The cue in discriminated escape conditioning as a secondary positive reinforcer

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Twelve albino rats were given escape training in a two-compartment Miller box. Seven Ss received a 1.5 sec tone indicating when a door-press escape was possible, whereas, for the five controls, the tone was not paired with escape. Following intermittent reinforcement, Ss receiving discriminated escape training acquired a new response more effectively than controls when the new response produced the tone but no escape.

In recent years, there has been an increasing interest in attempts to demonstrate that stimuli associated with termination of an aversive stimulus (negative reinforcer) acquires secondary positive reinforcement properties through that association. In a review of much of this material, Beck (1961) indicated that studies suggesting positive results usually could be interpreted in some alternative manner. Two recent studies (Hughes & Adams, 1967; Wagman & Allen, 1964) obtained positive results, but pretrained with positive reinforcer and used a classical condition procedure for pairing the cue and shock termination.

The present study was conducted in an attempt to remove some of the ambiguity surrounding the conceptualization that cues associated with fear reduction would acquire positive reward effect. Several methodological refinements from appetitive drive studies, notably those used by Zimmerman (1959), were jointly applied to maximize the similarity between the current situation and those of the usual secondary reinforcement study. The design thus employed procedures which (a) maintained a similar motivational state during training and testing, (b) introduced a neutral stimulus which, through training, would acquire discriminative control over an instrumental escape response, (c) utilized intermittent reinforcement during training to provide additional resistance to extinction of any secondary reinforcing properties such as stimulus might have acquired, and (d) tested the effectiveness of this stimulus as a secondary positive reinforcer by making it the sole basis for the acquisition of a new response, eliminating interpretations in terms of a cue function. In addition, fear rather than pain conditions were used to motivate Ss to minimize learning of irrelevant escape response patterns during training.

METHOD

Subjects

The Ss were 12 male, albino rats, 90 days old when they arrived at the laboratory, and approximately 142 days old at the beginning of training. The Ss were maintained on an ad libitum food and water schedule, and handled and weighed daily throughout the period previous to and during the experiment.

Apparatus

Training and testing was conducted in a two-compartment Miller Box, separated by a guillotine-type door, with each compartment 6 x 9 x 8 in. The light gray safe compartment had a fiberboard floor and the black shock compartment had a grid floor consisting of ¼ in. steel rods, ½ in. apart, by means of which shock was presented. Mild pressure exerted on the door activated a microswitch which could be programmed to release the door allowing Ss to escape into the safe compartment. On the side wall of the shock compartment was mounted a Gerbrands lever which was uncovered and available

to the Ss only during the testing sessions at the end of training.

The cue was a mild tone from a Foringer multiple stimulus panel presented through a 3 in. speaker. The apparatus was enclosed in a sound resistant chamber with a one-way mirror in the door and illuminated by a 15 W lamp. The electric shock used was 70 V ac presented to the grids through 122 K ohm series resistance.

Procedure

All Ss were given two 15 min explorations of the apparatus, and a 10 min fear training session. In the latter, Ss were placed in the black compartment with the door closed and presented 10 5 sec shocks on a VI 1 min schedule. Escape training was begun the next session with some R shaping on early trials. At the beginning of each session prior to the first trial, Ss were placed in the shock compartment for 30 sec with the door closed, and received two irregularly spaced 5 sec shocks, a procedure followed on all subsequent days including testing. Any pressure on the door following this initial 30 sec period released the door and allowed S to escape to the safe compartment, where he remained for 15-20 sec until the next trial. At no time did S escape the shock itself by means of door response.

Following 40 trials of escape training with the last five trials in the continual presence of the tone, Ss were randomly subdivided into a discriminated escape (DE) group (N = 7) and a simple escape (SE) control group (N = 5). In DE, door pressure did not release the door until the 1.5 sec tone sounded. The tone thus was useable as a cue signalling the availability of door escape. The tone and subsequent possibility of escape was presented on a VI schedule, the interval between confinement in the shock box and tone presentation ranging from 5-40 sec for 105 trials and 5-220 sec for 30 more trials. Following a 15 min preliminary test for positive secondary reinforcement effects, 10 more training trials were given and then the equivalent to an intermittent reinforcement schedule was used for the final 30 training trials. This consisted of presenting from one to four tones during a given confinement interval before the S was actually allowed to escape when responding to cue. A training session consisted of 10 trials, except for three sessions in the middle of the training during which 15 trials were given.

SE controls were matched with the DE group as to time until escape, and number of tone presentations, but escape was in no way contingent upon the occurrence of the tone.

Conditions during the 15 min preliminary test and the 30 min final test were similar to those of training except that the lever in the shock box which previously was covered was now available. For both groups, any depression of the bar resulted in the tone sounding for 1.5 sec, the same duration as during training, but no escape was permitted. This procedure measured the reinforcing effects of the tone on a new response as the tone was simultaneously extinguished as a cue for discriminated escape.

RESULTS AND DISCUSSION

Prior to the preliminary test, it was difficult to determine for certain that discriminative control was being established except in an informal way. Controls spent much of their time door responding and thus their latencies were short from any arbitrary point in time, including tone onset. But during the test, the tone was presented only for lever responding, thus, the location in the test chamber was approximately the same for all Ss when the tone occurred. Although response latencies were significantly faster for DE, indicating some

Fig. 1. Mean response latencies from lever initiated tone to door responses during final test.

discrimination control, there was no reliable difference in the total number of lever response during the 15 min test ($\bar{X}_{DE} = 12.4$, $\bar{X}_{SE} = 10.8$; Mann-Whitney U, $p = .378$). Inspection of average cumulative response records suggested rapid extinction of a small reinforcement effect.

Following retraining including intermittent reinforcement, an additional 30 min test was performed. Figure 1 presents the mean door response latencies to the tone for the first eight lever-produced tones (one control made only eight lever responses). The Mann-Whitney U applied indicated the reliability of the faster latencies for the DE group ($p = .001$). It would seem safe to say that discriminative control over the escape response was quite successfully established even with intermittent reinforcement. Figure 2 provides the cumulative

Fig. 2. Cumulative mean lever responses during final test plotted minute by minute.

mean lever response during the final test plotted minute by minute. A similar result occurred when plotting started with the first lever response for each S to correct for time before the first response, a problem if the controls tended to stay near the door. The DE group made significantly more lever responses than SE evaluated by the Mann-Whitney U ($\bar{X}_{DE} = 33.4$; $\bar{X}_{SE} = 10.6$; $p = .024$) and remained significant when differences were removed for time to the first response ($p = .037$). The overall number of door responses was not significantly different for the two groups, a desirable (but uncontrollable) factor for interpreting the results.

The present findings would support a conclusion already accepted by many psychologists on the basis of minimal data, that a cue associated with fear termination, as in the present discriminative escape procedure, functions as a secondary positive reinforcer in strengthening a new response. In addition, it would appear that partial reinforcement training was crucial if the reinforcement effect was to be durable enough to be demonstrated in the test situation. However, the effects of intermittent reinforcement on the establishment of a secondary reinforcer was not the purpose of the present study and the above observation is quite tentative. For example, the present study might also be seen as giving indirect evidence for the discriminative stimulus hypothesis of secondary reinforcement to the extent that the present positive results are due to the satisfactory establishment of the tone as a cue during training. Observations comparing behavior in the training sessions before and following the preliminary test suggested discrimination was considerably better prior to the second test. The more effective functioning of the tone as a secondary reinforcer following the additional training could thus be due to the intermittent reinforcement schedule, improved discrimination, or both, and cannot be determined in the present study.

It should be noted that the present study involved 175 pairings of fear removal and the tone before final testing was performed. The data recently reported by Hughes & Adams (1967) and Wagman & Allen (1964) with respect to a decreasing secondary reinforcing effect with increased pairings seems to be inconsistent with the present study. At least, they are not applicable to the present procedure involving discrimination training in an instrumental conditioning context, where reaching a well-established discrimination performance is deemed important.

REFERENCES

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NOTE

1. This experiment is based on a thesis submitted by the second author under the guidance of the first author to the Graduate School, Saint Louis University, in partial fulfillment of requirements for the M.S. degree.