

THE DISTRIBUTION OF OBSERVING RESPONSES IN A MIXED FI-FR SCHEDULE^{1, 2}

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In Exp I, three pigeons were trained on an observing response procedure where observing responses produced a stimulus correlated either with FI or with FR. Stimulus duration was 30 sec. During FR, the subjects completed the ratio before the stimulus terminated. During FI, the subjects usually observed the stimulus only once. Observing responses occurred immediately after food reinforcement. In Exp II, stimulus duration was shortened to 5 sec and the FR for food was increased. The results were similar to those of Exp 1. During most FIs and FRs, only one observing response occurred. The results of both experiments could be interpreted in a response competition framework. Immediately after food reinforcement, observing behavior is strong. When behavior on the food key begins it competes with further observing behavior.

Wyckoff originally defined an observing response as one which produces a pair of discriminative stimuli (Wyckoff, 1952). Under some circumstances, this may be a response which converts a mixed schedule into a multiple schedule (Kelleher, Riddle, and Cook, 1962). The observing response produces one of a number of discriminative stimuli, depending on which component is present. If no observing response is emitted, the reinforcement contingency is not affected, but no discriminative stimuli are present.

Previous studies of observing behavior have used one intermittent schedule of food reinforcement and extinction as the components of the mixed or multiple schedule (Wyckoff, 1952; Kelleher, 1958; Kelleher, *et al.*, 1962). If no observing responses occur, subjects perform in a mixed schedule consisting of intermittent reinforcement FI, VR, *etc.*) and extinction. If observing responses occur, subjects perform in a multiple schedule with the same components. This study provides data on observing responses where reinforcement is programmed in both schedule components.

EXPERIMENT I

Subjects

Three homing pigeons of undetermined age and sex were run at about 80% of free-feeding

¹The data from Exp I were reported at the 1964 meetings of the Southeastern Psychological Association.

²Reprints may be obtained from the author, Box 2078, University, Alabama.

weight. Two of them, P-2A and P-2C, had previously been on a mixed FR DRO schedule. P-2B was naive. P-2B was accidentally killed during the course of the experiment.

Apparatus

A two-key pigeon chamber, measuring 1 cu ft, contained a work panel housed in a 3/4-in. thick plywood box. The keys were mounted 9 in. from the floor and 4 1/2 in. apart, center to center. The pigeon's compartment was illuminated by a 15-w bulb directly in front of and above the work panel, which was separated from the pigeon by a piece of window glass. The construction was similar to that described by Ferster and Skinner (1957).

Conventional relay and timing circuitry were used and responses were recorded on a Gerbrands cumulative recorder. Food reinforcements and discriminative stimuli were recorded on a Lehigh Valley event recorder. The relay circuitry and pigeon chamber were housed in separate rooms.

Procedure

The two experienced subjects were placed on a multiple schedule (mult FI 2 FR 10) without preliminary training. A red light illuminated the food (left) key during FI; a blue light during FR. The naive subject was given preliminary key training. The schedule sequence was roughly random, containing 24 intervals and 28 ratios. Preliminary work indicated that observing behavior was maintained better with slightly more ratios.

When performance had become stable, the schedule was changed to a mixed schedule (mix FI 2 FR 48). Stability was assessed by comparing the daily cumulative records. At this stage, the second key was connected so that a single peck illuminated the food key with the color of the component programmed. For each bird, the observing response failed to develop. Subsequently, the observing key was illuminated with a blue light. Since this was the S^D for the FR, the bird usually pecked the key immediately, and 5 to 10 reinforcements were delivered for pecks on the observing key. Additional reinforcements were then given for pecks on the observing key when the blue light was absent. This training established observing responses within about 10 min, after which reinforcement for pecks on the observing key was discontinued. The only contingencies became the illumination of the food key with the discriminative stimuli.

After the observing response was established, the observing requirement was raised to FR 5 for P-2A and P-2C and to FR 2 for P-2B. P-2B's observing requirement was kept at FR 2 since its observing behavior was less stable. The entire observing requirement, henceforth referred to as an observing response, had to be emitted without an intervening response to the food key. If a subject pecked but failed to fulfill the total requirement before pecking the food key, the stepper programming the observing FR reset. This kept the observing response together as a unit.

Each observing response illuminated the food key for 30 sec or until a reinforcement occurred. If no observing response was made, the food key remained dark. Except for preliminary training, the observing response key was never illuminated.

Session length was 1 hr for P-2A and P-2C and 2 hr for P-2B, which kept weights approximately constant without additional feeding.

Results

The striking regularity of the observing response is shown in two ways. Figure 1 shows representative segments from the event record for each bird. The top line represents reinforcement; the bottom line the occurrence of an S^D . Since observing responses produced S^D s, this line represents, at the same time, an observing response. Pecks at the observing key which did not complete the observing response were unrecorded.

Observing responses occurred most frequently immediately after reinforcement. During FR, there was opportunity for only one S^D since an FR 48 was run off in less than 30 sec. During FI, however, as many as four S^D s could occur. When performance had reached stability, the interval S^D never occurred more than three times.

The FI data are summarized another way in Fig. 2, taken from the last 8 hr of the record for each bird. These sessions occurred after 60-70 sessions of observing response training for P-2A and P-2C and 40 sessions for P-2B. P-2A always made at least one observing re-

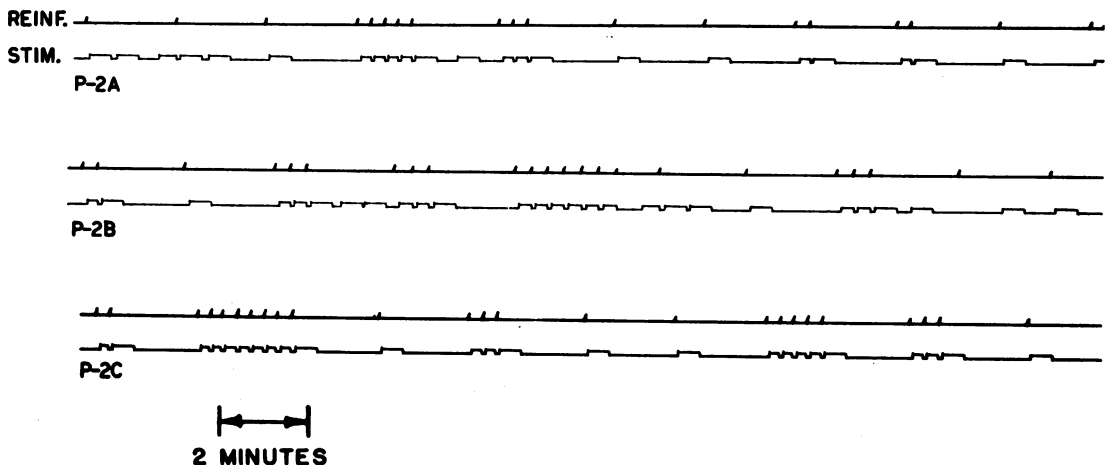
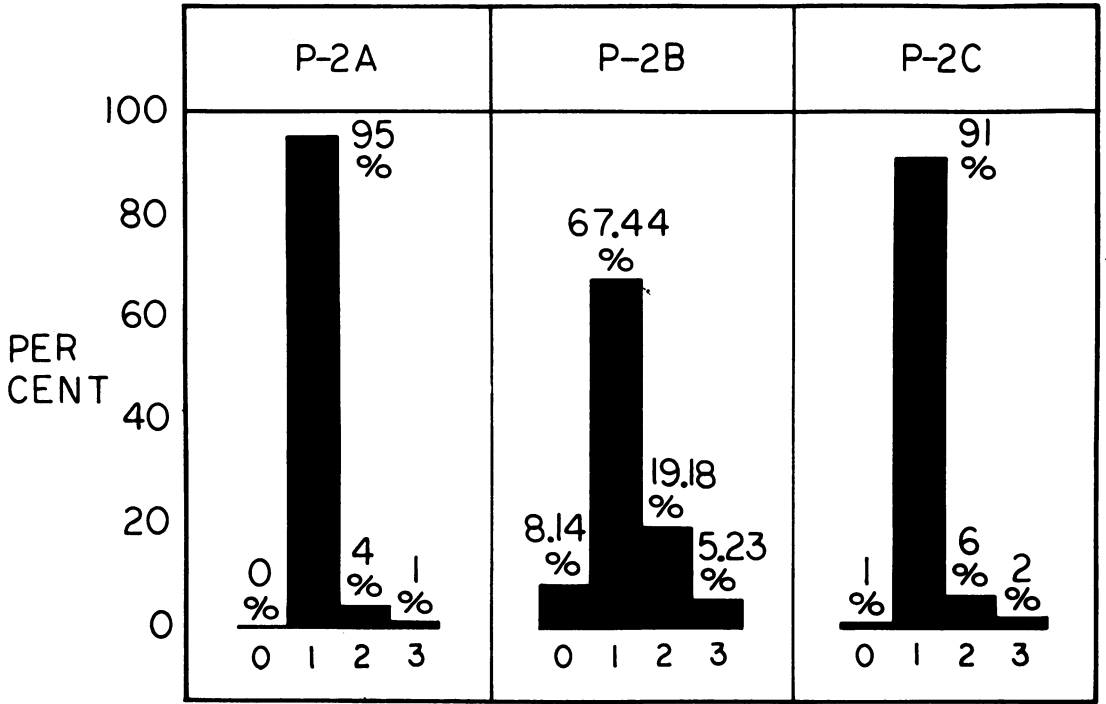


Fig. 1. Representative event records for each of the three subjects. The top line of each record represents reinforcements. The bottom line represents S^D s produced by observing responses.



NUMBER OF OBSERVING RESPONSES PER REINFORCEMENT DURING FI

Fig. 2. Percent of occurrence of zero, one, two, or three observing responses during FI. Data is taken from all FIs during the last 8 hr of running for each subject.

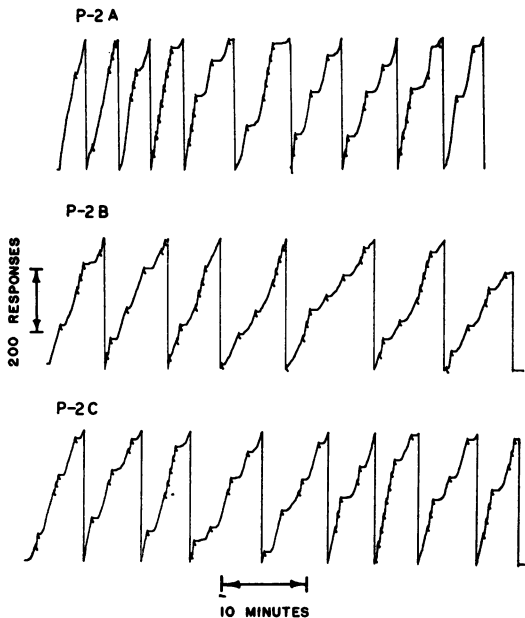


Fig. 3. Sample cumulative records of food key performance for each of the three subjects.

sponse during an FI. On 95% of the total FIs, it emitted only one observing response. In rare instances, it made two or three observing responses during an FI. These instances usually occurred at the beginning of a session. The data for P-2C is similar to that for P-2A but shows slightly more variability. P-2B is the most variable. This bird had a greater frequency of FIs containing zero, two, or three observing responses than either of the others. During FI, however, a single observing response was the most frequent occurrence.

Figure 3 shows sample cumulative records for each subject. Typical multiple schedule performance was obtained from all (Ferster and Skinner, 1957), although scallops failed several times to appear in the record of P-2A. Several of these instances are at the beginning of the session and are typical of this subject.

Additional data for P-2A are shown in Fig. 4. This record was made about a year after the record shown in Fig. 3. Discriminative stimuli are marked by the event pen, and incomplete observing responses are marked by pips. The subject usually, but not always,

waited until the stimulus terminated before responding in FI. The ratio was always completed before termination of the ratio S^D . Occasionally, during FI, stimulus control appeared to be lost and the bird responded at a high rate. Some ratios were broken by short pauses once the ratio had begun. This did not occur in the other record (Fig. 3), but developed with continued running of this subject.

The data may be summarized by saying that observing responses usually occurred immediately after a reinforcement, and only once during FI.

EXPERIMENT II

The S^D duration was shortened to 5 sec, which provided opportunity for more than one observing response during FR. In this way, distribution of observing responses during FI and FR could be compared.

Apparatus

The single modification was to house the pigeon chamber in a sound attenuating chamber.

Procedure

The general procedure of Exp I was followed with these exceptions: the FR for food

was raised to 72; the observing requirement for both birds was lowered to FR 2; and the S^D produced by an observing response was shortened from 30 sec to 5 sec. This last, combined with the extended FR for food, permitted more than one observing response during FR. A delay contingency (COD) was also added. Subjects could not collect a reinforcement until at least 20 sec had elapsed from the last peck on the observing key, to eliminate superstitious chaining. This contingency was in effect only during FI.

Results

Figure 5 includes FR data, from the final six 1-hr sessions for P-2A and the final seven 1-hr sessions from P-2C, after 60-70 sessions of the new procedure.

Comparing the FI data for Exp I and II, both birds show less tendency to make only one observing response during an FI and more tendency to emit zero, two, or three observing responses. Again, no instances of four or more observing responses were observed, although the subject now had opportunity to do so.

Both subjects emitted a single observing response during most FRs. P-2C made zero observing responses during FR more frequently than P-2A but the frequency of two observing responses in FR was about the same

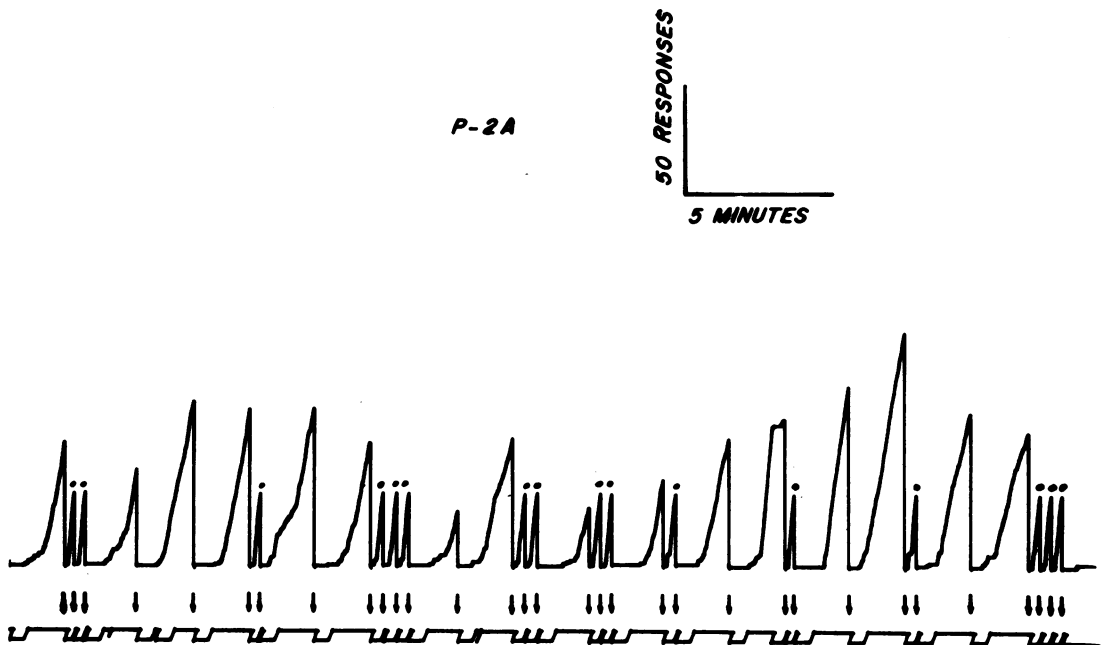


Fig. 4. Sample cumulative record for P-2A. The step pen resets at reinforcement. Ratios are marked by a dot. The event pen indicates the presence of discriminative stimuli. Arrows mark the point of reinforcement.

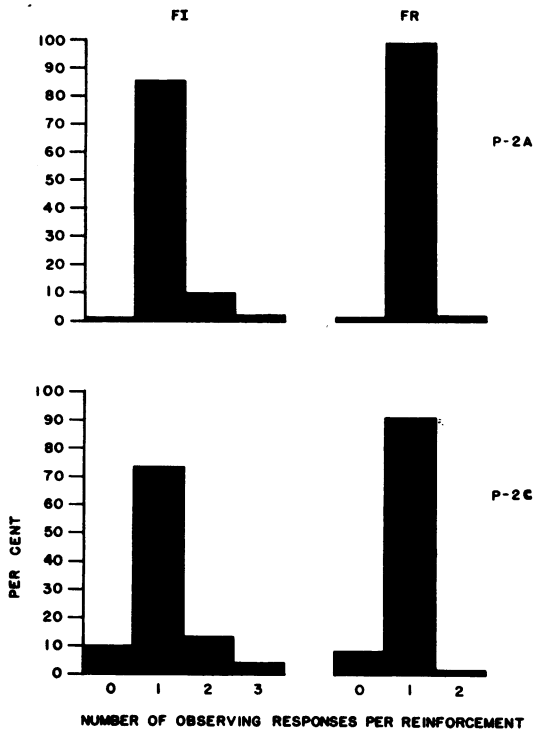


Fig. 5. Percent of occurrence of zero, one, two, or three observing responses during both FI and FR for each of the two subjects. Data is taken from all FRs and FIs during the last 6 hr for P-2A and the last 7 hr for P-2C.

for both. The event record revealed that the observing responses occurred shortly after reinforcement. In rare instances where there were two observing responses during FR, the event records indicated that there was always a time lag between the offset of the S^D and the occurrence reinforcement. In FR, reinforcement was collected in the presence of the dark key. No instances of three or more observing responses occurred during FR.

Figure 6 shows cumulative records from Exp II. Again, the records are similar to those produced by a multiple schedule. Both subjects show fairly good scallops during FI, although scallops do not appear in some instances.

Figure 7 shows both food responses and discriminative stimuli for P-2A. This record was made about a year after the original data were collected. While the FI data are similar to those in Fig. 6, there are more instances of two observing responses during FR. In the third FR, three observing responses were made. Several of the FIs are marked by a

period of acceleration followed by deceleration. While this did occur with the 30-sec S^D , it was more pronounced with the 5-sec S^D .

DISCUSSION

Kelleher *et al.* (1962) have discussed their observing response data within a competing response framework. At certain times (during VR, for instance), food key responses compete with the observing response, and the observing response rate is low. At other times (during extinction), rate on the food key is low and does not compete with observing key behavior. This interpretation is invited by their data since observing key rate was higher during extinction than during VR.

If the analysis of Kelleher *et al.* is extended to the present data, the outcome could be interpreted as follows. Immediately after reinforcement, the probability of food key behavior is low and does not interfere with the observing response, provided a short pause follows reinforcement in mixed FI-FR schedules. The observing response is stronger immediately after food reinforcement because it is reinforced, perhaps intermittently, for a relatively low behavioral output. When an S^D occurs, behavior appropriate to the schedule is initiated. Once behavior on the food key begins, it then competes with further responding on the observing key.

Although this interpretation is tenable, it may be noted that responses, especially during FI, do not occur at a rate high enough to interfere physically with observing responses. Experiments with concurrent schedules have shown that the pigeon may respond at a fairly high rate on each of two keys (Herrnstein, 1958).

Another plausible interpretation of the FI data might assume that the S^D for FI is not a conditioned reinforcer and that further observing behavior after that S^D is extinguished. The S^D for FI usually terminated some time before reinforcement and the pigeons always collected reinforcement in the presence of the dark key. This was necessarily true in Exp II, where a 20-sec COD was in effect during FI. This interpretation is compatible with the observation that during the initial stages of training for Exp I, the subjects kept the food key lights on most of the time during FI. The results of Exp I were obtained only after two

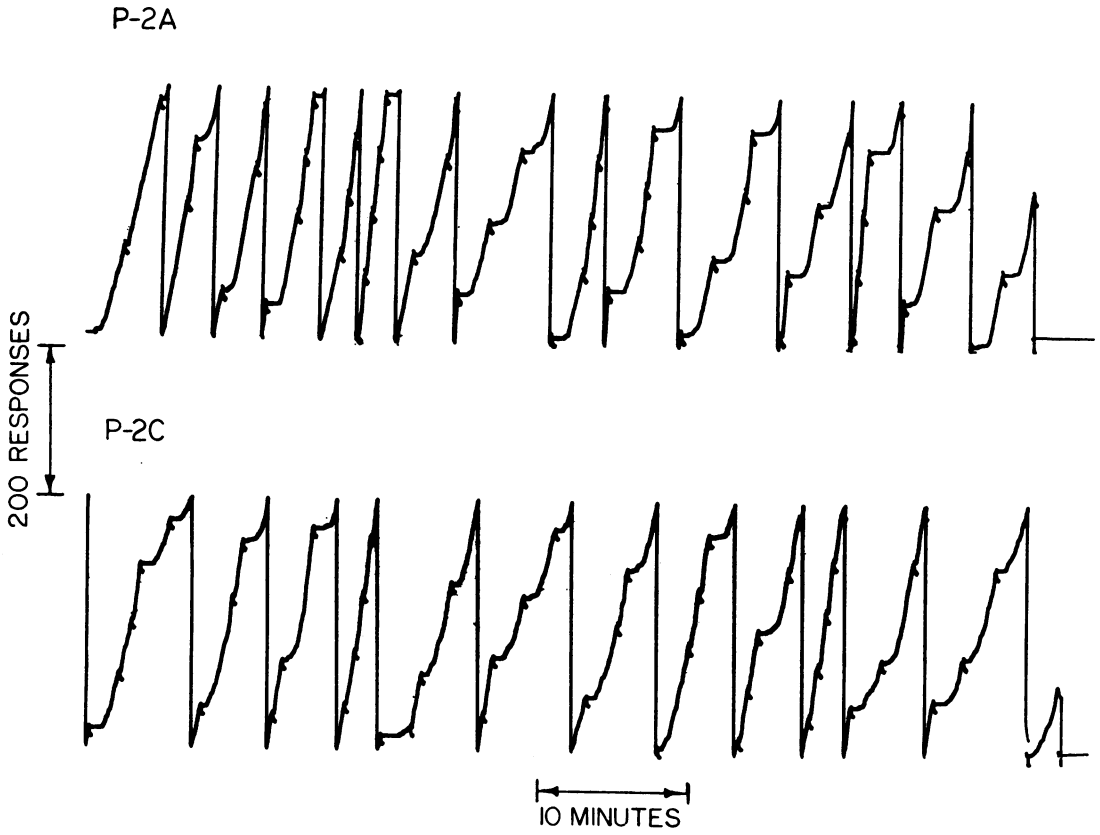


Fig. 6. Sample cumulative record of food key performance for each of the two subjects.

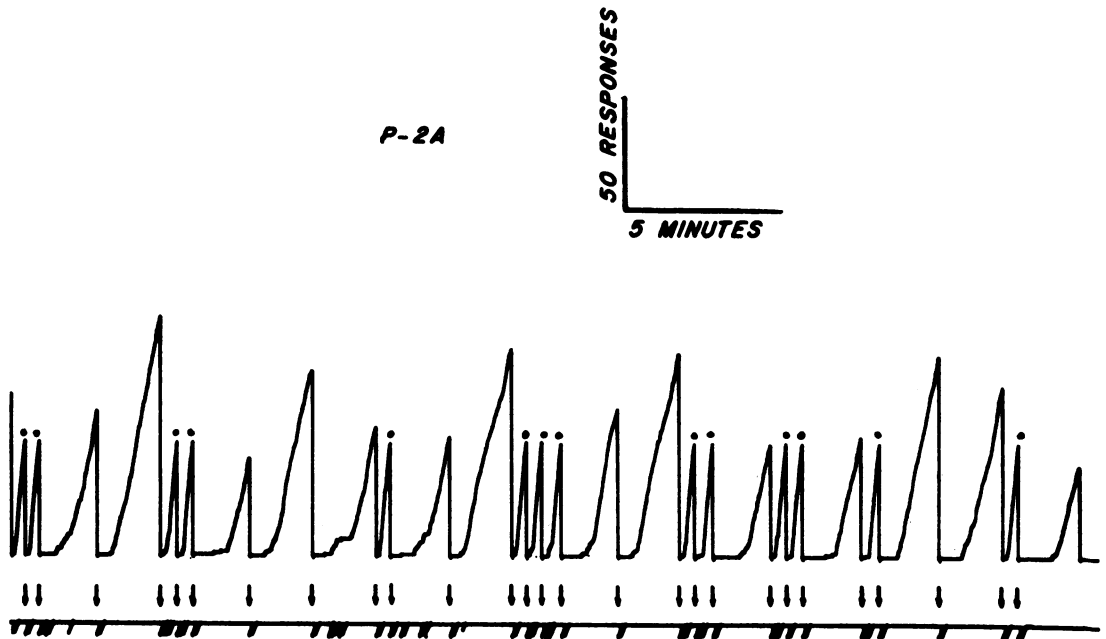


Fig. 7. Sample cumulative record for P-2A. The step pen resets at reinforcement. Ratios are marked by a dot. The event pen indicates the presence of discriminative stimuli. Arrows mark the point of reinforcement.

or three weeks of training with the observing response procedure.

In Exp II, the COD may have discouraged an increase in observing behavior during FI. The COD was not used in Exp I because of the 30 sec stimulus duration. The birds did not respond to the observing key during a period when a stimulus was on, so that the danger of a response to the observing key preceding a reinforced response was slight. This does not mean that superstitious chaining could not have developed, however, since the subject could have made an observing response just before a reinforcement became available. The COD in Exp II guaranteed (a) that a reinforcement would not follow a response to the observing key for at least 20 sec and (b) that, during FI, the reinforcement could not be received in the presence of the red light. The latter was true because the COD interval exceeded the S^D duration. Both factors could have suppressed observing behavior in Exp II. Since the subjects were never run without the COD in Exp II, knowledge of COD effects requires further data.

The data from Exp II, particularly the FR data, are compatible with the analysis of Kelleher *et al.* Food key responding is strong at the time the S^D terminates and competes with behavior to the observing key. If it is assumed that the COD in Exp II has no effect on observing response output, a comparison of the FI data from Exp I and II might also support the competing response framework. Both subjects showed an increased tendency to make the observing response two or three times during an FR in Exp II. Food key behavior at the termination of a 5-sec S^D should not be so strong as at the termination of a 30-sec S^D and would not compete so strongly with observing responses.

It is interesting to compare these data with other experiments where non-food reinforced responses are concurrent with FI or FR. Azrin (1961), Appel (1963), Thompson (1964), and Zimmerman and Ferster (1964) have studied time-out producing responses which were concurrent with FR. One consistent finding was that when time-out producing responses occur, they are emitted during the pause after reinforcement, typical of FR schedules, and are not likely to occur once responding on the food key has begun. These findings are similar to the present results. The interpretation of

the two kinds of experiments are different, however. The time-out producing responses are presumably reinforced by escape from aversive stimuli which are present after reinforcement of FR, but observing responses are assumed to be reinforced by conditioned reinforcement (Wyckoff, 1959; Kelleher *et al.*, 1962).

In a study by Skinner and Morse (1957), responding on an FI schedule was placed in competition with running in a wheel; the subjects could emit one or the other of the responses, but not both. Just after reinforcement, the subjects did neither. When the subjects began responding, running was predominant, but eventually gave way to lever pressing. Again, these results are analogous to the observing response data in that the non-food reinforced responses predominate after reinforcement.

It appears, then, that when non-food reinforced responses compete with food reinforced responses, the non-food behaviors are most probable at times when food behavior would not otherwise be occurring. This interpretation may not hold for the studies on response produced time out, however, since the aversive stimuli for escape may not be present at any time except just after reinforcement. Thompson's (1964) data, using a mixed FR 25 FR 225 schedule would seem to contradict this notion. He found that the subject took time-outs only during FR 225 and that these occurred after a priming run of 25 responses or more, not immediately after reinforcement.

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