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CATALYSIS OF CONTROLLED LEADERSHIP IN COOPERATION BY HUMAN STIMULATION*

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OVER the past 30 years, free-operant conditioning techniques have been developed for investigating the behavior of individuals in fully controlled experimental environments (Skinner, 1938, 1959). Typically, a subject is comfortably seated in a small room. He faces a lever or similar device which he can operate at any time during the experimental session. Reinforcers (i.e., rewards such as candies or coins) are automatically presented to the subject when he operates the lever. The only stimuli present are those relevant to the experiment and controlled by the experimenter. The subject's responses (pulling the lever) are automatically recorded. Operant techniques have been modified and refined for application to a wide variety of normal and pathological behaviors.

Recently an operant conditioning procedure has been developed for studying interactions between two people. Social variables can be introduced and removed from the experimental environment without also changing other aspects of the situation (Lindsley, 1961). Social behavior can therefore be clearly differentiated from individual behavior. Ongoing social and asocial behaviors are continuously and automatically measured, and the effects of changes in the situation can be functionally analyzed.

The method has been used to study leadership, co-operation, and competition in two-person teams (Lindsley, 1961). It has proved sensitive to extra-experimental social variables (Cohen, 1962) and stable in test-retest studies with long experimental interruptions (Lindsley and Cohen, 1963).

In this paper, we demonstrate that human discriminative stimuli catalyze a team's acquisition of differentially reinforced leadership in co-operation. This is related to the historical problem of "social emergents". Hunter (1919) questioned whether social and individual behavior could be treated within the same conceptual framework. Keller and Schoenfeld (1950) and Skinner (1953) suggested that no new principles are exemplified in the interaction between persons that are not also demonstrated in manipulation of the environment by an individual person. On the other hand, Triplett (1897), Simmel (1921), and Köhler (1947) proposed that there are uniquely social phenomena. The catalytic effect of human stimuli on the acquisition of co-operation is an experimental demonstration of a socially emergent phenomenon.

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METHOD

Subjects

Fourteen subjects were used in seven two-person teams. Eight subjects (seven male) were university students, 18 to 28 years old, hired through a university employment office for 'short term jobs'. Four were 11 to 13 year old boys, selected from a group of approximately 100 volunteers from a local parochial school. Two subjects were husband and wife, both about 50 years old.

For experiments in which social connotation is introduced after the start of the experimental session, it is necessary to select team-mates from different populations, guarantee that neither team-mate knows of the other's participation in the experiments, and have the subjects report to the laboratory at different times. For experiments consisting of more than one experimental session, extra-experimental contact is further prevented by conducting the subjects from the experimental rooms separately and having them leave the laboratory at different times. As a further precaution, the subjects are asked about their extra-experimental activities on the experimental days, and, at the end of the experiment, whether they knew the other person.

Apparatus

Two six-by-six foot rooms, each fitted with an operant conditioning panel (Lindsley, 1956), are separated by a sound-attenuated wall with a plexiglass window (Fig. 1). Each operant panel includes a plunger-type operandum which the subject can pull and a tray into which reinforcers, in this case pennies, are dispensed when the subject and his team-mate have made appropriate responses (see below). For a detailed description of the apparatus and methodology, see Lindsley (1961) or Cohen (1962).

The window can be blocked with a sliding partition. On each side of the partition are two discriminative stimuli: a red light which flashes when the person in the other room pulls his plunger, and a white light which brightens throughout the 5 sec reinforcement cycle when the person in the other room receives a penny. As diagrammed in Fig. 1, two positions of the partition were used in this experiment: the subjects could see the response and reinforcement signal lights but not each other (L^2), or the subjects could see the lights and also see each other through the window (HL^2). Other arrangements of the discriminative stimuli have been previously described (Lindsley, 1961):

White masking noise was maintained loud enough to prevent subjects from hearing either each other or the operating sound of the apparatus.

Response definition

In our experiments, team-mates are designated as subjects *A* and *B*. As shown in Fig. 2, two successive responses by subject *A*—uninterrupted by a response by *B*—are automatically classified by a switching circuit as an AA individual response pair. Two successive responses by subject *B* are classified as a BB individual response pair.

Team responses require participation of both subjects. When subject *A* makes a response and subject *B* follows with a response, the response pair is classified as an AB team response. When *B* leads and *A* follows, the response pair is classified as a BA team response.

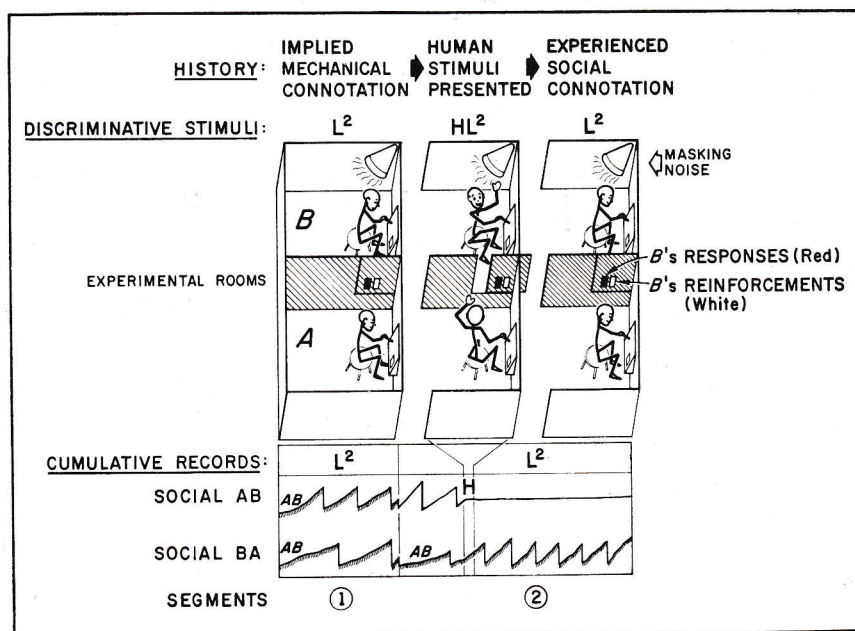


FIG. 1. Experienced social connotation can be introduced into a situation with prior implied mechanical connotation by briefly presenting the human stimulation (H). For each subject, the discriminative stimuli can be either mechanical lights alone (L^2) programmed by the other person, or the view of the other person in addition to these socially programmed lights (HL^2). Adding H to L^2 yields HL^2 . The effects of adding human discriminative stimuli during co-operation are recorded on cumulative recorders which operate throughout the experimental session. Schematic cumulative records for the social team responses show the catalytic effect of human stimulation.

Each team response is further classified as social (SOC) if the A and B responses occur within 0.5 sec of one another, or nonsocial (NON-SOC) if more than 0.5 sec elapses between them. Thus, if A responds and B follows within 0.5 sec the team response is classified as a SOC AB. If B does not respond until 0.5 sec elapses, it is classified as a NON-SOC AB. Similarly, if B responds and A follows within 0.5 sec, the team response is classified as a SOC BA. If A does not respond within the 0.5 sec time limit, it is classified as a NON-SOC BA.

Using our own descriptive terminology (Lindsley, 1963), the AB and BA team responses are joint responses. The faster team responses (SOC) require stimulation from the other individual for accurate timing and represent simultaneous bi-directional social behavior. The slower team responses (NON-SOC) do not require cross-stimulation for high rates of emission and therefore represent pseudo-social grouping.

Reinforcement

When reinforcement is programmed for both SOC AB and SOC BA responses, *leadership is uncontrolled*. Regardless of which team-mate leads, as long as the other follows within 0.5 sec both are reinforced with a penny. The follower may be

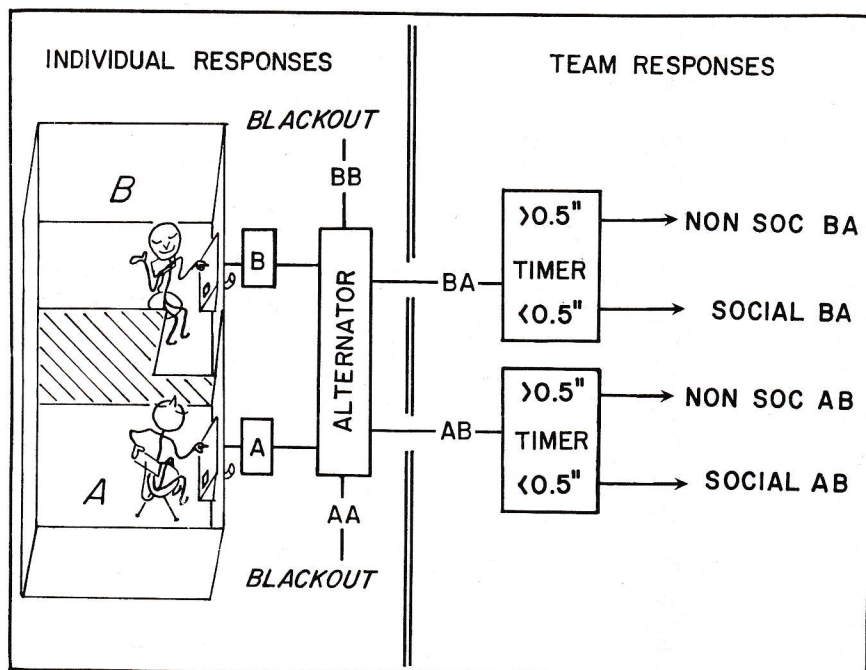


FIG. 2. Response definition for bidirectional social behavior, in which each member of the team must respond to the other in order to maintain the social behavior. Sequential pairs of plunger pulls are defined as individual responses (*A* twice in a row, AA; *B* twice in a row, BB) or team responses (*A* leading *B*, AB; *B* leading *A*, BA). Team responses are further classified by a timer as social (follower responds within 0.5 sec after leader) or nonsocial (following response comes after 0.5 sec).

responding solely to the red light activated by his team-mate's response (L^2) or to the sight of his team-mate responding as well (HL^2).

During *controlled leadership*, both team-mates are reinforced only for co-operative social responses led by *A* (SOC AB) or only for co-operative social responses led by *B* (SOC BA).

In both controlled and uncontrolled leadership, each individual is reinforced at the same time as his team-mate with an event available to himself only and not to the other member of the team.

Each time an appropriate social team response occurs, a small white light illuminates the reinforcement tray in each room and a penny drops into each tray. During the 5 sec reinforcement cycle, the lights in the experimental rooms are dimmed. The change in room and tray lighting was designed as conditioned positive reinforcement to accentuate the presentation of the penny.

In this experiment, nonsocial team responses (NON-SOC AB and NON-SOC BA) are extinguished (i.e., never reinforced). Individual responses (AA and BB) are punished with a 2.5 sec total blackout (see Ferster, 1958) in the room of the subject who responds twice in succession. During a blackout, a 500 cycle tone is sounded over a speaker in the subject's room.

Response recording

During each session, individual response pairs (AA and BB) are automatically recorded as pips on two separate event recorders that run continuously.

Team responses (SOC AB, SOC BA, NON-SOC AB, NON-SOC BA) are automatically and continuously recorded on four separate cumulative recorders. In cumulative recording, the paper moves at a constant speed, while a pen moves up the paper one small step with each response. Thus, the higher the emission rate of a particular team response, the steeper the line on the appropriate record. Periods in which a team response does not occur, appear as a horizontal line on the record for that team response. The pen on a recorder automatically drops back to the base-line after 500 responses have been recorded.

Changes in experimental conditions are marked on the cumulative records as numbered segments. The vertical lines drawn through the cumulative response records in Figs. 3–8 indicate the points in the continuous experimental sessions at which an experimental condition was changed. The circled segment numbers at the bottom of each figure thus refer to the temporal order of environmental changes. These successive segments within each session are referred to by both figure and segment number. In Fig. 3, the first segment is segment 3–1; the third segment of Fig. 5 is segment 5–3; and so on.

The cumulative recorders are reset between segments (no matter how many responses were recorded in the previous segment). The discriminative stimuli (DISC. STIM.) for each segment are indicated as L^2 (mechanical lights alone) or HL^2 (human stimulation in addition to the lights). When both *A* and *B* are rewarded for a social response, *AB* above the cumulative record for that social response during that segment indicates this. Cumulative records over which *AB* is not written are programmed for extinction—neither subject is reinforced. Thus, *AB* merely indicates that both subjects are simultaneously reinforced; the leader is indicated by the label for the response: SOC AB (*A*—leading) or SOC BA (*B*—leading).

If the recorders are reset and new segments started for very brief presentations of human stimuli, the changes in response rate are not clearly seen. For this reason, brief presentations of human stimuli (*H*) during L^2 segments (see segments 4–3 and 4–4) are marked on the records with vertical lines indicating the approximate duration of time human stimuli were present in addition to the mechanical stimuli.* Thus, during the very brief presentations of *H*, the discriminative stimuli arrangement is the same as during the first segment in Fig. 8 (HL^2).

Experimental design

A typical experimental session is schematically diagrammed in Fig. 1. The two members of a team (subject *A* and subject *B*) are taken to the experimental rooms separately. They are given no instructions, so that exploratory behavior can be studied. They are told only that money earned during the session is the total salary

*Human stimuli presentations (*H*) were at least as long as stated and occasionally several seconds longer because the partition resisted closing. The left vertical line accurately indicates the beginning of each brief presentation of human stimulation; the right line may deviate a few seconds from the end of brief periods whose duration is stated in the text.

for the session. As soon as both subjects are seated, the rooms brighten and plunger pulling is recorded. Since the partition is at the L^2 position, the subjects can see only the mechanical discriminative stimuli. Despite lack of instruction, subjects almost always begin to pull the plunger after only a few moments.

To ascertain the degree of initial leadership (see Lindsley, 1961), the team's first session begins with the *uncontrolled leadership* contingency. The situation has implied mechanical connotation but *no social connotation*. Each subject's responding flashes a red light in the other room, but since the partition is closed, neither subject can see the other or know that another person's responding is causing the red light to flash. For maximally efficient (i.e., rapid and correct) social responding, each subject has to respond every time the red light in his room flashes.

When the team acquires efficient social responding at stable rates, the contingency is changed to *controlled leadership*. The initial leader is required to follow the red light flashes in his room, and the initial follower is required to assume leadership in order to get reinforcements. In other words, the initial leadership direction of the first segment is counter-reinforced. During this second segment, while the non-reinforced response is still emitted at a high rate, the partition is opened for a very brief period (about 15 sec). During this short period, each subject can see the other seated in front of an identical operant panel. This presentation of human stimuli (H) in addition to the lights (L^2) gives the situation *experienced social connotation*.

After the brief presentation of human plus mechanical stimuli (HL^2), the panel is again closed (L^2) and we record the effect of experienced social connotation on the subjects' performance with mechanical stimuli.

Experimental sessions last from one to two hours. Changes in the program are signalled to the subjects only by changes in the frequency and contingency of the reinforcements they receive.

RESULTS

Experimental histories of four teams illustrate the effect of human stimulation on teams with different rates of social response acquisition and on initial leadership reversal. Records from the other three experimental teams almost doubled the amount of data and number of teams without increasing the range or magnitude of results. A further increase of the N alone in this experiment was not necessary because of this inter-team replicability and supporting data from experiments very similar to the present one involving about 115 normal and pathological experimental subjects in over 250 experimental sessions.

Acquisition of co-operation without human stimulation

Figure 3 shows the first experimental session of a team composed of two 22-year-old graduate students. The subjects were brought to the experimental rooms separately, did not know each other, and had not participated in previous experiments.

Segment 3-1. With no social connotation (L^2) and with leadership uncontrolled (reinforcement programmed for both SOC AB and SOC BA responses), co-operative social responding was slowly acquired. *B* emerged as the strong initial leader after

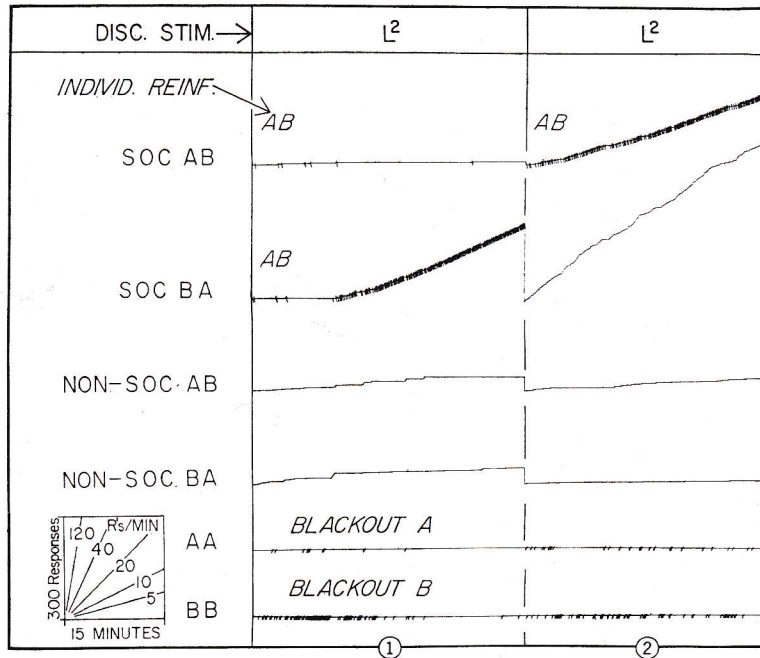
N 34¹ - N 35¹ (1)

FIG. 3. Acquisition of co-operative responding and development of strong initial leadership (*B*-leading) without human stimulation in an experimentally naive adult team. Each vertical slash on the cumulative records indicates the delivery of a penny reinforcement to both *A* and *B*. In segment 1, the team was reinforced for both social team responses. In segment 2, SOC AB responses were reinforced, and SOC BA responses were programmed for extinction. Over 35 min of counter-reinforcement did not reverse the initial leadership relation in which *B* led and *A* followed.

12 min in which there were few team responses and a high frequency of individual responses by *B*.

Segment 3-2. After rate stabilization, *B*-leading responses were counter-reinforced. That is, reinforcement was programmed to both subjects only for *A*-leading social responses. Still with no social connotation, the initial follower was required to lead for reinforcement. The increase in the rate of reinforced SOC AB responding was expected. The even greater increase in the rate of nonreinforced SOC BA responding showed *B*'s resistance to relinquishing leadership.

Post-session interview

In separate interviews both subjects said they were working a machine on which the lights flashed irregularly. One subject asked if the lights were "programmed to simulate a person's responses".

The subjects were not told anything about the experiments and left the laboratory separately.

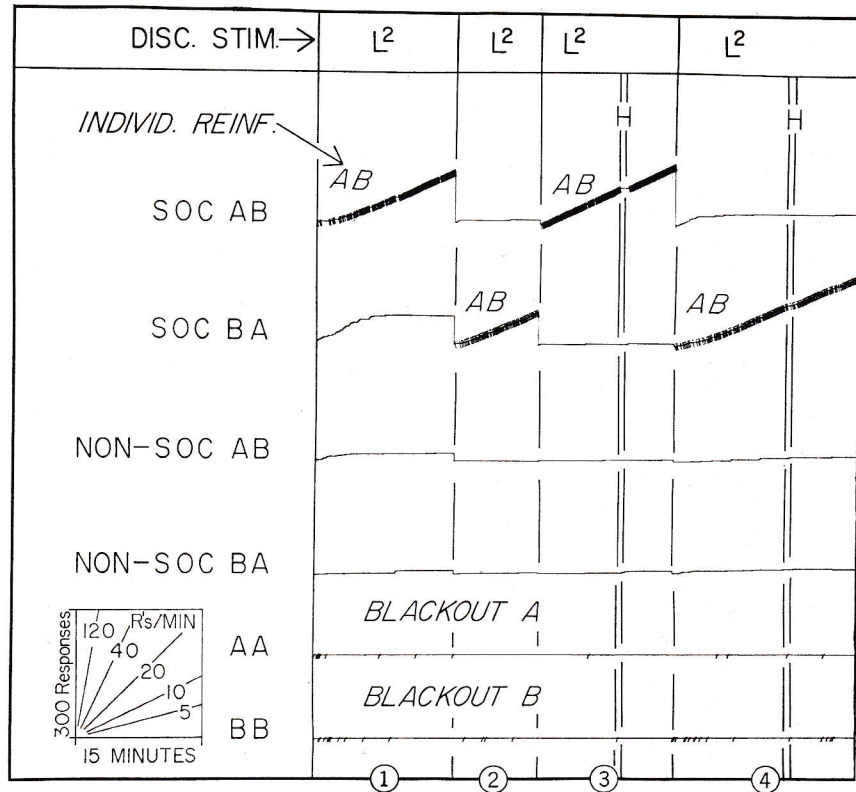
N 34² - N 35² (2)

Fig. 4. Full reversal of initial team leadership by counter-reinforcement without social connotation. In this second experimental session of an adult team, whose first session is shown in Fig. 3, human stimulation was briefly presented after the team showed complete formation of controlled leadership during co-operation. The human stimulation (in segments 3 and 4, narrow bands marked H) temporarily suppressed responding.

Acquisition of controlled leadership without human stimulation

Figure 4. The two graduate students returned for a second experimental session and again were conducted separately to the experimental rooms.

Segment 4-1. With discriminative stimulus and reinforcement conditions the same as in the last segment of the previous session, *B* still led at a moderately high rate, showing that there was no change in the behavior between sessions. However, in 6 min this unreinforced responding was totally extinguished and the reinforced SOC AB responding was emitted at a high even rate. Thus, by mere differential counter-reinforcement, the initial leadership was reversed without social connotation.

Segment 4-2. For the first time, the team was reinforced only when *B* led (SOC BA). Within 1 min, the leadership was fully reversed from *A* to *B* solely by differential reinforcement.

Segment 4-3. The team was again reinforced only when *A* led (SOC AB), as in segments 3-2 and 4-1. The leadership immediately and fully reversed. A high rate of responding continued until the partition was opened to the HL² position for 30 sec (*H* in segment 4-3). The human stimulation suppressed responding throughout its duration. About 1 min after the human stimuli were removed, the reinforced *A*-leading social responses were restored to their prior high rate.

Segment 4-4. In order to determine the effect of the human stimulation on *B*-leading social responses, reinforcement was changed to SOC BA responses as in segment 4-2. Human stimulation (*H*) again suppressed responding for about 1 min, but not as completely as the first time (segment 4-3).

Post-session interview

The subjects were asked to write a description of the experimental situation. Subject *B*, whose description was typical of others, wrote:

"The penny comes when I figure out under what system the little red light is blinking, and I co-operate with that system. . . . Now when I discovered that a person in the same circumstances as myself replaced (functionally) the red light, then either pulling after him or before him became the respective time a penny would come."

Summary of two sessions

The records (Figs. 3 and 4) for this team demonstrate the emergence of rapid social responding, strong initial leadership, and controlled leadership in a team without social connotation. The gradual, extended nature of the acquisition of social responding—not unlike the gradual acquisition of a mechanical discrimination by an isolated individual—provides a predictable moving baseline to determine the catalytic effect of brief presentations of human stimuli on the acquisition of controlled leadership in co-operation.

Catalysis of leadership control by human stimulation

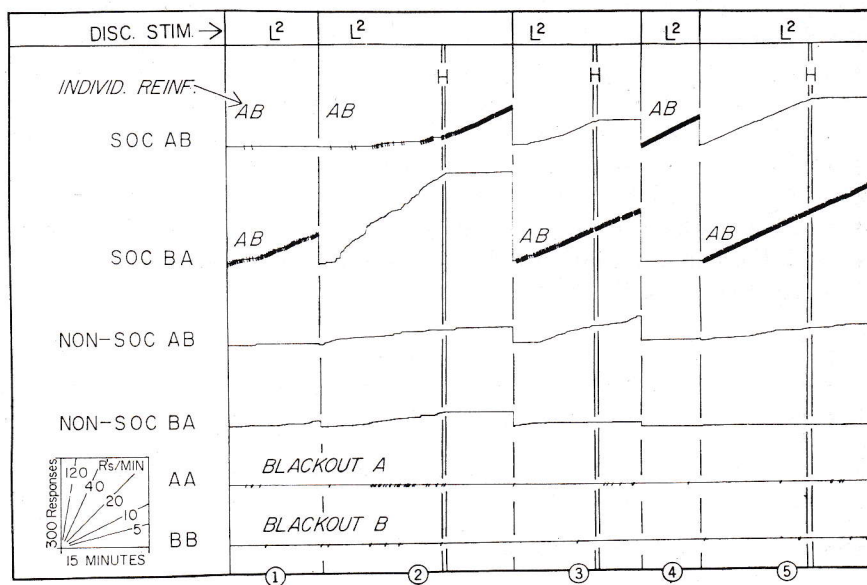
Figure 5: A Team with No Prior Experience. This team was composed of a graduate student (subject *A*) and a college senior (subject *B*), neither of whom had been in the experimental situation before.

Segment 5-1. The subjects acquired co-operative responding without human discriminative stimuli and with no social connotation. Although leadership was uncontrolled, *B* led the social responding from the start of the session.

Segment 5-2. Reinforcement was programmed only for SOC AB responses, but the initial leader-follower relation (*B*-leading) was maintained at a high rate. However, 20 sec of human stimulation (*H*) produced immediate extinction of the nonreinforced SOC BA response and full acquisition of the reinforced *A*-leading social response.

Segment 5-3. Reinforcement for leadership reversal produced the predicted increase in *B*-leading responses, but there was also a steady rate of the now nonreinforced *A*-leading responses. Human stimulation (*H*) immediately catalyzed the formation of efficient co-operative leadership by producing full extinction of SOC AB responding, although some NON-SOC AB responding continued.

Segment 5-4. When reinforcement was again programmed for responses led by *A*,



N 38' - N 39' (I).

FIG. 5. Rapid catalysis of controlled leadership in co-operation by three brief presentations of human discriminative stimuli (H). The team of experimentally naive adults acquired co-operative social responding (segment 1) without experienced social connotation.

as in segment 5-2, no further catalysis was required as the leadership instantly and fully reversed.

Segment 5-5. When reinforced only for *B*-leading social responses, as in segment 5-3, the nonreinforced *A*-leading social responses were emitted at the same rate as the reinforced responses. A presentation of human stimulation (H) again catalyzed extinction of nonreinforced *A*-leading social responses.

Session summary

Without human discriminative stimuli, the team rapidly acquired social responding and *B* emerged as the initial leader (segment 5-1). In segments 5-2, 5-3, and 5-5, brief presentations of human stimuli catalyzed acquisition of the controlled co-operative leadership. While two presentations were required to extinguish *A*'s nonreinforced leadership (segments 5-3 and 5-5), only one was necessary for *B* (segment 5-2).

Figure 6: A Team with One Experienced Member. This was the first experimental session for a team composed of a 12-year-old (subject *A*) and an 11-year-old (subject *B*) schoolchild. *A* had previously been in the experimental situation with another team-mate. He had completely acquired the co-operative responding and leadership reversal, and he knew the social nature of the experiment. *B* was experimentally

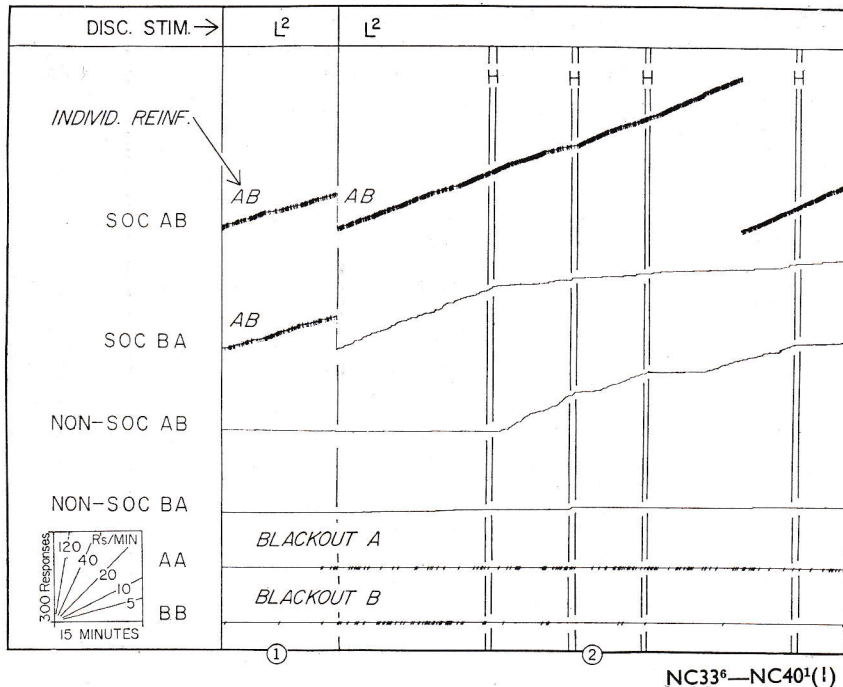


FIG. 6. Gradual catalysis of co-operative leadership by four brief presentations of human stimulation (H) in a team of grammar school boys. Human stimulation reduced nonreinforced leadership attempts by *B*, the experimentally naive team-mate, and the nonreinforced responses in which *B* followed too slowly.

naive and without social connotation. The subjects were brought to the experimental rooms separately.

Segment 6-1. With mechanical discriminative stimuli (L^2) and uncontrolled leadership, acquisition of social responding was rapid. There were few individual or nonsocial responses, and the leadership was balanced—nearly equal rates of SOC AB and SOC BA.

Segment 6-2. Reinforcement was programmed only for social responses led by *A*, the experienced team-mate. For 26 min, nonreinforced SOC BA responses continued to occur at a rate nearly equal to that of the reinforced response. When human stimuli were presented (H), *B*, the naive team-mate, almost totally relinquished leadership while the rate of SOC AB responding increased. However, about 1 min after the partition was closed, the team began to emit nonsocial *A*-leading responses (NON-SOC AB) at a high rate. Although these responses were in the appropriate direction (*A*-leading), they exceeded the social response criterion of 0.5 sec: *B* was following *A*'s response light, but not fast enough. Three more presentations of human stimuli (H) gradually suppressed the NON-SOC AB responses: first for 4 min, then for 10 min, and finally for 9 min, after which the session was terminated.

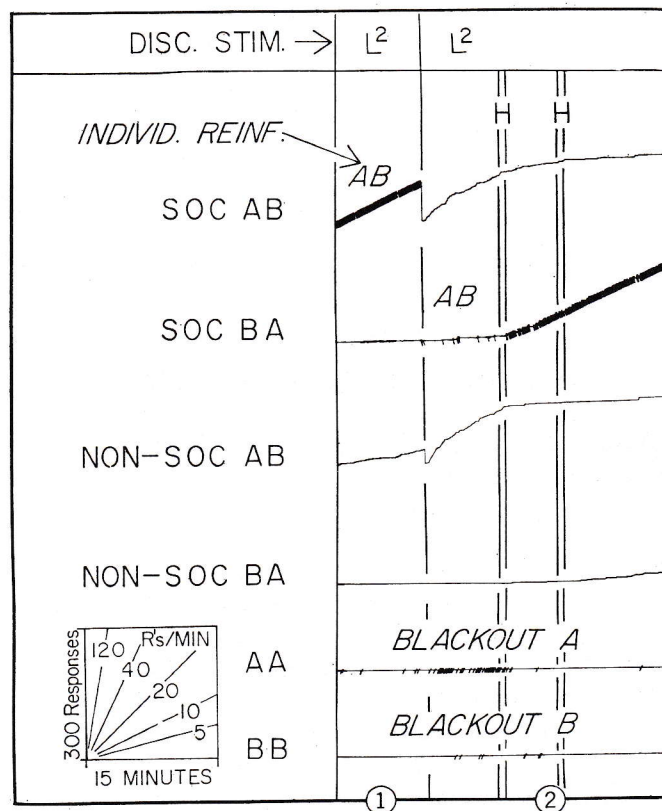
Session summary

This team, with one experienced member, showed acquisition of co-operative

social responding without an initial team leader. When reinforcement was scheduled only for social responses led by the experienced team-mate (*A*), the team-mate without prior experimental experience (*B*) did not learn to respond only following the red light flash. When the partition was opened, revealing the other person, the non-reinforced social responses extinguished. Nonsocial responding was increasingly reduced by each successive presentation of human stimuli. Thus the brief presentations of human stimulation showed a summative catalytic effect.

Figure 7: Permanence of Catalysis and Leadership Reversal. The schoolboy team whose first session is shown in Fig. 6 returned for a second experimental session after a one-day interruption.

Segment 7-1. The team's responding at the start of the second session was identical to responding during the last 9 min of the first session (segment 6-2), showing that the presentations of human stimulation maintained their effect between sessions.



NC 33⁷-NC 40² (2)

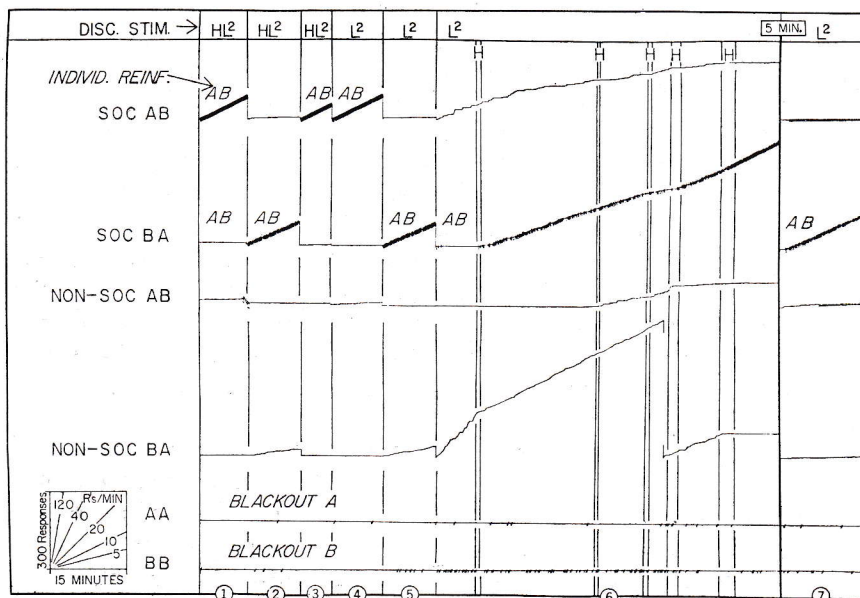
FIG. 7. Maintenance between experimental sessions of full co-operative leadership previously catalyzed by human stimulation and catalysis of reversal of this leadership by further brief presentations of human stimulation (H). This was the second session for the schoolboys whose first session is shown in Fig. 6.

Segment 7-2. When reinforcement was switched from *A*-leading to *B*-leading social responses, *A*, the previously reinforced leader, produced a high rate of individual responses (AA). The high rates of social and nonsocial AB responding, and very low rate of reinforced SOC BA responding showed the disruptive effect of the leadership reversal contingency. After 9 min, the window was opened for 35 sec (first H). By the time it was closed, NON-SOC AB responding was sharply reduced in rate, and reinforced SOC BA responses had sharply increased in rate. Since the nonreinforced *A*-leading responses continued to decrease in rate throughout segment 7-2, the two presentations of H had little effect on them.

Session summary

The team behavior during the first segment of this session showed the permanence of the catalytic effect observed during the last minutes of the team's first session (Fig. 6). In segment 7-2, the immediate catalytic effects of human stimulation were again demonstrated.

Figure 8: A Team with Two Experienced Members. The subjects in this session were two 13-year-old boys, both of whom knew from prior experimental experience with other team-mates that the discriminative stimuli could be socially programmed. Thus for each subject the situation had prior experienced social connotation.



NC 32²-NC 28¹²(1)

FIG. 8. Gradual catalysis of co-operative leadership which had been disrupted by decreasing the social response criterion from 0.5 to 0.1 sec (segment 8-6). This team had fully acquired controlled leadership (segments 8-1 through 8-5) prior to its disruption, and for both 13-year-old boys the situation had social connotation attained through experience.

Segment 8-1. The session began with the partition open (HL^2) so that the subjects could see each other and the lights. Although leadership was uncontrolled and this was the first time these subjects were in the experiment together, the rapid social responding which emerged was without exception led by *A* (SOC AB).

Segments 8-2 and 8-3. Reinforcement was programmed only for SOC BA responses. The less experienced subject *A* was required to follow for reinforcement, and team behavior was somewhat disrupted. When there was stable reversal of the initial leadership, with *B* leading almost exclusively, the leadership was again reversed (segment 8-3), and *A* resumed full leadership.

Segment 8-4. When the partition was closed (L^2), forcing the team to rely on mechanical stimuli, there was no change in responding.

Segment 8-5. With the partition still closed (L^2), reinforcement was changed to *B*-leading social responses (SOC BA). The leadership reversal, as in segment 8-2, was accompanied by a slight disruption of the social responding and an increase in NON-SOC BA responding.

Segment 8-6. The temporal criterion for social responding was changed from 0.5 to 0.1 sec. For reinforcement, *A* now had to follow *B*'s response light within 0.1 sec. The immediate effect of this change was an almost total elimination of the reinforced *B*-leading response, since *B*-leading responses which were within the previous social response criterion (0.5 sec) now exceeded the social response criterion and were recorded as nonsocial. The team also began to emit the previously extinguished *A*-leading social responses.

When the partition was opened for a 30 sec presentation of human discriminative stimuli (first H), *B*-leading social responding was again emitted, with a corresponding reduction in the rate of NON-SOC BA responding. A second briefer presentation of H increased the rate of NON-SOC AB responding without affecting the other team responses. A third presentation of H had no significant effect. The fourth presentation, which lasted for 2 min, affected all four team responses. The rate of SOC BA responding increased, and both NON-SOC AB and SOC AB responding were reduced. NON-SOC BA responding was suppressed for about 1.5 min after H was removed. The fifth presentation of H, for 2.5 min, produced complete acquisition of the controlled co-operative leadership response and complete extinction of the nonreinforced responses, having its greatest effect on NON-SOC BA. The behavior was almost identical to that observed in segment 8-5, in which the social response criterion had been 0.5 sec.

Experimental interruption. Five minutes of experimental interruption was programmed to permit the subjects to rest and to determine whether fatigue of almost two hours of responding might have reduced the rates of the nonreinforced responses in segment 8-6. Between segments 8-7 and 8-8 the subjects remained in the rooms without communication with one another for 5 min. Both boys accepted soda and cookies offered by the experimenter.

Segment 8-7. After the 5 min interruption, the experimental session continued with the same conditions as in the previous segment. After a 1 min delay, the team members responded for 17 min as they had during the last minutes of segment 8-6, showing that the reduction in nonreinforced responding was due to the catalytic effect of human stimulation rather than fatigue.

Session summary

With the 0.5 sec criterion, the team showed complete acquisition of both *A*- and *B*-leading social responding with mechanical plus human discriminative stimuli and with mechanical stimuli alone. When the temporal criterion for social responding was reduced to 0.1 sec (segment 8-6), further learning was necessary. Even in a team with knowledge of the social nature of the situation, presentations of human stimulation catalyzed acquisition when the task was changed slightly from what the subjects knew to be social. The interruption between segments 8-6 and 8-7 eliminated fatigue as an interpretation and showed the stability of the catalyzed acquisition observed in segment 8-6.

DISCUSSION

Data from teams with different experimental histories clearly indicate the profound effects of introducing human discriminative stimuli and social connotation. The major findings of this study are: (1) Human stimulation catalyzes acquisition of leadership in co-operation. (2) The catalytic effect of human stimulation does not appear to transfer from one response to another. (3) The effects of brief presentations of human stimulation differ from the effects of longer presentations which we have reported previously (Lindsley, 1961).

When the partition between the rooms is opened, each subject sees the other in the same situation as himself. This view, although lasting for only a few seconds, gives social connotation to the mechanical discriminative stimuli. In other words, the situation becomes an interaction with another person rather than a transaction with a machine. The dramatic effects of human stimulation may be attributable to rapid generalization of previous social learning to this new situation. The elements of a social situation are present before the actual presentation of the human stimulation (Lindsley, 1961) and opening the sliding partition gives these elements an explicitly social connotation. These effects, which were noted in our experiments with initial social connotation, have been related to joint problem solving and the importance of a social set (Lindsley, 1961).

Personal interviews after experimental sessions indicate that some subjects view the experiments partially in social terms even before human stimuli are presented. This tendency to interpret the situation in social terms may be due to the idiosyncratic nature of human programming.* This programming presents stimuli to each subject in a non-stereotyped manner which may change in tempo in some relation to that subject's own responding. Each subject and each team show individual differences. One team we have studied consisted of a husband and wife with marital problems. As soon as the husband left the experimental room, he reported to the experimenter that he "knew from the start" that his wife was in the adjacent room controlling the lights: "Only my wife could have acted like that."

Teams acquire the co-operative response, and initial leadership emerges, without

*In 1637, Descartes distinguished the actions of humans, "who act by reason", from those of automata, "which act by the disposition of their parts". Machines behave in rigid, standardized patterns; men do not. "A clock, which is composed only of wheels and weights, can count hours and measure time more exactly than we can with all our knowledge" (Pp. 55ff.).

experienced social connotation. However, *differential control of leadership is catalyzed by presentation of human stimuli*. In most cases it is necessary to present human stimuli more than once for complete acquisition of a specific response, although each single presentation has an effect in the appropriate direction. The number of times human stimuli have to be presented for complete acquisition depends not only on the degree of acquisition but also on the specific response reinforced.

The experimental data, particularly the records in Fig. 8, show that *social connotation is response-specific*. A team showing acquisition of a response as a result of human stimulation may require another presentation of human stimuli in order to acquire a slightly different response. This was demonstrated when the reinforcement contingency was changed from *A*-leading responses to *B*-leading responses and when the social response criterion was changed from 0.5 to 0.1 sec.

Brief presentations of human stimuli appear to have a strong 'cognitive' effect on stable team performance in a situation without experienced social connotation and on team performance which has not yet stabilized.

The effects of longer presentations of human stimulation differ from the cognitive catalytic effects of brief presentations in at least four major ways. First, longer periods of stimulation influence both stable and dynamic leadership states with prior social connotation. Second, longer stimulation may decrease efficiency of performance or may increase efficiency and stability, depending on team constitution (Lindsley, 1961).

Third, under the appropriate circumstances, each brief presentation of human stimulation tends to catalyze further the formation of reinforced responding. The effects summate and continue after the human stimuli have been removed. With longer presentations of human stimulation, disruption of team efficiency occurs primarily during the time that the subjects can see each other, and when the human stimuli are removed, responding returns to its former state. The effects of long presentations are thus more reversible and do not seem to summate. Teams showing disrupted performance, however, may eventually adapt to the long presentations.

Fourth, the number of brief presentations of human stimulation necessary for complete formation of controlled co-operative responding seems to be related to such factors as the subjects' developmental stage (Kessen, 1962), chronological age, or degree of social exposure. The effect of long presentations of human stimulation seems clearly dependent on the nature of the subjects' extra-experimental social adjustment or competence. Disruption of stability and efficiency by long presentations has been observed in a psychiatric patient with social deficits (Lindsley, Schneller, and McBurnett, 1963), in subjects who view each other as belonging to stereotypically (e.g., racially, economically, or educationally) opposing classes, and in subjects with prior extra-experimental hostility (Lindsley, Alexander, and Cohen, 1963).

The differences obtained in team performance between the conditions of mechanical signalling (L^2) do not result from differences in ease of discrimination, differential reaction time, or other nonsocial properties. We have previously shown (Lindsley, 1961) that with certain teams long presentations of human stimulation increase the efficiency of the reinforced social responding, and with other teams human stimulation decreases social responding efficiency. If the differences in team behavior between the human and mechanical stimuli conditions resulted from such

nonsocial variables as greater ease of discrimination, teams would all show effects of prolonged human stimulation on social response efficiency in the same direction. Since human stimulation produces effects in opposite directions on different teams, these effects must result from the social elements of the situation and not from differences in the mechanics of stimulus presentation.

Thus, long presentations contrast with brief presentations in four major, somewhat overlapping ways: (a) generality of the effect on teams in various performance states and with different experimental histories; (b) occasional reduction in efficiency; (c) reversibility of the effect; and (d) association with the general social relations of the subjects. These contrasts might be related to the psychological literature by interpreting the long presentations as producing "personality"* or interpersonal effects and brief presentations as producing "cognitive"† or situational learning effects.

There are clearly logical and empirical interconnections between these personality and cognitive effects. The concepts are empirically useful because they direct our attention to different aspects of a social interaction and different functions of human discriminative stimuli. One further datum concerning presentation of human stimulation applies to both the cognitive and personality effects and indicates one type of interconnection. As observed in this experiment, a very short suppression of responding frequently occurs with human stimulation (e.g., segments 4-3, 5-3). This may be related to the prepotency of human over mechanical stimuli. The shift in attention from the mechanical stimuli to the other person may behaviorally compete with the efficient emission of previously ongoing responding. Suppression throughout a long presentation of human stimulation is a disruptive personality effect produced by human discriminative stimuli. The concepts relating to the cognitive and personality effects represent our first steps in the experimental analysis of Pavlov's "effect of person" (Pavlov, 1928; Royer and Gantt, 1961).

In future research, we plan to use closed-circuit television for more rapid and controlled presentations of human stimulation (see Lindsley, 1962). This will also permit linking together several different rooms and switching between experimental subjects with ease, in order to experimentally analyze the dimensions of the personality effect. Most important, closed-circuit television will permit unidirectional presentation of social stimulation which will permit more exact and more economical experimental analyses than is now possible with the bidirectional window (Lindsley, 1963). Current research on competition, distracting stimuli, and developmental social psychology will extend our understanding of the primary roles of the presence of another person.

*"Personality, I now define in the particularist sense as the *relatively enduring pattern of recurrent interpersonal situations which characterize a human life*" (Sullivan, 1953, p. XI).

†"Cognition (*cognitive*). A generic term for one of the two classes of immanent determinants of behavior. A cognition . . . is present in a behavior in so far as the continued going-off of that behavior is contingent upon environmental entities (i.e., types of discriminanda, manipulanda, or means-end-relations) proving to be 'so and so'. And such a contingency will be testified to whenever, if these environmental entities do not prove to be so and so, the given behavior will exhibit disruption and be followed by learning." (Tolman, 1932, p. 440.)

CONCLUSIONS

In an experimental situation with bidirectional social behavior, controlled leadership during co-operation can be learned using socially programmed mechanical stimuli without explicit social connotation. The presentation of bidirectional human stimulation, producing experienced social connotation, catalyzes the formation of controlled leadership. This catalytic effect of human stimulation is not only team-specific, but is response-specific. Team acquisition of controlled leadership with catalysis is sometimes gradual and shows a summation effect of several presentations of human stimulation.

While human stimulation catalyzes the formation of controlled co-operative responding (cognitive effect), a team with efficient performance may respond at a more stable and higher rate when human stimulation is absent and only mechanical stimuli are used (personality effect).

The results indicate that there are social emergents, differences between human manipulation of the physical environment and human interaction with other humans. These differences require not only all the controls and refinements of individual small-animal experimentation, but in addition concepts and experimental techniques beyond the boundaries of individual psychology.

SUMMARY

A new method for experimentally analyzing co-operative and competitive interactions between two people has been developed (Lindsley, 1961), validated (Cohen, 1962), and proven reliable (Lindsley and Cohen, 1963). Here we used the method to generate controlled leadership during co-operation without social connotation by using socially programmed mechanical stimuli.

Presenting bidirectional human stimulation catalyzed the formation of differentially reinforced leadership, showing that leadership is acquired more rapidly with social connotation than without. However, once appropriate leadership was acquired, the performance of some teams was suppressed when human stimuli were used.

These two effects of human stimulation on co-operative leadership—acquisition catalysis and performance suppression—are new socially emergent phenomena. They were not predictable from individual data and prove the need for methods to analyze both individual and social behavior without confounding variables.

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