PRODUCING EITHER POSITIVE OR NEGATIVE TENDENCIES TO A STIMULUS ASSOCIATED WITH SHOCK¹

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A technique is described in which rats are pretrained with reinforcement to bar press. Each bar press was associated with a tone. This tone was later paired with one of two aspects of an electric shock, either at the onset or at the end of the shock, in a situation in which the shock is inescapable. These animals were retested in the operant situation under conditions of extinction, but with tone present as a conditioned reinforcer. The finding was that animals for which the tone was associated with shock onset extinguished quickly, whereas animals for which the tone was paired with shock termination extinguished more slowly.

It is well known that an animal will later avoid a stimulus associated with the onset of an electric shock. A few investigators (Barlow, 1952; Buchanan, 1958) have attempted to demonstrate that an animal will later approach a stimulus associated with the termination of an electric shock. However, no technique exists for comparing positive and negative tendencies occasioned by stimuli which have been associated with these two temporal aspects of the same electric shock (Beck, 1961).

METHOD

Subject

The subjects were 12 300-day-old male hooded rats of the Long-Evans strain.

Apparatus

The apparatus consisted of two Grason-Stadler operant-conditioning boxes, Model E 3125 A-300; a Davis Scientific Instrument liquid pump, Model LR-130A; a Grason-Stadler stimulator, Model E 1064GS; and a Hewlett Packard audio oscillator, Model 200 C. The remainder of the apparatus was standard operant-conditioning control equipment. One of the conditioning boxes was modified by insertion of a solid-metal floor and a liquid-reinforcement cup on the side opposite the response lever. The reinforcement cup was connected to the liquid pump so that a 20% sucrose solution could be delivered in

discrete amounts of 0.04 ml per reinforcement. This box will be called the "training" box.

The other conditioning box was modified by insertion of a black inner liner in the animal compartment. This liner made the box a simple container (no response bar or reinforcement cup), lighted from above like the training box but with black walls and a grid floor. This will be called the "shock" box.

Procedure

The animals were trained in a free-operant situation until all animals exceeded a criterion of 80 responses per 30-min daily training session. Training was conducted by continuous reinforcement with the sucrose solution. Each bar press was accompanied by a magazine click and a 0.5-sec tone of 10,000 cps at approximately an 83-db sound pressure level. Food other than that received during training was 10 g of powdered Purina rat food given to each animal immediately after each training session.

After all animals exceeded the criterion, the 12 consecutive days of testing were begun. A 4-day test procedure was repeated three times so that each rat was subjected to each of three experimental conditions in a counter-balanced order.

The 4-day test procedure was the same for all animals, except on the third day. The procedure on the first day was identical to the training sessions. This was necessary to insure adequate levels of performance during the second and third repetitions of the procedure. On the second day (to be called the preshock

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day), each animal was run in the "training" box in the same manner as on the first day, and its responses were recorded on a Varian cumulative recorder. On the third day, each animal was placed in the "shock" box and eight unavoidable shocks of 5-sec duration and 0.2-ma intensity were administered on a variable-interval schedule with a mean of 4 min. A tone-click, the same as that previously occurring with each bar press during training, was presented with each shock in the "approach" and the "avoidance" conditions. The particular temporal arrangement of the tone-click and the shock was dependent upon the experimental condition. During the "approach" condition, the onset of the tone-click was temporally contiguous with the termination of the electric shock. In the "avoidance" condition, the termination of the tone-click was temporally contiguous with the onset of the shock. During the "shock only" condition, the tone-click was not present. Figure 1 is a diagram of these relationships.

On the fourth day (to be called the postshock day), each animal was again placed in the "training" box for a 30-min extinction session with the tone-click present as during training, but with no sucrose reinforcement. The responses of each were again recorded.

Fig. 1. Experimental conditions.

RESULTS AND DISCUSSION

Table 1 presents the scores for each of the 12 rats as ratios of its total responses on the postshock day to its total responses on the pre-

Table 1
Table of Total Responses and Derived Scores for Each Animal

Rat No. (order)*	Approach		Shock Only		Avoidance		Approach Ratio Shock-only Ratio	Avoidance Ratio Shock-only Ratio
	Post	Pre/ Post	Post	Pre/ Post	Post	Pre/ Post		
1 (A, B, C)	112	.82	53	.50	38	.29	1.64	.58
2 (A, B, C)	57	.56	42	.40	24	.20	1.40	.50
3 (A, C, B)	148	.69	93	.49	57	.25	1.41	.51
4 (A, C, B)	69	.66	56	.53	28	.32	1.25	.60
5 (B, A, C)	54	.57	59	.54	37	.43	1.06	.80
6 (B, A, C)	116	.93	68	.62	52	.45	1.50	.73
7 (B, C, A)	97	.61	83	.46	21	.09	1.33	.20
8 (B, C, A)	68	.72	57	.58	38	.33	1.24	.57
9 (C, B, A)	82	.66	78	.56	22	.22	1.18	.39
10 (C, B, A)	49	.50	44	.39	16	.15	1.28	.38
11 (C, A, B)	62	.67	52	.51	14	.16	1.31	.31
12 (C, A, B)	59	.67	24	.37	7	.09	1.81	.24

* Order of presentation of the conditions; A is Approach, B is Shock Only, and C is Avoidance.

shock day. This ratio was used to compensate for the general response levels of the animals in both preshock and postshock situations.

As Table 1 shows, the ratio score for every rat is greatest for the "approach" condition, smallest for the "avoidance" condition, and intermediate for the "shock only" condition.

The "shock only" condition can be considered to be of relatively neutral value compared with the other two conditions. This assumption of relative neutrality is substantiated by the performance of a different group of eight rats which were trained and tested in an identical manner but received neither tone-click nor shock in the "shock" box. The post-test/pretest ratio of this group (mean = .44, SD = .20) does not differ significantly from the "shock only" condition (mean = .50, SD = .07).

The relative strengths of "approach" and "avoidance" tendencies were then determined for each animal by dividing the "approach" and "avoidance" ratio by the "shock-only" ratio (Table 1). The mean ratio for "approach" strength was 1.37, with a range from 1.06 to 1.81. The mean ratio for "avoidance" tendency was .53, with a range from .20 to .80. A two-tailed nonparametric comparison of these scores was a $p < .0005$.

These results demonstrate that a neutral stimulus associated with the onset of a shock will later hasten extinction, and that the same neutral stimulus associated with the termination of the same shock will later hinder extinction.

There are three advantages of this procedure over previously used techniques: first, both

positive and negative secondary reinforcement may be produced without recourse to different types of primary reinforcers; second, the CS-UCS association occurs when the parameters, particularly number and sequence of pairings, are easily controlled; and third, the operant response, which is used later as the measure of the positive and negative tendencies associated with the CS, is not present during acquisition of these tendencies.

There are also two disadvantages: first, the behavioral change is significant but not large; and second, the schedule is an extremely delicate balance of behavioral tendencies dependent on shock intensity, generalization of factors other than the CS between the "shock" box and the "test" box, and individual differences among animals.

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