SOME DATA ON MATCHING BEHAVIOR IN THE PIGEON¹

WILLIAM W. CUMMING and ROBERT BERRYMAN

COLUMBIA UNIVERSITY

In matching behavior, the subject is first presented with a standard stimulus, and then required to select the corresponding stimulus from a set (usually two) of comparison stimuli. There has been increasing contemporary interest in this situation (Blough, 1957, 1959; Ferster, 1960), perhaps because it shares a number of common dimensions with several other important research areas. If the number of standard stimuli is made large, the matching procedure relates closely to the "learning set" problems of Harlow (1959). If time intervals are introduced between the presentation of the standard and comparison stimuli, contact is made with studies of delayed responding. If, after a specified history, the subject is required to match "novel" stimuli, the procedure is relevant to investigations of generalization and concept formation. Finally, if the set of comparison stimuli is suitably chosen, psychophysical functions are generated.

Preliminary data are reported here on a procedure which can be easily adapted to the study of all of these problems.

METHOD

Subjects and Apparatus

The subjects were three White Carneaux barren hens. Throughout the experiment, the birds were maintained at 80% of their free-feeding weights. Grit and water were continuously available in the home cages. Maple peas were given in the home cages when feeding outside the experimental situation was required. The reinforcement grain mixture consisted of 50% Kaffir, 40% vetch, and 10% hempseed. Both the living quarters and the experimental room were air-conditioned.

Experimental sessions were scheduled daily for each bird, except on those occasions when the animals' body weights differed from the 80% free-feeding value by more than ± 15 grams.

The response chamber was in the form of an isosceles right triangle approximately 24 by 24 by 35 inches. The hypotenuse of the triangle was a plate-glass front which permitted observations of the Ss' behavior. The legs of the triangle were two solid walls, painted flat black. One was furnished with an access door; on the other were mounted the reinforcement magazine and three milk-plastic response keys, each 1 inch in diameter. The entire ceiling of the box was of translucent plastic, which diffused the light from three 25-watt bulbs. Behind each key was a light box with three 7.5-watt Christmas-tree bulbs.

All aspects of the experimental procedure were programmed automatically by relay circuitry located in a separate control room.

Procedure: I. Preliminary training

Using a separate response chamber, the birds were first magazine-trained, and then the pecking response was differentiated to a key illuminated with white light. When the key-pecking response was well established, the birds were placed in the experimental chamber. Each of the three keys was illuminated with red, green, or blue light in random sequence, and responses to the illuminated key were regularly reinforced with 3 seconds' presentation of the grain magazine. Preliminary training was terminated when the birds readily pecked at any key, no matter what its hue. On the following day, the matching procedure was instituted.

Procedure: II. Matching

Figure 1 provides a schematic representation of the matching procedure. Between trials, all keys were dark. At the start of a trial, the standard stimulus was presented on the center key by illuminating it with red, green, or blue light. A response to this key resulted in presentation of the comparison stimuli on the side keys, while the standard stimulus remained present on the center key. One of the comparison keys was of the same hue as the standard; the other was one of the two alternative hues.

Fig. 1. Schematic representation of the matching procedure. R = responses, S^R = reinforcement, BL = black-out.

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While all the keys were illuminated, (1) an additional response to the center key had no effect; (2) a response to the side key of matching hue turned off both standard and comparison stimuli, and activated the grain magazine for a 3-second period; (3) a response to the non-matching side key turned off both standard and comparison stimuli as well as the overhead illumination, leaving the bird in the darkened cage for 3 seconds.

At the conclusion of either the reinforcement or the blackout, an intertrial interval of 25 seconds was initiated. During this interval the keys were dark, but the overhead light was on. Responses other than those specified above, such as pecking during the intertrial interval, or pecking nonilluminated keys during the trial, had no effect.

Each *S* was given 140 trials per day; the first 10 and the last 10 trials were excluded from data analysis.

With the described procedure, there are 12 stimulus conditions under which matching behavior may occur. These are shown in Table 1.

The sequence of presentation of these 12 conditions was randomized each day, and the randomized block repeated until 140 trials had been presented.

The birds were exposed to this procedure for 22 sessions. On the 23rd and 24th sessions, the procedure was as described above except that a yellow light was substituted for the blue light.

Fig. 2. Number of correct matches (out of a possible 120) in the first 22 experimental sessions.

TABLE 1
Stimulus Conditions

Condition	Left Key	Center Key	Right Key
1	Blue	Red	Red*
2	Red*	Red	Blue
3	Green	Red	Red*
4	Red*	Red	Green
5	Red	Blue	Blue*
6	Blue*	Blue	Red
7	Green	Blue	Blue*
8	Blue*	Blue	Green
9	Red	Green	Green*
10	Green*	Green	Red
11	Blue	Green	Green*
12	Green*	Green	Blue

*Response reinforced.

RESULTS AND DISCUSSION

The acquisition of matching behavior is shown in Fig. 2, which gives for each subject the number of correct responses (out of a possible 120) for each of

Fig. 3. Color and position preferences for the first 22 experimental sessions. For explanation, see text.

the first 22 experimental days. The preliminary training was effective in producing transfer since no bird failed to respond to the stimuli presented on the first day of the matching procedure. Under the experimental conditions used, all patterns of behavior other than correct matching resulted in a 50% probability of reinforcement per trial. For the first 3 days (4 days in the case of Bird 74), the number of correct responses remained at the chance level, showing that responding was at this time uncontrolled by the standard stimulus. After this initial period, acquisition of matching behavior begins abruptly and follows about the same course in each of the subjects, approaching a final, *almost* perfect level of success about 5 days thereafter.

Although no latency measures were taken, observation of the birds' behavior showed that the side-key response followed the center-key response with extreme rapidity. In the well-trained bird, the few errors made seemed to result from cases in which the bird had not been in front of the center key when responding to the standard stimulus, thus making the distances to the side keys unequal.

All three subjects displayed superstitious behavior during the intertrial interval. For two of the birds, this consisted of rapid, energetic, pacing back and forth before the plate-glass front, while the third bird occupied the interval with slow, rhythmic responding to the center key.

The fact that all subjects showed very close to chance behavior during the first few sessions indicates that the standard stimulus had not yet acquired control over the side-key response. Among other identifiable aspects of the situation exercising control position and color preferences are two obvious possibilities. Either type of preference would appear as a chance performance in Fig. 2. Indices of position and color preferences were constructed by considering chance performance as 0% preference, and the maximum possible deviation from chance as 100% preference. The results of these computations are shown in Fig. 3. For each of the three subjects, the early sessions are characterized by a pronounced position preference. This position preference begins to disappear at about the same time the matching performance starts to develop. At this time, all subjects show some tendency to exhibit color preferences. In the final stage, almost complete control is exercised by the hue of the standard stimulus, and both position and color preferences virtually disappear. At no point during the development of this discrimination, therefore, does the behavior display random characteristics; instead, it is controlled at each stage by either position or color preferences, or by the hue of the standard stimulus.

For two sessions following the 22 days of exposure to the matching procedure, a yellow light was substituted for the blue light on both the center and the side keys. As in the preceding matching sessions, correct matching of any hue resulted in reinforcement. Figure 4 compares the results of these two sessions (Y-1 and Y-2) with the behavior exhibited on the 22nd and

Fig. 4. Per cent correct matching for the 22nd experimental session, and for the two experimental sessions in which a novel yellow standard was substituted for the blue. Matching of each standard is separately presented.

final day of the matching procedure (M-22). In this figure, the 120 trials constituting a session are segregated according to the hue of the standard presented on the center key. While ability to match red and green appeared to be unimpaired by the introduction of the yellow light, the birds were unable to do better than chance in matching the yellow stimulus on the first day of its introduction. Instead, the subjects reverted to a position preference whenever the standard was yellow.

It is apparent that training to match red, green, and blue stimuli had not resulted in the formation of a "matching" concept applicable to novel stimuli; or, stated in another way, the birds had not learned that the "odd" hue was S^Δ. Such a tendency would have resulted in a performance considerably above the chance level. Alternatively, there is no evidence of any pronounced tendency for the subjects to make responses exclusively to those stimuli for which they had been previously reinforced, or to avoid the novel yellow stimulus, since such a pattern would have resulted in performance considerably below the chance level. The position preference adopted by the birds yielded about 50% reinforcement when the standard stimulus was yellow. This position habit, however, shows signs of

extinguishing more rapidly on Day Y-2 than the original position habit shown during the first days of the matching procedure. All three animals made some improvement in matching yellow on Day Y-2.

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