Response-contingent CS termination as a factor in avoidance conditioning

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Abstract:
Four groups of five dogs each underwent acquisition and extinction of a conditioned leg flexion avoidance response, The CS-US interval was 4.0 sec for all groups, but CS duration was either .3. 1.0, 2.0 or 4.0 sec for each group. Responses occurring prior to CS offset terminated the CS. There was no evidence that CS termination facilitated acquisition of the avoidance response. There was slight evidence that the 4.0 sec group took longer to extinguish the avoidance response.

Article:
A basic postulate of the two factor theory of avoidance conditioning (Solomon & Brush, 1956; Rescorla & Solomon, 1967) is that response termination of the secondarily aversive CS serves as reinforcement for the avoidance response. The effect of delaying CS offset after the avoidance response (Bower, Starr, & Lazarovitch, 1965) and the difference between trace and delay avoidance conditioning (Kamin, 1954) can both be interpreted readily within this framework.

Recently several experiments have cast doubt upon this conditioned reinforcement interpretation with its emphasis on the efficacy of response-contingent CS termination (Bolles & Grossen, 1967; D'Amato, Fazzaro, & Etkin, 1968). It has been suggested in these latter experiments that informative feedback concerning the success of the response in precluding the shock is the critical event in learning. The Bower et al and Kamin results are also interpretable within this framework.

However, there have been almost no direct attempts to assess the importance of response termination of the CS. In one relevant experiment, Brush (1957) studied acquisition and extinction of shuttle box avoidance in dogs using traumatic shock. The interval between CS and US onsets was 25 sec for all Ss. Groups differed with respect to the duration of the CS, which was .25, 10 and 20 sec for three independent groups. She found no difference among groups in acquisition, but the number of trials to extinction was a direct function of CS duration. Obviously the groups differed with respect to the opportunity that the dogs had to response during the CS. Unfortunately, interpretation of Brush's results is made difficult by Bower et al's (1965) finding that delay of CS termination following an avoidance response retards learning and hastens extinction; the two effects were competing in Brush's experiment.

The present experiment used a procedure analogous to Brush's except that any dog who responded during the CS terminated that stimulus; groups differed with respect to the duration of the CS in the absence of a response.

Method. The Ss were 24 mongrel dogs, weighing from 15 to 25 lb which were obtained from a local Animal Shelter, In addition six other dogs were discarded owing to sickness, excessive struggling or apparatus failure. All Ss *were housed* individually and given free access to food and water.

Prior to the first day of training, each S was given three 1-h adaptation sessions in the restraining device. On the last two days, the number of spontaneous responses was recorded.

The Ss were restrained in a standing position in a sound attenuated chamber. The right forepaw was strapped to a response lever, the lifting of which turned a potentiometer to yield a voltage proportional to the height of the leg. An electronic gate was set to operate when the leg was lifted 2.5 in. above the floor of the stand. The dog was restrained with a neck collar and a strap around his stomach. In some cases additional straps attached to other legs were also required.

The US was a shock applied through two silver EEG electrodes to the right leg just above the lever strap. The shock level was adjusted for each S to the minimum value yielding a reliable unconditioned response. A response was recorded as any leg lift greater than 2.5 in. from the floor.

The CS was a compound consisting of the onset of a 1000 1iz tone at 77.5 dB and the offset of a 68.5 dB white noise which otherwise was on continuously.

An analog record of the position of the right leg during each trial was taken on a Sanborn Model 297 recorder. Trial sequencing and frequency recording of other response information were carried out with operant relay equipment. Response latencies to the nearest .001 sec were recorded on a Beckman 7250 timer and punched automatically onto cards with an IBM 026 keypunch.

Following pretraining, all Ss received 50 trials per day with a 4 sec interval between CS and US onsets. The US was 5 sec in duration when it occurred and was escapable. The intertrial interval was programmed on a VI 60 schedule. Conditioning was carried to a criterion of 10 successive avoidances, at which time the US was no longer presented and CS-alone trials were presented until S failed to respond within 9 sec on 10 successive trials. If either the acquisition or extinction criterion were not met within 500 trials, training was terminated. The Ss were divided into four experimental groups, roughly equated for the number of responses given on the last day of habituation. The four groups differed in the possible duration of the CS following *CS* onset. The four durations were .5, 1.0, 2.0 and 4.0 sec. During the interval between CS offset and US onset the conditions were the same as during the intertrial interval.

During acquisition, a response of less than 4 sec latency avoided the US and terminated the CS (if it was still present). After US onset a response would terminate the US and CS (if it was still present for the 4.0 sec conditions). The US terminated automatically after 5 sec if no response was made. During extinction the same contingencies held except that the US was never presented.

Results and Discussion. Three Ss in the 4.0 sec group and one in the .5 sec group failed to reach the acquisition criterion. In order to assess the effect of the CS duration on trials to extinction, these Ss were replaced by new ones. Consequently the results for acquisition and extinction reflect the data of different populations of Ss, a fact which should be kept in mind when interpreting the results.

Table 1

	Trials to Criterions[1] Median Range	Trials to Criterions[2] Median Range	Avoidance Latency at Criterion	Probability that Response Terminates CS	Trials to Extinguish Median Range
.5	157 28-500	157 28-165	1.72	.05	146 51-321
1.0	132 23-400	132 23-400	1.54	.19	172 53-212
2.0	100 60-416	100 60-416	1.66	.61	43 31-100
4.0+	500 4-500	53 4-84	1.62	1.00	500 47-500

1. First five dogs in each group.
2. First five dogs meeting acquisition criterion in each group.

Table I summarizes the results of the experiment. There are live Ss represented at each data point (with the proviso that Ss which did not reach the acquisition criterion were replaced in the extinction analysis). There were no differences among the groups in acquisition ($H = 1.39$, $df = 3$, $p > .10$).

Turning now to the analysis of those Ss who did acquire the avoidance response within 500 trials, we find that the groups did not differ with respect to number of trials to the acquisition criterion or mean response latency (all p's > .10). However, there was a significant difference in the proportion of responses that terminated the CS

for the three groups ($H = 11.6$, $df = 3$, $p < .01$): the longer the CS, the greater the probability that an avoidance response terminates it. The 4.0 sec group was excluded from the analysis because all Ss terminated the CS by definition.

There was also a reliable difference in the trials to the extinction criterion ($H = 8.8$, $df = 3$, $p < .05$) which was primarily due to the slower extinction of the 4,0 sec group ($H = 4.95$, $df = 1$, $p < .05$). The difference among the three trace groups was not significant ($H = 4.42$, $df = 2$, $p > .10$).

Although these results are complicated by the failure of some Ss to acquire the initial ,avoidance response and by the large variability within groups, they certainly give no support to positions which posit response-contingent CS termination as an important event in acquisition of the avoidance response: any trend in the data was in the opposite direction.

Despite the large differences in several experimental parameters, the results from this experiment and that conducted by Brush (1957) are strikingly similar, Her major variable, CS duration, did not influence acquisition of the avoidance response, but did affect extinction. This would seem to indicate that response-contingent CS termination is not a potent variable for dogs in learning the avoidance response. Rather, the evidence seems to point to feedback from the response as the important stimulus in controlling the animals' learning in our experiment. Clearly, more research is required to determine the conditions which control the efficacy of cues from the CS and the avoidance response. Recent evidence indicates that either may come to control the response under as yet unknown conditions (Rescorla, 1967; Black, 1965).

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