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EFFECT OF DETAINMENT ON EXTINCTION OF AVOIDANCE RESPONSES[1]

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Following shuttle-box avoidance training, 10 rats were assigned to each of 6 groups, matched on the basis of trials to acquisition criterion. During extinction, Ss were detained in the presence of the CS for intervals of 0–20 sec. before being allowed to perform the avoidance response. The rate of extinction increased with the duration of detainment. The results are interpreted in terms of both "conservation of anxiety" and counterconditioning.

In contrast to classical aversive conditioning, responding persists in the absence of the US (shock) in instrumental avoidance situations when the CS is co-terminous with the conditioned avoidance response (CAR). In order to explain this difference, it has been proposed that anxiety is classically conditioned to the CS during escape (shock reinforced) trials, and that the reduction of the originally conditioned anxiety. Continued inforcement for the CAR (Mowrer, 1939). Thus, extinction of the CAR would depend upon prior extinction of anxiety. Supplementing this position, Solomon and Wynne (1954) have proposed that continued CAR performance is due to the "conservation of anxiety" by short-latency avoidance responses which quickly terminate the CS, and so prevent the elicitation of much of the originally conditioned anxiety. Continued exposure to the CS should elicit more of the total anxiety reaction, and so enhance extinction of anxiety and consequent extinction of the CAR. The present study sought the relationship between the duration of detainment in the presence of the CS and the rate of CAR extinction.

METHOD

Subjects

The *Ss*, 60 naive male albino rats of the Holtzman strain 90–120 days of age, were maintained in individual cages on an ad-lib schedule of Rockland rat diet.

Apparatus

A modified Miller-Mowrer shuttle box, 36 × 5½ × 3½ in., had sides of clear Plexiglas, and ceiling, roof, and ends of unpainted wood. A wooden molding protruded ½ in. from the floor to the ceiling at the middle. This served as the runners for a remotely operated aluminum guillotine gate, painted with alternating horizontal ½-in. black and white stripes. When lowered, this gate prevented crossing to the other side of the shuttle box. The grid floor was of $\frac{3}{32}$-in. stainless-steel rods spaced $\frac{9}{16}$ in. apart at center. It was wired in three sections which could be electrified separately. The middle 10 in. were energized whenever either end section was charged. This procedure forced *Ss* to run completely across the middle to escape shock, so that they were rarely in the center of the box at the start of a trial. The probability of the gate striking an animal as it was lowered was thus minimized.

The shuttle box was enclosed in a sound-deadening chamber illuminated by a 15-w. bulb mounted on the rear wall, above the shuttle box and equidistant from its ends. A damped house buzzer mounted immediately below the bulb served as the CS. The US was a pulsating 30 cps, 300-v. condenser discharge through *S*. Trials were programed automatically. Response latency during acquisition was the interval between CS onset and crossing of the midline. Latencies during extinction were counted from the moment the gate was raised.

Procedure

Following acquisition, 10 *Ss* were assigned to each of six extinction groups, equated on the basis of the mean number of trials required to reach the criterion of acquisition. Treatment during extinction consisted of detaining *Ss* in the presence of the CS for a given interval before permitting them to cross to the other side. Each group was detained by the gate, which was lowered 5 sec. before CS onset, for an interval of 0, 2.5, 5, 10, 15, or 20 sec.

Day 1. Habituation trials were given prior to acquisition training. Following 15 min. of free exploration, the CS was sounded for a maximum of 20 sec., at intervals averaging 1 min. A response, i.e., crossing to the other side of the box, terminated the CS. Shock was never present. Habituation trials were continued to a criterion of

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TABLE 1

MEANS AND STANDARD DEVIATIONS OF ACQUISITION MEASURES

Measure[a]	Detention time (in sec.)											
	0		2.5		5		10		15		20	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Trials to criterion	62.6	23.2	63.0	21.4	61.5	23.5	62.7	26.2	63.6	27.3	62.2	27.1
Number of escapes	28.7	17.2	31.7	17.4	24.5	14.2	31.3	23.0	29.0	20.4	31.0	21.7
Criterion speed	400.9	136.6	453.5	247.5	471.7	295.8	521.0	317.1	555.9	353.2	446.7	188.7

[a] All F ratios nonsignificant; $df = 5/54$.

no response for three consecutive trials. Acquisition was begun immediately after habituation. The CS-US interval was 15 sec; intertrial intervals were 30–90 sec. and averaged 60 sec. The response terminated both the CS and US on escape trials, and terminated the CS while preventing the US on avoidance trials. Acquisition was continued to a criterion of 10 successive avoidance responses.

Day 2. Acquisition training was repeated. Extinction was started 5 min. after attainment of the criterion. Shock was never present. The gate was lowered 5 sec. prior to CS onset, and remained in that position for the appropriate detainment interval, measured from CS onset. The CS terminated after 50 sec. The criterion of extinction was 10 successive trials during which *S* made no avoidance response. Extinction was continued until this criterion was reached, or for a maximum of 150 trials.

Day 3. Extinction was repeated to a maximum of 150 trials for all *S*s not having reached the criterion on Day 2. The experiment was terminated after a 2 day total of 300 trials for two *S*s that did not reach the criterion.

RESULTS

Acquisition

Acquisition data for both days were combined. Trials to criterion, total number of escapes (shocks), and mean speed (reciprocal latency × 1000) for the 10 avoidance criterion trials on Day 2, were each subjected to analyses of variance with "groups" as the main factor. None of these yielded significant F ratios, indicating that the groups were adequately matched (see Table 1).

Extinction

Introduction of the guillotine gate on the first extinction trial resulted in similar behavior for *S*s in the detained (2.5–20 sec.) groups: viz., strenuous attempts to "get through" the gate (clawing), urination, and defecation. Figure 1 presents the mean trials to the criterion of extinction (A), percentage of responses

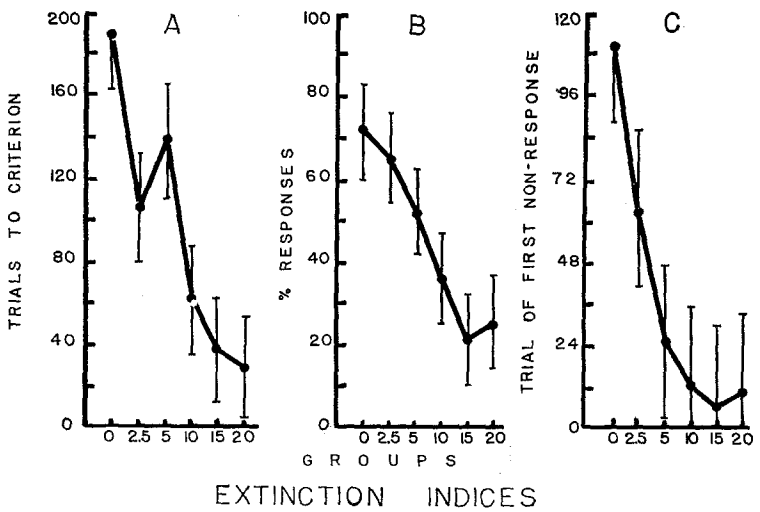

FIG. 1. Extinction measures. (The vertical lines through the plotted points represent ± 1 *SE*. The mean number of trials to the criterion, A. The mean percentage of responses, B. The mean trial of the first nonresponse, C.)

TABLE 2

EXTINCTION MEASURES FOR *Ss* REQUIRING 20 OR MORE TRIALS TO REACH EXTINCTION CRITERION

Measure	Detention time (in sec.)											
	0[a]		2.5[b]		5[b]		10[c]		15[d]		20[e]	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Trials to criterion	234.3	51.9	148.0	45.3	193.6	99.6	114.4	63.4	103.3	102.5	59.3	22.3
Percentage of responses	89.7	4.6	88.4	7.1	74.9	6.2	68.1	24.5	63.7	5.8	52.0	23.8
Trial of first nonresponse	138.4	85.7	89.9	66.3	34.0	77.6	25.8	44.2	16.0	5.9	24.3	30.4
Response speed	268.3	77.5	447.9	77.2	341.8	118.3	359.6	145.7	285.1	51.2	230.5	76.5

[a] $N = 8$.
[b] $N = 7$.
[c] $N = 5$.
[d] $N = 3$.
[e] $N = 4$.

(B), and trial of the first nonresponse (C). Each of these measures is a decreasing function of the duration of detainment. Analyses of variance indicated significant group differences for each of these three measures: A, $F = 5.21$, $df = 5/54$, $p < .001$; B, $F = 3.47$, $df = 5/54$, $p < .01$; and C, $F = 3.67$, $df = 5/54$, $p < .01$. Partition of the groups variance by the method of orthogonal polynomials revealed the linear components to be significant in each case: A, $F = 21.74$, $df = 1/54$, $p < .0001$; B, $F = 16.70$, $df = 1/54$, $p < .0001$; and C, $F = 14.52$, $df = 1/54$, $p < .001$. These analyses indicate that the rate of extinction was an increasing linear function of the duration of detainment in the presence of the CS; i.e., the longer the detainment, the faster the extinction.

Sixteen *Ss* reached the extinction criterion at the tenth trial, i.e., did not respond, and an additional 10 *Ss* attained the criterion prior to the twentieth trial. Following initial unsuccessful attempts to perform the CAR with the gate in place, many of these 26 *Ss* retreated to the end of the shuttle box where they remained, usually crouching during the duration of the first trial and most of the remaining extinction trials. Extinction data for the remaining 34 *Ss* are summarized in Table 2. Small and widely disparate group sizes precluded further statistical analysis. However, the rate of extinction appears to be more rapid with increasing durations of detainment, as with the total sample (see Figure 1). Also, response speed for the detained groups decreased with increasing intervals of detainment.

DISCUSSION

Previous investigators have found enhanced extinction of CARs by punishment (Kamin, 1959), response prevention (Page, 1955; Page & Hall, 1953), and a combination of both (Solomon, Kamin, & Wynne, 1953). The present findings extend these studies by indicating that detainment in the presence of the CS prior to permitting CAR performance is similarly effective. In addition, the rate of extinction was found to be an increasing function of the duration of detainment. CAR extinction has been explained on the basis of counterconditioning, i.e., the acquisition of a new, competing response (Page & Hall, 1953). According to this interpretation, longer durations of detainment may have increased the probability that *S* would assume a crouching position, incompatible with CAR performance, consequently resulting in faster extinction. This interpretation is supported by the finding that the number of *Ss* requiring at least 20 trials to reach the extinction criterion was smaller for longer detainment intervals (see Table 2). However, this explanation is not valid for the majority of *Ss*, who continued to perform the CAR for up to 300 trials. The data for these *Ss* appear to be consistent with the conservation of anxiety formulation of Solomon and Wynne (1954). Thus, longer intervals of exposure to the CS would elicit more components of the total anxiety reaction which was originally conditioned during acquisition training. This would result in the extinction of greater amounts of anxiety and thus faster extinction of the CAR as a function of increasing durations of detainment.

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EFFECTS OF WATER CURRENT ON RESPONSES OF PLANARIA TO LIGHT

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The experimental group of planaria, Dugesia tigrina, was tested on 150 trials for responses to light with 10 widely spaced occurrences of pressure stimulation produced by puffing water near S, a procedure used in condition experiments with planaria. A control group was tested for responses to light without puffs. The experimental group showed a significant increase in responses to light while the control group did not. The results are discussed in terms of the possible confounding effects of puffs on results of conditioning studies. 2 interpretations of the relationship between puffs and responses to light are noted.

Scrutiny of the conditioning procedure ordinarily used with planaria (Thompson & McConnell, 1955) reveals a variable that may complicate the interpretation of the results of conditioning experiments that use light as the CS. Specifically, stimulation in the form of current movements of water is induced with a medicine dropper pipette in order to maintain the movement and orientation of the worm in the conditioning trough. Such stimulation leads to rheotactic responses (Fraenkel & Gunn, 1961, p. 254) and might affect the animals' responsiveness to light. The present study was designed to investigate this relationship.

METHOD

Subjects

Sixteen planaria, *Dugesia tigrina*, 10–12 mm. in length, were obtained from Carolina Biological Supply and were maintained under diurnal conditions in 1 qt. of aged (24 hr.) tap water at room temperature (70 ± 2° F.). They were fed raw pork liver every 4 days with a water change after feeding. To reduce "lethargic" effects due to feeding, *Ss* were not fed for 10 days before testing although the water was changed every 4 days.

Apparatus

The apparatus was similar to that described by Thompson and McConnell (1955). Two 100-w. bulbs were mounted 12 in. above a triangular plastic trough (10 × ¾ × ½ in. deep). A 1-in. deep volume of water was placed between the trough and bulbs to reduce heating effects from the bulbs.

Procedure

The *Ss* were divided randomly into two groups. The experimental group, Group E, consisted of 10 *Ss*; the control group, Group C, consisted of 6 *Ss*. Each *S* in Group E was placed in the plastic trough with a medicine dropper and tested for responses to light. The *S* had 150 trials with a 60-sec. ITI and 5-min. rests after the first and second blocks of 50 trials. On each trial, as in a conditioning procedure, lights were turned on for 3 sec. and responses were recorded during the first 2 sec. of this 3-sec. period. Cephalic turns or longitudinal contractions were recorded. If more than one occurred during the 2-sec. period, only one was counted. The *Ss* in Group E received pressure stimulation, puffs, from expelling water drawn from the trough from a medicine dropper so that three small waves approximately ⅛ in. in amplitude were created about 1 in. from *S*. The 10 puffs occurred 1 sec. after the light was turned off