The recovery-from-extinction of an avoidance response following an inescapable shock in the avoidance apparatus¹

Morrie Baum
UNIVERSITY OF PENNSYLVANIA

Abstract

18 albino rats were trained in a one-way avoidance box until they had reached a learning criterion. Then the shock was turned off and the Ss were run until they had reached an extinction criterion. At this point three different treatments were introduced. One group of six (the experimental group) received a 3-sec. inescapable shock in the "danger" side of the avoidance box. A second group (the shock-control group) received the inescapable shock in what had previously been the "safe" side of the avoidance box. A third group (the handling-control group) received the same handling as the experimental group, except that no shock was administered. The experimental group showed complete recovery-from-extinction. The avoidance performance of the handling-control group continued to deteriorate, while the shock-control group virtually ceased all avoidance responding.

Problem

The two-factor theory of avoidance learning as put forth by Mowrer, 1951 and Solomon & Wynne, 1953 maintains that an avoidance response is acquired and maintained by fear reduction, and that the fear is established through classical conditioning and the contiguity principle. It is possible from this point of view to consider the extinction of an avoidance response as resulting from the extinction of the conditioned fear reaction. Consequently, re-establishing fear by an inescapable shock in the avoidance apparatus should result in the recovery-from-extinction of the avoidance response. The present experiment was designed to test this prediction.

Method

The Ss were 18 male albinos of the Sprague-Dawley strain. At the time of training, the Ss were 80 to 110 days old and weighed an average of 348 gm (range of 280 to 430 gm).

The avoidance apparatus employed was a modified aluminum shuttlebox, 14 in long x 5 1/2 in wide x 7 1/2 in high (inside dimensions) which could be separated into two equal-sized compartments by a vertically-sliding guillotine door. One compartment was painted flat black while the other was unpainted. When the guillotine door was in the "down" position, the S could not cross between compartments; when it was in the "up" position, a 4-in high clearance was available to permit crossing.

The floor of the entire box was a grid of 3/16-in wide steel bars set at 7/8 in intervals, center-to-center. The

sections of the grid floor underlying the two compartments were independently electrifiable by a manually controlled switch, resulting in a 550-volt shock being applied through a resistance of 700 K. in series with the animal. Underneath the grid floor lay a steel tray to collect droppings. The appropriate half of the tray was painted black. The ceilings over the two compartments of the box were transparent plexiglass panels which permitted observation. The rat was placed in and removed from the apparatus by means of a hinged door which occupied most of one side of the apparatus.

Initially, all 18 Ss were trained to a criterion of 10 consecutive avoidance responses. Each trial was of the following nature. The rat was placed in the black compartment, and the guillotine door was raised to the "up" position. After 5 sec., the grid which formed the floor of the black compartment was electrified. When the rat had crossed to the unpainted compartment, the door was lowered to prevent retracing. The rat remained in the "safe" unpainted compartment for 30 sec., after which it was removed and replaced directly into the black compartment for another trial.

When the S had reached the criterion of 10 consecutive avoidances (i. e., 10 responses with a latency of less than 5 sec.), the shock was turned off and extinction training was continued. When the extinction criterion of three "non-avoidances" in four consecutive trials was reached, three different treatments were introduced. Following the 30-sec. interval after the last extinction-criterion trial, the six Ss in the experimental group received a 3-sec. inescapable shock in the black compartment, with the guillotine door in the down position. After an additional 3 sec. after shock termination, the rat was removed from the black compartment and held in the experimenter's hand for 10 sec. Then the S was returned to the black compartment and given another 25 ordinary extinction trials. The six Ss in the handling-control group received the same handling as the experimental group after reaching the extinction criterion, except that no shock was administered. The six Ss in the shock-control group received a 3-sec. inescapable shock in the previously "safe" unpainted compartment. This was administered after the S had spent 30 sec. in the unpainted compartment following the last extinction-criterion trial. Again, after an additional 3 sec. the rat was removed from the apparatus, held for 10 sec. and then given the additional extinction trials. If a rat failed to make the response of crossing from the black to the unpainted compartment in 4 min., it was removed, held

Table 1.

Performance Measure	Experimental Group (n=6)	Handling-Control Group (n=6)	Shock-Control Group (n=6)
Proportion of animals showing complete recovery-from-extinction.	6/6	0/6	0/6
Median number of test trials required to make 5 non-avoidances.	> 25.0	9.5	5.0

for 10 sec., and then returned for another trial. If, following one of the post-extinction-criterion treatments, an S had a latency of more than 45 sec. on five consecutive trials, its training was discontinued.

Results

Table 1 represents a brief summary of the results. All of the Ss in the experimental group demonstrated a complete recovery-from-extinction, with each S making 25 avoidance responses (latency less than 5 sec.) in the 25 test trials following the inescapable shock. All of the rats in the handling-control group made at least five non-avoidances before the 25th test trial, the median number of trials for this to occur being 9.5. None of the Ss in the shock-control group made any further avoidances from the black compartment after having received an inescapable shock in the "safe" unpainted side. In fact, four of the six Ss never made the response again at all, and had the maximum latency of 4 min. on five consecutive trials. The remaining two in the shock-control group made several crossings, but never with a latency of less than 20 sec.

Statistical comparison of the proportion of Ss showing complete recovery-from-extinction confirms the superiority of the experimental group over the two groups (6/6 vs. 0/6, $p < .01$, using a Fisher exact probability test). Using a Mann-Whitney U-Test for a comparison of the number of trials required to make five non-avoidances, and assigning a value of 25 trials to each S in the experimental group (25 representing the most conservative estimate), one finds that the experimental group is significantly superior to the handling-control group ($U=0$; $p=.002$) and to the shock-control group ($U=0$; $p=.002$). Also, the handling-control group is superior to the shock-control group ($U=3$; $p=.016$). All of the above statistical comparisons utilized "two-tails."

Discussion

The results of this experiment are consistent with the conditioned-fear two-factor theory of avoidance learning. It was found that an inescapable shock which was terminated by the experimenter resulted in a complete recovery-from-extinction of the avoidance response. That this recovery was not the result of a mere non-

discriminative "energizing" of the S is seen in the fact that rats which received the identical inescapable shock in the safe compartment of the one-way avoidance box virtually ceased responding. A very reasonable interpretation is that the inescapable shock in the "danger" compartment served to re-instate the conditioned fear which had undergone extinction. With the conditioned fear to the black compartment re-established by simple contiguous pairing with shock, the avoidance response acquired and maintained by fear reduction recovered completely.

This experiment showing an improvement in performance following an escapable shock is consistent with the findings of Sidman et al, 1957 that inescapable shock can increase the rate of responding and the resistance to extinction of a bar-press avoidance response. In a similar vein, Hoffman et al, 1961 have found that a series of unavoidable shocks eliminates a "warm-up" in avoidance performance. Kelleher et al, 1963 demonstrated that squirrel monkeys previously trained to avoid will emit responses when on a schedule with an aversive component, even when the avoidance responses are no longer effective in averting shock. Similarly, Waller & Waller, 1963 have found that unavoidable shocks administered to dogs who were bar-pressing on a multiple schedule having an avoidance component resulted in increased rates of avoidance responding.

References

- HOFFMAN, H. S., FLESHLER, M., & CHORNY, H. Discriminated bar-press avoidance. *J. exp. Anal. Behav.*, 1961, 4, 309-316.
- KELLEHER, R. T., RIDDLE, W. C., & COOK, L. Persistent behavior maintained by unavoidable shocks. *J. exp. Anal. Behav.*, 1963, 6, 507-517.
- MOWRER, O. H. Two-factor learning theory: summary and comment. *Psychol. Rev.*, 1951, 58, 350-354.
- SIDMAN, M., HERRNSTEIN, R. J., & CONRAD, D. G. Maintenance of avoidance behavior by unavoidable shocks. *J. comp. physiol. Psychol.*, 1957, 50, 553-557.
- SOLOMON, R. L., & WYNNE, L. C. Traumatic avoidance learning: acquisition in normal dogs. *Psychol. Monogr.*, 1953, 67, No. 4 (Whole No. 354).
- WALLER, M. B., & WALLER, P. F. The effects of unavoidable shocks on a multiple schedule having an avoidance component. *J. exp. Anal. Behav.*, 1963, 6, 29-37.

Note

1. This research was supported by USPH grant MH 04202 to Richard L. Solomon.