

*EFFECTS OF INSTRUCTIONS AND REINFORCEMENT-
FEEDBACK ON HUMAN OPERANT BEHAVIOR
MAINTAINED BY FIXED-INTERVAL REINFORCEMENT¹*

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In three experiments, human subjects were trained on a five-component multiple schedule with different fixed intervals of monetary reinforcement scheduled in the different components. Subjects uninstructed about the fixed-interval schedules manifested high and generally equivalent rates regardless of the particular component. By comparison, subjects given instructions about the schedules showed orderly progressions of rates and temporal patterning as a function of the interreinforcement intervals, particularly when feedback about reinforcement was delivered but also when reinforcement-feedback was withheld. Administration of the instructions-reinforcement combination to subjects who had already developed poorly differentiated behavior, however, did not make their behavior substantially better differentiated. When cost was imposed for responding, both instructed and uninstructed subjects showed low and differentiated rates regardless of their prior histories. It was concluded that instructions can have major influences on the establishment and maintenance of human operant behavior.

Several experiments have demonstrated the influence of instructions on the acquisition and maintenance of human operant performance. One finding has been that when instructions about the desired response are omitted, substantial numbers of subjects may fail to acquire the response despite scheduling of reinforcing contingencies deemed favorable for acquisition (*e.g.*, Ader and Tatum, 1961; Ayllon and Azrin, 1964; Turner and Solomon, 1962). By comparison, addition of instructions about the desired response results in rapid adoption of the response (*e.g.*, Ayllon and Azrin, 1964; Baron and Kaufman, 1966) but also may induce inappropriately high rates, particularly on temporally based schedules (Kaufman, Baron, and Kopp, 1966; Weiner, 1962). More detailed instructions about reinforcing contingencies, as well as the response itself, typically produce response rates approximating the requirements of the reinforcement schedule (*e.g.*, Dews and Morse, 1958; Kauf-

man *et al.*, 1966; Weiner, 1962). Finally, several studies have shown that instructions about the reinforcement schedule may have effects overriding those of the schedule itself. Thus, instructions can induce behavior in the absence of reinforcement (Ayllon and Azrin, 1964; Kaufman *et al.*, 1966), and can produce behaviors more in accord with instructions than with actually scheduled reinforcement (Kaufman *et al.*, 1966; Lippman and Meyer, 1967).

The present experiment dealt with performances by human subjects on fixed-interval schedules of reinforcement, and, in particular, the influences of instructions on such performance. Holland (1958) reported that uninstructed subjects exhibited the temporal patterning characteristic of subhuman subjects on fixed-interval schedules, with overall response rates decreasing with increases in the duration of the fixed interval. Other researchers (*e.g.*, Blair, 1958; Weiner, 1962), however, observed high, undifferentiated rates under analogous conditions. In addition, Weiner (1962) showed that one way of producing lower rates and temporal patterning on fixed-interval schedules is by making "response cost" contingent upon responding, as when in his study each response resulted in loss of the points used to maintain the fixed-interval behavior.

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The three experiments of the present series trained subjects on a five-component multiple schedule with different fixed-interval schedules of monetary reinforcement in the different components. Experiment I compared the controlling influences of instructions with those exerted by the reinforcement schedule itself. Subjects were trained under either standard conditions, *i.e.*, when uninstructed about the schedule of reinforcement, or with one of several combinations of the instructions and reinforcement conditions, *i.e.*, when instructed about the schedule but without feedback about reinforcement in the experimental environment, with both instructions and reinforcement, and with neither instructions nor reinforcement. Experiment II was concerned with the reversibility of the effects observed in Exp. I. Finally, Exp. III examined the effects of response-cost when introduced in conjunction with some of the above procedures.

METHOD

Subjects

Eighteen female college students served as paid subjects for an extended series of experimental sessions: Subjects 1 to 14 in Exp. I, Subjects 1, 2, 5, 6, 9, and 10 in Exp. II, and Subjects 15 to 18 in Exp. III. Subjects were paid \$0.75 for each 50-min experimental session and could earn up to \$0.88 more depending upon performance.

Apparatus

The subject sat at a table in a 6-ft (1.82-m) sq sound-attenuated room. Mounted on the table was an 11 by 18 in. (279 by 457 mm) sloping panel with a plastic pushbutton in the center (Grason-Stadler, E8670A) that required a force of 50 to 90 g to operate. A five-digit electrical-reset counter was situated 2.5 in. (64 mm) to the left of the pushbutton. For some subjects in Exp. I and II and for all subjects in Exp. III, a second counter was located symmetrically to the right of the response key. This second counter was not part of the procedure when present in Exp. I and II; it always read zero and subjects were told to disregard it.

Spaced at 2.5-in. (64-mm) intervals at the top of the panel were five small lights covered with different colored plastic caps, 0.5 in. (13 mm)

in diameter. The colors, in the order left to right, were: blue, red, green, yellow, and orange. Control and recording equipment were located in an adjacent room.

Preliminary Orientation

Before the preliminary training session, which lasted for only 10 min, each subject read a printed description of the job for which she had applied. She was informed that: (a) no information could be provided about the purpose of the research but that it was neither physically nor psychologically harmful; (b) that she would be able to earn, on the average, from \$1.00 to \$1.50 per session; (c) she must await payment until the end of the experiment; (d) she would be fined \$1.00 for each absence without prior notice and excuse; (e) she would forfeit all earnings if she dropped out before the end of the experiment.

Experimental Procedure

Before entry into the experimental room, personal belongings were taken from the subject including her purse, books, watch, and any writing materials. The session began shortly afterwards and, except for the preliminary session, always lasted 50 min.

After each session, subjects were given a written voucher indicating their earnings for that session. Actual payment usually was given only at the end of the experiment, although in a few cases fractional payments were made earlier because of the subject's financial need.

The same five-component multiple schedule operated during all sessions. Each session was divided into five 10-min periods during each of which a different colored light was presented. Four of the lights, blue, red, green, and yellow, were associated with fixed-interval schedules of reinforcement with temporal intervals of 10, 30, 90, and 270 sec respectively. The fifth, orange light was associated with extinction.

The first interval of a given schedule was timed from the onset of the component and subsequent intervals from preceding reinforcements. The order of components was varied in a semi-random order from session to session in such a way that each component preceded every other component an equal number of times. Changes from one component to another were separated by 3-sec timeout periods when all stimulus lights were off and respond-

ing had no scheduled consequences. During the preliminary 10-min session, only the FI 90-sec schedule was used.

During the training under the *feedback* condition, the left-hand counter in the experimental room advanced as the reinforcer was delivered. During training under the *no-feedback* condition, the left-hand counter never advanced, but a record was kept in the control room of the number of reinforcements. For the *cost* condition (Exp. III only), the right-hand counter advanced each time the response key was operated.

Instructions

Five sets of printed instructions, corresponding to the different conditions studied in the three experiments, were used. These instructions, which the subject was asked to read before the first session, remained in the room for the duration of the condition.

Schedule Instructions-Feedback (I-F). The most comprehensive instructions were given to subjects exposed to this condition, and are given in their entirety below. Instructions used for other conditions, described later, primarily involved deletion and/or substitution of certain sections. Numeration of paragraphs has been added below for ease of reference to these sections.

- (1) This is how you will earn money. First, you always will be paid at least 75¢ for each session you work regardless of what you do. You can earn money in addition to the 75¢ by pressing the button located in the center of the panel. To work properly, the button must be pressed all the way down and then released.
- (2) Now look at the counter to the left. Right now it registers zero. Each time that the counter advances, it means that you have earned 1¢. If, for example, at the end of the session the counter registers 70, it means that you have earned 70¢ by pressing the button. When added to the 75¢ mentioned above, you would have earned \$1.45 for that session.
- (3) Here is how the counter works. When the button is pressed, the counter sometimes will advance. The counter can work only after a fixed

period of time has elapsed since the last time it worked. This means that if you press the button before the period of time is up, nothing will happen. Once the time is up, the counter will be ready to work when you press the button. Upon pressing the button, the counter will register and the fixed period of time will begin over again. If you delay pressing the button when the counter is ready to work, you will be losing time when you could be making money.

- (4) Now, look at the five lights at the top of the panel. During different portions of the session, one of these lights will be on. These lights will serve as signals to you.
- (5) The color of the light indicates the duration of the time interval associated with the working of the counter, that is, how soon it can work after its last operation: BLUE = 10 seconds; RED = 30 seconds; GREEN = 90 seconds; YELLOW = 270 seconds; ORANGE = the counter does not work at all. One other thing about the signal lights and the time intervals: when there is a change from one color to another, the particular time interval starts when the light goes on.

Subsequent parts of the instructions indicated that: (a) the onset of one of the signal lights on the darkened panel would indicate the beginning of the session and offset of all lights the end of the session; (b) responding would be ineffective during the brief interval when the colors changed; (c) earnings based on the counter reading would be entered on a payment sheet at the end of the session; and (d) no questions could be answered.

Schedule Instructions-No Feedback (I-NF). For subjects exposed to this condition, the following paragraph, indicating that the left-hand (reinforcement) counter would not operate, was substituted for paragraph (2) in the I-F instructions:

- (2a) Now look at the counter to the left. This counter does not work and will always register zero. However, each time that a counter just like it in the adjacent room advances, you have earned 1¢. If, for example, at

the end of the session, the counter in the adjacent room registers 70, it means that you have earned 70¢ by pressing the button. When added to the 75¢ mentioned above, you would have earned \$1.45 for that session.

No Schedule Instructions-Feedback (NI-F). For subjects trained with this condition, paragraphs (3) and (5) of the I-F instructions, those parts pertaining to the fixed-interval schedules, were deleted.

No Schedule Instructions-No Feedback (NI-NF). For subjects trained with this condition, paragraphs (3) and (5) of the I-F instructions were deleted, and in place of paragraph (2) the alternative no-feedback paragraph (2a), described for the I-NF condition, was used.

Cost (C). This condition was employed only in Exp. III and always in combination with one of the above sets of instructions. Following paragraph (5) in the NI-F instructions, or in the analogous place in the other instructions, the following paragraph about the right-hand, cost-counter was inserted:

Finally, notice the counter to your right. It now registers zero. This counter will advance each time you press the center button. It has nothing to do with how much money you earn; it just advances each time the button is pressed.

Subsequently in Exp. III, when the cost condition was introduced, the following additional instructions were given:

From now on, each time the right-hand counter advances it means that you have lost one-tenth of a cent from your earnings on the left-hand counter. Every 10 counts on the right-hand counter, then, means the loss of 1¢. When the session is over, I will subtract the money you have lost, as indicated on the right-hand counter, from the money you have earned, as indicated on the left-hand counter, up to the limits of those earnings. As before, you always will earn 75¢ for each session regardless of the counter readings at the end of the session.

EXPERIMENT I: INSTRUCTIONS AND FEEDBACK, ALONE AND IN COMBINATION

Subjects 1 to 14 served in Exp. I. As summarized in Table 1, four subjects (S1, S2, S3,

and S4) were assigned to the I-F condition, *i.e.*, they were given instructions about the reinforcement schedule, and reinforcement-feedback was provided on the left-hand counter in the experimental room. The four subjects (S5, S6, S7, and S8) assigned to the I-NF condition also were given schedule instructions, but the reinforcement counter remained inoperative.

Table 1
Assignment of subjects and sequence of conditions in Experiments I and II.

Subjects	Exp. I Sessions 1-20	Exp. II Sessions 21-40
1, 2	I-F	I-NF
3, 4	I-F	—
5, 6	I-NF	I-F
7, 8	I-NF	—
9, 10	NI-F	I-F
11, 12	NI-F	—
13, 14	NI-NF	—

The four subjects (S9, S10, S11, and S12) assigned to the NI-F condition were uninstructed about the schedule, but reinforcement-feedback was provided. Finally, two subjects (S13, S14) were assigned to the NI-NF condition, *i.e.*, they were neither instructed about the schedule nor given reinforcement-feedback.

As indicated by the instructions, at the end of each session subjects in the feedback condition were told their additional earnings based on \$0.01 for each count registering on the left-hand counter at the end of the session. Subjects in the no-feedback condition were told their earnings based on the number of times the counter would have registered had it been operative.

All subjects were trained for twenty 50-min sessions.

EXPERIMENT II: SEQUENTIAL EFFECTS OF CHANGES IN INSTRUCTIONS AND FEEDBACK

Subjects 1, 2, 5, 6, 9, and 10, all of whom had served in Exp. I, were used. Beginning with Session 21, and continuing for a total of twenty 50-min sessions, the following procedural changes shown in Table 1 were made: (a) S1 and S2, trained originally in Exp. I with the I-F procedure, were shifted to the I-NF procedure, *i.e.*, the reinforcement counter now was inoperative; (b) S5 and S6, trained originally in Exp. I with the I-NF procedure, were shifted to the I-F procedure, *i.e.*, reinforce-

ment-feedback now was added to the schedule instructions; (c) S9 and S10, trained originally in Exp. I with the NI-F procedure, also were shifted to the I-F procedure, *i.e.*, schedule instructions now were added to reinforcement-feedback. In all cases, subjects were asked to read, before Session 21, the instructions appropriate to the new condition, and these new instructions remained in the room thereafter.

EXPERIMENT III: ADDITION OF RESPONSE

COST TO INSTRUCTIONS AND FEEDBACK

Four subjects (S15, S16, S17, and S18), who had not previously served, were used. As indicated in Table 2, three (S15, S16, and S17) were trained for twenty 50-min sessions using the NI-F procedure, while the fourth subject (S18) was trained using the I-NF procedure. During these 20 sessions, the right-hand counter advanced each time a response was made, but, as stated in the instructions, these counts were unrelated to earnings.

During Sessions 21 to 40, the cost instructions were introduced for all four subjects, and one cent was deducted from left-hand counter earnings for each 10 counts that registered on the right-hand counter at the end of the session.

Finally, during Sessions 41 to 60, S15 and S16 were observed under the I-NF condition with cost while S18 was observed under the I-F procedure with cost.

Table 2

Assignment of subjects and sequence of conditions in Experiment III.

Subjects	Sessions		
	1 to 20	21 to 40	41 to 60
15, 16	NI-F	NI-F (C)	I-NF (C)
17	NI-F	NI-F (C)	—
18	I-NF	I-NF (C)	I-F (C)

RESULTS

The main concern was with the functions relating response rates to rates in the different components of the schedule. Direct graphic presentation of these data was complicated by wide variations between rates of different subjects and within rates of individual subjects. To deal with this problem, and to reduce the effects of occasional discrepant rates, the num-

ber of responses in each 10-min component of each session of the experiments were converted to common logarithms (with the value of one added to each daily total to eliminate scores of zero). These logarithms of response rates then were averaged in five-day blocks and graphed as a function of the reinforcement rate within each of the components. In referring to the response rate-reinforcement rate functions given below, it may be helpful to note the response-rate equivalents (antilogarithms) of the integers on the logarithmic ordinate: 0 = 0 responses/10 min; 1 = 9 responses/10 min; 2 = 99 responses/10 min; and 3 = 999 responses/10 min.

EXPERIMENT I: INSTRUCTIONS AND FEEDBACK, ALONE AND IN COMBINATION

The results summarized in Fig. 1 show performances of the members of each of the four groups during Days 1 to 5 (top panels) and Days 16 to 20 (bottom panels) of training. The data in the top four panels indicate systematic differences involving the instructions variable during the first five training days. Five of the eight subjects given instructions, three trained with the I-F procedure (S1, S2, S3), and two with the I-NF procedure (S7, S8), responded at rates appropriate to the schedule, *i.e.*, their response rates generally were low (within the range 0 to 100 responses/min) and were close to the minimum required to produce all scheduled reinforcements. Rates of the remaining three instructed subjects, S4 trained with the I-F procedure and S5 and S6 trained with the I-NF procedure, also varied as a function of component, but rates were somewhat higher and the progression of rates was less orderly. By comparison with modal performances of instructed subjects, rates of the six uninstructed subjects (NI-F and NI-NF) during Days 1 to 5 were considerably higher and, with the possible exception of S10 in the NI-F condition, no tendencies can be seen for response rates to vary as a function of reinforcement rates.

The top panels of Fig. 1 also show that the feedback condition had little or no initial effect. Thus, average performances of subjects trained with the I-F procedure were not markedly dissimilar from performances of subjects trained with the I-NF procedure. Similarly, no differences of any great magnitude can be discerned between the NI-F and NI-NF subjects.

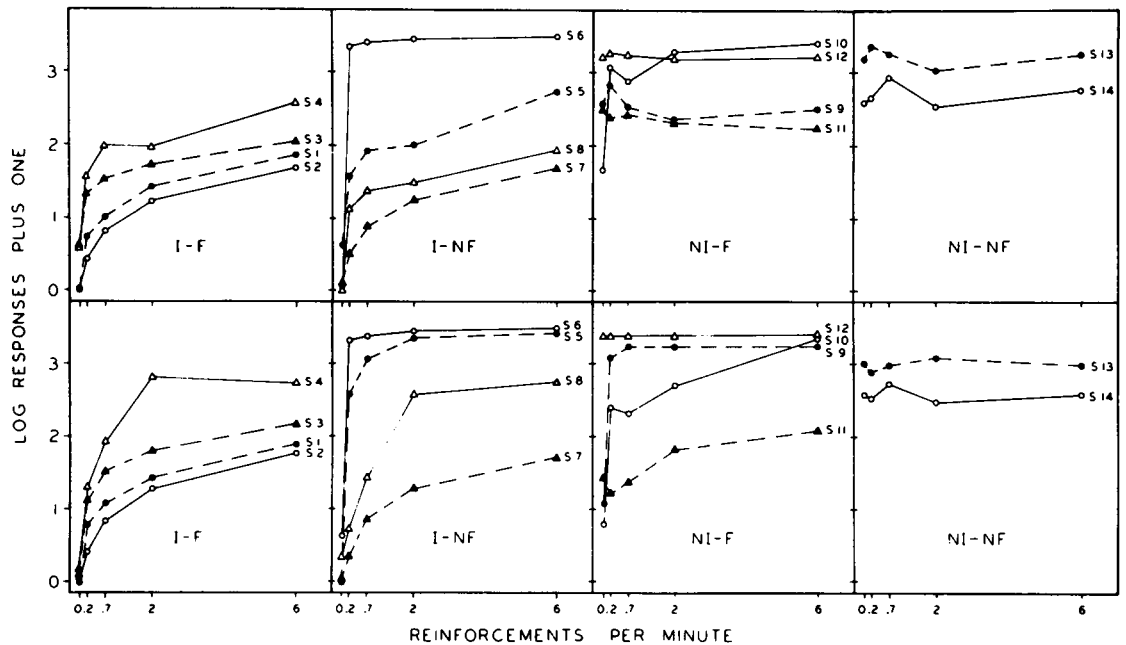


Fig. 1. Logarithms of response rates as a function of reinforcement rates in Exp. I. The response rate equivalents (antilogarithms) of the logarithmic values represented on the ordinate are: 0 = 0 responses/10 min; 1 = 9 responses/10 min; 2 = 99 responses/10 min; 3 = 999 responses/10 min. The top four panels show average response rates for each subject early in training (Sessions 1 to 5) and the bottom panel shows response at the end of training (Sessions 16 to 20). Reading from left to right, the conditions were: Instructions and Feedback (I-F), Instructions and No Feedback (I-NF), No Instructions and Feedback (NI-F), and No Instructions and No Feedback (NI-NF). The five points for each subject correspond to the five components of the multiple schedule expressed as reinforcement rates: Extinction or 0 reinforcements/min; FI 270-sec or 0.2 reinforcements/min; FI 90-sec or 0.7 reinforcements/min; FI 30-sec or 2 reinforcements/min; and FI 10-sec or 6 reinforcements/min.

The bottom four panels of Fig. 1 summarize performances during Sessions 16 to 20, the last five sessions of the experiment. Comparison of performances during these sessions with initial performances indicates that previously described differences were maintained but in somewhat reduced form. Attenuation of differences associated with the instructions variable may be seen to have stemmed from the following changes: (a) the discrepant I-F subject (S4) showed further increases in overall rates, although an orderly progression of rates still was maintained; (b) response rates increased in three of the four I-NF subjects (S5, S6, S8), although rates continued to vary systematically; and (c) response rates of three of the four NI-F subjects (S9, S10, S11) declined somewhat and tendencies appeared for differential responding as a function of schedule component.

Despite these modifications, performances during Sessions 16 to 20 support the conclusion that instructions both with and without

feedback enhanced sensitivity to the different components of the multiple schedule. One way of assessing relative degrees of sensitivity is to count the number of irregularities in the performance curves of individual subjects, *i.e.*, the number of times response rates did not increase with increases in reinforcement rates. From this standpoint, Fig. 1 indicates that seven of the eight instructed subjects showed a monotonic relationship between response and reinforcement rates (although differences for S6 in the range 0.7/min–6/min appear small on the logarithmic ordinate of the graph). The remaining instructed subject (S4) showed one inversion involving 2/min and 6/min. By comparison, of the four subjects given feedback but no instructions, one (S12) did not show any degree of differentiation, as was the case with both of the NI-NF subjects. A number of irregularities are apparent in the curves of the remaining three NI-F subjects: for S10, 0.7/min is less than 0.2/min; for S9, 6/min is less than 2/min and 0.7/min, and for S11,

EXT is greater than 0.2/min and 0.7/min.

Aside from the overall differences in rate described above, the instructions and feedback variables also influenced temporal patterning within schedule components. Figure 2 presents cumulative records obtained during a given session at the end of training for a subject in each condition. Pen deflections on the records indicate reinforcement (advancement of the subject's counter) for the feedback conditions, and the points at which reinforcement would have occurred for the no-feedback conditions. The records have been assembled in 10-min segments in order of reinforcement rates within the five components, from FI 10-sec to extinction.

Figure 2 shows that the subject trained with the I-F procedure (upper left) developed precise temporal patterning of responses within the fixed-interval components, with most responses occurring near the end of the intervals, and that no responses occurred in the extinction component. By comparison, the subject

trained with the NI-F procedure (lower left) responded at steady rates with the shorter fixed intervals (10 and 30 sec). Tendencies for temporal patterning appeared with FI 90-sec and FI 270-sec, but marked irregularities also were present. Some responding occurred during the extinction component for this subject. The subject trained with the I-NF procedure (upper right) performed at levels intermediate between the performances of the I-F and NI-F subjects. Temporal patterning occurred with fixed intervals of 30, 90, and 270 sec, but, as might be expected, without feedback these patterns were not coordinated with the actual times when reinforcement would have been delivered. Also to be noted is the absence of responding during the extinction component. Finally, the subject trained with the NI-NF procedure (lower right) showed no evidence of temporal patterning. Rate differences among the different components for this subject stemmed from progressive decreases in rates during the course of the session.

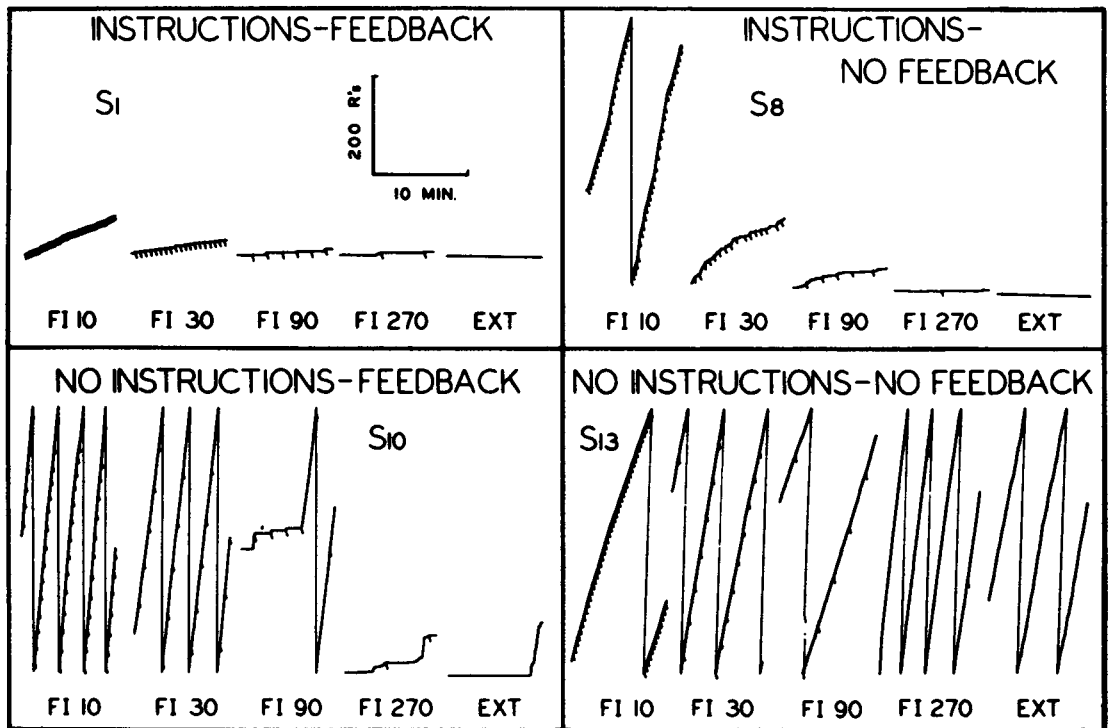


Fig. 2. Cumulative records for four subjects, one from each of the four conditions of Exp. I. Pen deflections on the records indicate occurrences of reinforcement (advancement of the subject's counter) for the feedback conditions, and points at which reinforcement would have occurred for the no-feedback conditions. The records have been assembled in 10-min segments in order of reinforcement rates within the five components of the multiple schedule, *i.e.*, from FI 10-sec to EXT (extinction).

EXPERIMENT II: SEQUENTIAL EFFECTS OF CHANGES IN INSTRUCTIONS AND FEEDBACK

Figure 3 compares rates during the last five sessions of Exp. I (solid lines) with rates during the last five sessions of Exp. II (dashed lines).

The top two panels show the consequences of changing from the I-F procedure to the I-NF procedure. For the two subjects studied (S1 and S2), the differentiated behavior previ-

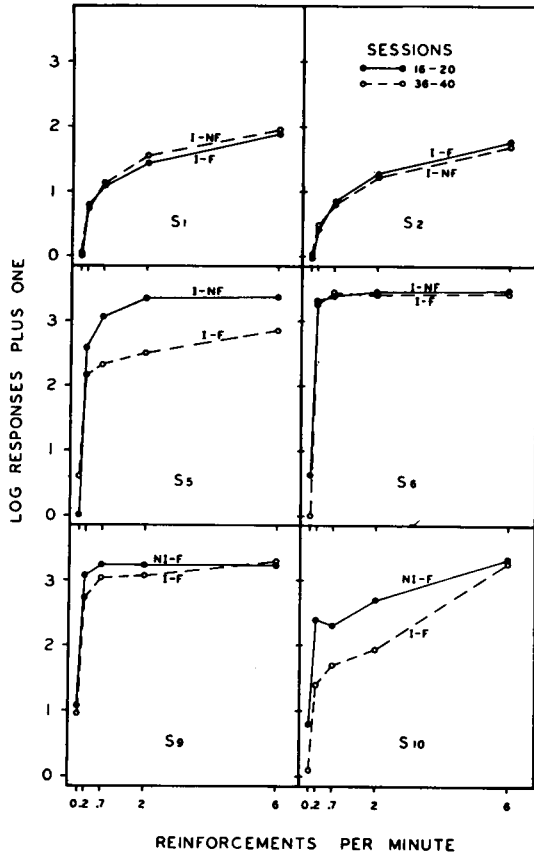


Fig. 3. Logarithms of response rates as a function of reinforcement rates during the last five sessions of Exp. II (Sessions 36 to 40). Also presented are the last five sessions of Exp. I (Sessions 16 to 20). The response rate equivalents (antilogarithms) of the logarithmic values represented on the ordinate are: 0=0 responses/10 min; 1=9 responses/10 min; 2=99 responses/10 min; 3=999 responses/10 min. Subjects 1 and 2 were trained with Instructions and No Feedback (I-NF) in Exp. II, while Subjects 5, 6, 9, and 10 were trained with Instructions and Feedback (I-F). The five points for each subject correspond to the five components of the multiple schedule expressed as reinforcement rates: Extinction or 0 reinforcements/min; FI 270-sec or 0.2 reinforcements/min, FI 90-sec or 0.7 reinforcements/min, FI 30-sec or 2 reinforcements/min., and FI 10-sec or 6 reinforcements/min.

ously controlled by the instructions-feedback combination was well maintained when feedback no longer was provided. The cumulative records for these subjects indicated that temporal patterning, previously established with the I-F procedure, also continued when feedback was omitted. But, as was the case in Exp. I, in the absence of feedback, patterning was not always closely coordinated with the points at which reinforcement would have been delivered.

The remaining panels of Fig. 3 show the effects of changing to the I-F procedure after training with either the NI-F procedure or the I-NF procedure. It may be seen in the middle two panels that addition of feedback to instructions (S5 and S6) had relatively small influence and did not produce the low rates and differentiated behaviors associated with the I-F procedure in Exp. I. To be noted is that these two subjects were the least efficient of the four originally trained with the I-NF procedure in Exp. I. The bottom two panels show that addition of instructions to feedback (S9 and S10) also did not produce the high degree of differentiation observed with the I-F procedure in Exp. I, although rates declined somewhat for both subjects.

EXPERIMENT III: ADDITION OF RESPONSE COST TO INSTRUCTIONS AND FEEDBACK

The results summarized in Fig. 4 indicate that during Sessions 16 to 20, when cost was not contingent upon responding (solid line), two of the three NI-F subjects (S15 and S17) showed the high rates and relatively poor differentiation previously observed under this condition. The remaining NI-F subject (S16) was atypical in comparison with other subjects trained with this procedure, insofar as rates were quite low and approached the minimal rates required by the schedule. Finally, the subject trained with the I-NF procedure evidenced intermediate rates of responding, but as was observed previously, rates exceeded the minimal requirements of the schedule.

Introduction of the cost procedure during Sessions 21 to 40 (closed circles, dashed lines) had similar effects on all four subjects despite previous variations in their performances. In all cases, there were marked reductions in response rates with terminal performances approximating the minimal required rates. Additional details of the effects of cost on tem-

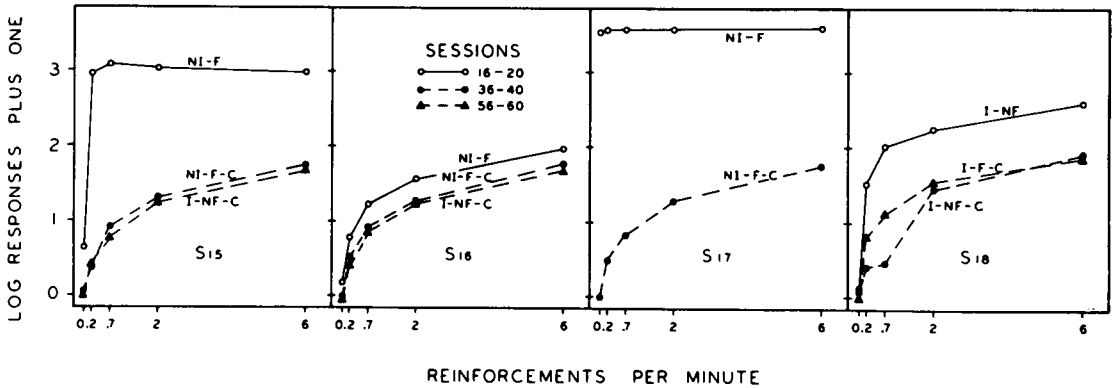


Fig. 4. Logarithms of response rates as a function of reinforcement rates in Exp. III. The response rate equivalents (antilogarithms) of the logarithmic values represented on the ordinate are: 0 = 0 responses/10 min; 1 = 9 responses/10 min; 2 = 99 responses/10 min; 3 = 999 responses/10 min. Shown are the last five training sessions without cost (Sessions 16 to 20), and the last five sessions in the first and second cost series (Sessions 36 to 40 and Sessions 56 to 60). The five points for each subject correspond to the five components of the multiple schedule expressed as reinforcement rates: Extinction or 0 reinforcements/min; FI 270-sec or 0.2 reinforcements/min; FI 90-sec or 0.7 reinforcements/min; FI 30-sec or 2 reinforcements/min, and FI 10-sec or 6 reinforcements/min.

poral patterning may be seen in Fig. 5, which gives the cumulative record of a subject trained with the NI-F procedure. At the end of training without cost (top panel), this subject showed no evidence of temporal patterning and poor differentiation of rates among the various components. By comparison, the record obtained at the end of training with NI-F plus cost for each response (bottom panel) shows highly precise temporal patterning with most responses occurring close to the end of the fixed intervals, and with no response occurring during the EXT component.

Finally, Fig. 4 also shows the outcome with respect to overall rates during Sessions 41 to 60 (triangles, dashed lines) when feedback was removed and instructions added (S15 and S16) and when feedback was added to instructions (S18). It may be seen that in all cases, differentiated patterns of responding were maintained.

DISCUSSION

Performances of subjects given feedback without instructions about the schedule provide parametric data about reactions of humans to fixed-interval schedules of reinforcement. Although the work of Holland (1958), using sequential presentations of fixed-interval schedules and a signal-detection procedure, suggested that uninstructed subjects would develop good differentiation of different fixed-intervals incorporated into a multiple sched-

ule, this expectation was not borne out by the present results. In Exp. I and III, over a total of twenty 50-min sessions, only one of seven uninstructed subjects showed an orderly progression of response rates as a function of reinforcement intervals, and response rates generally were much higher than the minimum required by the schedules. Another indication of the insensitivity of the subjects was that even at the end of training, six of the seven

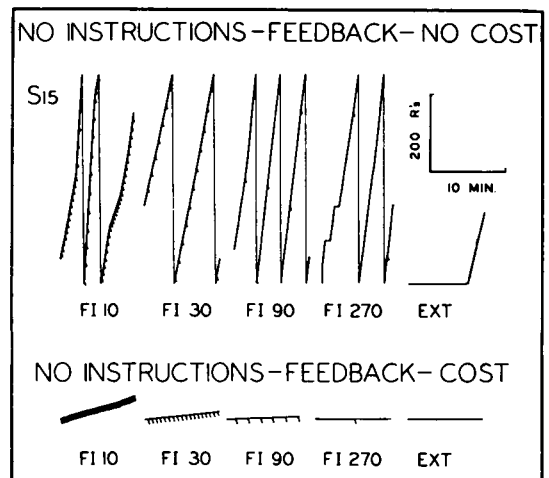


Fig. 5. Cumulative records for a subject trained with the No Instructions-Feedback procedure without cost (top) and with cost (bottom). The records have been assembled in 10-min segments in order of reinforcement rates within the five components of the multiple schedule, from FI 10-sec to EXT (extinction).

subjects continued to respond during the extinction component, although reinforcement never occurred in this component. The basis for the atypical performance of the one uninstructed subject who did adjust to the schedule cannot be specified; it may be noteworthy that each response by this subject advanced the counter subsequently used to indicate response cost.

A number of factors may be relevant to the lack of sensitivity to reinforcing contingencies observed in the present experiment. An obvious possibility is that exposure to the schedule was not sufficiently prolonged. However, consideration of sequential changes over the 20 sessions indicated that whatever systematic decreases in rate did occur were completed by the fifteenth session and no changes of great magnitude occurred thereafter. A different account of these results stresses the conditioning histories that human subjects may bring into the experimental situation (*cf.* Kaufman *et al.*, 1966; Long, 1962; Weiner, 1964). If it is correct to assume that such natural histories characteristically involve ratio schedules, thus generating tendencies for high rates, then human subjects might be expected to respond at unnecessarily high rates when reinforcement is provided on the basis of time, rather than on the basis of work output. In this regard, Weiner (1964) demonstrated that a prior experimental history of ratio reinforcement produces inappropriately high rates on interval schedules. A further possibility is related to the relative effortlessness of the response used in the present study. High rates on interval schedules have been attributed to the lack of substantial "cost" per response (Weiner, 1962); an inherent feature of interval schedules is that while reinforcement may be lost if rates are too low, there is no penalty for unnecessarily high rates, save for the effort required to respond.

Evidence for the importance of response cost in the development of differentiated fixed-interval behavior was obtained in Exp. III. The results indicated that introduction of monetary cost for responding generated highly differentiated behavior for both uninstructed and instructed subjects. This outcome, which is similar to that reported by Weiner (1962) using an FI 1-min schedule, occurred in the present study regardless of prior rates. Thus, both S16 and S18, who had shown relatively good adjustment to the schedule, and S15 and

S17, who showed little or no differentiation, were brought to the same level of maximum differentiation when cost was introduced. These findings add to those of Weiner by showing the generality of response-cost effects in a multiple schedule that included fixed intervals ranging from FI 10-sec to FI 270-sec, as well as an EXT component.

The other major finding of the present investigation concerns the effects of instructions on fixed-interval performance. When schedule instructions were given initially in Exp. I, with or without reinforcement-feedback, differentiated behavior developed rapidly and was maintained to the end of the experiment. While there was some indication that instructions were more effective when combined with reinforcement-feedback, differences in this regard were small in comparison to the effects of instructions in general. These results concerning the controlling influences of instructions differ from those reported by Ayllon and Azrin (1964), who found with psychiatric-patient subjects that instructions without immediate reinforcement did not maintain behavior in many cases. The greater degree of sensitivity to instructional control observed in the present study may be related to the use of young-adult college students; as Ayllon and Azrin indicate, a defining characteristic of psychiatric patients is their inability to follow instructions. A further indication of control by instructions was seen in the performances of those subjects in Exp. I instructed to respond but given neither schedule-instructions nor reinforcement-feedback. Although, as might be expected, differentiated behavior as a function of schedule component did not appear, these subjects continued to respond at high and persistent levels for the 20 sessions of the experiment.

While Exp. I indicated that a combination of instructions and reinforcement-feedback characteristically resulted in differential responding to different schedule components, the results of Exp. II suggested that this outcome is related in complex ways to the subject's experimental history. Experiment II showed that when control initially was established with both instructions and reinforcement, low and differentiated rates were maintained even when reinforcement-feedback was no longer provided. When, however, the instructions-reinforcement combination was in-

troduced after previous establishment of high and undifferentiated rates, the instructions-reinforcement combination was relatively ineffective in producing discrimination of schedule contingencies. It would appear, then, that extended training unaccompanied by differential responding to the contingencies of a schedule may reduce the effectiveness of a set of conditions that otherwise would produce sensitivity if introduced at the start of training. This general finding has occurred in other studies of human operant behavior in our laboratory (Kaufman and Baron, 1969).

It is of interest to consider the present results from the standpoint of the place of instructions in the experimental analysis of human operant behavior. Under the heading, "The circumvention of an operant analysis", Skinner (1966) raised the question of whether instructions about contingencies have the same behavioral effects as actual exposure to the same contingencies. Skinner suggested that since subjects usually cannot verbalize accurately the contingencies to which they actually have been exposed, they cannot be expected to react appropriately to descriptions of contingencies provided by experimenters. On these grounds, he contended that verbal instructions should not be used as a substitute for the actual arrangement and manipulation of contingencies, although he did concede that instructions may be of value as an alternative to shaping when concern is with eventual performance of a response rather than with its acquisition.

The present study provides needed experimental evidence about establishment and maintenance of human operant behavior as a function of instructions about contingencies and as a function of direct exposure to the same contingencies. The results appear to bear out Skinner's contention that these two procedures lead to different consequences, but in a surprising way. In the absence of instructions about contingencies, reactions to actual contingencies were imprecise, and differed markedly from what might be expected on the basis of the contingencies themselves, or from studies with subhuman subjects employing similar contingencies. By comparison, instructions about contingencies had the consequence of producing the kinds of differentiated behaviors that might be expected from the animal literature and from the contingencies themselves, particularly when instructions

about contingencies were combined with actual exposure to contingencies and when the combination was present from the start of training.

The present findings, as well as those of other recent studies of instruction effects, suggest two broad conclusions. First, insofar as the goal of an experimental analysis of behavior is to identify variables with major controlling influences, these studies indicate that investigation of instruction effects with humans is a necessary step toward this goal. Worth stressing is that instructions represent an external, observable determinant of behavior whose influences, although complex, can be investigated in a straightforward, objective manner. Second, as Ayllon and Azrin (1964) pointed out, instructions given to humans provide a means of evoking and controlling operant behaviors whose establishment in other ways would be impractical, if not impossible. Once behavior has been established, various experimental contingencies become accessible to study, as were effects of fixed-interval reinforcement in the present study. Thus, use of instructional manipulations in the study of human behavior may be viewed as playing a role parallel to such manipulations as deprivation and drug administration in work with subhuman subjects; by increasing the probability of desired behaviors in this way a means is provided whereby the controlling influences of reinforcement contingencies may be studied effectively.

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