A CLASSIFICATION AND REVIEW OF COOPERATION PROCEDURES¹

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The definition of cooperation allows many procedural variations, as revealed by examination of the cooperation literature which includes procedures differing so greatly that it is surprising that all of them are considered under the same topic. This paper attempts to provide a framework for organizing that literature by (1) indicating some procedural dimensions along which cooperation procedures can be classified, (2) classifying and reviewing briefly the research at the extremes of these procedural dimensions, and (3) indicating the behavioral effects that are necessary to demonstrate control by the various cooperation procedures.

I. DEFINITION OF COOPERATION

The essential aspects of any 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. An increase in cooperative responses is indicative of a cooperation effect. The basic procedural requirements allow considerable variation, as shown by the cooperation literature, in which procedures are included that differ so greatly it is surprising that all of them are considered under the same topic. With deference to such an impression, the present paper indicates some dimensions along which cooperation procedures can be classified, classifies and reviews briefly the research at the extremes of these procedural dimensions, and indicates the behavioral effects that are necessary to demonstrate control by the various cooperation procedures.

II. THE BASIC PROCEDURAL UNIT: AN EPISODE OF COOPERATIVE RESPONDING

The obvious place to begin classifying cooperative procedures is the basic procedural unit that gives the minimal response requirement for reinforcement. This basic procedural unit will be designated as the cooperative episode, and refers to all of the responding, including at least one cooperative response, that is required for the delivery of a reinforcer. A cooperative episode may require responses from both individuals or from only one individual, it may include reinforcement for both or for only one of the individuals, it may include an equitable or an unequitable distribution of work and/or reinforcers, but it must include at least one cooperative response and one reinforcer. Simply, whenever there has been enough responding, including at least one cooperative response, to result in the delivery of a reinforcer, the basic procedural unit has been completed. The definition of cooperation requires the possibility of an equitable distribution of work and/or reinforcers; hence, if an equitable distribution cannot be reached in a single episode, but only over several episodes, time must be allowed for the occurrence of several episodes. The entire time allowed for cooperative episodes to occur will be designated as the cooperation period.

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III. CHOICE AND PERFORMANCE PROCEDURES

All cooperation research can be placed into two major categories, which will be designated as performance procedures and choice procedures. Performance procedures measure the behavior that occurs during the carrying out of a cooperative solution or, in other words, the cooperative behavior itself. On the other hand, the choice procedures measure only the selection of a solution: they do not measure the behavior required to carry out a solution. In choice procedures, such as the Prisoner's Dilemma game (see review by Nemeth, 1970), there are several alternative solutions to choose from, including one in which reinforcers are equally distributed (cooperation) and one in which reinforcers are unequally distributed (competition). This paper is concerned with classification of procedures that measure the behavior that occurs during the actual carrying out of a cooperative solution, and thus deals with performance procedures.

Experiments can include both choice and performance procedures. For example, the recent experiments of Schmitt and Marwell (1971a, 1971b) included a choice procedure in that the choice of a cooperative or individual solution to a task was measured. The experiments included a performance procedure in that the behavior that was necessary to complete the cooperative solution was also measured. The cooperative solution required first that one subject pull his plunger and produce a 3-sec stimulus light, and then that the other subject pull his plunger within 0.5 sec after termination of the stimulus; when this performance occurred, the behavior of both subjects was reinforced. For individual responding, only a single pull of the plunger was reinforced. Whenever an experiment, such as the above, includes objective measurement of both choice and performance, that procedure will be categorized under performance procedure.

IV. PROCEDURAL DIMENSIONS ALONG WHICH PERFORMANCE PROCEDURES CAN BE CLASSIFIED

A. Dependency upon Behavior of Partner for Reinforcement

1. *Interdependent cooperation procedures.* In any cooperation procedure, the reinforcers

of each individual must be at least in part dependent upon the responses of the partner, but the extent of this dependency can vary. At one end of the continuum, an individual's reinforcers can be largely dependent upon his own behavior and only slightly dependent upon the behavior of his partner. At the other end of the continuum, an individual's reinforcers can be largely or even completely dependent upon the behavior of his partner. Whenever the responses of both individuals are necessary for, or can affect, the reinforcers of one individual, the cooperation procedure will be designated as interdependent. On the other hand, when the reinforcers of a given individual are completely dependent upon the responses of the partner, the cooperation procedure will be designated as dependent. All of the cooperation studies under the performance procedure are classified as either interdependent or dependent in Table 1. Table 1 also classifies these studies at one of the two extremes of three other procedural dimensions discussed in this paper. The table is organized into an ordered arrangement of the 12 logically possible combinations of these classifications (out of 16 possible), thereby allowing the studies to be further classified under one of the 12 combinations.

Rosenberg and Hall (1958) and Rosenberg (1959, 1960) used a cooperation procedure that varied the extent to which each subject's reinforcers were dependent upon the responses of a partner. For example, the cooperation procedure was interdependent when both subjects' reinforcers depended on the number of times both subjects turned their response dials. At times, a high percentage of a subject's own dial turns, but only a small percentage of his partner's, counted toward his response requirement for reinforcement. Hence, the reinforcers of a given subject were largely dependent upon his own responses. At other times, the percentages were reversed so that the reinforcers depended more on the responses of his partner than on his own responses. And, finally the procedure was dependent when each subject's reinforcers were entirely dependent upon the partner's responses.

In the preceding interdependent cooperation procedures, both subjects responded by turning a dial. In everyday life, however, interdependent cooperation frequently consists of different responses by each of the individ-

Table 1

Classification of cooperation studies under one of the two classifications on each of the four procedural dimensions, and under one of the twelve logically possible combinations of the classifications.

Procedural Dimensions				Studies	Subjects
(1)	(2)	(3)	(4)		
INTERDEPENDENT	RESPONSE SHARING	NONSOCIAL	FORCED	Lindsley (1966)	Children, Adults
			ALT. RESP.	No Studies	
		SOCIAL	FORCED	Cohen (1962): Lindsley (1966)	Children, Adults
				Azrin & Lindsley (1956): Brotsky & Thomas (1967): Vogler (1968): Nelson & Madsen (1969): Stewart, Zelman & Mithaug (1971)	Children
				Schmitt & Marwell (1968)	College Students
				Hollis (1966)	Retarded Children
				Hingtgen & Trost (1966)	Autistic Children
				Peters & Murphree (1954) King, Armitage & Tilton (1960)	Mental Patients
	Crawford (1941)	Chimpanzees			
	ALT. RESP.	Schmitt & Marwell (1971 a & b) Marwell, Schmitt & Shotola (1971)	College Students		
		Mithaug & Burgess (1967, 1968): Mithaug (1969)	Children		
		RESPONSE EXCHANGE	NONSOCIAL	FORCED	Rosenberg & Hall (1958): Rosenberg (1959, 1960)
ALT. RESP.				No Studies	
DEPENDENT	RESPONSE EXCHANGE	SOCIAL	FORCED	Rosenberg (1963)	College Students
				Weingold & Webster (1964) Hingtgen, Sanders & DeMyer (1965)	Children Autistic Children
				Boren (1966)	Macaque Monkeys
				Daniel (1942, 1943): Taylor & Erspamer (1971)	Rats
		ALT. RESP.	Hake & Vukelich (unpublished)	Retarded Patients	
		NONSOCIAL	FORCED	Sidowski, Wyckoff & Tabory (1956): Sidowski (1957)	College Students
				Rosenberg & Hall (1958): Rosenberg (1959,1960)	Air Force Trainees
			ALT. RESP.	No Studies	
	SOCIAL		FORCED	Sidowski (1957)	College Students
		Hollis (1966)		Retarded Children	
		Boren (1966)		Macaque Monkeys	
		ALT. RESP.		Hollis (1966)	Retarded Children

Note. Procedural dimensions and classifications at the extremes of each dimension
 (1) Dependency on partner for reinforcement: Interdependent or Dependent
 (2) Deviations from reciprocity: Response Sharing or Response Exchange
 (3) Partner as social stimulus: Non-Social or Social
 (4) Alternative non-cooperative response: Forced or Alternative Response

Of the 16 possible combinations of classifications, only 12 are logically possible. A response-sharing procedure by definition cannot involve a dependent procedure thereby eliminating 4 combinations. A given study may appear under more than one of the twelve combinations since it may have included more than one of the procedural combinations.

uals because it is often necessary or more convenient for the individuals to work on different parts of the response requirement. Consider, for example, the work of a local lawn-mowing service. One worker operates the mower while another worker trims the yard and rakes the cut grass. Each worker responds differently; together, they efficiently complete the requirement for reinforcement. The classic procedure of Daniel (1942, 1943) is an example of an interdependent cooperation procedure in which the subjects (rats) made different responses. During an episode of cooperative responding, one rat terminated aversive grid-shock by sitting on a platform while a second rat ate from a food bowl placed on the grid floor. The procedure was interdependent in that the responding of both rats was required for an episode of cooperative responding.

Nor does the cooperation procedure have to be the same for both members of a partnership. For example, the reinforcers of one individual can be completely dependent upon the responses of his partner, while the reinforcers of the partner are dependent upon the responses of both individuals. This procedure may be called an asymmetrical cooperation procedure. Similarly, the procedure for a given individual can change from dependent to interdependent from one episode of cooperative responding to the next.

2. *Dependent cooperation procedure.* Few studies have made a subject's reinforcers entirely dependent upon the responses of his partner (see Table 1). Boren (1966) required one monkey to press a lever 32 times to deliver a reinforcer to a partner, another monkey visible in an adjacent chamber. Similarly, the first monkey received a reinforcer only when the partner reciprocated by pressing a lever 32 times. In the studies of Sidowski, Wyckoff, and Tabor (1956) and Sidowski (1957) college students received points only when their partners pressed a particular button. Each subject had two response buttons; the operation of one delivered points to the partner and the operation of the other delivered shocks to the partner.

B. Deviations from Reciprocity

1. *Response-sharing procedure.* As used here, reciprocity refers to an equal distribution of responses and reinforcers between two participants on a given episode of cooperative

responding or over an entire period of cooperation. Deviations from reciprocity, therefore, will refer to inequities in the distribution of responses and/or reinforcers on an episode of cooperative responding or over an entire cooperation period. Since reciprocity is defined as an equal distribution of responses and reinforcers, reciprocity on each episode of cooperative responding can occur only in an interdependent cooperation procedure that requires the same response from and delivers the same reinforcer to each partner in each cooperative episode. Procedures that require reciprocity on each episode of cooperative responding will be designated as response sharing. As an example of a response-sharing procedure from everyday life, consider two individuals who have the assignment of carrying heavy barrels from one place to another. The barrels are so heavy that both individuals are necessary to carry one. In this example, there is an interdependent cooperation contingency in which both individuals make the same response and both receive the same reinforcers.

A response-sharing procedure frequently used in the laboratory is that of Cohen (1962) and Lindsley (1966), which is a modified version of Azrin and Lindsley (1956), and Skinner (1953, p. 306). (See Table 1 for other response-sharing procedures.) Under the basic Lindsley (1966) procedure, two subjects visible to each other through a window between their compartments, each receive a reinforcer when they pull their response plungers within 0.5 sec of each other. Since each episode results in reciprocity, in terms of both the workload and the distribution of reinforcers, the procedure may be designated as response sharing.

2. *Response-exchange procedures.* Procedures that do not require an equitable distribution of reinforcers or responses during an episode of cooperative responding will be designated response-exchange procedures. Since reciprocity is not required, the cooperation procedure can be dependent or interdependent (see Table 1), either one or both of the individuals can receive reinforcers during any given episode, and deviations from reciprocity can be in terms of the responses or reinforcers. Reciprocity, of course, is still possible under these procedures, but it requires responses and reinforcers to be equalized over the period of cooperation, rather than during a cooperative

episode as in response sharing. In actuality, such a procedure is not unusual and one form might be characterized as: "I will do the work this time, you do it next." Thus, a man who mows his neighbor's lawn is probably not behaving altruistically; rather, he is probably responding as a result of a previous history in which the two individuals have exchanged cooperative episodes under a response-exchange procedure.

Response-exchange procedures have varied in the extent to which they allow deviations from reciprocity. Some are similar to the response-sharing procedure in that deviations are severely limited. For example, Hingtgen, Sanders, and DeMyer (1965) used an interdependent cooperation procedure in which an episode of cooperative responding consisted of one subject activating the apparatus of his partner who could then respond and produce a reinforcer for himself. The procedure was response exchange in that cooperative episodes resulted in deviations from reciprocity, but because strict alternation of cooperative episodes was required, the duration and extent of these deviations was severely limited. In another experiment, Hollis (1966, Experiment 2) studied the cooperative behavior of retarded children using a Wisconsin General Test Apparatus (WGTA) modified for use with two subjects. Each session consisted of 24, 1-min trials during which each subject could pull a handle to extend a baited cart to his partner. The extent of the deviations from reciprocity was restricted by the limit put on the absolute number (24) of cooperative episodes of each subject during each session. This "trials" procedure can be contrasted to the free operant procedure of Boren (1966, second procedure), where no limits were placed upon the rate of cooperative episodes or the deviations from reciprocity. In that dependent cooperation procedure, the fixed-ratio responding of one monkey resulted in reinforcement for the other and *vice versa*.

Hollis (1966) and Boren (1966) used dependent cooperation procedures in which cooperative episodes deviated from reciprocity in terms of the distribution of both the workload and the reinforcers. Dependent cooperation procedures can also be arranged so that only the workload deviates from reciprocity during a cooperative episode. For example, Hollis (1966, Experiment I) altered the WGTA to

allow each subject the choice between delivering a baited cart only to himself, or working the task cooperatively by extending two baited carts, one to his partner and one to himself. (On alternate sessions, his partner had the same choice.) In this procedure, the only deviation from reciprocity during a cooperative episode was in the workload.

Interdependent cooperation procedures can also allow deviations from reciprocity (see Table 1). Large deviations are especially possible when the procedure allows only one subject to receive reinforcers on each cooperative episode. For example, in Daniel's (1942, 1943) procedure, one rat sat on a platform, thereby terminating grid shock and allowing the other rat to stand on the grid and eat from the food bowl. Since only one rat could eat without being shocked, there could be large deviations from reciprocity on each cooperative episode. And, since this was a free operant study, there were no limits upon the extent of the deviations, allowing the possibility of only one rat obtaining food during a session. Deviations from reciprocity can also result when an episode of interdependent cooperative responding produces reinforcers for both subjects. For example, the reinforcers could differ for subjects on each episode in Rosenberg's (1963) procedure, where the reinforcers were a function of the number of dial turns made by each subject. For a given subject, a percentage of his own responses (*e.g.*, 60%) and a percentage of his partner's responses (*e.g.*, 40%) counted in determining his reinforcers. When these same percentages were in effect for the partner, there could be deviations from reciprocity whenever the subjects turned their dials a different number of times on a cooperative episode.

C. The Partner as a Social Stimulus

1. *Non-social procedures.* In non-social procedures, precautions are taken to prevent subjects from learning that the reinforcers delivered to them are at least in part dependent upon the responses of another subject or that there is another subject in the experiment. The rationale is that the main factors controlling social behavior are the laws of conditioning for individual subjects, rather than the complex variables introduced by social interaction. Sidowski, Wyckoff, and Tabor (1956) and Sidowski (1957) assumed the major factors

controlling social behavior to be reward and punishment. Sidowski described the essential features of the social situation as follows: "(a) Two or more subjects have at their disposal responses which result in rewarding or punishing effects on other subject. (b) The principal sources of reward and punishment for any subject depend on responses made by the other subject. (c) The responses controlling reward and punishment are subject to learning. It will be assumed that whatever else may be involved, at least the above features are present in any social situation" (Sidowski, 1957, p. 318). In one study, subjects were divided into an "informed" group, in which the subjects were told that another subject was serving in the experiment, or an "uninformed" group, in which subjects were not told that they were in a social situation. The two members of a pair were tested at the same time but in separate rooms, in which the only sources of interaction were two buttons. Depending upon their subgroup and which button was pressed, they could give each other points, points or shock, or shock alone. When the subjects could give each other points, or points or shock, cooperative responses increased over time: subjects soon learned to press the button that delivered points to their partners, regardless of whether they even knew they had a partner.

2. *Social procedures.* Under social cooperation procedures, the subjects are typically tested in full view of one another, and are either told about the social relationship or presumably learn it. Such procedures are considered important because (1) cooperative behavior is observed to occur under similar conditions in everyday life and, (2) social stimuli may produce behavioral changes that are not easily produced under non-social procedures or explained by the laws of conditioning for individual subjects.

In any social situation, it is difficult to separate the social stimuli that are affecting behavior from non-social stimuli that may be simultaneously affecting the behavior. Many studies of social cooperation ignore the possible effects of non-social stimuli and assume that the existence of cooperative responding indicates behavioral control by the social relationship. This, of course, is in direct contrast to the work of Sidowski (1957) discussed in the previous section.

Behavioral changes that are attributable exclusively to social stimuli have been called "social emergents" and are considered of utmost importance in social psychology (Lindsley, 1963, 1966). For example, social facilitation (an increase in a behavior of one individual as a result of the presence of another individual) is, by definition, a basic social emergent. Studies concerned with the social facilitation of feeding, the response most frequently studied, have shown that the increase in behavior cannot be attributed to non-social mechanical stimuli, such as the activation of the co-actor's food tray (e.g., Hake and Laws, 1967; Hake, Powell, and Olsen, 1969).

Few studies have isolated social emergents effectively enough to evaluate their effect upon cooperative behavior. In a classic study, Lindsley (1966) compared cooperative behavior under several social and non-social conditions. Subjects were placed in individual experimental chambers, and each chamber contained lights and buzzers that signalled responses and/or the delivery of reinforcers. In addition, the experimenter could uncover a transparent partition between the chambers and thus permit the subjects to observe each other. A cooperative episode was defined as either subject pulling a response plunger within 0.5 sec of the other. The order in which the subjects were required to respond, designated as a leadership requirement, could be varied so that either Subject A or Subject B might be required to respond first and thereby be the leader. The subject could be tested under three basic conditions:

(1) Non-social, in which the partition was covered and the only information available came from the lights and buzzers.

(2) Social, in which the partition was uncovered and the subjects could see and signal each other, as well as use the information available from the lights and buzzers.

(3) "Quasi-social", in which subjects were first exposed to the social condition and then tested on the non-social condition. The term quasi-social is ours and is used to indicate mechanical stimuli such as lights and sounds which, due to previous experience or instructions, are known to be produced by another individual. The quasi-social stimuli in this experiment are comparable to some mechanical stimuli seen in everyday life such as signs,

letters, and porch lights. Quasi-social stimuli are included in Lindsley's (1963, 1966) term social connotation, but social connotation also appears to include social stimuli (*e.g.*, Lindsley, 1966).

Although cooperative responding was learned under non-social conditions, learning was faster under both the social and quasi-social conditions. In addition, when the social and quasi-social conditions were compared, it was found that the sight of the partner influenced the determination of who was to be the leader.

D. Alternative non-cooperative responses

1. *Forced cooperation.* Cooperation procedures that do not allow an alternative non-cooperative response that will produce the same reinforcer as the cooperative response will be designated as "forced" cooperation, because the only alternative to cooperation is doing without the reinforcer. As shown in Table 1, most cooperation research under the performance procedure has involved forced cooperation.

2. *Alternative-response procedures.* Cooperation procedures can involve both choice and performance procedures, as is the case when the same reinforcer can be obtained by either cooperative or non-cooperative responses. This is frequently the arrangement in daily life, when individuals cannot depend upon the availability of a cooperative partner. Mithaug (1969) reported one of the few studies in which an alternative, non-cooperative response produced the same reinforcer as the cooperative response. A cooperative episode involved a response-sharing procedure in which each of the three subjects was required to pick the correct response key from among 14 possibilities, and then respond within 0.5 sec of the others. Once the correct key was found, the subjects could continue responding throughout each 30-sec trial. Alternative, non-cooperative responses were simply individual responses that did not meet the 0.5-sec requirement for coordinated responding but were effective in producing the same reinforcer. Subjects typically chose the individual response, but preference could be shifted from individual to cooperative responding by raising the number of individual responses required for reinforcement.

Hake and Vukelich (unpublished study) also provided individual and cooperative solu-

tions for subjects who were each working matching-to-sample problems. For each subject, reinforcement was contingent upon responses on each of two different panels. The first response, on one panel, was a button press that produced a sample stimulus on that panel. The second response, on the other panel, was the pressing of the button corresponding to the matching stimulus on this panel. Each subject had both a sample panel and a matching panel. The matching panels of the two subjects were located at opposite ends of the room 6 m apart, but a subject's sample panel could be placed at different distances from his matching panel. As long as each subject's sample panel was next to his matching panel, subjects worked the problems individually. However, when the sample panel of Subject A was next to the matching panel of Subject B, and the sample panel of Subject B was next to the matching panel of Subject A, the subjects produced the sample stimuli for each other and then made the matching response for themselves. In order to work the matching task individually, subjects would have had to walk the length of the room, produce their own sample stimulus, and then return to their matching panel to make the matching response. The relative response requirement for individual and cooperative solutions could be varied by systematically manipulating the distance of each subject's sample panel from his response panel, *e.g.*, the sample panels of both subjects could be placed in the middle of the room or at any proportion of the distance to the other subject. The subjects always selected whichever solution involved the least amount of walking.

Alternative responses can take many forms and more than one may be available in a cooperative procedure. In the Prisoner's Dilemma game, as well as other game-playing (typically choice) procedures, subjects can make competitive as well as cooperative responses. Schmitt and Marwell (1971a), using a performance procedure, allowed their subjects to select cooperative or individual solutions. A third alternative, taking points away from the partner, was permitted when a special light was illuminated. The subjects generally chose to avoid the stimulus for taking by selecting the solution, cooperative or individual, during which this stimulus was presented least often. Obviously, the inclusion of alterna-

tive responses such as these, or others, can drastically affect the probability of cooperative responding.

V. DEMONSTRATION OF CONTROL BY THE COOPERATION PROCEDURE

The essential aspects of any cooperation procedure are that the reinforcers of both individuals be at least in part dependent upon the responses of the other individual, and that the procedure allows such responses, designated as cooperative responses, to result in an equitable division of reinforcers and responses. The essential aspect of a cooperation effect is an increase in cooperative responses. However, as with other behavioral phenomena, the mere increase in a given behavior does not necessarily indicate that the behavior was under the control of the procedure. For example, if the rate of a response increases when it has been consistently followed by the delivery of a stimulus, this does not necessarily mean that the stimulus meets the definition of an operant reinforcer. To conform to this definition, the increase must be due to the specified operant procedure, rather than elicited effects of the stimulus, another reinforcer, or another procedure. Several studies of cooperation have been weakened because they failed to demonstrate that the observed cooperative-like behavior was actually under control of the cooperation procedure rather than some other social or individual procedure. A reciprocal reinforcement procedure is more complex than reinforcement with only one individual; consequently, it is more difficult to show that cooperative-like behavior is under the control of the cooperation procedure. Demonstration of control by a cooperation procedure requires demonstration of control by (a) the reinforcer resulting from the cooperation procedure and (b) the specified procedural relation between responses and reinforcers.

A. Control by the reinforcer resulting from the cooperation procedure

If cooperative-like responding is under the control of the cooperation procedure, that responding should be maintained by the reinforcer resulting from the cooperation procedure, rather than by any other reinforcer. For example, consider Taylor and Erspamer's

(1971) study, in which two rats separated by a hardware cloth partition "cooperated" for food reinforcement. The two rats were connected by a string that passed through holes at the back of the experimental chamber, and that was long enough so that only one rat at a time could be at the front of the chamber where the food trays were located. The cooperative response of going to the back of the chamber could have been produced by several factors in addition to the food reinforcement: cooperative-like responses could have been maintained by avoidance of the discomfort resulting from the "hungrier" rat pulling on the string, or one rat could have been literally dragged to the back of the chamber by the pulling of the "hungrier" rat. The question is whether the cooperative-like responding was maintained by food reinforcement, by an individual avoidance procedure, or simply by the other animal's food responses. In the latter two cases, going to the back of the chamber could not be considered cooperative.

Demonstration of control by the reinforcer produced by cooperation would appear to be particularly important in studies using human subjects and allowing verbal interaction between them. Is the cooperative-like responding of a given subject maintained by instructions from the partner and the possible negative consequences of not following the instructions? In such a case, the cooperative-like behavior of the subject would be maintained at least in part because following instructions avoids aversive consequences.

B. Control by the specified procedural relation between responses and reinforcers

In single-subject experiments, control by the procedural relationship between responses and reinforcers is indicated by an increasing correspondence between the observed responses and reinforcers and the procedural requirement between responses and reinforcers. For example, in complex individual procedures such as the fixed-interval schedule of reinforcement, not only does the rate of responding gradually increase, but there is also a gradually increasing correspondence between the observed responses and the response requirement, *i.e.*, a higher percentage of responses occur near the end of the fixed-interval where responding is reinforced. The manner in which procedural control is demonstrated for

cooperation depends upon whether cooperation is considered under a social or a non-social procedure. First, consider cooperation as a social process where the procedural relationship between responses and reinforcers is reciprocal reinforcement. The best 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 numerical correspondence between the responses and/or the reinforcers of the two subjects. These two types of control would be indicative of the social and reciprocal nature of the cooperative behavior.

The way to show that the cooperative behavior of each subject is under the control of the cooperative behavior of his partner will depend upon whether both (*e.g.*, interdependent, response sharing) or only one (*e.g.*, dependent) of the subjects make a cooperative response during each episode of cooperative responding. As an example of an interdependent, response-sharing procedure, consider the procedure of Lindsley (1966) and Cohen (1962) in which the reinforcers of both subjects were dependent upon the subjects pulling their response plungers within 0.5 sec of each other. Under this procedure, the question is whether the resulting high rates of cooperative-like responding are under the control of the cooperative behavior of the partner or are under the control of an individual, high-rate contingency. For example, a steady response rate of 120 responses per minute by each subject would result in many reinforced or cooperative-like responses. If the responding were under the control of an individual high-rate contingency, individual responses that did not meet the 0.5-sec criterion for coordinated responding would be expected to increase and to be maintained along with responses meeting the 0.5-sec criterion (Brotsky and Thomas, 1967; Vogler, 1968; Schmitt and Marwell, 1968). On the other hand, if a subject were under the control of the cooperative behavior of his partner, individual responses would be expected to decrease to a near-zero level, leaving only those responses that met the 0.5-sec requirement for cooperative responses. To demonstrate this type of social 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 dependent cooperation procedures. It is simply unrealistic to expect that subjects will always respond in strict alternation such that the cooperative response of one subject is always the stimulus for the next cooperative response of his partner. For example, consider two cooperative neighbors exchanging favors. There may be instances in which neighbor A might do several favors for neighbor B before neighbor B reciprocates. The neighbors may not pay back the favors after each cooperative response; rather, as in this example, reciprocity would be reached over a period of time or over several cooperative responses. In an experimental setting, however, it would be an easy matter to determine whether or not the cooperative responding of each subject was under the control of the partner as a social stimulus by systematically manipulating the presence and absence of each subject. Control by the partner as a social stimulus would be indicated if (1) a subject stopped responding and/or switched to individual responding immediately upon the removal of his partner from the situation and (2) resumed cooperative responding upon the return of the partner. Control by the actual cooperative responding of the partner would be more difficult to demonstrate because it would necessitate leaving both subjects in the situation and providing the reinforcers of Subject A at the usual rate, even though Subject B had stopped responding. Then, if Subject A also stopped responding, it would indicate that his cooperative responding was under the control of the cooperative responding of Subject B.

The reciprocal nature of cooperative behavior would be indicated (1) when the correspondence between the number of reinforcers and/or responses of the two subjects is higher during cooperation than during an individual responding procedure (Hake and Vukelich, unpublished study) or (2) when the correspondence is higher after cooperative responding has stabilized than at the introduction of the cooperation procedure. It would be difficult to make a case for control by a reciprocal aspect of a cooperation procedure for procedures

(response sharing) that never allow deviations from reciprocity.

Non-social cooperation procedures attempt to prevent the subjects from learning that the reinforcers delivered to them are at least in part dependent upon responses of a partner or that there is another subject in the experiment. As a result, the cooperative behavior of both subjects should be under the control of the laws of conditioning for individual subjects, rather than the social nature of the procedure. Control by the laws of conditioning for individual subjects would be indicated (1) by showing that each subject learned to respond in such a way as to maximize his probability of reinforcement and (2) by showing that the rate of cooperative responding and/or other choices was a function of the rate of reinforcement scheduled for those responses by the partner (see Sidowski, 1957).

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