Effects of a classical conditioned 'fear signal' and 'safety signal' on nondiscriminated avoidance behavior¹

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Rats were trained to avoid shock on a Sidman schedule in a shuttle apparatus; then they were tested with a probe stimulus that in a Pavlovian session for different groups signalled shock, or absence of shock. The danger signal increased the rate of avoidance responding and the safety signal decreased it. Two control procedures are compared.

Several investigators have reported that fear conditioned by Pavlovian procedures can affect instrumental behavior (Hammond, 1966, 1967; Rescorla & LoLordo, 1965). The procedure involved in these studies is to establish a conditioned fear signal (CS^+) by explicitly pairing a signal with electric shock and then looking for facilitation by CS^+ of a previously learned avoidance response. Alternatively, fear conditioning can be shown by the suppression of appetitive behavior by CS^+ in a CER situation.

A related procedure involves the presentation of a signal (CS^-) which explicitly predicts the nonoccurrence of shock and then looking for a suppression of avoidance responding in the aversive case, or an enhancement of response rate in the appetitive CER case whenever the CS^- is presented. On the assumption that both CS^+ and CS^- effects are genuine, Rescorla (1967) has recommended a control procedure with a random CS-US pairing which, presumably, allows the CS to gain no associative control over the behavior since it consistently predicts neither the occurrence nor nonoccurrence of shock.

There is some reason, however, to doubt the validity of Rescorla's assumptions. The present experiment is concerned with whether Pavlovian training is given in a situation other than the test situation. Are the same effects obtained when S is a rat rather than a dog? Do the effects occur when a control other than Rescorla's random control procedure is used? Do the danger signal and safety signal effects appear when appropriate allowance is made for possible sensitization effects?

Subjects. The Ss were 24 female Long-Evans rats approximately 110 days old at the beginning of the experiment.

Apparatus. The shuttle apparatus was 36 in. x 5 in. high with metal walls. The floor was 3/8 in. stainless steel bars spaced on 1-in. centers. A 2-in. barrier, located in the center of the box, had two parallel 1/8-in. stainless steel bars wired to a 120 V source through 250 K resistance across its top. Responses were detected by a photocell located 1-3/4 in. above the barrier.

The Pavlovian conditioning apparatus was a 10-in. square box with a grid floor similar to the shuttle box floor and metal walls which were included as an element in the grid floor.

Shock was provided to the apparatus by a Grason-Stadler shocker-scrambler, model E1064GS. All programming and recording was done by appropriate electronic equipment isolated from the apparatus.

Procedure. All Ss were given five training sessions with a Sidman procedure in the shuttle apparatus with an R-S interval of 30 sec and an S-S interval of 5 sec. Shock intensity was 1.25 mA and shock duration was .25 sec. Each session lasted until S had made 300 responses.

Following this initial training on the avoidance response in the shuttle apparatus, all Ss were given 30 shock-tone pairings in the Pavlovian conditioning apparatus on each of three days (90 total). The CS was a 5-sec, 3300 Hz tone, approximately 90 dB. The US was a 2-sec, 1.25 mA intermittent shock. The Ss were now separated into four equal groups and given different treatments as follows: For Group CS^+ , the US always occurred within 30 sec after CS onset. For Group CS^- , the US never occurred within 30 sec after CS onset. For the random group, Group R, the CS and shocks occurred randomly in time. A sensitization-control group, Group S, received only the shocks without an CS presentation. The intertrial interval was variable with a mean of 90 sec.

Following the Pavlovian-conditioning phase, all Ss were given four test sessions back in the shuttle apparatus. The tone used in the Pavlovian

conditioning situation was presented as a probe on 10 trials which were distributed randomly among the last 100 of each session while the Ss were on extinction. The onset of the tone followed 1 sec after the shuttle response.

Results. The avoidance response was readily acquired and was occurring at a very stable rate by the fifth training session with a mean interresponse latency of 15.6 sec; the median S was receiving only 12 shocks during the last 300-response session. This shock rate is considerably lower than that typically found in bar-pressing situations at the same stage in acquisition (Sidman, 1967). All Ss acquired the response.

The mean response latency of each group on test trials is shown in Fig. 1 along with the baseline mean response latency measured on non-CS trials. Analysis of variance of these test trial latencies yielded significant differences among conditions ($F=10.70$; $df=3/80$; $p < .01$). Neither the sessions factor nor the interaction was significant ($F < 1$).

The CS^- group's response latencies on CS trials were reliably longer than those of all other groups except the random control group during the third and fourth test sessions ($p < .05$, Duncan Range Test). The response latencies on CS trials for Group CS^- were reliably longer than their response latencies on non-CS trials ($p < .02$, correlated t test).

The CS^+ group's response latencies on CS trials were reliably shorter than those of any other group during all test sessions ($p < .01$, Duncan Range Test), and they were also reliably shorter on CS trials than on non-CS trials ($p < .01$, correlated t test).

The two control groups did not differ significantly from each other on CS trials nor was there a difference in latency between test trials and nontest trials for either group.

Discussion. These results indicate that a sensitization group provides an appropriate control for this kind of Pavlovian conditioning procedure. If multiple test sessions are run, as in this investigation, it appears that the random group fluctuates considerably around the baseline response latency, whereas the sensitization group very closely parallels baseline response latencies. This may indicate that a sensitization control has some advantages over a random control. Notice that the random group's CS trial response

Fig. 1. The mean latency of a previously learned avoidance response in the presence of a stimulus which for different groups is a danger signal (CS^+), a safety signal (CS^-), or not systematically related to shock.

latencies on test day one are *shorter* than their baseline response latencies, but by the fourth test session their CS trial latencies are *longer* than the baseline latencies. This finding suggests that for this group the CS acts initially like CS⁺, but becomes more like CS⁻ during the course of testing. Thus, for the random group the CS appears to gain some associative control over the avoidance behavior in the test situation.

The behavior of the CS⁺ and CS⁻ groups confirm the findings of Rescorla (1967) and add further generality to his findings, since the present study was done with rats while he used dogs. These results also support Rescorla's assumption that fear can be conditioned using a Pavlovian paradigm; i.e., fear can be either elicited or inhibited by a signal depending upon what the CS-US relationship has been.

Perhaps some caution should be exercised in interpreting these results, however. Although it is possible that the differences in behavior observed in the avoidance situation depend upon differences in the momentary strength of fear, as Rescorla has contended, there are other theoretical possibilities. Thus, it may be that the effect of CS⁻ is not due to an inhibition of fear, but represents a positive reinforcing effect of the safety signal. The occurrence of a CS⁻ may be a reinforcing event similar in some way to what happens when S makes an avoidance response that takes it out of the danger situation and into

a safe place. If that is the case, then it may be that the CS⁻ effect is limited only to those situations in which the occurrence of the avoidance response fails to produce well-defined changes in situational stimuli. This interpretation suggests that, e.g., a one-way avoidance response might not be appreciably suppressed by a CS⁻, whereas the effect might be even more prominent in a bar-press situation than it was here.

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