Stimulus intensity and trace intervals in sensory preconditioning using the CER

JOHN D. ROGERS
California State University, San Jose, Calif. 95114

Sixty-four rats were given preconditioning training (S_1-S_2 pairings) with a trace interval of 0, 2, 5, or 8 sec and an S_1 of either strong or mild intensity. Preconditioning was followed by conditioned emotional response (CER) training, with S_2 used as a CS. The response measure used for analysis was the suppression of consummatory drinking in the presence of S_1. The results indicated: (a) a significantly greater amount of suppression for strong S_1 groups than for mild S_1 groups, (b) no significant differences in suppression among groups receiving various trace-interval lengths, and (c) no significant interaction effects. It was concluded that the results were similar to effects obtained in comparable classical conditioning situations.

The sensory preconditioning (SPC) paradigm may be divided into three phases. In the preconditioning phase, two neutral stimuli (S_1 and S_2) from different sensory modalities are repeatedly presented in close temporal contiguity. In the conditioning phase, an overt CR is established to S_2. The third phase consists of a test for transfer of the CR to S_1.

The SPC phenomenon can be interpreted as a form of S-R learning by invoking a mediational hypothesis (Osgood, 1953). In the mediation hypothesis, the preconditioning phase is treated as a classical conditioning paradigm, with S_1 corresponding to a CS and S_2 corresponding to a mild US. During preconditioning, a covert UR elicited by S_2 becomes conditioned to S_1. In the conditioning phase, S_2 becomes a CS, produces a UR, and the sensory feedback from that response also becomes a part of the stimulation to which the measured response (overt CR) is conditioned. In the test phase, S_1 elicits the covert CR acquired during preconditioning and the sensory feedback from this response elicits the overt CR.

An implication of the mediation hypothesis is that variable manipulations known to affect CR magnitude in classical conditioning should have a similar influence on the strength of the covert CR acquired during preconditioning. Several variables of importance in classical conditioning have been investigated within the SPC framework. For example, Prewitt (1967) examined the function of the number of preconditioning trials on SPC; Tait, Marquis, Williams, Weinstein, & Suboski (1969) examined the function of the number of extinction presentations of S_1 following preconditioning on SPC and the effect of forward and backward preconditioning on SPC; Tait, Black, Katz, & Suboski (1972) investigated the effect of preconditioning discrimination training on SPC. Despite the fact that, in SPC, covert CR strength must be measured indirectly from the amount of response transfer, the results of these studies generally indicate that SPC and classical conditioning are similarly responsive to the manipulation of comparable variables.

Little attention has been given to the effect of variations of a preconditioning trace interval (i.e., an interval between S_1 offset and S_2 onset) on performance. In addition, the evidence regarding the effect of S_1 intensity variations on performance seems to be equivocal (e.g., Holmes, 1968; Tait & Suboski, 1972; Thornton, 1958; Wokoum, 1959). The present study was designed to compare the effects of the above variables with those of classical conditioning in similar parametric experiments. If preconditioning is a form of classical conditioning, then the amount of transfer should vary inversely with the length of the trace interval (Kamin, 1961), and an increase in S_1 intensity should produce an increase in the amount of transfer (Gormezano & Moore, 1969). Also, there seems little reason to believe the S_1 intensity effect will not be independent of the trace-interval factor.

METHOD

Subjects

The Ss were 64 male Sprague-Dawley rats, 80 days old and 380-430 g in weight at the onset of the experiment. All Ss were individually housed and were allowed free access to food.

Apparatus

The apparatus for preconditioning and conditioning consisted of a 9½ x 8 x 7½ in. conditioning chamber, mounted inside a Scientific Prototype A-115 sound-attenuated box. The chamber had front and rear walls of aluminum, side walls and lid of Plexiglas, and a floor of 1/8-in. stainless steel grids on 9/16-in. centers. The scrambled electric shock delivered through the grids was generated by an A-615 Lafayette shock supply. A frosted 6-W light, serving as S_2, was mounted on the front wall 6 in. above the grid floor.

The testing apparatus consisted of a 9 x 7½ x 8 in. test chamber, mounted inside a Scientific Prototype A-115 sound-attenuated box. The chamber had three walls (front, rear, and side) of white acrylic plastic, one side wall and lid of Plexiglas, and a stainless steel sheet floor. The spout of a water bottle was exposed through an opening in the front wall, 2½ in. above the floor. Each tongue contact with the water was relayed through a Grason-Stadler electronic drinkometer and recorded on a BRS Foringer printout counter.

The S_1 was presented by means of a Lafayette 15010 audio-signal generator and amplifier. Duration of stimuli, trace intervals, and ITIs were regulated by repetitively connected Hunter timers. In each sound-attenuating box, a fan produced a background noise level of 73 dB, while a 6-W light provided ambient illumination. The lids of the conditioning and test chambers were covered with manila paper so as to make the lighting more diffuse. All sound-level measures were taken with a General Radio sound-survey meter.

Procedure

Eight Ss were assigned randomly to the cells of a 2 by 4

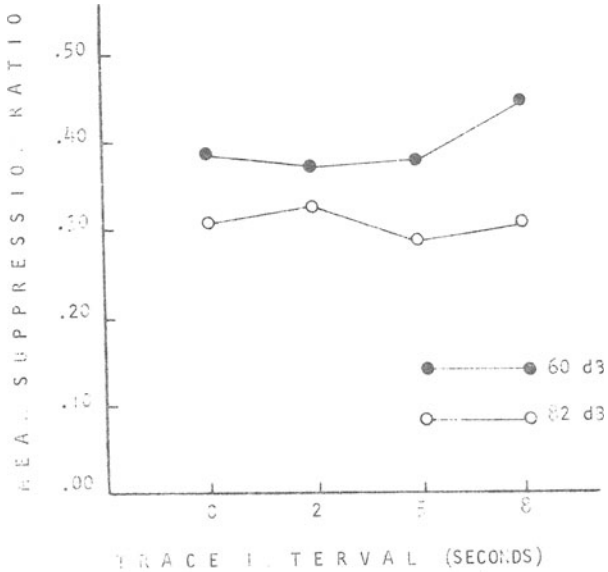

Fig. 1. Mean suppression ratios for groups given either a strong S_1 or a mild S_1 as a function of the length of the trace interval.

factorial design. The S_1 intensity factor was varied at two levels: 1000-cps 82-dB tone and 1000-cps 60-dB tone. The trace-interval factor was varied at four levels: 0, 2, 5, and 8 sec.

In this experiment, Prewitt's (1967) CER procedure was used. After handling, Ss were water deprived for 24 h and then received water on two occasions in the test chamber. These lick sessions were 24 h apart and lasted for 700 sec following the first burst of licking.

Preconditioning began 24 h after the second lick session. Sixteen S_1-S_2 (tone-light) pairings were given with a randomly prearranged ITI of 40, 60, or 80 sec. With the ISI (i.e., the interval between S_1 onset and S_2 onset) held constant at 10 sec, the length of the trace interval was varied at the four levels. Therefore, S_1 was either 82 dB or 60 dB in intensity and 10, 8, 5, or 2 sec in duration. The S_2 was 6 W in intensity and 10 sec in duration.

The CER conditioning began 60 sec after the preconditioning phase. Ten S_2-US (light-footshock) pairings were given with a randomly prearranged ITI of 40, 60, or 80 sec. The S_2 was of the same intensity and duration used during preconditioning. The US was 1.2 mA RMS in intensity and .5 sec in duration. The S_2 and US terminated simultaneously. A 30-min recovery period in the home cage followed CER conditioning. Subsequent to the recovery period, S was placed in the test chamber for a final 700-sec lick session.

The test for transfer began 24 h after the final lick session. Sixty seconds after the first burst of licking, 10 S_1 (tone) presentations were given, with a duration of 10 sec and a randomly prearranged ITI of 40, 60, or 80 sec. For each S, the intensity of S_1 presented on test trials was the same as that given during preconditioning.

Response Measure

The suppression effect was measured by computing a suppression ratio. This ratio was calculated for each S by taking the number of licks during any S_1 presentation and dividing it by the number of licks in the 10 sec immediately preceding S_1 onset plus licks during the S_1 presentation. When calculated in this fashion, smaller ratios indicate greater suppression.

RESULTS AND DISCUSSION

The results of this experiment are presented in Fig. 1. Each point represents a mean suppression ratio for a group of eight Ss. It is clear from Fig. 1 that suppression was consistently greater for strong S_1 groups than for mild S_1 groups, whereas variations in the trace interval produced very little difference in suppression by S_1. Figure 1 also suggests that the two factors function independently of each other. An analysis of variance conducted on the suppression ratios indicated that the strong S_1 groups showed significantly more suppression than the mild S_1 groups ($F = 14.23$, $df = 1/56$, $p < .001$), while no other F ratio approached significance.

In classical conditioning, most reviewers (e.g., Gormezano & Moore, 1969) have concluded that the majority of evidence shows CR magnitude to be a positive function of CS intensity. In the present study, the finding that a strong S_1 led to a significantly greater suppression effect than a mild S_1 seems to indicate that this same relationship may indeed occur in SPC.

In CER conditioning, Kamin (1961) found that the amount of suppression was inversely related to the length of the trace interval. The second finding of the present investigation, unlike Kamin's (1961) results, revealed that trace-interval variations during preconditioning had no significant effect on suppression. However, it appears that there is an ISI by Trace Interval interaction in CER conditioning (Kamin, 1965). That is, delay and trace conditioning procedures do not produce any significant differences in suppression, provided the ISI is "favorably close" to the US; yet, when the ISI is "too far" from the US, the delay procedure is significantly superior to short and long trace procedures, and the short trace procedure in turn is significantly superior to the long trace procedure. Therefore, if, as Kamin (1965) says, the 3-min ISI used in Kamin's (1961) study is beyond the optimum range for CER conditioning and if the 10-sec ISI used in the present study can be accepted as within the optimum range for SPC, then, unlike the effect obtained by Kamin (1961), the trace-interval manipulations in the present study should not have produced any significant differences in suppression. The fact that no significant effect was obtained, therefore, seems to indicate that trace-interval effects in SPC and classical conditioning are similar when the ISI is close to optimum.

Given that comparable parametric work in SPC and classical conditioning can provide the basis for a decision as to their equivalence, the present findings lend additional empirical support to the notion that classical conditioning occurs during the preconditioning phase of the SPC procedure.

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