arm's reach (0 m). Except for the first session, when Subjects 1 through 6 were tested individually, subjects were always tested with their partner. The following instructions were read before the first session.

"Watch closely and I will show you how to make money by naming colors. First, watch what happens when I push this button (sample-response button). What color do you see? (Experimenter waited until subject named the color.) That's right. Now watch what happens when I push the same color on this box (matching-response button). Did you see the white light flash (feedback stimulus)? That means I pushed the button with the same color that came on here (sample panel). Do you see the number 1 here (counter)? That means I was right. I chose the right color. Every time you name the right color, you will get a penny. Now you try one. Push this but-

ton. (The experimenter waited until subject pushed the sample-response button.) Good, now push the button here that is the same color (matching-response button). Did you see the light flash? What does that mean? (Experimenter waited until subject verbalized the function of the feedback stimulus.) That's right. Now how many points do you have? Right, and how many pennies is that worth? Good, now remember that for every point you get, I'll give you a penny. I'll set this timer and you can work for 8 minutes. When the buzzer sounds like this (buzzer sounded), stop working. I will pay you your money when you finish working."

For the second session, both sample panels were moved straight ahead 3 m away from their respective matching panels so that the two sample panels were next to each other, halfway between the subjects. The sample panels were still to the left of and facing their respective matching panels. Sessions with the sample panels 0 m from the matching panels lasted only 8 min because of the high response rates and the rapid accumulation of money at that distance. Sessions at all other distances of the sample panels lasted 16 min. For the second session and all subsequent sessions, three correct responses were required for the counters to register a penny. The subjects were read the following instructions before the second session and all subsequent sessions.

"Do you remember how to do your work? (If a question were asked, that part of the previous instructions relevant to the question was read.) Try to make as many points as you can without moving your chair or these (sample panels). Any other way you want to do your work is all right. Remember, (*S's name*), your chair is yellow, so watch the colors on the yellow stand. (*S's name*), your chair is blue, so you watch the colors on the blue stand. I'll set the timer and you can work for 16 minutes. When the buzzer sounds, stop working. I will pay you your money when you finish working."

There was at least one session but never more than two sessions at distances of 0, 3,

and 4.5 m. The maximum number of training sessions was four.

Cooperation test. After the training sessions, the sample panels were moved straight ahead 6 m from their respective matching panels so that the yellow sample panel was next to the blue matching panel and the blue sample panel was next to the yellow matching panel. Each sample panel still faced the matching panel of the same color, as shown in Figure 1. The sample panels remained at 6 m until cooperative behavior developed and met the stability criteria. Responding was designated as cooperative whenever a subject produced the sample stimulus for his partner by pressing the sample-response button on his partner's sample panel. Responding was designated as individual or non-cooperative when a subject produced his own sample stimulus. When the subjects' sample panels were at the 6-m distance, individual responding required the subjects to walk to their own sample panel, press their sample-response button, and then return to their matching panel to make the matching response. Cooperative responding did not require any walking because the subjects could remain seated to observe their sample stimulus, which was produced by their partner, make their matching response, and produce their partner's sample stimulus. Responding was designated as stable when the frequency of the dominant response (cooperative or individual) and the amount of money earned per session changed by less than 15% for three consecutive sessions with no consistent direction of change.

Varying the relative response requirement for individual and cooperative responses. The relative response requirement for individual and cooperative responses was varied by moving the sample panels of both subjects to distances of 4.5, 3, 0, and 6 m from their matching panels.

The 0-m distance required no walking for individual responding because each subject's sample panel was next to him. Similarly, no walking was required at the 6-m distance if the subjects cooperated by pressing their partner's sample-response button, which was next to them. However, the 3- and 4.5-m distances involved walking regardless of whether the subjects worked cooperatively or individually. For example, at 3 m both sample panels were equidistant from both subjects; hence,

both cooperative and individual responses involved walking the same distance, 3 m. The 4.5-m distance involved less walking if the subjects cooperated because the partner's sample panel was only 1.5 m away, as compared to 4.5 m for their own. The sample panels remained at each distance until both members of a pair met the stability criteria.

RESULTS AND DISCUSSION

Figure 2 shows a session-by-session analysis of the number of cooperative (open circles) and individual (solid triangles) responses of each subject as a function of the distance of his sample panel from his matching panel. Generally, subjects selected the response with the smaller response requirement, in this case, the least amount of walking. First, consider the four pairs (S-1 and S-2; S-3 and S-4; S-5 and S-6; S-7 and S-8) at the top of Figure 2. No subject responded cooperatively during the training sessions but all of them cooperated in the first (S-1 and S-2; S-5 and S-6; S-7 and S-8) or second session (S-3 and S-4) after the distance of the sample panel was increased to 6 m. Cooperation then remained the dominant response at 6 m, 4.5 m, and at 3 m for one pair (S-7 and S-8). Subjects 3 and 4 had one session of individual responding at 4.5 m, but once cooperation became the dominant response, it was typically the only response. Only one pair (S-1 and S-2) had any sessions (Sessions 6 and 7 at 6 m and Sessions 1 and 2 at 4.5 m) with any individual responses after cooperation became the dominant response: during these sessions, S-1 and S-2 changed from cooperative to individual responding and *vice versa* several times a session. All subjects resumed individual responding when their sample panels were returned to 0 m. A final re-determination at 6 m produced an abrupt change to cooperation (Subjects 7 and 8 were transferred to another hospital before this re-determination).

The first four pairs of subjects were under the control of their own sample stimulus during cooperation even though they were producing their partner's sample stimulus. An average of 45% correct per session on the matching response would be significant at the 0.01 level. Subject 4 dropped below 45% for three of the initial cooperation sessions (indicated by arrows), but averaged 66% correct during subsequent cooperation sessions.

The other subjects averaged over 85% correct.

Although the subjects frequently talked and compared scores during sessions, the decisions to cooperate or to work individually were typically made at the start of those sessions that the distances of sample panels were changed. For three pairs, the eventual solution was consistently mentioned first by one member who might be designated as the leader (S-2, S-5, S-7). Leadership was not consistent for the other pair (S-3 and S-4).

The last pair (S-9 and S-10) failed to cooperate during 15 sessions of cooperation testing. Two brief periods of cooperative responding did occur during the eleventh and fourteenth sessions of cooperation testing, but these occurred after S-9 had been tested with another subject (S-1) who had learned to cooperate. Starting with the tenth session of cooperation testing, S-9 was tested on alternate sessions with S-1. The data of S-9 for these sessions are shown in the last panel of the graph of S-9 and reveal that the training was successful: S-9 made 32 individual responses during the first training session, but all of her responses were cooperative by the second training session. A similar but unsuccessful training procedure was tried with S-10. Starting after the sixth session of cooperation testing, S-10 was tested on alternate sessions with three subjects who had learned to cooperate (S-7, S-5, and S-2). Although S-10 did produce the sample stimulus for S-5 and S-2, her accuracy on the matching response dropped to chance (indicated by arrows), suggesting that she was under the control of her partner's instructions rather than the cooperation procedure. This conclusion is supported by the finding that she always returned to individual responding during the alternate sessions with S-9.

Since there were distances of the sample panel at which the subjects responded individually, the experiment allowed a comparison of individual and cooperative responding in terms of the correspondence of the relative frequency of the partners' sample-producing responses. For each pair, the number of sample-producing responses of the subject who made the fewest in a given session was calculated as a percentage of the number of his partner. These percentages for each session were then averaged for each distance and categorized in Table 1 in terms of cooperative or individual responding. If the cooperative responses were

Fig. 2. Session-by-session plot of individual (closed triangles) and cooperative responses (open circles) of each subject as a function of the distance of the subject's sample panel from his matching panel. For purposes of comparison, graphs of subjects who were tested together are placed above and below each other except for Subjects 9 and 10, whose graphs are alongside each other. Determinations at 0 m are based on 8-min rather than 16-min sessions and have been multiplied by 2. The arrows above some points indicate that subject responded at chance accuracy on the matching task for that session. The extra panels on the graphs of S-9 and S-10 show the sessions that these subjects were tested with other subjects who had learned to cooperate (see text).

under the control of a reciprocal reinforcement procedure, cooperative responding should have resulted in higher percentages (correspondence) than individual responding. Although there was an average of 70 to 86% correspondence during the training sessions when each subject responded individually, correspondence increased to 90 to 97% when the subjects began cooperating. Correspondence never dropped below 90% during cooperative responding. On the other hand, upon

the return to individual responding at distances of 3 m and 0 m, correspondence typically dropped below 90% and the grand mean under individual responding did not reach 90% for any subject. Even though correspondence did increase during cooperation, the cooperation procedure may not have been the only source of control. There were also indications of competition during cooperation. First, as mentioned earlier, the audio monitoring revealed

Table 1

Correspondence of the relative frequency of partners' sample-producing responses under cooperative and individual responding. For each pair, the number of sample-producing responses of the subject who made the fewest in a given session was calculated as a percentage of the number of his partner. The numbers in parenthesis indicate the number of sessions at each distance.

Distance to Sample Panel (Meters)	Subjects							
	S1 and S2		S3 and S4		S5 and S6		S7 and S8	
	Coop.	Ind.	Coop.	Ind.	Coop.	Ind.	Coop.	Ind.
0-4.5 (Training)		85.7(4)		86.5(4)		76.3(2)		80.6(4)
6	94.5(8)		90.1(8)		97.6(5)		94.1(6)	
4.5	93.8(8)		96.9(5)		99.4(3)		97.9(4)	
3		87.6(3)		95.1(3)		69.9(5)		92.5(4)
0		93.2(5)		80.7(3)		93.7(5)		82.7(3)
6	92.8(3)		90.3(3)		98.6(3)			
Mean	93.9(19)	89.3(12)	92.2(16)	87.3(10)	98.4(11)	79.8(12)	94.7(14)	82.5(7)

frequent checks concerning each other's score. Frequently for S-1 and S-2, and occasionally for the other subjects, the reported score was an underestimate of the actual score.

Second, there were indications that the subjects responded faster for themselves than for their partner. This is suggested in Figure 3, which summarizes the number of sample-producing responses made by each member of a pair at each distance. The vertical line through each graph separates distances at which subjects cooperated from those where they worked individually. The number of individual responses at 0 m may provide an estimate of the maximum number of cooperative responses at 6 m, since in both cases a sample panel was next to each matching panel. The reciprocal nature of the cooperative responding might be expected to put a limit on cooperative responding because subjects would not be expected to respond faster than the slowest member of the pair. However, Figure 3 reveals that during cooperation at 6 m, only one pair (S-3 and S-4) approximated 100% of the slowest member of the pair at 0 m. The other three pairs ranged from 50 to 75% of the slowest member at 0 m.

Further indication that subjects tended to respond faster when responding for themselves rather than for their partner can be seen in the sample-producing behavior of the subjects who earned the most money at 0 m (individual) and 6 m (cooperation). (A subject had to average at least 5¢ more per session than his

partner to be designated as earning the most money.) For three of the four pairs (S-1 and S-2, S-3 and S-4, S-7 and S-8), the same subject within each pair made the most money at 6 m and 0 m. Although accuracy differences could affect the amount earned, the major factor producing the differences was a higher rate of producing sample stimuli when working individually than when working cooperatively. For example, for two pairs (S-1 and S-2, S-7 and S-8), the subject who made the most money had the lowest number of cooperative responses at 6 m, but the highest number of individual responses at 0 m. For the third pair (S-3 and S-4), the subject who made the most money also had a higher rate of cooperative responses than his partner, but the difference increased during individual responding at 0 m.

EXPERIMENTS IIA AND IIB

As stated earlier, the minimal indications of control by a reciprocal reinforcement procedure appear to be (1) that the cooperative behavior of each subject is under the control of the cooperative behavior of the other subject, (2) that the cooperation procedure increased the correspondence of the relative frequency of responses and/or reinforcers of the two subjects, and (3) that the cooperative responding is maintained by the reinforcer resulting from the cooperation procedure. Increased correspondence was shown in

Experiment I; the following two experiments were intended to clarify the control by the remaining two variables.

That the cooperative behavior of each subject was under the control of the cooperative behavior of his partner was suggested in Ex-

periment I by (1) the several changes from individual to cooperative responding and *vice versa*, which were presumably a function of the cooperative or individual behavior of the partner, and (2) the increased correspondence of the relative frequency of responses of the

Fig. 3. Sample-producing responses of each subject as a function of the distance of the subject's sample panel from his matching panel. Each point is the mean of the last three sessions at a given distance. The unconnected points are the redeterminations. The vertical line through each graph separates distances at which a given pair cooperated from those at which they worked individually. The closed symbols indicate when a subject earned at least 5¢ more per session than his partner.

two subjects during cooperation. However, these indications of social control could have been the result of only one subject being under the control of the cooperative behavior of his partner. For example, the switching to and from cooperative responding by one subject might have resulted from his partner's instructions. Although the phenomenon would appear to be cooperation, the responding would actually be maintained by the consequences of following or not following instructions. Similarly, the increased correspondence could have resulted from only one of the subjects attempting to maintain a response rate similar to the response rate of his partner.

Social control could be evaluated by the systematic removal and representation of each subject into the cooperative situation. Control by the cooperative behavior of the partner would be indicated by an immediate change to individual or cooperative responding upon removal or re-representation of the partner. Changes to individual responding with no errors, *i.e.*, no cooperative responses, upon the removal of the partner would be the best indicator of control because there would be no chance for instructions. Experiment IIA used the above procedures to evaluate social control.

To determine if the money was maintaining the cooperative responding, Experiment IIB arranged for cooperative responding to result in money or the loss of money, depending upon the stimulus conditions. If money was maintaining cooperative responding, this behavior should be maintained when it results in money and decrease when it results in the loss of money.

EXPERIMENT IIA

Subjects and Apparatus

Six, mentally-retarded students from special education classes served as subjects. Four (S-2, S-8, S-5, S-6) had served in Experiment I and two (S-11, S-12) had not. The two new subjects, who were in the same age and IQ range as the others, were given the pre-tests, the training sessions, and then the cooperation test, which was continued until cooperative responding developed.

The experimental apparatus was the same as in Experiment I.

Procedure

Each subject of a pair (S-2 and S-8, S-11 and S-12, S-5 and S-6) was seated at his matching panel with his sample panel 6 m away. All of these subjects had cooperated at this distance. The standard instructions were given, and the subjects were allowed to work for 4 min. Then, the experimenter asked one of the subjects to go into an adjoining classroom. The remaining subject was given the standard instructions except for the section concerning his partner, and then he was allowed to work for 4 min. The sample panels remained at the 6-m distance so that the subject had to walk in order to produce his sample stimulus. The subjects were then interchanged so that the second subject was tested alone. Following these two individual sessions, the subjects were again tested together for 4 min.

RESULTS AND DISCUSSION

If the cooperative behavior of one subject was a social stimulus that exerted control over the cooperative behavior of the other subject, there should have been (1) an immediate change to individual responding upon removal of the partner, and (2) an immediate return to cooperative responding upon the return of the partner. Figure 4 shows that this was the case for five of the six subjects. Upon the removal of the partner, these five subjects left their matching panel, walked to the other end of the room, and produced their own sample stimulus. There were no "cooperative" responses in the absence of the partner. When the partner returned, these five subjects remained seated and produced their partner's sample stimulus. There were no individual responses with the partner present.

Subject 6 differed from the others. She did respond cooperatively when her partner was present: she and her partner each produced 130 to 160 sample stimuli for each other and their accuracy was over 90%. However, when her partner was absent, she initially produced the sample stimulus for her absent partner and made a matching response on her own panel. She then walked the length of the room, produced her own sample stimulus, and started back to her own matching panel, but she stopped midway between the panels and did not move the remainder of the 4-min session. The procedure was repeated twice the

following day with similar results. The fact that she could respond individually as well as cooperatively when her partner was present (Experiment I), suggests that she had been under the control of her partner's instructions, rather than his cooperative responding or the cooperation procedure. This conclusion was supported by the audio-monitoring, which revealed that her partner (S-5) was always the leader and frequently instructed her concerning what response to make and how fast to make it. Thus, the subject's responding was under social control, but the social control did not appear to be a function of the present cooperation procedure.

EXPERIMENT IIB

Subjects and Apparatus

The four subjects (S-8 and S-11, S-1 and S-5) had participated in the previous experiments and had been tested subsequently to determine if they could perform simple addition and subtraction. The apparatus was the same as in previous experiments except for the addition of (1) a counter labelled "lose" mounted on the matching panel (the already existing counter was labelled "win"), and (2) a stimulus light (an ordinary 75-w houselight) that was placed on a desk midway between the two matching panels.

Procedure

The subjects were seated at their matching panels and told that they would win a penny for every point on the "win" counter and that they would lose a penny for every point on the "lose" counter. The session was divided into three parts with the first and third parts lasting 6 min and the second part 4 min. During the first and third parts (designated as the reinforcement condition), the "win" counter was operative and a point was given for every third correct response. During the second part of the session (designated as the punishment condition), the stimulus light was illuminated and each sample-producing response activated the "lose" counter. Since the sample panels were at the 6-m distance, and since all subjects had learned to cooperate, the cooperative sample-producing responses of each subject resulted in the loss of money for his partner. However, each subject could control the

amount he lost because his sample stimulus could not be produced until he had completed the previous matching response. As a result, the elimination of the cooperative sample-producing responses of a given subject could be due to that subject ceasing to emit cooperative responses or his partner ceasing to emit matching responses. However, one subject stopping both cooperative responses and matching responses could not eliminate all sample-producing responses for both members of a pair because the partner could still emit individual or non-cooperative sample-producing responses.

Fig. 4. Cooperative (open circles) and individual responses (closed triangles) of each subject as a function of the presence and absence of their partner. Each subject's sample panel was 6 m from his matching panel.

To evaluate the effect of the stimulus light alone there were two initial sessions with the stimulus light presented during the second part of the session, but with the reinforcement condition in effect.

RESULTS AND DISCUSSION

Figure 5 shows the effect of loss of money upon the rate of sample-producing responses.

Since there were no individual responses, all of the sample-producing responses were cooperative responses. For each session, the rate of cooperative responses has been presented sep-

Fig. 5. Effects of punishment upon the number of cooperative responses per minute of each subject. During the punishment condition, each cooperative sample-producing response subtracted a point from the partner's score, but cooperative sample-producing responses could not be made unless the partner completed the preceding matching response. The sample panel of each subject was 6 m from his matching panel. The graph in the right-hand corner shows the responding of one subject who was also tested individually with his sample panel at arms length (0 m).

arately for the reinforcement condition (circles) and the punishment condition (triangles). Before punishment was introduced, the response rate was about the same during the two stimuli, indicating that the stimulus light alone had little or no effect. When punishment was introduced, the rate of cooperative responding decreased for three of the four subjects. However, one subject (S-5) continued making cooperative responses even though this responding resulted in his partner (S-1) losing more money than he made. Subject 1 could have prevented this loss of money by not making matching responses, but he continued to make them. This raised the possibility that the matching response of S-1 might be under the control of some reinforcer that was more effective than money. One possibility was instructions to respond. Instructions to respond could come from his partner or they could be implicit to the school-type situation. In an attempt to sort out these two possibilities, S-1 was tested without his partner and with his sample panel at arms length (0 m). The results in the lower right corner of Figure 5 reveal only partial control under this individual punishment contingency. It appeared that the continued responding of S-1 did not result from instructions from his partner. The only partial reduction even after six individual sessions with the punishment contingency suggests that the school-type situation may have contained implicit instructions to respond.

GENERAL DISCUSSION

The present cooperation procedure contained three features common to the cooperation procedures observed in the natural setting of humans: the procedure was social; it allowed an alternative, individual response that resulted in the same reinforcer as cooperation; and it allowed deviations from reciprocity during cooperative responding. Hollis (1966, Experiment I) found little cooperation during a cooperation procedure that also allowed deviations from reciprocity and an alternative response. However, that study allowed one day between the responses of the two subjects. The delay may have been critical because the present results revealed that cooperative responding generally developed within a session or two.

Varying the relative response requirement for cooperative and individual responses revealed no bias inherent to individual or cooperative responding; once the subjects learned to cooperate, they ordinarily chose the response with the smaller response requirement. A previous study that provided for both individual and cooperative responses found that the cooperative response was chosen only when it had a smaller response requirement (Mithaug, 1969). In that study, cooperative responding required the subjects to press the correct response key within 0.5 sec of each other, while individual responding required only that a subject press the correct response key. Rather than a preference inherent to individual responding, the preference may have been because the 0.5-sec requirement for coordinated responding was already more difficult than the individual response requirement.

The cooperative behavior in the present study did not appear to be a unitary social process: other social behaviors were observed during cooperation. One that occurred frequently was the questioning between subjects concerning the points each had earned. Another was the leadership observed when the sample panels were moved and one member of a pair was consistently the first to mention the eventual solution. When one behavior occurs during another, the two behaviors may affect each other. For example, preventing the communication and leadership behaviors in the present study might have affected the degree of reciprocity and the speed of acquisition of cooperative responding. However, cooperation has been most frequently studied by manipulating the contingencies applied to the cooperative behavior: cooperative responses have been reinforced, extinguished, punished, and brought under stimulus control. The correlated social behaviors observed in the present study suggest that another approach is to measure the effects of correlated social behaviors upon cooperation.

The importance of testing for control by the cooperation procedure was indicated by the findings that the cooperative-like responses of three subjects (S-10, S-6, S-1) were at least in part under the control of instructions. Instructional control by the partner and instructional control implicit to the situation may be social procedures but they are not cooperation.

Previous studies have also shown that what appears to be cooperative responding may in fact be under the control of individual, non-cooperative procedures (Schmitt and Marwell, 1968; Brotsky and Thomas, 1967; Vogler, 1968). One reason for the absence of tests for the source of control in most cooperation studies is that the subjects make the cooperative response and, therefore, appear to be under the control of the cooperation procedure. The present research suggests that this may not be a safe assumption. A second reason for the absence of such tests may be that cooperation procedures are viewed in the same way as non-social procedures. Some cooperation procedures are non-social in that the subjects are given no indication that they have a partner, e.g., Sidowski, Wyckoff, and Tabor (1956), Sidowski (1957). However, the procedure changes from an individual reinforcement procedure to a reciprocal reinforcement procedure when a partner becomes visible and the experimenter becomes interested in the control by the partner. An increase in cooperative responses may be sufficient to demonstrate control by reinforcement, but it is not sufficient to demonstrate control by a reciprocal reinforcement procedure.

The present criteria and experimental tests were only a beginning in the attempt to demonstrate control by a reciprocal reinforcement procedure. Ideally, tests for social control should show that cooperative behavior is under the control of the cooperative behavior of the partner, rather than the presence of the partner. However, the way to show this depends upon whether or not the cooperation procedure requires the cooperative responses to occur in close temporal contiguity or in a specified order. Consider the well-known procedure of Lindsley (1966) in which the reinforcers of both subjects are dependent upon both subjects pulling their response plungers within 0.5 sec of each other. Both responses are cooperative because both are essential for the reinforcement of the other individual, and there is a specified temporal relationship between the responses. If a subject were under the control of the cooperative behavior of his partner, individual responses, responses not meeting the 0.5-sec criterion for coordinated responding, would be expected to decrease to a near-zero level, leaving only those responses that met the 0.5-sec requirement. To demon-

strate this control for both subjects, the leader-follower requirements would have to be varied so that at times the responses of Subject A had to follow those of Subject B and at other times the responses of Subject B had to follow those of Subject A. It is more difficult to demonstrate that the cooperative behavior of a subject is under the control of the cooperative behavior of his partner in procedures, such as the present one, that do not specify a time or order requirement for the cooperative responses. When subjects are free to make cooperative responses at any time, it is unrealistic to expect subjects to respond in a strict temporal relationship or order so that the cooperative response of one subject is always the stimulus for the next cooperative response of his partner and *vice versa*. It is, however, an easy matter to determine whether or not the cooperative responding of each subject is under the control of the partner as a social stimulus by systematically manipulating the presence and absence of the partner, as was done in the present experiment. Furthermore, the finding that cooperation increased the correspondence of the relative frequency of the responses of the two subjects, taken in conjunction with the finding that the partner was a social stimulus, suggests that the increased correspondence was the result of the subjects being under the control of the cooperative behavior of their partner.

Before separating control by instructions from control by the cooperation procedure, two types of instructions in this study should be distinguished. One type involved a subject describing the cooperation procedure to his partner who then came under the control of the cooperation procedure. This type of instructional "help" does not interfere with control by the cooperation procedure and should be contrasted with instructional control. Instructional control involves a subject describing the cooperation procedure to his partner who remains under the control of instructions and the consequences of following or not following them. Instructional control would appear to rule out the possibility of control by the cooperation procedure. For most subjects, the results of the tests for control by the cooperation procedure indicated that the cooperative behavior was social, reciprocal, and maintained by money; hence, the results of these tests were consistent with

control by the cooperation procedure. Were the results of these tests also consistent with instructional control? It is possible that instructions from the partner or instructions implicit to the school-type situation could have existed during some of the tests. However, if a subject had not learned how to work the task, and responding had been maintained by instructions from his partner, the subject would not have been expected to work the task when his partner was absent. Similarly, if the cooperative behavior had been maintained by the consequences (aversive stimuli) of not following his partner's instructions, increased correspondence would not have been expected. Finally, if instructions that were implicit to the school-type situation had controlled responding, responding would not have been expected to change during the punishment condition. The tests for control by the cooperation procedure were not exhaustive, but it does not seem likely that the results of all three tests would have all been consistent with control by the cooperation procedure if responding had been under instructional control. The elimination of all social interaction (non-social procedures) may be the only way to eliminate the possibility of instructional control.

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