

*SUPPRESSION OF BEHAVIOR BY TIMEOUT
PUNISHMENT WHEN SUPPRESSION RESULTS IN
LOSS OF POSITIVE REINFORCEMENT¹*

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This investigation, using rats as subjects and punishment by timeout for responses maintained on a ratio schedule, sought to determine whether behavior would be suppressed by timeout punishment when such suppression also reduced reinforcement density or frequency. A series of experiments indicated that timeout punishment suppressed responding, with the degree of suppression increasing as a function of the duration of the timeout period. Suppressive effects were found to decrease as a function of increases in deprivation (body weight) and were eliminated when the punished response also was reinforced. It was concluded that timeout can produce aversive effects even when loss of reinforcement results. An alternative interpretation of the findings, based on the effects of extinction periods and delay of reinforcement on chained behavior, was discussed.

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Studies with both animal and human subjects have used timeout from positive reinforcement as the aversive event in conjunction with avoidance, escape, and punishment procedures. These studies have indicated that timeout has influences on behavior similar to those observed when aversive events such as electric shock are used with these procedures. Thus, Ferster (1958) and Thomas (1965), using free-operant avoidance procedures, trained

chimpanzees and pigeons to avoid periods of timeout from food reinforcement. Similar results were obtained with human subjects by Baer (1960) who demonstrated that preschool children will avoid interruption of a cartoon movie, and by Baron and Kaufman (1966) who observed avoidance of timeout from monetary reinforcement by young adults. Kaufman and Baron (1966) used a discriminated escape-avoidance procedure and found that rats could be trained to escape periods of timeout from food reinforcement, but not to avoid such periods consistently. Using punishment procedures and mental patients as subjects, Holz, Azrin, and Ayllon (1963) showed that punishment of variable-interval reinforced behavior by periods of timeout from reinforcement led subjects to switch to a second key producing reinforcement but not timeout. More recently, McMillan (1967) punished the VI-reinforced responding of monkeys with timeout in a single key situation and found that responding was suppressed.

In considering the question of whether timeout is an aversive event, Leitenberg (1965) pointed out that the above procedures, conventionally used to assess the aversive properties of electric shock, do not necessarily provide definitive evidence that timeout is aversive. The problem is that the behavior changes used to indicate the aversiveness of timeout when avoidance, escape, and punishment procedures are used may have the consequence of increasing the relative density of re-

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inforcement. By avoiding or escaping periods of timeout, as was the case in studies by Ferster (1958), Baer (1960), Thomas (1965), and Baron and Kaufman (1966), the subject replaces periods of timeout with periods when reinforcement can be obtained, and, as a consequence, obtains a higher density of reinforcement over time, or possibly greater numbers of reinforcers than if timeout had occurred. Similar relative increases in reinforcement may occur in situations where organisms can switch from the response punished by timeout to an alternative unpunished response (Holz *et al.*, 1963) or through rate reductions in situations with a single response key and VI reinforcement (Holz *et al.*, 1963; McMillan, 1967). Thus, the results of the above and similar studies of timeout effects may be interpreted in terms of increased positive reinforcement, although, as Leitenberg pointed out, this interpretation in no way negates the alternative possibility that timeout is an aversive event.

The purpose of the present study was to observe the effects of timeout under circumstances where its behavioral influences could not result in increased reinforcement densities or frequencies. This was accomplished by studying the effects of timeout punishment on a response maintained by a ratio schedule of reinforcement, *i.e.*, a schedule in which reinforcement density decreases with decreases in response rates. Response suppression under these conditions could not be explained in terms of increased reinforcement, and would provide support for the hypothesis that timeout from reinforcement is aversive. At least two investigations have been published in which ratio-reinforced behavior was punished by timeout, thus providing the possibility of reinforcement loss if behavior was suppressed. Ferster and Skinner (1957, pp. 116-128) scheduled timeout following fixed-ratio reinforcements and observed in some instances pausing after the timeouts, although acceleration of responding also was noted. The effects of timeout were not investigated in sufficient detail to permit a statement to be made about the variables leading to one or the other of these two consequences. Using matching-to-sample procedures, Ferster and Appel (1961) and Zimmerman and Ferster (1963) observed pausing prior to the matching response when incorrect responses were punished by timeout durations ranging from 2 to 10 min. Pausing and conse-

quent reinforcement loss did not occur when shorter timeout durations were used.

GENERAL METHOD

Subjects

Six female albino rats, 90 days old at the start of the experiment, were obtained from the Holtzman Co., Madison, Wisconsin. With the exception of Exp. IV, in which body weight was varied, subjects were maintained at 80% of the median weight of a control group of same-aged non-deprived animals following the method of Davenport and Goulet (1964). Maintenance feeding with dry food always followed daily training by at least 30 min. Animals were housed in individual cages where water always was available.

Apparatus

Training was conducted in two standard lever-pressing units (Grason-Stadler, E 3125A). The chamber of each unit was plastic except for the front wall and grid floor, which were metal. The response lever was centered on the front wall directly above a circular enclosure into which a 0.1-cc dipper could be raised. Throughout the series of experiments, full-strength evaporated milk (Pet Milk Co.) was presented in the dipper. Adjacent to the chamber was a speaker for delivering auditory stimuli and a lamp for illumination. Each chamber was enclosed within a sound-attenuating ventilated chest. Scheduling and recording equipment were located in an adjacent room.

Preliminary Training

Lever-press training. After two 45-min dipper-training sessions, when the dipper operated independently of the subject's behavior, each 2-sec operation of the dipper was made dependent upon a lever-press response. Fifteen daily sessions were conducted on this basis (continuous reinforcement [CRF] schedule) during which the response was acquired and the rate stabilized. Each session was terminated after 90 reinforcements or 45 min, whichever came first. The standard procedure for starting each session was to place the subject in the dark, silent chamber with the lever inoperative. With the start of the session, the response lever became operative, the chamber was illuminated, and white noise, the S^D or discriminative stimulus correlated with rein-

forcement, was continuously presented. During certain phases of the experiments, described below, a 500-cps pure tone, rather than white noise, was used as the S^D . When the session was over, the lever was made inoperative, and the chamber remained dark and silent until the subject could be returned to its home cage.

Discrimination training. After lever-press training, a discrimination training procedure was introduced in which every response was reinforced (CRF) in the presence of white noise (S^D) and no responses were reinforced in the presence of 500-cps tone (S^A). The S^A periods always lasted for at least 2 min and each response during the last 10 sec prolonged the period for 10 more sec. This procedure was used to facilitate acquisition of the discrimination and to eliminate adventitious reinforcement of responses at the end of each S^A period. The S^A periods were scheduled to occur irregularly throughout the session, every 15 sec on the average. Onset of the S^A periods always occurred as the dipper started to retract so that S^A was separated by 2 sec from the last lever press, and was concurrent with the subject's feeding behavior. Daily sessions were terminated after 90 reinforcements or 2 hr, whichever came first. A total of 20 sessions were conducted with the discrimination training procedure, by which time S^A responding was minimal, and S^D responding was stable from day to day.

EXPERIMENT I: PUNISHMENT OF RESPONDING BY RESPONSE-DEPENDENT TIMEOUT

Experiment I investigated the effects of making the S^A period, *i.e.*, a period of timeout from positive reinforcement, dependent upon responding. Subsequently, the roles of the specific stimuli used to define the S^A and S^D periods were evaluated by reversing the functions of the white noise and tone as used originally during discrimination training.

METHOD

Subjects

Animals 1, 3, and 5 were used.

No punishment control. After discrimination training, the procedure used during subsequent punishment training was introduced. Sessions were conducted with the white noise

S^D present throughout and with dipper operation scheduled in sequences of three responses. The first two responses in each sequence (R_1 and R_2) were followed by operation of the dipper but R_3 was not. Thus, R_3 was not reinforced, nor was it followed by timeout, as was the case during subsequent punishment training. Daily sessions were continued until 90 reinforcements had been received. Training was continued for 15 sessions, by which time response rates had stabilized.

Punishment training. The procedure was similar to the preceding no-punishment procedure, with R_1 and R_2 reinforced and R_3 not reinforced in the presence of the white noise S^D . But, in addition, timeout punishment was now made dependent upon R_3 of each cycle. Thus, R_3 immediately terminated the white noise S^D , and produced the 500-cps S^A for 2 min, during which time responses went unreinforced. As in the discrimination training procedure, any responses occurring during the last 10 sec of the timeout period prolonged the period for 10 sec. Daily sessions were terminated after 90 reinforcements or 2 hr, whichever came first. A total of nine sessions was conducted on this basis, by which time the effects of punishment training were reliably seen in all three animals.

Reversal of stimuli. To determine whether reactions to response-dependent timeout were associated with the specific stimuli used to define the periods, the functions of the white noise and tone were reversed. This was accomplished by retraining the subjects in the previously described CRF lever-press, discrimination, and no-punishment phases with the tone defining the S^D periods and the white noise the S^A periods. The number of retraining sessions in each of the three phases was 2, 15, and 11, respectively, and performance was stable when discrimination and no-punishment training were terminated. Punishment training sessions were then resumed with the third, unreinforced response now terminating the tone S^D and producing the white noise S^A concurrently with 2 min of timeout. Punishment training was continued on this basis for 82 sessions for Subject 1 and for 40 sessions for Subject 3 and Subject 5.

RESULTS

Data analyzed during the no-punishment and punishment phases were the mean interre-

response times (IRTs) between the three responses of each sequence of two reinforced and one unreinforced responses. Not included in these values were the 2-sec periods when the dipper operated or the timeout periods. Thus, during punishment training the IRT between the third response of one cycle (the punished response) and the first response of the next cycle represented the interval between re-onset of the S^D and R_1 .

Average daily IRTs are presented in Fig. 1 for each of the three subjects. The first panel shows terminal performances during the no-punishment control phase when white noise was the S^D . It is apparent that IRTs in all cases were quite brief (under 5 sec), and that IRTs between the second, reinforced response, and the third non-reinforced response (R_2 - R_3) were of about the same durations as the R_3 - R_1 and R_1 - R_2 IRTs.

The second panel of Fig. 1 shows performances during the punishment training phase when R_3 terminated the white noise S^D and produced the timeout period. By the fourth session of punishment training for all three subjects, and as early as Session 2 for Subject 5, considerable suppression of R_3 was manifested. When training was terminated after nine sessions, the average pause prior to R_3 was 66 sec for Subject 1, 77 sec for Subject 3, and 95 sec for Subject 5. These values are to be compared with the R_2 - R_3 IRTs during the prior, no-punishment phase when, for all three animals, the average intervals were 5 sec or less. Figure 1 also shows that punishment training had little or no effect on the IRTs of the first and second responses.

The third and fourth panels of Fig. 1 show performances when the discriminative functions of the S^D and S^A stimuli were reversed, that is, when the tone was the S^D and the white noise the S^A . Performances during the no-punishment phase (panel 3) were about the same as during prior no-punishment training, although Subject 5's performance was not as efficient or as regular as before reversal. The fourth panel shows that when punishment training was reintroduced with the reversed stimuli, suppression of the third response reappeared. Suppressive effects increased in all three subjects over the early punishment-training session to a level that was maintained with some variability but without systematic change during subsequent punishment train-

ing sessions. Terminal R_3 latencies for Subject 3 and Subject 5, after 40 sessions, were about 215 sec and 55 sec respectively. For Subject 1, trained for 82 days on the punishment procedure, the terminal R_3 latency was about 30 sec.

Figure 2 presents cumulative records of performances during the various phases of Exp. I. The records to the left show terminal rates when responding was not punished by timeout. To the right may be seen the extent of suppression with the noise S^D and the tone S^A (top curves) and when the stimuli were reversed (bottom curves). The top curves for each subject, obtained during initial exposure to timeout, illustrate instances of the most extreme suppression observed. The bottom curves show performances after extended exposure to timeout punishment with the reversed stimuli. Although somewhat reduced in the cases of Subjects 1 and 5, suppression was a stable aspect of intra-session performance for all three subjects over an extended series of sessions (see also Fig. 1).

Figure 3 shows enlarged portions of cumulative records of Subject 1 taken during Sessions 3 and 82 with the tone S^D and noise S^A . These records make clear the rapidity of the two reinforced responses and the long pauses preceding the third, punished response. Figure 3 also shows that the intervening 79 sessions did not reduce the extent of response suppression. If anything, the duration of pausing was greater during the segment chosen from Session 82 than for Session 3, although the average pause lengths for both sessions were approximately equal, as may be seen by comparing the points plotted in Fig. 1.

DISCUSSION

Response-dependent timeout punishment markedly suppressed behavior in all three subjects. During the no-punishment control phase, R_3 , although not reinforced, always was rapidly executed with IRTs of 5 sec or less, about the same durations associated with R_1 and R_2 . By comparison, timeout punishment of R_3 produced long pauses prior to R_3 with average IRTs in the range 100 to 300 sec for the subject showing most extreme suppression, and 25 to 40 sec in the subject whose suppression was least.

A possible basis for suppression of responding by timeout punishment is that the stimuli

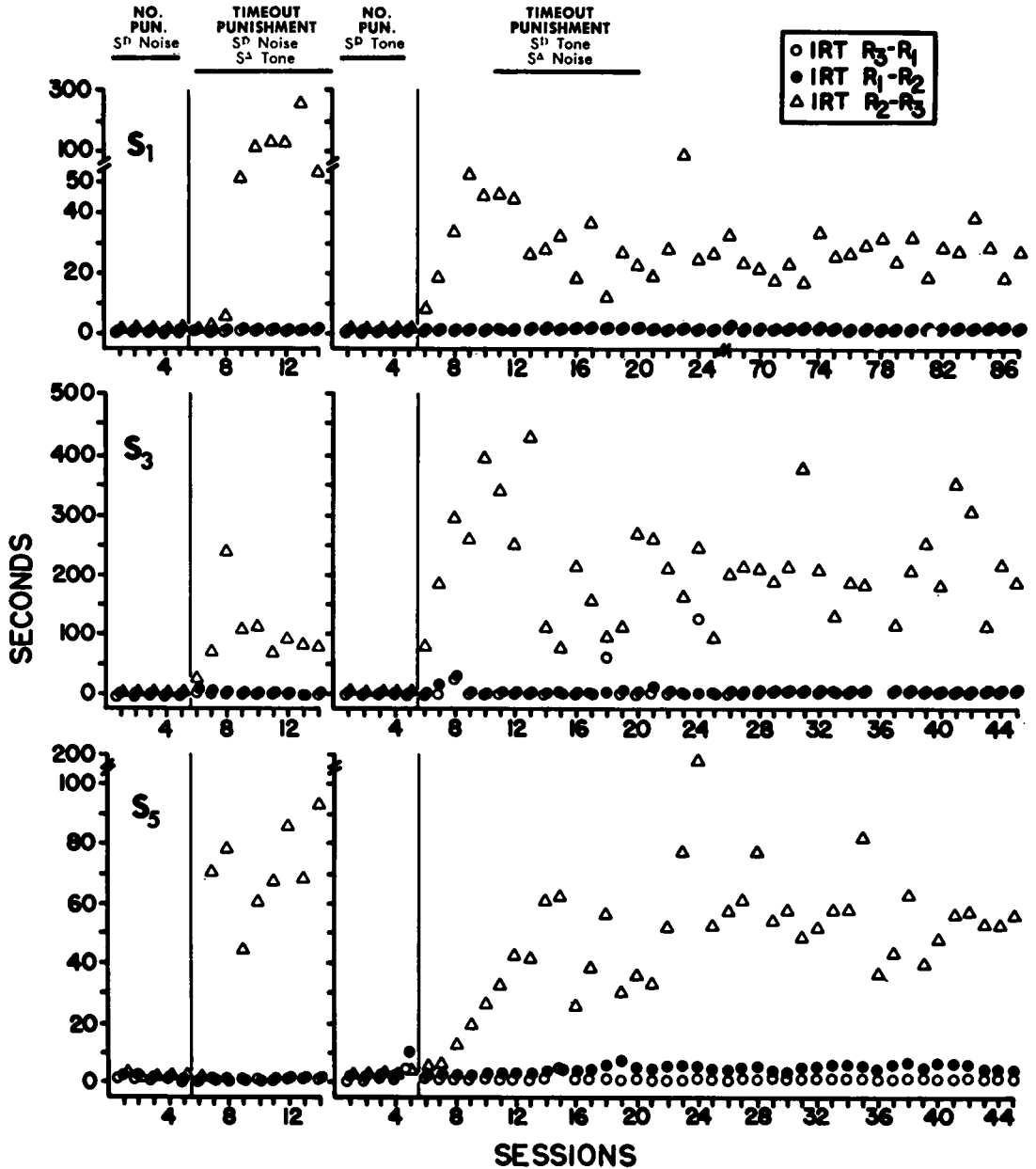


Fig. 1. Daily mean interresponse times (IRTs) in Exp. I. R_3-R_1 is the time from the third response of one cycle to the first response in the next cycle in the no-punishment procedure, and the time from termination of timeout to the first response in the next three-response cycle in the punishment procedure. R_1-R_2 is the time from the first response to the second response of the cycle, and R_2-R_3 is the time from the second response to the third response of the cycle. In both the punishment and no-punishment procedures, R_1 and R_2 were reinforced and R_3 was not reinforced. During the punishment procedure, R_3 produced 2 min of timeout. Throughout the sessions depicted in the two left-hand panels the S^D and S^A stimuli were white noise and tone respectively; during the sessions depicted in the two right-hand panels, the S^D was tone and the S^A white noise.

used to define the timeout period possessed independent aversive properties. Several studies (Baron, 1959; Baron and Kish, 1962) have indicated that pure tones, without history of as-

sociation with other aversive events, can suppress the behavior of rats and mice when made response dependent. Such an explanation clearly does not apply to the present results

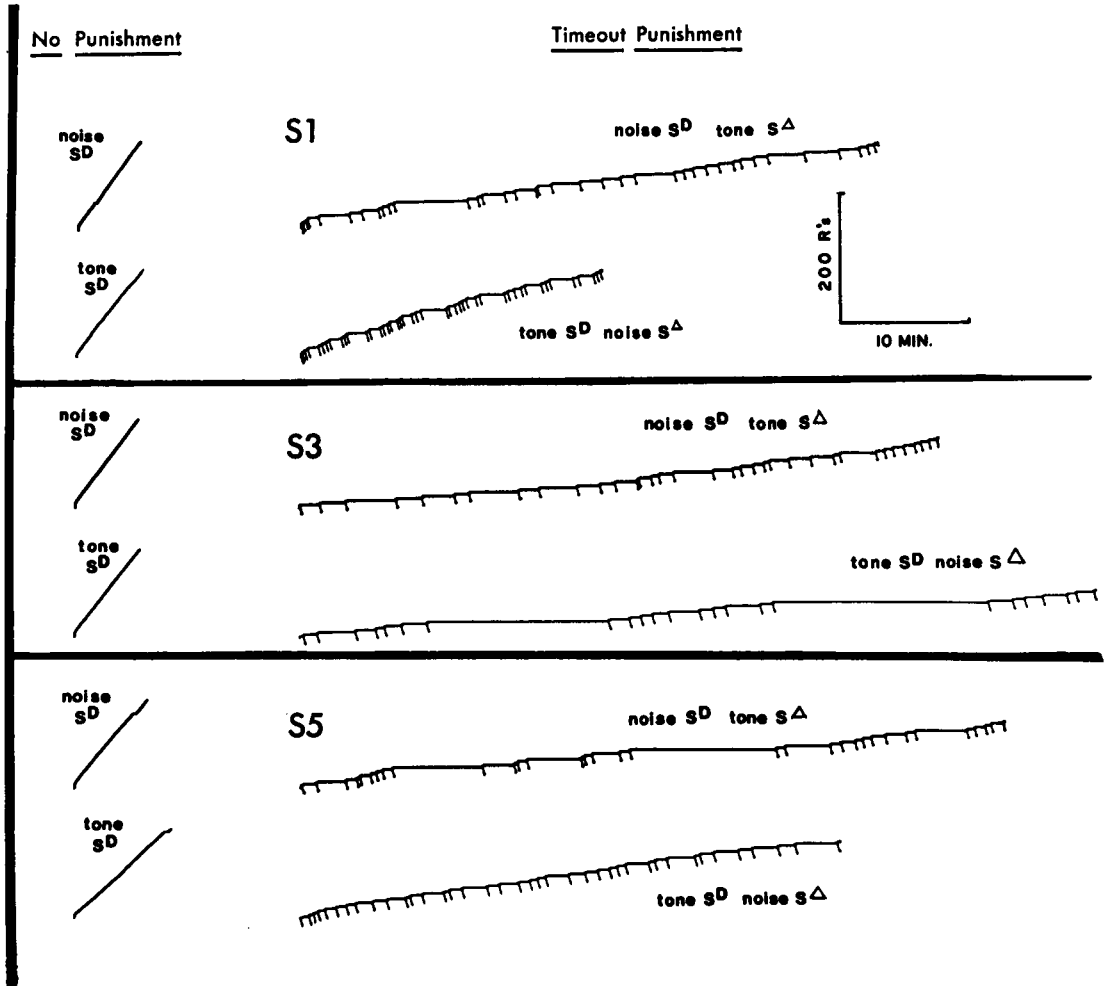


Fig. 2. Cumulative records from terminal sessions of the various procedures of Exp. I. In the no-punishment procedure, reinforcements (not marked on the record) followed the first two responses of each three-response cycle. In the punishment procedure, in addition, the third response produced timeout. During the 2-min timeout period, the response pen deflected but responses were not recorded and the chart drive did not operate.

because response suppression occurred regardless of whether responding terminated the white noise S^D and produced the pure tone S^A , or *vice versa*.

The second possibility, and the one providing the major rationale for the present series of experiments, concerns whether suppression was maintained by positive reinforcement, rather than by any aversive properties possessed by timeout. Although several other studies have shown that behavior can be suppressed by timeout punishment (*e.g.*, Holz *et al.*, 1963; McMillan, 1967), the procedures of these studies were such that response suppression usually served to increase positive reinforcement above levels that otherwise would

have occurred, and on this basis their results do not provide conclusive evidence about aversiveness of timeout. The present results, however, cannot be explained in terms of suppression increasing positive reinforcement. The procedure excluded this possibility since responding was reinforced on a ratio schedule and the sessions ended after 90 or fewer reinforcements. Not only was response suppression ineffectual in increasing the relative density of positive reinforcement but suppression, if sufficiently extreme, actually resulted in loss of reinforcement. In the case of Subject 3, for example, one-third of the 90 reinforcements potentially available were consistently lost during punishment training.

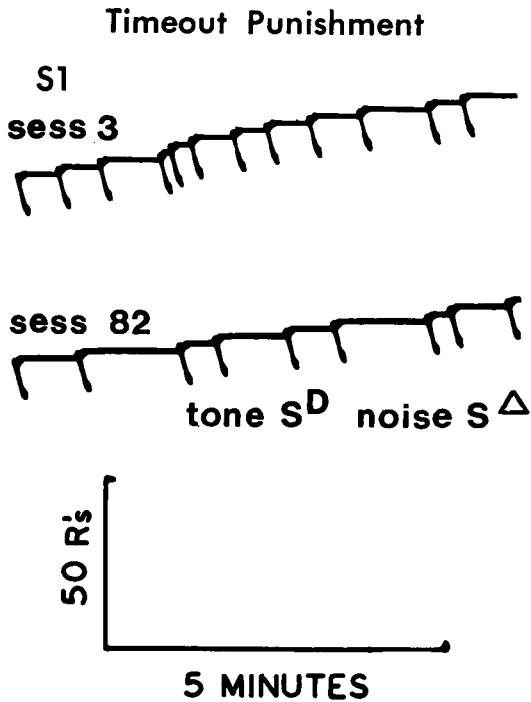


Fig. 3. Enlarged sections of cumulative records of Subject 1 during Sessions 3 and 82 of the second punishment procedure in Exp. I. The records begin with the sixteenth timeout in the session. The recorder operated as described for Fig. 2.

The results, then, offer strong evidence for the contention that timeout is aversive, insofar as timeout punishment suppressed behavior without increasing positive reinforcement, and often at the cost of some reinforcement. Loss of reinforcement is a common outcome, of course, when responding is punished by the aversive events of electric shock and loud sound.

EXPERIMENT II: PUNISHMENT BY TIMEOUTS OF DIFFERING DURATIONS

Experiment II studied the duration of timeout as a variable potentially affecting suppression of responding by timeout punishment. It was hypothesized that aversiveness of timeout would be an increasing function of its duration.

METHOD

Subjects

Animals 2, 4, and 6 served.

Procedure

The initial procedures were identical to the no-punishment and punishment training phases of Exp. I with white noise the S^D , tone the S^A , and a timeout duration of 120 sec. After a total of 26 punishment training sessions with the 120-sec duration, subsequent sessions were conducted first with a duration of 10 sec, then 60 sec, and finally 90 sec. Training was continued with each duration until all three animals showed stable performances. This required 24, 31, and 38 sessions.

RESULTS

During the no-punishment phase, and when the 120-sec timeout duration was studied, performances were within the range of IRTs observed in Exp. I. Figure 4 summarizes the effects of the various timeout durations on the average IRT between R_2 and R_3 . Plotted values for each subject are based on the last eight days of training with each timeout duration.

Figure 4 shows that suppression of R_3 generally was an increasing function of the duration of timeout within the range from 0 sec (no-punishment training) to 120 sec. The only deviation from this relationship occurred with Subject 4, where somewhat more suppression occurred with 60 sec than with 90 sec. The individual curves all show substantial increases in the range from 0 to 10 sec, relatively little change from 10 to 60 sec, and increases again between 60 and 120 sec. As in Exp. I, the IRTs preceding the first and second response were generally less than 3 to 4 sec when R_3 was punished with the various timeout durations.

DISCUSSION

Timeout duration was found to be a significant variable influencing the effectiveness of timeout punishment, with degree of suppression of R_3 increasing as a function of increased timeout duration. These findings, in a situation in which a simple operant response was punished by timeout, are similar in general outline to the effects of punishing matching-to-sample errors of pigeons (Ferster and Appel, 1961; Zimmerman and Ferster, 1963) where suppression of incorrect responses progressively increased with increases in the dura-

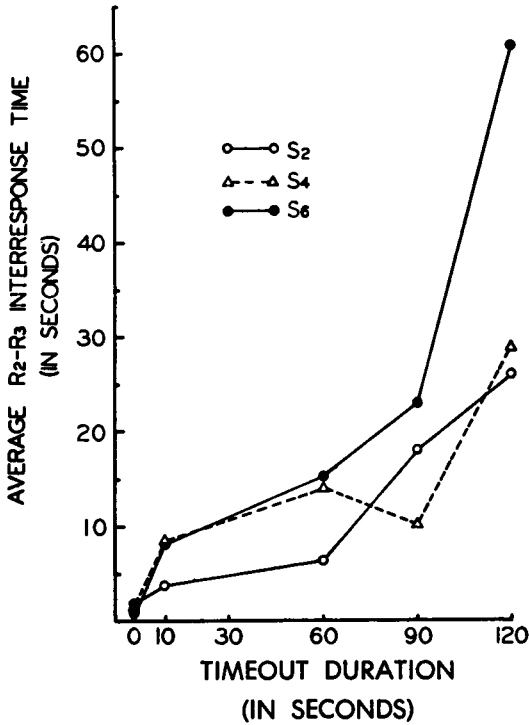


Fig. 4. Interresponse times between the second and third response (R_2 - R_3) in each cycle as a function of timeout duration in the punishment procedure of Exp. II. Plotted points represent the median of the last eight days with each duration. Values for the 0-sec duration were obtained from the no-punishment procedure of Exp. I.

tion of timeout punishment within the range 0 to 60 sec. Worth noting, however, is that when matching errors are suppressed by timeout, behavioral changes serve to increase positive reinforcement. In the present study, by comparison, suppression of behavior could only have the consequence of reducing positive reinforcement.

EXPERIMENT III: TIMEOUT PUNISHMENT OF A REINFORCED RESPONSE

Experiment III examined the effects of reinforcing the third, previously unreinforced, response in each cycle of three responses. It was expected that strengthening of R_3 by reinforcement would reduce suppressive effects associated with response-dependent timeout.

METHOD

Subjects

Animals 3 and 5, previously exposed to the procedures of Exp. I, served.

Procedure

After the fortieth day of punishment training in Exp. I, reinforcement was introduced for the third as well as the first two responses in each cycle. Thus, R_3 terminated the tone S^D , produced the noise S^A , and also produced the dipper for the first 2 sec of the timeout period. As was the case for these subjects in Exp. I, the duration of the timeout period was 120 sec, and responses during the last 10 sec of the period prolonged it for an additional 10 sec. Fifteen sessions were conducted with R_3 reinforced, followed by 26 (Subject 5) or 27 (Subject 3) sessions when R_3 again was not reinforced. Daily sessions were terminated after 90 reinforcements or 2 hr, whichever came first.

RESULTS

Figure 5 presents mean daily IRTs for Subject 3 and Subject 5. The first panel shows these values during the last 15 days of punishment training in Exp. I when R_3 was not reinforced. With introduction of reinforcement for R_3 (second panel), the average R_2 - R_3 IRT decreased markedly, from 215 to 4 sec for Subject 3 and from 55 sec to 5 sec for Subject 5. In both cases, suppressive effects of timeout were eliminated, since R_2 - R_3 IRTs decreased

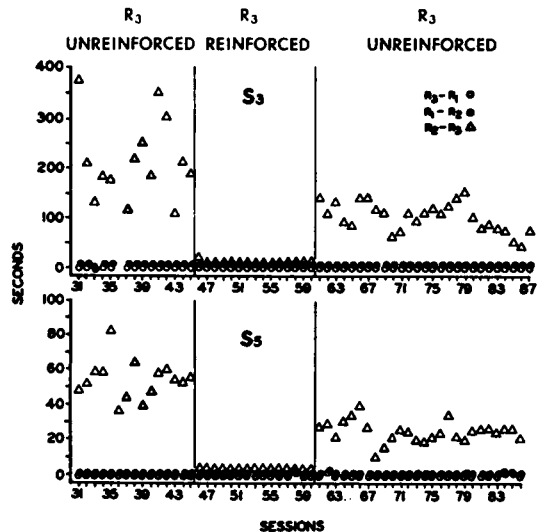


Fig. 5. Daily mean interresponse times in Exp. III. During all sessions, R_1 and R_2 were reinforced and R_3 produced 2 min of timeout. During Sessions 46-60, R_3 also was reinforced. Interresponse times were determined as described for Fig. 1.

to the levels of the no-punishment control phase, as well as to the levels characteristically obtained for the R_1 - R_2 and R_3 - R_1 IRTs in the same and previous phases of the experiment.

The third panel of Fig. 5 shows effects of the punishment training procedure when reinforcement again was withheld following R_3 . Average R_2 - R_3 IRTs increased substantially for both subjects, and were maintained throughout subsequent training. There was however, a substantial residual effect of R_3 reinforcement when it was no longer provided. When terminal performances are compared for sessions, before and after R_3 was reinforced (panels 1 and 3), it may be seen that suppressive effects were substantially reduced: from 215 sec to 75 sec for Subject 3 and from 55 sec to 26 sec for Subject 5. Also noteworthy is the tendency for Subject 3's IRTs to continue to decrease during the 27 punishment training sessions with R_3 unreinforced.

An additional consequence of reinforcing the punished response was a transitory increase in response rates during the timeout period itself. Prior to reinforcing R_3 , as well as during previous experiments, timeout rates were quite low, rarely exceeding a daily average of about one response per timeout period. During the first session when R_3 was reinforced, rates increased sharply to about five responses per period for both subjects. During subsequent sessions, rates declined and by Session 7 and thereafter were well within the previous range shown by both subjects.

DISCUSSION

The net effect of reinforcing R_3 was to eliminate the pauses characterizing performances when R_3 was not reinforced. Holz *et al.* (1963) suggested that timeout is not an exceptionally aversive event, when compared with shock, for example. The present findings are consistent with this interpretation since suppression by timeout punishment was not maintained with concurrent reinforcement of the punished response.

Worth emphasizing, however, is that suppression by shock punishment also can be markedly reduced, if not eliminated, by increasing the strength of the punished response through reinforcement. A recent study of this question (Church and Raymond, 1967) compared the effects of shock punishment on per-

formance of a response maintained either by VI 5-min or VI 0.2-min reinforcement. In a manner similar to the present findings, punishment markedly suppressed behavior on the VI 5-min schedule but had considerably less effect on behavior maintained by the VI 0.2-min schedule, which provided considerably more positive reinforcement.

The present findings, together with those of previous experiments in this series, suggest the circumstances under which timeout punishment might suppress reinforced behavior. Presumably such effects would be manifested when reinforcement of R_3 is either weaker than was the case in the present experiment (*e.g.*, with lesser amounts of reinforcement) and/or when the aversiveness of timeout is greater (*e.g.*, with longer durations of timeout).

Reinforcement of R_3 , aside from eliminating concurrent suppressive effects, also reduced subsequent suppressive effects when reinforcement of R_3 again was withheld. This finding is of some significance since extended punishment training with R_3 unreinforced (40 previous sessions) did not systematically reduce the suppressive effects of punishment for either animal.

EXPERIMENT IV: DEPRIVATION AND TIMEOUT PUNISHMENT

The purpose of Exp. IV was to study the effects of food deprivation upon the suppressive effects of timeout punishment. Deprivation was varied by manipulating subjects' body weights.

Procedure

All six animals served after participating in Exp. I to III.

The same punishment training procedure used in the immediately preceding phase for each animal was employed in Exp. IV. Thus, in the cases of Subjects 1, 3, and 5, the 500-cps tone continued to serve as the S^D and the white noise as the S^A ; timeout duration was 120 sec. In the cases of Subjects 2, 4, and 6, the white noise was the S^D , the tone the S^A , and timeout duration was 90 sec.

Following training with body weights adjusted to 80% of the median weights of same-aged control subjects, punishment training was conducted when subjects were either 70%

of normal weights (Subjects 3, 4, and 6) or 90% (Subjects 1, 2, and 5).

Subjects were trained daily, including the periods when body weights were increased or decreased. Weight reduction from 80% to 70% was achieved over an 11-day period by withholding all food except that available during training sessions. Weight increase to the 90% criterion was accomplished in four days by providing 20 g of dry food per day in the home cage. Training was continued for at least 16 sessions after body weight had stabilized at the appropriate level.

RESULTS

Figure 6 presents daily IRTs for the three subjects whose weights were increased from

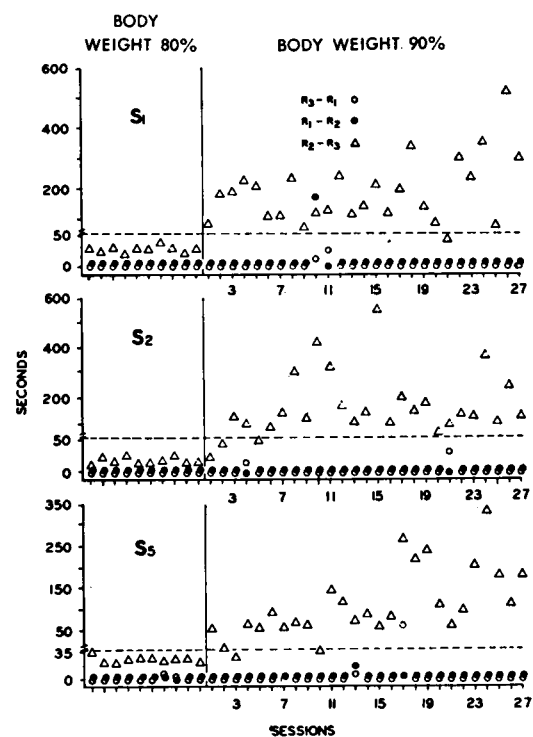


Fig. 6. Daily mean interresponse times in Exp. IV as a function of increased body weight. During all sessions, R_1 and R_2 were reinforced and R_3 produced 2 min of timeout (Subjects 1 and 5) or 90 sec of timeout (Subject 2). The left panel represents terminal performances at 80% body weight during the previous phase of the experiment for each subject. The right panel shows performances when body weight was increased from 80% and reached 90% in all animals by the fourth session of increased feeding. Dotted lines indicate changes in the scale of the ordinate with points at or below the line corresponding to the lower scale. Interresponse times were determined as described for Fig. 1.

80% to 90% of normal weight; the left panel shows terminal performances at 80% and the right panel subsequent performances at 90% from the point at which additional food was provided. It is apparent that for all three subjects, body weight increases were accompanied by substantial increases in R_2 - R_3 IRTs. For Subjects 1, 2, and 5, terminal R_2 - R_3 IRTs at 80% of normal weights were 28 sec, 18 sec, and 26 sec (median of last 10 days); by the end of training at 90% of normal weight, these values had increased to 273, 149, and 178 sec respectively. Figure 6 also shows that weight increases were not accompanied by consistent changes of any great magnitude for R_3 - R_1 or R_1 - R_2 IRTs, although occasional long pauses, not seen at 80% of normal weight, did occur.

Figure 7 presents comparable data for the three subjects whose weights were reduced from 80% to 70% of normal. Two of the three (Subject 3 and Subject 6) showed reliable decreases in R_2 - R_3 IRTs when the last 10 days' performance at each weight are compared. In the case of Subject 3, the decrease was from 83 sec to 38 sec, on the average, while Subject 6 decreased from 25 sec to 15 sec. The performance of the remaining subject whose weight was decreased (Subject 4) did not change reliably as a consequence; terminal R_2 - R_3 IRTs at the two levels were 10 and 11 sec respectively. This discrepant performance may be related to unusually short IRTs at 80% (training was with a 90-sec timeout), leaving relatively little opportunity for further reductions when body weight was reduced to 70%. Figure 7 also shows that, as was the case with weight increases, weight reductions did not result in systematic changes in the IRTs associated with R_1 and R_2 .

Additionally, it may be noted that changes in the R_2 - R_3 IRT were considerably more rapid when weights were increased than when weights were decreased. This difference in rate of change undoubtedly was related to the fact that more time was required to reduce weights from 80% to 70% than to increase weights from 80% to 90%.

DISCUSSION

The influence of deprivation level on punished behavior has not been studied at all with timeout punishment, and only in a limited way with shock punishment. After reviewing

the limited evidence with respect to shock punishment, Azrin and Holz (1966) concluded that increased deprivation reduces the effectiveness of a given level of shock punishment. Perhaps the strongest support for this conclusion is a study by Azrin, Holz, and Hake (1963) in which the VI-reinforced behavior of pigeons was completely suppressed by shock punishment when the animals were at 85% of their normal weights, but reductions and eventual elimination of suppression occurred when weights were progressively reduced to 60% of normal weight. The present results are consistent with those obtained with shock punishment, since response suppression by timeout punishment increased when body weights were increased from 80% to 90% of normal weights and suppression decreased when body weights were reduced from 80% to 70%.

Thus, it may be concluded that variations in motivation to perform a punished response have generally similar effects regardless of whether punishment is by shock or by timeout.

Although the results of manipulation of deprivation levels in the present study seem consistent with the conception of timeout as an aversive event, they raise one puzzling question. Reductions in the effectiveness of electric shock punishment with increased deprivation can be understood in terms of the direct influence of deprivation on the punished response: the strengthening effects of deprivation on free-operant behavior are well-established, but there is little or no evidence to indicate that deprivation directly influences reactions to electric shock. When timeout punishment is used, increased deprivation also would be expected to strengthen the punished response. But unlike the case with shock, it might be expected that variations in deprivation would also have some direct influences on the aversiveness of timeout, with increased deprivation increasing aversiveness and decreased deprivation decreasing aversiveness. At the extreme, for example, a completely satiated organism should not find timeout from food reinforcement at all aversive. This reasoning with respect to the direct influence of deprivation on the aversiveness of timeout leads to the prediction that increased deprivation should produce increased suppression by timeout punishment, a prediction exactly the opposite of the present results. The conclusion must be reached, then, that variations in deprivation have greater influences on the strength of the punished response than upon the aversiveness of timeout punishment.

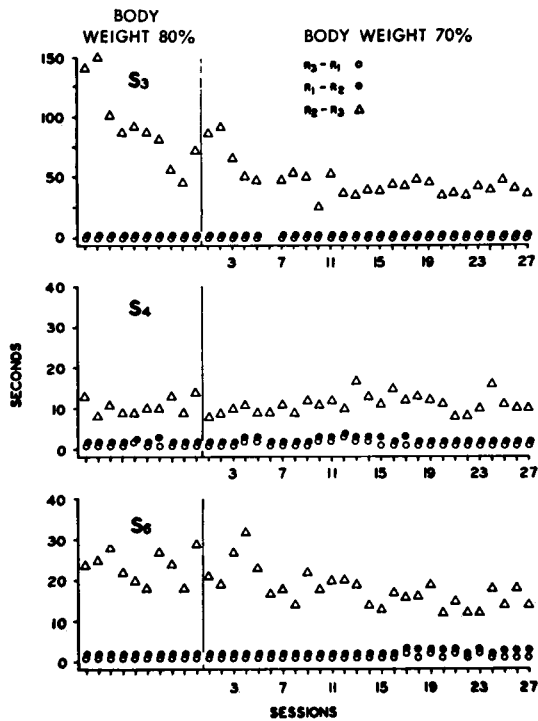


Fig. 7. Daily mean interresponse times in Exp. IV as a function of decreased body weight. During all sessions, R_1 and R_2 were reinforced, and R_3 produced 2 min of timeout (Subject 3) or 90 sec of timeout (Subjects 4 and 6). The left panel represents terminal performances at 80% body weight during the previous experiment for each subject. The right panel shows performances when body weight was reduced from 80% and reached 70% in all animals by the eleventh session of reduced feeding. Interresponse times were determined as described for Fig. 1.

GENERAL DISCUSSION AND CONCLUSIONS

The results demonstrated that timeout punishment can suppress behavior under circumstances in which suppression could not increase reinforcement density or frequency. From the standpoint of the two hypotheses offered by Leitenberg (1966) about timeout effects, the present results support the hypothesis that timeout is an aversive event, and argue against the hypothesis that the influences of timeout stem from increased positive reinforcement.

Worth considering are the possible roles of other variables in determining the outcome of the present experiments. One way of viewing the procedure is in terms of a response chain in which R_3 , the punished response, constituted one element. When timeout was made dependent upon R_3 , considerable delay ensued before the next response element in the chain, R_1 (and its associated S^D and primary reinforcer), became available. Thus, weakening of R_3 by timeout punishment may have been due to the disruptive influences of delayed reinforcement (Azzi, Fix, Keller, and Rocha e Silva, 1964; Ferster, 1953) rather than to the aversive influences of the timeout period itself. The additional findings that suppression decreased as the timeout period was shortened (Exp. II), and that suppression was eliminated when R_3 was reinforced by immediate dipper operation (Exp. III) also suggest the contribution of delayed reinforcement to response suppression.

Another factor which may have produced suppression of R_3 was discriminative control by stimuli associated with non-reinforcement. Since timeout punishment resulted in increased R_3 times without change in R_1 and R_2 times, it is clear that the period initiated by the second dipper operation was effectively discriminated. During this period, as well as during the timeout period following R_3 , responses were never reinforced. Thus, suppression of R_3 may be attributed to the weakening of behavior in the presence of stimuli systematically associated with extinction. In considering such an account, the complex and presumably interoceptive nature of these stimuli should be noted; suppression of R_3 occurred regularly in the presence of the S^D otherwise associated with reinforcement of R_1 and R_2 .

The above considerations suggest, then, that conclusions about the 'aversiveness of timeout punishment must be adopted with caution. Although the present results have established that aversive effects occur even when reinforcement is lost, it remains unclear to what extent the present results may have been due to the influences of such additional factors as delayed reinforcement and control by stimuli associated with extinction.

It is instructive to compare the present conclusions with those reached in the studies of delayed reinforcement mentioned previously.

Azzi *et al.* (1964) found that with a fixed delay of primary reinforcement, the presence of an exteroceptive stimulus during the delay period reduced the disruptive effects of the delay. To account for this finding they appealed to an explanation previously offered by Ferster (1953), namely, ". . . the bar-press is presumably reinforced immediately by the new stimulus situation, . . . which is at once an S^A for bar-pressing and an S^D for the occurrence of the mediating behavior . . ." (Azzi *et al.*, 1964, p. 161). Thus, Azzi *et al.*, faced with the need to account for increased response strength when the response produced a stimulus associated with a period of timeout, concluded that the stimulus possessed the properties of a conditioned reinforcer. By comparison, the present results indicated response suppression when the response produced a stimulus associated with a period of timeout, thus suggesting the conclusion that the timeout stimulus was a conditioned aversive stimulus. Since there is empirical support for either view, and since timeout periods may occur in varying relationships to many other events, it may well be that the appropriate question is not whether timeout is an aversive event, but rather under what conditions does timeout assume aversive properties? It may be noted in this connection that the dynamic properties of electric shock punishment were made clear only after experimental evidence indicated that shocks could serve either discriminative, reinforcing, or punishing functions (Holz and Azrin, 1962), depending upon the nature of the association of shock with the response and with the schedule of positive reinforcement.

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