EFFECT OF PAIRED STIMULI ON EXTINCTION OF A CONDITIONED AVOIDANCE RESPONSE

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Albino rats were trained to avoid shock by pressing a lever. A Sidman avoidance-training procedure was used. A second stimulus (paired stimulus) was presented simultaneously with the unconditioned stimulus in selected training trials and in place of the unconditioned stimulus during selected extinction trials. A separate group of animals was trained on each of four schedules. Results indicated that the paired stimulus had no significant effect on extinction of the response. Implications of the finding are discussed.

As defined by Sheffield and Temmer (1), the term avoidance training is only applicable to those experimental situations in which a short period of time precedes the onset of a punishing stimulus. This period of time allows the organism to perform a response which prevents the onset of, or contact with, the punishing stimulus.

It is now generally accepted that once an avoidance response has been soundly established it is highly resistant to experimental extinction. This finding has been confirmed in a number of experimental situations and with several species of experimental animals (2, 3, 4). Banks (5), however, contradicted the finding by using human subjects in a study with shock as the unconditioned stimulus (UCS) and a light as the conditioned stimulus (CS) for a hand-withdrawal response. A third stimulus, a buzzer, was presented simultaneously with the shock on 100% of 80 training trials and on 0% of 40 extinction trials for one group (100%-0%) of subjects. Another group of subjects (0%-0%) received no buzzer during training or extinction. The level of response during extinction was typically high for the 0%-0% group. However, extinction occurred much more rapidly for the 100%-0% group. After further experimentation, Banks concluded that extinction was significantly faster if the 100% difference was represented by a decrease in paired-stimulus frequency (100%-0%) from training to extinction than if by a corresponding increase (0%-100%).

In an effort to explain his findings, Banks suggested a generalization-decrement hypothesis similar to that proposed by Sheffield (6). The presentation of a second stimulus, hereafter referred to as a paired stimulus (PS), with the UCS in any training trial elicited traces of the PS which became part of the CS pattern of the following trial. Hence the subject was conditioned to respond during training to the PS traces as well as to the usual CS. When extinction was begun and the PS omitted the CS pattern was changed considerably by the cessation of the PS traces. Part of the decrement of response strength during extinction would be interpreted, therefore, as a weakening of the response through generalization to a new stimulus pattern. Also, incompatible responses produced by the new stimulus pattern during extinction might be partially responsible.

The object of the present experiment was twofold: first, to reproduce Banks' (5) finding, in this case using animals instead of humans; second, to evaluate Sheffield's (6) hypothesis as an explanation of Banks' observations. Factors of interest in Banks' report included his finding that resistance to extinction of an avoidance response varied as a function of (a) the difference between the number of paired stimuli presented during comparable acquisition and extinction was begun and the PS omitted of difference from acquisition to extinction in the number of paired stimuli presented.

It was important to experiment with lower animals because a traditional problem is encountered in the use of electric shock with human subjects in a free-response situation. Quite frequently students become extremely anxious about participating in experiments involving electric shock. As a result, the experimenter often observes a pseudoconditioning effect in these subjects. The pseudoconditioned responses appear very similar, if not identical, to conditioned responses, and may often be mistaken for

true conditioned responses. However, they are made upon presentation of the CS without its having been paired with the UCS a sufficient number of times to produce conditioning. Particularly in studies employing electric shock, the sudden presentation of a light, or of almost any type of stimulus, will elicit a response.

Banks' study appeared to be a good example of a situation in which pseudoconditioning might be expected. Each subject was conditioned, before training was begun, to leave his hand on the electric grid through two consecutive presentations of the CS. During this period the UCS was not presented. During training, however, few pairings of the CS with the shock produced a high rate of response. An average of only 3.25 shocks was received by subjects during 80 training trials. This number of pairing of conditioned stimuli and unconditioned stimuli is usually not sufficient for conditioning to take place. Pseudoconditioning could, therefore, have explained Banks' observations.

As noted above, the hypothesis proposed by Sheffield (6) is based upon traces of the stimuli from one trial extending to the next trial. The shorter the intertrial interval, the greater would be the traces of stimuli passing from one trial to the next. As a result, commencement of extinction should entail a greater change in the stimulus pattern at shorter intertrial intervals than at longer ones. Hence, extinction should become increasingly faster as the intertrial interval is shortened. If the effect of differences in PS presentations can be explained by this hypothesis, the magnitude of effect should vary inversely with the length of the interval between stimulus presentations. Thus, in the present study, the plan was to compare the performance of two groups of subjects trained and extinguished with intertrial intervals of 5 sec and 30 sec, respectively.

METHODS

Subjects

The 72 male albino rats which served as subjects were of the Holtzman strain and 76 days old at the beginning of the experiment. Subjects were kept under conditions of constant illumination. Home cages, which were very similar in size to the training apparatus, housed two animals each. Food and water were available in the home cages at all times.

Apparatus

Training was carried out in a Lehigh Valley 143-23 operant test cage. To minimize the effects of external stimuli, the conditioning unit was placed inside a Lehigh Valley 132-02 small universal cubicle. A Lehigh Valley 112-01 sonalert, which served as the PS, was an integral part of the factory equipment of the operant test cage. Internal illumination was provided solely by the house light on the test cage. The UCS (shock) was produced by a model A-615A Lafayette Master Shocker and was applied to the grid floor of the conditioning unit via a Lehigh Valley 113-04 shock scanner. To provide a current at 2 milliamps, power and resistance settings of the shocker were 2,000 volts and 1 megohm, respectively. The shock duration was timed by a model 111-B Hunter interval timer. Recording devices consisted of simple counters and a cumulative recorder. Meylan timers regulated the length of intervals.

The programming and recording equipment were located in a room separate from that in which training took place.

Procedure

A Sidman (7, 8) conditioning procedure was selected for use in the study. Sidman demonstrated that an avoidance response (lever pressing) can be conditioned in rats with no exteroceptive warning stimulus (CS). Shock (UCS) was presented at regular intervals (S-S intervals) until a response was made by the animal. Each correct response, defined as one press of the lever, delayed the UCS by a given amount of time (R-S interval). Sidman noted that multiple responses did not have an effect of accumulating a lengthy time interval during which no UCS was presented. The UCS always followed the response by a time interval equal to the R-S interval. If the R-S interval elapsed after a response was made, the original schedule for presenting the UCS, as defined by the S-S interval, was resumed. A continued depression of the lever by the *S* was defined as one response and delayed the UCS for only one R-S interval. Sidman demonstrated that an average asymptotic rate of 2.5 responses per min can be reached with rats on such a training procedure in a few 3-hr training sessions. Requirements

included a S-S interval within the range of 2.5-30 sec and a constant R-S interval of 50 sec. The age of subjects was not relevant to Sidman's findings.

All subjects in the present study were randomly assigned to four (0%-0%, 100%-100%, 0%-100%, 100%-0%) equal PS groups. The study consisted of two 3-hr training sessions and one 3-hr extinction session per animal. One session was administered on each of three consecutive days. All sessions were begun at the same time each day for any given subject.

A PS (buzzer) was presented during training and extinction as designated by the four PS conditions. Subjects in the 0%-0% condition received a PS during neither training nor extinction. Subjects in the 100%-100% condition received a PS on all trials during both training and extinction. Subjects in the 100%-0% condition received a PS on all trials during training but not extinction. Subjects in the 0%-100% condition received a PS on all trials during extinction but not training. Half of the animals receiving each stimulus condition were trained with a 5 sec S-S interval. The other half were trained with a 30 sec S-S interval. Hence, eight subgroups of nine animals each were involved in the experiment. The R-S interval was 50 sec for all subgroups.

The PS was presented simultaneously with the UCS during training sessions requiring a PS. Therefore, each response delayed the next presentation of both the shock and buzzer for 50 sec. When required during extinction, the PS was presented on the same schedule as was the shock during training for any given animal. For example, if an animal had been trained on a 5 sec S-S interval and stimulus conditions required that he receive a PS during extinction, the PS was presented every 5 sec. A response during extinction would thus delay the presentation of the next PS for 50 sec. Responses made during extinction under stimulus conditions not requiring a PS led solely to a counting of the number of responses. The duration of the PS and UCS was 0.2 sec.

Order of training subjects was determined by nine randomized training programs. Each program consisted of a schedule for randomly training one subject from each of the subgroups in the study. Every subject was handled briefly by the experimenter on each of seven days immediately preceding the animal's first training sessions.

RESULTS

The average number of conditioned responses (CRs) elicited from all subjects during the first and second training sessions are presented in Figure 1. A mean of 460 responses was elicited during the second training session. Hence, the subjects were responding at a mean rate of 2.56 responses per minute, a rate slightly higher than that obtained by Sidman (7, 8) under similar conditions.

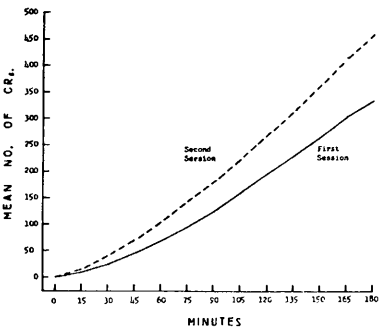

FIGURE 1. Cumulative mean number of conditioned responses (CRs) of 72 animals, during the first and second training sessions, plotted at 15-min intervals.

An analysis of variance was performed on the number of CRs emitted by all subjects during the second training session. A summary of this analysis is presented in Table 1. The analysis failed to reveal any significant differences in performance as a result of S-S interval or stimulus condition. This finding is in accord with the findings of Banks (5) and Sidman (7, 8).

TABLE 1. *Summary of analysis of variance of conditioned responses (CRs) elicited during the second training session.*

Source	Sum of squares	df	Mean squares	F
Paired stimulus	2,485.09	1	2,485.09	.14
S-S interval	43,365.09	1	43,365.09	2.58
Interaction	5,151.11	1	5,151.11	.30
Error	1,138,977.70	68	16,749.67	
Total	1,189,978.99	71	16,760.26	

An analysis of variance was also performed on the number of CRs elicited during extinction. The results of this analysis are presented in Table 2. Inspection of this table reveals that no significant differences between groups were found in the number of CRs elicited during extinction.

Since no significant differences were found between groups during extinction, it might be reasonable to ask if extinction actually took place. The mean number of CRs for all subjects during extinction is plotted at 15-min intervals in Figure 2. The

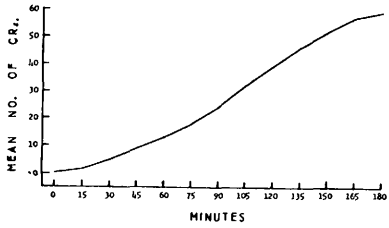

FIGURE 2. Cumulative mean number of conditioned responses (CRs) of 72 animals during extinction plotted at 15-min intervals.

negative acceleration of the lateral portion of the curve indicates that extinction did take place. Further evidence of extinction comes from the fact, also depicted by Figure 2, that all subjects gave an average of only 59 CRs during the 3-hr extinction period. This may be compared to an average of 460 CRs during the final three hours of training.

TABLE 2. *Summary of analysis of variance of conditioned responses (CRs) elicited during extinction.*

Source	Sum of squares	df	Mean squares	F
Paired stimulus	34,150.11	3	11,383.37	1.44
S-S interval	9,800.00	1	9,800.00	1.24
Interaction	21,247.22	3	7,082.40	.90
Error	502,696.67	64	7,854.63	
Total	567,894.00	71	7,998.50	

DISCUSSION

Results of the present study failed to confirm Banks' (5) finding that the addition of a PS to the avoidance conditioning paradigm reliably facilitates extinction. It should be recalled that avoidance behavior gradually developed as expected in the present study. By the second training session the rats were responding at a rate of 2.56 responses per minute, which is remarkably similar to the data of Sidman (7, 8). Figure 2 presents evidence that extinction also took place in a quite normal fashion. Thus, it appears that the results of the present study were not due to failure of the subjects to learn the avoidance response or to failure of this response to extinguish.

The discrepancy between the present finding and that of Banks might be partially explained by noting certain characteristics of Banks' design. His study involved a hand-withdrawal response by human subjects with a light as the CS and an electric shock as the UCS. Subjects were informed that they would receive shock intermittently during experimentation, and also that they could avoid the shock as often as they wished, once they learned how to do so. These instructions might be expected to produce something other than true conditioning. Such instructions suggest problem solving rather than the gradual development of a conditioned response. This supposition is supported by the extremely high frequency of avoidance responding during training. Banks reported that subjects received an average of 3.25 shocks during an 80-trial training session. This level of performance is not to be expected in conditioning studies. If it can be assumed that Banks' study involved mainly a problem solving task, it is reasonable to suppose that pairing another stimulus with the UCS would have a different effect upon extinction than it would in a true conditioning paradigm.

Failure to reproduce Banks' finding made it impossible to evaluate a hypothetical explanation of his results.

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