Terrace's "Fading-in" of CS- in differential eyelid conditioning

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Abstract

Differential eyelid conditioning experiments were run to determine whether the use of "fading-in" and "shaping" procedures would result in the suppression of responses to CS- similar to that demonstrated by Terrace in the pigeon operant situation. Suppression of CR- and CR+ resulted when CS- was slowly "faded in" from the background; however, no decrement or enhancement of differentiation was observed. These results were interpreted in terms of generalization of inhibition from the background stimuli.

Problem

According to Terrace (1963), one implication of the excitation-inhibition theory of discrimination learning (Kimble, 1961, pp. 364-374) is that the occurrence of error responses (responses to S-, which are never reinforced) are necessary for the learning of a discrimination, since error responding and consequent nonreinforcement is presumably the mechanism which establishes a gradient of inhibition about S-. Terrace's (1963, 1964) experiments have brought this assumption into question. In an operant situation with pigeon Ss, a visual S- was "faded in" along dimensions of stimulus duration and intensity, while the wavelength differential between the two discriminative stimuli was held constant. Ss who received this "fading-in" procedure made very few error responses in training, and some made none at all. At the same time, responding to S+ was maintained at a high level. Similar results have been reported by Cole et al (1964) in a size discrimination task with nursery school children. "Fading-in" the visual S- along the dimension of size and degree of figural completeness produced discrimination learning without errors in 18 of 25 Ss.

Experiment I

The purpose of this experiment was to determine whether suppression of responding to CS- by use of the "fading" procedure results in improved differential eyelid conditioning when compared with a conventional procedure.

The gross features of the apparatus are the same as the two chair arrangement described by Moore & Newman (in press). The CSs were sinusoidal tones of 600 and 1000 cps, 60 db SPL. The US was a puff of nitrogen of 100 mm Hg static pressure (1.98 psi). The CS-US interval was 800 msec. and the CS terminated together with the 50 msec. US. Inter-trial interval was 10, 15, and 20 sec., randomly distributed over trials, with an average ITI of 15 sec. A conditioned response was defined as any positive deflection of the recording pen of at least 1 mm ampli-

tude in the interval 150 to 825 msec. after CS onset.

The Ss were 80 undergraduates recruited from Introductory Psychology classes at the University of Massachusetts. The control group was a conventional differential conditioning group in which CS+ and CS- differed only in frequency. The experimental (Fade) group received 80 trials over which the intensity of CS- was gradually increased from 40 db SPL on the first CS- trial at the rate of 1 db for every two CS-trials up to trial 80. This group then received 60 additional trials on which the two CSs were of equal intensity at 60 db SPL. There were 20 men and 20 women in each group. For half of the Ss in each group, the 600 cps tone was CS+ and the 1000 cps tone was CS-, and vice versa for the other half. Ss received "neutral" instructions over an intercom immediately before the first trial and no "ready" signals were employed. All Ss received 140 acquisition trials, half of them being CS+ trials and half CS- trials, in a random sequence, with no runs of length greater than three.

Figure 1 presents the learning curves for the two groups of Experiment I as well as the data from Experiment II. Consider only the "fade" and control groups for the moment. The figure shows that CR- for the "fade" groups never attained the level of CR- for the control group, but CR+ as well as CR- was suppressed compared with the control group. An analysis of variance of the arcsine-transformed percentage scores indicated that the uniformly higher levels of responding for the control group was significant, $F(1,72) = 5.44, p < .025$. Moreover, the discrimination performance did not differ for the two groups, $F(1,65) = .75$.

Experiment II

The "fading-in" technique does not make any allowances for individual differences in reaction threshold to CS-. It was thought that a "shaping" procedure would be more sensitive to individual differences in reaction threshold and therefore might improve differentiation over the two groups of Experiment I, and thereby yield results which are more compatible with Terrace's (1963) findings.

The "shaping" technique consisted in increasing the intensity of S- 1 db following each trial on which S did not respond to S-. If a CR- were made, the intensity of S- was reduced 3 db for the next trial, and increments of 1 db were then reinstated. Figure 2 shows the actual mean intensity of CS- as a function of trial-block. S were 14 women and 8 men recruited from the same population as were the Ss in Experiment I, and the frequency of the tonal CSs and all other procedural details were the same as in Experiment I.

Fig. 1. Mean percentage of CRs to CS+ and CS- as a function of trial-block for Experiments I and II.

Fig. 2. Mean intensity of CS- in db SPL for the "shape" groups of Experiments II and III.

Fig. 3. Mean percentage of CRs to CS+ and CS- as a function of trial-block for Experiment III.

Figure 1 reveals that the shaping procedure depressed both CR+ and CR- even more than did the "fading-in" procedure of Experiment I.

Experiment III

The "fading-in" and "shaping" procedures were generally successful in depressing CR-, but contrary to expectations from Terrace's findings, it proved impossible to suppress responses to CS- completely, and there was no enhancement of differentiation scores (CR+ minus CR-) compared with conventional differential conditioning.

A yoked control experiment provided one way of assessing the role of stimulus variability in the suppression of responding observed in Experiment I and II. In Experiment III, variation of the intensity of CS- was contingent upon the CR- performance of one S, as in the "shaping" procedure, but not upon the performance of the yoked control S. Hopefully, this design permitted the effects of counter-conditioning through shaping to be separated from the effects of stimulus variability (Voeks, 1954).

Twenty-four pairs of Ss completed the design, with sex, recording channel, and which tones served as CS+ and CS- counterbalanced. The method was essentially the same as in Experiment II except that "shaping" was restricted so that large cumulative reductions in the intensity of CS- did not occur. Thus, with extremely high level responders, CS- intensity was not attenuated as much as for the average S in order that the intensity of CS+ and CS- would be more comparable by the end of training. (See Fig. 2)

Figure 3 shows that the experimental S responded less to both CS+ and CS- than the yoked control Ss. For 18 of the 24 pairs of Ss, total percentage of CSs (CS+ plus CR-) for the experimental S was below that of his yoked partner. This difference is significant by a Sign test

TABLE I

Pearson Product-Moment Correlations between Proportion CR+ and CR- for each Group of Experiments I-III.

	Trial 21-80	Trial 81-140
Control (I)	.52	.06
Fade (I)	.44	.44
Shape (II)	.21	.31
Exp't (III)	.23	.53
Yoked Control (III)	.38	.41

($p = .011$; Cf. Church, 1964).

Moore & Newman (in press) have shown that the intertrial stimulus (ITS) can be a source of inhibition for a CS, provided the two stimuli are similar enough. Assuming that a weak tone (CS-) is sufficiently similar to white noise (ITS in these experiments), it is clear that the CS- accumulates inhibition from both nonreinforcement and the ITS. Generalization of this augmented inhibition from CS- to CS+ can account for the lower level of CR+ in those groups in which CS- started "close to" the ITS compared with the conventional differential conditioning group of Experiment I. This effect was understandably greater in the "shaping" groups than the "fade" group of Experiment I and the yoked controls of Experiment III because, here, the similarity between CS- and the ITS was immediately increased whenever needed, i.e., whenever a CR- indicated CS- to be in a momentary state of excitation.

Table 1 indicates positive correlations between CR+ and CR- which persisted over trials 81-140 in all groups in which the intensity of CS- was in some way "faded in". Since the magnitude of this correlation is inversely related to the stage of differentiation (from generalization to discrimination), the failure of these correlations to decrease from the first to the second half of training, as in the conventional group, suggests that differentiation was not well advanced and that further training might have produced greater separation between CR+ and CR-.

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Notes

- Now at Indiana University.
- This investigation was supported in part by Public Health Service Grant NIH-HD-00955-03. The authors wish to acknowledge the assistance of Ruth Pollack and Sandra Teguis.