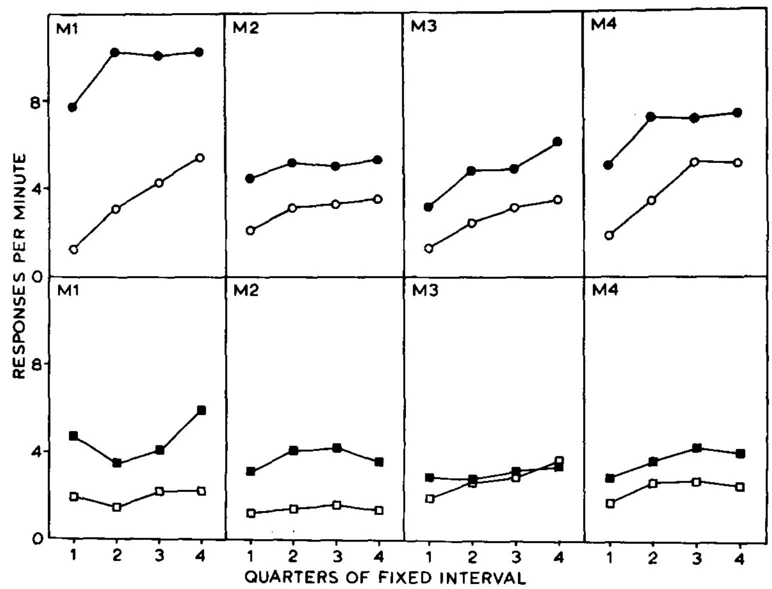


**Fig. 4. Mean response rate in initial component of chained schedule in each quarter of the 13-min interval between presentations of primary reinforcement. Open circles: stimulus presented on FI 13-min, with subsequent primary reinforcement in terminal component. Solid circles: continuation of FI 13-min, with added stimulus presentations on VR 10. Open squares: stimulus presented on DRO schedule, with subsequent primary reinforcement. Solid squares: continuation of DRO schedule, with added stimulus presentations on VR 10.**

procedure was higher than it was under the second procedure. This result is consistent with the idea that primary reinforcers are stronger than conditioned reinforcers: When responding was maintained, in part, by primary reinforcement and, in part, by conditioned reinforcement, the rate was higher than when responding was maintained by conditioned reinforcement alone. In the second procedure, a considerable response output continued over a period of time when only conditioned reinforcement maintained responding. Here, the capacity of the stimulus to act as a reinforcer was maintained by association with primary reinforcement without primary reinforcement of lever pressing.

The results are consistent with those obtained by Kelleher (1966) and others, who found that a brief exteroceptive stimulus can modify responding on second-order schedules, and by Zimmerman, Hanford, & Brown (1967), who found that a brief exteroceptive stimulus associated regularly with food can maintain key-pecking responses in the pigeon over extended periods of time in the absence of primary reinforcement of key pecking. These results also suggest that conditioned reinforcement is important in maintaining responding in the initial component of chained schedules.

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NOTE

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# Effect of chromatic surround during nondifferential training and generalization test upon generalization along the angularity dimension in pigeons[1]

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*Two groups of pigeons were nondifferentially trained in the presence of a white vertical line. For one of these, the surround was chromatic; for the other, it was black. The two groups were subdivided; half of each group was tested for generalization with a chromatic and half with a black surround. The chromatic surround during training produced steeper angularity gradients than the black surround; surround color during generalization test did not influence angularity gradient slope.*

In a recent experiment (Baron & Bresnahan, 1969), generalization gradients along the angularity dimension were examined following nondifferential training to a vertical white line. Training and test with a chromatic surround (578 mμ) in both the experiment and a replication produced somewhat (but not significantly) steeper gradients than training and test with a black surround. These data suggested that, during nondifferential training, chroma attracts attention, but that the attention is nonselective, i.e., that chroma in the surround tends to increase attention to the vertical white line.

Two experiments have provided evidence that chroma in the surround during generalization test has a somewhat different effect. Following training to a white vertical line on a chromatic (555 mμ) surround, Freeman & Thomas (1967) and Newman & Benefield (1968) tested for generalization along the angularity dimension and found a flatter gradient with the chromatic than with the black surround. These investigators suggested a cue-utilization explanation, viz, that during generalization test, the chromatic surround is dominant, and that the Ss utilize the dominant more than the less dominant (angularity) cue as a basis for responding.

The findings of the last two studies suggest an explanation for the lack of significance of the effect noted by Baron & Bresnahan (1969). Assuming, as the latter investigators suggest, that chroma in the surround during nondifferential training increases the slope of the angularity gradient, while, as Freeman & Thomas (1967) and Newman & Benefield (1968) have found, chroma in the surround during generalization test decreases the slope of the angularity gradient, then Baron and Bresnahan's failure to find a significant effect may have been due to the fact that, in their study, the chromatic surround was present during both training and test.

The present study, like Baron & Bresnahan's (1969), provided nondifferential (single-stimulus) training to a vertical white line. By employing a factorial design, the present study examined the effect of a chromatic (578 mμ) surround during training and during generalization test, upon the slope of the gradient along the angularity dimension.

## METHOD

The Ss were 40 experimentally naive homing pigeons obtained from a local supplier.

Three identical Skinner-type pigeon boxes, described in Newman & Baron (1965), were utilized. An overhead jeweled GE 47 bulb illuminated each box.

The stimuli, projected on the key by a display cell, consisted of a chromatic (578 mμ) light and a white line (¼ x 1 in.) tilted at one of five angular orientations, varied in 30-deg steps from a position 60 deg counterclockwise to 60 deg clockwise from the vertical. The surround could be made black by switching off the light source for the 578-mμ filter.

White noise was continuously presented via a speaker mounted in the ceiling of each box.

The Ss were maintained at 75% (±10 g) of their ad lib weight. On Day 1, they were unsystematically assigned to one of four treatment groups and were magazine and key-peck trained. The stimulus key contained a white vertical line on a chromatic surround for Groups C-B and C-C and on a black surround for Groups B-B and B-C. Each pecking response at the key provided 3 sec of food reinforcement. Each S was allowed to make 100 continuously reinforced responses, 50 on Day 1 and 50 on Day 2.

On Days 3 through 12, all Ss were gradually shifted to a VI schedule in which two reinforcements were randomly programmed during each 55 sec. Each day's

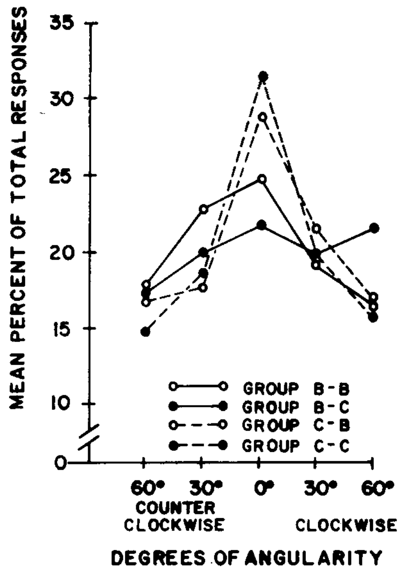


**Fig. 1. Relative number of responses to test stimuli for two nondifferentially trained groups each subdivided and tested under two conditions.**

training consisted of 30 55-sec periods, during which the visual display remained unchanged.

On Days 13 and 14, Ss were given a warm-up session immediately followed by a generalization test on the angularity dimension. Warm-up consisted of six 55-sec presentation periods of the complex stimulus that had been present in training. Two reinforcements were programmed in each 55-sec period. The test consisted of 10 presentations (45 sec each) of the five test stimuli in a counterbalanced sequence. Groups B-B and C-B, which had been trained with a black and with a chromatic surround, respectively, were tested with a black surround; Groups B-C and C-C, trained with a black and with a chromatic surround, respectively, were tested with a chromatic surround. Each group of 10 Ss was divided into five pairs; each pair started the generalization test series with a different angular orientation.

## RESULTS

The relative generalization gradients of the four groups of Ss are shown in Fig. 1. The gradients appear steeper for Groups C-B and C-C than for Groups B-B and B-C. An analysis of variance showed that the interaction between Training Conditions and Angular Orientations was significant ($F = 2.89$, $df = 4/144$, $p < .05$). In other words, when the performance of the two training groups was averaged across test conditions, steeper angularity gradients were obtained with the chromatic than with the black surround present during training.

A comparison of the generalization gradients of the groups tested with the two different surround colors suggests that test conditions did not influence the gradient slopes. An analysis of variance confirmed this observation; the interaction of Test Conditions by Angular Orientations (averaged across training conditions) was not significant.

## DISCUSSION

Failure to find that chroma in the surround during generalization test reduced angularity gradient slope is inconsistent with the findings of Freeman & Thomas (1967) and Newman & Benefield (1968), which formed the basis for the cue-utilization hypothesis. The discrepancy between the results of the present study and those of Freeman & Thomas (1967) may be more apparent than real since these authors question the reliability of the effect they observed.[2] The difference between the present results and those of Newman & Benefield (1968) are not readily explained but may have resulted from differences in procedure. They established a white line on a chromatic surround as a secondary reinforcer by means of a nondifferential training procedure. This allowed Ss to differentiate a blank key (in the presence of which no reinforcement was given) from the white line on the chromatic surround (the secondary reinforcer); in the present study, the complex training stimulus remained unchanged throughout training. In addition, Newman and Benefield utilized a 555-mμ light as a surround, while the present study utilized a 578-mμ light.

The finding of a steeper angularity gradient with nondifferential training to a white line on a chromatic (rather than achromatic) surround is consistent with evidence reported by Baron & Bresnahan (1969). The present finding supports their suggestion that, with nondifferential (single-stimulus) training, attention is nonselective, and that the (salient) chromatic surround increases attention to the line and to its angularity.

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## NOTES

1. A version of this paper was presented at the meeting of the Midwestern Psychological Association, Chicago, May 1969.

2. Personal communication.