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# A ROLE FOR NEGATIVE REINFORCEMENT OF RESPONSE OMISSION IN PUNISHMENT?

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This experiment attempted to disentangle response-rate reductions controlled by the direct suppressive effects of a punisher from those due to negative reinforcement of response omission. Key-peck responding of pigeons was maintained by a conjoint variable-interval 3-min schedule of food presentation variable-interval 30-s schedule of response-dependent electric shock presentation. Omission of responses for 5, 10, or 30 s resulted in the possibility of canceling a scheduled shock. Response rates were a function of required pause duration, with lower rates occurring when longer periods of response omission were required for shock cancellation. These results show that, with several parameters of punishment held constant, response rates were controlled by the negative reinforcement contingency. Such a finding argues for renewed consideration of the role of negative reinforcement in punishment contingencies.

*Key words:* punishment, negative reinforcement, response-dependent shocks, response omission, avoidance, variable-interval schedule, response pacing, key peck, pigeons

Punishment of an operant response often will maintain concomitant behavior that may decrease the punishment frequency or intensity. These contingencies may be scheduled directly or they may be by-products of the punishment procedure (cf. Zeiler, 1977, pp. 203–204). In an example of an explicit escape contingency, Azrin, Hake, Holz, and Hutchinson (1965) conducted a series of experiments in which punishment and escape from punishment were studied simultaneously using a two-key concurrent schedule. Responses on one key were conjointly punished and reinforced, while completion of the schedule requirement on the second key removed the punishment contingency from the first key for a short period. Escape responses were maintained under several schedules at punishment intensities that only slightly suppressed responding when escape was not possible. Rates and patterns of these escape responses were functionally related to the schedules required for escape from punishment and to the intensity of the punishing stimuli. These responses were maintained regardless of whether reinforcement frequency increased, decreased, or stayed the same. In an example of escape responding that was a by-product of the punishment procedure, Azrin and Holz described a "breakfast in bed" effect wherein a rat "learned to avoid grid shock by lying on its back while pressing the response lever with its hind foot to produce food pellets" (1966, p. 385). Hearst and Sidman (1961) reported an experiment in which escape from punishment occurred both as a by-product of the punishment procedure and as a result of an explicit escape contingency. They used a two-response concurrent schedule in which one response produced conjointly scheduled variable-interval (VI) reinforcement and fixed-ratio (FR) punishment, and the second response suspended both the punishment and reinforcement contingencies for the first response. Approximately half of the subjects made escape responses and suspended the punishment and reinforcement contingencies, resulting in a lowered overall frequency of punishment and a lowered overall frequency of reinforcement. The other subjects lowered shock frequency while still obtaining reinforcers by reducing the rates of the first (punished) response.

A similar reduction in punishment frequency or intensity by negative reinforcement of response omission may have been a factor in several other studies of punishment in which

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negative reinforcement was not explicitly arranged. Azrin (1956) punished responses according to fixed-interval (FI) or VI schedules in one component of a multiple VI VI schedule of reinforcement. Responding in the other component was not punished. The two components alternated at 2-min intervals. When response-dependent shocks were scheduled according to FI schedules, negatively accelerated responding occurred in the punishment component with responding ceasing just prior to the scheduled punisher, thereby precluding its presentation. Responding started again when the component without punishment was reinstated. Hoffman and Fleshler (1965) used a modified conditioned suppression procedure in which they scheduled response-dependent electric shocks at the end of a warning stimulus. After a 2-min warning-stimulus tone, a 2-min shock-contingency period, also in the presence of the tone, was in effect. If a response occurred in this period, shock was delivered and the tone terminated. If no responding occurred in this period, the tone remained on for the entire 2-min shock-contingency period. Responses frequently were omitted during the entire 4-min period of tone presentation, an outcome described as passive avoidance by Hoffman and Fleshler (1965, p. 91). Results of these studies suggest that one factor in the omission of responding may have been that, by so doing, punishment frequency was reduced. This outcome may be viewed either as avoidance of shocks or as escape from the punishment contingency. Either description seems accurate; however, we will adopt the former description in describing our procedures and interpretations. In those cases in which the original investigators used the latter term we will adhere to their usage.

In each of the experiments described in the preceding paragraph, control of the response reductions was confounded by another process. In these experiments, it is not possible to separate the effect of the escape contingency from the direct suppressive effect of punishment on responding. To separate these effects it is necessary to keep as many punishment parameters (e.g., intensity, frequency, and duration) as constant as possible, while observing a functional relation between the varying escape requirements for punishment omission and the rates and patterns of responding. The work of Azrin et al. (1965), described above, included such a series of manipulations of the escape requirements. However, their procedures used the key peck as an explicit escape response. In a more direct analysis of escape from punishment by response omission, Lattal and Cooper (1969) used a procedure in which pausing rather than a discrete response produced escape from punishment. They arranged an FR 25 schedule of positive reinforcement but punished each response. In subsequent conditions, the omission of responding for a specified duration changed the stimuli and eliminated punishment until the food reinforcer occurred. Most responses were emitted in the absence of punishment. The required pauses of 15, 30, or 45 s (which exceeded both the mean and median postreinforcement pauses in a punishment baseline condition with escape not possible) typically occurred immediately after each reinforcer. Characteristic FR responding occurred immediately after onset of the stimulus correlated with suspension of the punishment contingency.

Although the focus of punishment experiments has been on the direct suppressive effects of punishment (Azrin & Holz, 1966; Galbicka & Branch, 1981), reports like the above studies invite reconsideration of a role for negative reinforcement contingencies in describing punishment effects (cf. Dinsmoor, 1954, 1955, 1977). The paucity of research on the topic precludes conclusions about the reliability and generality of empirical demonstrations of negative reinforcement of response omission, not to mention the contributions of such a process to punishment. In the present experiment, therefore, we examined further the negative reinforcement of response omission under two conditions not studied previously. In the Lattal and Cooper (1969) experiment, the effect of pausing was to produce a relatively extended period during which responding could be reinforced without punishment. In addition, in the experiments of Hoffman and Fleshler (1965), Azrin (1956), Azrin et al. (1965), and Lattal and Cooper (1969), this punishment-free period always was correlated with a different exteroceptive stimulus configuration than was punishment. In contrast, we examined shock avoidance by response omission in the absence of an exteroceptive stimulus change. Rather than eliminating punishment for extended periods, pausing for required intervals at most eliminated only a single shock delivery in the present study so that further shocks were canceled only by additional pausing.

## METHOD

### *Subjects*

Two White Carneau pigeons were maintained at 80% of their free-feeding weights. Water and grit were available continuously in their home cages. Subject P3611 had been exposed to multiple VI VI schedules of reinforced key pecking and treadle pressing, with various delays of reinforcement. Subject P9767 had been exposed to simple VI schedules of treadle pressing with various delays of reinforcement.

### *Apparatus*

An operant conditioning chamber was used, which enclosed a space 28 cm long by 33 cm wide by 38 cm high. The 2.5-cm diameter response key was located in the center of the work panel 25 cm from the floor of the chamber. It was transilluminated by a green 7-W 110-V AC bulb throughout a session except during reinforcement. A minimum force of approximately 0.16 N was required to operate the key. General illumination of the chamber during sessions was provided by an orange 7-W 110-V AC bulb at all times except during reinforcement. Reinforcement was 4-s access to mixed grain in a standard food magazine, the opening to which was on the work panel, 5 cm from the right wall and 10 cm from the floor. The opening was illuminated by a white 7-W 110-V AC bulb when the magazine was operated. Punishment consisted of single 0.076-s pulses of 60 Hz, AC, that were delivered through a 10,000 ohm series resistor to electrodes implanted around the pubis bones (Azrin, 1959). Every 10 V was equivalent to approximately 1 mA. Supporting relay circuitry and recording equipment were located in an adjacent room.

### *Procedure*

Both birds received preliminary key-peck training on a series of VI schedules. The values of the VI schedules were increased gradually over several sessions, until the VI value reached 3 min. The VI 3-min schedule was arranged such that at the end of an interval averaging 3 min, determined by a constant-probability distribution of 12 intervals (Fleshler & Hoffman, 1962), the availability of food was held and the next response delivered the reinforcer. Once responding was stable, shocks were presented conjointly on a VI 30-s schedule. In a conjoint schedule, two or more independent schedules are arranged simultaneously on the same operandum. Therefore, for this experiment, pecks on a single key produced both reinforcers and punishers on each of their respective schedules. If a single key peck was scheduled to produce both a reinforcer and a punisher, only the reinforcer was delivered. The VI 30-s schedule consisted of 50 intervals that also were constructed from the constant-probability distribution of Fleshler and Hoffman (1962). Shocks were presented initially at 10 V and were increased gradually in intensity across several sessions. For P3611, shock intensity was increased to 35 V during the initial shock-delivery condition. It remained at that intensity throughout the rest of the experiment. For P9767, shock intensity was increased to 55 V during the 20 sessions of the initial shock-delivery condition and was increased further to 105 V between Sessions 1 and 38 of the 54 sessions comprising the first shock avoidance condition. Shock intensity remained at that intensity throughout the rest of the experiment.

A shock-avoidance contingency was added to the conjoint schedule, wherein once a shock was scheduled it was delivered by the next response if that response followed the preceding response by less than some specified duration. If that specified duration elapsed without a response, the shock was canceled. This is similar to an appetitive limited-hold (LH) contingency in that a reinforcer would be canceled if no response occurred within the LH period (Catania, 1979, p. 177). It differs in that an LH interval begins with reinforcer availability, whereas here the required duration of response omission for shock avoidance reset and began with each response. Required response omission durations of 30, 10, and 5 s were compared to a condition in which shock avoidance was not possible. The sequence of these conditions is shown in Table 1.

Sessions were conducted daily and lasted until 20 reinforcer deliveries occurred, which took approximately 1 hr. Occasional exceptions were made when response rates were sufficiently low to reduce reinforcement frequency. In this latter case, session lengths usu-

Table 1

Sequence of experimental conditions, number of sessions at each condition, and responses, shocks, and reinforcers per minute for each subject. All means and ranges represent the last 6 days of each condition. For each conjoint (conjt) schedule, required-pause durations (in seconds) are indicated in parentheses. A required-pause duration of ∞ s indicates that avoidance was not possible.

| | | Responses per minute | | Shocks per minute | | Reinforcers per minute | |
|---|---|---|---|---|---|---|---|
| Condition | Sessions | Mean | Range | Mean | Range | Mean | Range |
| P3611 | | | | | | | |
| VI 3 min | 28 | 56.9 | 48.2–66.8 | — | — | 0.35 | 0.34–0.36 |
| Conjt VI 3 min VI 30 s (∞) | 21 | 56.6 | 29.5–72.2 | 1.66 | 1.08–1.97 | 0.34 | 0.29–0.37 |
| Conjt VI 3 min VI 30 s (30) | 21 | 1.6 | 1.2–1.9 | 0.24 | 0.15–0.32 | 0.27 | 0.25–0.29 |
| Conjt VI 3 min VI 30 s (10) | 18 | 4.3 | 3.7–5.6 | 0.17 | 0.12–0.23 | 0.32 | 0.30–0.36 |
| Conjt VI 3 min VI 30 s (5) | 14 | 11.1 | 8.1–13.2 | 0.22 | 0.13–0.26 | 0.34 | 0.31–0.37 |
| Conjt VI 3 min VI 30 s (30) | 17 | 1.2 | 0.8–1.8 | 0.15 | 0.11–0.22 | 0.28 | 0.25–0.34 |
| Conjt VI 3 min VI 30 s (∞) | 14 | 0.2 | 0.1–0.4 | 0.09 | 0.02–0.18 | 0.13 | 0.06–0.19 |
| Conjt VI 3 min VI 30 s (30) | 32 | 1.0 | 0.5–1.6 | 0.13 | 0.02–0.25 | 0.26 | 0.16–0.31 |
| P9767 | | | | | | | |
| VI 3 min | 18 | 47.7 | 41.3–53.3 | — | — | 0.35 | 0.34–0.35 |
| Conjt VI 3 min VI 30 s (∞) | 20 | 62.7 | 54.1–74.4 | 1.86 | 1.68–1.96 | 0.35 | 0.32–0.37 |
| Conjt VI 3 min VI 30 s (30) | 54 | 3.0 | 2.7–3.8 | 0.32 | 0.24–0.45 | 0.29 | 0.25–0.33 |
| Conjt VI 3 min VI 30 s (10) | 18 | 9.3 | 8.7–10.6 | 0.33 | 0.29–0.36 | 0.32 | 0.30–0.36 |
| Conjt VI 3 min VI 30 s (5) | 10 | 16.6 | 12.7–18.4 | 0.17 | 0.08–0.31 | 0.34 | 0.31–0.40 |
| Conjt VI 3 min VI 30 s (30) | 12 | 2.9 | 2.7–3.2 | 0.23 | 0.17–0.29 | 0.28 | 0.25–0.34 |
| Conjt VI 3 min VI 30 s (∞) | 16 | 1.9 | 1.5–2.3 | 0.55 | 0.49–0.61 | 0.26 | 0.21–0.30 |
| Conjt VI 3 min VI 30 s (30) | 41 | 3.8 | 3.0–4.7 | 0.33 | 0.18–0.47 | 0.29 | 0.26–0.33 |

ally ranged from 65 to 85 min. Except for the initial shock-delivery condition (no avoidance), in which responding was highly variable, conditions were changed when response rates were stable. Each condition was in effect for at least 10 sessions and until response rates appeared stable on visual inspection.

## RESULTS

Figure 1 provides response-rate data for each condition. Table 1 provides the average and range of response rates for each subject averaged over the last 6 days of each condition. Response rates were related functionally to response omission requirements. As less pausing was required for shock deletion, response rates increased. Although absolute response-rate differences among these conditions were small, the differences were consistent in that the response-rate ranges among the conditions generally were nonoverlapping. Response rates during avoidance conditions also usually did not overlap with the response rates of the last no-avoidance condition. Average response rates for the initial no-avoidance condition were approximately the same as those in the VI 3-min no-shock baseline for Bird 3611 and increased over the VI 3-min baseline rates for Bird 9767. Response rates in the initial no-avoidance condition were quite variable, fluctuating from session to session by approximately 43 responses per minute for P3611 and 20 responses per minute for P9767. Response rates during the second no-avoidance condition were much lower than those observed during the first no-avoidance condition.

Shock frequency data are provided in Figure 2, which shows shock rates for the last 6 days of each shock condition, and in Table 1, which provides the mean and range of shock frequency averaged over the last 6 days of each of these conditions. The avoidance contingency reduced the shock frequency from the one to two shocks per minute that were obtained in the initial no-avoidance condition to 0.33 shocks per minute or less. The differences between shock frequencies in the different avoidance conditions were relatively small. Although response rates for both birds decreased during the second no-avoidance condition relative to those observed during the avoidance condi-

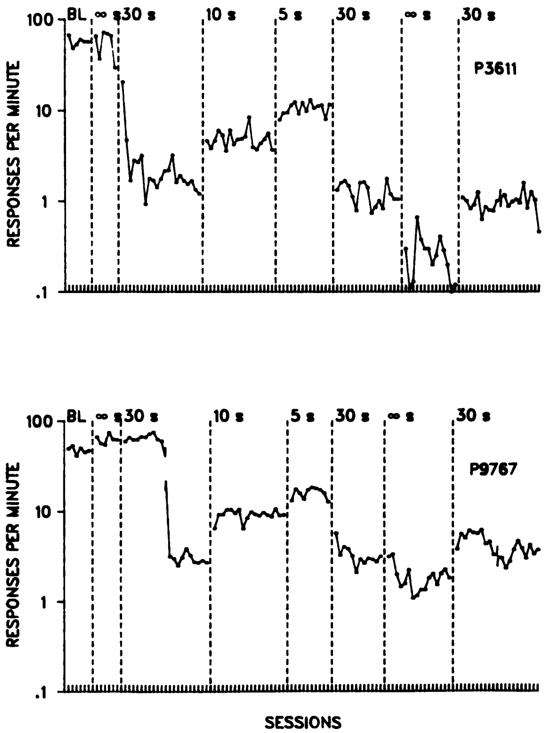

Fig. 1. Responses per minute as a function of successive sessions for each subject. Shown are the last six sessions of the first two conditions and all sessions for the remaining conditions except in those cases where the total number of sessions exceeded 21. In these latter conditions the first and last 10 sessions are shown. The baseline (no shock) is labeled BL. All punishment conditions are labeled with the duration of the avoidance requirement except where ∞ s indicates conditions in which the avoidance contingency was not in effect. Note that the *y*-axes are logarithmic (base 10).

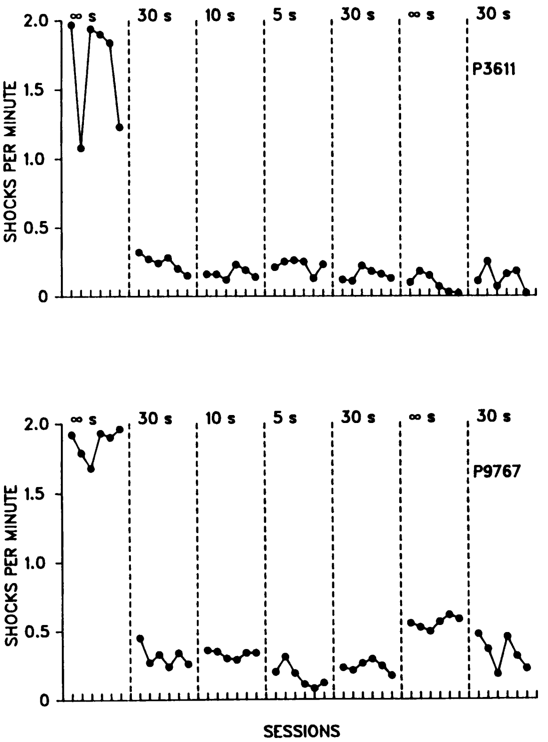

Fig. 2. Shocks per minute for each of the last six sessions of each shock condition for each subject. Conditions are labeled with the duration of the avoidance requirement except where ∞ s indicates conditions in which the avoidance contingency was not in effect.

tions, shock frequency changed in different directions during the second no-avoidance condition for the 2 birds. These differences in shock frequency simply mirror the slight differences in response rates (an average of 1.7 responses per minute) between the 2 birds, and are consistent with their response- and shock-rate differences when one compares the initial versus the second exposures to the no-avoidance condition.

Figures 3 and 4 provide cumulative response records from consecutive sessions in the first avoidance condition. These records show the rapid changes that occurred in response rates when responding contacted the avoidance contingency. With P3611, this occurred over the first three sessions of the condition, and with P9767, this occurred during the 38th through the 41st session. This difference may be accounted for by local response-rate differences within a session during the first no-avoidance condition. As noted above, response rates of Bird 3611 were highly variable during the first no-avoidance condition, characterized by pauses and bursts of responding (see Figure 3, record a). In contrast, the local rates for Bird 9767 were more uniformly high until the voltage was increased to 105 V during Session 38, after which the local rates became more variable, more like those for Bird 3611 (see Figure 4, record a). As a result, P3611's performance contacted the avoidance contingency over the first three sessions of the condition because of the frequent pausing that allowed the required response omission period to elapse between responses. The relatively high constant response rates of P9767 prevented contact with the avoidance contingency until Sessions 38 through 41. Thus, the transition can be characterized as the interruption of relatively high response rates by periods of rela-

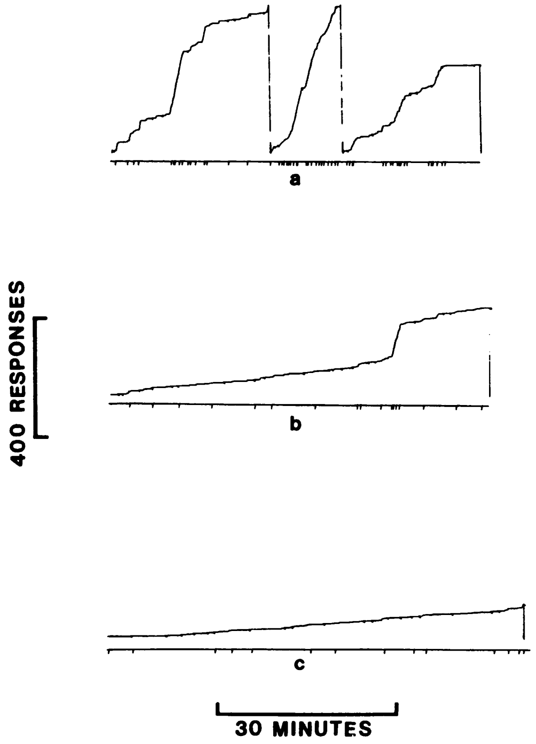

Fig. 3. Cumulative response records of the performance of Bird 3611 during the first three sessions (labeled a, b, and c, respectively) of the initial avoidance condition, showing the transition in response patterns produced by the first exposure to the avoidance contingency. Deflections of the response pen indicate reinforcer deliveries, and deflections of the event pen indicate shock deliveries.

tively low-rate responding. These periods of low response rates then increased in duration across days until the entire session consisted of relatively low-rate responding.

Figures 5 and 6 show representative cumulative response records of stable performance for each subject for each of the different avoidance conditions and for the second no-avoidance condition. These records reiterate the findings shown in Figure 1; that is, response rates for both subjects decreased as the duration of the required pause was increased. The second no-avoidance condition produced the lowest response rates. Responding was uniform throughout each of the avoidance conditions. Local patterns of responding exhibited more of a pause-and-respond pattern in which short pauses were interspersed among relatively high local response rates. These effects are illustrated in the magnified sections of the records.

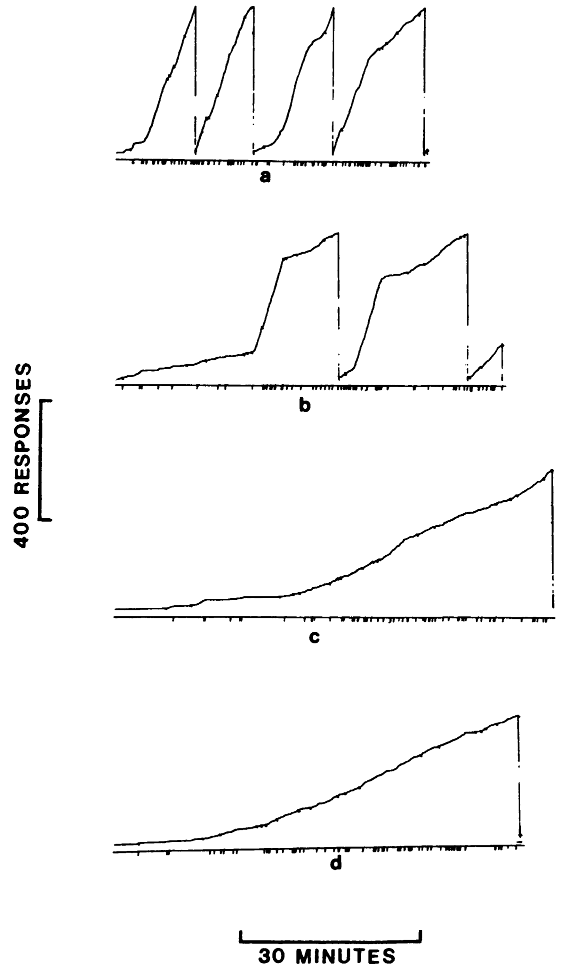

Fig. 4. Cumulative response records of the performance of P9767 during the 38th to the 41st sessions (labeled a through d) of the initial avoidance condition, showing the transition in response patterns produced by the first exposure to the avoidance contingency. Deflections of the response pen indicate reinforcer deliveries, and deflections of the event pen indicate shock deliveries.

Table 1 shows that, except for the last no-avoidance condition for P3611, frequency of positive reinforcement did not vary by more than five reinforcers per hour among the other conditions.

## DISCUSSION

The addition of the avoidance contingency to the shock schedule produced orderly effects. Response rates became uniform with low variability within conditions. The duration of the required pause controlled response rates such

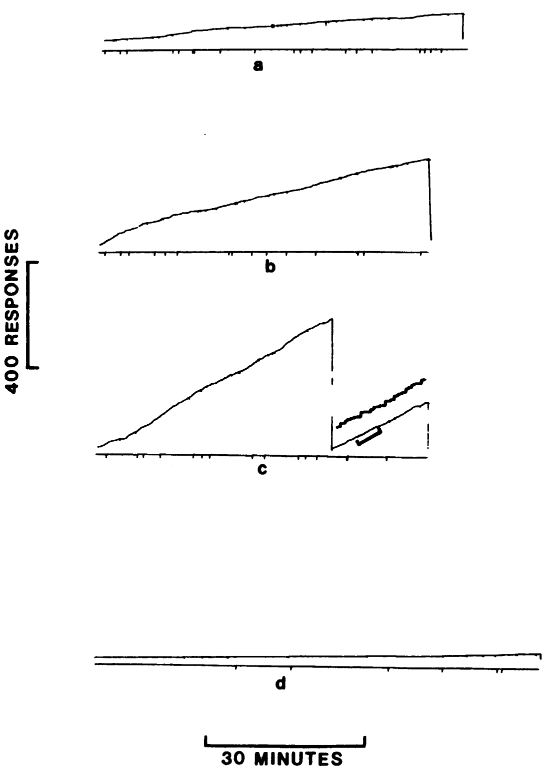

Fig. 5. Sample cumulative response records of the performance of P3611 showing stable performance under the 30-s (a), 10-s (b), and 5-s (c) avoidance contingencies, and during the second exposure to a no-avoidance contingency (d). Deflections of the response pen indicate reinforcer deliveries, and deflections of the event pen indicate shock deliveries. The magnified section of record c, located above the actual record, was taken from the bracketed area.

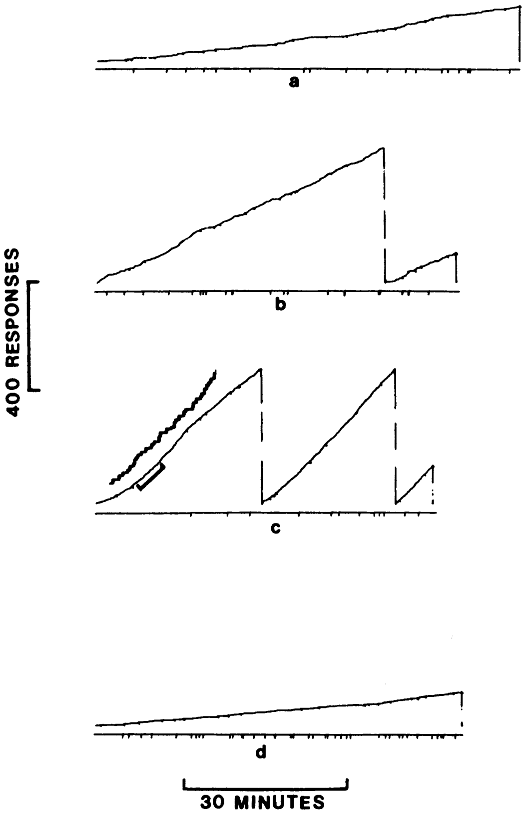

Fig. 6. Sample cumulative response records of the performance of P9767 showing stable performance under the 30-s (a), 10-s (b), and 5-s (c) avoidance contingencies, and during the second exposure to the no-avoidance contingency (d). Deflections of the response pen indicate reinforcer deliveries, and deflections of the event pen indicate shock deliveries. The magnified section of record c, located above the actual record, was taken from the bracketed area.

that with decreases in the pause durations that could cancel shocks, the relatively uniform and constant response rates increased. These effects were reversible (as illustrated by the reestablishment of higher response rates when a 30-s pause requirement was reinstated after the no-avoidance condition) and reliable, in that similar effects occurred with both subjects.

When shocks followed responses on a VI 30-s schedule, considerable variability in response rates was obtained. Such variability in the effectiveness of VI punishment schedules has been reported by Filby and Appel (1966) where both response-rate facilitation and extreme degrees of response suppression occurred. This variability occurred with Bird 9767 only when the voltage was increased during the initial avoidance condition. Although the data from this condition could have resulted from an interaction between the direct suppressive effects of the shock and the avoidance contingency, two factors render this interpretation unlikely as a general account of the effects. First, Bird 3611 showed the response-omission effect during the initial avoidance condition when its shock intensity had not been changed. Second, unlike previous studies of negative reinforcement of pausing during punishment procedures, the functional relation between required pause duration and response rate subsequently was shown for both birds when shock intensity was constant and shock frequency was relatively constant. For example, for Bird 9767 the shock intensity and the shock frequency were identical for the first 30-s required-pause condition and the 10-s required-pause condition, and yet a three-fold difference in response rate was obtained.

Response rates and patterns between the first and the second no-avoidance conditions differed greatly. During the first of these conditions, key-peck responding was variable and relatively frequent. By contrast, in the second, responding was less variable and was suppressed uniformly to levels lower than that during the avoidance conditions (see Figure 1). For Bird 3611, the differences in rates between the two no-avoidance conditions occurred even though shock intensity was the same in both of these conditions. Both subjects were exposed to the second no-avoidance condition after repeated exposure to the avoidance contingency. This history of reducing the shock frequency by adjusting response rates may explain the lowered and more uniform response rates during the second exposure to the no-avoidance condition. The training under the avoidance contingency shaped lower response rates. Without the avoidance contingency, however, the shock frequency would not be lowered substantially until a substantial decrease occurred in the response rates with a potential decrease in reinforcement frequency. This is similar to the effect obtained by Hearst and Sidman (1961), in which FR shock frequency was reduced by decreases in appetitively maintained VI responding.

Changes in shock frequency did not relate systematically to changes in response rates within the avoidance conditions. The positive reinforcement contingency operated to maintain responding and the avoidance requirement set an upper limit on responding that could occur in the absence of shock. Thus, positive reinforcement was optimized while holding shock frequency at low, constant levels. Rachlin (1972, Experiment I) noted a related effect using a titration-of-punishment procedure in which each key-peck response of pigeons on a VI food reinforcement schedule increased shock intensity while each pause of at least 3 s decreased intensity. Under this contingency, rates of positively reinforced responding were lower than during a condition in which intensity was constant. Rachlin's procedure maintained rates that continued to produce food while keeping shock intensity at tolerable levels. However, like the studies described in the present introduction, the processes of punishment and negative reinforcement were confounded. That is, because continued responding increased shock intensity proportionally, the omission of responding may have been due to either the primary positive punishment effect resulting from increased shock intensity or to the avoidance contingency.

Response-dependent shocks in the first no-avoidance condition failed to suppress the responding of Bird 3611 consistently, yet shocks at this same intensity effectively maintained avoidance responding. If the removal of stimuli is reinforcing, the stimuli then can be described as aversive (Skinner, 1953, p. 171). This difference in the effectiveness of the aversive and punishing functions of the shocks can be compared to the similar motivational aspects of escape from punishment obtained by Azrin et al. (1965) where escape responses were maintained at intensities of punishment that produced only slight suppression of responding when escape was not possible. These results indicate that although a stimulus or a set of contingencies may be sufficiently aversive to produce escape or avoidance responses in one situation, they still may not function effectively as punishers.

The aversive and punishing functions of a stimulus may be independent, and, therefore, the demonstration of control by a stimulus in one context (e.g., maintaining avoidance responding) does not imply that the same stimulus exerts a different type of functional control in another context (e.g., as a punisher). Azrin and Holz (1966, p. 382) raised this same point in their review of punishment when they asserted that because punishment is a primary process, the defining characteristic of a punisher is that its contingent presentation reduces the future probability of a response. It is not necessary that a punishing stimulus be shown to maintain some other escape response for it to be considered a punisher.

The suggestion that punishment is a primary process may be contrasted to an alternative offered by Dinsmoor (1954), described as an avoidance hypothesis of punishment. Dinsmoor asserted that the response suppression of punishment was actually a secondary effect of negative reinforcement. This occurs because the punished response is aversive by virtue of its relation to the punisher. Any response that is incompatible with the punished response would avoid the now-aversive punished response and would be negatively reinforced. The increase in the incompatible responses therefore decreases the frequency of the punished response, resulting in response suppression. Our results suggest that response rates can be controlled by the direct negative reinforcement of nonresponding independently of systematic changes in the frequency and intensity of punishment.

Alternatively, Galbicka and Branch (1981) have suggested that the mechanism by which punishment has its effects is differential punishment of responses. They arranged a punishment schedule where interresponse times (IRTs) greater than *t* seconds were punished. This contingency reduced the frequency of IRTs greater than *t* seconds, thereby showing punishment, and increased IRTs less than *t* seconds, which increased the overall response rates. When the same frequencies of shocks were delivered as were delivered during the IRT punishment condition, but independently of IRTs, the typical punishment effect occurred whereby overall response rates were suppressed.

If short IRTs are punished, as in the present experiment in which only IRTs less than the duration of the required pause could be punished, response rates would be expected to be lower than would be obtained if the punishers were delivered independently of IRTs. Although the present results could be accounted for by the Galbicka and Branch (1981) analysis of the direct effects of punishment, the generality of such an account to other instances of negative reinforcement in punishment is limited. For example, it is not useful in explaining instances of escape from punishment in which a topographically distinct escape response is required, as in the experiments of Azrin et al. (1965).

Galbicka and Branch's (1981) demonstration of differential punishment of IRTs seems equally interpretable as an instance of negative reinforcement. For each punishment condition, a criterion IRT value was selected for which all IRTs greater than that value were eligible to be punished according to a random-ratio 3 schedule. The random-ratio 3 schedule of punishment allowed shock frequency to vary as the frequency of the targeted IRTs also varied. As response rates increased and the frequency of the long IRTs decreased, shock frequency was reduced. The suppression of long IRTs may be interpretable as resulting from the negative reinforcement of short IRTs by reductions in shock frequency.

Galbicka and Platt (1984) recognized this difficulty and attempted to address it by holding punishment frequency constant while responding was maintained by a free-operant avoidance procedure (Sidman, 1953). Response rates were shown to change as a function of IRT punishment independently of punishment frequency. The results seem ambiguous, however. As responding decreased as a function of disrupting the relation between the punisher and the current IRT, complex interactions developed among responding, punishment frequency, and shocks delivered by the failure to meet the shock-postponement schedule requirement. This, plus embedding the IRT punishment contingency within a conjointly available negative reinforcement contingency, renders it difficult to rule out a role for negative reinforcement in punishment.

Interpretations of punishment in terms of negative reinforcement do not negate the obvious contributions of empirical studies of punishment exemplified by Azrin and Holz (1966). However, the possible operation of negative reinforcement contingencies that contribute to response suppression within a response-dependent shock (punishment) paradigm suggests that direct suppression and avoidance may interact to suppress responding. Procedures designed to analyze such independent contributions should shed further light on the validity of theories that address punishment as a primary or derived process.

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