Deterioration of avoidance during a preshock signal*

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A 1-min signal followed by unavoidable shock was presented to Ss whose behavior was being maintained by a free operant avoidance schedule. Measures of the response and shock rate before, during, and after presentation of the signal were obtained. Although the response rates during successive periods of the signal exceeded baseline performance, the shock rate data indicated a progressive breakdown of avoidance as a function of the signal's duration.

Under a free operant shock avoidance procedure the S can preclude shocks by responding at a constant rate. If shock is occasionally given independently of the S's behavior, avoidance often deteriorates. It is possible that the coincidence of shock and ongoing avoidance behavior account for these findings (McIntire et al, 1968). If response-independent shocks (RIS) are signaled, the deterioration of avoidance worsens so that most of the shocks available under the avoidance schedule during the signaled period are encountered (Hurwitz & Roberts, 1969, 1971).

In the present study we examine in more detail the deterioration of avoidance during a 1-min preshock signal. Measures were obtained of shock frequency and response rates during the first, second, and third 20 sec of signal presentation.

SUBJECTS

Six female hooded rats served as Ss. They were purchased from Blue Spruce Farms, N.J., and were approximately 120 days old at the beginning of experimentation.

APPARATUS

Three 23 x 24 x 24 cm chambers were used. Each chamber had a 5-cm-wide bar protruding 2.5 cm through one of its walls, 5 cm above the grid floor. A .01-N force was needed to depress the lever. At the beginning of the session, houselights were turned on, but coincident with each leverpress the light momentarily extinguished, thus providing a visual feedback for the designated response. The floor grids consisted of 25-cm brass rods spaced 1.3 cm apart and were parallel to the lever. A constant shock generator delivered a 0.8 mA constant current shock via a

mechanical scrambler to the grids, lever, and sides of the chamber. Each chamber was located in a larger sound-insulated box. An exhaust fan provided ventilation and a masking noise (approximately 80 dB). A clicking noise presented for 1 min was used to signal shock. It added 10 dB to the ambient noise level. All three boxes were housed inside a sound-attenuated man-sized cubicle, and the electromechanical programming and recording equipment were stationed on the outside.

PROCEDURE

The experiment consisted of two phases. During the first phase, the Ss received daily 2-h sessions of training under a free operant avoidance procedure for 20 days. The procedure was programmed so that a 0.1-sec shock occurred at 5-sec intervals unless a leverpress was made, in which case shock was postponed for 20 sec. At the end of the 20 sec, the 5-sec shock series was resumed.

During the second phase, daily 2-h sessions were given for 20 days. A 1-min clicking signal was followed immediately by a shock of the same intensity as that used under the avoidance procedure. The signal-shock sequence was presented on a variable interval schedule, at a mean rate of 6 min so that 20 signal-shock

presentations were encountered on each session.

The number of shocks preceding and following each signal-shock presentation was recorded in addition to shock frequencies during the first, second, and final 20 sec of each signal presentation. The rates of response were recorded during pre- and postsignal periods as well as during each 20-sec interval of the signal.

RESULTS AND DISCUSSION

Table 1 presents the mean shock and response rates for each S over the experimental periods. The first column presents the mean shock and response rates per minute during the last five free operant avoidance sessions. The second column presents the mean shock and response rates per minute during signaled and unsignaled periods of the second phase of the experiment. The data indicate that the mean number of shocks during the signal was higher than during unsignaled periods. However, in only one S did the mean number of responses reveal a drastic suppression of responding, namely, S 1.

The period of the signal was divided into three intervals of equal length (20 sec), and shock and response rates were computed for each interval. The mean rates of shock (Panel A) and the mean rates of responses (Panel B) for each S over successive intervals of the signal are shown in Fig. 1. The rate of shock and rate of response for 1 min before and after each signal presentation is also shown. With the exception of one S, S 3, the pre- and postsignal shock rates during the second phase of this experiment were comparable to the rate of shock during training sessions under the free operant avoidance procedure (Phase 1). For S 3 the shock rates during the pre- and postsignal periods were substantially lower. Note that none of the Ss demonstrated a phenomenon previously observed in studies of the conditioned suppression of avoidance, namely, that the number of avoidable shocks increased after

Table 1
Mean Shock and Response Rates Per Minute for Each S During Each
Experimental Phase (See Text for Details)

S		Free Operant Avoidance	Free Operant Avoidance and Signal Shocks	
			Nonsignal	Signal
1	Shocks/Min	.39	.34	1.03
	Responses/Min	19.00	19.98	11.73
2	Shocks/Min	1.73	1.51	1.61
	Responses/Min	10.56	11.87	12.10
3	Shocks/Min	1.32	.56	1.46
	Responses/Min	9.42	11.79	11.16
4	Shocks/Min	.38	.53	1.32
	Responses/Min	12.92	11.46	10.55

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Fig. 1. Panel A: Mean shocks per minute for each of the four Ss during a 1-min presignal period, during successive 20 sec of signal presentation, and during a 1-min postsignal period. Panel B: Mean response rate per minute for each of the four Ss during a 1-min presignal, during successive 20 sec of signal presentations, and during a 1-min postsignal period.

response-independent shocks (RIS) were introduced. One difference between earlier studies (McIntire et al, 1968; Hurwitz & Roberts, 1969, 1971; Roberts, 1971) and the present study was the amount of training under the free operant avoidance procedure. Previous studies by the principal investigator and his associates preceded exposure to the RIS procedure by 39, or more, 2-h sessions of free operant avoidance training. Whether this difference in procedures accounts for the differences in results will have to be confirmed in independent studies.

The rate of shock during the signal increased substantially, except for S 2, who, for practical purposes, had failed to acquire avoidance behavior during free operant avoidance training sessions (mean shock rate = 1.73/min). Figure 1, Panel A, indicates that the shock rate was highest during the second 20-sec interval of the signal and declined during the final 20 sec.

These data were treated by a randomization test for matched pairs as described in Siegel's (1956) text. The difference between the rates of shock during the first and second 20-sec and the second and final 20-sec periods were significant ($p = .05$ and $p = .03$, respectively), whereas there was no difference of significance between the first and final 20 sec. The

shock rates during the presignal and signal periods and the postsignal and signal periods were also significantly different ($p = .05$, $p = .02$, respectively).

The response rate data were treated in the same manner as the shock data. These analyses showed that the rates of response between the presignal and signal periods did not differ significantly. The rates during the different periods of the signal also failed to demonstrate a significant trend. However, the rate of response during postsignal periods was highly different from rates recorded during either the presignal period ($p = .03$) or during the signal period itself ($p = .03$).

The response data presented in Table 1 and Fig. 1, Panel B are not comparable. Specifically, the rate of response during nonsignaled periods shown in Table 1 are lower than the rate of response obtained when the presignal and postsignal rates represented in Fig. 1 are averaged. This disagreement may be accounted for as follows: the rate of response increased significantly immediately following shock, especially following a response-independent shock. Following shock there is a gradual but systematic decline in response rate (Wertheim, 1965) until the interresponse interval once again

exceeds the response-shock interval, RS. In obtaining the data for Fig. 1, we have necessarily sampled from a period during which the response rate tends to be low (the presignal period) or unusually inflated, the postshock periods. Furthermore, the data in Table 1 are averaged over an 80-min session with relatively infrequent postshock response bursts, whereas half of the sample in computing an average rate of response for Fig. 1 is drawn from postshock periods, that is, from high response periods.

The finding that the rates of response increased during the first 20 sec of the signal lends additional support to a suggestion by Hurwitz & Dillow (1969) and Roberts (1970) that the onset of the signal may momentarily startle the S and, as a result, lead to an enhancement of avoidance-motivated behavior. Of greater interest was the finding that the rate of response measured did not enable one to predict this level of avoidance: The rate of response during the signal was often as high and sometimes higher than the rate of response during presignal periods, yet the rate of shock indicated a breakdown in avoidance. As Hurwitz & Bounds (1968) pointed out, the rate of response measure is usually contaminated by high rates of response generated by unavoided shocks, and such high response rates make only a minimal contribution to the postponement of shock under the free operant avoidance procedure. This analysis is vindicated by the small improvement in avoidance observed during the final 20 sec of the signal. Note that avoidance during the final 20-sec period was usually poorer than during pre- or postsignal periods. The third result, an increase in rate of response during the postshock period, is undoubtedly attributable to the response-independent shocks which occurred at the termination of each signal, i.e., is attributable to postshock response burst (Hurwitz & Bounds, 1968). Again, despite the high response rates recorded during the postsignal period, the effect on shock rate was minimal, for shock rates during the postsignal periods were not significantly different from those observed during the presignal periods.

The major findings of this study may be summarized as follows. If the effects of a preshock signal are assessed by reference to response rates, it would appear that such signals enhance avoidance-maintained behavior. If the effect is assessed by reference to the number of shocks avoided—the measure favored in our studies—it would appear that a preshock signal acquires the property of interfering with avoidance-relevant

behaviors. Furthermore, the signal's interfering or suppressive function appears to increase over time, for the results indicated an increase in the mean shock rate over successive intervals of the signal's duration.

REFERENCES

- HURWITZ, H. M. B., & BOUNDS, W. Response specification and acquisition of free operant avoidance behavior. *Psychological Reports*, 1968, 23, 483-494.
- HURWITZ, H. M. B., & DILLOW, P. V. Discrimination learning under avoidance schedules. In R. M. Gilbert and N. S. Sutherland (Eds.), *Animal discrimination learning*. New York: Academic Press, 1969.
- HURWITZ, H. M. B., & ROBERTS, A. E. Suppressing an avoidance response by a pre-aversive stimulus. *Psychonomic Science*, 1969, 17, 305-306.
- HURWITZ, H. M. B., & ROBERTS, A. E. Conditioned suppression of an avoidance response. *Journal of the Experimental Analysis of Behavior*, 1971, in press.
- McINTIRE, R. W., DAVIS, H., COHEN, S. I., & FRANCH, E. O. Sidman avoidance performance under punishment and non-contingent shock conditions. *Psychological Reports*, 1962, 22, 897-903.
- ROBERTS, A. E., & HURWITZ, H. M. B. The effects of a pre-shock signal on a free-operant avoidance response. *Journal of the Experimental Analysis of Behavior*, 1970, 14, 331-340.
- ROBERTS, A. E. Stimulus control of the conditioned suppression of an avoidance response. Doctoral dissertation. University of Tennessee, 1970.
- SIEGEL, S. *Nonparametric statistics for the behavioral sciences*. New York: McGraw-Hill, 1956.
- WERTHEIM, G. A. Some sequential aspects of IRT's emitted during Sidman avoidance behavior in the white rat. *Journal of the Experimental Analysis of Behavior*, 1965, 8, 9-15.
- BARRETT, R. J. (Psychology Research Laboratories, Veterans Administration Hospital, Nashville, Tenn. 37203), HUGHES, R. A., & RAY, O. S. ECS disruption of time-dependent processes in discriminated-avoidance conditioning in rats: Incubation or consolidation? *Journal of Comparative and Physiological Psychology*, 1971, 74, 319-324.
- BLACK, M., & SUBOSKI, M. D. Incubation and ECS-produced gradients in one-trial and multitrial discriminated-avoidance conditioning in rats. *Journal of Comparative and Physiological Psychology*, 1971, 74, 325-330.
- BRADLEY, R. M., (Nuffield Institute for Medical Research, University of Oxford, Headington, Oxford, England), & MISTRETTA, C. M. Intravascular taste in rats as demonstrated by conditioned aversion to sodium saccharin, 1971, 75, 186-189.
- CICALA, G. A. (University of Delaware, Newark, Del. 19711), MASTERSON, F. A., & KUBITSKY, G. Role of initial response rate in avoidance learning by rats. *Journal of Comparative and Physiological Psychology*, 1971, 75, 226-230.
- DeVIETTI, T. L. (Central Washington State College, Ellensburg, Wash. 98926), & LARSON, R. C. ECS effects: Evidence supporting state-dependent learning in rats. *Journal of Comparative and Physiological Psychology*, 1971, 74, 407-415.
- DUNCAN, N. C., GROSSEN, N. E., & HUNT, E. B. (University of Washington, Seattle, Wash. 98105). Apparent memory differences in inbred mice produced by differential reaction to stress. *Journal of Comparative and Physiological Psychology*, 1971, 74, 383-389.
- DUNCAN, P. M. (Department of Physiology and Biophysics, University of Washington, Seattle, Wash. 98105). Effect of temporary septal dysfunction on conditioning and performance of fear responses in rats. *Journal of Comparative and Physiological Psychology*, 1971, 74, 340-348.
- EICHELMAN, B. S., JR. (National Institute of Mental Health, Bethesda, Md. 20014). Effect of subcortical lesions on shock-induced aggression in the rat. *Journal of Comparative and Physiological Psychology*, 1971, 74, 331-339.
- FRIED, P. A. (Carleton University, Ottawa, Ontario, Canada). Limbic system lesions in rats: Differential effects in an approach-avoidance task. *Journal of Comparative and Physiological Psychology*, 1971, 74, 349-353.
- KESNER, R. P. (University of Utah, Salt Lake City, Utah 84112). ECS as a punishing stimulus: Dependency on retrograde amnesia, duration of anterograde amnesia, and intensity of pain. *Journal of Comparative and Physiological Psychology*, 1971, 74, 398-406.
- KREMER, E. F., & KAMIN, L. J. (Princeton University, Princeton, N.J. 08540). The truly random control procedure: Associative or nonassociative effects in rats. *Journal of Comparative and Physiological Psychology*, 1971, 74, 203-210.
- LEVIS, D. J. (University of Iowa, Iowa City, Iowa 52240). Short- and long-term auditory history and stimulus control in the rat. *Journal of Comparative and Physiological Psychology*, 1971, 74, 298-314.