JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1967, 10, 451-460 NUMBER 5 (SEPTEMBER)

DISCRIMINATED PUNISHMENT: AVOIDABLE AND UNAVOIDABLE SHOCK

JOHN GIBBON[1]

NEW YORK STATE PSYCHIATRIC INSTITUTE

Warning stimuli for two punishment conditions were alternated with periods of appetitive responding by rats. In either warning stimulus, the first response produced a brief shock, terminated the stimulus, and started an interval during which the baseline appetitive schedule was in effect. Not responding resulted in stimuli of random duration, which terminated with a shock under one condition and without a shock under the other. Each subject was exposed to several shock intensities, with trials for the two conditions programmed during alternate portions of the session. In general, response frequency in the warning signal for either condition decreased with increasing intensity; however, at a given intensity, responding was more frequent in the stimulus invariably terminating with shock than in the stimulus terminating without shock when no response was made. The frequency difference was greatest at intensities intermediate between those producing minimal and maximal suppression.

Experimental findings suggest that a warning stimulus may be more aversive than the noxious event it signals. The sense in which this description has been interpreted is that the rewarding effect of terminating the warning stimulus may successfully compete with the punishing effect of the coterminous noxious event. For instance, an experiment by Kamin (1956) showed that termination of the warning signal in the traditional shuttle-box avoidance situation was sufficient to maintain some non-maximal level of responding even when such responding did not avoid shock. A series of discriminated avoidance experiments by Sidman and Boren (1957) and Sidman (1957) showed that conditions may be devised in which rats will respond at a higher rate to postpone a warning signal than to postpone a shock. In these studies, animals responded in the dark to postpone onset of a light. If the light was permitted to come on, responding in its presence postponed shock. If a shock was permitted to occur, darkness was reinstated. They found that when the response-light interval was long, relative to the response-shock interval in the presence of light, subjects tended to wait for light termination at the cost of the associated shock, and spent the greater part of the session responding to postpone light onset.

The present experiment examined two punishment contingencies under which warning stimuli may terminate with shock, as in the avoidance experiments cited above. Under both conditions the first response in the warning stimulus terminated it, and was accompanied by a brief shock. In the absence of a response, warning signals terminated at some random time after onset. Under one condition, termed Unavoidable Shock (US), shock was delivered at the termination of the warning stimulus when no response was made. This condition is similar to that investigated by Kamin, since every trial ended in shock whether the subject responded or not. Under the other condition, termed Avoidable Shock (AS), warning signals terminated without shock if no response was made. This condition is comparable to a punishment contingency in which shock is delivered after each response and not otherwise. Between signals (inter-stimulus interval) responding was maintained on a positive reinforcement schedule, so that a response in the presence of the warning stimulus for either condition produced the onset of this interval, as well as a shock.

[1]Partial report of a Ph.D. dissertation, Columbia University, 1965. The author is indebted to Professor Howard F. Hunt (sponsor) for his guidance and support, and to Mr. James Towey for invaluable assistance in conducting the experiment. The research was supported by U.S.P.H. Service Grant MH 07279 to Dr. Hunt and by and in the facilities of the New York State Psychiatric Institute. Reprints may be obtained from the author, New York State Psychiatric Institute, 722 West 168th St., New York, N.Y. 10032.

This feature, common to both experimental conditions, means that suppression under AS provides a baseline for evaluation of suppression under US. Production of the interstimulus interval, during which the appetitive schedule is in effect, provides the same support for responding in either warning stimulus, and a response-produced shock provides the same negative reinforcement. The difference between conditions lies in the consequence of not responding, and so differences in response frequency in the two conditions should reflect differences in the conditioned aversiveness of not responding in the warning stimuli. Termination of the warning signal by a response is perforce termination of a period of no response in the signal. The extent to which this event contributes to response strength on US trials may be evaluated by comparison with AS responding, when waiting in the signal is never shocked.

Many sources establish that the suppression produced by punishment varies with shock intensity (reviewed in Azrin and Holz, 1966; and Church, 1963). Accordingly, subjects were exposed to several intensities to obtain comparisons between the AS and US conditions at different levels of suppression.

METHOD

Subjects

Six naive albino rats were housed in pairs with food constantly available in the living cages. They served in experimental sessions on alternate days, with three animals, one member of each pair, being run on a given day. After each experimental session, subjects were placed in a watering cage for 2 hr with food and water available, and then returned to the living cage. On days when an animal was not run, water was available in the living cage for 30 min at the same hour at which the session was to begin on the following day.

Apparatus

Sessions were conducted in a two-lever chamber enclosed in a sound-attenuating chest (Lehigh Valley, #316 and #316C). Retractable levers protruded through one wall of the chamber with a water dipper (0.02 cc cup) located midway between them at the base of the wall. The levers required approximately 15 g of force to activate the microswitch. Only the right-hand lever was operative for experimental consequences, and only responses on this lever are reported. (Responding on the non-functional lever was recorded. However, no appreciable responding occurred except by three of the subjects for a short period after shock was introduced. Non-functional responding only occurred in the AS warning stimulus, and inspection of the records revealed occasional adventitious coincidence of a response with termination of the AS stimulus by the apparatus.)

The chamber could be illuminated with a General Electric #304 miniature lamp shining through translucent white paper covering the rear Plexiglas wall. Additional illumination was available through stimulus jewel lights located directly above the levers. Auditory stimulation could be provided through a speaker located in the rear of the enclosing chest. The grid floor of the chamber consisted of 16 stainless steel bars, 3/16 in. in diameter, which were connected to the output of a Grason-Stadler #E1064GS constant current 60 cycle ac shock generator and scrambler. Two walls and the levers served as an additional electrode. Specification of shock intensity in this report refers always to dial settings on the shock generator.

Procedure

Subjects received seven sessions, 2⅓ hr long, of preliminary training on a variable-interval schedule (VI 40-sec) of lever pressing for water reward. Throughout preliminary training, and during the interstimulus interval when the VI schedule was in effect, the rear house light was on and a Lehigh Valley #1524 noise generator provided a continuous masking noise. The stimulus for one of the punishment conditions was a rapid (4 per sec) interruption of the noise level with no change in illumination. The other stimulus was a reduction and change in the source of illumination with no change in the masking noise. For this stimulus the rear light was turned off and the two lights over the levers were turned on. For three subjects the warning signal for the US condition was the change in illumination, and that for the AS condition the rapid interruption of the noise level. For the other three subjects, these stimulus assignments were reversed. Whenever either stimulus was on, the VI reinforcement schedule was not in effect and any reinforcements available but not obtained before stimulus onset were cancelled.

The sequencing of warning stimuli, responses, and shocks are schematized for the US and AS conditions on the left and right, respectively, of Fig. 1. During intervals between warning stimuli, responding was maintained on the VI baseline schedule. When a warning stimulus was on under either condition the first response produced a brief shock (0.5 sec), stimulus termination, and the onset of the interstimulus interval (top three rows). Throughout the study, interstimulus intervals were 1 min long. When no response was made in the warning signal it terminated with a shock under the US condition (lower left), and without shock under the AS condition (lower right). The termination of either warning signal without a response was programmed by a probability generator (Lehigh Valley #1485). In the presence of the stimulus the probability generator was pulsed at successive 6-sec intervals. The device was set so as to pass, on the average, one in 10 input pulses, and the first pulse passed terminated the warning signal. This arrangement resulted in a distribution of warning signal durations which was roughly exponential in form with a 1-min mean ($\mu = T/P = 6$ sec$/0.1 = 1$ min). A maximum duration was fixed at 5 min.

Experimental sessions were divided into four successive periods: two 10-min periods followed by two 1-hr periods. In each portion, only one of the two warning stimuli was presented. If, for instance, Avoidable Shock was scheduled first, the AS stimulus came on as programmed in Fig. 1 during the first 10-min period, then the US stimulus during the next 10 min, the AS stimulus was again presented for the next hour, and in the final hour, the US stimulus was presented. The condition programmed first in each session was alternated from day to day. Thus, AS and US alternated within each session and the starting condition alternated from session to session. The two 10-min portions at the start of each session were included to allow for "warm up" effects (Azrin 1956, 1959, 1960). Possibly because of the small number of trials during the 10-min periods, no reliable differences appeared between these and later periods, and so the data from corresponding portions of the session have been pooled.

After preliminary training all subjects were run for eight days with the shock circuit disconnected from the grid (0.0 ma). At 0.0 ma both conditions are similar to a Chain: FR 1 or variable-DRO 60-sec, VI 40-sec. Production of the interstimulus interval typically results in a high level of response frequency in the stimuli, from which suppression produced by punishment may be observed.

After 0.0 ma, all subjects were given extended exposure to 0.2 ma (a minimum of 44 and a maximum of 88 sessions). Shock intensity changes were then programmed for each subject which depended on the animal's performance at 0.2 ma and at later intensities. The course of these experimental changes is described in the Results.

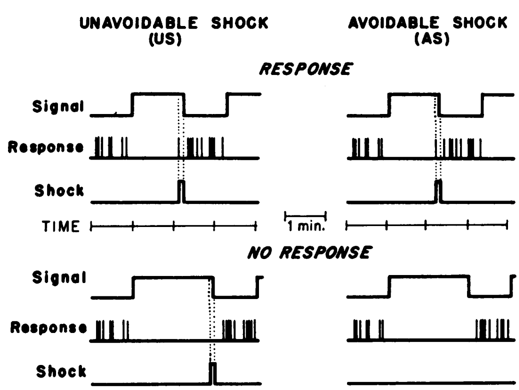

Fig. 1. Schematic temporal specification for US and AS. The sets of three lines represent the presence or absence of warning stimulus, response, and shock; both when a response occurs in the stimulus (upper three rows), and when it does not (lower three rows). The passage of time is from left to right.

RESULTS

Initial Suppression and Recovery

Figure 2 presents cumulative records for the last day without shock (day 8), the first day at 0.2 ma (day 9), the twelfth day at 0.2 ma (day 20), and the last day at 0.2 ma (day 52) for Rat 45P. Responding on the VI baseline during the 1-min intertrial interval was recorded cumulatively and onset of the signal is indicated by a deflection of the recording pen. The pen remained deflected until the trial was terminated. Response-terminated trials reset the pen vertically downward; trials terminated by the probability generator returned the pen to its undeflected position.

Before shock was introduced, nearly every stimulus under either condition was termi-

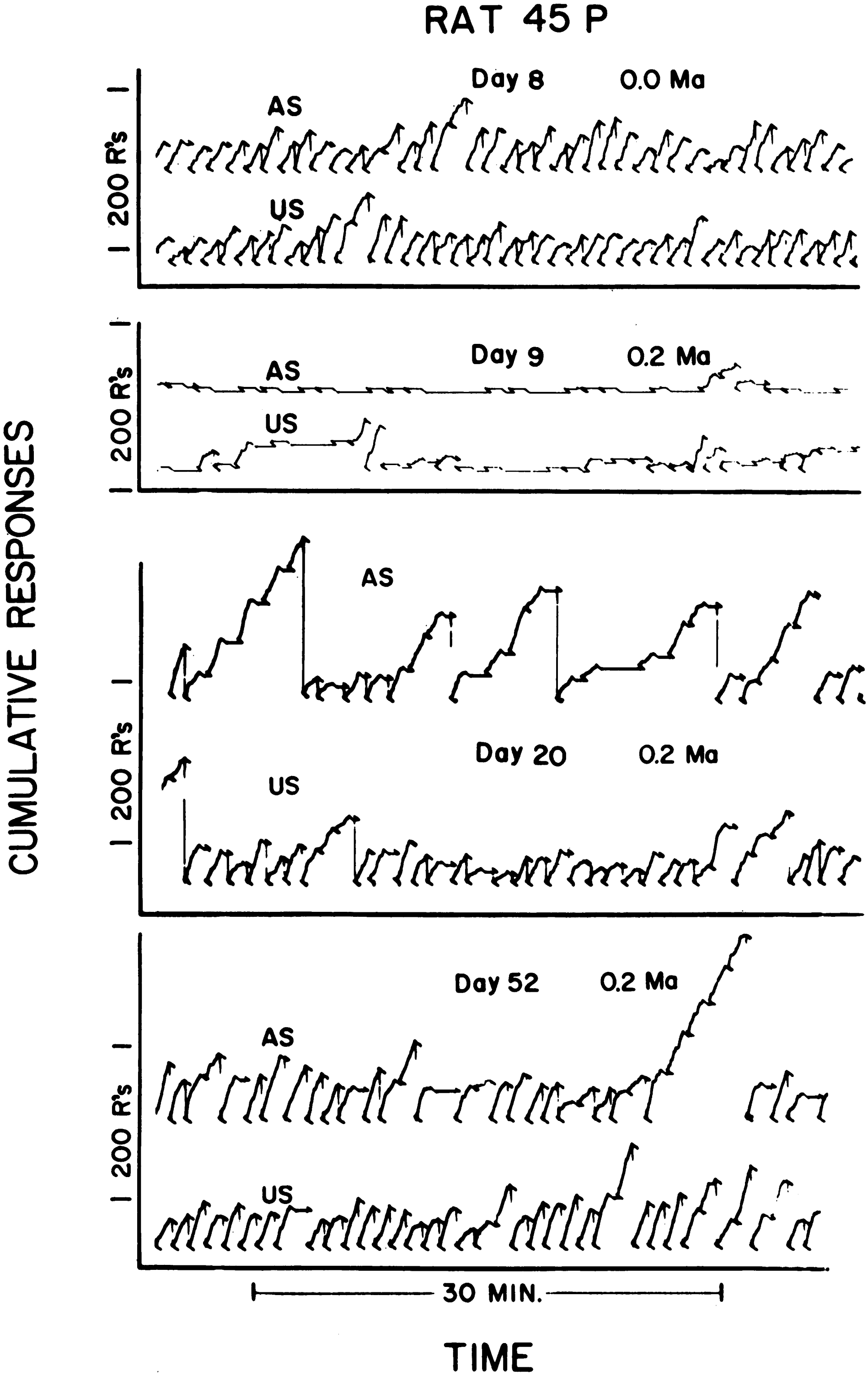

Fig. 2. Cumulative records for one subject before shock (day 8), and during exposure to 0.2 ma (days 9, 20, and 52). For each day, the upper record is the last hour under the AS condition, and the lower record is the last hour under the US condition.

nated immediately. These records are typical of all animals at day 8. The next pair of records, the first day at 0.2 ma, show severe suppression under either condition both in the warning stimuli and the interstimulus intervals. Again, these records are typical of all animals on the first day of shock. After 12 days at 0.2 ma, unpunished responding during the interstimulus interval had recovered to preshock levels. Typically, responding stopped abruptly at the onset of the warning stimulus for either condition and resumed immediately after termination. Response-terminated trials were less frequent than before shock was introduced, and this suppression was greater under the AS condition. By day 52, responses occurred in more than 75% of the trials for either signal, and again suppression remained somewhat greater under the AS condition. For instance, the steplike portion at the upper right of the AS record indicates that the subject occasionally avoided shock when the probability generator terminated the stimulus relatively early. Under the Unavoidable Shock condition, waiting in the warning stimulus was less frequent.

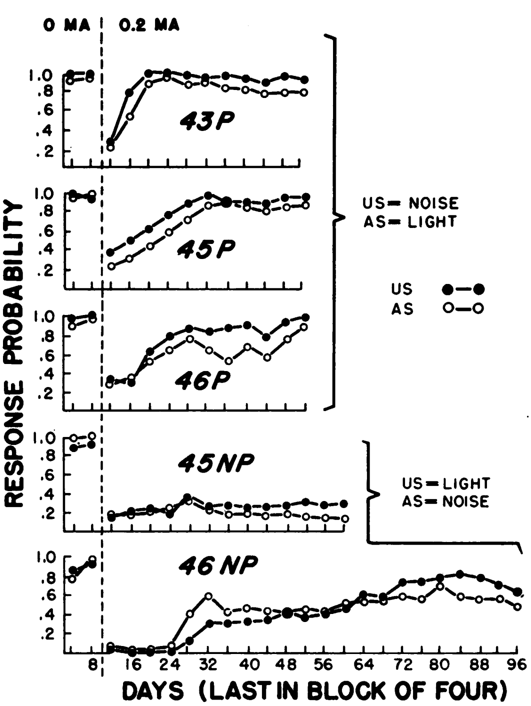

Fig. 3. Response probability (the proportion of response-terminated trials) in the AS and US conditions before introduction of shock (0.0 ma), and throughout exposure to the initial shock level (0.2 ma). Each point represents data pooled over blocks of four sessions.

The relative frequency with which subjects responded in the warning stimuli (response probability) is plotted on the ordinate of Fig. 3 for five of the six animals. For the subject not shown, responding was virtually eliminated both in and out of the warning stimuli throughout 44 sessions of punishment training. Subjects differed considerably in the rate at which recovery occurred, and in the level of responding eventually attained. But for all subjects, after sufficient exposure to the two contingencies, response probability was greater in the US than the AS warning stimulus.

Recovery of unpunished responding in the interstimulus intervals preceded somewhat the recovery of punished responding (as in Fig. 2). There was no consistent difference between baseline rates in the US and AS portions of the session, and rate relative to preshock rate did not covary with the terminal level of response probability. All subjects showed marked suppression of interstimulus responding just before stimulus onset. The histogram on the left of Fig. 4 presents the per cent of total responding averaged over subjects during successive quarters of the interstimulus interval. On the right, individual gradients are presented. The discrimination of trial onset time is evidenced by the degree to which histogram

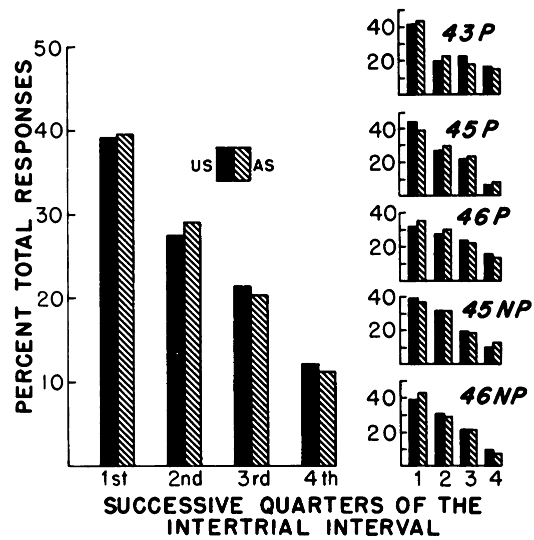

Fig. 4. Distributions of appetitive baseline responding during the last four days at 0.2 ma, over the interstimulus interval for the US and AS halves of the session. Individual gradients have been pooled in the gradient on the left.

bars deviate from 25% in the last 15-sec period. A comparison of the filled and hatched bars reveals no differential interstimulus responding during the US and AS portions of the session.

The lack of a contingency effect for appetitive responding is perhaps not surprising, since the contingencies were in force only during warning stimuli. However, the latencies of responses that occurred in the warning stimuli also did not show a substantial US-AS difference. Generally, response latencies were quite short for all subjects. Individual latency distributions for response-terminated trials for the last four days at 0.2 ma showed a mode below 6 sec and most frequently the median lay below 6 sec also. The largest median latency was 9.2 sec (Rat 43P, AS) and the smallest was 4.8 sec (Rat 45P, US). For each subject, median latency was shorter before shock was introduced. The range of medians at 0.0 ma was 3.8 to 5.2 sec.

In general, US latency was somewhat shorter than AS latency, but the differences were very small. The range of differences between US and AS median latencies for the last four days at 0.2 ma is 0.3 to 3.5 sec. The small size of the latency difference bears on an interpretation of the response probability difference.

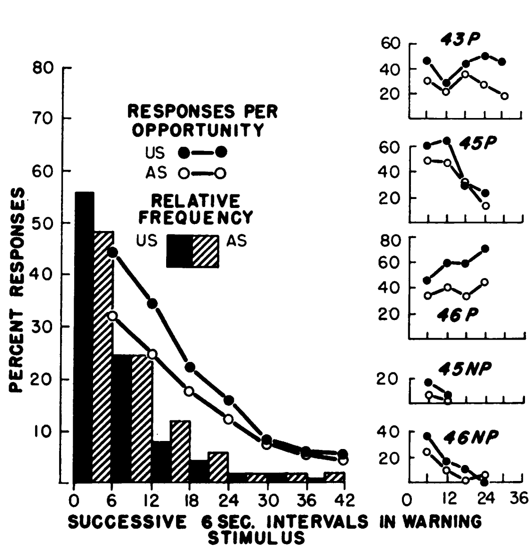

Fig. 5. Response frequency at different times after signal onset as a proportion of the number of signals at least as long (latency per opportunity). The data are taken from the last four days at 0.2 ma and are pooled over subjects for the plot on the left. The histogram bars represent pooled relative frequency distributions for response-terminated trials.

Given the exponential distribution of signal durations in the absence of responding, typically longer AS than US latencies would produce lower AS than US response probabilities. This is true because a long latency has fewer opportunities to occur. In fact, however, responses most frequently occurred within the first 6 sec of either warning signal, and the probability generator never terminated signals of this duration. This point is clearer in Fig. 5, which presents latencies per opportunity. The frequency of response-terminated trials at different latency values is plotted as a proportion of the number of trials that long or longer. Along with the pooled gradients on the left are pooled latency distributions (calculated for response-terminated trials only). The severe skew evident in both distributions is typical of individual subjects. Both US and AS conditional probability gradients show a tendency toward low response probability at long durations, which reflects this severe skew. The strong tendency to respond early in the signal means that the number of long latencies in either condition was small relative to the number of trials of long duration.

The summary response probability measure (Fig. 3) may be regarded as a weighted average of points along each individual conditional probability gradient. That is, $P(R) = \Sigma P_i W_i$, where P_i is the probability of a response in the i^{th} category given an opportunity, and W_i is the relative frequency with which such opportunities occur. The US-AS difference evident in the response probability measure is evident in its components as well. The largest contribution comes from trials of 12 sec or less, since these first two intervals include more than 70% of the responses for each animal. However, the contingency effect is also discriminable at longer durations. The difference between the US and AS conditions appears to affect whether or not responses occur, but not the latency at which they occur.

Suppression at Different Shock Intensities

After the determinations at 0.2 ma, subjects were run at several different shock intensities. For four animals, response probability at 0.2 ma was relatively high in both conditions and these subjects were moved to higher shock intensities. For the fifth animal, whose response probability was relatively low, shock intensity was decreased.

Data on latency to respond in the warning stimuli and interstimulus interval responding at different shock intensities did not differ from the results presented for the 0.2-ma determination. A Friedman two-way analysis of variance by ranks was performed on median latencies and interstimulus rates for both punishment contingencies with $p > 0.5$ in all cases. Latencies remained low even when responses in the warning stimuli occurred very infrequently; and unpunished responding, with one exception which will be noted, remained at the 0.2-ma levels. Reductions in rate occasionally observed at higher intensities appeared to result from greater suppression just before onset of the warning signal.

The frequency of punished responding, however, did vary with shock level. Figure 6 presents response probability as a function of intensity. For the top four subjects, shock intensities were run in an increasing order and, for the lower subject, in a decreasing order. The first two intensities after 0.2 ma were run for 12 days each. Subsequent intensities were run for eight days. Within the limits of exposure studied, recovery was not observed at intensities other than 0.2 ma. The data points represent performance during the last four days at each intensity.

For all subjects, response probability in the AS condition varied inversely with shock intensity. For four of the five subjects, response probability in the US signal also dropped with intensity but not as rapidly. One animal, 43P, showed no substantial reduction of response strength in the US signal even at severe shock intensities. This subject showed marked suppression of responding between trials at intensities above 1.0 ma, and direct observation of the 2.5-ma determination seems worth recording. Responses never occurred during the warning stimulus for Avoidable Shock and responding between AS trials was restricted to the first half of the 1-min interval. Under the Unavoidable Shock contingency, this animal responded in over 80% of the trials. Almost no responses occurred during the intervals between trials, with the result that there were more punished than unpunished responses during the US half of the session. The shock at the end of each US stimulus was accompanied by considerable jumping and vocalization. After the trial was over, the subject would typically approach and lick the dipper, which was dry, for several seconds and then crouch immobile until the onset of the next US warning stimulus.

For the other animals, the US function is similar to that for AS except that it is displaced upward in shock intensity. At low levels of shock, animals frequently terminated both signals, at intermediate levels response probability was higher when shock was inevitable on every trial, and at sufficiently severe shock, response probability was low in both conditions. χ^2 comparisons of corresponding US and AS points are significant at the 0.05 level for differences of about 0.06 at low levels of response probability, and for differences of 0.04 at high levels of response probability.

Except for Rat 43P, shock intensity was changed until US and AS functions appeared to converge at some low level response probability for increasing intensity, and at some high level of response probability for decreasing intensity (Rat 45NP). Subsequently, animals were returned to 0.2 ma for a redetermination. A comparison of the squares with the circles in Fig. 5 reveals that for animals that received interpolated experience at higher intensities, response probability upon redetermination was lower. For the subject that received interpolated experience of lower shock intensities, redetermination values are higher for US and the same for AS. The reduction in response probability for the subjects receiving interpolated higher intensities may reflect the severity of the maximum intensity experienced. Rat 46NP, which received the lowest maximum intensity, showed the smallest reduction in response probability; Rat 45P, which received a relatively severe maximum intensity, showed a correspondingly large reduction in response probability for the redetermined values. In line with findings of "behavioral inertia" in response to changes in punishment intensity (Hake, Azrin, and Oxford, 1967), suppression upon redetermination is increased after exposure to a more severe punishment intensity. Redetermination exposures lasted a minimum of eight and maximum of 28 days, and the reduced levels of responding were reliable over these periods.

DISCUSSION

The emergence of differential response strength in the two warning stimuli is the

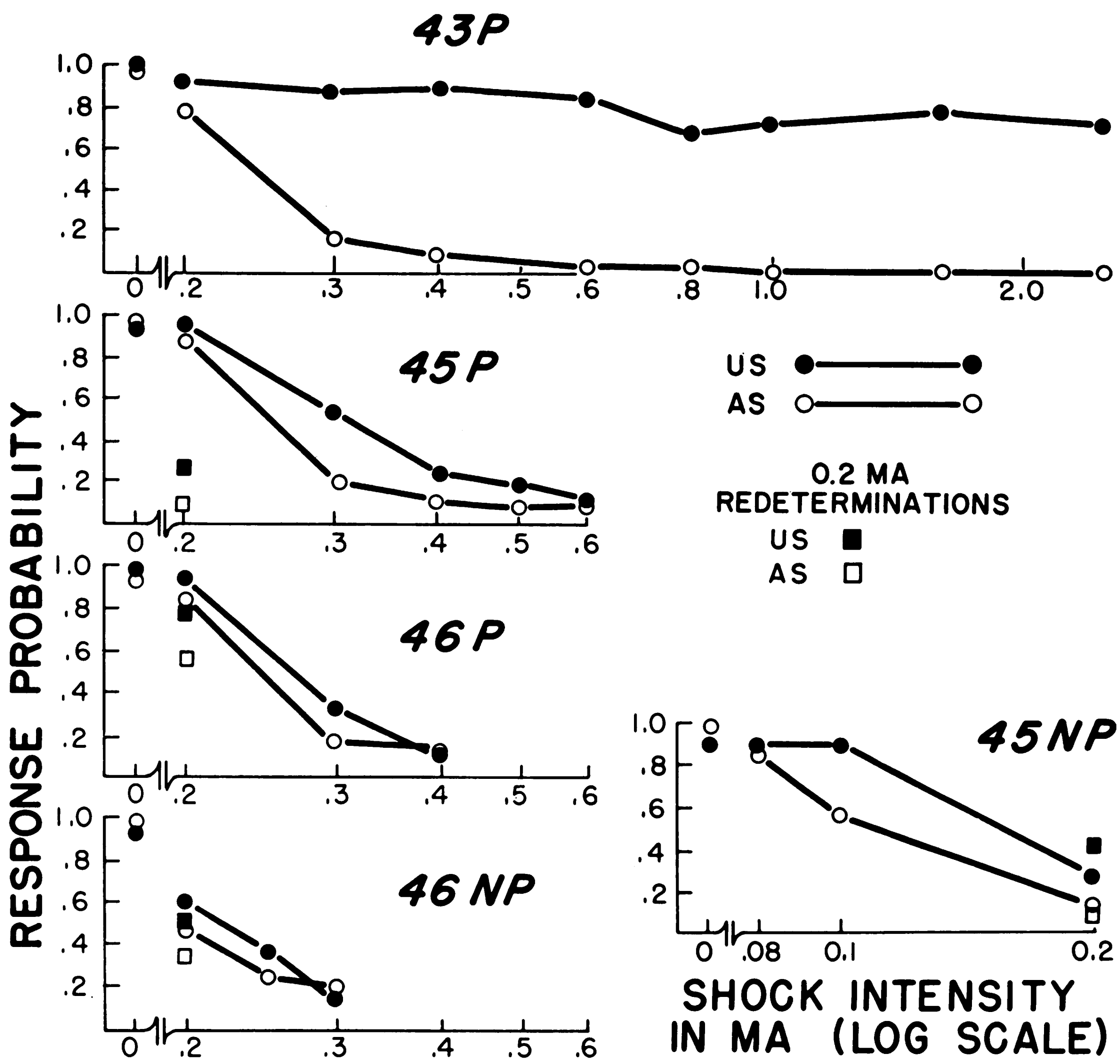

Fig. 6. Response probability at different shock intensities. Intensity is plotted on a log scale and the abscissa for Rat 45 NP has been shifted to the right.

central finding of this study. Punishment was less effective in suppressing behavior when shock was inevitable on every trial than when waiting in the warning stimulus avoided shock. Dinsmoor (1954, 1955) described in detail the "avoidance hypothesis" as an explanation of the suppression produced by punishment. In the usual punishment procedure, the compound of stimuli associated with performing the response is the only such compound ever paired with shock. The stimulus compound associated with not responding is never paired with shock and should therefore constitute a reinforcing change from stimuli associated with a sequence of behavior normally ending in a response. Response suppression results from interrupting such sequences, thereby producing a change from "dangerous" to "safe" stimulus compounds.

The existence of any suppression at all under the two contingencies appears to require some speculation about (unrecorded) behavior leading to a (recorded) response, but the difference observed between the AS and US response frequencies does not strictly require an analysis of this sort. A response in either warning stimulus produced: (1) a shock, (2) onset of the interstimulus interval during which the appetitive schedule was in effect, and (3) termination of the warning stimulus or, equivalently, termination of a period of no response in the stimulus. The two conditions are identical with respect to the negative reinforcement value of a response-produced shock, and with respect to the positive reinforcement value of the onset of the interstimulus interval. Periods of no response, however, have had different histories in the two warning stimuli. Irrespective of the variety of behavior other than bar pressing which subjects engage in during the warning stimulus, periods without a response may be expected to acquire some conditioned aversiveness in the US stimulus, and no conditioned aversiveness in the AS stimulus. Responses terminate such periods, and should reflect this difference.

An alternative or supplementary view might hold that the reinforcement for interrupting a sequence of behavior normally leading to a bar press, is less under the US than the AS condition. Under AS, interruption of such a sequence eliminates conditioned aversiveness; under US, some conditioned aversiveness remains associated with any behavior whatever in the warning stimulus. If interruptions occur more frequently in the AS stimulus one might expect longer AS than US latencies. While the latency difference is generally in the appropriate direction, it is usually so small as to provide little support for this view. With the possible exception of latencies, data relevant to this interpretation have not been recorded here, and evaluation of the role of aborted incipient responses must await information on their actual occurrence.

The failure to find differential suppression of interstimulus responding just before the onset of the two warning stimuli may be related to the 6-sec minimum stimulus duration in the absence of a response. Responding immediately after signal onset produced shock and signal termination, while not responding produced neither. Contact with the difference between the contingencies depends upon sampling trials of at least 6-sec duration. Thus, the onsets of the two stimuli may not reflect differences in conditioned aversiveness which nevertheless appear after the trial has began. The extent to which the distribution and minimum interval of signal durations in the absence of a response are parameters of the amount of pre-signal suppression (Fig. 4) and of the severe skew in the latency distribution (Fig. 5) are presently under investigation. The US-AS difference evident in the conditional probability gradients suggests that the variability in duration when signals are terminated by the apparatus results in differences in conditioned aversiveness associated with not responding at any stimulus duration.

The recovery of punished responding observed after shock was introduced is consonant with previous reports (Azrin, 1959, 1960; Appel, 1963; Appel and Peterson, 1965; Azrin and Holz, 1966). Recovery was usually more rapid under the US condition (Fig. 3), but it is not clear whether this is a function of the contingency difference, the more frequent contact with shock under US, or the higher terminal level of responding under US. Recovery has also been observed after increasing shock intensity (Azrin, 1960; Hake *et al.*, 1967). The failure to find recovery at intensities above 0.2 ma may be related to the durations of exposure to the higher intensities (12 and 8 days), although these durations were sufficient to observe recovery in some subjects after the initial introduction of shock (Fig. 3). Recovery has previously been found in experimental arrangements in which responding produces both shock and occasional positive reinforcement and may reflect the acquisition, by shock, of discriminative or secondary reinforcing properties (*e.g.*, Azrin and Holz, 1966). In the discrete trial situations studied here, shocks and water rewards were never delivered simultaneously, and so the recovery phenomenon is not restricted to direct association of primary reward with the aversive stimulus.

The range of shock intensities spanning minimal to maximal suppression is comparable to previous reports on punishment with rats (Appel, 1963; Appel and Peterson, 1965), with the exception of one subject. The Avoidable Shock function for Rat 43P is similar to those obtained with the other subjects, but this animal continued to respond in the US stimulus at levels of shock more than double those frequently used to condition nondiscriminated avoidance behavior (Boren, Sidman, and Herrnstein, 1959). It is not clear what the parameters of this deviation are. It is possible that at severe intensities, particular topographies or modes of lever pressing reduced the aversiveness of a response-produced shock relative to that of an unpredictable shock delivered by the apparatus. Rat 43P appeared to be solely under the control of shock and signal termination at severe intensities, and its behavior seems similar to a recent report on monkeys, of responding maintained by shock (Morse and Kelleher, 1966).

For the other subjects, the US intensity function shows the same downward trend as that for AS. The interpretations put forward above for the difference between conditions do not explain, without adjustment, the change in US response probability with shock intensity. Whether the difference between conditions results from a greater reinforcement value for terminating US as opposed to AS trials, or from a reduction in reinforcement value for aborting an incipient response in the US signal, the critical variable is the difference between the aversiveness associated with lever pressing in either warning signal, and the aversiveness of periods of no response in the US signal. The US intensity functions suggest that the difference between these two levels of aversiveness changes with shock intensity.

Other sources may also contribute to suppression at the higher intensities. Direct observation of the subjects suggested that at these levels of shock, the US warning stimulus elicited "freezing" behavior, similar to behavior observed in the "anxiety" paradigm (Hunt and Brady, 1955). Also, shock frequency may play a role. When responses occurred early in every warning signal, subjects received approximately 70 shocks per session in each condition. When no responses were made in either signal, no shocks occurred in the AS condition, and about 35 shocks occurred in the US condition. Particularly at relatively severe shock intensities, suppression under either condition may reflect a discriminable reduction in shock density.

The responding for punishment obtained under the Unavoidable Shock condition bears some resemblance to human behavior colloquially described as "expiation", "facing the music", and the like. When shock is inevitable on every trial, subjects terminate the threat of punishment at the cost of the punishing event itself. They, so to say, "get it over with". The utility of such a description, however, is limited by the range of intensities at which responding under US is maintained. For the work presented here, threats are worse than punishments only at levels of punishment just worth avoiding.

REFERENCES

Appel, J. B. Punishment in the squirrel monkey *Saimiri Sciuria*. *Science*, 1961, **133**, 36.

Appel, J. B. Punishment and shock intensity. *Science*, 1963, **141**, 528-529.

Appel, J. B. and Peterson, N. J. Punishment: Effects of shock intensity on response suppression. *Psychol. Rep.*, 1965, **16**, 721-730.

Azrin, N. H. Some effects of two intermittent schedules of immediate and non-immediate punishment. *J. Psychol.*, 1956, **42**, 3-21.

Azrin, N. H. Punishment and recovery during fixed-ratio performance. *J. exp. Anal. Behav.*, 1959, **2**, 301-305.

Azrin, N. H. Effects of punishment intensity during variable-interval reinforcement. *J. exp. Anal. Behav.*, 1960, **3**, 123-142.

Azrin, N. H. and Holz, W. C. Punishment. In W. K. Honig (Ed.), *Operant behavior: areas of research and application*. New York: Appleton-Century-Crofts, 1966. Pp. 380-447.

Boren, J. J., Sidman, M., and Herrnstein, R. J. Avoidance, escape and extinction as functions of shock intensity. *J. comp. physiol. Psychol.*, 1959, **52**, 420-425.

Church, R. M. The varied effects of punishment on behavior. *Psychol. Rev.*, 1963, **70**, 369-402.

Dinsmoor, J. A. Punishment: I. The avoidance hypothesis. *Psychol. Rev.*, 1954, **61**, 34-46.

Dinsmoor, J. A. Punishment: II. An interpretation of empirical findings. *Psychol. Rev.*, 1955, **62**, 96-105.

Hake, D. F., Azrin, N. H., and Oxford, Rebecca. The effects of punishment intensity on squirrel monkeys. *J. exp. Anal. Behav.*, 1967, **10**, 95-108.

Hunt, H. F. and Brady, J. V. Some effects of punishment and intercurrent "anxiety" on a simple operant. *J. comp. physiol. Psychol.*, 1955, **48**, 305-310.

Kamin, L. J. The effects of termination of the CS and avoidance of the US on avoidance learning. *J. comp. physiol. Psychol.*, 1956, **49**, 420-424.

Morse, W. H. and Kelleher, R. T. An interlocking shock-postponement schedule in the squirrel monkey. Paper read at East. Psychol. Ass., New York, April, 1966.

Sidman, M. Conditioned reinforcing and aversive stimuli in an avoidance situation. *Trans. N.Y. Acad. Sci.*, 1957, **19**, 534-544.

Sidman, M. and Boren, J. J. The relative aversiveness of warning signal and shock in an avoidance situation. *J. comp. physiol. Psychol.*, 1957, **55**, 339-344.

Received 22 July 1966