Concurrent stimulus matching and color discrimination[1]

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Three pigeons were trained on a stimulus matching discrimination in which the matching stimuli were red or violet and the nonmatching combinations were yellow and blue. Three other pigeons were trained with a matching red stimulus and the nonmatching combinations were red and violet. In both cases, generalization tests indicated that the birds learned to discriminate between the positive and negative stimuli on the basis of absolute color and not on the basis of the relation between the matching and nonmatching colors.

There are data indicating that when two stimulus dimensions are involved in the formation of a discrimination, only one dimension may develop stimulus control (Newman & Barron, 1965). This is particularly the case when the values along the two dimensions differ greatly in their discriminability (Warren, 1956). Thus far, the work in this area has involved simple physical dimensions. In the present experiments, one of the dimensions is a relational one based on an abstract concept. The concept is that of stimulus matching. The reinforced stimuli (S+) and the unreinforced stimuli (S-) can be differentiated on the basis of the matching of two colors and on the basis of absolute color. The S+s consist of pairs of matching colors. The S-s are pairs of nonmatching colors. To some extent, the actual colors used differ between the S+s and S-s. It will be of interest to determine the extent to which the two properties of the stimuli develop stimulus control.

Method

The Ss were six experimentally naive White Carneaux barren hen pigeons. They were maintained at 70% of their free-feeding body weights. A Lehigh Valley Electronics No 1519A pigeon test chamber was used. Stimulus colors were projected behind the response key with a black vertical line dividing the key in half. The color of each half of the key could be manipulated independently of the other half.

Birds A-4-7, A-4-8 and A-4-9 were trained with two S+s in which both halves of the key were red or violet (RR or VV) and two S-s, the two nonmatching combinations of yellow and blue (YB and BY). Birds A-4-10, A-4-11 and A-4-12 were trained with one S+ (RR) and two S-s, the two nonmatching combinations of red and violet (RV and VR). The stimuli were presented in the same sequence each time, RR-VV-YB-BY or RR-RV-VR.

After initial shaping in the presence of the matching stimulus, the birds were reinforced for every response when an S+ was on the key and not reinforced for responding when an S- was on the key. The S+s remained on until reinforcement was delivered, and then the next stimulus in the series was presented. The S-s remained on the key for 30 sec of no responding. That is, a response during a 30 sec S- period caused that 30 sec interval to recycle. Thus, an S- remained on until 30 sec had elapsed without a response. The house light was off at all times.

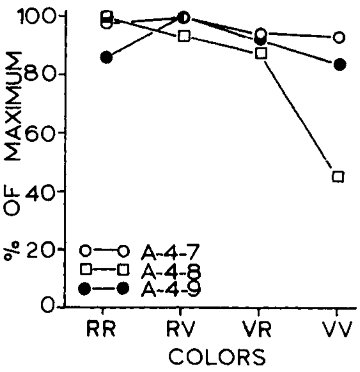

Fig. 1. The percent of the maximum amount of responses (the peak) as a function of the color combinations of red and violet for Birds A-4-7, A-4-8 and A-49.

The reinforcement requirements, in the presence of the S+s, were gradually increased until the pigeons were responding on a random-interval schedule of 64 sec (RI 64 sec) (cf., Farmer, 1963).

After 15 days of training on the RI 64 sec discrimination schedule, each pigeon was given a generalization test over the four combinations of red and violet (RR-RV-VR-VV) and the four combinations of yellow and blue (YY-YB-BY-BB) to determine if the matching discrimination would generalize to the new color combinations. The eight stimuli were presented randomly for 20 sec without reinforcement. A 10 sec time out period,

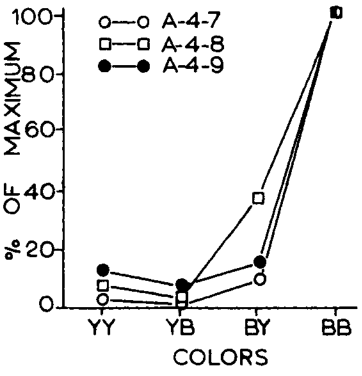

Fig. 2. The percent of the maximum amount of responses as a function of the color combinations of yellow and blue for Birds A-4-7, A-4-8 and A-4-9.

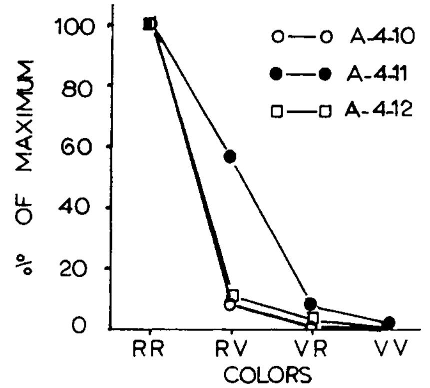

Fig. 3. The percent of the maximum amount of responses as a function of the color combinations of red and violet for Birds A-4-10, A-4-11 and A-4-12.

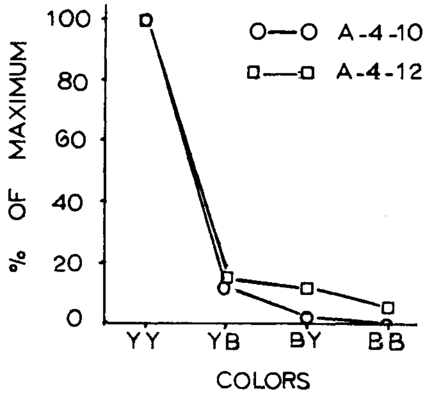

Fig. 4. The percent of the maximum amount of responses as a function of the color combinations of yellow and blue for Birds A-4-10, A-4-11 and A-4-12.

during which the stimuli were changed and the responses of the previous trial were recorded, separated each trial.

Results and Discussion

The results of the generalization tests for Birds A-4-7, A-4-8 and A-4-9 are shown in Figs. 1 and 2. In Fig. 1, where the matching and nonmatching combinations were made up of the colors used in the S+s, the gradients are relatively flat. In Fig. 2 (the four combinations of yellow and blue) all the gradients peaked at BB. Neither of these figures indicates any formation of a concept of matching. Had one developed, the gradients should be U-shaped as were obtained by Malott & Malott (1967) in the earlier stimulus matching experiments. This was definitely not the case in Fig. 1. Fig. 2 is also flat, except for the sharp peak at BB. This could be explained by the fact that the BB was closer on the wavelength continuum to VV than was YY to RR. Thus, one would expect more generalization. The number of responses at the peaks of the gradients in Fig. 1 were 285, 206 and 580 and in Fig. 2 were 143, 23 and 61, respectively. This further supports the conclusion that these birds were discriminating on the basis of absolute color alone.

The generalization gradients for the other three birds are shown in Figs. 3 and 4. In Fig. 3 the gradients peaked at RR and dropped sharply at the other combinations. This would be expected since V had always been part of an S-. That is, a discrimination was formed solely between red and violet, and not the matching combinations. The two gradients obtained in Fig. 4 have the same general shape, although responding was somewhat lower since these were novel colors. Probably for the bird for which a gradient could not be obtained due to lack of responding, this novelty was too great. The peaks at YY and low rates at the other combinations can be explained in terms of simple color generalization. That is, red generalized to yellow and violet to blue.

The results of this experiment demonstrate that when pigeons are faced with this type of problem, they will learn to discriminate between the positive and negative stimuli the simplest way possible (which, in this case, was a simple color discrimination). Nor do the present data indicate that pigeons are not capable of acquiring a stimulus matching discrimination. The data simply indicate that whenever one analyzes data from complex discriminations, or other types of problem solving behaviors, the type and quality of stimuli used and the response contingencies associated with them should be carefully examined.

References

FARMER, J. Properties of behavior under random interval reinforcement schedules. *J. exp. Anal. Behav.*, 1963, 6, 607-616.

MALOTT, R. W., & MALOTT, MARILYN K. An analysis of stimulus matching in terms of stimulus generalization. Submitted for publication, *J. exp. Anal. Behav.*, 1967.

MEYER, D. R., TREICHLER, F. R., & MEYER, PATRICIA M. Discrete-trial training techniques and stimulus variables. In A. M. Schrier, H. F. Harlow, & F. Stollnitz (Eds.), *Behavior of nonhuman primates.* New York: Academic Press, 1965. Pp. 1-50.

NEWMAN, F. L., & BARRON, M. R. Stimulus generalization along the dimension of angularity: A comparison of training procedures. *J. comp. physiol. Psychol.*, 1965, 60, 59-63.

Note

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