Debilitated shock escape is produced by both short- and long-duration inescapable shock: Learned helplessness vs. learned inactivity

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Inescapable shocks of short (.5 sec) and long (5 sec) duration interfered with subsequent shock escape in rats. In addition, there were no differences between groups that received the pretreatment shocks and testing in the same or different apparatuses. These results are consistent with the learned helplessness account but conflict with recent learned inactivity accounts for the interference effects produced by inescapable shocks.

Exposure to inescapable shock typically interferes with the subsequent acquisition of escape behavior, but exposure to equivalent amounts of escapable shock does not (e.g., Maier, Albin, & Testa, 1973; Seligman & Beagley, 1975). The learned helplessness hypothesis claims that animals exposed to inescapable shock learn that their behavior is independent of shock termination. This learning leads to the expectation of "nothing I do matters," and this expectation (1) decreases motivation to initiate escape behavior and (2) decreases ability to associate future responding and shock termination (Maier & Seligman, 1976; Maier, Seligman, & Solomon, 1969; Seligman, Maier, & Solomon, 1971).

Several alternative hypotheses have been proposed to account for the helplessness effects observed in rats. Each is based on the premise that during inescapable shock the rat adventitiously learns responses that later interfere with appropriate escape behavior (Anisman, deCatanzaro, & Remington, 1978; Bracewell & Black, 1974; Glazer & Weiss, 1976a, 1976b; Levis, 1976). One version of these competing response theories suggests that it is the motor response of inactivity that is adventitiously reinforced during inescapable shock. Rats typically engage in frantic active behavior during the initial 2-3 sec of shock (motor-activation phase); then, responding decreases dramatically. The learned inactivity theory (e.g., Anisman et al., 1978; Glazer & Weiss, 1976a, 1976b) claims that if shock durations are longer than 3 sec, inactivity will coincide with shock termination and the animal will learn to become

passive adventitiously. If shocks are shorter than 3 sec, however, the active behavior of the motor-activation phase coincides with shock termination, and no interference effects should be observed. Indeed, Anisman et al. (1978) found that 2-sec durations of inescapable shock did not interfere with later escape in mice but that 6-sec duration shocks did, and Glazer and Weiss (1976a) reported no interference with inescapable shocks of 2, 3, and 4 sec durations when rats were tested 72 h after pretreatment. Both learned helplessness and learned inactivity theories predict interference effects 24 h later if inescapable shocks of over 3 sec duration are used; however, learned inactivity theory alone predicts no interference with shorter duration shocks.

The findings of Anisman et al. (1978) and Glazer and Weiss (1976a) surprised us, since in our own pilot work and in a number of other studies, interference effects were observed in rats with shocks of less than 3 sec duration (e.g., Altenor, Kay, & Richter, 1977; Kelsey, 1977). In these experiments, however, a yoked design was used that allowed variations in the duration of shock from trial to trial, with some trials consisting of long-duration shocks. Accordingly, this experiment examined the effects of short-duration shocks (.5 sec) in subsequent escape behavior in the rat relative to long-duration shocks (5 sec), equated for total amount of shock (after Overmier & Seligman, 1967). We were also interested in the transfer of interference from one apparatus to another, reflecting a general expectation of response-reinforcer independence rather than inactivity associated with particular apparatus cues.

METHOD

Subjects

The subjects were 50 male Sprague-Dawley rats obtained from the Holtzman Company, Madison, Wisconsin. The animals were 90-110 days old at the start of the experiment and were individually housed for 10 days prior to the start. Animals were

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allowed free access to food and water under a 12-h light/dark cycle. All experimental manipulations were carried out during the light phase of the cycle.

Apparatus

The animals were exposed to inescapable shock in one of two units: two shuttleboxes or two barpress boxes. Each shuttlebox was 47.0 cm long, 20.4 cm wide, and 19.7 cm high. The walls were constructed of stainless steel and the ceiling was of clear acrylic plastic. The floor was a stainless steel grid with bars .4 cm in diameter, 1.9 cm apart. The chamber was divided into two identical sections by a metal divider with a rounded archway 7.8 cm high and 5.8 cm wide cut out of the bottom of it. Each barpress box was 30.5 cm long, 20.4 cm wide, and 19.7 cm high. The floor was a stainless steel grid with bars .64 cm in diameter, 1.9 cm apart. The long sides of each box were constructed of clear acrylic plastic; the end walls were of stainless steel. Centered on the right-hand wall was a lever 6.8 cm wide protruding 1.5 cm into the box and 6 cm above the grid floor. Each unit was housed in a sound-attenuating chamber with 76-dB background noise supplied to the experimental room. A .7-mA scrambled shock was delivered to the grid floor and metallic sides of each unit. The shock source consisted of a 600-V ac transformer with a limiting resistor that supplied a constant-current shock through a Hoffman-Flesher (1962) scrambler to the shuttleboxes and a Lafayette scrambler (Model 82500) to the barpress boxes.

Procedure

The animals were nonsystematically assigned to one of five groups. A nonpreshocked group ($n = 10$) served as controls. Of the remaining animals, one half received 60 5-sec shocks either in the shuttleboxes or in the barpress boxes (with the levers removed) on Day 1. The other half received 600 .5-sec shocks in one of the two units. For the 5-sec shock groups, shock was delivered on a variable-time 60-sec schedule (range = 10-110 sec); for the .5-sec groups, shock was delivered on a variable-time 6-sec schedule (range = 1-11 sec). On Day 2, all animals were tested on the acquisition of a leverpress response to escape from shock in the barpress boxes. The test consisted of 15 trials of up to 30 sec of unsignaled .7-mA shock delivered on the variable-time 60-sec schedule used with the 5-sec shock groups. Shock was terminated when the rat depressed the lever three times (FR-3).

RESULTS AND DISCUSSION

All the preshocked groups did worse at escape than

the nonshocked controls, but they did not differ from each other. Table 1 presents a summary of the findings. Preplanned comparisons among the preshocked groups revealed no reliable effects for either shock duration or place of pretreatment (all $F_s < 1$) when analyzed for escape latency or number of failures to escape. However, the preshocked groups, taken together, were slower to escape than the nonpreshocked group [$F(1,45) = 5.61$, $p < .025$], and they also had more failures to escape [$F(1,45) = 7.20$, $p = .01$].

As shown in Table 1, the animals pretrained in the shuttlebox did as poorly as the animals pretrained in the barpress box. This indicates that the interference effect is not specific to the location at which inescapable shocks occur. This supports the notion that helplessness effects reflect a generalized state and are not place specific. More important, shock duration in pretreatment had no differential interference effect. Contrary to the prediction of the learned inactivity hypothesis, the short-duration shocks interfered with later escape responding, as did long-duration shocks.

While both learned helplessness and learned inactivity theories readily account for the interference effects produced by inescapable shocks of 5 sec duration, only the learned helplessness theory predicts the effects observed with the .5-sec duration shocks. Can the learned helplessness theory account for the reported failure of 2-sec duration shocks to produce interference in the studies by Anisman et al. (1978) and Glazer and Weiss (1976a)? In only one experiment (Anisman et al., 1978, Experiment 10) are 6-sec duration shocks compared with 2-sec duration shocks when each group received the same total amount and density of shock. If these two groups are compared, no reliable difference is observed. While only the 6-sec group reliably differs from the no-shock group, the differences between the 2-sec group and the no-shock group are in the direction predicted by the learned helplessness theory. Glazer and Weiss (1976a, Experiment 2) report no differences between groups that received 2-, 3-, and 4-sec duration

Table 1
Mean Shock-Escape Latencies (L) and Failures (F) to Escape in 15 Trials

	Shuttlebox						Barpress Box			
	Naive		.5 Sec		5 Sec		.5 Sec		5 Sec	
	L	F	L	F	L	F	L	F	L	F
	6.93	1	8.83	2	13.99	4	6.37	0	12.36	1
	7.17	0	9.37	1	10.50	1	6.77	0	30.00	15
	6.63	0	8.44	2	9.59	1	26.97	12	17.04	5
	8.68	0	18.12	7	6.17	0	6.62	0	16.35	5
	13.06	2	30.00	15	30.00	15	30.00	15	30.00	15
	21.76	8	10.87	2	10.81	3	7.94	1	11.63	2
	8.69	0	28.92	14	26.35	12	30.00	15	7.55	1
	9.91	1	23.28	10	9.61	2	30.00	15	9.53	2
	11.47	2	22.92	8	28.82	14	15.71	5	26.67	12
	7.75	0	11.91	4	25.93	12	28.05	12	7.56	1
Mean	10.21	1.40	17.27	6.50	17.18	6.40	18.84	7.50	16.87	5.90
SD	9.55	2.46	8.48	5.17	9.38	6.06	11.07	6.88	8.92	5.84

shocks, but they report that these groups were faster to escape from shock than animals that received 5- and 6-sec duration shocks when tested 72 h after inescapable shock. However, as Maier and Jackson (1979) report, exposure to 180 2-sec inescapable shocks produces as much interference as 72 5-sec shocks when animals are tested 24 h later. Since Weiss' data are presented for performance 24 h after inescapable shock, we cannot compare their findings with ours. With respect to the Anisman et al. (1978) findings, we cannot explain why the interference effects obtained for the 2-sec group were not statistically reliable in their experiment, but our results suggest that their learned inactivity interpretation does not generalize beyond the parametric manipulations used in their own experiments. While the findings reported here differentiate between the learned helplessness and learned inactivity accounts, they do not rule out the possibility that the deficits that follow inescapable shocks are due to some neurochemical imbalance (e.g., Anisman, 1975).

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