EMOTIONAL REACTIONS OF RATS TO THE PAIN OF OTHERS[1]

RUSSELL M. CHURCH

Brown University

It has been observed that animals and people are often responsive or "sympathetic" to the emotional states of others. Of course, emotional reactions of one individual do not always result in sympathetic responses by another, so the general problem is to determine some of the conditions affecting the development of sympathetic responses.

Conditioning theory provides a straightforward explanation for the development of sympathetic responses (Allport, 1924). According to the theory a particular unconditioned stimulus elicits the emotional response; for example, electric shock elicits a pain or fear response. Now if *S* experiences the pain reactions of another *S* to a shock and is himself shocked, on subsequent trials he should show fear at the pain reactions of the other *S*. The present experiment is a test of this hypothesis, using the depression in the rate of bar pressing for food reinforcement as the measure of degree of fear (Estes & Skinner, 1941).

METHOD

Subjects

The *S*s were 32 albino rats of Sprague-Dawley strain, about 100 days old at the beginning of the experiment. Half the *S*s were male and half were female.

Apparatus

The apparatus in which *S*s could press a lever for food consisted of two identical lever boxes. The adjacent sides of the two boxes were $\frac{1}{4}$-in. transparent Lucite, and the boxes were set 1 in. apart. Each compartment was $7\frac{1}{2}$ in by 8 in., 9 in. high. The front and back were stainless steel; the sides and top were $\frac{1}{4}$-in. Lucite. The floor was composed of 16 stainless-steel bars. The lever was made of stainless steel, rounded and smoothly finished, $\frac{1}{2}$ in. thick and 2 in. wide.

The apparatus in which *S*s were given fear conditioning was a grill box with a hardware-cloth partition dividing the box into two identical compartments. Each compartment was 12 in. by 12 in., 10 in. high. The front, back, and sides were wood; the top was wire-mesh screen. The floor of each compartment was composed of 20 bus bars, $\frac{1}{8}$ in. in diameter.

The shock was 2,250 v. a.c., 60 cy., with 15-meg. resistance in series with the rat. This shock reliably elicited considerable motor activity and loud, high-pitched squeaks.

Procedure

Training subjects to press the lever. On the first day *S*s were permitted to explore the lever box for 10 min., and the number of lever presses was recorded as the operant level. The *S*s were then given magazine training and shaping procedures and allowed to press the bar 50 times for 100% reinforcement. On the second day *S*s were given 50 presses for 2:1 fixed ratio and 50 presses for 4:1 fixed ratio. On Days 3 to 13 *S*s were given 10 min. of training for a 4:1 fixed ratio of reinforcement.

Adaptation of the initial reactions to a shocked subject. On Days 14 and 15 *S*s were given 10 min. of training for a 4:1 fixed ratio of reinforcement, and the two panel lights were turned on during Minutes 3 and 7 of Day 15. On Days 16 and 17 *S*s were given the same procedure as on Day 15, except that another rat in the adjacent box was shocked during Minutes 4 and 8 (i.e., the minute after the panel lights were turned on), and the panel lights remained on while the leader rat was shocked.

Emotional conditioning. The *S*s were divided into three groups, matched on a number of aspects of their previous performance. The experimental group (N = 16) was given three 1-sec. shocks a day for two days in the grill box. These occurred on Minutes 2, 5, and 8 of a 10-min. session on Days 18 and 19. Preceding each of these shocks another rat was shocked for 30 sec., and both shocks terminated simultaneously. The shock-control group (N = 8) received the same six 1-sec. shocks, but these were not associated with shock to another rat. The no-shock control group (N = 8) did not have any experience in the grill box.

Test for emotional reaction at pain response of other rat. During the next ten days (Days 20–29) *S*s were given 10 min. per day in the lever box. On Minutes 3 and 4 the two panel lights were on, and during Minute 4 the rat in the duplicate compartment was shocked.

The *S*s were 22-hr. deprived at the time of running. They were housed in community cages, and water was accessible at all times in the home cages. Lab rat food pellets (4 mm., 45 mg.) obtained from P. J. Noyes Co., Lancaster, N. H., were used as reinforcement for lever pressing.

Records were made of the number of responses made by each *S* during each minute of the experiment. The measure of anxiety to a stimulus (the dependent variable) was the decrease in the rate of response during the presentation of that stimulus.

RESULTS

Original Response to the Pain of Others

Figure 1 indicates that *S*s showed a radical depression in the rate of bar pressing (from

[1] This investigation was supported by a research grant (M-1812) from the National Institutes of Health, Public Health Service.

over 30 responses a minute to 0 responses) on the first time another rat was shocked. This depression in rate adapts very quickly, i.e., in two or three further exposures to a shocked rat there is no further depression in the rate of bar pressing. The three groups were matched on the basis of their performance, so there are no significant differences between them.

Conditioned Responses to the Pain of Others

The experimental group had been exposed to six trials in which *S*s had been shocked for 1 sec. following 30 sec. of shock to another rat. These *S*s showed a radical depression of rate in the lever box when exposed to another rat being shocked for 1 min. (Fig. 2). The no-shock control group, which had not been exposed to the fear-conditioning procedure, did not show this depression in rate, i.e., the emotional responses to the pain of another remained adapted out. Although the number of responses made by the experimental group increased on successive days, even on the tenth day there was a significant difference between the experimental group and the no-shock control group (C_1) in the number of responses made while another *S* was shocked (Mann-Whitney test, $p = .01$).

The shock-control group, that had been given six shocks in the grill box not associated with shock to another rat, showed an effect intermediate between the experimental and the no-shock control group. Both on the first day and over the ten-day period they had a significantly greater number of responses than the experimental group and significantly fewer responses than the control group (Wilcoxon's extension of the *U* Statistic, $p < .01$) (Mosteller & Bush, 1954).

None of the groups showed any depression of rate to the two panel lights that preceded the shocking of the leader rat.

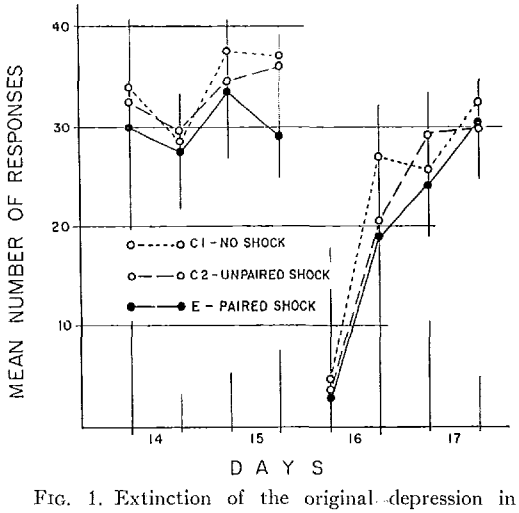

FIG. 1. Extinction of the original depression in the rate of lever pressing during the pain responses of another rat. Data are from Minutes 3 and 7 of Day 14 (with no additional stimulus), Minutes 3 and 7 of Day 15 (with the panel lights on), and Minutes 4 and 8 of Days 16 and 17 (with another rat shocked in the adjacent box).

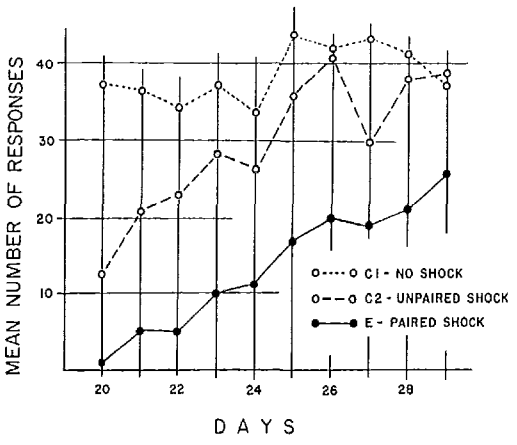

FIG. 2. Extinction of the conditioned emotional reaction to the pain responses of another rat. Data are from the fourth minute of the ten test sessions (when another rat was shocked continuously in the adjacent box).

DISCUSSION

The results of this experiment give empirical support for the conditioned-response interpretation of some cases of "sympathy." Thus, if the painful responses of others have been followed by pain to *S*, then *S* will show fear. If, on the other hand, this contingency has not been established, *S* will not show fear.

Perhaps the most interesting result is that a group of *S*s that had been exposed to the painful stimulus (shock-control group) showed greater fear to the pain of others than a control group that had not been exposed to this painful stimulus. There are two possible explanations of this result. The first is that this was a result of "sensitization." That is to say, a group of *S*s that have been shocked may be more responsive to all stimuli, including the pain responses

of others. As a matter of fact, the group was run just to guard against this contingency. However, there are a number of objections to this interpretation. There is no report of such a result on sensitization in any of the dozen or more published studies of the "conditioned emotional reaction," and in an unpublished study the author has failed to obtain this effect using a loud intermittent buzzer as the conditioned stimulus. That is to say, the shock-control group and the no-shock control groups were identical and neither showed any effect of the stimulus, but the experimental group showed the characteristic depression of rate to the stimulus. Furthermore, the *S*s in the shock-control group were not generally sensitized to all external stimuli, i.e., they did not show a greater depression of rate to the panel lights on the first test day than did the no-shock control group. Thus, if they were sensitized, they must have been selectively sensitized to a class of stimuli.

An alternative explanation for the fact that the shock-control group showed greater fear to the pain of others than a no-shock control group is that the shock-control *S*s *conditioned themselves* to be responsive to the emotional reactions of others. That is to say, these *S*s were shocked, and simultaneously they exhibited pain responses (jumping and squeaking). Thus, when they were later exposed to the pain responses of others, they might show conditioned fear. Of course, the interval between the conditioned stimulus (fear responses) and the unconditioned stimulus (shock) is not ideal, i.e., they occur simultaneously. However, in the case of the learning of fear there is reason to believe that this simultaneous conditioning can occur and can have a large effect (Mowrer & Aiken, 1954).

The original response of the *S*s to the shock of others may have been previously conditioned in the fighting behavior occasionally observed in the community cages, or it may have been a response to a dramatic stimulus (external inhibition). In any case, it was an extremely marked effect that lasted for only a very brief time before it became adapted or extinguished.

Contrary to expectation, the experimental group did not develop any anticipatory fear to the two panel lights that preceded the shock by 1 min. A procedure is still to be found to produce the "higher-order conditioning" of the conditioned emotional response. The problem is to find a set of conditions under which *S*s will learn to fear the objects that frighten a leader.

SUMMARY

Prior to any emotional conditioning rats showed a depression in the rate of bar pressing during the pain responses of another animal, but this depression rapidly adapted. Then 16 experimental *S*s were given six 1-sec. shocks, each preceded by 30 sec. of shock to another rat. Following such emotional conditioning *S*s showed a dramatic depression in the rate of bar pressing to the pain response of another rat. This depression, considered a measure of anxiety, gradually extinguished, but it was still significantly present after ten days. Eight unshocked control *S*s did not show this depression in rate to the pain of another rat. The difference between the experimental and unshocked control group was considered support for a conditioned-response interpretation of some cases of "sympathy."

A second control group consisted of eight *S*s that were shocked six times for 1 sec. unassociated with the pain response of another rat. Like the experimental group, they did show a depression in rate of response, although not as great as that of the experimental group. This latter finding was interpreted to be the result of self-conditioning rather than sensitization.

REFERENCES

ALLPORT, F. H. *Social psychology.* Boston: Houghton Mifflin, 1924.

ESTES, W., & SKINNER, B. Some quantitative properties of anxiety. *J. exp. Psychol.*, 1941, **29**, 390–400.

MOSTELLER, F., & BUSH, R. Selected quantitative techniques. In G. Lindzey (Ed.), *Handbook of social psychology.* Vol. I. Boston: Addison-Wesley, 1954.

MOWRER, O. H., & AIKEN, E. Contiguity vs. drive-reduction in conditioned fear: Variations in conditioned and unconditioned stimuli. *Amer. J. Psychol.*, 1954, **67**, 26–38.

Received March 17, 1958.