EXPERIMENTAL SELF-PUNISHMENT AND SUPERSTITIOUS ESCAPE BEHAVIOR

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Rats were trained to escape from shock by pressing a bar. Bar holding was subsequently punished with very brief shocks. This treatment failed to depress bar-holding behavior. In some cases, although the escape shocks were delivered very infrequently, bar holding was maintained and resulted in the delivery of several thousand punishments per session. These and other effects of the punishment treatment were investigated. Finally, some of the possibilities of superstitious escape responding were explored by presenting inescapable shocks to rats that had been trained to escape shock by lever pressing. Although responding during these shocks had no programmed consequences, responding was sustained.

Many experimenters have observed that rats trained to press a bar to terminate shocks will hold the bar depressed between shocks. When we attempted to train rats on an escape-avoidance procedure, this typical bar-holding behavior prevented the animals from learning the avoidance response. Brief shocks delivered to the animals whenever they held the bar down for several seconds not only failed to eliminate the bar holding, but in some cases seemed to strengthen it. The effect was seen repeatedly and was termed "self-punishment." A series of follow-up experiments to investigate the conditions under which the effect appeared will also be described.

METHOD

Subjects

Male, albino rats, with a few male Canadian hooded rats, were obtained from the Walter Reed Army Institute of Research colonies and were experimentally naive. They were maintained on *ad libitum* food and water, except during experimental sessions, and their weights ranged from 250-460 g.

Apparatus

All procedures were carried out in a conventional experimental space measuring 10 by 11 by 8 in. deep with a microswitch lever mounted on one wall $3\frac{1}{2}$ in. above the grid floor. Electric shock, when applied, was delivered by scrambling polarities across the grid floor, walls, and lever. The shock intensity for most animals was approximately 1 ma, (given the vagaries of electromechanical shock scramblers). For a few animals the intensity was higher or lower, but constant for the particular animal. This was done to keep the behavioral effect (amount of jumping, squeaking, *etc.*) roughly the same, rather than keeping the current the same. The experiment was programmed and recorded automatically.

EXPERIMENT 1

Three rats, X-5, -6, -7, were given the following training. Every 10 sec a shock (escape shock) was delivered (about 1 ma) which the animal could terminate by pressing a bar. If the animal did not press the bar within 10 sec the shock was turned off automatically, and the next shock was delivered 10 sec later. There was also an avoidance contingency; if the rat pressed the bar between shocks it reset the 10-sec timer (the response-shock or R-S timer) and postponed the next shock for 10 sec.

After 50 min of escape-avoidance training, the self-punishment contingency was added for 30 min. During this 30-min period, the rat received a brief shock (.05 sec) whenever it held the bar down for 2.5 sec (self-punishment shock or S-P); if the rat stayed on the bar, another shock was delivered 2.5 sec later, and so on. When the rat shocked itself, it also reset

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the R-S timer. The intensity of the self-punishment shock was the same as the intensity of the escape shock. Ten such 30-min sessions were run.

Results

Figure 1 shows the results for each rat. The abscissa for all curves is the sequence of sessions, with escape-avoidance in Session 1A (50 min) and the self-punishment contingency added in Sessions 1B and 2 to 10. The upper row of curves shows that the animals spent a large percentage of each session holding the bar down. They maintained this holding behavior even though they delivered 650 to 850 self-punishment shocks to themselves per session (middle row of curves). The animals received an escape shock only when they stayed off the bar for 10 sec; because they rarely did this, the number of escape shocks became very low (bottom row of curves).

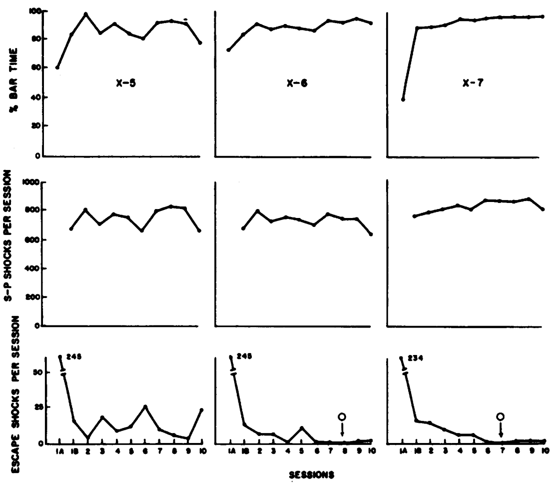


Fig. 1. Percent bar-holding time, number of escape shocks, and number of self-punishment shocks for three rats. The data for each rat is shown in a column. In session 1A escape training only was in effect, in sessions 1B to 10 the self-punishment contingency was added.

Figure 2 shows cumulative records for session 1A (50 min of escape-avoidance), session 1B (30 min with self-punishment added), and the last (10th) session of self-punishment. A downward deflection of the pen indicates delivery of a shock—either escape or self-punishment. The self-punishment effect was almost immediate, and changed little over the 10 sessions. Shock density became very high and the shocks were almost entirely self-administered, as the middle and lower curves in Fig. 1 indicate. Rat X-7 did not release the lever enough with each shock to open the microswitch contacts, and there are few responses on the cumulative records for this rat. On the other hand, Rat X-5 released the bar more frequently when it received the self-punishment shocks. Rat X-7 bounced off the bar regularly with delivery of the self-punishment shock, particularly in the last few sessions, giving many spurious "avoidance" responses.

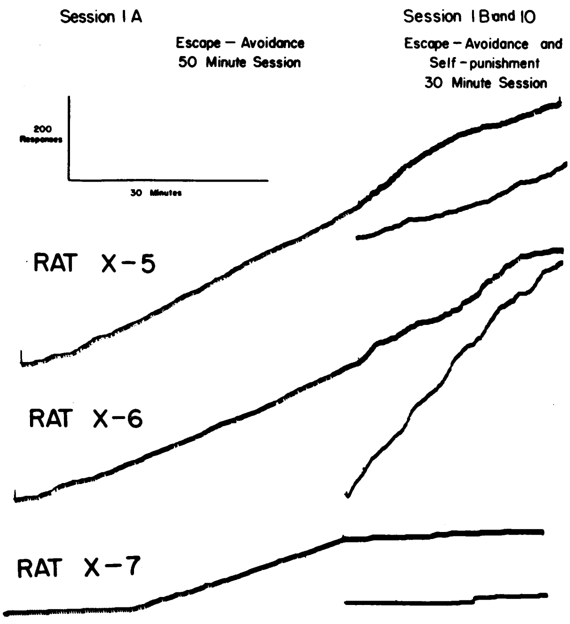


Fig. 2. Cumulative records for the three rats shown in Fig. 1. For each rat, session 1A (escape only), 1B and 10 (with self-punishment added) are shown.

The main finding of this experiment was that bar holding was maintained and that punishment did not weaken it. (Actually it was not clear throughout these experiments whether the bar holding was merely maintained or in fact, facilitated; in any case the punishments did not reduce this behavior.) The following procedures attempt to explore the conditions under which the effect can be seen.

EXPERIMENT 2

In Exp. 1 the rats first learned to press a bar and escape from shock; then the self-punishment contingency was added. In the second experiment, the preliminary escape-avoidance training was omitted and the combined pro-

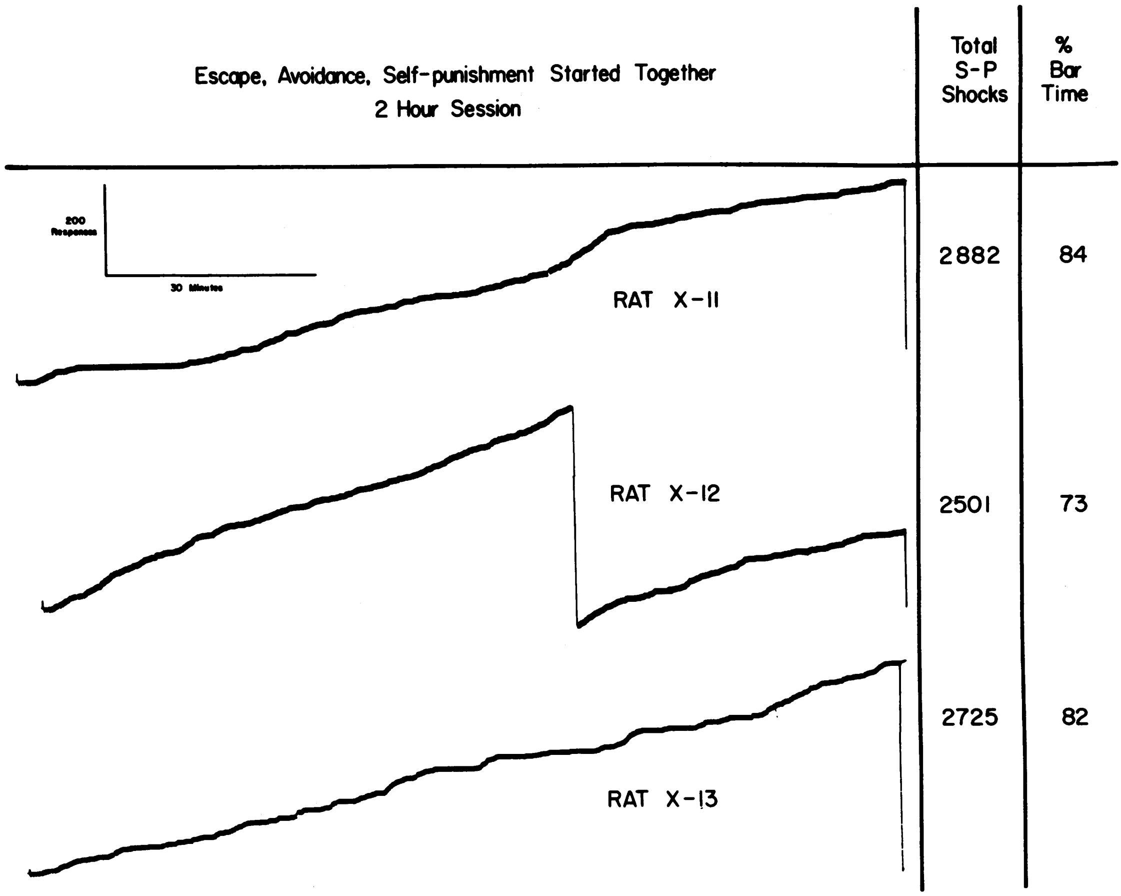


Fig. 3. Complete cumulative records for the three rats in Exp. 2. The number of self-punishment shocks and the percentage of time spent holding the bar down during the 2-hr session are given at right.

cedures of escape-avoidance with self-punishment added were started together. Three rats were given a single 2-hr training session. The temporal values for escape-avoidance were the same as in Exp. 1, R-S 10 sec with a 10-sec maximum shock duration, and .05-sec shock whenever the animal held the bar down for 2.5 sec. Each self-punishment shock again reset the R-S timer.

Results

The cumulative records for the three animals are shown in Fig. 3 and the accompanying table lists both the total self-punishment shocks and the percentage of the session the animals held the bar down. Clearly, the preliminary escape-avoidance training was not essential for the development of the self-punishment effect. The rats began to shock themselves at about the same time that the escape response developed, and they continued to do this for the rest of the 2-hr session.

EXPERIMENT 3

The original procedure described in Exp. 1 employed preliminary escape-avoidance training, followed by escape-avoidance with self-punishment added. Experiment 2 showed that the preliminary training was unnecessary. The next question concerned the necessity for the avoidance contingency. Would simple escape training suffice to produce the self-punishment effect? Experiment 3 attempted to answer this question by eliminating the avoidance component. If the animals pressed the bar between shocks, they did not reset the R-S timer; otherwise the conditions were as before.

A second question faced in Exp. 3 was the effect of exposing the animal to the self-punishment contingency without either preliminary (as in Exp. 1) or concurrent (as in Exp. 2) escape-avoidance training.

Three rats were the subjects. Each animal was first placed in the box for a 4-hr session of self-punishment only. Whenever the animal held the bar down for 2.5 sec, it produced a .05-sec shock. Immediately after this 4-hr session, escape training was started. Every 10 sec the animal received an escape shock (10-sec maximum duration) which it could terminate by pressing a bar. If it pressed the bar between escape shocks, the rat did not postpone them, but the self-punishment contingency remained in effect. This training was continued for 2 hr.

Results

Figure 4 presents the results for the three rats. The animals gave themselves few self-punishment shocks (see arrows) during the 4 hr. The addition of escape training, however, quickly produced self-punishment behavior in essentially the same manner as in Exp. 2.

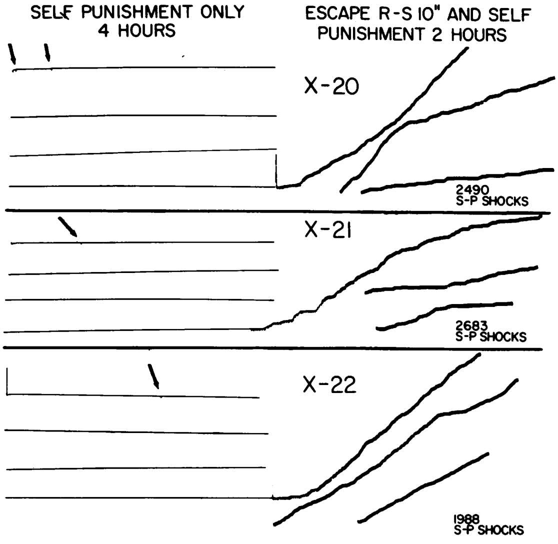


Fig. 4. Complete records for the three animals in Exp. 3. Four hr of self-punishment alone are shown at the right followed by 2 hr with escape conditioning added. The number of self-punishment shocks for each rat in the last 2 hr is given below the last segment for each rat.

EXPERIMENT 4

Experiment 3 showed that avoidance contingency was irrelevant and that preliminary exposure of the animals to self-punishment would not produce the self-punishment effect (nor prevent its subsequent development). What would happen, however, if an animal with an escape-training history were then exposed to self-punishment alone? Experiment 4 attempted to answer this question.

Three rats were first given 1 hr of escape training with the same temporal values used previously, but without shocking them for holding the bar; *i.e.*, simple escape conditioning. Immediately after this 1-hr escape session, the self-punishment contingency was introduced for an additional hour and the escape shock was simultaneously eliminated.

Results

Figure 5 shows the effects of this training sequence. The animals rapidly developed both the escape response and the typical bar-holding behavior. Note that the animals actually held the bar down more at the end of the first hour than the overall value for the session indicates, since the overall value includes the acquisition period. The right side of the figure shows the main effect. Rats X-2 and X-3 stopped holding the bar almost immediately after the escape shock was eliminated; the third rat, X-4, shocked itself 211 times and then abruptly stopped holding the bar. A history of escape training, therefore, was not sufficient to maintain the self-punishment effect in isolation, *i.e.*, without continued escape training.

EXPERIMENT 5

Experiment 4 had shown that elimination of the escape component (increasing the R-S value of the escape shock timer from 10 sec to infinity in one step) eliminated the self-punishment effect. Would the self-punishment behavior be maintained when the increments on the R-S timer were made gradually over a number of sessions?

Three rats were the subjects. In the first 50 min of the first session, the rat was trained to press the bar and terminate the shock, with 10 sec between escape shocks. Immediately after this escape training the self-punishment contingency was added for 30 min. If the rat held the bar depressed for 2.5 sec, it received

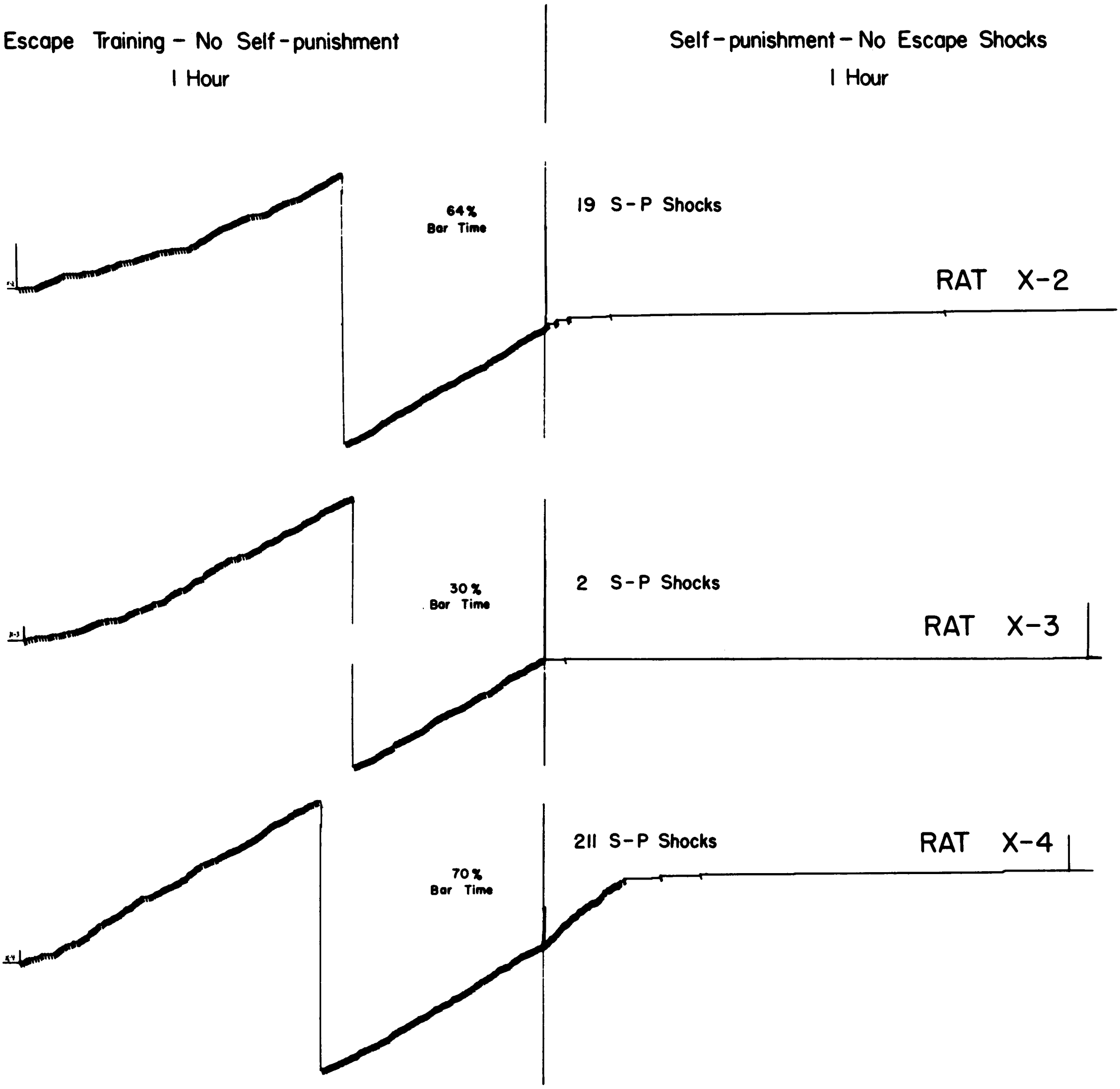


Fig. 5. Complete records for the three animals in Exp. 4. One hr of escape training is shown at the right. In the 2nd hr, which followed immediately, the escape contingency was dropped and the self-punishment contingency substituted. The percent bar holding is given at the end of the 1st hr directly above the record.

a .05-sec self-punishment shock. Each self-punishment shock postponed the escape shock. Whenever the rat let go of the bar the escape shock would come 10 sec later (maximum duration of 10 sec) if the animal did not press again. In the next daily session (30 min) the escape shock was delivered 20 sec (R-S interval) after the last self-punishment shock or the last escape response if there were no self-punishment shocks intervening. In the next session the interval was increased to 30 sec, and in each subsequent 30-min session there was a 10-sec increment until a value of 2 min was reached between escape shocks. At this point the interval was increased in 15-sec increments up to a value of 3 min and, since so few escape shocks could be delivered in a 30-min session at these high values, the session length was increased to 2 hr.

Results

Figure 6 shows the progress of Rat X-8. The curve in the upper left corner represents the initial 50 min of escape training, followed by 30 min with self-punishment added. The increasing R-S values indicate the progression of the sessions. The lower part of the figure shows the 2-hr sessions with the 15 sec increments on the R-S timer. The number above and near the end of each record is the number of escape shocks the animal received in that session.

Generally, one escape shock at the start of the session was sufficient to drive the rat onto the bar, where it stayed for most of the session, shocking itself almost continuously. Finally, in the last two sessions, the rat took no escape shocks. In each of the last four sessions, this rat shocked itself approximately 3,000 times per session. (The records are flat, because the rat did not release the bar when the brief self-punishment shock was delivered. Delivery of the shock was visually confirmed; the rat's body pulsed briefly with each shock.)

Figure 7 shows the results with Rat X-9. As the R-S values increased during successive sessions this rat began to spend more time off the bar; note the blank spaces in the records. The number of self-punishment shocks in the last four sessions was approximately 1,400, 1,300, 1,000, and 900, in that order. In the final sessions there were many more long pauses, but few escape shocks (as indicated at the end of the records), indicating that on many occasions the rat returned to the bar after a long pause and resumed self-punishment without being driven to the bar by an escape shock.

The third rat (Fig. 8) started very much like the others; the early records are dense and the number of escape shocks very low, indicating fairly heavy self-punishment. How-

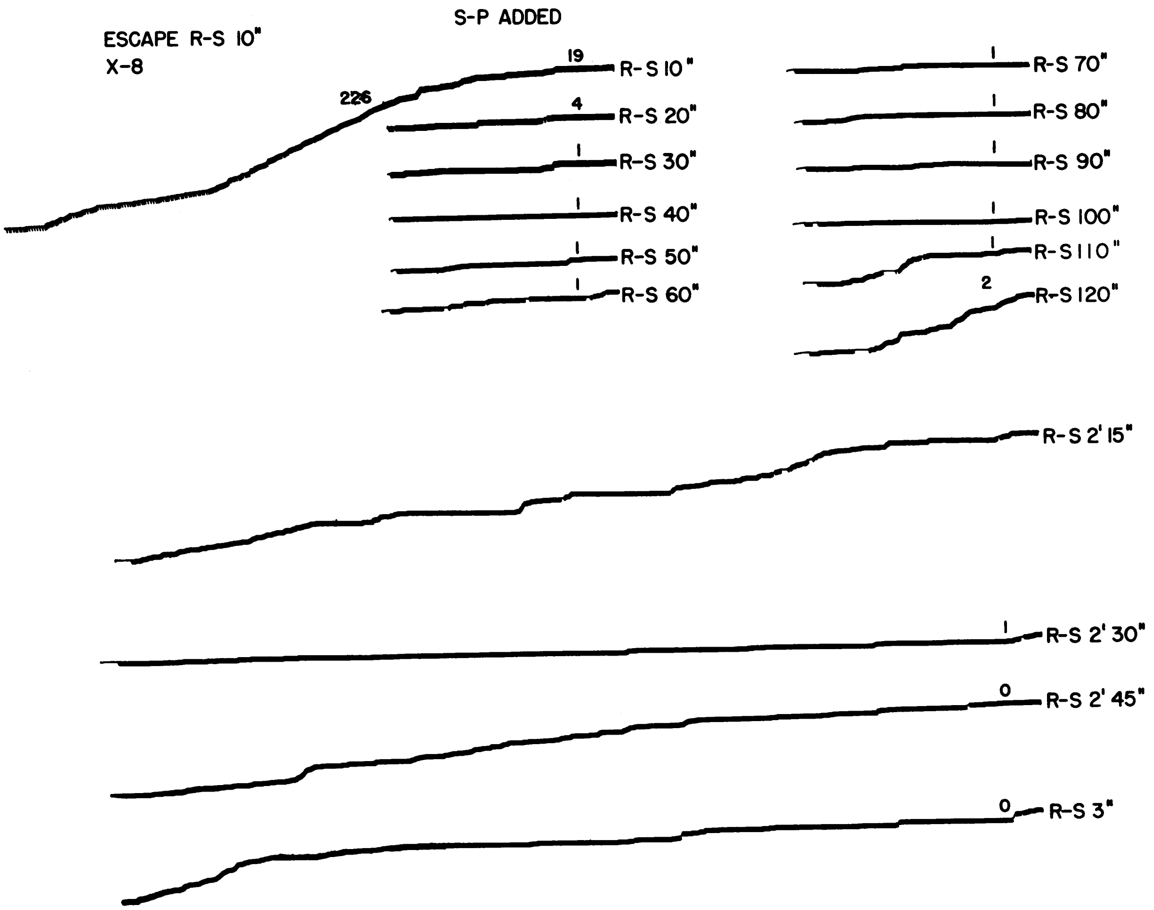


Fig. 6. Cumulative records for rat X-8. The upper left segment shows the performance in the first session (50 min) with escape conditioning alone followed by the addition of the self-punishment contingency (30 min). The number of escape shocks per session is indicated above and at the end of each segment. The progressive increase in R-S values is indicated to the right of each record.

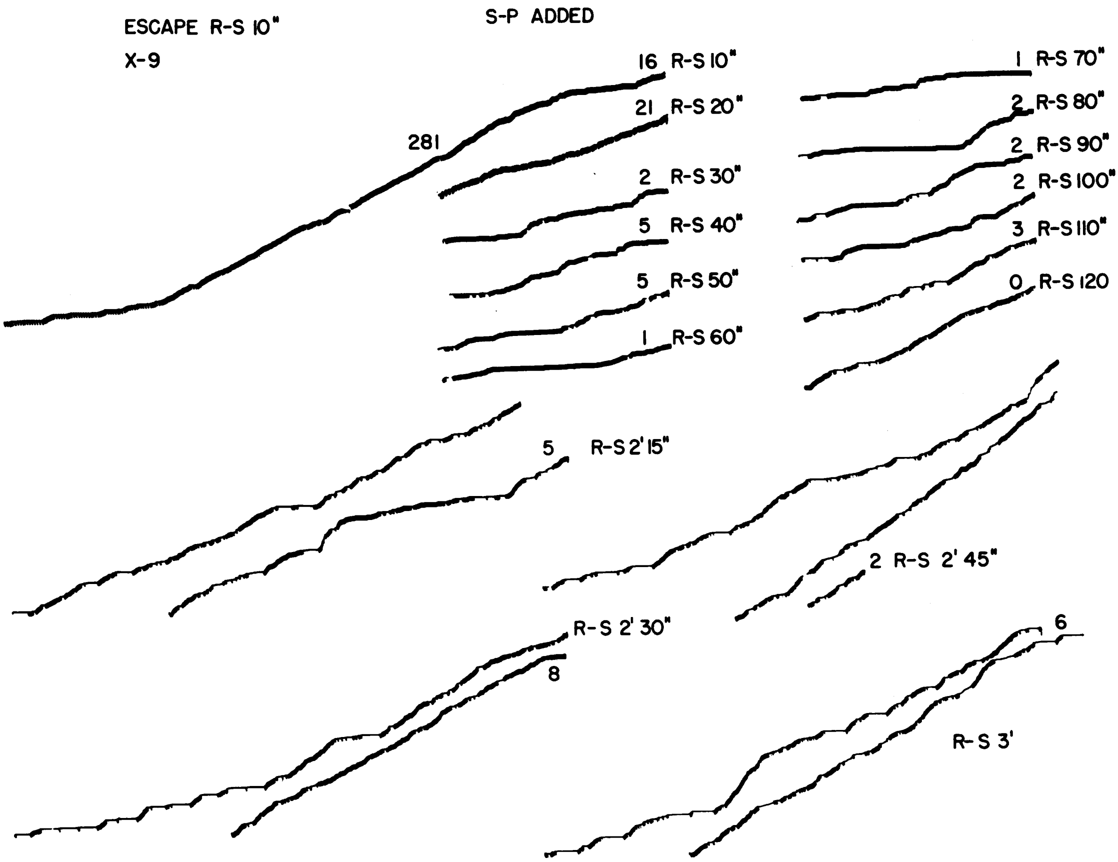


Fig. 7. Cumulative records for rat X-9. See caption for Fig. 6.

ever, as the R-S interval was increased, shocks became less frequent. Finally, at the maximum R-S value of 3 min, the rat took 39 escape shocks and shocked itself 52 times. The record (R-S = 3 min) reveals that the self-punishment shocks and the escape shocks occurred close together, since there are only about 50 groups of shock marks. The rat usually pressed the bar and turned off the escape shock, stayed on the bar, shocked itself once, released the bar, and remained off until the next escape shock.

The question arose at this point as to whether the animal would maintain its rather efficient performance if the R-S interval were progressively decreased. The sequence of R-S values and session lengths was therefore repeated in descending order, and the lower part of Fig. 8 shows the records. The rat did not return to its earlier behavior at the low R-S values. At R-S 10 sec it received 133 escape shocks and only 154 self-punishment shocks.

Figure 9A shows the ratio of escape shocks to self-punishment shocks during the ascending and descending series of R-S intervals. The ordinate runs from zero, which represents heavy self-punishment, to one, which represents the pattern in which the animal shocked itself once for each escape shock. The lower curve shows the heavy self-punishment in the early part of training with this rat; the upper curve traces the animal's performance during the return to lower R-S values. Clearly, the self-punishment seen at the beginning of training with low R-S values did not return.

To determine whether continued exposure to R-S = 10 sec would cause return to self-punishment, or further improvement, the rat was run for an additional 20 sessions at R-S = 10. Figure 9B shows the effect of the continued training. For continuity the last session of the descending series of Fig. 9A is circled and reproduced in Fig. 9B. The self-punishment effect still did not return; in fact, in the last few sessions the ratios are well above 1.00, indicating that the rat was now avoiding many of the self-punishment shocks by releasing the bar after terminating the escape shock, and staying off the bar until the next escape shock. However, in some sessions, for example 4 and 11 (see arrows), the performance appears to be rather poor. The records for these two sessions are reproduced on the right side of Fig. 9 along with the records for two low self-punishment sessions, 5 and 17 (see downward arrows). These records reveal that the low ratios seen in Fig. 9 result from a temporary return to heavy self-punishment, as shown at the arrows. Within a few minutes the rat shocked itself about 100 times, sufficient to drive the overall ratio far down. However, the performance in the rest of the session was adequate. Sessions 5 and 17, representative of more efficient sessions, lack these flat segments of breakdown.

EXPERIMENT 6

One possible explanation of the main self-punishment effect is that the rats preferred to take the string of brief shocks of $\frac{1}{20}$ sec in duration, every 2.5 sec rather than wait off the bar for the escape shock which they must then terminate. Since the escape response latency was easily longer than $\frac{1}{20}$ sec, the postponement of the escape shock by the S-P shock might indeed be the controlling variable. The procedure to answer this is a simple one: let the S-P shock *not* reset the escape shock timer. This was done with three rats in Exp. 6.

The procedure was as follows. Each rat was run for a single 2-hr session. Both the escape and self-punishment contingencies were started together. Every 10 sec the escape shock was delivered (maximum duration of 10 sec) and a bar press would terminate the shock.

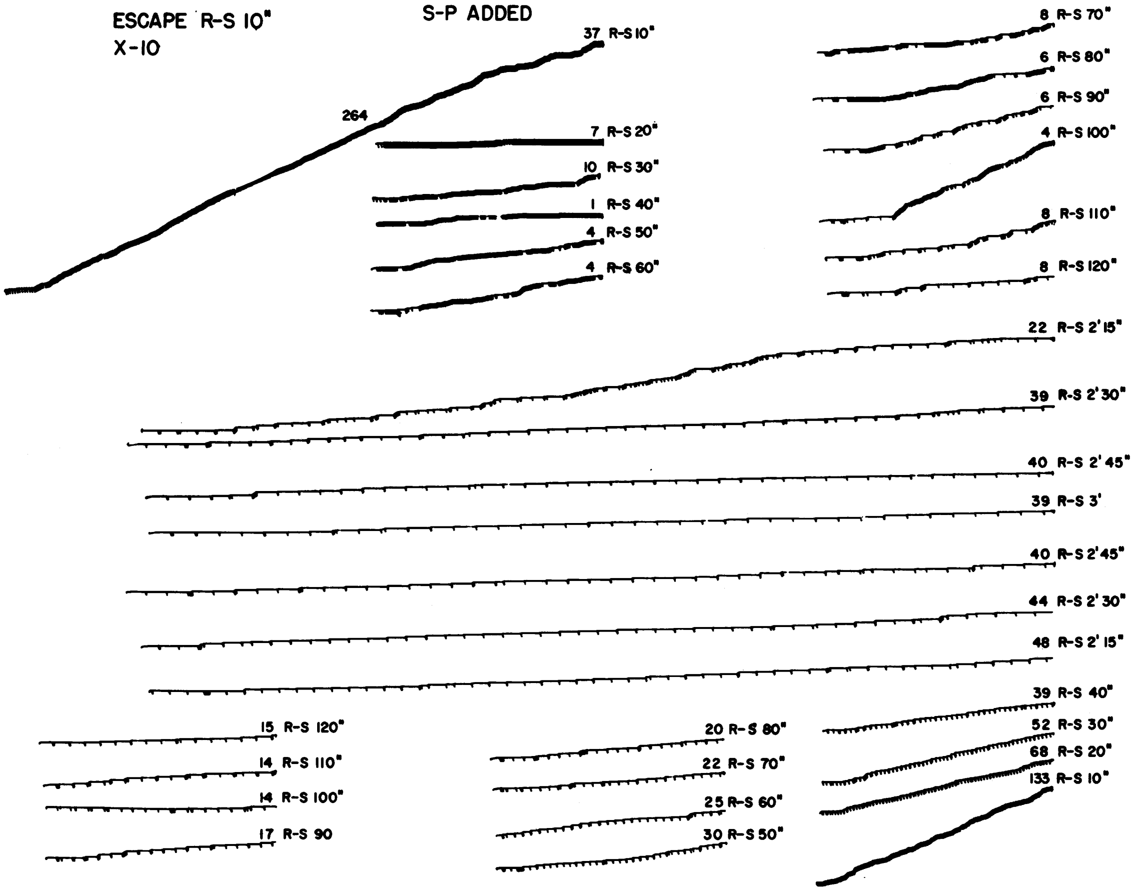


Fig. 8. Cumulative records for rat X-10. See caption for Fig. 6. The progressive decrease in R-S values is shown in the lower half of the figure.

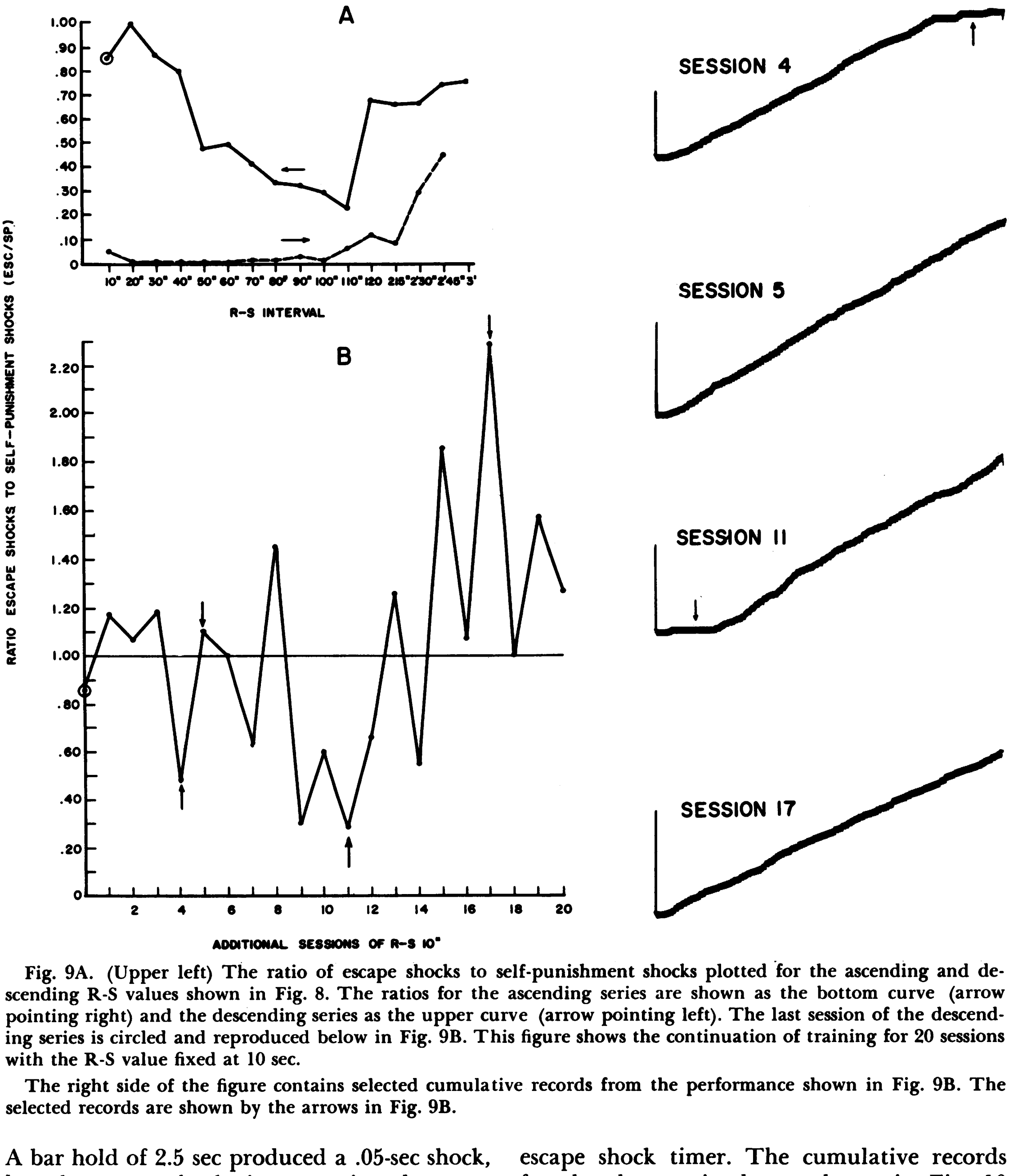


Fig. 9A. (Upper left) The ratio of escape shocks to self-punishment shocks plotted for the ascending and descending R-S values shown in Fig. 8. The ratios for the ascending series are shown as the bottom curve (arrow pointing right) and the descending series as the upper curve (arrow pointing left). The last session of the descending series is circled and reproduced below in Fig. 9B. This figure shows the continuation of training for 20 sessions with the R-S value fixed at 10 sec.

The right side of the figure contains selected cumulative records from the performance shown in Fig. 9B. The selected records are shown by the arrows in Fig. 9B.

A bar hold of 2.5 sec produced a .05-sec shock, but the escape shock timer continued to run and delivered a shock every 10 sec regardless of the bar-holding or S-P shocks that had occurred between escape shocks.

Results

The behavior that developed under these conditions was essentially the same as that seen before where the S-P shocks did reset the escape shock timer. The cumulative records for the three animals are shown in Fig. 10 with the accompanying table. Rat X-40 showed a weak response to the initial shock intensity of about 1 ma and the intensity was increased (at the arrow) and maintained there for all three rats. The S-P effect developed with the acquisition of the escape response. The total S-P shocks was low partly due to the interruption by the escape shock every

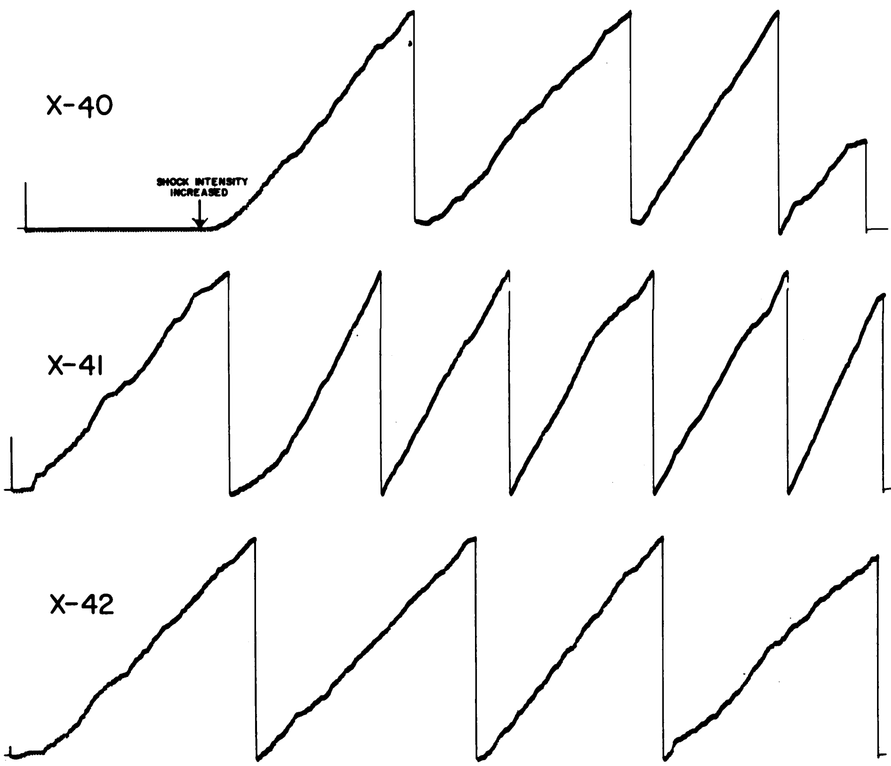
10 sec, and in the case of X-40, partly due to the late development of the escape response.

A close-up of this behavior was obtained by recording these sessions on an event recorder. Segments of these records with heavy self-punishment in them, selected from the second hour of the session, are shown in Fig. 11. Three events were recorded for each rat. Responses were recorded on the lower pen—the pen was held deflected while the bar was held down. The middle pen recorded S-P shocks and the top pen recorded escape shocks, with the pen held deflected until the escape shock was terminated by a bar press. Notice first that the escape shocks were delivered regularly at 10-sec intervals and were promptly turned off. Notice, in addition, that the rats still held the bar depressed between escape shocks, delivering the S-P shocks. Clearly, therefore, the initial development of the self-punishment effect is not dependent upon the postponement of the escape shock.

EXPERIMENT 7

Migler (1963) suggested that relative shock durations might control bar holding in simple escape conditioning. For example, if the animal permits the escape shock to remain on for an average of .30 sec, and gives itself .05-sec shocks by holding the bar, its bar-holding behavior might become relatively prepotent. Likewise, if the self-punishment shock was increased from .05 to .5 sec, so that it was relatively greater than the prevailing escape shock duration of .3 sec, then the bar holding might not be strengthened. Experiment 7 attempted to test this notion.

Three rats were used. Each session lasted 30 min. In the first session, escape training and self-punishment were started together. The temporal values were: escape shock every 10 sec; 10-sec maximum duration of escape shock; .05-sec shock when the animal held the bar for 2.5 sec. Self-punishment shocks



SP SHOCKS	ESCAPE SHOCKS
1360	569 (80)
1962	643 (8)
1143	628 (10)

Fig. 10. Complete records for the three rats in Exp. 6. The number of self-punishment shocks and escape shocks are listed in the table. The number of escape shocks not escaped in 10 sec is given in parenthesis.

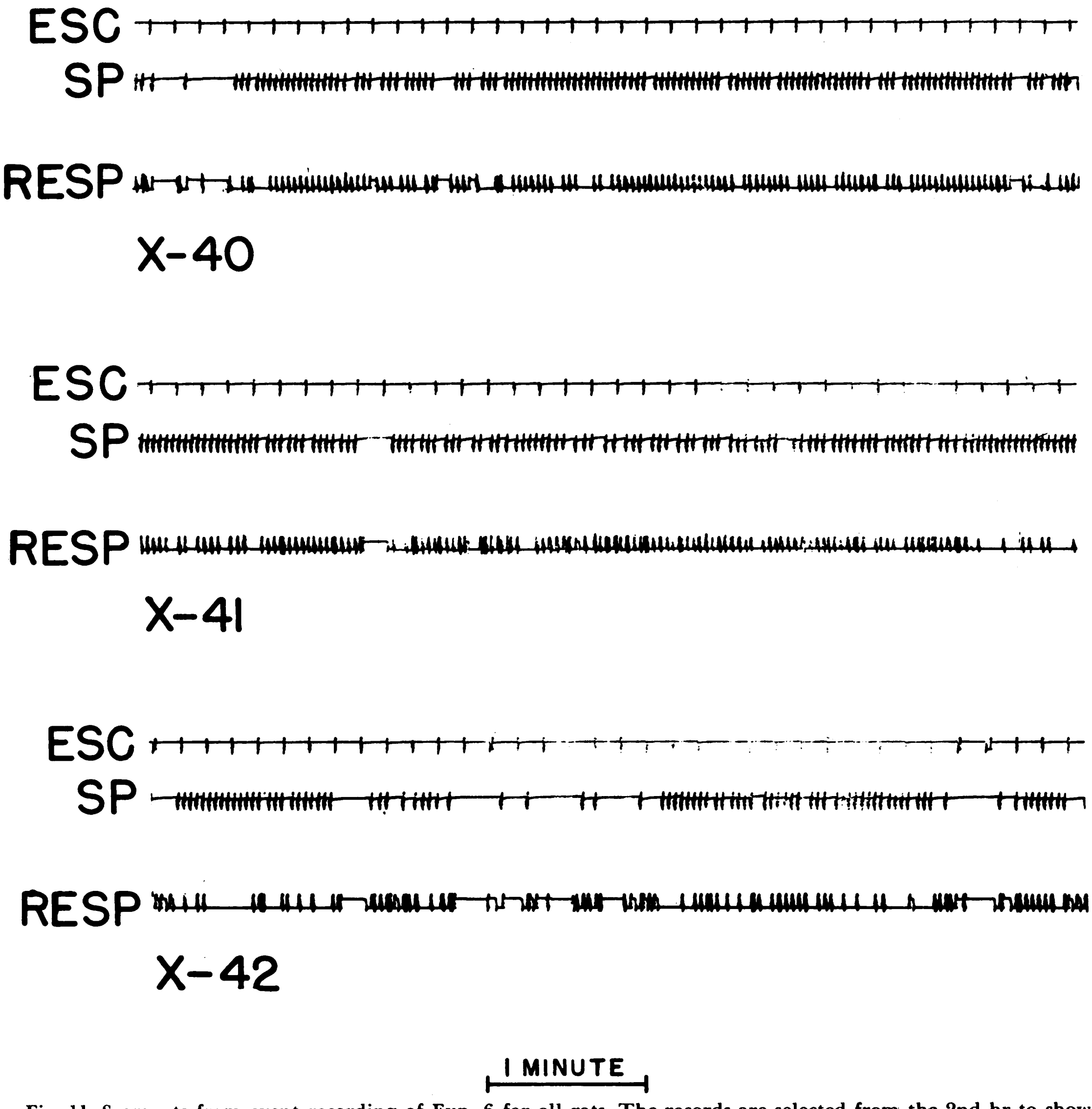


Fig. 11. Segments from event recording of Exp. 6 for all rats. The records are selected from the 2nd hr to show periods of dense self-punishment. The upper pen is held down during the escape shock. The middle pen is briefly deflected for each self-punishment shock. The lower pen is held down while the rat holds the bar down.

did not postpone the escape shocks. Procedural variations will be explained as the results are presented.

Results

Figure 12 presents the results for the three rats. Consider first the performance of Rats X-49 and X-50. For the first 10 sessions the number of self-punishment shocks and the large proportion of time the animals spent on the bar indicate that the self-punishment effect developed as usual. The mean escape-shock duration for Rats X-49 and X-50 is well above the duration of the self-punishment shock.

To test the idea that the low duration of the self-punishment shock relative to the mean escape-shock duration was maintaining the self-punishment effect, the duration of the self-punishment shock was increased to .5 sec for sessions 11 and 12 for Rats X-49 and X-50, and was then returned to .05 sec for the 13th session. When the self-punishment shock duration was increased to .5 sec the animals spent less time on the bar and took fewer self-punishment shocks; when the self-punishment shock duration was then decreased to .05 sec in session 13 the original behavior returned. This effect supported the main idea behind the experiment (except for the inescapable fact that the mean escape-shock duration also increased and stayed above the self-punishment shock duration in sessions 11 and 12).

Rat X-51 developed the main effect very briefly in session 2 and then reduced its holding behavior over several sessions to unusually low levels. This animal had practically stopped shocking itself by session 10. No good reason could be offered for this result, except to note that the mean escape-shock durations were rather low and therefore the difference in duration of self-punishment and escape shocks was small. With Rat X-51, the effect of relative shock duration was investigated by increasing the mean escape-shock duration rather than the self-punishment shock duration. This was done by requiring the animal to press the bar twice to terminate the shock, in sessions 13-17.

Although the mean escape-shock duration increased, the animal did not appreciably increase its holding behavior. The idea that a large difference between the mean escape-shock duration and the self-punishment shock duration is necessary for the maintenance of the self-punishment effect is therefore not quite adequate. Nevertheless, the effect with Rats X-49 and X-50 indicated that the variable is relevant, but not yet precisely specified.

EXPERIMENT 8

In Exp. 1 the basic effect was described and named "self-punishment." Rats previously trained on escape-avoidance held the bar down almost continuously when they gave themselves a brief shock for every 2.5 sec of holding. In Exp. 2, the preliminary escape-avoidance training was shown to be unnecessary for the development of the effect. In Exp. 3, the avoidance contingency was shown to be unnecessary. In Exp. 4, concurrent escape training was shown to be necessary to develop the self-punishment effect. In Exp. 5, a gradual increase in the time between escape shocks maintained self-punishment at full strength in one rat, at reduced strength in a second rat, and practically eliminated the effect in a third rat. The self-punishment behavior did not return when the escape contingency was gradually reinstated in this rat.

In Procedure 6, one possible mechanism for the development of the effect (the postponement of the escape shock by the self-punishment shock) was explored and rejected. Experiment 7 tested the possibility that the essential condition for the development of the effect was a large difference in the duration of the escape shock relative to the self-punishment shock. Some of the data suggested that shock duration was a controlling variable, but needed more precise specification. A more precise specification might separate out the self-punishment shock duration relative to the onbar versus the offbar shock durations.

Another approach to the analysis of the main effect was attempted in the next experiment. There is the possibility that superstitious conditioning (Skinner, 1948) may be involved in the development and maintenance of the self-punishment effect. The next experiment departs from the self-punishment paradigm used so far in order to explore

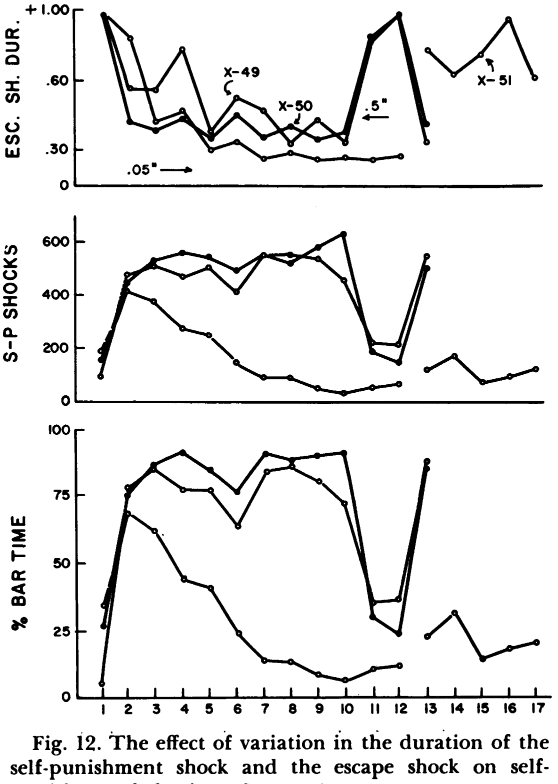


Fig. 12. The effect of variation in the duration of the self-punishment shock and the escape shock on self-punishment behavior. (See text.)

directly some of the possibilities for the development of superstitious behavior during escape conditioning.

Four adult male albino rats served as subjects. For this experiment, two microswitch levers 4⅜ in. apart protruding through one wall were used.

The first 10 sessions for all rats consisted of simple escape training. Every 10 sec a shock was delivered which the rat could escape by pressing the left lever (lever A). (The second lever on the right side (lever B) was not connected to the escape circuit and lever presses there had no consequences at any time in the experiment.) When the rat escaped from the shock by pressing the lever the next shock occurred 10 sec later. If the rat failed to press the lever in 10 sec the shock was automatically turned off and the next shock was delivered 10 sec from the shock termination. The shock intensity was 1 ma ± .25 ma, delivered to the grid floor, four walls, and both levers.

After the initial 10 sessions of simple escape training a test session was given on the 11th session. In the test session the shock was delivered for a fixed duration of 1 sec followed 10 sec later by another shock of 1-sec duration, *etc.*, for the entire session. Responding had no experimentally-programmed consequences. The test sessions were followed by several sessions of simple escape conditioning and then another test session, *etc.*, for a total of eight test sessions.

Three additional, slightly different test sessions were given and the details of this will be developed further. Test sessions and escape sessions were 1 hr in duration.

Results

Figure 13A illustrates the performance of the four rats in the 10th session of simple escape training. The escape behavior was well established at this point.

Figure 13B presents the performances for the next session, the first test sessions for all rats. Although lever presses had no effect on shock termination considerable responding was generated by this procedure.

The 1-sec fixed-duration shocks (about 330 per test session) were well above the mean shock durations during the regular escape sessions, as shown by Fig. 14, indicating that the test condition was considerably different from the regular escape sessions for the rats.

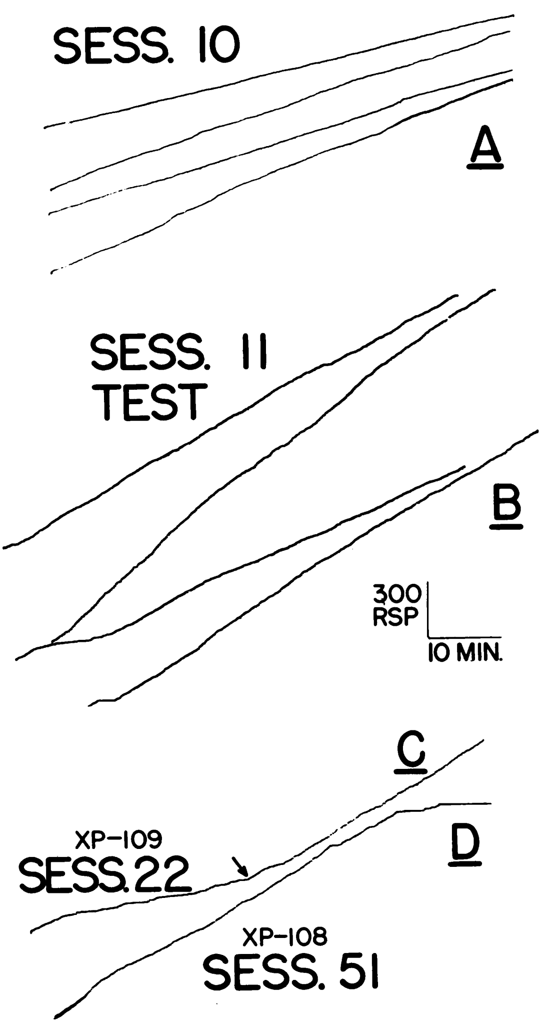


Fig. 13. *A*—Cumulative records for complete 1-hr sessions for all rats during regular escape training. *B*—during test sessions in which responding had no consequences and the shock duration was fixed at one second. *C*— (foreshorten) development of responding in the middle of a session. *D*—sudden cessation of responding at the end of a session due to a switch to another lever.

Every 10 min during the test sessions the total number of lever presses occurring during the 1-sec fixed-duration shock were recorded, as was the total amount of time the rat spent holding the bar depressed. This permitted a within-session plot of the percentage of time spent holding the bar depressed (percent bar time) and the mean number of responses per shock. These two measures are presented for the first eight test sessions in Fig. 15.

As these data indicate, the rats pressed the lever in a short burst during the inescapable shock, and also held on to the lever for much of the test session.

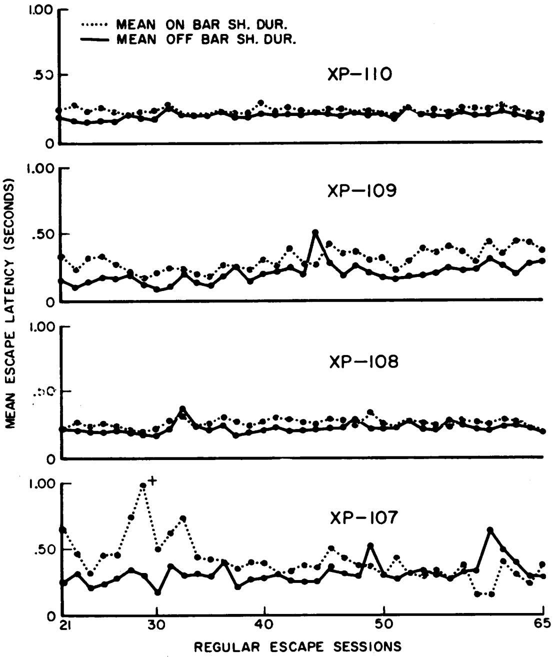


Fig. 14. Escape shock durations for the regular escape sessions were recorded from sessions 21 to 65. Shock durations for shocks that occurred when the rat was on or off the bar were recorded separately.

It is of interest that for rat XP-107 the effect did not appear for tests 2 and 3 and reappeared in full strength for tests 4 to 8. The same thing can be seen for rat XP-109 in test 2. In the third test the behavior was rather weak for the first 30 min but suddenly reappeared in full strength in the last half of the session. This session produced the interesting cumulative record shown in Fig. 13C.

The final detail of interest in this figure is the last test session for rat XP-108. Prior to this session the behavior had been very consistent from test to test. In the last 20 min of this session the bar holding and bursting disappeared (Fig. 13D). This was quite unusual for this rat and the experimenter looked into the box to investigate. The rat had switched over to the second lever in the box and was bar-holding and bursting there during the shock. A counter was connected to this lever (lever B) and 47 responses were recorded in the next few minutes. Lever B, of course, did not escape the shock, nor did lever A, but furthermore, responding on lever B had *never* been reinforced by escape from shock.

To confirm and further explore this switch to lever B, lever A was removed in the next test session. Although none of the other rats showed any indication of switching to lever

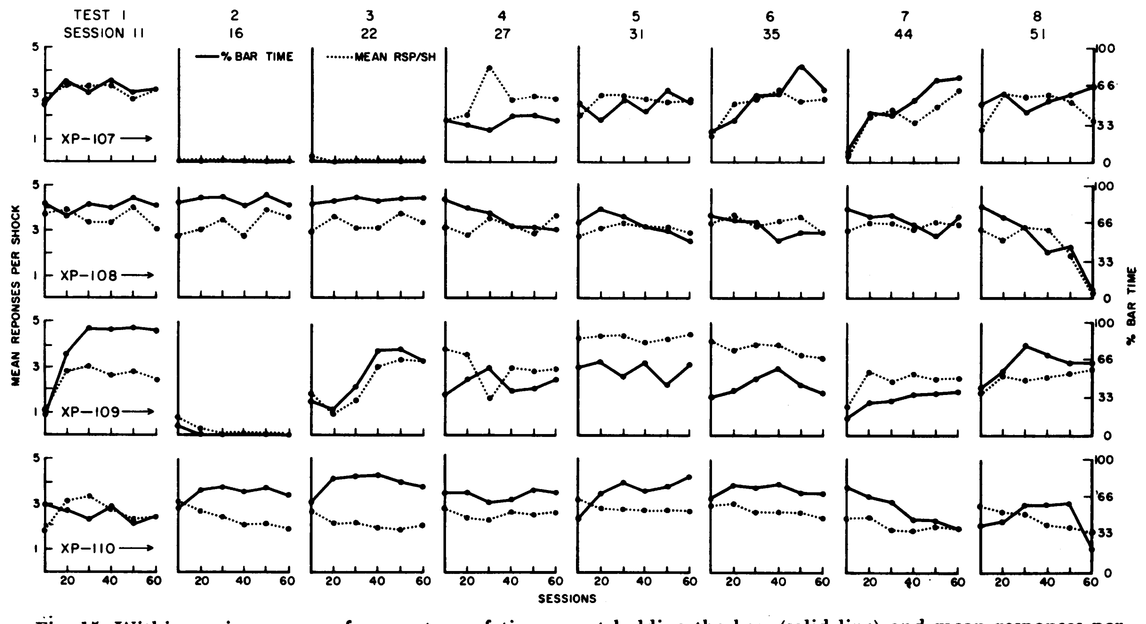


Fig. 15. Within session curves of percentage of time spent holding the bar (solid line) and mean responses per shock (dotted line). The data was plotted every 10 min during test sessions.

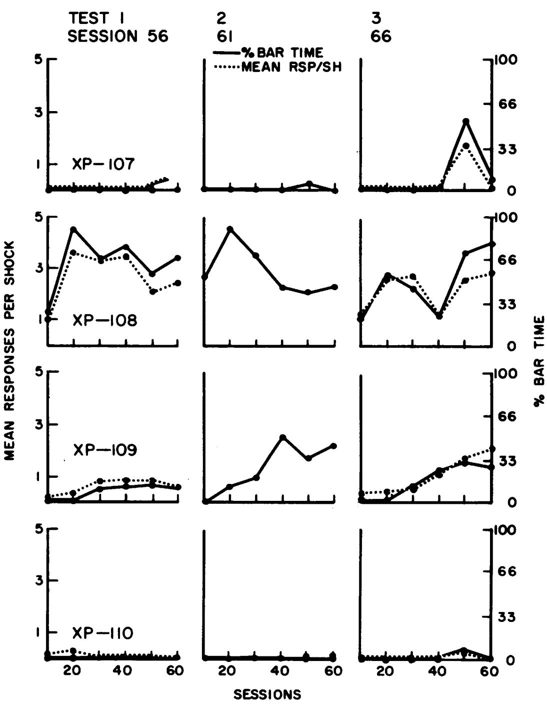


Fig. 16. See caption for Fig. 15. These test sessions were conducted with the training lever (A) removed, and with lever B, which had never been effective in escaping shock, remaining. (Response counter failure in test 2.)

B, lever A was also removed for them to see what would happen. Three such test sessions were run with lever A removed and with regular escape training on lever A between test sessions. The results are shown for all rats for these three test sessions in Fig. 16. XP-108, the rat that had apparently switched to lever B in the last test session with lever A and B present, responded regularly on lever B during the three tests. In addition, a second rat, XP-109, also responded regularly although at a lower level on lever B, and XP-107 also responded on lever B for a short time in the third test.

The most reasonable explanation of these effects is clearly "superstitious conditioning." One can describe the probable sequence of events that generated this effect as follows: in the test session, when the shock was turned on, the rat behaved as it was trained to behave, *i.e.*, it pressed the lever; the failure of the shock to terminate probably produced a burst of responses following which the shock was terminated automatically by the 1-sec timer, thereby reinforcing the entire burst of responses.

However, some of the details of the results cannot be accounted for as easily as the main effect. In particular, *A*, the absence of responding in some test sessions (see the flat curves in Fig. 15); *B*, the abrupt onset of bursting in the middle of one test session (see the arrow in Fig. 13C); and, *C*, the switch from lever A to lever B (XP-108, test 8) with lever A present, cannot be readily accounted for by any obvious variable.

The appearance of "superstitious" escape responding on lever B, which had never been effective in escaping shock, indicated some possibilities for the induction of "superstitious" escape behavior.

The relative ease of developing and maintaining this kind of "superstitious" behavior strongly suggests a possible partial role of this variable in the self-punishment effect. In the case of the very brief self-punishment shocks, the mechanism for generating the superstitious conditioning effect may be somewhat different in details. For example, during simple or regular escape conditioning those behaviors which permit very fast escape responses become strengthened (Migler 1963). The termination of brief self-punishment shock may, in the present experiments, function to reinforce superstitiously the bar holding behavior. Clearly, however, no final analysis can be offered at this time, although some combination of superstitious conditioning, relative shock duration, and shock reduction seems most probable at this point.

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Received June 1, 1962