TIMEOUT AND PUNISHMENT OF A SINGLE RESPONSE WITHIN A SHORT FIXED RATIO SCHEDULE OF FOOD REINFORCEMENT

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ABSTRACT

TIMEOUT AND PUNISHMENT OF A SINGLE RESPONSE WITHIN A SHORT FIXED RATIO SCHEDULE OF FOOD REINFORCEMENT

By

Ralph William Richards

The purpose of the present study was to determine if pigeons would take timeouts from a fixed ratio 50 when the twenty-fifth response within this ratio was punished. A secondary purpose was to examine the location of these timeouts within the ratio.

Four pigeons were reinforced on one key according to a fixed ratio 50 until a stable performance was attained. Shock was then delivered immediately after the twenty-fifth response of each ratio. A response to a second key produced a thirty second timeout.

For two subjects the intensity was initially set at 12.0 ma.; however, this intensity produced severe response suppression and was later reduced to 8.0 ma. For one subject timeouts occurred only during the first session of the 8.0 ma. shock; this was the only shock session (except for the first session at 12.0 ma.) during which any ratios were completed and reinforcement obtained. The other subject maintained responding to the food key and took many timeouts. Although the

timeouts decreased to near zero on further exposure to the shock, the location of the timeouts within the ratio changed as a function of the number of sessions under the shock contingency. Timeouts occurred after the shock on its initial introduction; however, on further exposure they occurred more frequently before shock. Eventually, their most frequent location was during the pause-after-reinforcement or early in the ratio.

Complete response suppression on the food key was suggested as a possible cause for the absence of timeouts for one of the preceding subjects; therefore, the method of shock introduction was altered for the two remaining subjects. For these subjects the intensity was gradually increased to either 12.0 ma. or 17.0 ma. Only one of these subjects took timeouts. The location of timeouts again showed a change on further exposure to the shock. Initially timeouts occurred after shock; later they occurred before shock, most frequently during the pause-after-reinforcement or early in the ratio.

The present results while not definitive suggest that shock intensity, its manner of introduction, and the number of shocks administered may have a profound influence in determining whether pigeons will initiate timeouts in a situation where responses to one key are both punished and rewarded according to short fixed ratios. It was also suggested that a thirty second timeout may not be sufficient to maintain escape from shock.

Approved: Mark Pilling
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INTRODUCTION

Punishment is defined as a reduction in the future probability of a response on delivery of a stimulus immediately following the response. The stimulus following the response is, by definition, a punishing stimulus (Azrin & Holz, 1966). One of the most widely studied punishing stimuli has been electric shock. Although the immediate introduction of an intense shock after each response may result in complete suppression, responding has been maintained at extremely high shock intensities when the intensity is gradually increased (e.g. Azrin, Holz, & Hake, 1963).

The effect of punishing each response is also partially dependent upon the schedule of reinforcement maintaining the response. When each response on a variable interval schedule is followed by shock, a stable, but reduced, response rate is maintained (Azrin, 1960). On a fixed ratio schedule, the effect is to selectively lengthen the pause-after-reinforcement, while leaving the local response rate unchanged (Azrin, 1959a). On a fixed interval schedule, a response reduction occurs in all portions of the interval, leaving the temporal discrimination unaffected (Azrin & Holz, 1961). Punishment of each response on a DRL schedule (differential reinforcement of low response rates) selectively reduces the shorter interresponse times (Holz, Azrin, & Ulrich, 1963).

Dardano & Sauerbrunn (1964), using pigeons, punished a single response within a fixed ratio 50 schedule of food reinforcement. Performance was differentially affected depending upon the position of the punished response within the ratio. If intense shock was delivered after the first response of the ratio, performance was characterized by a prolonged pause-after-reinforcement, breaks in responding after the intial responses, and unstable response rates at the beginning of the ratio. Punishment of the twenty-fifth response resulted in an unstable response rate in the first half of the schedule, with response rate in the second half being unaffected; the duration of the pause-after-reinforcement was found to be highly variable. Punishment of the fiftieth response had no such localized effect; rather, response breaks and changes in local response rates occurred within different portions of the ratio, and although the mean pause-after-reinforcement increased slightly, many of the ratios showed a short pause-after-reinforcement.

Azrin, Hake, Holz, & Hutchinson (1965), in an attempt to determine if escape was motivated by punishment, conditioned pigeons to respond on one key under various schedules of food reinforcement. After responding on this key had become stable, shock was delivered after every response. A response on a second key removed the punishment contingency. Results showed that the subjects would escape from the punished to the unpunished situation and that this behavior could be brought under the control of both fixed interval and fixed ratio schedules of escape reinforcement.

Self-imposed timeouts from positive reinforcement (i.e., a period of time during which positive reinforcement is not available have also been used to infer the existence of aversive stimuli (e.g., Azrin, 1961; Hearst & Sidman, 1961; Thompson, 1964; 1965). Azrin (1961) introduced a timeout key when pigeons were being reinforced under a fixed ratio schedule on another key. The first response to the timeout key put an extinction period, with changes in overhead illumination and key colors, into effect; a second response restored the original illumination, key colors, and the possibility of reinforcement. Thus, the subjects were able to initiate and terminate extinction periods. These self-imposed timeouts were usually located within the characteristic pause-after-reinforcement. Further, the amount of time spent in timeout was an increasing monotonic function of the number of responses required for food reinforcement. Azrin suggests the existence of aversive stimuli at certain stages within the fixed ratio schedule as a plausible explanation of the escape from a schedule of food reinforcement.

Several other studies (Appel, 1963; Thompson, 1964; 1965; Zimmerman & Ferster, 1965) have also shown that food reinforcement is delivered on a fixed ratio schedule.

Hearst & Sidman (1961) employed a fixed duration timeout to determine if escape from a conflict situation was reinforcing. Rats were reinforced (with a mixture of sweetened milk and tap water) on a variable interval schedule for pressing one lever in the presence of a discriminative stimulus. Concurrently, responses on this lever were punished according to a fixed ratio schedule. Responses to a second lever terminated the discriminative stimulus and put a period of extinction into effect. Results suggested that rats will escape from a situation where responses are concurrently rewarded and punished.

The primary purpose of the present study was to determine if pigeons would escape from a fixed ratio 50 schedule of reinforcement when the twenty-fifth response within this ratio was punished. The escape response was pecking a second key which produced a 30 second timeout. If timeouts did occur, a secondary purpose was to examine their location within the ratio.

METHOD

Subjects

Four experimentally naive female White Carneaux pigeons were used. All subjects were between 3 and 5 years of age and were maintained at approximately 75% of their free-feeding weight throughout the present experiment.

Apparatus

A standard operant conditioning chamber (Lehigh Valley Electronics, model 1519) with a three stimulus key intelligence panel was employed. The right and left keys were illuminated green and red, respectively. The center key was not illuminated and responses to it were not recorded. A minimum force of approximately 20 grams was necessary to record a response to either key. During reinforcement, both the key lights were extinquished and a light within the food aperture was illuminated. Reinforcement was 3 second access to mixed grain, with the timing of this interval beginning when the subject placed its head through the aperture, thus interrupting a light beam focused on a photocell. An overhead light provided general illumination, except during periods of timeout.

The shock source was of the constant current design. Line current was connected to the primary of a 460 volt AC step-up transformer, the secondary of which was connected to a series circuit consisting of two 12 K ohm fixed resistors, the bird, a milliammeter, and a 250 K ohm variable resistor. In calibrating shock intensity, an 800 ohm resistor was substituted for the bird. Shock duration was .045 seconds and was delivered through electrodes implanted in the subjects' back (Azrin, 1959b).

Reinforcement and punishment contingencies were programmed by standard electro-mechanical equipment in an adjacent room. A cumulative recorder and three-channel printout counter were also used.

Procedure

Each subject had one session a day, except on holidays and as necessary to maintain deprivation level. After the initial shaping, sessions usually terminated on the delivery of 50 reinforcements or six hours, whichever occurred first. The chamber was completely dark for a variable duration, before and after each session.

All subjects were magazine trained and shaped to peck the left key (red) within two sessions. The shaping session terminated on the delivery of 50 reinforcements under a schedule of continuous reinforcement.

On all days thereafter, a response on the right key (green) produced a 30 second timeout. During timeouts, the chamber was completely dark, and all responses were nonfunctional. After a second session of continuous reinforcement, the response requirement for food reinforcement was gradually increased until an FR 50 (fixed ratio 50) schedule was established. Subjects were given a minimum of 25 sessions on the FR 50 without shock.

Shock was then delivered immediatedly following the twenty-fifth response of each ratio. The shock intensities used and the number of sessions at each are shown in Table 1 for each subject.

For S-832, the intensity was initially set at 12.0 ma. with sessions terminating at the end of four hours or 50 reinforcements, whichever occurred first. In an attempt to increase responding to the food key, maximum session length was increased to seven hours for one session, and set at six hours for all days thereafter. In a further attempt to increase responding, the intensity was reduced to 8.0 ma. after 12 sessions under the 12.0 ma. shock. On the completion of 400 ratios at 8.0 ma., the shock contingency was removed and 8 sessions of FR 50 without shock programmed. Then, the 12.0 ma. shock was reintroduced following the twenty-fifth response until 400 ratios were completed.

For S-660, shock intensity was set at 12.0 ma. for 22 sessions. As responding to the food key was completely suppressed at this intensity, it was necessary to reshape the key peck response and deliver food reinforcement under the FR 50 without shock for 16 sessions. Shock was then presented for 9 sessions at an 8.0 ma. intensity.

In a further attempt to prevent complete suppression of responding, a different procedure for introducing the shock was employed for S-440 and S01055. Shock intensity was initially set at 2.0 ma. and increased in 2.0 ma. steps following the completion of three ratios at that intensity until the 12.0 ma. intensity was reached. For S-440 the 12.0 ma. intensity remained in effect for 25 sessions. For S-1055 the intensity was further increased to 15.0 ma. and 17.0 ma. on the following two days, and was maintained at 17.0 ma. for 25 sessions.

For S-440 and S-1055 an apparatus failure occurred during two sessions of the FR 50 without shock. During these two sessions, the food magazine did not raise up completely, thus permitting only restricted access to the mixed grain reinforcement.

Throughout all of the above, the number of timeouts and their location within the ratio were recorded.

Table 1

Summary of Procedure

SUBJECT	CONDITION	NUMBER OF SESSIONS
S-832	no shock	40 sessions
	12 ma.	12 sessions
	8 ma.*	16 sessions
	no shock	8 sessions
	12 ma.*	10 sessions
S-660	no shock	40 sessions
	12 ma.	22 sessions
	no shock	16 sessions
	8 ma.	9 sessions
S-440	no shock	25 sessions
	2 → 12 ma.**	1 session
	12 ma.	25 sessions
S-1055	no shock	25 sessions
	2 → 12 ma.**	1 session
	15 ma.	1 session
	17 ma.	25 sessions

*to the completion of 400 ratios

**intensity increased in steps of 2 ma.

RESULTS

Figures 1 and 2 show the percent of each session spent in timeout for S-832, S-660, and S-1055. S-440 took no timeouts during the 25 sessions of the 12.0 ma. shock. It is clear from these figures that only S-832 and S-1055 spent any appreciable time in timeout.

For S-832, on the initial introduction of the 12.0 ma. shock (during session 56), timeouts increased. However, on further exposure to this intensity timeouts decreased; during sessions 65-67, timeouts accounted for only about 8% of the sessions' length. On the reduction of intensity to 8.0 ma. (during session 68), timeouts increased and later decreased, until less than 1% of the sessions' length was spent in timeout. On the removal of shock (sessions 84-91), no timeouts occurred except during session 84. It should be noted that the timeouts during session 84 occurred before the completion of any ratios without shock; after the completion of one ratio, no timeouts were taken. On the reintroduction of the 12.0 ma. shock (during session 92) timeouts increased, although to a lower level than had previously occurred at either the 12.0 ma. or the 8.0 ma. intensity. Again, further exposure to the shock resulted in decreased timeouts.

Although the decrease in timeouts at 8.0 ma. and the smaller number of timeouts and their subsequent decline on the reintroduction of the 12.0 ma. intensity may have been a recovery phenomenon, such does not appear to be the case during the initial presentation of the 12.0 ma. shock. Rather, here the decrease in timeouts was accompanied by severe response reduction (see appendix A), and further, timeouts did increase on the <u>reduction</u> of the intensity to 8.0 ma.

This decrease in responding to both the food and timeout key may explain the absence of timeouts for S-660. The lower portion of figure 1 shows that S-660 took few timeouts, except during the first session of the 8.0 ma. intensity, during which 19.7% of the session was spent in timeout. With the exception of the first session at 12.0 ma., this was the only session during which any ratios were completed and reinforcement obtained (see appendix A).

As the complete suppression of responding on the food key was suggested as a possible cause for the absence of timeouts for S-660, the method of shock introduction was altered for S-440 and S-1055. For these subjects, the intensity was gradually increased as previously described. S-440 took no timeouts during the 25 sessions of the 12.0 ma. shock, and although the responding was reduced, it was not completely suppressed. S-1055 did initiate some timeouts as shown in figure 2, with the greatest amount of any shock session spent in timeout being 19.3% of the total session length.

As previously mentioned, an apparatus failure occurred during two sessions of the FR 50 without shock for S-440 and S-1055. The effect of this restricted access to reinforcement is shown in figure 2 (sessions 15 and 16) for S-1055. A slight increase in timeouts occurred for S-440 (see appendix A), while for S-1055 the increase is readily apparent, accounting for 37.3% and 21.8% of the session length. Session length also increased for both subjects. On repair of this failure, timeouts and session length rapidly declined.

<u>location of timeouts within the ratio</u>

S-832 took 39 timeouts during the 40 sessions of FR 50 without shock. All of these timeouts occurred during the pause-after-reinforcement. As can be seen in figure 3, the initial introduction of shock resulted in most timeouts occurring after the shock. However, on further exposure to shock, timeouts occurred more frequently before shock, than after shock. Only timeouts from completed ratios were used in forming figures 3-6. If no ratios were completed or less than three timeouts taken, no point was plotted for that session in figures 3 or 5. Figure 4 is a series of histograms showing the location of timeouts within the completed ratios. Each histogram was computed from five sessions of shock. Part I of this figure shows that on the initial exposure to shock most timeouts occurred immediately after the shock. On further exposure, timeouts began to occur frequently at all locations within the ratio and the percent occurring immediately after the shock decreased (see part III). Eventually, timeouts rarely occurred after shock and their most frequent location was during the pause-after-reinforcement or early in the ratio run (see parts VI and VIII).

S-1055 took 189 timeouts during the sessions of FR 50 without shock (except sessions 15 and 16); 147 of these were during the pause-after-reinforcement. For the last 20 sessions on FR 50 without shock (except sessions 15 and 16), 123 of the 129 timeouts occurred during the pause-after-reinforcement. Figure 5 shows that most timeouts occurred after shock on the shock's initial introduction. On further exposure to the shock, timeouts occurred more frequently before shock, except during sessions 43-46. Figure 6 is a series of histograms representing the percent of timeouts at each location within the ratio. Again, each histogram was computed from five sessions of shock. Although the initial introduction of shock did not produce many timeouts after shock nor a wide spread in timeout locations, it is evident that during block V timeouts occurred early in the ratio.

Portions of the cumulative records for S-832 are shown in figure 7. The upper pen returned to baseline on the delivery of reinforcement, and the "pips" represent the delivery of shock; timeouts are indicated by deviations from the lower line. The record for day 54 is one of the last sessions without shock and is typical of short fixed ratio performance (Ferster & Skinner, 1957). Day 59 shows disrupted responding throughout the ratios with timeouts occurring after the shock. Days 64 and 69 also show disrupted responding throughout the ratio, but with timeouts occurring at all locations within the ratio. By day 74 timeouts were occurring mainly before the shock. Day 80 shows what appears to be the acquisition of differential responding, i.e. broken and unstable response rates before shock and high stable response rates after shock. Timeouts have decreased to near zero (see figure 1). Days 93 and 98 clearly show differential responding within the ratios; this differential responding is in agreement with that found by Dardano and Sauerbrunn (1964). On day 93 timeouts occurred in "groups" after the rapid completion of several ratios. Cumulative records for S-440 and S-1055 showed similar differential responding during the two halves of the ratio.

Figure 1. Percent of session spent in timeout as a function of shock intensity for S-832 and S-660.

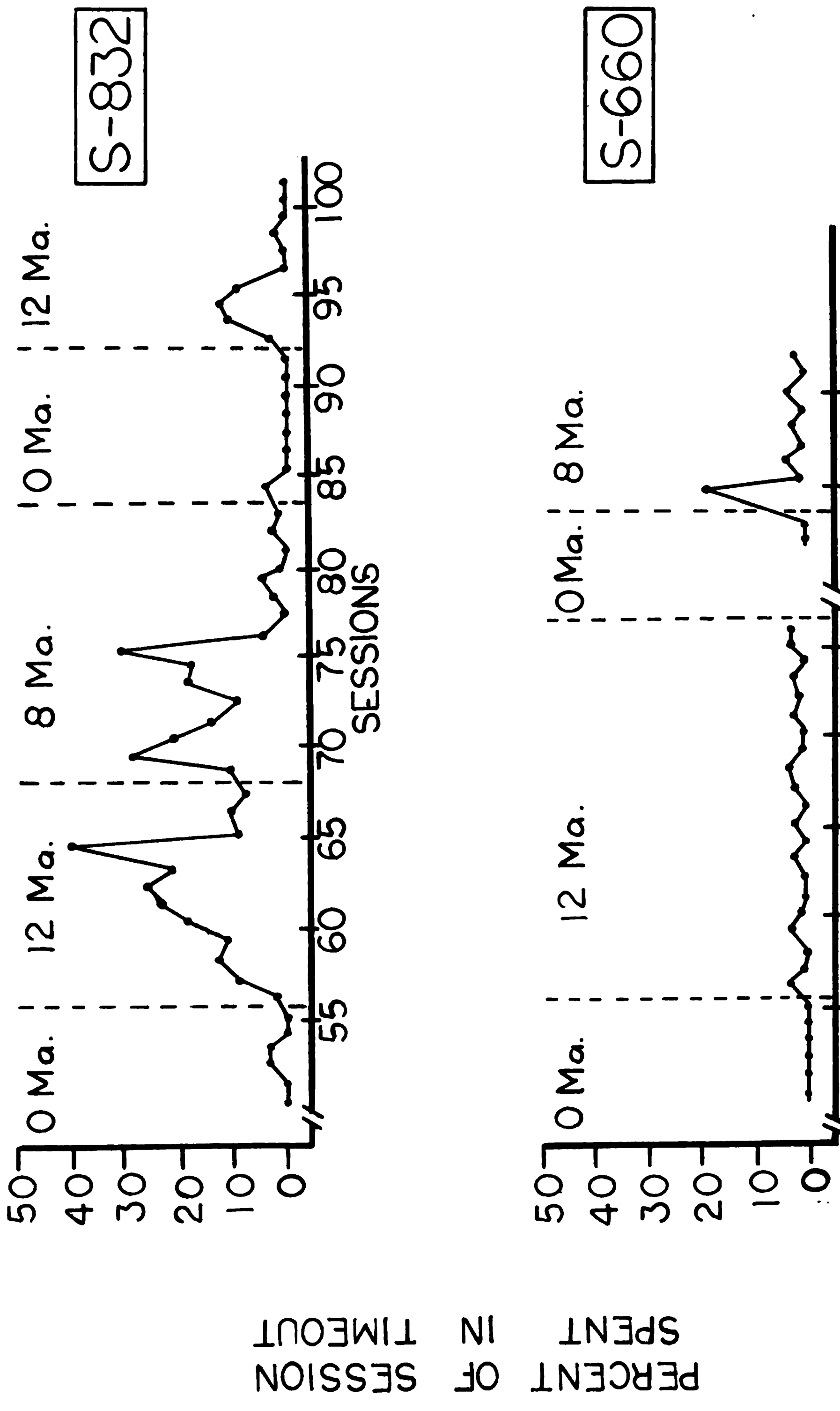
S-832
S-660
0 Ma.
12 Ma.
8 Ma.
0 Ma.
12 Ma.
0 Ma.
12 Ma.
0 Ma.
8 Ma.
SESSIONS
SESSIONS
55
60
65
70
75
80
85
90
95
100
0
10
20
30
40
50
PERCENT OF SESSION SPENT IN TIMEOUT

FIG. 1

Figure 2. Percent of session spent in timeout as a function of shock conditions for S-1055.

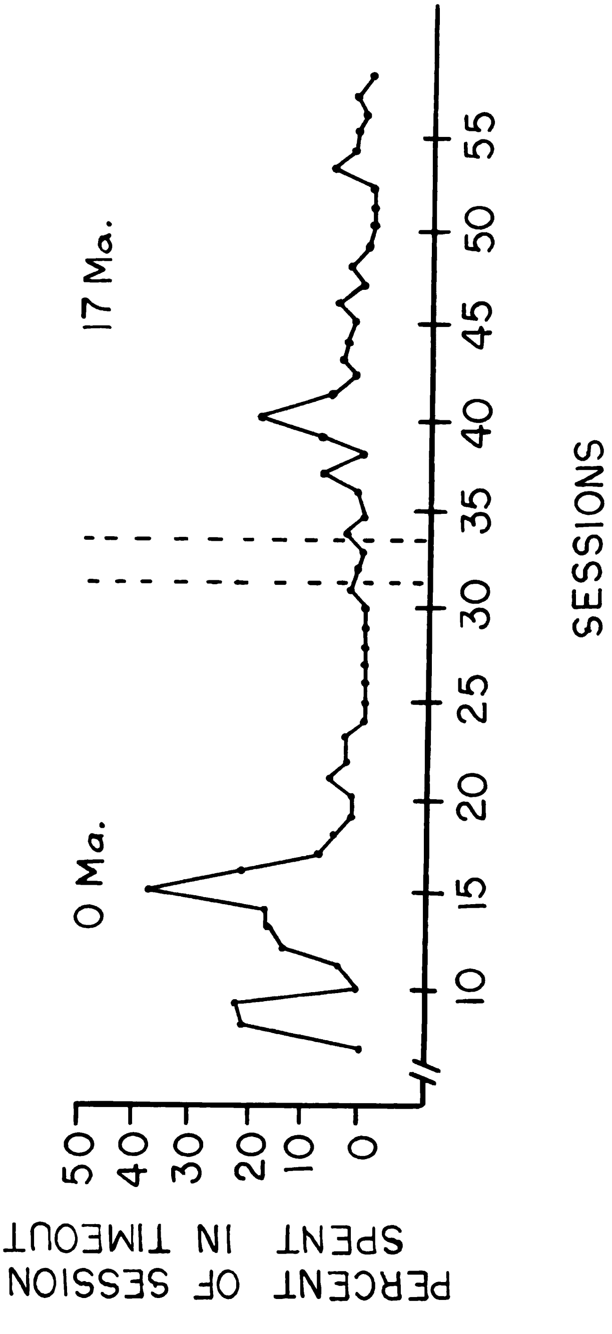
S-1055
0 Ma.
17 Ma.
PERCENT OF SESSION
SPENT IN TIMEOUT
0
10
20
30
40
50
10
15
20
25
30
35
40
45
50
55
SESSIONS

FIG. 2

Figure 3. Percent of timeouts occurring before shock for S-832. During sessions 84-91, no shocks were delivered.

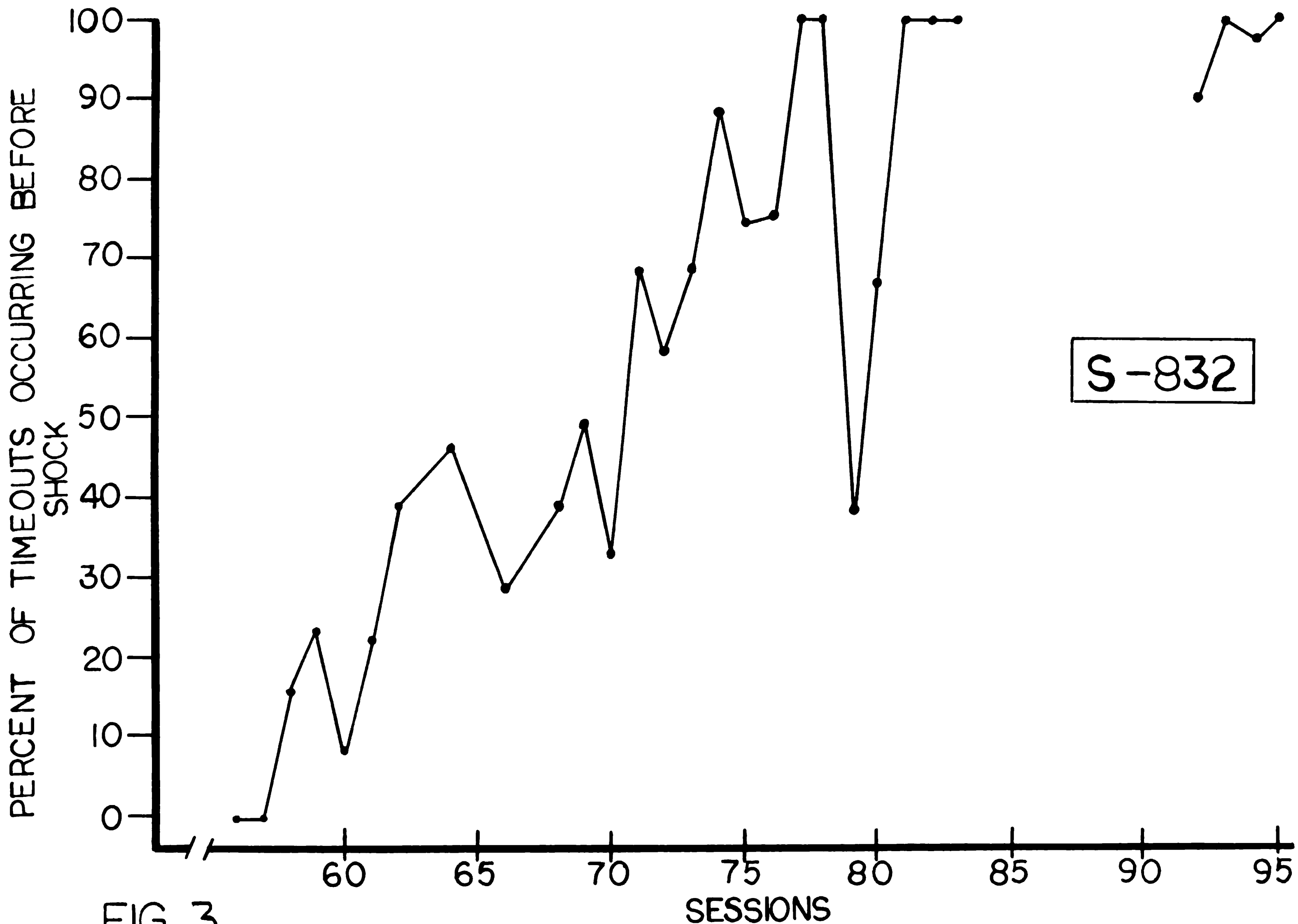
PERCENT OF TIMEOUTS OCCURRING BEFORE SHOCK
100
90
80
70
60
50
40
30
20
10
0
60
65
70
75
80
85
90
95
SESSIONS
S-832

FIG. 3

Figure 4. Location of timeouts within the fixed ratio 50 schedule for S-832. Each block was computed from five sessions of shock. Block V is not shown.

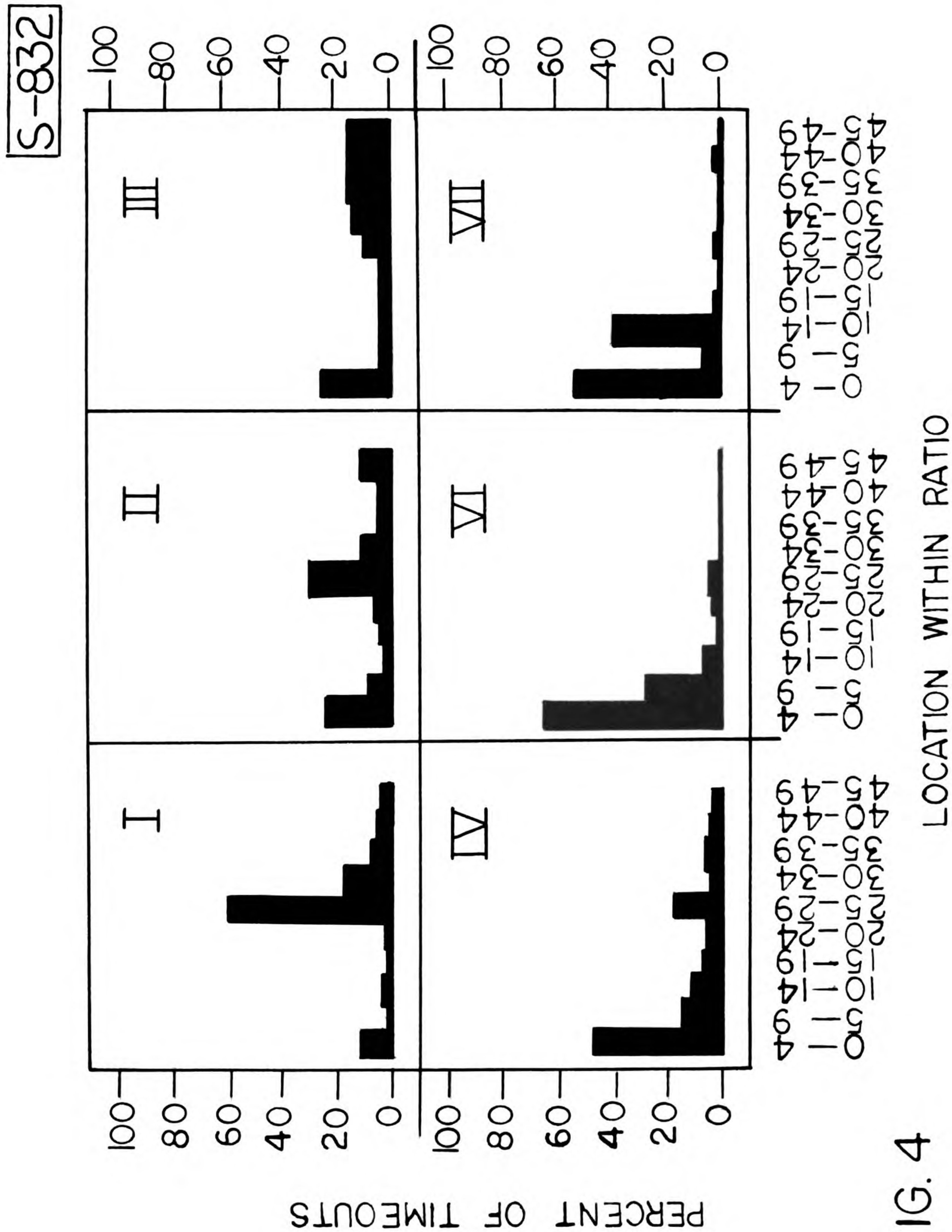
S-832
I
II
III
IV
VI
VII
PERCENT OF TIMEOUTS
LOCATION WITHIN RATIO

FIG. 4

Figure 5. Percent of timeouts occurring before shock for S-1055.

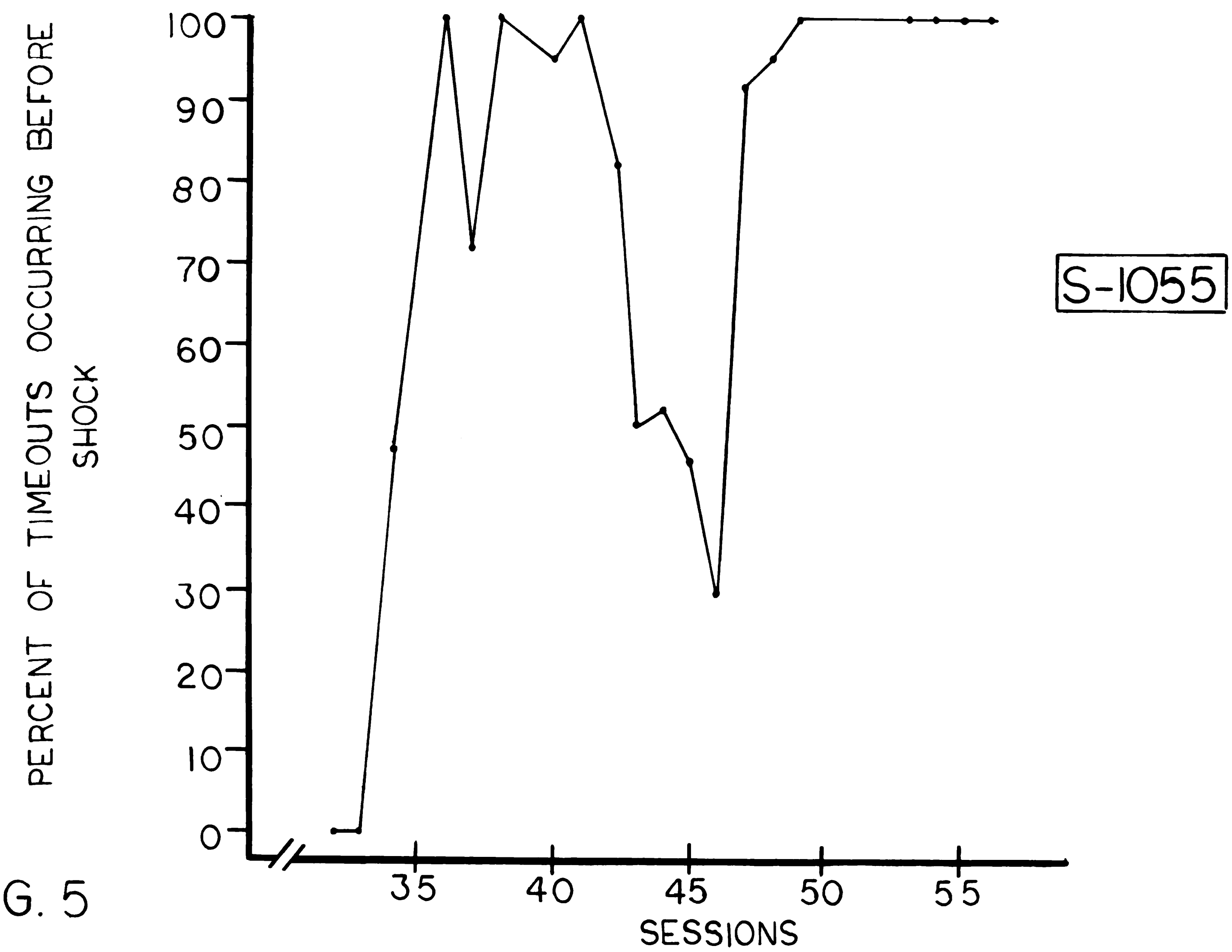
S-1055
PERCENT OF TIMEOUTS OCCURRING BEFORE SHOCK
100
90
80
70
60
50
40
30
20
10
0
35
40
45
50
55
SESSIONS

FIG. 5

Figure 6. Location of timeouts within the fixed ratio 50 schedule for S-1055. Each block was computed from five sessions of shock.

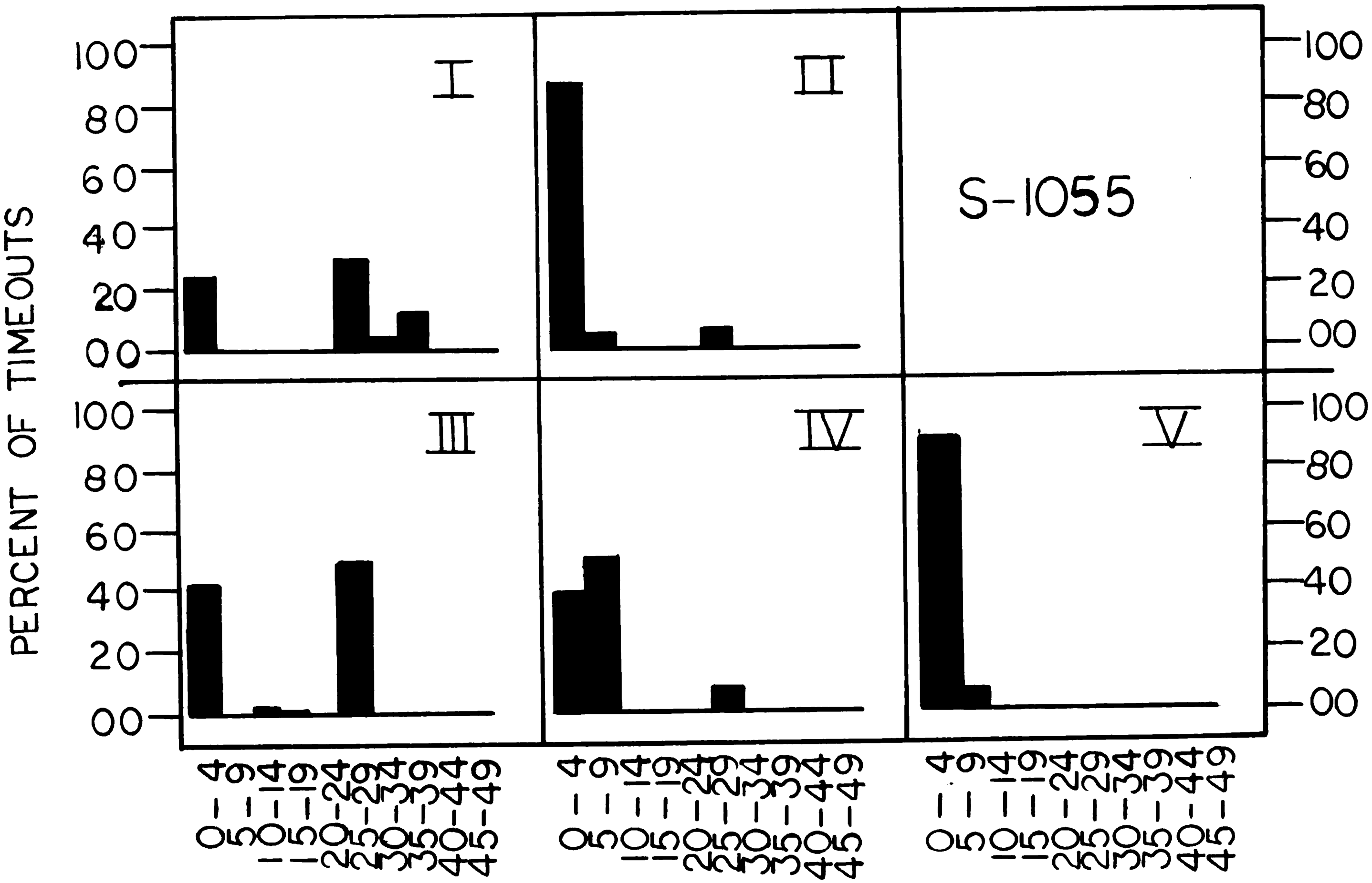
PERCENT OF TIMEOUTS
100
80
60
40
20
00
I
II
III
IV
V
S-1055
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
LOCATION WITHIN RATIO

FIG. 6

Figure 7. Sample cumulative records for S-832.

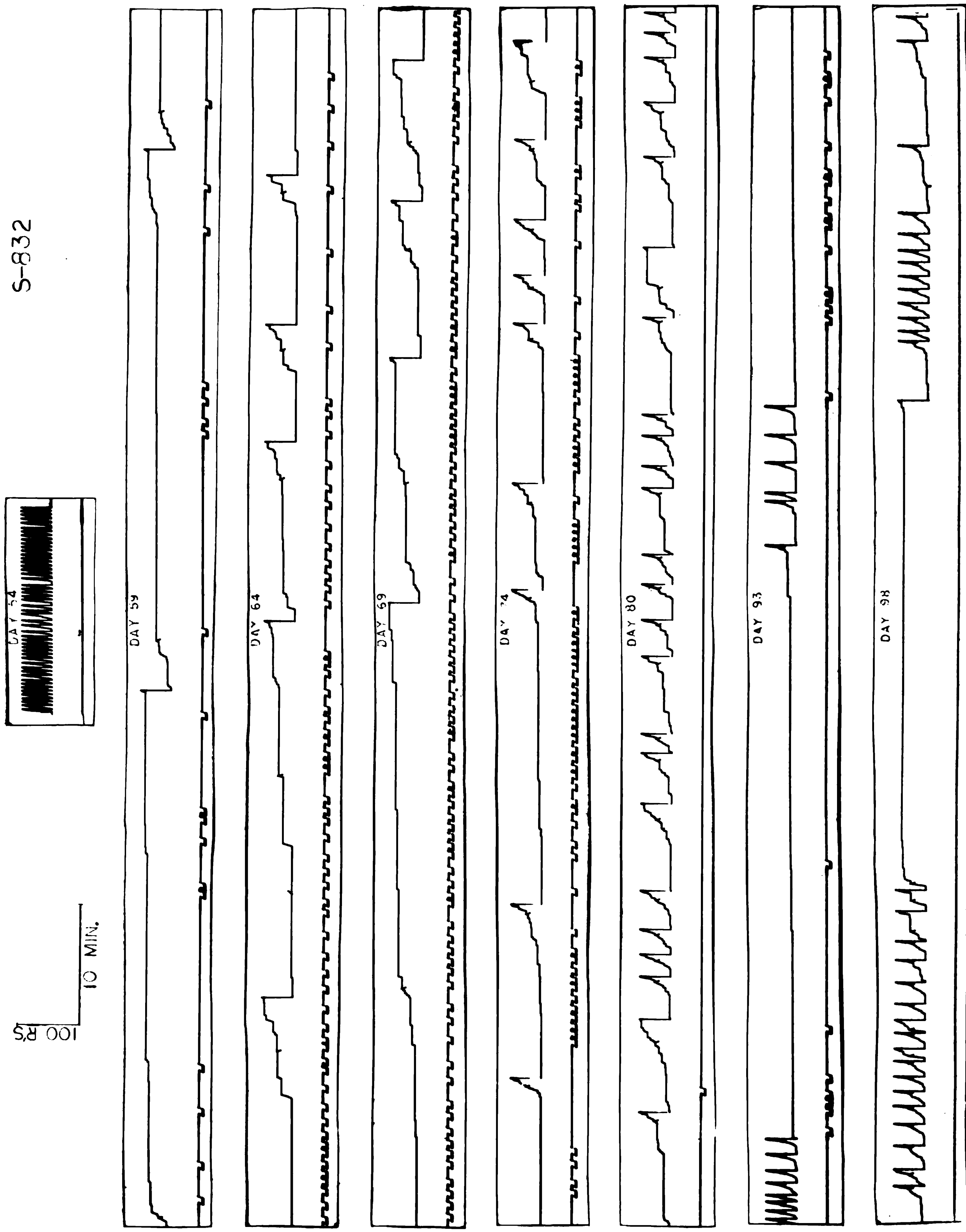

FIG. 7

DISCUSSION

The purpose of the present study was to determine what effect shocking the twenty-fifth response within a fixed ratio 50 schedule of reinforcement had on time-out behavior in pigeons. Results should be considered exploratory and suggestive, rather than definitive.

Except for S-1055 during sessions 8-16, few timeouts were taken from the fixed ratio 50 schedule without shock. The timeouts were usually located within the characteristic pause-after-reinforcement, which agrees with the previous findings of Azrin (1961) and Thompson (1964; 1965).

It appears that under some conditions pigeons will take timeouts from shock. Variables of importance may include shock intensity and its degree of accompanying response suppression. With responding almost completely suppressed, S-660 took few timeouts. For S-832 responding was maintained and many timeouts taken. Unfortunately, the percent of session spent in timeout varied and eventually decreased to zero. Attempts to achieve stability by changing shock intensity were unsuccessful.

Although the present study gives no definitive explanation for this decrease in timeouts or its absence in some subjects, several possibilities are suggested. As responding has been shown to result in a characteristic recovery from mild punishment (e.g., Azrin, 1960;

Hake & Azrin, 1963), the decrease in timeouts may simply be a recovery phenomenon. In conjunction with this, the constant location of the shock may have allowed it to acquire discriminative properties (Holz & Azrin, 1962); support for this may be seen in figure 7 and in the Dardano & Sauerbrunn study (1964). Further, timeouts did not only decrease on further exposure to shock, but their location within the ratio also changed. While initially timeouts occurred after the shock, they eventually occurred only before the shock and most often early in the ratio (figures 3 and 4). Although this change is less clear for S-1055, the timeouts did eventually occur most often early in the ratio (figures 5 and 6). Following Hearst & Sidman (1961), the delivery of both food and shock under either a variable ratio or variable interval schedule might have been more effective in maintaining a conflict situation and possibly timeout behavior.

A third possible explanation for the decrease in timeouts and their relative fewness concerns the duration of the timeout. Zimmerman & Ferster (1964) found timeout duration to be an important factor in timeout from simple fixed ratio schedules. A fixed duration 10 second timeout resulted in fewer timeouts than a "free-switching" procedure. Possibly a "free-switching" procedure, which allows the subject to both initiate and terminate timeouts, would have been more effective in the present study. If a thirty second timeout has been shown effective in maintaining escape from a simple fixed ratio (e.g., Thompson, 1965), it does not necessarily follow that this duration will be sufficient to maintain escape responding when shock is added. In this regard, it should be mentioned that Hearst & Sidman (1961) employed a fixed duration timeout of either 10 or 15 minutes. More recent research (Hearst & Koresko, 1964; Hearst, 1967) has employed the "free-switching" procedure. Gross observations in the present experiment revealed that the subjects when not responding would often turn away from the intelligence panel and face the backwall. This may suggest that the timeout duration was not sufficient to maintain escape responding or that the locating of the timeout key on the backwall would have generated more escape.

Another important variable may be the manner in which the shock is introduced. For S-1055 and S-440, the intensity was gradually increased and although this proved successful in maintaining responses to the food key, it did not result in timeouts accounting for much of the sessions' length. Examination of the location of timeouts within the ratio for S-1055 showed timeouts occurring within the early portions of the ratio, after the initial exposure to shock. While Hearst <u>et al</u> have been able to manipulate shock intensity in maintaining timeouts with rats, the present experimenter was unable to duplicate this with pigeons. Several procedural differences that might account for this were suggested above.

In summary, results suggest that the shocking of the twenty-fifth response within a fixed ratio 50 schedule of food reinforcement may result in pigeons taking time-outs from positive reinforcement, although the results are not clear as to the important variables underlying this behavior. Subjects which did take timeouts showed a tendency to take them early in the ratio on further exposure to shock.

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APPENDIX A

APPENDIX A

S-832

session	shock intensity	responses	session length	percent in timeout
16	0.0 ma.	2500	16.92 min.	00.0
17	0.0	2500	18.61	00.0
18	0.0	2500	18.75	00.0
19	0.0	2500	19.67	00.0
20	0.0	2500	58.77	00.0
21	0.0	2500	18.37	00.0
22	0.0	2500	17.81	00.0
23	0.0	2500	20.56	00.0
24	0.0	2500	17.92	00.0
25	0.0	2500	20.20	00.0
26	0.0	2500	18.41	00.0
27	0.0	2500	18.77	00.0
28	0.0	2500	19.19	00.0
29	0.0	2500	19.14	00.0
30	0.0	2500	18.56	00.0
31	0.0	2500	19.19	00.0
32	0.0	2500	33.20	16.6
33	0.0	2500	31.89	20.4
34	0.0	2500	18.62	08.1
35	0.0	2500	25.77	11.6
36	0.0	2500	17.57	02.8
37	0.0	2500	19.44	05.1
38	0.0	2500	16.37	00.0
39	0.0	2500	15.36	00.0
40	0.0	2500	15.21	00.0
41	0.0	2500	15.84	00.0
42	0.0	2500	16.53	00.0
43	0.0	2500	16.27	00.0
44	0.0	2500	18.90	00.0
45	0.0	2500	17.30	00.0
46	0.0	2500	16.94	00.0
47	0.0	2500	17.98	00.0
48	0.0	2500	18.79	02.7
49	0.0	2500	16.10	00.0
50	0.0	2500	16.08	00.0
51	0.0	2500	16.84	00.0
52	0.0	2500	17.48	02.9
53	0.0	2500	17.29	02.9
54	0.0	2500	17.36	00.0
55	0.0	2500	17.48	00.0
56	12.0	175	241.57	00.2
57	12.0	175	240.87	07.1

S-832

session	shock intensity	responses	session length	percent in timeout
58	12.0	83	234.79	12.1
59	12.0	175	240.29	11.9
60	12.0	114	240.25	18.5
61	12.0	103	240.22	22.1
62	12.0	193	240.19	23.3
63	12.0	25	240.54	20.6
64	12.0	354	420.28	40.2
65	12.0	0	360.81	08.0
66	12.0	177	359.62	08.9
67	12.0	0	360.00	07.5
68	8.0	232	360.00	08.1
69	8.0	500	359.84	28.1
70	8.0	157	360.43	21.4
71	8.0	1075	359.04	12.7
72	8.0	707	359.87	09.7
73	8.0	844	360.36	19.3
74	8.0	1394	259.12	19.3
75	8.0	1319	359.93	30.4
76	8.0	2266	359.44	05.3
77	8.0	213	362.89	00.6
78	8.0	656	362.13	00.8
79	8.0	2500	219.56	03.0
80	8.0	2500	317.66	00.5
81	8.0	2500	311.23	00.3
82	8.0	1300	259.55	00.7
83	8.0	2500	340.11	00.4
84	0.0	2500	84.46	03.0
85	0.0	2500	19.68	00.0
86	0.0	2500	28.48	00.0
87	0.0	2500	21.90	00.0
88	0.0	2500	19.33	00.0
89	0.0	2500	21.20	00.0
90	0.0	2500	19.16	00.0
91	0.0	2500	18.34	00.0
92	12.0	811	361.82	03.9
93	12.0	1403	361.06	12.3
94	12.0	2500	236.37	12.5
95	12.0	2408	359.50	10.6
96	12.0	1950	360.23	00.0
97	12.0	2500	293.26	00.0
98	12.0	2500	350.60	00.3
99	12.0	2500	299.30	00.0
100	12.0	2500	182.02	00.0
101	12.0	1400	110.34	00.0

S-660

session	shock intensity	responses	session length	percent in timeout
16	0.0 ma.	2500	34.86 min.	00.0
17	0.0	2500	34.68	00.0
18	0.0	2500	30.02	00.0
19	0.0	2500	26.36	00.0
20	0.0	2500	21.96	00.0
21	0.0	2500	20.00	00.0
22	0.0	2500	22.84	00.0
23	0.0	2500	32.26	00.0
24	0.0	2500	20.94	04.7
25	0.0	2500	28.20	05.3
26	0.0	2500	36.79	00.0
27	0.0	2500	28.18	00.0
28	0.0	2500	22.39	00.0
29	0.0	2500	20.51	00.0
30	0.0	2500	23.36	00.0
31	0.0	2500	22.27	00.0
32	0.0	2500	19.54	00.0
33	0.0	2500	16.79	00.0
34	0.0	2500	16.15	00.0
35	0.0	2500	16.77	00.0
36	0.0	2500	18.66	00.0
37	0.0	2500	19.06	00.0
38	0.0	2500	25.53	00.0
39	0.0	2500	20.69	00.0
40	0.0	2500	19.05	00.0
41	0.0	2500	15.89	00.0
42	0.0	2500	13.82	00.0
43	0.0	2500	13.24	00.0
44	0.0	2500	14.05	00.0
45	0.0	2500	17.64	00.0
46	0.0	2500	14.13	00.0
47	0.0	2500	15.56	00.0
48	0.0	2500	13.52	00.0
49	0.0	2500	13.75	00.0
50	0.0	2500	13.94	00.0
51	0.0	2500	13.92	00.0
52	0.0	2500	15.23	00.0
53	0.0	2500	14.57	00.0
54	0.0	2500	14.89	00.0
55	0.0	2500	14.16	00.0
56	12.0	375	361.97	01.2
57	12.0	28	363.31	00.6
58	12.0	2	363.41	00.3
59	12.0	27	363.43	02.3
60	12.0	0	363.51	00.4

S-660

session	shock intensity	responses	session length	percent in timeout
61	12.0	0	363.48	00.1
62	12.0	0	363.47	00.0
63	12.0	0	363.43	01.9
64	12.0	1	363.42	00.1
65	12.0	0	363.46	01.9
66	12.0	0	363.53	00.0
67	12.0	0	363.58	01.5
68	12.0	0	363.60	01.7
69	12.0	0	363.60	01.4
70	12.0	0	363.60	00.0
71	12.0	0	363.65	00.0
72	12.0	0	363.65	00.4
73	12.0	0	366.01	00.3
74	12.0	1	365.79	00.3
75	12.0	0	365.96	00.0
76	12.0	0	366.05	00.5
77	12.0	0	366.19	00.8
78	0.0			
79	0.0	2500	21.49	00.0
80	0.0	2500	23.27	00.0
81	0.0	2500	22.00	00.0
82	0.0	2500	32.27	00.0
83	0.0	2500	21.48	00.0
84	0.0	2500	18.66	00.0
85	0.0	2500	18.95	00.0
86	0.0	2500	32.13	00.0
87	0.0	2500	16.09	00.0
88	0.0	2500	16.92	00.0
89	0.0	2500	16.75	00.0
90	0.0	2500	14.52	00.0
91	0.0	2500	14.52	00.0
92	0.0	2500	13.08	00.0
93	0.0	2500	13.01	00.0
94	8.0	104	365.90	19.7
95	8.0	0	366.63	00.1
96	8.0	25	366.60	03.1
97	8.0	0	366.35	00.4
98	8.0	0	366.27	00.4
99	8.0	0	366.63	00.1
100	8.0	3	366.30	01.6
101	8.0	1	358.20	00.4
102	8.0	0	366.28	01.2

S-440

session	shock intensity	responses	session length	percent in timeout
8	0.0 ma.	2500	123.29 min.	00.0
9	0.0	2500	43.48	00.0
10	0.0	2500	41.61	00.0
11	0.0	2500	67.50	00.0
12	0.0	2500	40.01	00.0
13	0.0	2500	40.68	00.0
14	0.0	2500	34.00	00.0
15	0.0	2500	45.40	00.0
16*	0.0	2500	190.15	00.5
17*	0.0	2500	149.65	00.0
18	0.0	2500	33.43	00.0
19	0.0	2500	27.41	00.0
20	0.0	2500	26.89	00.0
21	0.0	2500	32.86	00.0
22	0.0	2500	28.37	00.0
23	0.0	2500	26.91	00.0
24	0.0	2500	26.53	00.0
25	0.0	2500	27.44	00.0
26	0.0	2500	27.52	00.0
27	0.0	2500	37.00	01.4
28	0.0	2500	30.68	00.0
29	0.0	2500	25.75	00.0
30	0.0	2500	27.47	00.0
31	0.0	2500	30.00	00.0
32	0.0	2500	31.17	00.0
33	2.0→12.0	1000	360.09	00.0
34	12.0	140	360.47	00.0
35	12.0	407	361.07	00.0
36	12.0	2500	280.68	00.0
37	12.0	1875	358.81	00.0
38	12.0	931	360.34	00.0
39	12.0	2050	358.52	00.0
40	12.0	351	361.18	00.0
41	12.0	375	361.20	00.0
42	12.0	452	361.00	00.0
43	12.0	1247	359.60	00.0
44	12.0	1500	359.25	00.0
45	12.0	325	361.28	00.0
46	12.0	2500	343.00	00.0
47	12.0	1615	359.12	00.0
48	12.0	2500	302.98	00.0

* apparatus failure

S-440

session	shock intensity	responses	session length	percent in timeout
49	12.0	2500	278.98	00.0
50	12.0	2500	292.61	00.0
51	12.0	2500	249.61	00.0
52	12.0	1301	360.04	00.0
53	12.0	1556	359.66	00.0
54	12.0	2025	358.90	00.0
55	12.0	2100	358.74	00.0
56	12.0	70	360.00	00.0
57	12.0	1935	357.45	00.0
58	12.0	2013	359.14	00.0

S-1055

session	shock intensity	responses	session length	percent in timeout
7	0.0 ma.	2500	115.50 min.	00.9
8	0.0	2500	126.75	16.6
9	0.0	2500	48.84	11.3
10	0.0	2500	41.51	01.2
11	0.0	2500	60.30	03.3
12	0.0	2500	109.07	13.8
13	0.0	2500	131.87	15.9
14	0.0	2500	118.71	16.0
15*	0.0	1805	360.00	37.2
16*	0.0	2500	105.47	21.8
17	0.0	2500	34.15	07.3
18	0.0	2500	29.70	05.1
19	0.0	2500	28.66	01.7
20	0.0	2500	29.68	01.7
21	0.0	2500	29.70	05.1
22	0.0	2500	31.07	03.2
23	0.0	2500	31.49	03.2
24	0.0	2500	26.84	00.0
25	0.0	2500	27.58	00.0
26	0.0	2500	27.21	00.0
27	0.0	2500	31.44	00.0
28	0.0	2500	30.57	00.0
29	0.0	2500	28.48	00.0
30	0.0	2500	28.45	00.0
31	0.0	2500	36.41	02.7
~~32~~	~~2.0→12.0~~	~~2500~~	~~325.02~~	~~02.3~~
~~33~~	~~15.0~~	~~2364~~	~~357.24~~	~~00.7~~
~~34~~	~~17.0~~	~~2210~~	~~342.38~~	~~04.1~~
35	17.0	2500	51.90	00.0
36	17.0	2500	284.30	00.5
37	17.0	2500	295.49	08.5
38	17.0	1809	354.44	01.4
39	17.0	0	361.72	07.0
40	17.0	2500	209.76	19.3
41	17.0	150	360.00	06.4
42	17.0	2500	224.84	02.9
43	17.0	2500	67.91	04.4
44	17.0	2250	357.69	04.5
45	17.0	1250	359.26	03.1
46	17.0	2500	313.58	04.9
47	17.0	2050	359.54	01.8

* apparatus failure

S-1055

session	shock intensity	responses	session length	percent in timeout
48	17.0	2353	325.56	03.1
49	17.0	2500	355.32	00.7
50	17.0	2500	222.92	00.0
51	17.0	2500	177.61	00.3
52	17.0	2450	155.41	00.0
53	17.0	2500	203.74	05.6
54	17.0	2500	285.63	02.8
55	17.0	2802	354.44	02.7
56	17.0	2500	263.88	01.7
57	17.0	17	361.77	03.2
58	17.0	2500	126.87	00.8