Termination of shock as a secondary reinforcer: The effect of replications

HOWARD HUGHES AND HENRY E. ADAMS

UNIVERSITY OF GEORGIA

Ten white rats were conditioned to press a bar for sucrose solution and an auditory stimulus. This auditory stimulus was later paired with the termination of unavoidable electric shock. A control group received only the shock. These animals were retested in the operant situation under conditions of extinction, but with the tone present as a conditioned reinforcer. This procedure was replicated three times. The results indicated that the positively reinforcing effect of the auditory stimulus is a function of both the number of contiguous associations of the auditory stimulus with the termination of electric shock and the time interval over which they are distributed.

Reinforcement theories (Keller & Schoenfeld, 1950; Mowrer, 1960) have generally made no distinction between the functional properties of positive reinforcement and the reinforcement provided by the termination of noxious stimuli. The early studies (Lee, 1951; Mowrer & Aiken, 1954; Litman & Wade, 1955; Crowder, 1959; and Beck, 1958, 1961) have not been able to demonstrate that stimuli associated with the termination of electric shock develop positive reinforcing qualities. Barlow (1952) did show positive results, but the response measure he used has been criticized by Beck (1961). Later studies (Hunter, 1961; Evans, 1962; Wagman & Allen, 1964) have also demonstrated positive results. Evans (1962) employed a design wherein each S received all three experimental conditions (tone contiguously associated with shock onset, shock termination, and shock only) in a counterbalanced order. Since the effect of the different experimental conditions would be expected to carry over into the following experimental sessions, it seems that a repeated measure design would not be appropriate, in view of the fact that the number of Ss employed was too small to test the effects of order of presentation. Hunter (1961) employed a yoked procedure where one group received shock for a variable interval (10-30 sec) then a tone which served as a discriminative stimulus for a bar press terminating both the shock and the tone. A second and a third group run simultaneously (but without a bar) received the tone and shock and the tone only, respectively, as determined by the bar pressing of the first group. The test was acquisition of a response of running back and forth from one end of a runway to the other, which turned on the tone. Although the results were positive, they may be accounted for equally well in terms of incentive motivation as in terms of conditioned reinforcement, as no shock-only control group was employed. In addition, the issue is confused since the tone was associated

not only with shock offset but also with shock onset and duration. Wagman & Allen (1964) employed a factorial design and varied the number of shock tone pairings (2, 4, 8, 12, 16, and 20) with a shock magnitude of 1 mA, shock duration of 3 sec, and a variable interval shock frequency (minimum interval was 2 min) distributed over a 1-h session. They found that only the 12 pairing experimental group differed from its shock-only control group, and it did not differ significantly from the no-shock no-tone control group. These authors demonstrated that the number of shock tone pairings was a critical variable and noted that the previous studies which were unsuccessful had employed from 25 to 100 pairings. They concluded that the degree of reinforcing influence appears to be limited by the suppressive nature of other stimuli which are associated with shock, and that the establishment of a conditioned positive reinforcing effect may be explained as a balance between the reinforcing and suppressive properties of the stimuli which have been associated with the shock.

The purpose of the present study is to test the hypothesis that the magnitude of a conditioned positive reinforcer based on the termination of shock is a function of both the number of contiguous associations of the neutral stimulus with the primary reinforcer and the time interval over which they are distributed.

Subjects

The Ss were 10-250 day old male white rats of the Dublin strain. They were on 23-h water deprivation and were fed and watered for 30 min immediately after the experimental session.

Apparatus

The apparatus consisted of a test compartment in a sound insulated cubicle, a shock generator, and an audio generator. The test compartment was equipped with a liquid dipper, two retractable levers, and two cue lights.

Procedure

Ten white rats were randomly assigned to two groups of five rats. Initially, both groups received pretraining during which they were conditioned to press a bar for 20% sucrose solution, a dipper click, and a 10,000 cps auditory stimulus at 62 dB sound pressure level for .5 sec duration on a continuous reinforcement schedule until they reached a criterion of 80 responses during a 30-min session. During this condition both stimulus lights inside the operant box were lit. After all animals reached the criterion, a four-day experimental procedure was begun. On the first two days (which will be referred to as the pretest condition), each animal received a 30-min session identical to the pretraining

Fig. 1. Mean ratio scores of barpressing as a function of replications.

condition. On the third day (which will be referred to as the experimental condition), both stimulus lights were off and response bars retracted. The control group received eight unavoidable .2 mA electric foot shocks of 5 sec duration on a variable interval schedule with a mean of 4 min. In addition, the experimental group received the dipper click and auditory stimulus presented contiguously with the termination of each electric foot shock. On the fourth day (which will be referred to as the post-test condition), the stimulus conditions were the same as in the pretest condition except the dipper contained no sucrose solution. This four-day test procedure was repeated four times, each time being considered a replication.

Results and Discussion

Response measures for each animal were converted into ratio scores by dividing the number of bar presses during the posttest condition by the number of bar presses during the pretest condition. Figure 1 illustrates the mean ratio scores as a function of the number of replications (number of shock tone pairings over sessions). The response ratios were at a maximum for both groups on the first replication (eight shock tone pairings) and essentially declined over the other three replications. A double classification analysis of variance with repeated measures indicated that the replication factor was significant ($F=6.29$, $df=3$, $p<.01$) while the stimulus condition and interaction factor were not significant. Thus, with each successive replication of the

experimental condition, the Ss made fewer responses during the test period.

In order to determine if the hypothesis of Wagman & Allen (1964) that the number of shock tone pairings is critical, a single classification analysis of variance was conducted on each of the replications. The only significant difference between experimental and control groups was in the second replication ($F=6.80$, $df=1$, $p<.05$). This data would tend to support the conclusions of Wagman and Allen that the positive increment of the conditioned reinforcer is conditioned simultaneously with and must coexist with a suppressive increment. Increased pairing of the neutral stimulus (tone) with the primary reinforcer results in an increase in the magnitude of the positive increment relative to the suppressive increment. This is true over only a narrow range of shock tone pairings. After some critical number of pairings, the suppressive effects of the shock become relatively stronger and bar pressing is suppressed rather than facilitated.

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