

direction (the same number of trials Capaldi employed in his between-group design) were enough to constitute "extended" training and produce greater resistance to extinction for the multiple-N-length direction.

Two groups of Ss with different overall sequences were used to insure that the results of this study and Capaldi's earlier study were determined by the N-lengths being compared rather than by some other variable or variables that might differentiate Capaldi's original single- and multiple-N-length sequences.

It is interesting to attend to the between-groups comparison that can be made. The Ss in one group experienced a maximum N-length of 6 independent of direction, while Ss in the other group experienced a maximum N-length of 3. Both groups experienced their maximum N-length the same number of times. Although the group with the maximum N-length of 3 experienced N-lengths of 1 and 2 more often than the maximum N-length of 6 group, the maximum N-length of 6 group had considerable experience with N-lengths of 4 and 5; i.e., the maximum N-length of 6 group experienced the N-lengths of 6, 5, 4, 3, 2, and 1, 10, 5, 0, 5, and 5 times, respectively, while the maximum N-length of 3 group experienced N-lengths of 3, 2, and 1, 10, 10, and 70 times, respectively. Thus, the maximum N-length of 6 group: (1) experienced three N-lengths that were greater than those experienced by the maximum N-length of 3 group and (2) experienced as much training on the maximum N-length of 6 as the maximum N-length of 3 group had on the N-length of 3. The maximum N-length of 3 group had more experiences with the short N-lengths of 1 and 2. The greater training on the N-lengths of 1 and 2 for the maximum N-length of 3 group makes an unequivocal statement about resistance to extinction for the two groups impossible. Nonetheless, the sequences suggest that the maximum N-length of 6 group should be considerably more resistant to extinction.

The similar performance that was obtained with both groups can tentatively be explained in terms of the response that was employed. The generic response of running was separated into running in two directions. The within-Ss comparisons suggest that the Ss were making two distinct responses in the two directions. Therefore, it is possible that the Ss' behavior was not greatly affected by their overall sequence independent of direction. This would imply that each S was making two responses and that running independent of direction is not an effective overall response.

The present study demonstrates that sequenced reinforcement effects can be obtained with a within-Ss design. Such a design enables the E to compare sequences using fewer Ss than needed in a between-groups design. Further, differences obtained with between-group and within-Ss designs can be useful for determining the differences between the two kinds of situations (see Grice, 1967).

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Two-cue discrimination learning by pigtail monkeys*

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Twelve monkeys were given a discrimination between black vertical and white horizontal rectangles and then given preference tests with original positive and negative stimuli paired with white vertical, black horizontal, white and black diagonal rectangles, and white and black circles. Ss responded more to circles than to other preference stimuli early in preference testing but less later, suggesting a novelty effect. Preference for the reinforced brightness was significantly higher than for the reinforced orientation.

Sutherland & Holgate (1966) trained rats to discriminate rectangles differing in both brightness and orientation and then gave preference tests with rectangles differing only in brightness or only in orientation. They found consistent negative correlations between appropriate responses to brightness and to orientation, indicating that the more the rat learned about one cue the less it learned about the other. Mumma & Warren (1968) replicated this study with cats and found a low positive correlation between responses to brightness and orientation. Cats' responses during preference testing were determined by stimulus novelty. Warren & Warren (1969) conducted a similar experiment with rhesus monkeys. Stimuli used in preference testing, however, were different from those used in training (i.e., black and

white circles for brightness and green horizontal and vertical rectangles for orientation) to control for novelty effects. The monkey's preferences for brightness and orientation were significantly negatively correlated, supporting Sutherland and Holgate's interpretation of multiple cue learning.

The present experiment was designed in part to replicate and in part to extend with monkeys Mumma and Warren's experiment with cats, with responsiveness to novelty of primary interest. Similarity between the preference stimuli and the training stimuli was varied. It was predicted that as the preference stimulus resembled less the training stimulus, S would respond relatively more to it.

SUBJECTS

Twelve pigtail monkeys (*Macaca nemestrina*), weighing from 2.5 to 3.5 kg, were used. They had been adapted to the WGTA and run in a size-color preference experiment.

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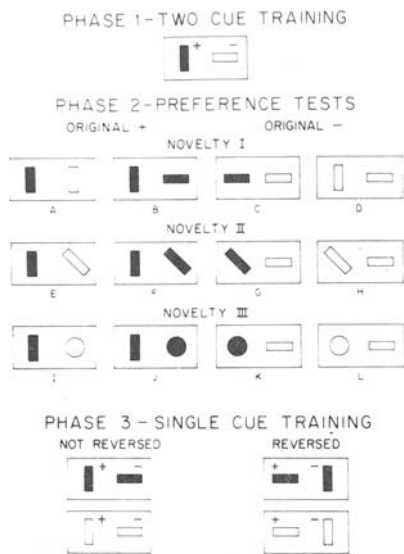


Fig. 1. Summary of experimental design.

APPARATUS AND STIMULI

The apparatus was a WGTA modified so that S displaced objects through a Plexiglas barrier with four circular holes 2 in. in diam. The formboard was slanted at a 45-deg angle with two foodwells placed 12 in. apart. Stimuli were $4\frac{1}{2} \times 4\frac{1}{2}$ in. rectangles and equal area circles cut from $\frac{1}{4}$ -in. fiberboard and painted black or white.

PROCEDURE

The Ss were given 36 noncorrection trials per day, 5 days a week. The position of the positive stimulus was varied in a random irregular sequence. The criterion of learning was 10 correct responses in a row within a day. Correct responses were rewarded with a raisin or a piece of apple.

DESIGN

The experimental design is presented in Fig. 1. In the first phase, training with two cues, all Ss were trained with black vertical positive and white horizontal negative.

After reaching criterion on this problem, Ss were given a series of preference tests with six new stimuli that varied in similarity to the training stimuli and were intended to represent three levels of novelty: (1) rectangle-white vertical and black horizontal rectangles (most similar), (2) diagonals-white and black diagonal rectangles (intermediate similarity), and (3) circles-white and black circles (least similar). Each preference stimulus was paired with both the original positive and the original negative stimulus, forming 12 preference pairs. Pairs were presented once a day in random order with two training trials given before each preference trial for a total of 10 days. For half the presentations of a given preference pair,

both stimuli were rewarded, while for the other half, neither stimulus was rewarded.

For the third phase of the experiment, Ss were divided into two groups that were either reversed (horizontal positive) or not reversed (vertical positive) relative to original training. As shown in Fig. 1, two pairs of stimuli were intermixed so that the orientation problem had irrelevant brightness cues.

RESULTS

Initial Learning and Preference Tests

Mean trials to criterion on the original two-cue discrimination task were 44.7. The Ss averaged 98.9% correct responses on the training trials given during preference testing. Mean percentage of preference responses toward the original positive (old+) cue and away from the original negative (old-) cue in training was 79.5. Mean percentage for pairs differing in brightness (A, C, E, G, I, K) was 93.2, while that for pairs not differing in brightness (B, D, F, H, J, L) was 65.8. This difference was significant ($t = 7.43$, $df = 11$, $p < .001$, two-tailed). When novel stimuli were presented with old+, the novel stimulus was selected on 21.9% of the trials; when with old-, the novel stimulus was selected on 81.0% of the trials. The differences between responses toward old+ (79.1) and away from old- (81.0) was not significant ($t = .54$, $df = 11$, two-tailed).

Responsiveness to novelty was analyzed with a two-way analysis of variance consisting of a 3 by 10 (Levels of Novelty by Days) factorial design with repeated measures on both factors. The difference between levels of novelty was not significant ($F = .64$, $df = 2/22$). Both days ($F = 2.24$, $df = 9/99$, $p < .05$) and Novelty by Days ($F = 2.58$, $df = 18/198$, $p < .01$) were significant.

An analysis of simple effects for days at each level of novelty showed that days was not significant for rectangle ($F = 1.39$, $df = 9/99$) or diagonal ($F = 1.16$, $df = 9/99$) but was significant for circle ($F = 3.94$, $df = 9/99$, $p < .01$).

Transfer Learning

Mean trials to criterion in the third phase of the experiment were 118.8 for the nonreversed Ss and 177.8 for the reversed Ss. This difference was not significant ($t = .89$, $df = 11$, two-tailed). Correlation coefficients were computed between percent preference for the originally positive orientation in Pairs B and D of Phase 2 and trials to criterion in Phase 3 of the experiment. For the nonreversed group the product moment coefficient was $-.95$ ($N = 6$, $p < .001$). For the reversed group the coefficient was $-.04$, which is not significantly different from zero.

DISCUSSION

The monkeys in this study differed from both rats and cats in having a high preference for brightness as compared with orientation. They also differed from cats in showing an equivalent number of appropriate responses on trials with old+ as on trials with old-. Both cats and monkeys selected the novel stimulus about 80% of the time when it was paired with old-, but monkeys chose novel only 21.9% of the time when paired with old+, while cats chose novel 55% of the time with old+.

Responsiveness to novel stimuli did not vary directly as a function of the "levels of novelty" selected, as the total number of responses to novel stimuli in each of the three categories did not differ. The overall variability of responses to the levels of novelty was small, implying that the stimuli would need to differ more from each other to yield a large effect.

Sutherland & Holgate's (1966) assumption that the more the animal responds to one cue the less it will respond to the other could not be tested meaningfully in this experiment. The monkeys responded virtually perfectly to the brightness cue.

The results of the third phase of the experiment lead to some contradictory interpretations. The fact that the reversed and nonreversed groups were not significantly different in trials to criterion suggests that the low percent preference for the orientation cue does, in fact, indicate that Ss have not learned the significance of the cue. The high negative correlation coefficient ($-.95$) between preference for the appropriate orientation cue in Phase 2 and trials to criterion in Phase 3 of the experiment for the positive transfer (nonreversed) group, however, suggests just the opposite. These findings support Mumma & Warren's (1968) statement that the method of equivalent stimuli "is a rather insensitive method for estimating what an animal learns in solving a discrimination problem," a point that has also been made by Warren & McGonigle (1969).

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