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POSITIVE AND NEGATIVE REINFORCEMENT EFFECTS ON BEHAVIOR IN A THREE-PERSON MICROSOCIETY

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Three-person groups, either of males or of females, resided for 6 to 12 days in a continuously programmed environment. Subjects followed a behavioral program that determined the sequential and contingent relations within an inventory of activities. The program consisted of positive reinforcement days and avoidance days. During a positive reinforcement day, each work unit completed by a subject incremented a group account. The account was divided evenly among the three participants at the conclusion of the study. During a negative reinforcement day, no money was earned, and the group was assigned a work unit criterion that, if completed, prevented a reduction in accumulated earnings. During negative reinforcement days, subjects made aggressive verbal responses, which differed in magnitude among the four groups. These differences were evident in several distinct behavioral measures. Performances on components of the work unit were not demonstrably affected by the reinforcement schedules in effect, although during the avoidance condition one subject stopped working and another subject's productivity declined.

Key words: programmed environment, microsociety, aversive control, aggression, humans

Contingencies of reinforcement affecting behavior in a 3-person microsociety were previously studied in a programmed environment (Emurian, Emurian, Bigelow, & Brady, 1976; Emurian, Emurian, & Brady, 1978). It was found that a cooperation contingency, requiring all 3 participants to select access to a social area, increased the durations of triadic social episodes when compared with triadic social periods under noncooperation contingencies in which solitary and 2-person access to the social areas was permitted. By-products of the cooperation contingency included (1) increased intercom communications among subjects, (2) increased synchrony among subjects' wake-sleep cycles, and (3) decreases in time spent alone (Emurian & Brady, 1983). Individual and social effects observed under noncooperation and pairing contingencies were never detrimental enough to require a return to a cooperation contingency.

The present experiment broadened the range of variables studied to include negative reinforcement procedures. It was influenced by evidence that has linked (1) hostility and aggression with aversive control (e.g., Hutchinson, 1976) and (2) dissipation of hostility with cooperative goals pursued under positive reinforcement conditions (e.g., Deutsch, 1962; Sherif, 1967).

METHOD

Subjects

The subjects were recruited through notices placed in a local newspaper. Four 3-person groups consisting of 9 males (G1, G2, and G4) and 3 females (G3) were accepted for participation on the basis of psychological evaluation, educational background, and availabil-

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ity. Before subjects were screened, they were given a tour of the laboratory and brief descriptions of the behavioral program, the method of payment, and the reinforcement schedules that would be presented. The mean age of a subject was 24 years with a range between 18 and 34 years. The Minnesota Multiphasic Personality Inventory and the 16 Personality Factors Inventory indicated no significant problems. Subjects were fully informed about procedures, and as a group were thoroughly familiarized with the laboratory during orientation and training sessions that preceded an experiment. No elements of deception were involved in the research, and informed consent was obtained. Remuneration was a function of the daily frequency of performing work tasks described below.

Apparatus

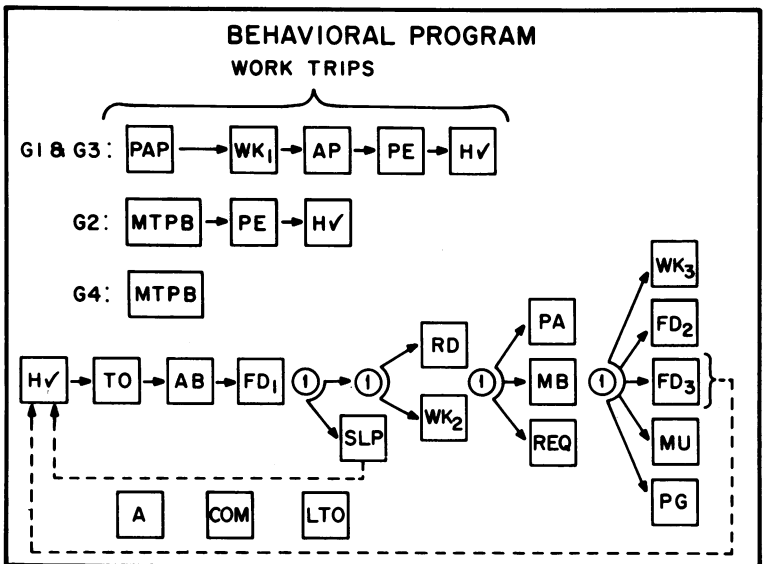
The programmed environment consisted of five rooms and an interconnecting corridor. The floor plan of the laboratory and its position within the surrounding building shell are presented in Emurian et al. (1976). Each of three private rooms (2.6 by 3.4 by 2.4 m), one for each subject, was similar to a small efficiency apartment containing kitchen, bathroom, bed, desk, and a computer CRT terminal. The recreation area (4.3 by 6.7 by 2.7 m) contained a complete kitchen facility as well as exercise equipment and games. The workshop (2.6 by 4.1 by 2.7 m) contained assembly projects (models, electronic kits, etc.) for Groups 1 to 3 and a computer CRT terminal for G4. A common bathroom served the recreation and workshop areas. Descriptions and photographs of the laboratory have been published elsewhere (Bigelow, Emurian, & Brady, 1975; Brady, Bigelow, Emurian, & Williams, 1975; Emurian, Brady, Ray, Meyerhoff, & Mougey, 1983).

Behavioral Program

Figure 1 presents a diagrammatic representation of the behavioral program that determined the sequential and contingent relationships within the inventory of activities. Beginning with Health Check, subjects followed the behavioral program sequentially from left to right. The circled "1" indicates that one choice could be made from those activities designated by the arrows. At the completion of either Sleep (SLP) or an activity within the last column, subjects returned to Health Check. Audit (A) and Limited Toilet Operations (LTO) were freely available, and Communication (COM) was available between activities within the full program. Work trips are described below. The behavioral program was not oriented to time of day, and subjects progressed through the program recurrently according to their personal dispositions. For G4, Physical Exercise (PE) was located between Health Check (H$\surd$) and Toilet Operations (TO), and Work Three (WK3) was deleted from the program so that the workshop could be used for the Multiple Task Performance Battery described below. All social activities were optional. Subjects could use the social areas alone, in pairs, or with all 3 subjects together. For Groups 1 to 3, subjects could meet together in the recreation area or workshop, but for G4, subjects could meet together only in the recreation area. Details regarding the composition of the behavioral program and the methods for stimulus control of component activities have been described previously (Emurian et al., 1976, 1978; Emurian, Emurian, Schmier, & Brady, 1979).

The critical feature of the program was the work trip. In the previous studies, subjects had received per-diem payments irrespective of their performance. In the present experiment, however, remuneration at the conclusion of an experiment was a function of the total number of work trips that group members completed each day. A work trip was available for selection between any two adjacent activities within the full behavioral program. Once a work trip had been selected, all of its performance requirements had to be completed before resuming the behavioral program from the point of departure. During a work trip, the intercom (COM) was not available, and the subject was not permitted access to music.

For PAP and AP, a correct response was the entry of an accurate solution to an arithmetic problem, and for PE, a correct response was pressing one of four wall-mounted switches



INVENTORY OF ACTIVITIES

NOTATION	FULL NAME	BRIEF DESCRIPTION
PAP	PRIVATE ARITHMETIC PROBLEMS	150 CORRECT SOLUTIONS OF ARITHMETIC PROBLEMS
WK1	WORK ONE	5000 LEVER OPERATIONS
AP	ARITHMETIC PROBLEMS	50 CORRECT SOLUTIONS OF ARITHMETIC PROBLEMS
PE	PHYSICAL EXERCISE	500 CORRECT PRESSES ON AUTOMATED TASK
MTPB	MULTIPLE TASK PERFORMANCE BATTERY	G2: 600 CORRECT RESPONSES G4: NO RATIO
HV	HEALTH CHECK	TEMPERATURE, PULSE, WEIGHT, STATUS REPORT
TO	TOILET OPERATIONS	USE OF PRIVATE BATHROOM AND CONTENTS OF DRAWER CONTAINING TOILETRIES
AB	AUTOGENIC BEHAVIOR	RELAXATION EXERCISES ON CASSETTE TAPE
FD1	FOOD ONE	TWO SELECTIONS FROM A LIST OF FOODS
SLP	SLEEP	USE OF BED AND PRIVACY CURTAIN
RD	READING	ACCESS TO BOOK
WK2	WORK TWO	PROBLEMS, EXPERIMENTS, ASSEMBLY PROJECTS
PA	PUZZLE ASSEMBLY	ASSEMBLE A PUZZLE
MB	MANUAL BEHAVIOR	ACCESS TO ART MATERIALS
REQ	REQUISITION	EARN DELAYED DELIVERY OF TREATS
WK3	WORK THREE	ACCESS TO WORKSHOP
FD2	FOOD TWO	PRIVATE MAJOR MEAL
FD3	FOOD THREE	MAJOR MEAL IN RECREATION ROOM, GAMES
MU	MUSIC	EARN A CASSETTE TAPE
PG	PRIVATE GAMES	ACCESS TO SOLITARY GAMES
A	AUDIT	RECEIVE WORK SCORES FOR ALL SUBJECTS
COM	COMMUNICATION	ACCESS TO INTERCOM
LTO	LIMITED TOILET OPERATIONS	ACCESS TO ESSENTIAL TOILET FACILITIES

Fig. 1. A diagrammatic representation of the behavioral program that determined the sequential and contingent relationships within the inventory of activities. For G4, Physical Exercise (PE) was located between Health Check (H√) and Toilet Operations (TO), and Work Three (WK3) was deleted.

within 1.5 s of its illumination. For WK1, a correct response was a single pull of a lever that was mounted above the desk.

The Multiple Task Performance Battery (MTPB) was composed of the following five tasks that were displayed simultaneously to an operator via a CRT terminal: (1) *blinking light,* a dynamic signal-detection task; (2) *warning light,* a static signal-detection task; (3) *probability monitoring,* an integrated signal-detection task; (4) *target identification,* a matching task; (5) *arithmetic calculations,* a computational task. Accurate responses produced points that were presented cumulatively on the screen as they were accumulated. False alarms on the signal-detection tasks produced a decrement in points. The parameters of the tasks were chosen so that an operator with 5 to 10 hours of practice could accumulate 500 to 600 points per hour, and the upper limit of performance was approximately 750 points per hour. A description of this minicomputer-controlled performance battery has been presented by Emurian (1978), and a rationale for this "synthetic work" methodology has been described by Chiles, Alluisi, and Adams (1968) and

Morgan and Alluisi (1972). Group G1 and G3 were presented with only the arithmetic calculations component of the battery (i.e., PAP and AP); G2 and G4 were presented with the full battery (i.e., MTPB).

Procedure

For Groups 1 to 3, work trips were completed within the private rooms, and subjects could select them concurrently. Whenever a subject in these groups completed a work trip, a counter incremented within his/her private room; counters were reset to zero at the beginning of each 24-hr day.

For G4, a single CRT terminal was located within the workshop that subjects could occupy *one-at-a-time* on a rotational basis that the group members determined on their own. If a subject within G4 selected the MTPB activity while another subject was operating the task within the workshop, an "activity unavailable" light was illuminated; the former subject could wait for the extinction of the light and proceed then to the workshop, or he could select the next activity within the behavioral program. When a subject stopped working and returned to his private room, a card was delivered to him, through a drawer accessible to the outside, indicating the number of points that he had earned during that particular work period.

For Groups 1 to 3, the parameters of the components of a work trip were chosen such that 1 to 2 hours were required to complete each trip. For G4, the parameters of the MTPB were chosen such that approximately 600 points per hour could be earned. Per-hour earning potential was roughly equivalent among the groups.

During a positive reinforcement schedule day (Appetitive Condition AP), each work trip completed by an individual subject within Groups 1 to 3 produced a $10 increment in a group account. For G4, each MTPB performance point produced a 1-cent increment to the group account. During a negative reinforcement schedule day (Avoidance Condition AV), completion of work trips did not produce increments in a group account: Each group was assigned a criterion (trips for Groups 1 to 3, points for G4) to achieve during a 24-hr period. Uncompleted trips (or points) below the criterion produced a *decrement* in the group account identical in magnitude to the increments that trips produced during Appetitive Condition AP. Money could be earned only during appetitive days. During avoidance days, no money was earned, and the completion of work trips had the effect of preventing a reduction of the amount previously accumulated within the group account.

In summary, for Groups 1 to 3 the completion of each work trip was maintained by a fixed-ratio contingency during an appetitive day, and during an avoidance day, the ratio size was based upon a criterion ratio value derived from previous appetitive performance. For G4, MTPB performance was maintained by a continuous reinforcement contingency during appetitive days and by a fixed-ratio contingency during avoidance days.

For different groups, Appetitive Condition AP and Avoidance Condition AV were investigated in differing orders and numbers of successive days under each condition, as follows: G1: AP-AV-AP (4,4,2); G2: AP-AV-AP-AV (3,3,3,3); G3: AP-AV-AP (3,6,3); and G4: AP-AV-AP (2,3,2). At the beginning of each 24-hr day, the subjects were notified, by a message on a communication CRT within each private room, about the condition that would be in effect for that particular day. At the beginning of each avoidance day, the trip or point criterion was presented in writing. The avoidance criterion was signed by one of the experimenters. Only one multiple reversal was conducted (i.e., G2) because of the untoward effects, described below, of ending an experiment with an avoidance condition. The trip criterion during avoidance days was based upon group productivity observed during immediately preceding appetitive days. For Groups 1 to 4, the daily avoidance criteria were as follows: G1, 20 trips; G2, 13 trips and 15 trips for the two respective avoidance conditions; G3, 13 trips; and G4, 12700 MTPB points.

On the morning that the experiment began or on the day before the experiment began, an orientation session was conducted in which a

manual of instructions was presented to the subjects and read aloud by the experimenters, detailing the behavioral program and all related procedures. A representative manual is presented in Emurian and Brady (1982). The manual was retained by the subjects for reference during the experiment. It explained the method of payment, and subjects were told verbally the remuneration they could expect from participation, which averaged $25 per day. If a group failed to earn the estimated amount, a bonus was awarded at the end of the experiment.

For G1, the manual instructions pertaining to the reinforcement schedules were as follows:

> A behavioral program *work trip* is composed of the following five activities: Private Arithmetic Problems (PAP), Work One (WK1), Arithmetic Problems (AP), Physical Exercise (PE), and Health Check (H√). The completion of work trips will determine your earnings during this experiment.
>
> There will be two rules by which work trips may be selected, one rule in effect under Program Condition AP, and a second rule in effect under Program Condition AV.
>
> Under Program Condition AP, you may select a work trip after completion of *any* activity in the fixed or optional activity sequence. When you have completed the work trip, you may then select the next activity in the program as if you had not selected the work trip. Of course, you may repeat work trips as often as you want before selecting the next behavioral program activity. Under Program Condition AP, your trip counter will advance at the completion of the last activity in the work trip. At the same time *$10* will be deposited in a group bank account that will be divided evenly among you at the experiment's completion. The counter will reset to zero every 24 hours.
>
> Under Program Condition AV, the experimenters will determine the number of work trips that must be completed by the group in a 24-hour period, and the group must accumulate the required work trips to avoid withdrawals from the group bank account. There will be a *$10* withdrawal from the group bank account for each work trip below the criterion not completed by the end of the 24-hour period. Each time you complete a work trip, your trip counter will advance once. You may use Audit to learn how many trips the other subjects have completed. As in Program Condition AP, you may begin a work trip after any behavioral program activity, and you may take as long as you wish to complete a trip.

For Groups 2 to 4 the instructions were changed only to reflect the different components of a work trip. Subjects were requested to paraphrase these instructions verbally to the experimenters to make certain the procedures and the method of payment were understood.

During each Health Check activity, each subject rated the Behavioral Program Condition (AP or AV) on a 4-point scale where 1 = not bothered by the program and 4 = extremely bothered by the program. An instance of a rating was a circled number (i.e., 1, 2, 3, or 4) adjacent to the prevailing program condition abbreviation (i.e., AP or AV) presented on the Health Check form. These scale anchors apply to all rating data presented below. When a subject completed the Health Check requirements, the information was immediately passed out through a drawer accessible to the monitors of the experiment. These rating scales are presented elsewhere (Emurian & Brady, 1982). Subjects within G4 had fewer opportunities to rate because the Health Check activity at the end of each work trip was not in effect.

Depending upon the duration of the orientation session, the experiment began between 1030 and 1200 hours. With the exception of beginning each experiment with the positive reinforcement schedule, the order and duration of the reinforcement schedules were not determined in advance. Conditions were changed when the appetitive baseline seemed adequate for comparisons to be made, when by-products of aversive control emerged under the avoidance condition, or when a change was required for procedural comparability (e.g., for G3, a return to the appetitive condition during Days 10 to 12).

RESULTS

The presentation of results focuses upon responses (1) that were differentially sensitive to the reinforcement schedules and (2) that were

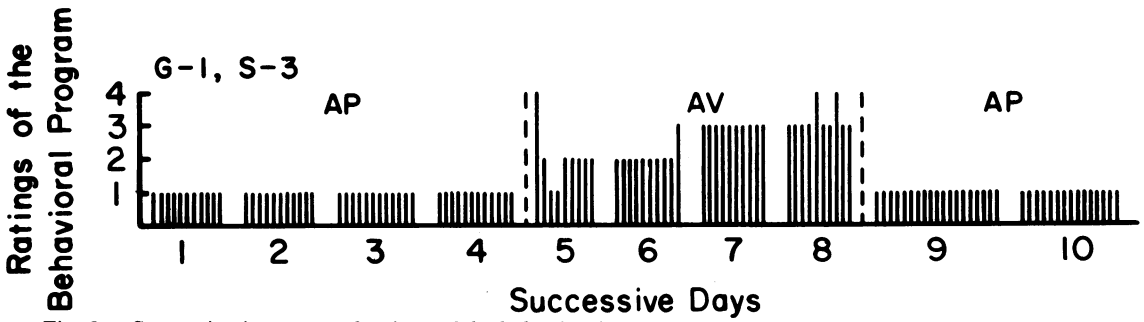


Fig. 2. Successive instances of ratings of the behavioral program across successive days of the experiment for S3 in G1. 1 = not at all bothered by the program, and 4 = extremely bothered. AP = appetitive condition, and AV = avoidance condition.

considered relevant to the status of a confined microsociety in relationship to satisfactory adaptation of participants and to sustained effective performance on work trips. For the four groups, the group accounts contained the following amounts when the avoidance condition was introduced: G1-$750, G2-$380 at end of the first AP period and $840 at end of the second AP period, G3-$310, and G4-$228. At the conclusion of the experiments, the group accounts contained the following amounts: G1-$1510, G2-$830, G3-$1240, and G4-$314. Subjects within G2 and G4 received bonus awards.

Behavioral program ratings. Verbal behavior in relation to the behavioral program changed as a function of the two types of reinforcement schedule. Figure 2 presents successive instances of ratings of the behavioral program across successive days of the experiment for a representative subject (G1, S3). During the first four appetitive days, no departure from a "1" rating was observed. On the first avoidance day (Day 5), the first rating instance was a "4." Thereafter across Days 5 to 8, instances increased in magnitude, with two "4" ratings occurring on Day 8. When the appetitive condition was reintroduced on Day 9, rating instances immediately recovered to "1," and they remained at that level for all successive instances. The functional control of this verbal performance indicates the "reliability" of the scale for this subject under test-retest conditions in which the test occurred during the first 4 appetitive days and the retest occurred during the final 2 appetitive days. All subjects showed the highest ratings during the avoidance condition, and these effects are presented below.

Figure 3 presents mean ratings of the behavioral program for all subjects in each group across successive days of the experiment. Subject 1 in G2 refused to provide rating data on Day 12, the last avoidance day. For each subject, the highest rating occurred during avoidance days, and the reversibility of this effect was indicated by comparatively low ratings that occurred during the appetitive days that followed avoidance days. The ratings of 9 of the 12 subjects gradually increased across successive avoidance days. In contrast, S1 and S3 in G3, composed of females, showed a decrease in ratings across successive avoidance days after initially elevated ratings on the first few days following introduction of the avoidance condition. Finally, subjects within G3, with the exception of S1 on Day 4, did not rate the behavioral program as bothersome during avoidance days as did subjects within remaining groups, despite 6 successive days within the avoidance condition.

Ratings of the experimenters. A subject's verbal behavior in relation to the experimenters sometimes changed as a function of the two types of reinforcement schedule. Figure 4 presents mean ratings of the experimenters for all subjects in each group across successive days of the experiment. Eight of the 12 subjects expressed their greatest annoyance with the experimenters during the avoidance condition, and the overall differences between the conditions were significant [$t(11) = 2.80$, $p < .02$].

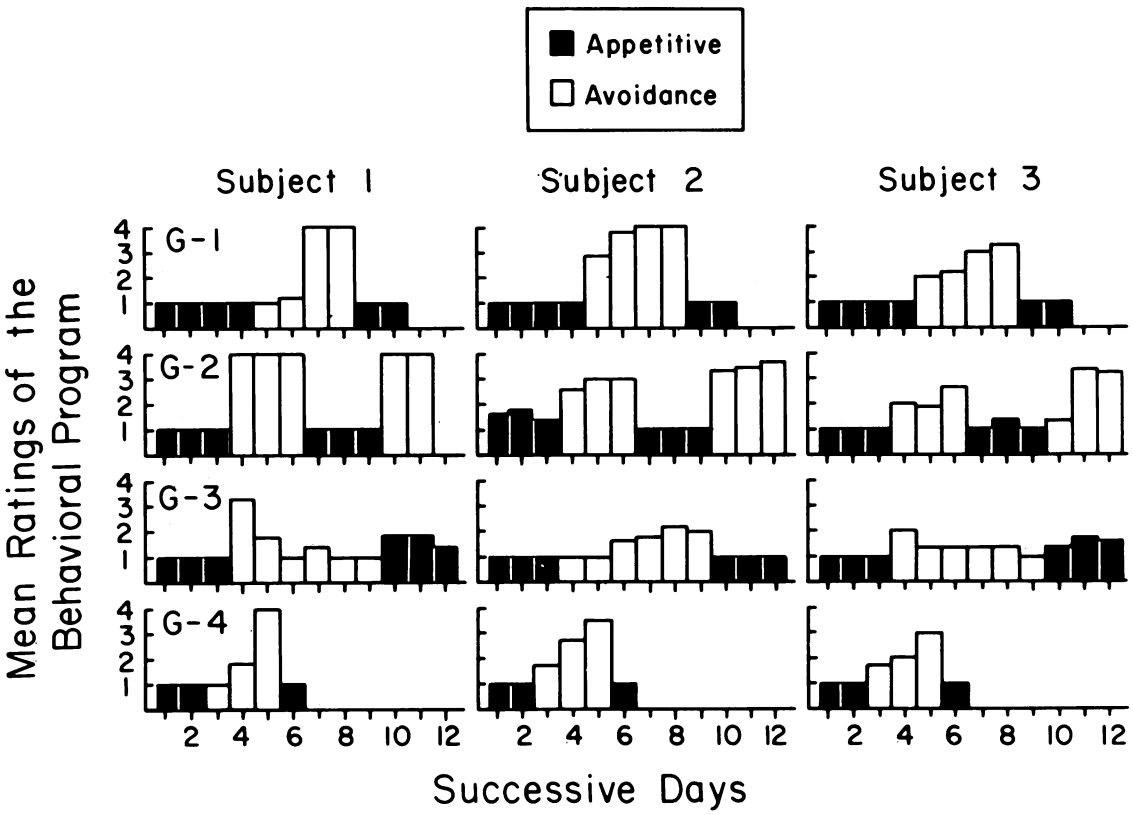


Fig. 3. Mean ratings of the behavioral program for all subjects in each group across successive days of the experiment. 1 = not at all bothered by the program, and 4 = extremely bothered.

Two subjects showed greatest annoyance during the appetitive condition (S1, G3 and S2, G4), and 2 subjects never expressed annoyance (S2, G1 and S3, G4). Finally, the greatest degree of annoyance was expressed during the avoidance condition (e.g., S1, G2, Day 11 and S1, G4, Day 5).

Interpersonal ratings. A subject's verbal behavior in relation to other subjects within a group sometimes changed as a function of the two types of reinforcement schedule. Figure 5 presents mean interpersonal ratings for all subject pairs in each group across successive days of the experiment. Subjects 2 and 3 within G1 and all subjects within G4 expressed greater annoyance with other subjects during avoidance days than during appetitive days. Subjects within G2 showed infrequent expressions of annoyance, and subjects within G3 showed no departure from "1" across 12 successive days. Intersubject and intrasubject variabilities in ratings were related to other effects discussed below.

Mood ratings. During each Health Check activity, each subject completed a "mood" questionnaire (Lorr, Daston, & Smith, 1967) that consisted of 62 adjectives presented in a list. The following 8 adjectives were determined by factor analysis to reflect a single factor that was labeled "Depression": hopeless, helpless, worthless, unhappy, lonely, blue, frightened, and apathetic. The scale anchors 1 to 4 appeared adjacent to each adjective, and subjects were instructed to circle the number that best represented their current state. An integrated score was obtained by summing the ratings associated with each adjective and transforming the result by subtracting the constant $c = 7$ from the sum.

Figure 6 presents mean ratings on the "Depression" factor for all subjects within each group across successive days of the experi-

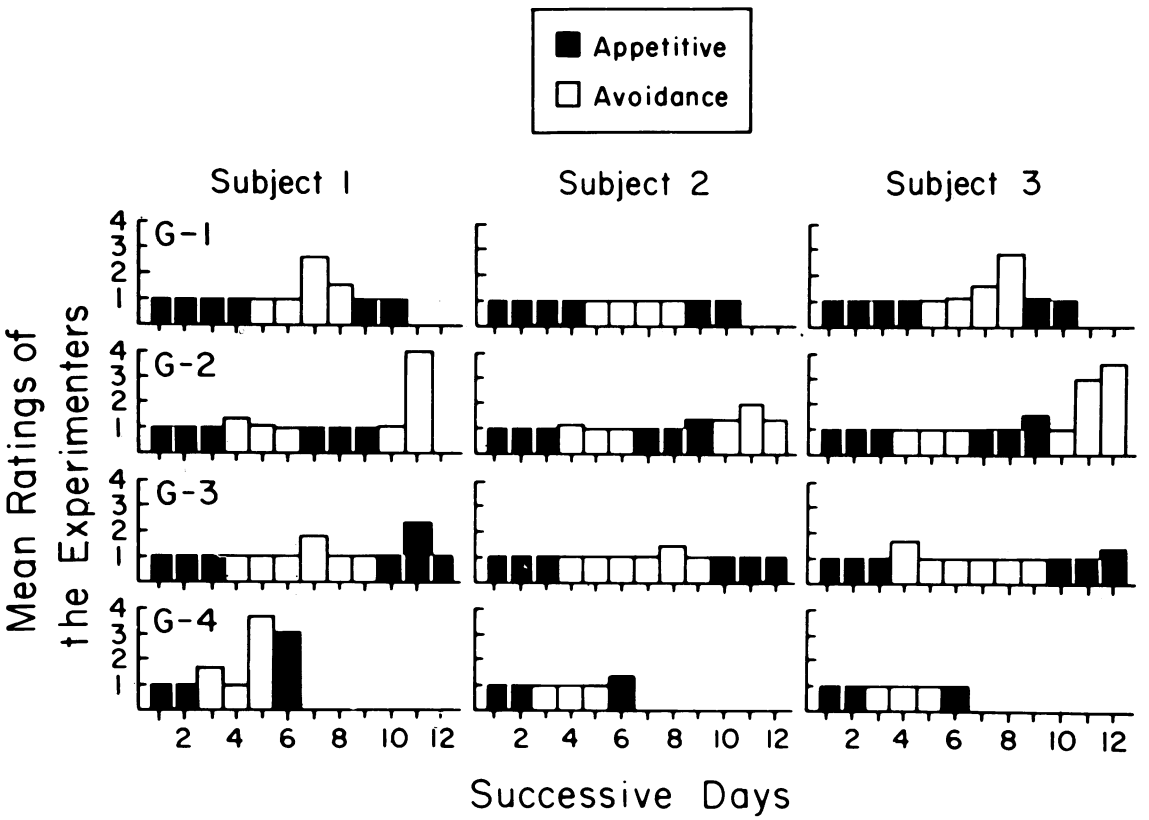


Fig. 4. Mean ratings of the experimenters for all subjects in each group across successive days of the experiment. 1 = not at all bothered by the experimenters, and 4 = extremely bothered.

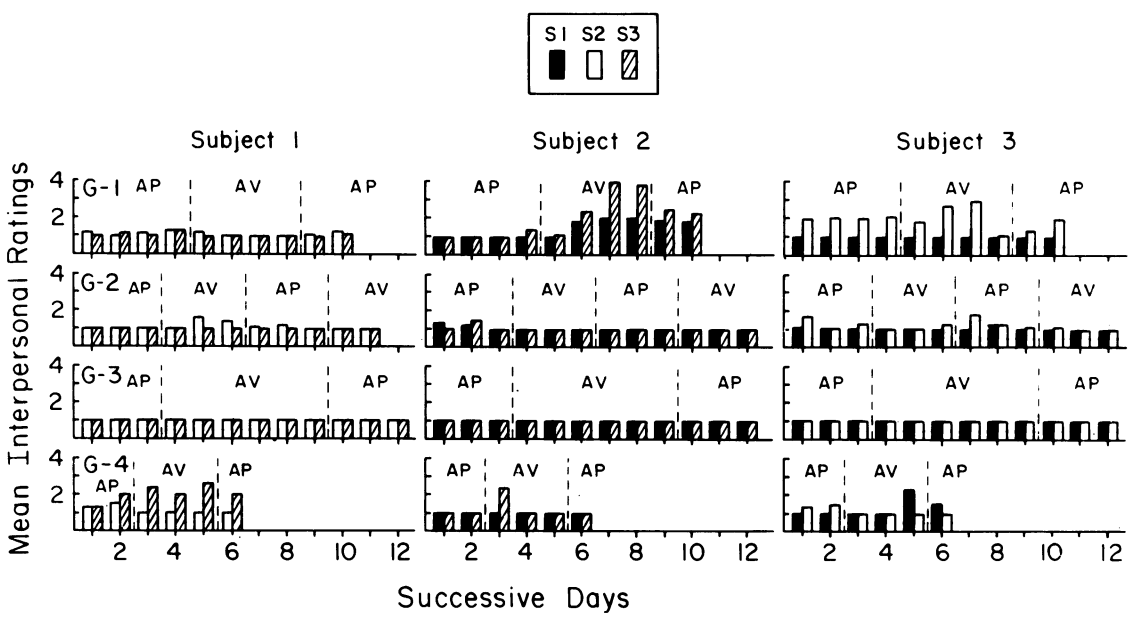


Fig. 5. Mean interpersonal ratings for all subject pairs in each group across successive days of the experiment. 1 = not at all bothered by a subject, and 4 = extremely bothered. AP = appetitive condition, and AV = avoidance condition.

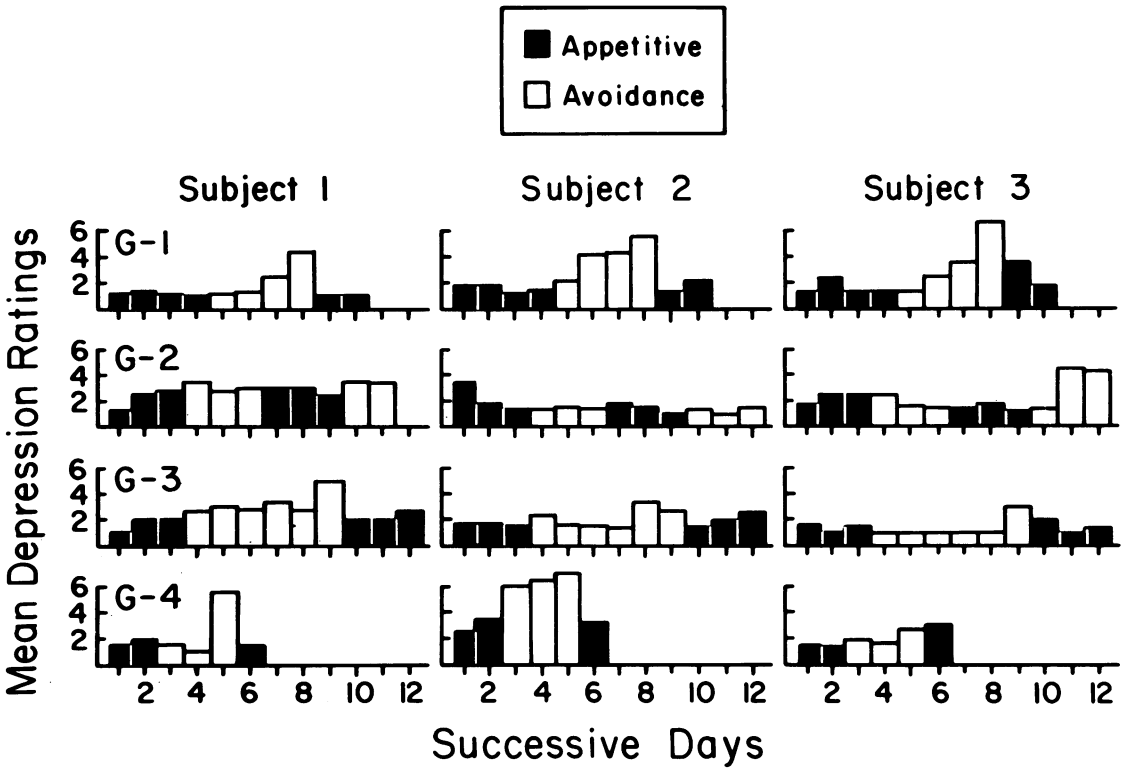


Fig. 6. Mean ratings of "depression" for all subjects in each group across successive days of the experiment.

ment. Ten of the 12 subjects showed the highest rating during the avoidance condition (S2, G2 and S3, G4 were the exceptions), and the overall differences between the conditions were significant [$t(11) = 3.22$, $p < .02$].

Social time. Figure 7 presents dyadic and triadic social durations for all groups across successive days of the experiment. The order of the social episode within a day is indicated by successive ordinal positions above the abscissa. Groups G2 and G3, the 12-day groups, showed triadic episodes on 10 and 9 experimental days, respectively. (Two separate triadic episodes were exhibited by G1 on Day 2.) In contrast, S2 in G1 did not participate in social episodes from Days 7 to 10, after participating in six successive daily triadic episodes. Subjects in G4 never exhibited a triadic episode, and only two dyadic episodes occurred during that 6-day experiment. These latter dyadic episodes never involved S1 and S3 together. The differences among groups in social activity durations were related to interpersonal confrontations within groups as discussed below.

Trip performance. Figure 8 presents cumulative records of four work trips completed by S3 in G1, the first (A) and last (B) in the first AP period, the last in the AV period (C), and the last in the second AP period (D). For PAP, AP, and PE, the stepper advanced only for correct responses. In all conditions, the fixed-ratio performance was stable. Progressively shorter times were required to complete the trip across records A to C. Once a ratio run began in all periods, performance was sustained at a steady rate until the component was completed. Cumulative records of S1 and S2 were similar. No subject within Groups 1 to 3 failed to complete a trip once it had been initiated.

Figure 9 presents details of the performance on the components of the MTPB for S1 within G4. Mean performances across the first three successive 30-min intervals are shown for all work episodes completed within successive program conditions where A = appetitive condition and B = avoidance condition. The fourth interval presents mean performance

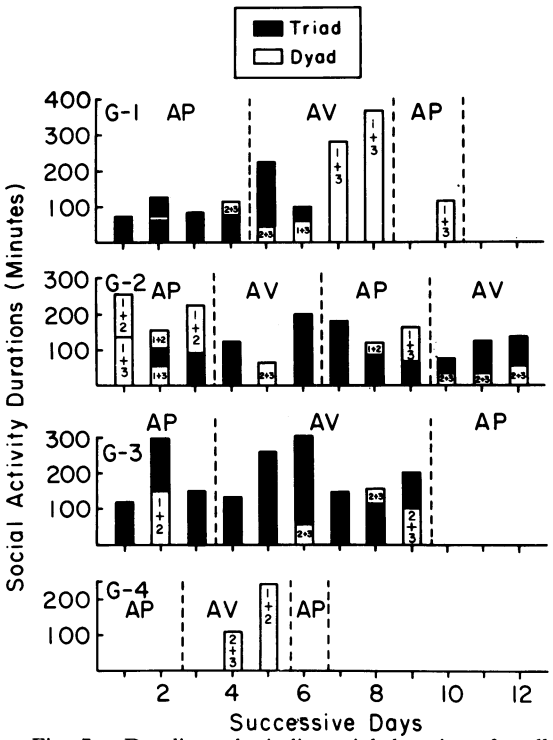


Fig. 7. Dyadic and triadic social durations for all groups across successive days of the experiment. The order of the social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. AP = appetitive condition, and AV = avoidance condition.

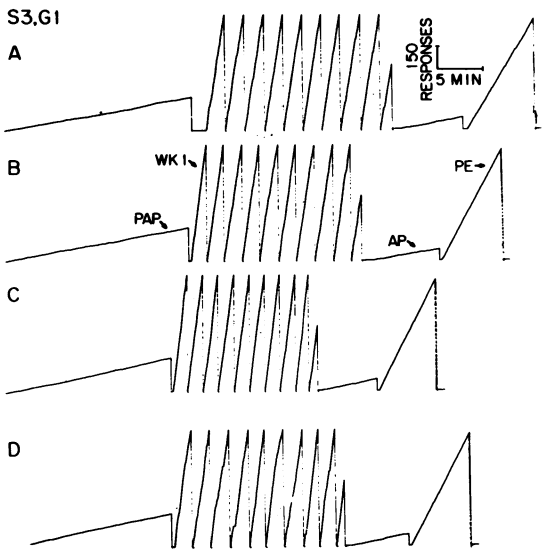


Fig. 8. Cumulative records of four work trips completed by S3 in G1, the first (A) and last (B) in the first AP period, the last in the AV period (C), and the last in the second AP period (D). AP = appetitive condition, and AV = avoidance condition. PAP and AP are arithmetic tasks, WK1 required lever pressing, and PE involved pressing wall-mounted switches when lighted.

during the last 30 min of a work episode. During the second 30 min of a work episode (black bars), a High Performance Probe (HPP) was in effect such that signal and task misses, false alarms, and errors produced reductions in accumulated points. Throughout the remaining intervals of work, only false alarms diminished points. All tasks were performed by the subject during any given interval presented. Errorless performance was never observed, showing that the tasks continued to challenge the subject even after many hours of practice. Improvement in overall performance was attributable, for the most part, to improvement on the Probability Monitoring Task: Over successive program conditions, correct responses increased, errors decreased, missed signals decreased, and the latency from signal onset to detection decreased. However, performance effectiveness was demonstrably sensitive only to the demands of the HPP. During the HPP, the subject showed an increase in false alarms (i.e., errors) on the Probability Monitoring Task during the first two program conditions. Further, the subject showed a striking increase in failures to respond (i.e., misses) during the HPP on the Target Identification Task during the first two program conditions. Similar effects were observed in the data of S2 and S3, although S2 did not show misses on the Target Identification Task during the HPP. The performance data for S2 and S3, along with physiological reactions to the HPP, can be found in a technical report presented elsewhere (Emurian & Brady, 1979). Although performance accuracy was not demonstrably changed between the two conditions, its sensitivity to change was revealed by the decrements observed during the HPP.

Work Trips. Figure 10 presents total work trips for Groups 1 to 3 and total MTPB points for G4 for all subjects across successive days of the experiment. For Groups 1 to 3, the work-trip contingency maintained substantial productivity levels for all subjects irrespective of the program condition, and none of these

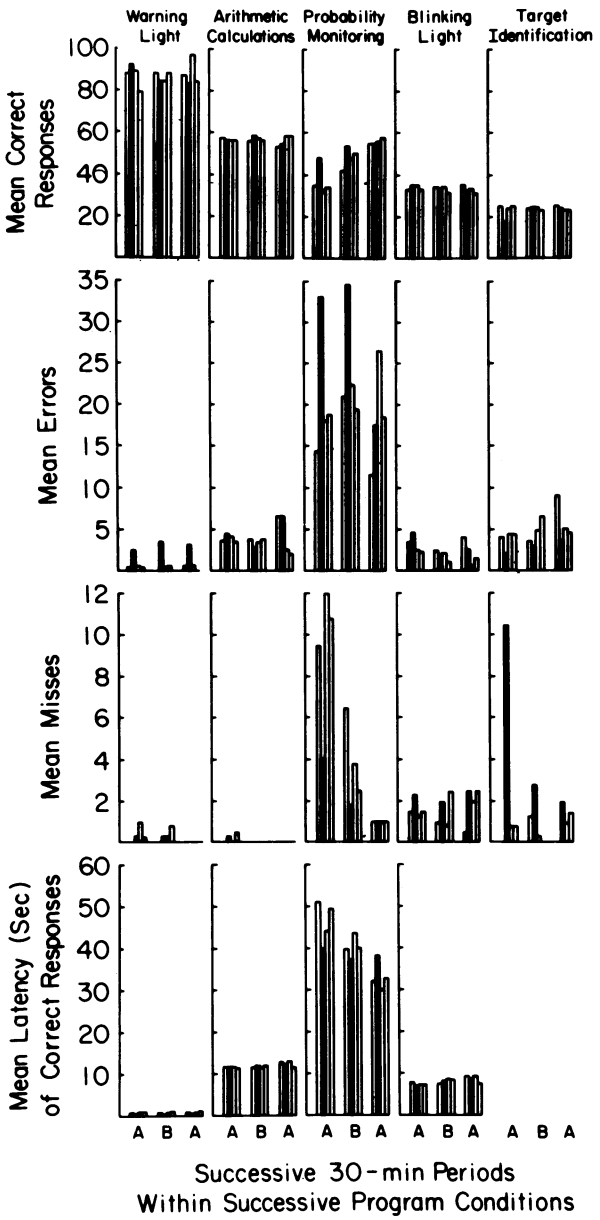


Fig. 9. Detailed data on the performance of S1 within G4 on components of the Multiple Task Performance Battery (MTPB). Mean performances across three successive 30-min intervals are shown for all work episodes completed within successive program conditions where A = appetitive condition and B = avoidance condition. The fourth interval presents mean performances during the last 30 min of a work episode. The black bar denotes increased task difficulty, whereby signal and task misses, false alarms, and errors all produced reductions in accumulated points.

groups failed to reach the criterion during avoidance days. No subject completed fewer than two work trips per day (e.g., S2, G2, Day 1), with a range of 2 to 16 trips (e.g., S2, G3, Day 12). Several subjects showed an increase in total trips during an avoidance period that followed an appetitive period (e.g., S2, G1; S2, G2; and S2, G3). Within Groups 1 to 3, total work trips were more evenly distributed among subjects across days during the avoidance condition than during the appetitive condition. A comparison was made between the

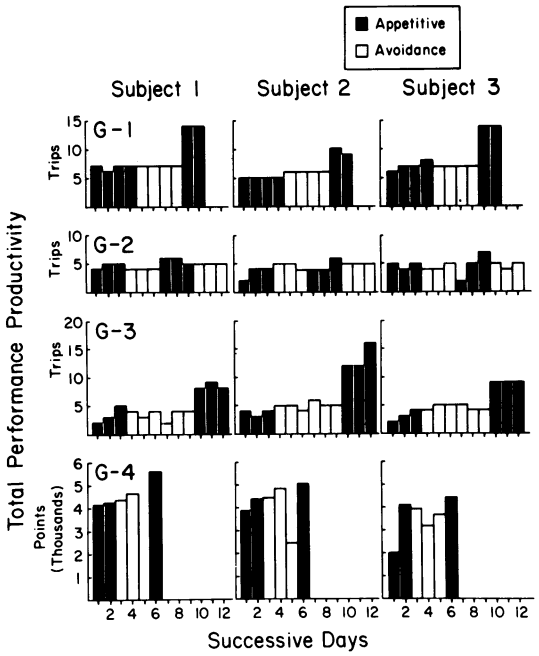


Fig. 10. Total work trips for Groups 1 to 3 and total MTPB points for G4 for all subjects across successive days of the experiment.

two conditions of the differences between the highest and lowest daily work-trip frequency, on the assumption that such differences approach zero when variability is absent. This revealed a statistically significant effect of program condition [$t(28) = 2.07$, $p < .05$]. Finally, all subjects within G1 and G3 showed an increase in daily work trips during the final appetitive days of the study.

In G4, points produced per day on the MTPB varied between and within subjects. Variability in productivity among group members was evident on Day 1 when S3 contributed only 19.8% of the total points earned on that day, in comparison to 41.2% and 40.0% for S1 and S2, respectively. On Day 4, the second day of the avoidance condition, S3 fell behind in what had been agreed upon by group participants as his share of work, and the criterion was missed by 56 points. In response, S1 refused to perform any further work during the avoidance condition, the duration of which was not known by the group. Subject 2 also showed a markedly diminished output of work on Day 5, during which the group lost heavily in potential earnings and the criterion was missed by 6495 points. When the appetitive condition was reintroduced on Day 6, S1 and S2 again contributed to work, and like G1 and G3, all subjects showed the greatest daily point accumulations on that final day of the experiment.

Work time. Figure 11 shows the times of day spent working for all subjects in G1 across successive days of the experiment. Avoidance days are bracketed. Typically, work trips were completed between 1000 and 0200 hours of a day, and each work trip lasted approximately 1 to 2 hours. Subjects did not complete a day's work during a single uninterrupted succession of work trips. Rather, work trips were interspersed throughout waking hours, and other behavioral program activities were interposed between episodes of one or more trips. In comparison to trip distributions during preceding appetitive days, intertrip intervals appeared briefer on avoidance Days 5 to 8. On the final appetitive days, more successive trips were completed without a pause than was observed during preceding appetitive and avoidance days. Similar effects were observed in Groups 2 and 3, although in G3, subjects did not show the pronounced shortening of intertrip intervals during the avoidance condition.

For G4, subjects initially adopted an orderly and alternating sequence of using the single CRT console to operate the MTPB, with each uninterrupted work episode lasting approximately 4 hr. During the first 3 days, there was almost perfect day-to-day agreement for the time of day when each subject worked. On Day 4, the second avoidance day, S2 and S3 switched positions from the previously established pattern, with S3 now working later in the day in comparison to his work times during the preceding days. On Day 5, S1 failed to work, S2 worked on one occasion, and S3 worked on two occasions. On Day 6 when the appetitive condition was reintroduced, subjects adopted an alternating work sequence identical to that on Day 4. Finally, only S1 maintained a consistent time of day when he worked across successive days of the experiment.

Sleep time. For subjects in Groups 1 to 3, sleep typically occurred during a single daily episode, and "naps" were infrequent. Subjects

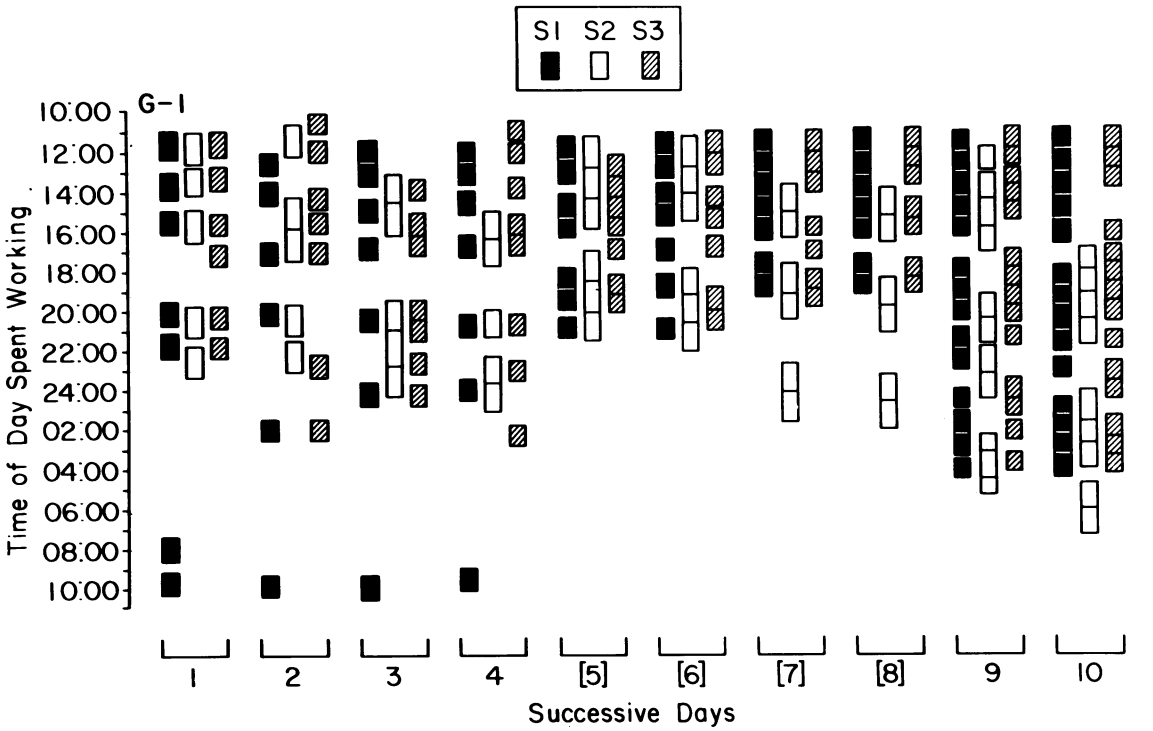


Fig. 11. Times of day spent working for all subjects in G1 across successive days of the experiment. Avoidance days are bracketed.

within and between those groups differed somewhat in stability of wake-sleep cycles over days. Almost all sleep periods exceeding 6 hr in duration began after 2400 hours.

Wake-sleep cycles for subjects in G4 were broken and unstable across successive days. Sleep episodes typically were less than 8 hr in duration, and more than one sleep period occurred per day for most subjects. These latter effects are attributable, at least in part, to the style of alternating work that the subjects adopted to operate the MTPB around the clock.

Audits. The Audit activity in the behavioral program was freely available, and whenever a subject requested an audit, all 3 subjects' cumulative performance scores (trips for Groups 1 to 3 and points for G4) for that day were presented on a CRT in the private room. Scores were reset to zero at the beginning of each day. Figure 12 presents total audit responses for all subjects in each group across successive days of the experiment. This figure shows that access to performance scores was a reinforcer for almost all subjects (S1 in G2 was the exception). Most prominent in these data is the intersubject variability in audit responses, with a range of zero (S1, G2) to 17 audits (S2, G1). The number of audit responses was not demonstrably affected by the reinforcement conditions.

DISCUSSION

Changing the consequences of performing a task from an appetitive to an avoidance schedule of reinforcement produced some by-products of aversive control. These effects were evident in nonsocially evoked verbal behavior (e.g., behavioral program and "mood" ratings), socially evoked verbal behavior (e.g., intersubject and experimenter ratings), and work performances (e.g., trip distributions between and within subjects). In the fourth group, one subject stopped working, and a second subject reduced his productivity during the avoidance condition. When the avoidance condition was changed to appetitive, such by-products were

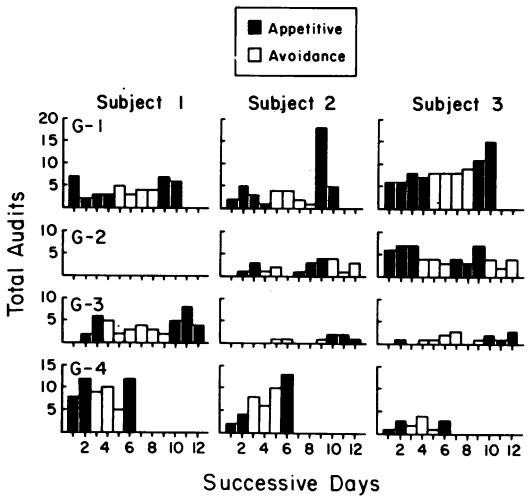


Fig. 12. Total audit responses for all subjects in each group across successive days of the experiment.

eliminated or reduced in intensity despite a group's several-day history of working under aversive control. These effects suggest that the functional properties of work were more significant to the group members' well-being than were the topographical properties (i.e., behavior required to perform work). Although effects of an avoidance schedule were seen with only a single multiple reversal experimental design (i.e., A-B-A-B with G2), the changes that occurred during a second appetitive condition in all groups, in contrast to effects observed during prior avoidance days, suggest control by that negative reinforcement schedule rather than control attributable to the passage of time within the laboratory environment or to other factors.

The present experiment consisted of four systematic replications in which control by the avoidance schedule was demonstrated by affirming the consequent (Sidman, 1960), in which case each successive replication incrementally contributed to an understanding of effects that can be reliably attributable to the antecedent condition (i.e., the avoidance schedule). The generality of the behavioral processes is indicated by the similar effects observed across a broad range of circumstances (e.g., subjects, duration of experiment, work tasks, order of experimental conditions, etc.). Interpersonal confrontations were most prominent within those groups (G1 and G4) having an assertive member who was intolerant of intersubject variability in work productivity during the avoidance condition. Other human operant studies have suggested that inequity (i.e., intersubject variability) in reinforcers is aversive within a social-exchange paradigm (Marwell & Schmitt, 1975; Shimoff & Matthews, 1975), and social psychologists have reported relationships between inequity and human anger (e.g., Adams, 1963, 1965; Ross, Thibaut, & Evenbeck, 1971) and "frustration" and human anger (e.g., Berkowitz, 1981). The variability in effects of the avoidance schedule may originate in between-subject variations in the way inequity affects performance under aversive control, inasmuch as the present contingencies, both appetitive and aversive, compensated subjects equally. The extent to which individual differences may be characterized as behavioral data must await clarification by further analyses of the interactions between reinforcement schedules and personal-history variables.

The continuity of behavioral processes is suggested by subjects' reactions to the avoidance schedule, which are similar to the results of the studies of similar phenomena under both social (e.g., Azrin, Hutchinson, & Hake, 1963) and nonsocial (e.g., Azrin, Rubin, & Hutchinson, 1968) conditions. Fixed-ratio schedule-induced aggression has been observed under fixed-ratio schedules (Cherek & Pickens, 1970; Flory, 1969; Gentry, 1968; Hutchinson, Azrin, & Hunt, 1968; Lyon & Turner, 1972; Webbe, DeWeese, & Malagodi, 1974), and recent analyses have emphasized the temporal patterning of reinforcers as the inducing events (DeWeese, 1977). Moreover, both fixed-ratio and extinction-induced aggressive responses have been reported with pigeons (Knutson, 1970), and extinction-induced aggression has been reported with humans (Kelly & Hake, 1970). All these factors suggest that the present findings may be incorporated within a single conceptual framework for analysis of by-products of aversive control (Hutchinson, 1976, 1983), for they suggest that similar variables may be involved.

The earliest indication of subjects' sensitivity

to the presence of an aversive reinforcement schedule was in the form of verbal responses. Recurrent written responses by subjects reflected complaints about the aversive contingency when it was first introduced, and such expressions of discontent usually increased in magnitude across the duration of the avoidance condition (see Figure 2). These written responses, along with anecdotally observed vocal complaints about the avoidance contingency, are categorized by their functional properties as mands (Skinner, 1957), and they emerge because similar verbal responses have been effective historically in eliminating aversive events from one's environment. These data suggest the importance of frequent and systematic assessment of subjects' descriptions of their environment so that the necessary adjustments may be undertaken to prevent a crisis situation such as occurred on Day 5 of the fourth experiment.

Within those groups in which negative intersubject ratings were prominent (i.e., G1 and G4), the interpersonal effects were correlated with a reduction in or even complete absence of social interactions. For example, S2 within G1 did not participate in either dyadic or triadic social episodes from Days 7 through 10. Subjects within G4 never participated in a triadic social episode, and neither of the two dyadic episodes involved S1 and S3 who showed most mutual annoyance. Relationships between interpersonal incompatability and social interactions have been reported in other studies of group behavior under conditions of isolation and confinement (e.g., Altman & Haythorn, 1967).

The only local effects of the two types of reinforcement schedules on the work performance baseline were reflected in trip distributions. Subjects within G1 and G3 sometimes showed more rapid completion of work, in relationship to the start of a day, during avoidance days than during preceding appetitive days. These effects are consistent with fixed-ratio avoidance performances where the ratio run in a multiple schedule occurred soon after component onset (Morse & Kelleher, 1966). The exceptions were the cessation of work (S1, G4) and the diminution of work (S2, G4) by 2 subjects in G4 during the last day of a 3-day avoidance condition. Withdrawal from a social exchange relationship has been suggested as a possible outcome when inequity cannot be overcome (Adams, 1965), and in G1 and G4, "high-productivity" subjects were apparently unsuccessful in persuading the "low-productivity" subject to increase markedly his output during both appetitive and avoidance days. That S1 in G4 remained "involved" with the group, however, was indicated by his audit responses on Day 5 when he refrained from work. Moreover, at least one "low-productivity" subject (S2, G1) increased his output during the avoidance condition, and both S2 in G1 and S3 in G4 showed the highest work output during the final appetitive days, as did all 10 remaining subjects. These latter effects occurred without deleterious by-products, and they indicate that differing performance productivity per se was not the source of negative reactions.

The insensitivity of the work performance baseline to disruption once work was in progress was consistent with previous analyses of the resilience of fixed-ratio performances in relation to reinforcer proximity in a conditioned-suppression paradigm (Lyon, 1964), to the intensity of punishment (Azrin, 1959; Dodd, Williams, Bissell, & Weisman, 1977) and to low values of a differential-reinforcement-of-other-behavior (DRO) contingency (Zeiler, 1979) required to disrupt performance. The characteristic fixed-ratio "break-and-run" pattern was observed (Ferster & Skinner, 1957). Once work was initiated after a preratio pause (Griffiths & Thompson, 1973), performance persisted at a high and steady rate until completion of a trip(s) or several hundred MTPB points. Diminution in performance productivity, when observed, was attributable to less frequent work trips or MTPB episodes (e.g., S2, G4, Day 5). Similar human performance under fixed-ratio schedules has been reported (Long, Hammack, May, & Campbell, 1958; Poppen, 1982; Weiner, 1970).

The above observations suggest that obtaining many distinct measures in the course of a behavior analysis is important. Intersubject and/or intrasubject variability observed

within one response domain may be interpretable in relation to variability observed within another domain. For example, the 2 subjects (S3, G1 and S1, G4) who exhibited consistent high rates of auditing, in comparison to other subjects, were also most prominent in intersubject confrontations during avoidance days. These two response domains may be functionally related: An initially high rate of interpersonal auditing under conditions of positive reinforcement may indicate, as a behavioral "marker" of individual differences, sensitivity to disruptive reactions when inequity exists under conditions of negative reinforcement. The importance of measuring several concurrent responses has also been demonstrated with human behavior analyses where a person's rate of auditing his and another's performance "score," produced within the context of a dyadic social relationship, was interpretable in terms of other observations (Hake, Vukelich, & Kaplan, 1973; Vukelich & Hake, 1974). High rates of auditing in both situations may be functionally related to a subject's low level of "trust" that an equitable relationship between work and reinforcers will prevail over time (Hake & Schmid, 1981; Schmid & Hake, 1983). A multidimensional strategy has also proved productive in other studies of group behavior under conditions of isolation (Altman, Taylor, & Wheeler, 1971).

The group whose members showed weak by-products of aversive control (G3) was composed of females. Had the avoidance condition for G3 persisted beyond 6 days, perhaps stronger effects than those observed would have emerged eventually. The appetitive condition was reintroduced for the final 3 days in G3 to maintain procedural comparability with other groups, to provide the opportunity for a terminal "burst" of responding, and to provide the opportunity for dissipation of those by-products that were observed. Although it is provocative to relate the observed differences in outcome between the males and females to a "gender effect," such an interpretation in the present analysis is premature. In a recent review of research studying sex differences in anger and aggressiveness, there were more similarities between men and women than there were differences (Averill, 1982). Possible sources of variability, other than gender, such as education, vocation, economic need, sociability, personality, and achievement motivation (Helmreich, Spence, Beane, Lucker, & Matthews, 1980), among many others, must be considered and controlled before such a conclusion can be reached (cf. Jones & Annes, 1983; Smith & Haythorn, 1972).

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