Acquisition and extinction of shuttlebox avoidance with complex stimuli

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Abstract

Rats were given avoidance conditioning in a shuttlebox with a complex cue stimulus, serially or simultaneously presented during training and extinction in a counterbalanced design. The hypotheses tested were that mode of stimulus presentation during training would not affect rate of learning, and serial stimulus presentation during extinction would produce significantly slower extinction. Both hypotheses were supported. The results are interpreted in a fear reduction model.

Introduction

It is difficult to account for extinction of avoidance without invoking an intervening emotional response and its diminution. Fear as an intervening variable in the interpretation of avoidance learning has been suggested by several investigators (Miller, 1948; Mowrer, 1960; Solomon, 1964). Other investigators have concluded that factors controlling conditioned fear responses are identical with those controlling Pavlovian conditioning (Annau & Kamin, 1961; Kamin, Brimer, & Black, 1963; Kamin & Schaub, 1963).

The present investigation is concerned with the degree of contrast of stimulation between the CS-UCS interval and the intertrial interval. If stimuli are presented in a serial order, and avoidance occurs before the onset of those portions of the stimulus complex late in the series, the later portions of the serial CS should not undergo extinction because they have not occurred, and therefore, fear conditioned to them should not be diminished.

Method

Subjects: Ss were 20 male Long-Evans rats, 105 days of age at the beginning of the experiment.

Apparatus: The apparatus was a shuttlebox with interior dimensions 6 in wide, 36 in long, and 10 in high, with wood walls painted flat black and a grid floor of 1/8 in brass rods spaced 5/8 in apart. The front was equipped with a 4 in by 34 in one-way glass observation window. Hinged lids over each side of the shuttlebox were covered with 1/2 in wire mesh. A removable flat black Masonite hood covered the box. The hood was 10 in high at the center, and contained one 15-w frosted light bulb 18 in above the center of the grid. Constant illumination of the hood made it possible to observe S through the one-way glass when the experimental room was darkened.

The US was 65 volts of direct current delivered to the bars through a home-built 8-bar grid scrambler. Shock was of the constant voltage type, with S supplying the resistance in the circuit. The grid scrambler, located below the center of the apparatus, produced a

rhythmical clicking of 68 db intensity while shock was being delivered.

The three components of the cue stimulus were blinking lights, buzzer, and retractable floors. The light cue was provided by five 6-w blinking lights located at either end of the box. The intensity of illumination produced was 40 cp measured 2 in above the grid and 2 in from the end of the box, and 12 cp when measured at the center of the box. The sound cue was produced by a buzzer set at 80 db intensity, located behind the center of the shuttlebox.

The retractable floors were constructed of 1/4 in tempered Masonite painted flat black. They could be independently withdrawn or returned on either side through slots in the back wall of the apparatus in 1-1/2 sec. by means of mechanical linkage attached to 18 rpm geared display motors. The distance from the surface of the floors to the grid was 3/8 in. A 60 db whirring sound from the actuating motors accompanied floor movement. Stimulus presentation was automatically controlled by a series of capacitor-discharge timers accurate to 1/4 sec. Digital counters automatically recorded the number of times each stimulus was presented. A sharp click of a timer relay accompanied onset of each stimulus. Stimulus offset was manually controlled by E. Latencies were measured with a Hunter Klockcounter activated by the appropriate timer.

Procedure

Training: Ss were randomly assigned to two training groups of 10 Ss each. Group I Ss were given training with the cue stimulus components presented in serial order. Each S was removed from his home cage and placed in the shuttlebox facing the center. Side was randomly assigned for each animal at the beginning of each session. After 25 sec. (the length of the intertrial interval) the blinking light (CS₁) came on, followed at successive 5 sec. intervals by buzzer (CS₂) and floor retraction (CS₃). Five sec. after floor retraction began, the shock and scrambler came on simultaneously. All CS components and shock remained on until all of the S except the tail had crossed the center of the shuttlebox. At this time, the shock and all components of the CS were simultaneously terminated. Training continued on the first day for 20 trials. At the conclusion of training trial 20, S was immediately removed from the apparatus and returned to the home cage. A second training session was given 24 hr. later. All Ss were trained to a criterion of 9 avoidances in 10 consecutive trials, but were given a minimum of 30 trials although, in all cases, criterion was reached earlier.

Group II Ss were trained to the same criterion with the same general procedure used for group I, except that a 30 sec. intertrial interval was used, and all components of the CS came on simultaneously 10 sec. before shock onset.

Extinction: In order to equate extinction subgroups as much as possible, after training was completed, each training group was divided in two on the basis of the number of shocks received during training. For extinction trials, one half of each training group was continued on the same order of stimulus presentation used during training. The other half of each training group was given extinction trials using the alternate method of stimulus presentation.

Extinction trials were begun 24 hr. after completion of training and were given in blocks of 100 trials per day to a criterion of 9 failures to respond within any 10 consecutive trials. Extinction was discontinued after 400 trials for any S still responding. A trial was scored as failure to respond if the S's response latency exceeded the CS-US interval. If S failed to respond at all, the CS was terminated 30 sec. after the end of the CS-US interval, and the next intertrial interval was initiated.

During both training and extinction phases, escape, avoidance and intertrial responses were manually recorded, as were the latencies for all responses.

Results

A comparison of the two training groups for mean number of escapes with a *t* test for uncorrelated means yielded a *t* of .6, *df*=18, *p* > .50. A similar comparison of the mean number of training trials to, and including the last escape, yielded a *t* of .15, *df*=18, *p* > .50. A final comparison of the training groups for mean amount of shock during training yielded a *t* of .88, *df*=18, *p* > .30. None of the *t* values approached significance. Response means for training are shown in Table I.

Number of trials to extinction criterion (Table I) was treated with a simple 2-way analysis of variance. The comparison was of the effects of mode of training and mode of extinction on rate of extinction. Mode of training yielded no significant differences in rate of extinction (*F*=1, *df*=1/16). For mode of extinction, serially presented CS during extinction produced a significantly slower rate of extinction (*F*=7.33, *df*=1/16, *p* < .02). No significant interaction effects were obtained (*F*=1, *df*=1/16).

Discussion

When complex stimuli are used as CS's, the total stimulus situation at the moment of UCS onset differs markedly from the stimulus situation existant during the intertrial interval. When such great differences exist between the stimuli during CS-US interval and the stimuli (apparatus cues, etc.) present during the inter-

TABLE I
MEAN TRIALS TO CRITERION FOR TRAINING AND EXTINCTION WITH SERIAL AND SIMULTANEOUS CS PRESENTATION

CS Condition	Serial	Simultaneous
TRAINING	18.9	19.3
EXTINCTION	367	199

trial interval, it would seem that learning should be more rapid. This has been suggested by Pavlov (1927) in his reference to the effectiveness of complex stimuli in his conditioning procedures. Confirmation of the effectiveness of complex stimuli in avoidance training has been obtained in our own laboratories. In the present investigation, however, the CS's at the time of UCS onset were equally complex, and the total stimulus situation was therefore identical for Ss under both conditions at the time of UCS onset. No differences in the acquisition of avoidance responses would be predicted and none were found.

The differences in rate of extinction resulting from the differences in extinction procedure can be interpreted in terms of the amount of fear reduction taking place during the procedures. The group extinguishing the more rapidly were always presented with the three stimuli simultaneously. When they avoided, fear was reduced to the whole complex of stimulation on each trial. When the stimuli were presented serially, the Ss soon learned to avoid when the first stimulus was presented. When this happened, fear was reduced to only that stimulus because the others were not present at the time of responding. Fear conditioned to the other stimuli was maintained, generalized from them back to the earlier stimulus, and responding was thus maintained. Theoretically, this could go on indefinitely except for the gradual reduction of fear associated with the second and third stimulus as the result of generalization of extinction.

References

- Annau, Z., & Kamin, L. J. The conditioned emotional response as a function of the intensity of the US. *J. comp. physiol. Psychol.*, 1961, 54, 428-432.
- Kamin, L. J., Brimer, D. J., & Black, A. H. Conditioned suppression of a monitor of fear of the CS in the course of avoidance training. *J. comp. physiol. Psychol.*, 1963, 56, 497-501.
- Kamin, L. J., & Schaub, R. E. Effects of conditioned stimulus intensity on the conditioned emotional response. *J. comp. physiol. Psychol.*, 1963, 56, 505-507.
- Miller, N. E. Studies of fear as an acquirable drive: I. Fear as motivation and fear-reduction as reinforcement in learning of new responses. *J. exp. Psychol.*, 1948, 38, 89-101.
- Mowrer, O. H. *Learning theory and behavior*. New York: John Wiley and Sons, 1960.
- Pavlov, I. P. *Conditioned reflexes* (G. V. Anrep, trans.). London: Oxford University Press, 1927.
- Solomon, R. L. Punishment. *Amer. Psychol.*, 1964, 19, 239-253.