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# Effects of a Multiple Schedule of Collective Reinforcement on Shaping the Cultivative Response Rate of Three-man Teams

David D. Burnstein

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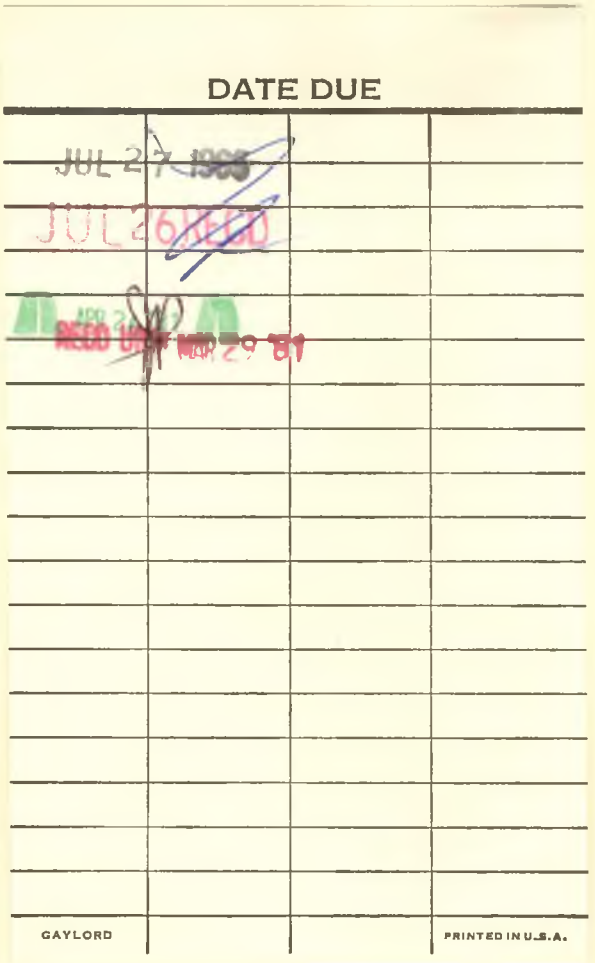

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# EFFECTS OF A MULTIPLE SCHEDULE OF COLLECTIVE REINFORCEMENT ON SHAPING THE CUMULATIVE RESPONSE RATE OF THREE-MAN TEAMS

By

David D. Burnstein

A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

# I. INTRODUCTION

The principle of reinforcement developed by experimenting with individual subjects has been extended in recent years for use with groups. In most of these studies some social interaction within the group is reinforced. For example, Azrin and Lindsley (1956) and Lindsley (1961) have manipulated imitation, cooperation, and competition between two subjects in an operant conditioning situation. Levin and Shapiro (1962) manipulated conversation between members of a group through appropriate reinforcement. Glaser and Klaus (1962) conditioned a team of two monitors and an observer to respond as a unit by reinforcing the group only when each member had made the proper response.

A second type of situation in which collective reinforcement is used does not involve a direct attempt to manipulate social interaction, but maniuplates only total group output. Any one team member or combination of members can make the response which is required to achieve reinforcement for the entire team.

This method was used in conditioning two-and three-man teams by means of either a differential high rate (DRH) or a differential low rate (DRL) of reinforcement (Wolff, Burnstein, and Cannon, 1962). Each man was put in an individual

sound-deadened room which contained a chair, a table, and a response panel equipped with a response button and a red light. Ss were instructed to press the button to make the light flash. Whenever the light flashed a certain number of times, a radio would play and all members of the team were free to listen to it. The team was reinforced for a correct response, regardless of which member or members of the team contributed to the correct response. Results showed that the team rate of response could be regulated by collective reinforcement. Control of the rate of group response, however, was found to be less efficient than control of individual rate of response. It was also found that team response could be shifted from one DRL or DRH schedule to another.

To date, the investigation of the effects of collective reinforcement have been concerned only with requirements for a single schedule of reinforcement. Few if any attempts have been made to condition a team to a multiple schedule by using collective reinforcement. A multiple schedule of reinforcement is one in which an organism is required to respond to two or more alternating schedules of reinforcement, each schedule being controlled by a different stimulus (Ferster and Skinner, 1957). Ferster and Skinner (1957), Ferster (1960), and Appel (1960) have achieved multiple stimulus control of infrahumans. With human subjects, multiple stimulus

control has been achieved with children (Long, 1959); retarded children (Orlando and Bijou, 1960), (Bijou and Orlando, 1961); and psychiatric patients (Bullock, 1959). In these studies, however, only individual Ss have been conditioned on a multiple schedule of reinforcement.

The purpose of this study was to shape the cumulative response rate of three-man teams to a Multiple DRL-DRH schedule by using collective reinforcement and to compare the manipulation and regulation of team behavior under a multiple schedule of reinforcement with manipulation and regulation of individual behavior on a similar multiple reinforcement schedule. No predictions were made in regards to possible results.

## II EXPERIMENTAL METHOD

### Subjects

The Ss were 17 enlisted US Army personnel, Fort Knox, Kentucky. No restriction was placed on the Ss in regard to age, race, or rank. Two Ss were run as controls in order to determine if individual Ss could learn the Multiple schedule. The other Ss made up five teams of three men each.

### Apparatus

Each S, either in a team or as an individual control, was placed in an isolated, sound-deadened room which contained a chair, a table, and a modified Lindsley operant Conditioning panel (as shown in Figure 1). Two of the stimulus lights on the S's panel indicated which phase of the multiple schedule was in operation. Under a continuous yellow light Ss could receive reinforcement for a DRL Response. That is to say that reinforcement is contingent on the time interval between responses. A DRL 5 means that the S must wait at least 5 seconds after his last response in order to be reinforced for the next response. Under a continuous blue light Ss could receive reinforcement for DRH responses. That is to say that reinforcement is contingent on a number of responses being made in a time interval. A DRH 12/2 indicates that 12 responses had to be made in a two second interval in order for reinforcement to occur. A white light flashed each time the team made the correct response for the particular schedule they were on.

Taped music was the reinforcer. Previous pilot work indicated that the kind of music played was irrelevant to the conditioning of Ss, thus a wide selection of musical works

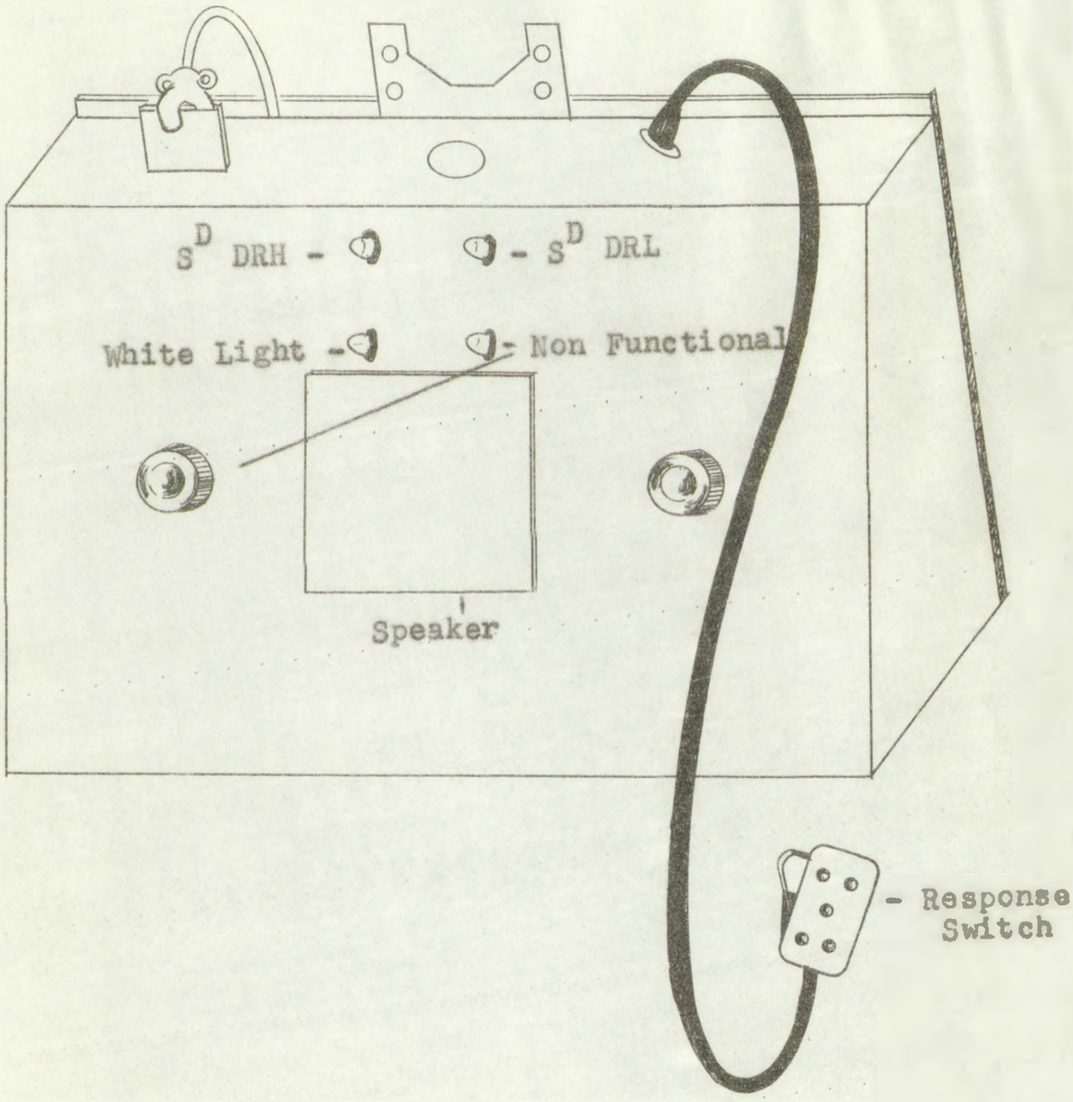



Fig. 1.--The Response Apparatus

were used. The reinforcer, the taped music, was programmed on a variable ratio schedule so that an average of 5 correct responses had to be made in order for the tape to come on. Once the music began, it was possible for the team to keep it on continuously. If the team made the correct response within a time interval of 45 seconds after the previous correct response, then the white light would flash, indicating that the team had made a correct response and that the team response was not made within 45 seconds after the previous correct response, then the music would go off and the team had to try to get it on again. Ss' responses were recorded on four Gerbrand's Cumulative Record recorders, one for each of the three Ss and one for cumulative team response. Cumulative response, the white light flashes, and periods of music reinforcement were recorded. Programming and recording equipment were placed in an isolated room apart from the Ss. Experimental sessions were run three hours a day for five days.

Procedure

To reduce the possibility of communication between team members, each S was supplied by a different organization. Each S reported to a different area in the experimental building, received his instructions separately (Appendix A), and was placed in a separate room. When each experimental session was over, Ss were individually escorted from the experimental rooms. Each S waited in a different area and was sent

back to his organization at a different time. Ss were not told that they would be working in a team; and when they were questioned at the end of the experiment, each S reported that he did not know he had been working in a team.

Conditioning began on the DRH leg of the multiple schedule. The teams were changed to the DRL leg of the multiple schedule when the team response rate became stable at a high rate and when the team could attain the reinforcement. Shifting between the components of the multiple schedule was based on the team output and stability of performance. As defined by the experimenter, the shifting continued until multiple stimulus control was indicated--that is, pausing during the yellow light and rapid responding during the blue. At this point, rate requirements within the components of the multiple schedule were increased. Shifting, both between and within the components of the multiple schedule, was based on the cumulative response record of the team. No well defined sequence of shifting was made, since each group was shifted from schedule to schedule on the basis of their own particular output.

## III. RESULTS

### Control Subjects

Figure 2, "Control Subjects," shows the development of a Mult DRL-DRH in the individual Ss. A drop in the lower pen line indicates points at which the S received the music reinforcement. The numbers below the bottom line show a shift in the schedule. The "pip" marks on the response record indicate when the momentary white light was presented. The scale at the bottom right is a reference point for gauging the rate of responding.

As seen in Figure 2, both Ss were brought under multiple stimulus control in the first session. Subject T initially responded at a high rate but was not reinforced for this rate until the schedule was shifted to DRH 6/2 (45 minutes later). He remained on the DRH for 45 minutes; the schedule was then changed to DRL 3. After 20 minutes on DRL, he was reinforced for some short pauses and his response rate gradually began to decline, though he continued to show some bursting under DRL. Stimulus control is evident during the last 45 minutes of the first day.

Subject S responded at a very slow rate initially but was not reinforced for this behavior until the schedule was shifted to DRL 3 (45 minutes after the start of the session).

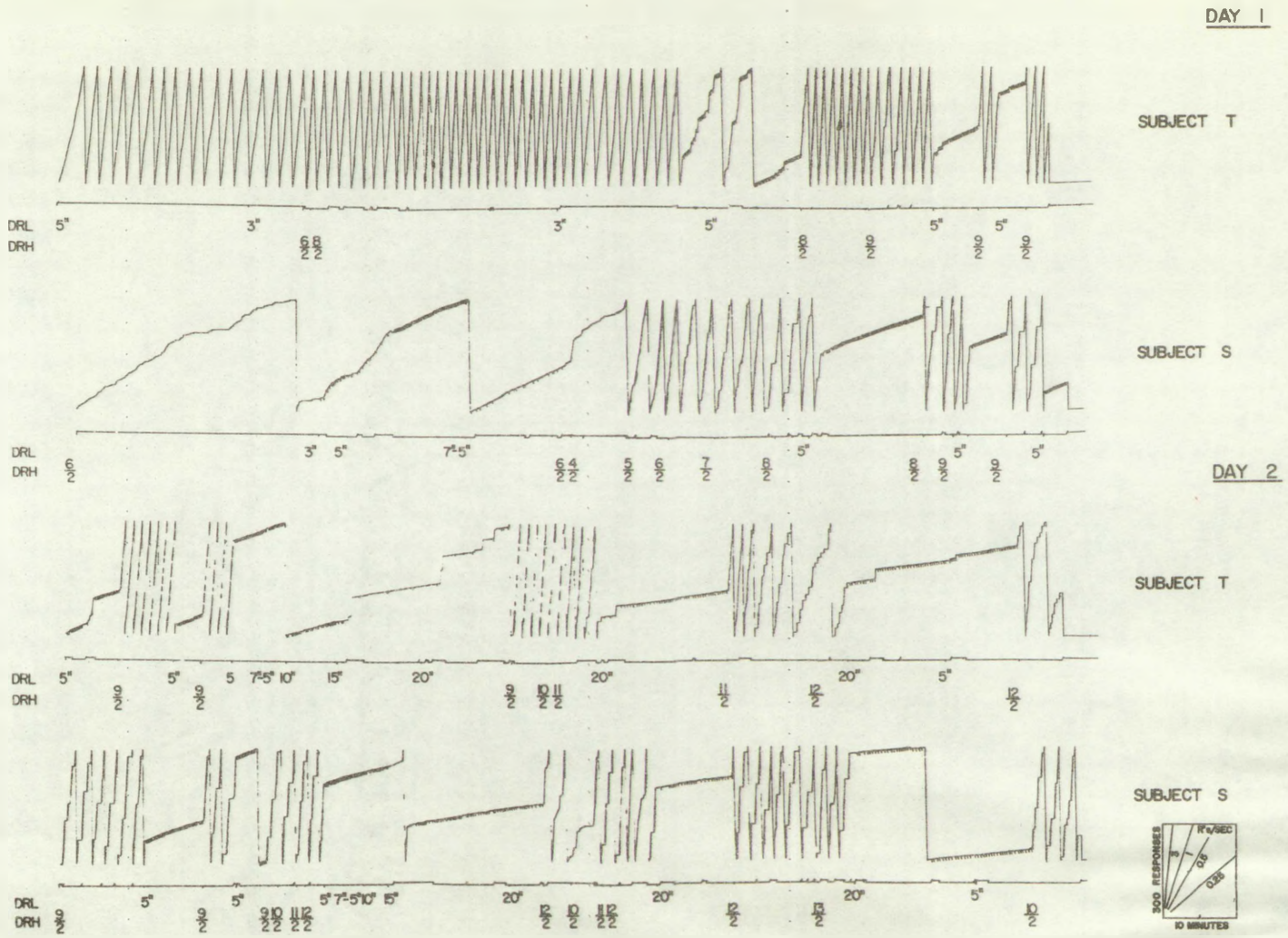



Fig. 2.--Cumulative Curves Showing the Development of the Mult DRL-DRH in the Individual Control Subjects (Days 1-2).

When he was shifted back to DRH 6/2 and continued to respond at a low rate, requirements were reduced to 4/2. Once reinforced, his rate of response gradually increased until DRH 8/2 was achieved.

At the start of the second day, the rates of response of both Ss (S and T) were still under multiple stimulus control. The records indicate that both had been conditioned to a Mult DRL 5-DRH 9/2. After 30 minutes the DRL and DRH requirements were raised, and by the end of the second session both Ss were conditioned to Mult DRL 20-DRH 12/2. Both Ss show an increasing number of pauses under the DRH condition. Subject T shows a slight tendency to burst occasionally under DRL 20.

During the remaining sessions the schedule ranged from DRL 2" to DRL 20" and from DRH 1/2 to DRH 15/2. Multiple stimulus control remained stable for these sessions, and Ss were able to get the reinforcement regardless of the requirement of the schedules (Figure 3). Ss generally paused over 20" on any DRL schedule and were thus enabled to get music and keep it continuously, though Subject T showed occasional bursting on DRL 15 and DRL 20 throughout all sessions. Both Ss showed high rates of responding and frequent pausing under the DRH schedule. Once the maximum requirements (DRL 20-DRH 14/2) had been met, there was little shifting to a lower rate of response under DRH or to a higher rate of response under DRL.

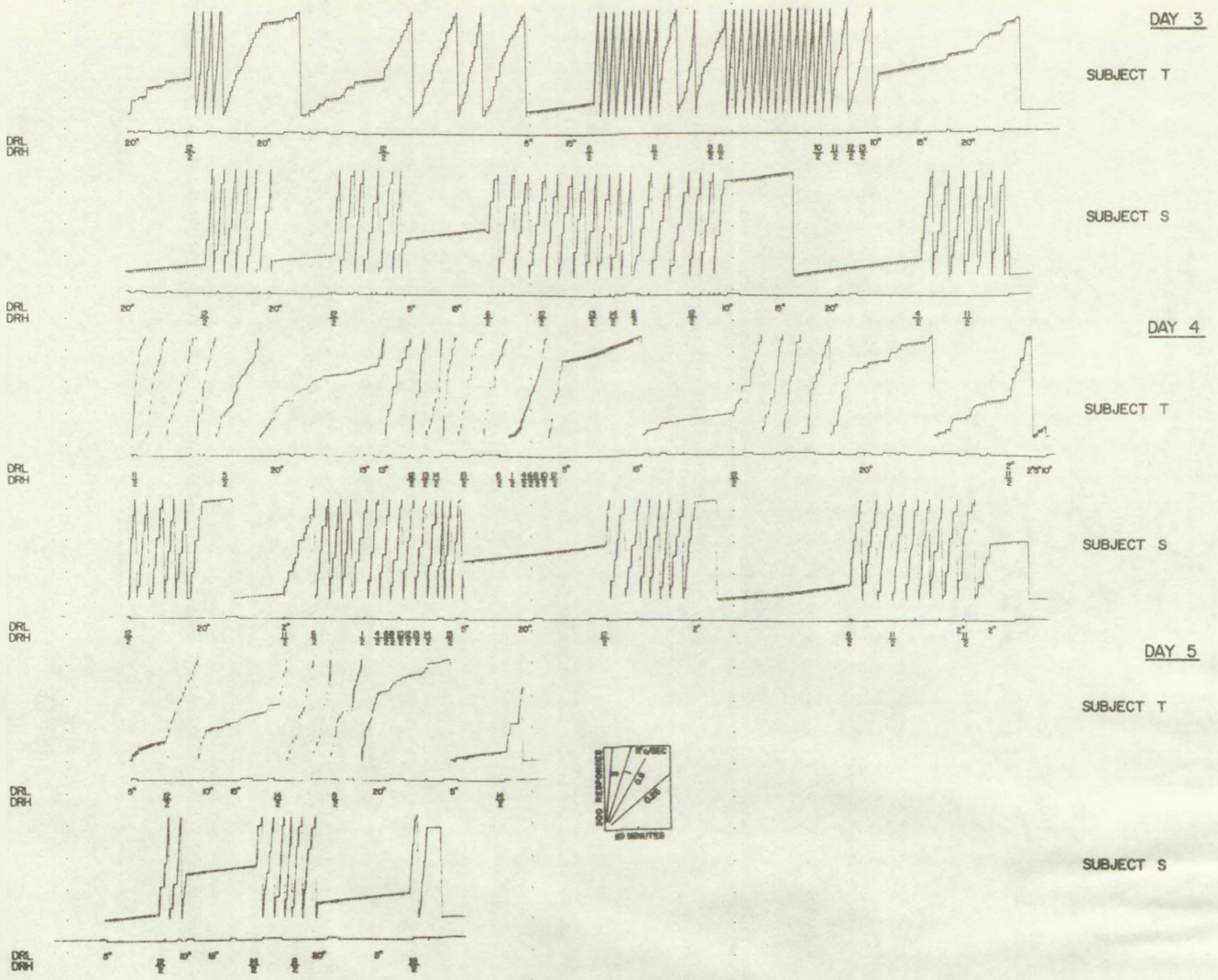



Fig. 3.--Cumulative Records Showing the Stability and Regulation of Response Rates in the Individual Control Subjects (Days 3-5)

Three-man Teams

Selected portions of the total cumulative response records for the five experimental sessions are shown for each of the five three-man teams in Figures 4-12. All five teams were brought under multiple stimulus control, although the degree of control achieved was not the same for all teams.

Figures 4 and 5 are records of the team which achieved the greatest degree of stimulus control. Multiple stimulus control was first indicated in Session I, and by Session IV the cumulative rate of response of the team was stable and was under multiple stimulus control. The team achieved reinforcement regardless of schedule or requirements of the schedule.

The individual cumulative records for the last two sessions indicated that Subject C achieved reinforcement for the team under the DRL leg of the schedule and responded at this same DRL rate under the DRH leg. Subject G responded at a high rate under the DRH leg and achieved the reinforcement for the team. Under the DRL leg Subject G did not respond. Subject K did not generally respond under either leg of the multiple schedule.

Figure 6 represents a second team in which one S achieved reinforcement for the team under the DRL. The group cumulative records indicate that the team responded appropriately on the DRH leg of the schedule in Session I and during every session thereafter. Stimulus control of

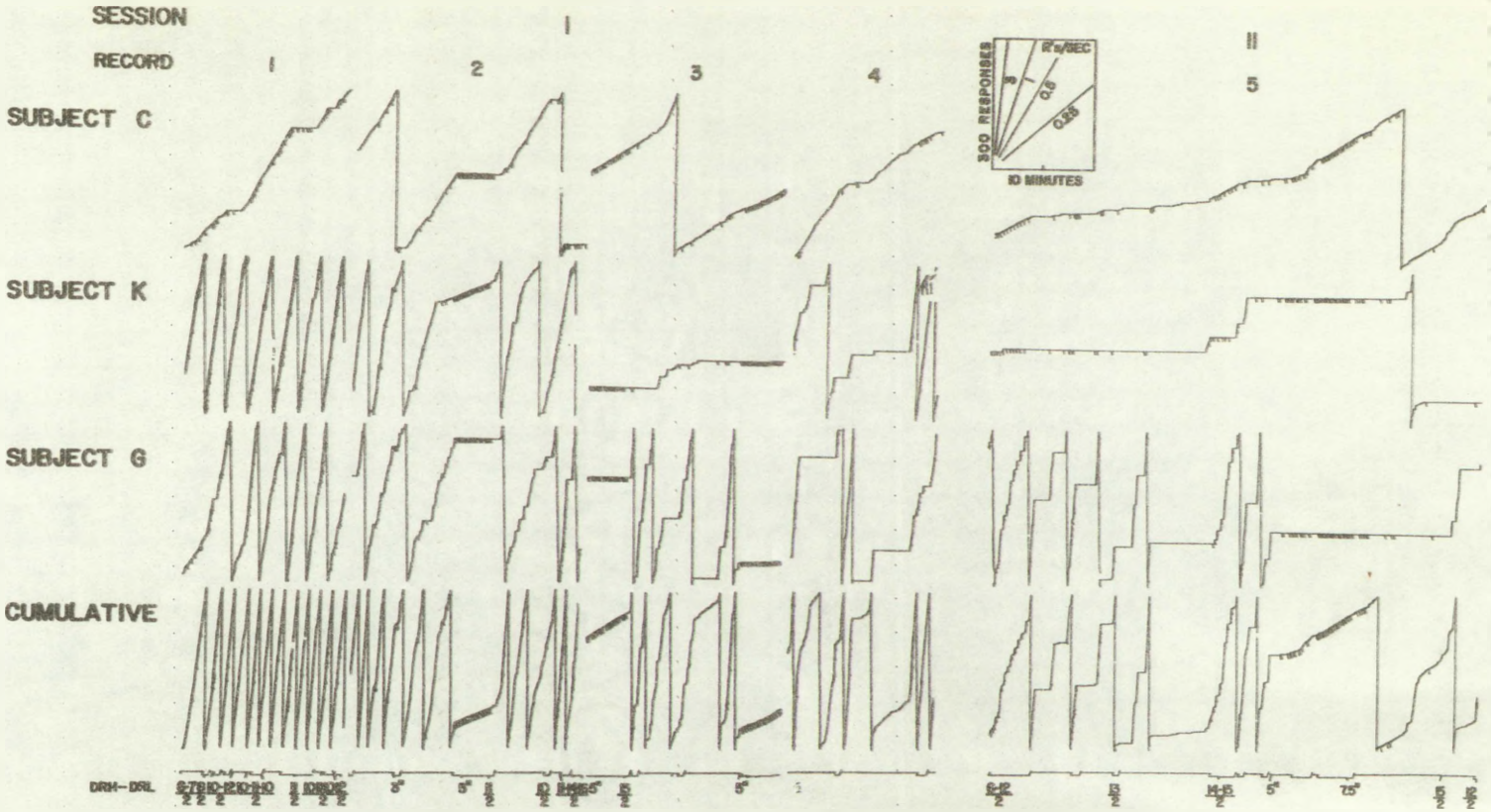



Fig. 4.--Cumulative Records Showing the Development of the Mult DRL-DRH in the Three-man Team—Subjects C, K, and G (Sessions 1-2)

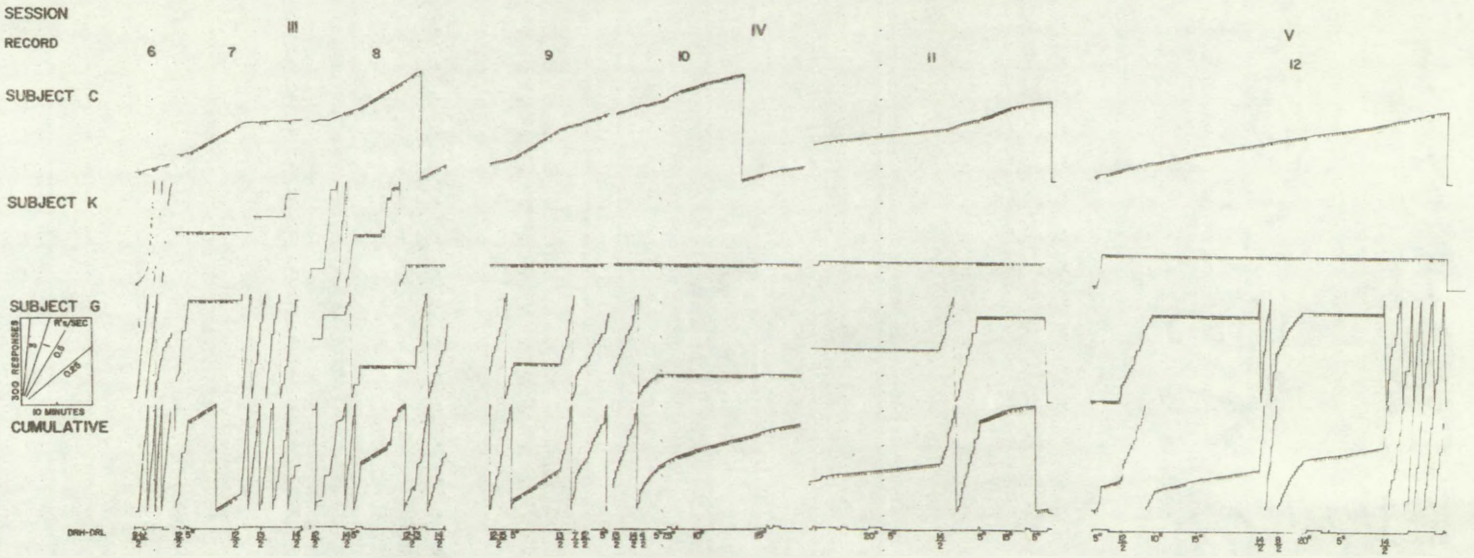



Fig. 5.--Cumulative Records Showing the Multiple Stimulus Control and the Stability and Regulation of Response Rates in the Three-man Team--Subjects C, K, and G (Sessions 3-5).

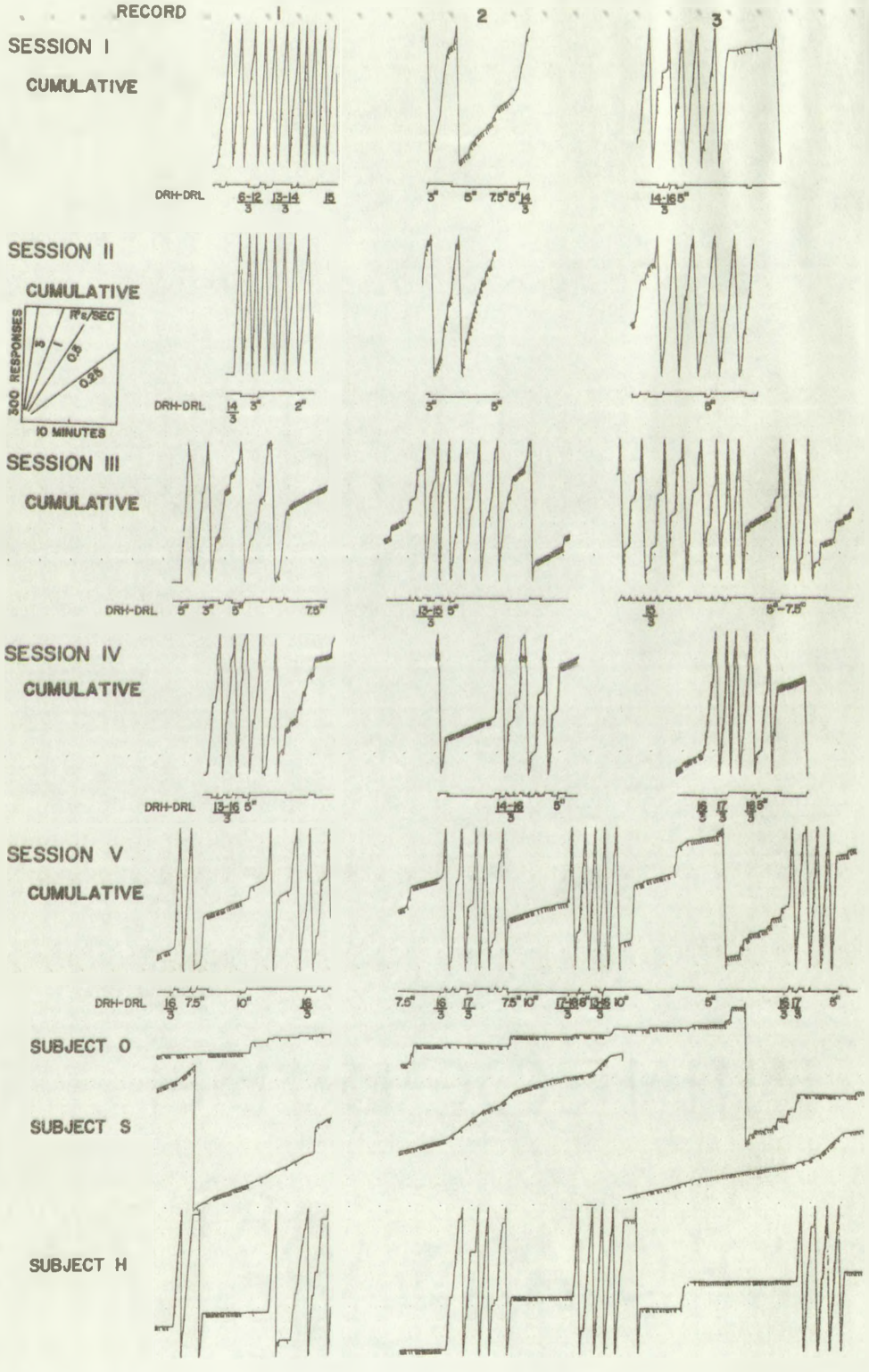



Fig. 6.--Cumulative Records Showing the Development of the Mult DRL-DRH in the Three-man Team—Subjects O, S, and H (Individual Records Shown for Session 5 Only)

the DRL leg of the schedule appears in Session III. DRL behavior during the remaining sessions was characterized by periods of high responding. The individual cumulative records for Session V show that Subject S achieved reinforcement for the team during the DRH leg and did not respond under the DRL leg. Subject S responded generally at the same rate regardless of the schedule, and achieved reinforcement for the team under the DRL leg. Subject O showed pausing and occasional bursting regardless of the schedule.

Figures 7 and 8 are the records of a team which was brought under multiple stimulus control in Session I. The DRH leg of the multiple schedule remained under control thereafter, but the DRL rate of response shifted back to a high rate in the latter part of Session II when the DRL requirements were raised; and the degree of control of low response rate in Session I never appears thereafter. As shown in the individual records, Subject H was under multiple stimulus control and responded appropriately under both schedules. In the latter part of Session II the other team members began responding, their increased responding continuing thereafter and interfering with the achievement of the reinforcement under the DRL. The cumulative record of the team for the DRL leg of the multiple schedule indicated pausing, and a generally lower rate of response under this leg than under the DRH. This result indicated that stimulus

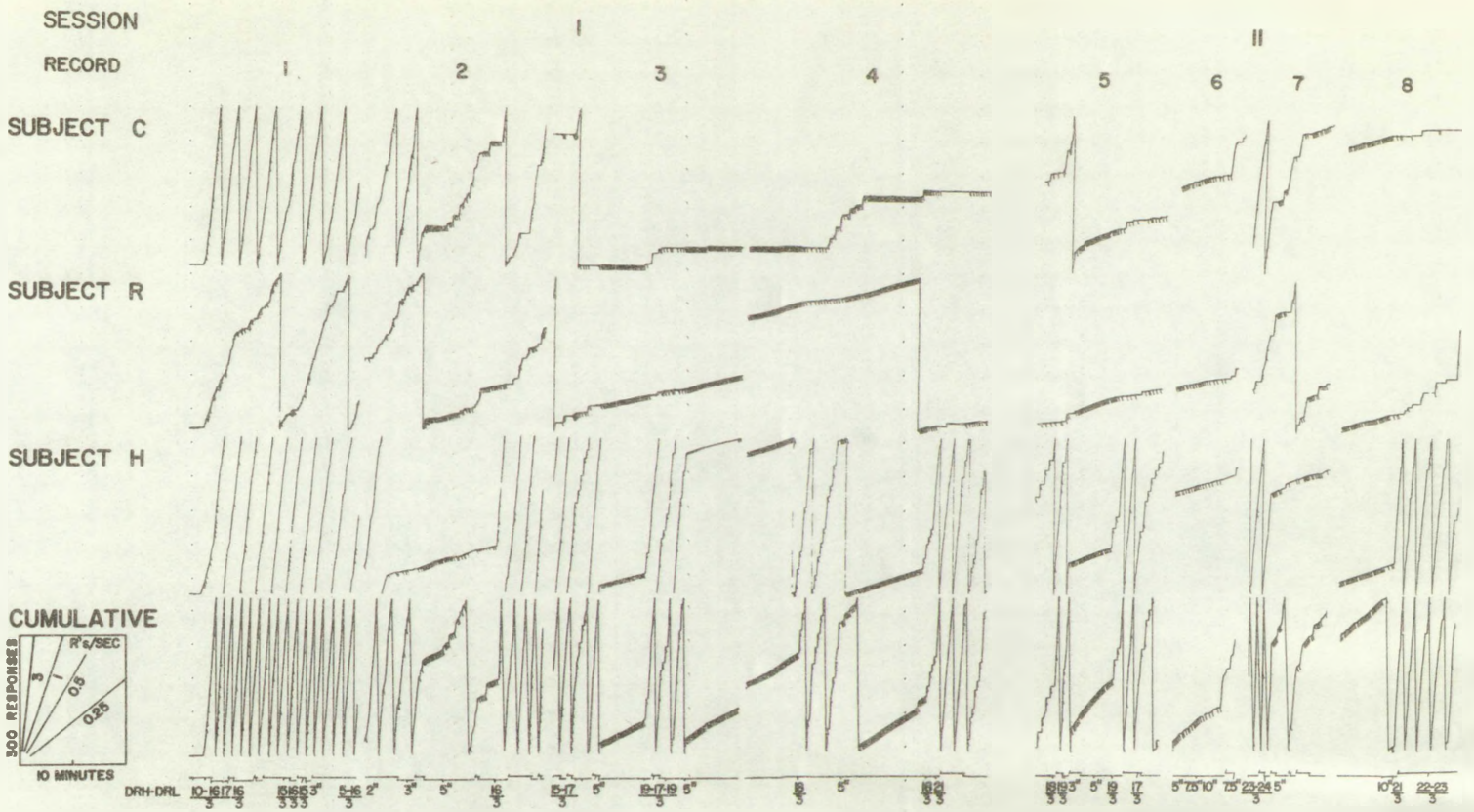



Fig. 7.--Cumulative Records for the Three-man Team—Subjects C, R, and H (Sessions 1-2).

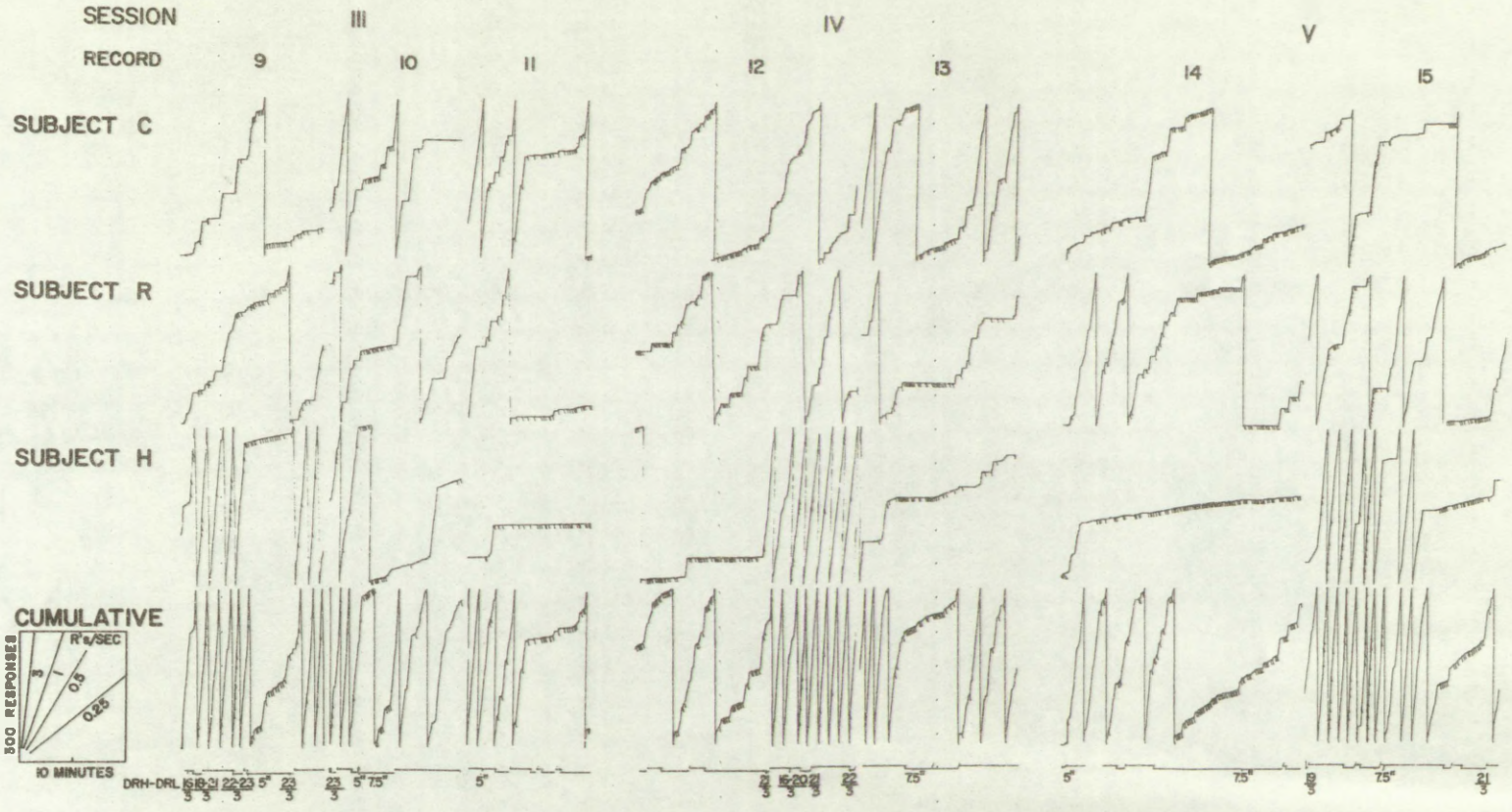



Fig. 8.--Cumulative Records for the Three-man Team--Subjects C, R, and H (Session 3-5).

control was still present for the team. Individual records indicated that only Subject H was under stimulus control.

Stimulus control for the three-man team composed of Subjects K, M, and S appeared in Session II. The rate of response for the team was high under the DRH and remained so thereafter, as shown in Figures 9 and 10. Although stimulus control appeared in Session II, change from a DRH to a DRL schedule did not result in an immediate change in response rate; and a change from a short DRL requirement to a longer one resulted in high rates of responding. This behavior was consistent during the remaining sessions. Individual records showed that for this team Subjects S and K were in control of the DRH schedule and that Subject K was in control of the DRL schedule. Subject M's response rate was characterized by a lock rate and intermittent pausing. The cumulative records of Subjects K and M indicate that they are under multiple stimulus control, but both showed bursting under the DRL.

Figures 11 and 12 are the results for the other three-man team. Stimulus control of this team appeared near the end of Session III, but did not become stable until Session V. All three members responded under the DRH condition, and Subject E achieved reinforcement for the team under the DRL leg. Individual records indicate that all three Ss were under stimulus control.

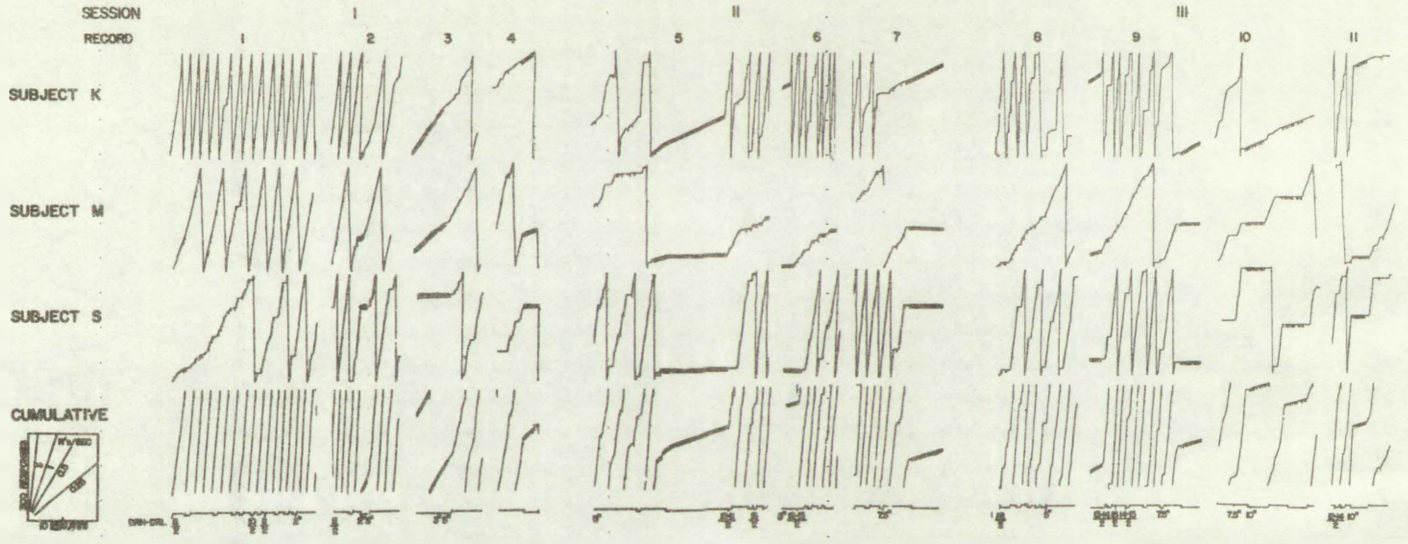



Fig. 9.--Cumulative Records for the Three-man Team—Subjects K, M, and S (Session 1-3).

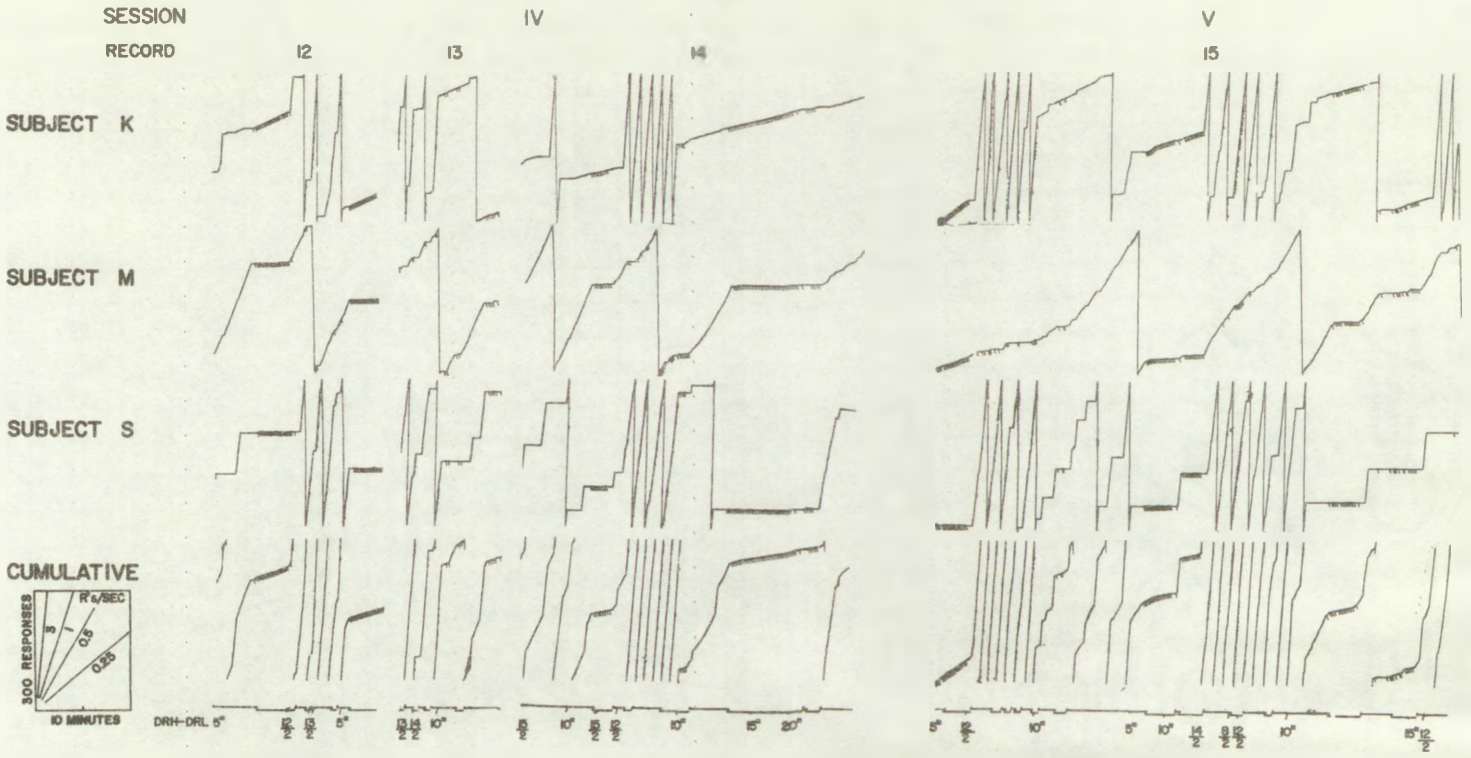
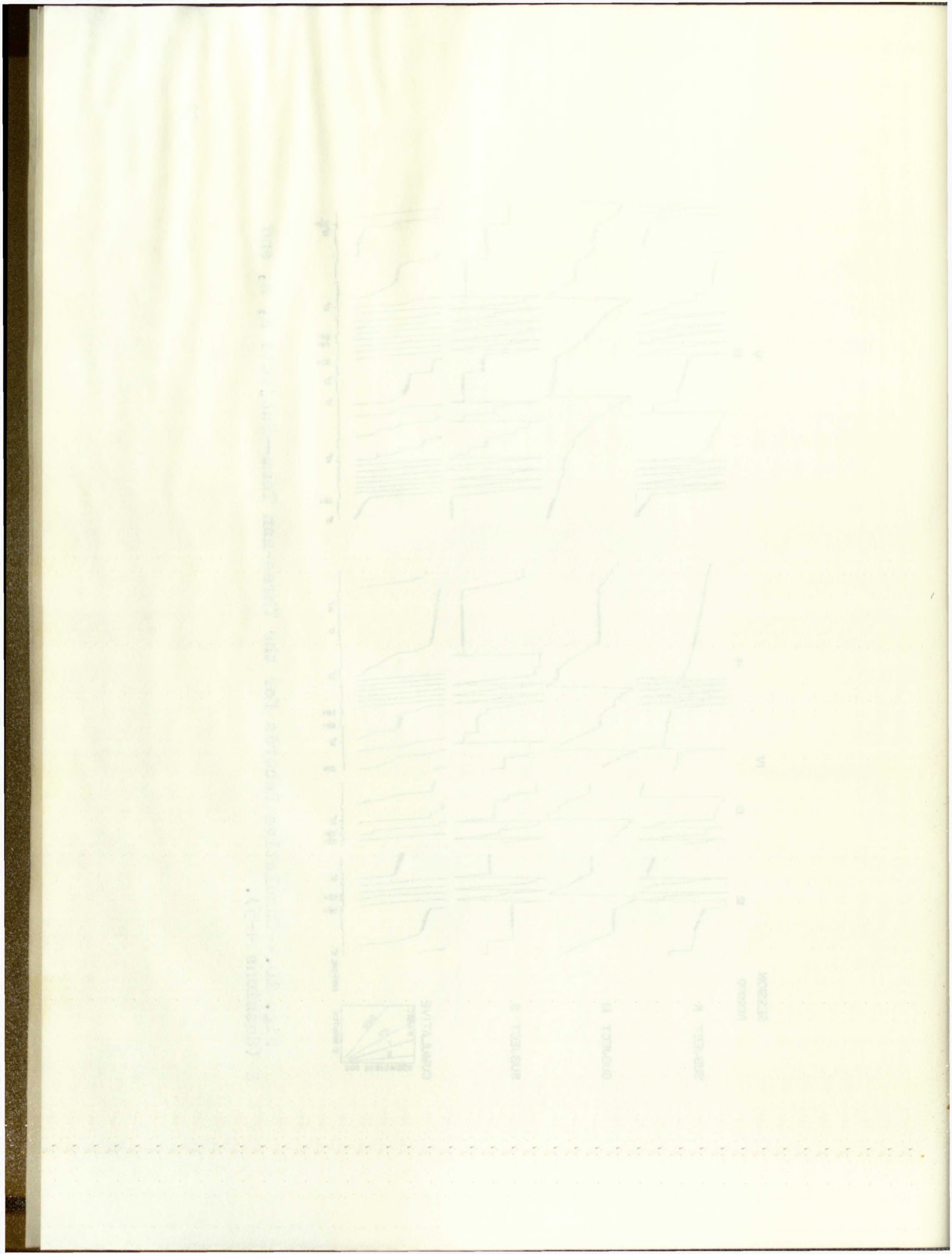



Fig. 10.--Cumulative Records for the Three-man Team—Subjects K, M, and S (Sessions 4-5).



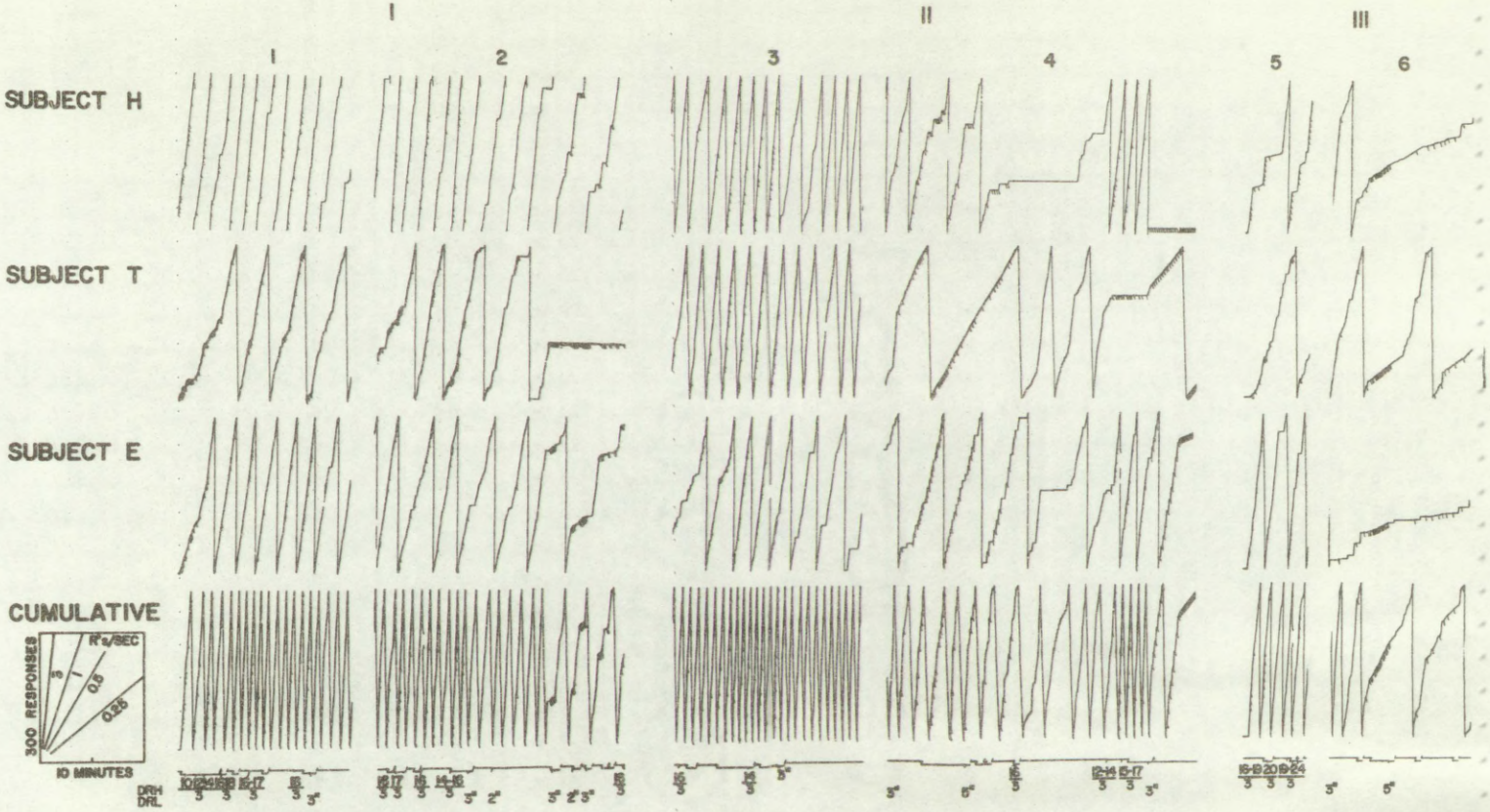



Fig. 11.--Cumulative Records for the Three-man Team--Subjects H, T, and E (Sessions 1-3).


Fig. 12.--Cumulative Records for the Three-man Team—Subjects H, T, and E (Sessions 3-5).

## IV. DISCUSSION

The results indicated that the conditioning of a team rate of response to a Mult DRL-DRH schedule of reinforcement could not be achieved as rapidly or as effectively as the conditioning of an individual rate of response to the same schedule.

Team conditioning was begun under the DRH leg of the multiple schedule. Although the team was reinforced when the cumulative team response rate reached the required DRH rate, the individual members of the team were not necessarily reinforced for DRH behavior. One member, two members, or all three members of the team might respond in such a way as to achieve the reinforcement for the team (the cumulative response reaching the required rate), yet they might be reinforced at the same time for a variety of response rates other than DRH, or even for not responding at all. For example, if one member of the team responds at a rate high enough to achieve the reinforcement for the team, the responses of the other two members contributed to the team output only in a random, unnecessary, or superficial manner. These responses are reinforced, because of the first member's high rate, and they may be emitted at a variety of rates and be reinforced. The second and third members of the team can be reinforced

at a variable interval schedule, a fixed interval schedule depending on the response rate of the first member, at a fixed ratio schedule, or a variable ratio schedule, depending on their own rates at the time of reinforcement, or if either happens to pause, he can be reinforced for pausing. Any response may then be periodically and/or aperiodically reinforced. The schedule of reinforcement which develops through collective reinforcement of the team's cumulative response rate, and under which any member of the team may be working, is one in which reinforcement is being delivered according to a schedule which the subject may or may not be able to influence. Furthermore, the subject himself may adopt any one of a wide variety of response patterns which will be periodically and aperiodically reinforced. This schedule of reinforcement is referred to in this paper as an "open" schedule.

Since a wide variety of response patterns may be reinforced, one which is irrelevant in producing the delivery of the reinforcement may be adopted. For the subject working in the team, reinforcement may arrive on a schedule which aperiodically reinforces irrelevant patterns of response. Once these responses have been on a schedule of aperiodic reinforcement, they become highly resistant to extinction. Table 1 is a schema of possible responses for a three-man team operating under a DRH 25/5. A, B, and C represent the team members, and Cum is the cumulative team record. R indicates the points at which Ss were reinforced. Responses

TABLE 1

SCHEMA SHOWING POSSIBLE RESPONSES FOR A THREE-MAN TEAM UNDER DRH 25/5

| Subjects | Possible Responses | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 15 | /*20 | /25 | /25 | /10 | /25 | /25 | /25 | /25 | /25 / |
| B | 5 | / 0 | / 5 | / 5 | /5≠5 | /5≠5 | / 5 | /5≠5 | /5≠5 | / 5 / |
| C | 3 | / 2 | / 1 | / 1 | / 1 | / 0 | / 0 | / 0 | / 0 | / 0 / |
| Cum | 23 | / 22 | /31 | /31 | /21 | /35 | /30 | /35 | /35 | /30 / |
| | | | R | R | | R | R | R | R | R |

*Each line represents a 5-second interval.

are shown for 5-second periods. Although the team is reinforced when the cumulative rate reaches 5 per second, each member of the team is being reinforced for a different response. Subject C is reinforced for a very low rate and for not responding, Subject B for a high output (but only when it reaches a high rate), and Subject A aperiodically for FR10, FR5, and spurts of 5. This example is only one of the many response possibilities for the three-man teams. Since any response is "open" to be reinforced and may be reinforced periodically and/or aperiodically, the "open schedule produces a response which is highly resistant to extinction. The "open" schedule, because of the variety of responses which can be reinforced, and because of the regularity and irregularity of the reinforcement, may produce a hierarchy of responses each of which has a different resistance to extinction.

Individual response rates conditioned by the "open" schedule under the DRH leg of the multiple schedule must be extinguished to bring about conditioning of pausing and DRL responding once the DRL leg of the multiple schedule is in effect. The speed of conditioning discrimination between the two legs of the multiple schedule and speed of conditioning the team response rate under each leg depends on which response rate of the hierarchy develops under the "open" schedule and how resistant this response rate is to extinction.

Differences between teams in speed and efficiency of conditioning team rate of response can then be attributed to the conditioning in individual team members of a variety of response rates each having a different resistance to extinction-- the conditioning of various rates being attributed to the "open" schedule. In the conditioning of the individual control subjects, no "open" schedule developed; Ss were therefore reinforced only for the appropriate DRL or DRH response. Extinction of the high rate of response conditioned under the DRH took place rapidly and DRL behavior was easily conditioned.

## V. SUMMARY

Five three-man teams were conditioned to a Mult DRL-DRH schedule through the use of collective reinforcement. Two individual Ss were run as controls. Although all teams were brought under multiple stimulus control, this control was not achieved as rapidly, and did not become as stable, as stimulus control of the individual Ss. Results suggested that collective reinforcement is less effective than individual reinforcement because it creates an "open" schedule of reinforcement. Under the open schedule any response may be reinforced, the reinforcement being delivered periodically and/or aperiodically. The open schedule produces a hierarchy of response rates having different degrees of resistance to extinction. These response rates which were difficult to extinguish interfered with the conditioning of the DRL portion of the multiple schedule and made conditioning of the cumulative response rate of the three-man teams to a Mult DRL-DRH difficult.

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# APPENDIX

Instructions to the subjects:

"You are here to participate in a psychological experiment. You will be placed in an isolated room containing an apparatus similar to this (point out drawing), which has four lights (point out) and a switch which is attached to the apparatus. (Hand Ss a switch.) It is your task to press the switch and attempt to get the white light to flash. The white light will be the bottom left light on the panel (point out). Each time the light flashes, it will indicate to you that you have pressed the switch correctly. Each time the light flashes, it will also cumulate; and after it flashes a certain number of times, music will come on into the room, and you can listen to the music.

However, while the music is on, you will try to keep it on. This is done also by pressing the switch. If you succeed in keeping the music on, the white light will flash, indicating that you have kept the music on. Thus, your task is to press the switch, get the light to flash as much as possible, get the music to come on, and keep it on. Any questions?

You will be here every afternoon (or every morning) for five consecutive duty days. At no time will you bring into the room any reading material, writing material, or portable radios. If you want to go to the latrine or get a drink, you must do this before you are put into your room. Once you are

put into your room, you will not leave until I take you out. Since this is an experiment, I do not want you to discuss it with anyone.

If you want to know what you are doing, you may ask me at the end of the five-day period. Other than that, I do not want it discussed at all."

Ss were then given the following notice to read:

You have your instructions for the task. At no time will you bring into this room any reading material, writing material, or portable radios. If you want to go to the latrine or get a drink, do this before you are put into the room. You will not leave the room until you are taken out.

In the room next door to you will be other men. At no time will you communicate with them nor will you use this period as time to take a nap. These rooms are in bad shape and further destruction of the room or any equipment in the room will not be tolerated. During the experimental period the rooms will be checked to make sure you are not sleeping or reading or writing. The rooms will also be checked at the end of the experimental session to make sure that no more damage has been done.

Failure to adhere to the above named rules will result in a letter to the company recommending disciplinary action be taken.

George H. Spires
Lt. Col., Armor
Chief