JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR VOLUME 8, NUMBER 1 JANUARY, 1965

MOTIVATIONAL ASPECTS OF ESCAPE FROM PUNISHMENT[1]

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Punishment and escape were studied simultaneously by allowing a subject to escape from a stimulus situation in which responses were punished, into a stimulus situation in which responses were not punished. The frequency of the punished responses was found to be an inverse function of the intensity of punishment, whereas the frequency of the escape response was a direct function of the intensity of punishment. Both of these functions were obtained under three different schedules of food reinforcement. The strength of the escape behavior was evidenced by (1) the emergence of the escape response even when the frequency of food reinforcement decreased as a consequence of the escape response, (2) the maintenance of the escape response by fixed-interval and fixed-ratio schedules of escape reinforcement, and (3) the occurrence of escape responses at intensities of punishment that otherwise produced only mild suppression of the punished response when no escape was possible. This last finding indicates that a subject may be driven out of a situation involving punishment even though the punishment is relatively ineffective in suppressing the punished responses when no escape is possible.

Aversive stimuli have been defined in several ways. One defining characteristic (Dinsmoor, 1954; Keller and Schoenfeld, 1950; Skinner, 1953; Holland and Skinner, 1961) is whether escape or avoidance conditioning results from the termination or postponement of the stimulus. A second defining characteristic is whether suppression results when responses produce the stimulus (Keller and Schoenfeld, 1950; Azrin and Holz, in press). This latter procedure is designated as punishment. The present experiment attempts to study both defining characteristics simultaneously. The same theoretical objective was pursued by Hefferline (1950) and Harrison and Abelson (1959) utilizing two components (bar-press and bar-release) of the same general response. The present study used two different responses to achieve greater independence: one response produced the aversive stimulus, a second avoided it. In order to establish motivation for producing the aversive stimulus, *Ss* were first conditioned to respond for food; then, the aversive stimulus was delivered for each response (punishment). A second response was available which enabled *S* to escape from the punishment. Thus, *S* could choose between a situation in which responses were punished and one in which they were not punished. This general procedure for studying schedule preference was developed by Findley (1958). As applied to this study, this method permits separate consideration of two questions: (1) What is the extent to which punishment suppresses the punished responses? (2) What is the extent to which punishment establishes motivation to escape from the punishment situation?

EXPERIMENT I

Six white Carneaux pigeons were maintained at 80% of free feeding weight. The experimental chamber contained two response keys, one located 2 in. below the other. The keys were differentiated to permit rapid discrimination between them. They differed in size (3/4 in. *vs* 1 in. diameter), and in pattern of illumination (white *vs* striped black on white), as well as in position. Illumination was provided by an overhead light and by the transillumination of the response keys. Food reinforcement consisted of the presentation of grain for 4 sec. The response was a peck of at least 15 g force against the circular

[1]This investigation was supported in part by grants from the Mental Health Fund of the Illinois Department of Mental Health, NIMH Grant 4925, and NSF Grant 16357. Reprints may be obtained from N. H. Azrin, Behavior Research Lab, Anna State Hospital, Anna, Illinois 62906.

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response keys. The duration of each session was 1 hr or 60 reinforcements, whichever came first.

The punishing stimulus was a brief 100 msec pulse of 60 cps ac delivered through a 10K ohm series resistance to gold wires implanted beneath the skin and anchored around the pubis bone on each side of the bird (Azrin, 1959a). When the punishment procedure was used, the shock was delivered immediately after each response.

All *Ss* were conditioned for several weeks to respond at the upper response key under a FR-25 schedule of food reinforcement. Responses on the upper key are designated as food responses. Punishment was then delivered for each of the food responses. The shock intensity was increased from 0 v (no shock) in 10-v steps, allowing at least three days at each shock intensity. After the rate of food-reinforced responses was fairly stable from day to day, as well as within each day, the lower response key was made available. A single response on it reduced the overhead illumination for the remainder of the FR requirement, during which time the food responses (on the upper key) were not punished. All food responses were punished if no escape response was made. The emission of an escape response produced a period of safety that was terminated by the delivery of food reinforcement. Thus, a single escape response allowed all of the remaining responses in the FR to go unpunished. Following the delivery of food reinforcement, the punishment contingency was reinstated until another escape response was made.

For three *Ss*, the escape key was covered and the food responses were punished at progressively higher shock intensities until an intensity was reached at which the response rate was approximately zero. This procedure permitted observation of the response reduction during punishment when no escape from punishment was possible. The shock intensity was then reduced to zero, and sufficient time was provided for the response rate to return to its unpunished level. The escape key was then uncovered for the three *Ss* and the same increasing sequence of shock intensities was programmed. This procedure permitted observation of the response reduction during punishment when escape was possible. For the other three *Ss*, the reverse order of availability was used: first the escape response was available, then unavailable.

Results

Figure 1 shows the typical change in escape responses for one *S* as a function of the punishment intensity. It can be seen that less than three escape responses were emitted daily by this *S* when the punishment intensity was less than 40 v. At a critical intensity (40 v for this *S*, but 20 to 50 v for the other five), the escape responses increased to 60 per session (one escape response per reinforcement) and remained at that level as the intensity was increased further to 70 v. As shown in Fig. 2, each of the 60 escape responses was emitted shortly after each of the 60 food reinforcements, thereby allowing the 25 responses in the subsequent FR 25 to be emitted without being punished.

The cumulative records of Fig. 2 illustrate the characteristic moment-to-moment changes in performance. The three segments of the records are taken from the start of three different experimental sessions. The top record shows the FR food performance when the escape response was available but no punishment was scheduled. It can be seen that the *S* emitted food responses at a high rate and there was little or no pausing after reinforcement (the food reinforcement is indicated by the reset of the pen). The *S* did not emit any escape responses (which would have been indicated by a short downward pip of the recorder pen) even though the escape response was available. The middle record shows the performance when each response was pun-

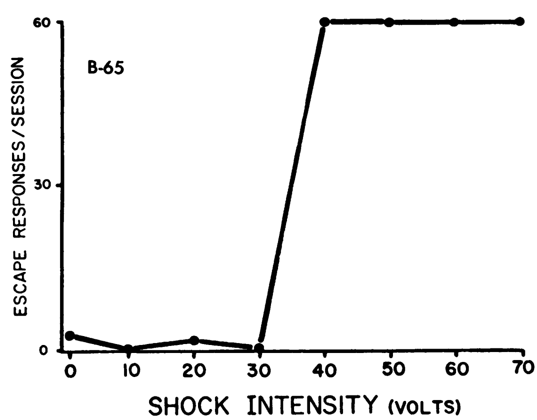

Fig. 1. Escape from punishment as a function of the intensity of the punishing shock for one *S*.

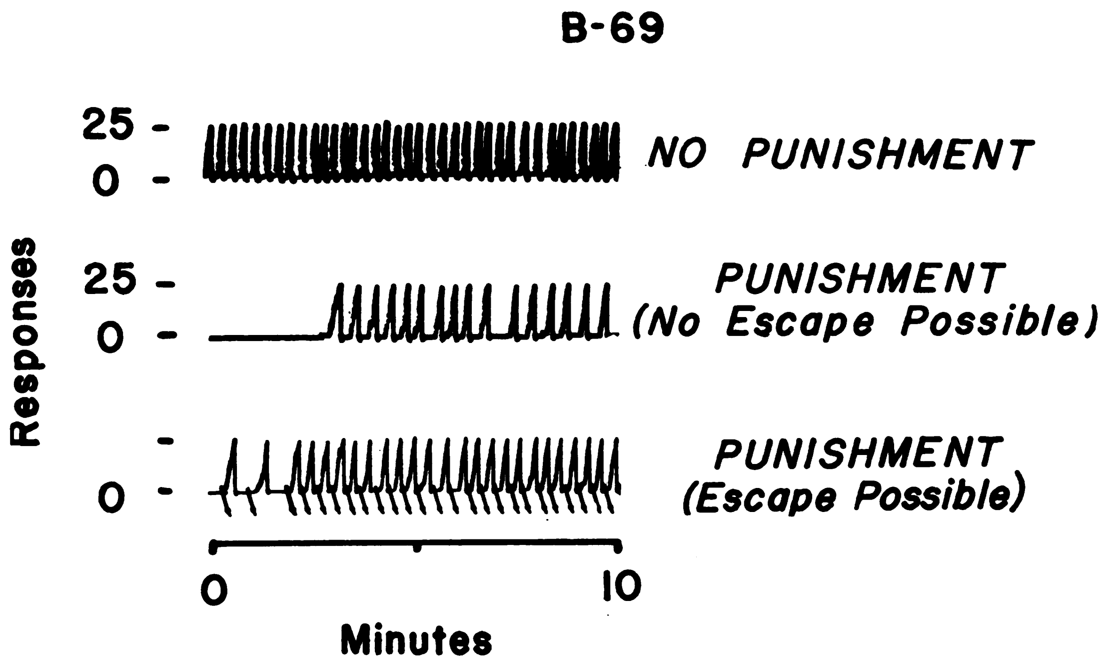

Fig. 2. Sample cumulative response record of one *S* for the first 10 min of the experimental sessions. The food delivery is indicated by the vertical reset of the recorder pen after every 25 responses. The top record shows the FR-25 performance when no punishing shock was used. The escape response key was available but no escape responses were made. The middle record shows the performance when shock was used at an intensity of 40 v to punish each response; no escape response was available. The bottom record shows the performance when the same shock intensity was used but now the escape response key was available. The escape response is indicated by a short downward pip of the recorder pen.

ished (40 v) and no escape responses were available. The responses were now suppressed as seen by the large warm-up (no responses) period at the start of the session and by the distinct pause following each food reinforcement. This increase of the post-reinforcement pause has been noted in a previous study of punishment of fixed-ratio performance (Azrin, 1959b). The bottom record shows the performance when an escape response was available. The same punishment intensity of 40 v eliminated all of the punished responses. The *S* typically emitted a single escape response (represented by the downward pip of the recorder pen on the bottom of the record) shortly before emitting the ratio run. Only rarely were food responses emitted before an escape response. Since the safe period began with the escape response and terminated with the delivery of food reinforcement, no punishment was delivered for the food responses which followed the escape response. The availability of the escape response allowed the *S* to go unpunished while obtaining the food reinforcements.

Figure 3 shows the response rate in the punished and unpunished (safe) situation as a function of punishment intensity. At 10 v and 20 v, almost all of the responses were emitted in the punished situation. At 30 v, the responses shifted over to the unpunished situation. The overall rate of response was only slightly reduced at the higher intensity. The major effect of the punishment was to displace the responses from the punished to the unpunished situation.

Consider now the results in terms of the number of punishments received. When the escape response was not available, the number of punishments was identical to the number of responses, of course, since each response was punished. When the escape response was available, however, the number of punishments received was inversely related to the number of escape responses.

Figure 4 shows the characteristic changes in the number of punishments received as a function of the punishment intensity. The results are presented for the condition in which no escape was possible as well as for the

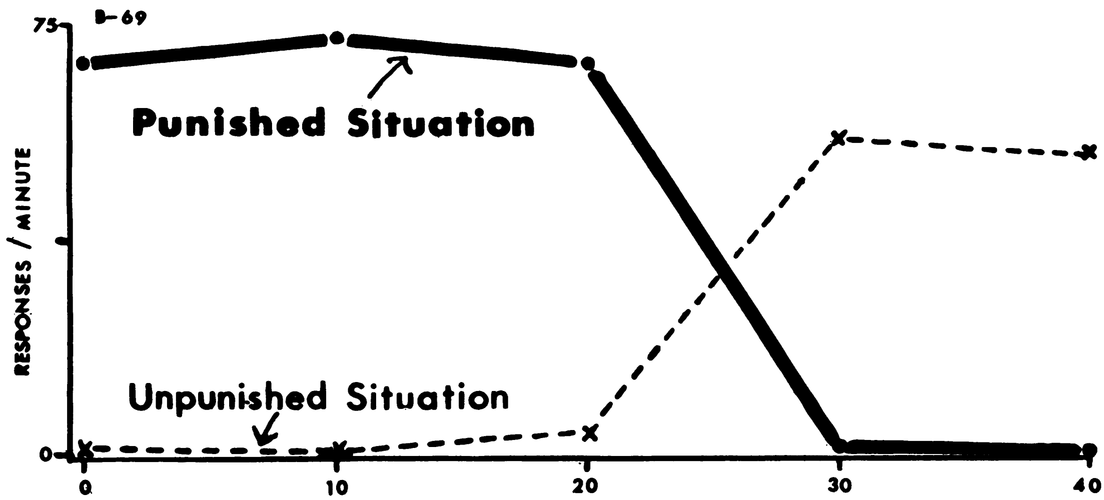

Fig. 3. Response rate in the punished and unpunished situation for one *S*. All points are based on at least five sessions.

condition in which escape was possible. When no escape response was available (solid curve), the rate of punished responses was an inverse function of the punishment intensity. At 30 v, the number of responses was reduced by about 30%, at 40 v by 40%, and at 60 v by 70%. Only at 70 v was responding suppressed to a near-zero level. When the escape response was available (dotted curve), the responses in the punishment situation were completely eliminated at intensities exceeding 30 v. These results show that moderate punishment produced almost complete suppression of the responses in the punishment situation when an escape response was available. In the absence of an opportunity to escape, however, the punishment produced relatively little suppression. The same findings were obtained for all six *S*s.

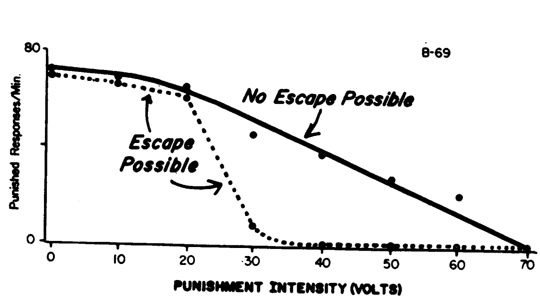

Fig. 4. Rate of punished responses when no escape was possible (solid line) as compared with the rate of punished responses when escape was possible (dotted line).

In this procedure, the escape response produced a stimulus change as well as eliminating the punishment. This stimulus change, and not the escape from punishment, might conceivably be responsible for the punishment-escape response. In an attempt to evaluate the role of this stimulus change, a procedure was followed for two *S*s (not shown) such that the escape response produced no stimulus change but still removed the punishment contingency. Under this procedure, the same results were obtained as seen in Fig. 1-4: the number of escape responses was a function of the punishment intensity. The major effect of eliminating the stimulus change was that up to six escape responses, rather than a single escape response, were usually emitted before the ratio run. The increase in the absolute number of escape responses is probably attributable to the loss of discriminative control provided by the stimulus change. Thus, the escape responses were a function of the punishment intensity even in the absence of a stimulus change. In order to determine definitively whether the escape response was maintained by the removal of the punishment contingency, an additional probe was conducted with one *S*; the "escape" response was followed by the usual stimulus change but the punishment contingency was not eliminated. The result was that the number of escape responses averaged less than two per session at all intensities from 0 v to 100 v. This same

S had shown an increase in escape responses, similar to the increase seen in Fig. 1, when the punishment contingency was removed by the escape response. Thus, stimulus change *per se* had no effect on the escape response unless the punishment contingency was eliminated during the stimulus change. The escape response appeared to be reinforced by the removal of the punishment contingency.

If escape from punishment is reinforcing in the same manner as other reinforcing stimuli, the escape response should be capable of being maintained by an intermittent schedule of escape reinforcement. To evaluate this possibility, the requirement was changed: for two *Ss*, several escape responses were required to produce the safe period. This requirement was gradually increased over a period of eight weeks to FR-150 for one *S* and FR-200 for the other. The intensity of the punishing shock was 80 v. The escape responses were recorded on a separate cumulative recorder, samples of which are presented in Fig. 5 for one *S*. When every escape response produced a safe period (FR-1), *S* emitted an escape response within a few seconds after the termination of the safe period. The recorder paper did not feed during the safe period, which is indicated only

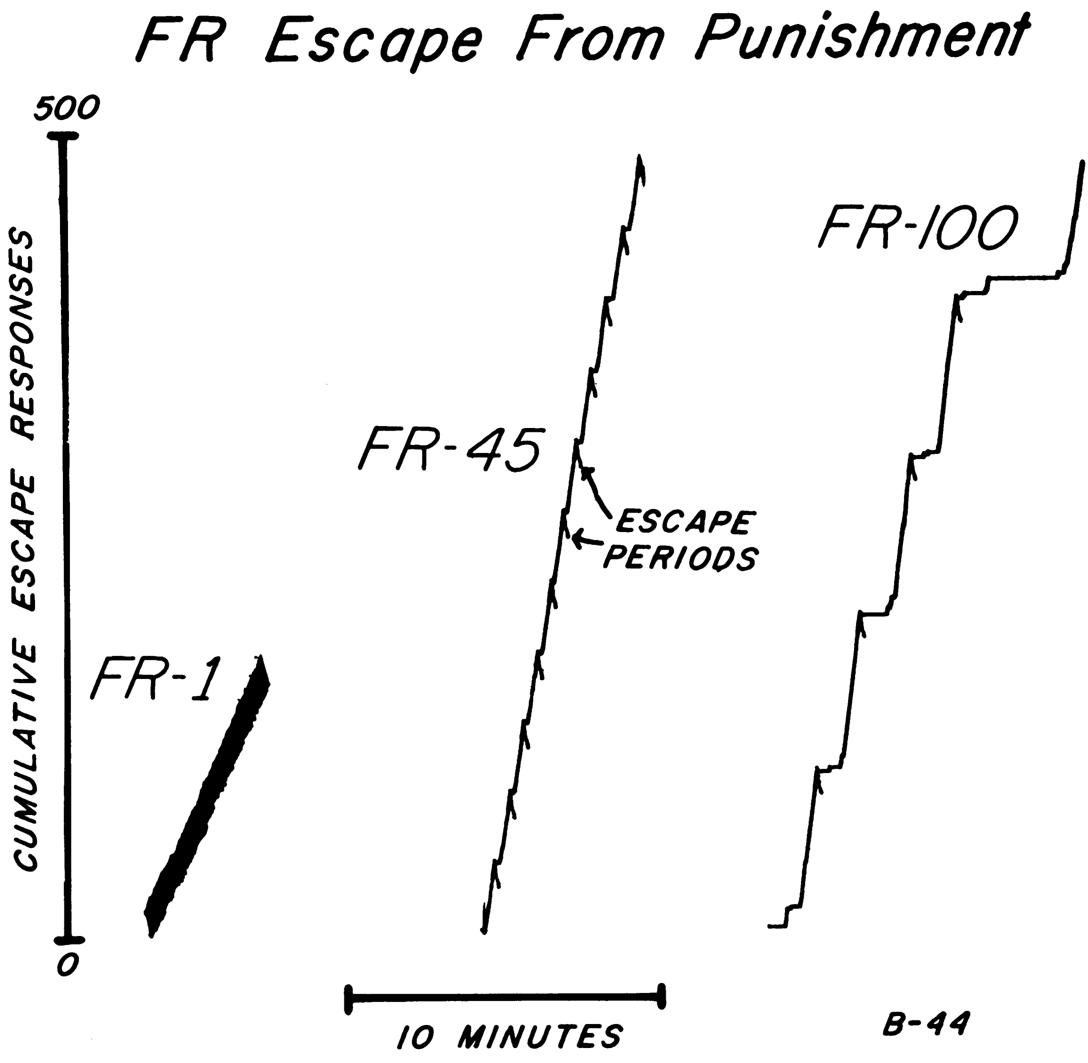

Fig. 5. Fixed-ratio reinforcement of the escape responses by a period of escape from punishment. The safe periods (designated as escape periods) are indicated by the short oblique line on the response record. The recording paper did not move during the safe periods. The records were taken from the start of the experimental sessions for one *S*.

by a downward deflection of the pen. This performance gave the record the appearance of a solid bar (left curve, Fig. 5). On successive days, the ratio requirement was increased. When 45 escape responses were required to produce the safe period (see middle curve), the escape response occurred in a consistent temporal pattern. Immediately following a safe period, there was a pause of about 20 sec. Following this pause, the escape responses were emitted at a rate exceeding one per sec until the 45th response produced another safe period. At higher ratios (FR-100), a longer pause followed each safe period; also, the response rate was often erratic during the initial portion of the ratio run of escape responses. At a requirement of 200 responses (not shown), the pause often lasted for 30 min and the entire ratio run of responses became erratic. Thus, within the range of FR-1 to FR-100, the escape responses showed the usual performance; ratios above 100 showed "ratio-strain". All but one or two food responses per session were emitted during the safe period. These unpunished food responses were recorded separately and showed a consistent pattern: the 25 unpunished responses were almost always emitted within 15 sec as seen in Fig. 2.

In an additional experiment with two other *Ss*, the escape responses were allowed to produce the safe period according to an FI schedule. As in the previous experiment, the food responses were maintained by an FR-25 schedule of food reinforcement and were recorded on a separate recorder. Again, the punishment intensity was 80 v and the escape key was available. When a single escape response produced a period of safety, *S* typically emitted a single escape response immediately after the termination of each safe period as seen in the left cumulative record (FI-0 min) of Fig. 6. The requirement was then changed so that the first escape response after 1 min produced the safe period (FI-1 min). On succeeding days, the interval was progressively lengthened. Figure 6 shows that the escape responses were positively accelerated between each safe period. At FI requirements greater than 10 min

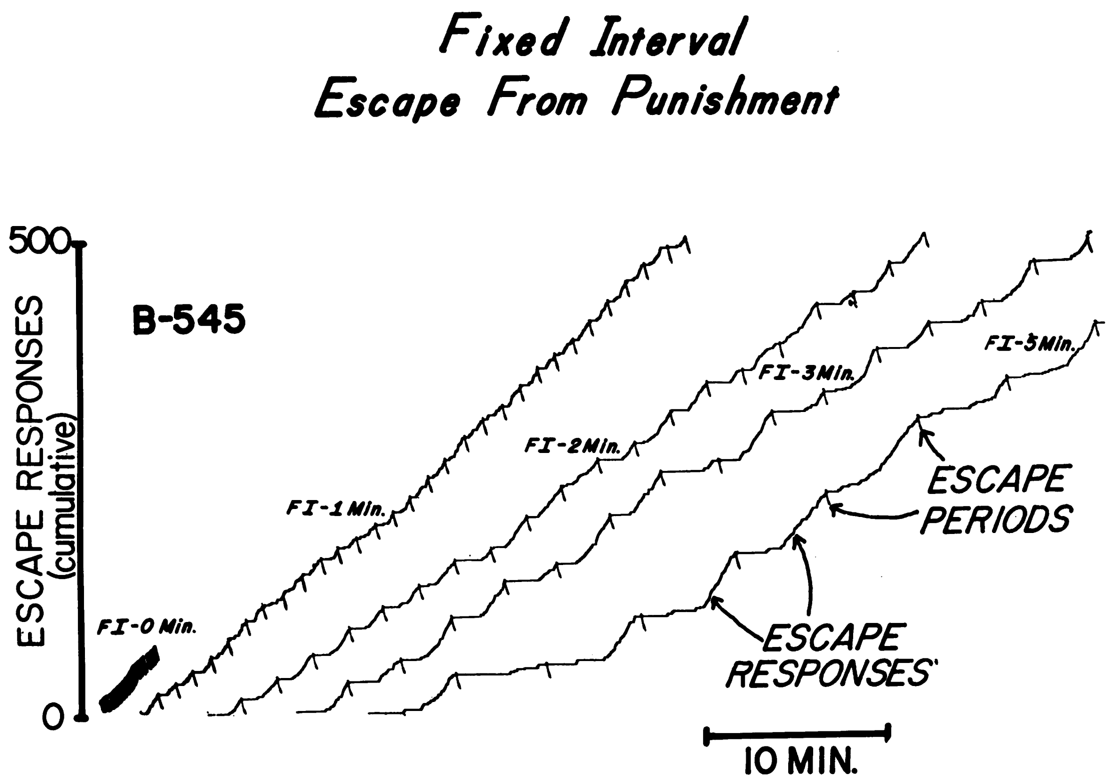

Fig. 6. Fixed-interval reinforcement of the escape responses by a period of escape from punishment. The safe periods (designated as escape periods) are indicated by the short oblique line on the response record. The five escape response records were taken from the start of the experimental sessions for one *S*.

(not shown), the overall frequency of escape responses dropped sharply for both *S*s to a rate less than 4 per min. Thus, FI schedules up to 5 min maintained a rate greater than 10 responses per min for both *S*s. At all FI durations, the escape responses generally accelerated between successive safe periods in the same manner as had been noted during FI food reinforcement (Ferster and Skinner, 1957).

Punishment of *S*s' responses appears to have created a strong tendency for *S*s to escape from the punishment situation. The tendency to emit the escape responses was a direct function of the punishment intensity. This motivation to escape was strong enough to maintain FI and FR escape performance. When *S* was given no opportunity to escape from the punishment situation, the punished responses were little affected as compared with the condition in which the opportunity to escape was available.

EXPERIMENT II

The conclusions of Exp I were based upon performance maintained by an FR schedule of food reinforcement. Experiment II attempts to ascertain the generality of these conclusions by replicating the essential features of the procedure, but substituting a variable-interval (VI) schedule of food reinforcement. The use of a VI schedule also serves to answer questions regarding the role of the frequency of food reinforcement.

In Exp I, the food responses were reinforced by an FR schedule. The frequency of food reinforcement during FR reinforcement was necessarily a direct function of the rate of responding, since every 25th response produced food. Since punishment reduced the response rate, the rate of reinforcement was reduced also. When an escape response occurred, the punishment was eliminated, thereby allowing a higher rate of food responses and, proportionately, a higher rate of food reinforcement. It appeared, therefore, that the escape responses during FR reinforcement might have been strengthened indirectly by the increased rate of food reinforcement that resulted from the escape response. In fact, the question may be raised of whether these responses may have been maintained by the increased frequency of food reinforcement rather than by the termination of punishment. This question could be answered partly by the use of a VI schedule for maintaining the food responses. Since VI schedules maintain a fairly constant rate of reinforcement over a wide range of response rates (Ferster and Skinner, 1957), the emergence of punishment-escape responses during VI reinforcement would indicate that the frequency of reinforcement seen in Exp I is not critical.

Method

The subjects were eight pigeons, three of which had been studied in Exp I. Performance was first stabilized for several weeks under a VI schedule of food reinforcement, 1 min VI for five *S*s, 2 min VI for three *S*s. Each *S* was exposed to progressively higher intensities of punishment by increasing the shock intensity in 10-v steps, allowing at least five days at each intensity. For four *S*s, shock intensity was first increased while the escape response was available. Recovery of the response rate was then accomplished by removing the punishment. The shock intensity was then increased in the same manner but with the escape response not available. The other four *S*s were given the opposite sequence. First the escape was not available, then it was. The sessions were 2-hr duration for five *S*s and 2½ hr for three *S*s. The procedure differed from that of Exp I primarily in that the escape response now produced a fixed duration of escape. When the escape key was available, a response on the escape key produced a safe period for 30 sec during which the food responses were not punished (for *S*s with 2½ hr sessions, the duration of the safe period was 60 sec). The same stimulus change was associated with the safe period as in Exp I.

Results

In the absence of punishment, the VI schedule produced the usual high and uniform response rate illustrated in Fig. 7 (left curve) for one *S*. Although the escape key was available, very few escape responses were made. The middle curve is a cumulative record illustrating the resulting performance of the *S* when the punishment intensity was 70 v and the escape response was not available. This curve shows the uniform reduction of responses that has been found to be characteristic during punishment of responses main-

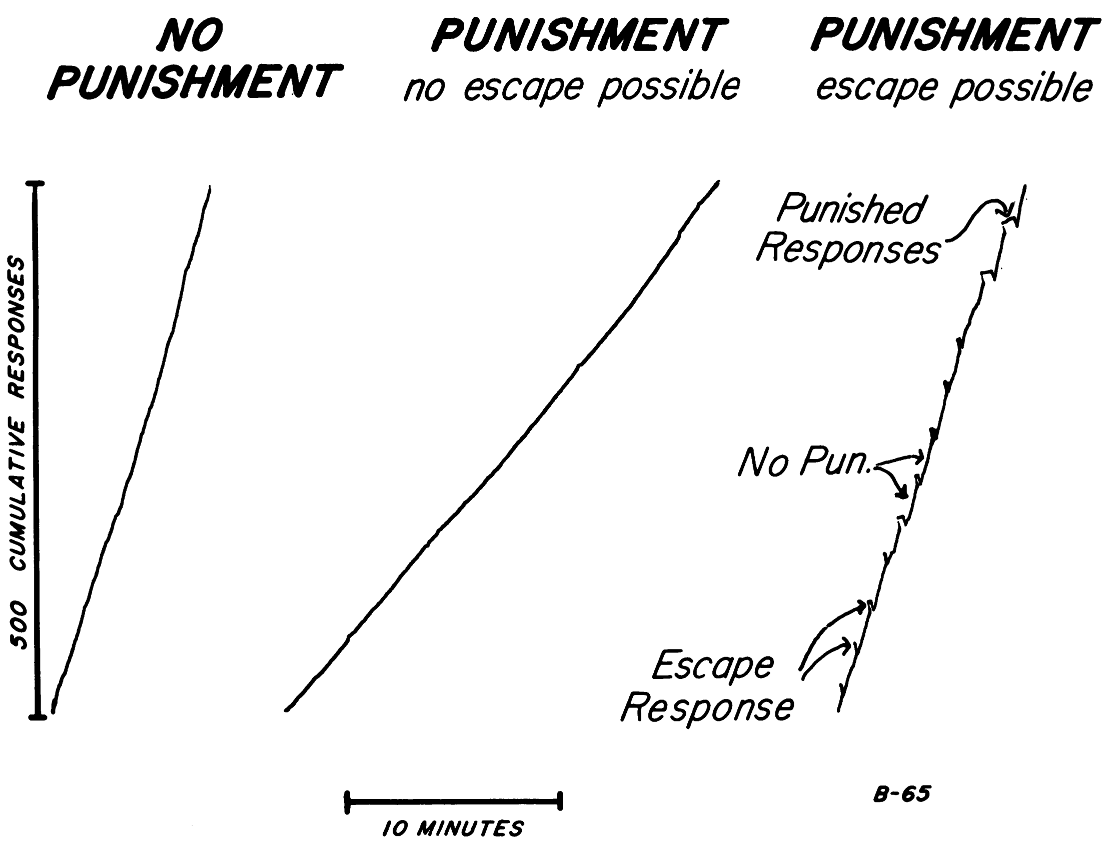

Fig. 7. Three segments of cumulative response records for one S taken 30 min after the start of the experimental sessions. The responses were being reinforced on a 2-min VI schedule of food reinforcement. The food delivery is not indicated on the records. The first segment shows the VI performance when no punishing shock was used. The second segment shows the VI performance when the punishing shock (70 v) was being delivered for each response. The escape response was not available during this time. The third segment shows the VI performance at the same intensity of punishment, 70 v, but with the escape response available. The escape response results in the slight downward movement of the recorder pen (see lower two arrows) for 30 sec during which time the food responses were not punished (see middle arrows). Otherwise, punishment was delivered for the responses (see upper arrow).

tained by a VI schedule of reinforcement (Azrin, 1960). The right segment of Fig. 7 shows the performance under the same punishment intensity of 70 v but with the escape key available. As noted previously, each response on the escape key produced a 30-sec period during which the overhead lights were extinguished and responses were not punished. The pen is deflected downward during this safe period; responses are not punished when the pen is deflected downward. It can be seen that the availability of the escape response had the same effect as observed in Exp I where an FR schedule of food was used. The S usually terminated the stimulus that was associated with punishment by emitting an escape response shortly after the safe period terminated. Since almost all of the food responses were emitted during the safe periods, only an occasional response was punished (top arrow, right curve). Again, as in Exp I, the total number of responses emitted when the escape response was available during punishment was approximately equal to the number of responses emitted when no punishment was used.

A count of the food reinforcements revealed that the frequency of food reinforcement was not appreciably changed (± 2%) by the addition of punishment. As can be seen in Fig. 7, food responses were occurring at a fairly uniform rate during punishment, with no more than a few seconds at most between any two successive responses. Hence, each reinforcement was delivered within a few seconds after the reinforcement was scheduled.

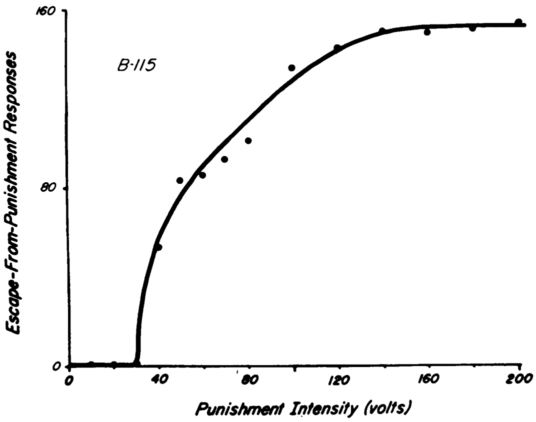

Fig. 8. Escape responses as a function of the intensity of the punishing shock for one *S*.

Six of the eight *S*s showed consistent escape responding as depicted in Fig. 7. The other two failed to emit many escape responses even during severe punishment. Intensive study of these two *S*s did not reveal the reason for the failure. For the six *S*s that emitted escape responses, the frequency of escape responding was a direct function of the punishment intensity, as Fig. 8 shows for one *S*. An asymptote of about 150 escape responses was reached at about 100 v; 150 safe periods was the maximum number obtainable during the 2½ hr session.

Figure 9 shows the characteristic changes in response rate in the punishment situation and in the unpunished situation as a function of the intensity of punishment for one typical *S*. At 0 v, the response rate in the punishment situation was about 75 responses per min whereas the response rate in the unpunished situation was only five responses per min. As the intensity of punishment was increased, the responses shifted over to the unpunished situation so that the overall response rate at the high punishment intensity of 80 v was approximately equal to the rate at 0 v. The major effect of punishment was to shift the responses from the punished to the unpunished situation with little reduction in the overall rate of response.

Figure 7 shows that the *S* usually reinstated the safe period within a few seconds after the termination of the previous safe period. An attempt was made, therefore, with two *S*s to manipulate the frequency of the escape responses by experimentally changing the duration of the safe period. The durations used were 240, 120, 60, 30, 15, 10, 5, 3, 2, and 1 sec. At least three sessions were provided for each duration. The results (not shown) showed an almost complete absence of escape responses during safe periods of all durations. Also, the average latency of the escape response varied

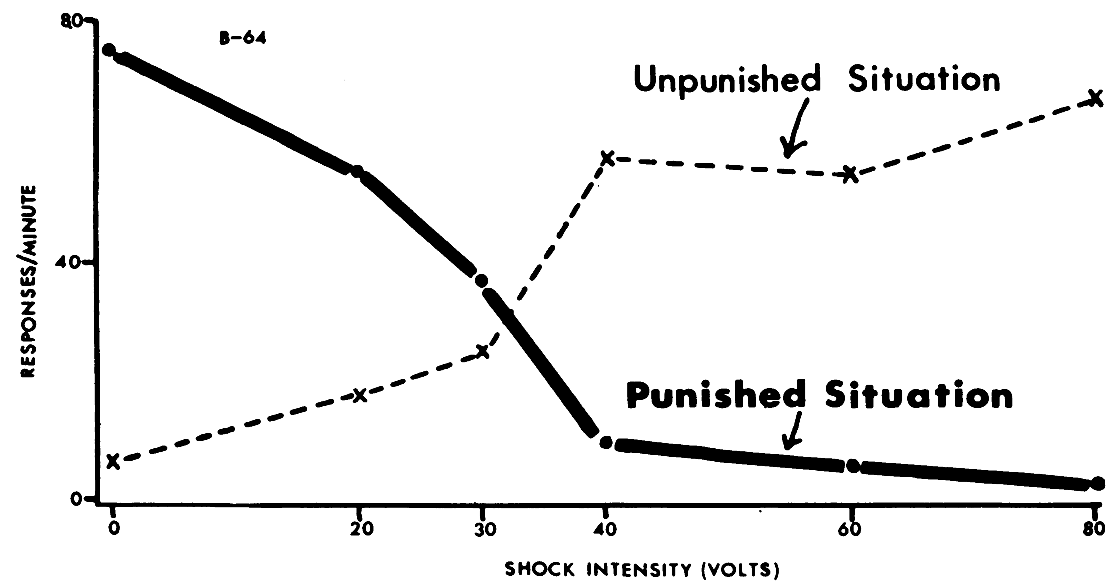

Fig. 9. Response rate in the punished and unpunished situation for one subject. The data at 10 v were not plotted since only one session was conducted at that intensity. All other intensities were based on at least five sessions.

only between 2 sec and 5 sec at the various durations of the safe period. All durations of the safe period were effective in maintaining escape responses even when the duration of escape was as low as 1.0 sec.

The escape responses appear to serve the function of allowing the food-reinforced responses to be emitted without punishment. A reduction of the motivation to emit the food responses should, therefore, reduce the tendency to emit the escape responses. This possibility was evaluated by satiation with food. Two *Ss* were progressively satiated over a period of six weeks by increasing the amount of food given at the end of each session. Figure 10 shows a progressive reduction of the food reinforced responses (solid curve) during the progressive satiation. This reduction was accompanied by a concurrent reduction of the escape responses (dotted curve). The second *S* showed this same co-variation between the food and escape responses as a function of the degree of food deprivation. In a second attempt to explore the dependence of the escape response upon the degree of motivation to emit the punished response, all *Ss* were subjected to extinction during a single extended session (not shown). The food-reinforced responses showed the usual progressive decrease in the rate of responding. Concurrently, the escape responses also decreased. The escape responses, as well as the food-reinforced responses, were at a near zero level for all *Ss* within 3 hr after extinction was initiated. When food-reinforcement was introduced at the end of the same session, the escape responses, as well as the food responses, increased to the high level seen prior to extinction. All *Ss* showed this concurrent reduction of the food responses and the escape responses as a function of the duration of extinction.

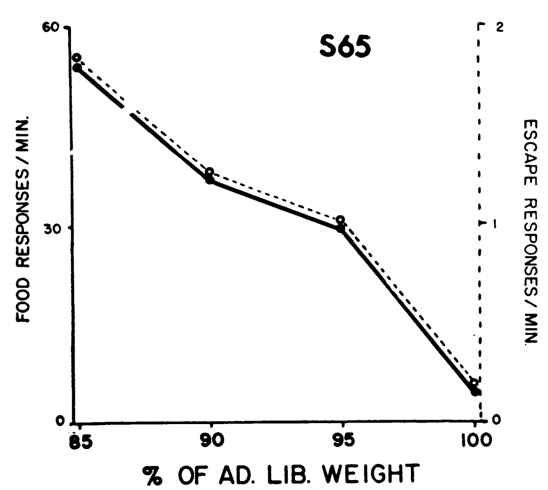

Fig. 10. Effects of food deprivation (per cent of *ad libitum* weight) on food-reinforced responses and on the responses that provided escape from the punishment of the food responses. The solid line shows the food reinforced responses; the dotted line shows the escape responses.

The results of Exp II, which utilized a VI schedule of food reinforcement, indicate that the occurrence of the escape responses did not require increased food delivery. Under VI reinforcement, the rate of reinforcement is known to be fairly constant over a wide range of response rates whether the responses are unpunished (Ferster and Skinner, 1957) or punished (Azrin, 1960). For example, it is noted previously (Fig. 7 of this study) that the rate of reinforcement was virtually unchanged in spite of a 60 per cent reduction of the food responses by punishment. Yet, escape responses did emerge during punishment in spite of the constancy of the rate of food reinforcement. It appears, therefore, that the escape responses do not require an increased rate of food reinforcement. The following experiment was designed to provide an unequivocal answer to this question by utilizing a DRL schedule of food reinforcement. DRL schedules differ in several respects from VI or FR schedules. The question was whether any of these factors, including the changes in food reinforcement, would prevent the maintenance of escape responses. Since the frequency of food reinforcement is known to increase as a consequence of punishment of DRL responses (Holz, Azrin, and Ulrich 1963), the emergence of escape responses would lead to a decreased, rather than an increased, frequency of food reinforcement.

EXPERIMENT III

Method

Three subjects were used, two of which had been studied in the previous experiment. The same basic procedure was used as in Exp II, except that the food response was reinforced only if the response was preceded by a 30-sec period of not responding for food (DRL 30 sec). A response on the escape key produced a stimulus change for 1 min during which the food responses were not punished. Responding was first allowed to stabilize under the DRL 30-sec procedure for about one month with no punishment. The escape response was available, but since no punishment was programmed, the only consequence of the response was the changed illumination for 1 min. Punishment was then delivered for each of the food responses. As in the previous experiments, the intensity of punishment was increased in 10-v steps allowing at least five days at each intensity. As in Exp I and II, the escape key was then covered and the same increasing sequence of intensities of punishment was programmed with no opportunity to escape from the punishment contingency. The session duration was 2 hr or 60 reinforcements, whichever came first.

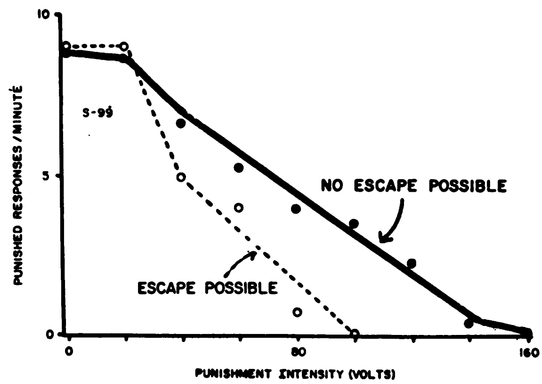

Fig. 12. The rate of punished responses as a function of the intensity of punishment for one *S*. The solid curve shows the procedure in which no escape was possible from the punishment. The dotted curve shows the procedure in which escape was available.

Results

Figure 11 shows that the escape responses during this DRL schedule increased as a direct function of the intensity of the punishing stimulus, just as seen previously during the FR and VI schedules (Fig. 1 and 8). Similarly, Fig. 12 shows that punishment of the DRL responses produced less suppression of the punished responses when no escape from punishment was available (solid curve, Fig. 12) than when escape was available (dotted curve, Fig. 12). Comparable results for the FR and VI schedules are seen in Fig. 4 and Fig. 7.

Figure 13 shows the changes in the frequency of food reinforcement that resulted from punishment. The solid curve shows that the rate of food reinforcement increased as a function of the punishment intensity when no escape was possible. This same relation had been noted in previous studies of punishment of DRL performance (Holz *et al.*, 1963). When the escape response was available (dotted curve), the frequency of reinforcement did not increase as a function of the intensity of punishment. The escape response eliminated the punishment, but simultaneously reduced the high number of food reinforcements that were normally obtained during the non-escapable punishment.

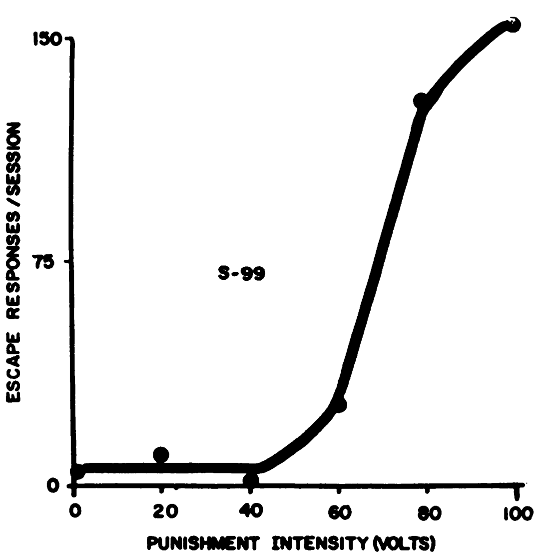

Fig. 11. Escape responses as a function of the intensity of the punishing shock for one *S*.

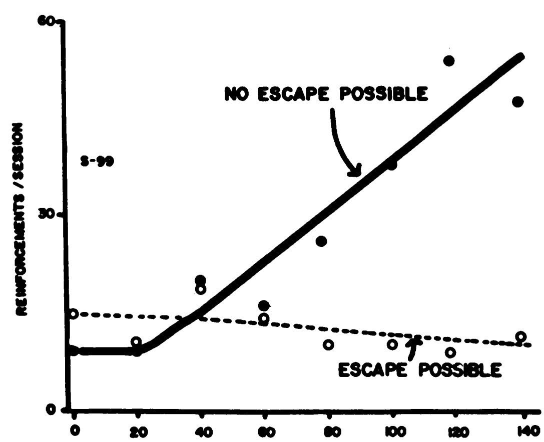

Fig. 13. Rate of food reinforcement for one *S* as a function of punishment intensity when the responses were maintained by a 30-sec DRL schedule of food reinforcement. The solid curve shows the procedure in which the escape response was not available; the dotted curve shows the procedure in which the escape response was available.

The other two *Ss* showed the same general relationships depicted for the individual *S* in Fig. 11, 12, and 13. For all *Ss*, the escape responses increased as a function of the punishment intensity. Also, when escape was possible, the punishment produced more suppression of the punished responses as well as a lower frequency of food reinforcement than when no escape was possible.

DISCUSSION

The escape responses were a function of punishment intensity whether the frequency of food reinforcement increased (Exp I), remained constant (Exp II), or decreased (Exp III). Thus, the escape responses occurred in spite of, rather than because of, any resulting change in food reinforcement. The source of strength for the escape response appears to be the removal of the punishment contingency. This finding is supported by Dardano and Sauerbrunn's (1964) finding that the removal of a punishment contingency is reinforcing even if an increased response requirement results. Similarly, the results of Hearst and Sidman (1961) indicate that an escape response might be maintained by the removal of a punishment contingency even if food extinction was associated with the period of safety. In a procedure somewhat similar to the present study, Hearst (1963) also measured the frequency of escape responses that removed aversive shocks combined with food. The principal difference in procedures is that the aversive stimulus was not response-produced, thus making the procedure fairly close to the standard avoidance paradigm. Hearst's findings were similar to the present findings in showing an increased rate of escape responses as a function of shock intensity.

The present findings with respect to the punishment-escape response confirms previous findings concerning the more usual type of avoidance and escape performance. For example, Kaplan (1952), Campbell (1955), Barry and Harrison (1957), Dinsmoor and Winograd (1958), Boren, Sidman, and Herrnstein (1959), and Harrison, Abelson, and Fisher (1960) found an increase of avoidance or escape responses as a direct function of the intensity of the aversive stimulus.

Similarly, the absence of punishment-escape responses during the period of safety is in agreement with the Ulrich, Holz, and Azrin (1964) finding during discriminated avoidance that the avoidance responses were almost completely absent during the safe stimulus. If, however, a discriminative stimulus does not precede the aversive stimulus, as in the Sidman (1953) avoidance procedure, many avoidance responses occur during the period of safety which is designated as the R-S interval. In the same manner, the absence of a discriminative stimulus for the safe period in this study resulted in an increased number of escape responses.

Previous findings have demonstrated intermittent reinforcement by the removal of aversive stimulation; *e.g.*, variable-interval reinforcement by Barry and Harrison (1957), Dinsmoor and Winograd (1958), and Dinsmoor (1962). The present results demonstrated FI reinforcement. Fixed-interval escape reinforcement showed a positive acceleration of responses similar to that seen during FI food reinforcement (Ferster and Skinner, 1957): further, the rate of responding was inversely proportional to the FI duration, as has also been observed by Skinner (1938) using food and by Kaplan (1952) using the termination of a bright light. The present results also revealed several distinctive effects of imposing an FR requirement on the escape response: (1) a bivalued pattern of responding, (2) an inverse relation between response rate and the size of the FR requirement, and (3) successful maintenance of a large amount of behavior. All three of these effects have been obtained in previous studies of escape reinforcement in which the aversive stimulus was a bright light (Kaplan, 1956), a shock-avoidance situation (Fig. 41, Sidman, 1960), or unavoidable shocks (Azrin, Holz, and Hake, 1962; Azrin, Holz, Hake, and Ayllon, 1963).

The present findings revealed an additional aspect of punishment-escape responding. In the usual escape or avoidance procedure, the aversive stimulus is not produced by any specific response but rather by a predetermined time interval. In Sidman avoidance, for example, the aversive stimulus occurs when the R-S or S-S interval elapses regardless of what specific behavior the subject is performing at the time. In the present procedure, the aversive stimulus was delivered only for a specific response. Consequently, no aversive stimulation could be delivered unless there was motivation and reinforcement for emitting the punished pecking response. The present results showed that when the motivation to emit the punished response was reduced by food extinction and by food satiation, the punishment-escape responses were also reduced. These results show that the escape responses were not maintained solely by the decrease in shock density, such as has been found by Sidman (1962) during avoidance conditioning. It may be said, then, that the tendency to escape from aversive stimulation is not only a function of the characteristics of the aversive stimulus such as intensity, frequency, duration of safety, *etc.*, but is also a function of the motivation to emit the behavior that is producing the aversive stimulation.

The present study confirmed our previous findings regarding the effects of punishment on the punished responses. At lower intensities of punishment (below 60 v), punishment had been found to produce only partial response reduction whether the performance was maintained according to a VI (Azrin, 1960), FR (Azrin, 1959b), or DRL (Holz, Azrin, and Ulrich, 1963) schedule of food reinforcement. The same results were obtained in the present study. The apparent conclusion might be that these moderate intensities of punishment were not very effective. Certainly, such a conclusion appears appropriate in describing the effect of punishment on the punished responses. Yet, a second attribute of punishment was found to be quite evident at these same moderate intensities. Punishment of one response served to strengthen those responses that allowed the *S* to escape from the punishing contingency. The considerable strength of this escape tendency was evidenced by the capacity of the safe period to reinforce escape behavior under fairly high ratio requirements as well as under fairly long interval requirements. Also, this tendency to escape into an unpunished situation was evident even when the unpunished situation provided a decreased frequency of food reinforcement. The consequence of punishing responses was to drive the *S* out of the situation in which the punishments were being delivered. Several theories of punishment have postulated the existence of escape tendencies during punishment training (Dinsmoor, 1954; Skinner, 1953; Solomon, 1964). The present results appear to provide a direct confirmation of the existence of this escape motivation.

In a previous study (Holz and Azrin, 1963), it was found that punishment could be more effective in eliminating behavior than other methods such as satiation, stimulus change, and extinction. On the basis of effectiveness in eliminating an undesired response, punishment would seem to be a method of choice. Yet, the advantages gained by the high degree of effectiveness of punishment on the specific punished response may be outweighed by the escape tendency. For example, we might speculate that punishing a child for undesired responses might succeed in reducing the frequency of the undesired responses; but in addition, reinforcement might be expected for any behavior that resulted in escape from the situation in which the punishment took place. An effect of this sort had been noted in a previous study (Azrin, 1958) that used intense noise as an aversive stimulus with humans. Although the intense noise produced only partial reduction of the punished behavior, *S*s typically refused to return to the experimental situation in which the noise was delivered. This tendency of the organism to escape from a situation involving punishment, and not any inherent ineffectiveness of punishment, may constitute one of the major disadvantages in the use of punishment for the practical control of behavior.

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Received July 1, 1964