EFFECTS OF COLORED BACKGROUNDS ON FOOD SELECTION BY PENNED MOURNING DOVES (*ZENAIDURA MACROURA*)

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Mourning Doves (*Zenaidura macroura*) and other columbiform birds often react strongly to artificial color stimuli. Bennett (1939) found that a male Ringed Turtle Dove (*Streptopelia risoria*) removed from a pen, bleached white and returned to the pen, elicited aberrant behavior by its seven pen mates, and affected the social order of the birds. Kalmbach (1943) and Kalmbach and Welch (1946) noted that several species of birds including domestic pigeons (*Columba livia*) selected against grains colored bright yellow and green, when offered other choices. Frankel and Baskett (1963) found that yellow marks placed on the heads of penned female Mourning Doves disrupted poorly established pair bonds. Goforth and Baskett (1965) performed more elaborate experiments, also showing that yellow marks on the females' heads affected pair bonding adversely under certain conditions. No measurable responses by Mourning Doves to artificial color were discerned by McClure (1945) who colored eggs of incubating pairs, nor by Mackey (1965), who applied orange paint to the mandibles of one mated pair and red to those of another.

Color vision in the Mourning Dove has had little study, but color vision in the closely related domestic pigeon has been investigated extensively. Results of several such studies were reviewed by Blough (1957), who indicated that the pigeon's ability to discriminate hue is similar to that of man.

The purpose of the present study was to explore the influence of backgrounds that differ in color on selection of food by penned Mourning Doves. The study was an outgrowth of our earlier investigations of color marking in relation to breeding behavior, and was prompted by the seeming aversion of male doves to yellow marks placed on females' heads. It was also prompted by reports that visual cues play little or no role in food selection in Mourning Doves under field conditions (Davison, 1962; Davison and Sullivan, 1963).

Methods

Responses of adult wild-trapped doves to blue, green, yellow, and red backgrounds were tested by placing food on colored backgrounds or by surrounding access openings to food with colored areas. The food used was "hen scratch," a mixture of grains including wheat, milo, cracked corn, and millet. In no case was the food itself colored artificially.

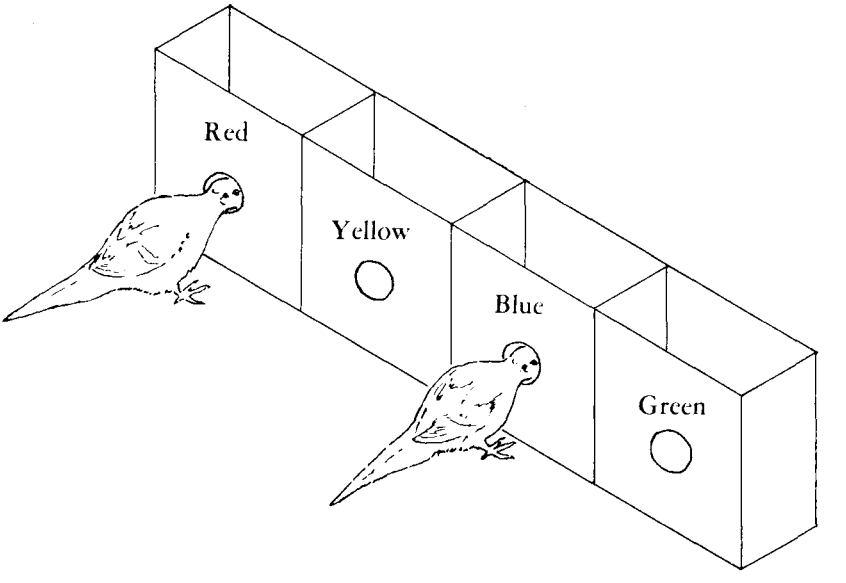

Figure 1. Diagram of the feeding apparatus used in colored plate experiment showing doves feeding.

No attempt was made to determine wavelengths of light reflected by the mixed pigments or transmitted through the light filters used.

Colored wheel experiment.—Doves were housed in an outdoor 6- × 6- × 8-foot wire pen. The pen contained a circular feeding apparatus of 30-inch diameter, divided into quarters, each colored differently by painting with bright red, green, blue, and yellow enamel.

Twenty-five g of grain per bird were evenly distributed on each quadrant daily. Before new grain was placed on the quadrants, the grain remaining from the previous period was weighed to determine the consumption from each quadrant. The wheel was turned one-quarter turn each day.

Two females were tested separately for 12 days each, and two others for 20 days each. Two males were tested separately for 12 days each, and four others were tested in sets of two for 20-day periods.

Colored plate experiment.—Ten doves were used in this series of tests, five singly, two together, and three together.

The wire pen measured 24 × 47 × 24 inches and was fitted with a water trough that extended the full length of one long side. These tests were conducted in a large room with glass walls on the south and east. No artificial illumination was supplied. A wooden feeder measuring 36 × 3 × 4 inches and located on the side of the pen opposite the water trough was divided into four equal compartments, each faced with a removable colored plate 8½ inches square (Figure 1). The birds gained access to the feed by thrusting their heads through a 1½-inch hole in each plate. Plates painted bright red, green, yellow, and blue were positioned daily according to a table of random numbers. For controls, the plates were reversed, with brown masonite sides showing.

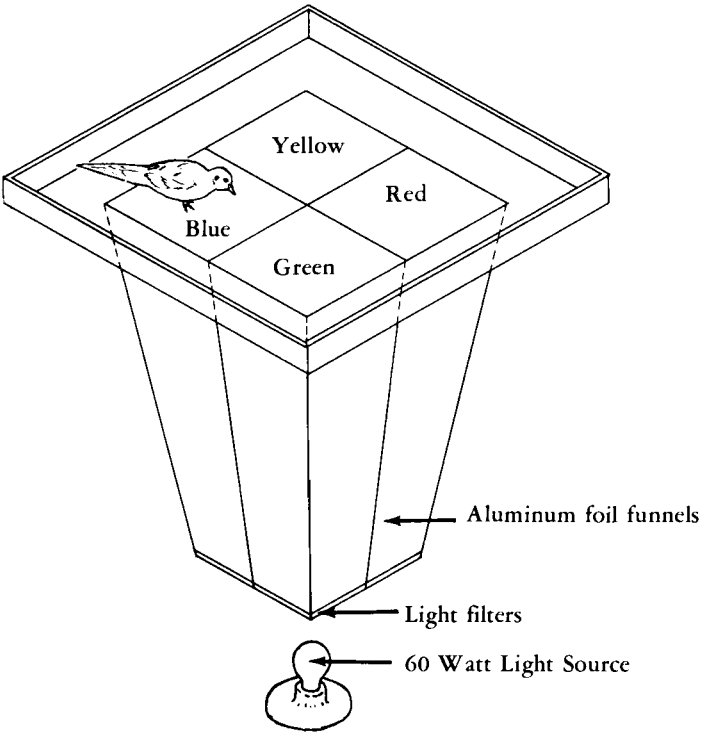

Figure 2. Diagram of the working portions of the light table showing arrangement of colors.

In each of the four feeder compartments we placed 80 g of grain each day. Every 24 hours the grain was again weighed to determine the amount consumed from each compartment.

Six tests were run for 10 consecutive 24-hour periods, and a seventh included 15 consecutive 24-hour periods.

Light table experiment.—In this experiment, the apparatus allowed the birds to feed directly on a background of colored light; no painted surfaces were involved as in the first two experiments. The apparatus was a wooden box 3 × 3 × 3 feet with an interior platform 8 inches from the top. The top was covered with 1- × 2-inch welded wire. An 18-inch square was cut from the center of the platform, and fitted with window glass. The glass was divided into four equal squares by two strips of black plastic tape on the surface. Under the glass, aluminum foil funnels were fitted to each of the four areas. Lower ends of these funnels were 10 inches above floor level. The bottom openings were fitted with light filters of 5-inch diameter (Figure 2). The red and yellow filters were Kodak Wrattan Safe-lite filters. Blue and green filters were fashioned from double layers of cinamoid theatrical gelatin. A 60-watt lamp emitting white light was positioned under the filters. This combination shone bright colors into each of the four squares. The glass surface was covered with translucent, textured contact paper to reduce the glare of the lights from below,

TABLE 1

GRAIN CONSUMED BY MOURNING DOVES FROM EACH QUADRANT OF COLORED WHEEL

Bird designation and duration of test	Blue	Red	Green	Yellow
F-1, 12 days	135.0 (73.7)[1]	40.4 (22.1)	5.2 (2.8)	2.5 (1.4)
F-2, 12 days	128.0 (63.7)	56.4 (28.0)	9.0 (4.5)	7.6 (3.8)
M-1, 12 days	138.8 (58.3)	53.2 (22.3)	26.9 (11.3)	19.2 (8.1)
M-2, 12 days	142.4 (58.4)	62.4 (25.6)	31.0 (12.7)	8.2 (3.3)
F-3, 20 days	224.4 (68.9)	58.4 (17.9)	26.0 (8.1)	16.7 (5.1)
F-4, 20 days	193.2 (61.3)	76.8 (24.3)	23.9 (7.7)	21.2 (6.7)
M-3 and 4, 20 days	526.0 (69.8)	147.7 (19.7)	51.5 (6.8)	27.9 (3.7)
M-5 and 6, 20 days	486.3 (68.2)	166.0 (23.2)	38.6 (5.4)	21.9 (3.2)

[1] Totals in grams, percentage of totals shown in parentheses.

and to provide some footing for the birds. To help stimulate the birds to feed, low-intensity white light was provided in the test room by a 40-watt lamp 10 feet to the side of and 2 feet above the apparatus.

Doves were isolated in a small pen, with water but no feed, for 36 hours before being used in the experiment. Grain was evenly distributed over the glass surface of the platform, and the bird was introduced into the box by way of a central opening in the wire cover. After the bird settled down, the light was turned on to illuminate the feeding area, which was watched through a slanted mirror above the box. Each peck on each color was recorded.

Twelve different doves were used in these tests. Each bird was used only once. Observations were terminated at the end of 30 minutes or 300 pecks, whichever came first. More than 300 pecks usually exhausted the grain supply in a given square and the bird was forced to move to another.

RESULTS

Colored wheel experiment.—As shown in Table 1, most (58.3 to 73.7 per cent) of the grain consumed was taken from the blue quadrant. Red was next (17.9 to 28.0 per cent), then green (2.8 to 12.7 per cent), and finally, yellow (1.4 to 8.1 per cent). In no case was all the food consumed from any quadrant on any day.

The colored wheel experiment was a pilot effort, and although positions of the colored quadrants were changed daily, the changes were not made randomly. Consequently statistical analyses were not made. Results are presented because they were consonant with those of subsequent experiments whose design permitted statistical treatment.

Colored plate experiment.—Results of this experiment are shown in Table 2. Most grain was consumed when the color environment was blue; red was next, then green, and yellow, last. These results were tested with Duncan's New Multiple Range Test at $P = 0.05$. In every case grain consumed through the hole in the blue plate was significantly higher than that from all other colors. Consumption through the red plate was sig-

TABLE 2
GRAIN CONSUMED BY MOURNING DOVES FROM COMPARTMENTS WITH OPENINGS SURROUNDED BY REMOVABLE COLORED PLATES

Bird designation and duration of test	Blue	Red	Green	Yellow
F-1, 10 days	61.1 (50.6)[1]	27.8 (23.4)	15.7 (13.0)	15.8 (13.0)
M-1, 10 days	75.2 (47.9)	37.8 (24.1)	20.9 (13.3)	22.9 (14.7)
F-2, 10 days	72.9 (44.8)	43.8 (26.5)	24.6 (14.9)	23.7 (13.8)
M-2, 10 days	82.4 (49.9)	34.6 (20.9)	28.8 (16.8)	19.5 (12.4)
M-3, 15 days	121.0 (46.8)	65.9 (46.8)	43.6 (16.9)	27.9 (10.8)
M-4 and 5, 10 days	151.8 (44.1)	79.0 (23.0)	55.0 (16.0)	58.1 (16.9)
M-6, 7 and 8, 10 days	225.8 (42.5)	144.9 (27.3)	85.1 (16.1)	74.9 (14.1)

[1] Totals in grams, percentage of totals shown in parentheses.

nificantly lower than blue, but higher than green or yellow in every case. Consumption through green and yellow were significantly different from each other in only two cases, series M-2 and M-3. In both of these cases the consumption rate through the green plate was significantly higher than through yellow.

Three series of controls were run; these showed no significant differences in consumption of grain between compartments, thus eliminating position bias.

Light table experiment.—Results are shown in Table 3. Grain on the blue surface was much favored over grain on the other surfaces by all but one bird. Two of the birds did not leave the blue area as long as food was available there. Only two birds fed from the yellow area.

TABLE 3
NUMBER OF PECKS TAKEN BY MOURNING DOVES ON EACH COLORED SECTION OF LIGHT TABLE

Bird number and duration of test	Blue	Red	Green	Yellow
1, 30 minutes	212 (99.5)[1]	0	1 (0.5)	0
2, 30 minutes	281 (97.2)	8 (2.8)	0	0
3, 21 minutes	300 (100.0)	0	0	0
4, 30 minutes	154 (74.8)	48 (23.3)	4 (1.9)	0
5, 16 minutes	294 (98.0)	6 (2.0)	0	0
6, 19 minutes	258 (86.0)	18 (6.0)	24 (8.0)	0
7, 24 minutes	218 (72.7)	82 (27.3)	0	0
8, 30 minutes	60 (92.3)	0	5 (7.7)	0
9, 30 minutes	297 (99.0)	2 (0.7)	1 (0.3)	0
10, 30 minutes	89 (38.0)	134 (57.7)	0	10 (4.3)
11, 30 minutes	150 (59.3)	101 (39.9)	2 (0.8)	0
12, 30 minutes	149 (61.7)	40 (16.6)	29 (11.7)	24 (10.0)

[1] Percentage of totals shown in parentheses.

The results of this experiment were subjected to χ^2 tests at $P = 0.05$. "Expected" frequency for each color was the total number of pecks divided by four. In every case blue was chosen with a significantly higher frequency than expected. In two cases, birds numbered 10 and 11, red was chosen with a frequency significantly higher than expected. Red was chosen with a significantly lower frequency than expected in seven cases, birds numbered 1, 2, 3, 5, 6, 8, and 9. In the other three cases, birds numbered 4, 7, and 12, red was chosen with a frequency not significantly different from the expected frequency. In every case green and yellow were chosen with significantly lower frequencies than expected.

Control trials involving four birds were made with the subplatform light turned on and the color filters removed. In the controls the birds began feeding in the nearest area and continued feeding there until the grain was consumed. They showed no consistent differences in grain consumption according to positions in the testing device.

Discussion

Penned Mourning Doves consistently consumed more grain against blue backgrounds than against backgrounds of the other colors tested; red, green, and yellow backgrounds followed in that order. The meagre consumption of grain against yellow backgrounds is consonant with our earlier finding that only yellow marks on the heads of females disrupted poorly established pair bonds (Goforth and Baskett, 1965).

The possibility that the birds simply could not see the grain against yellow backgrounds appears to be ruled out in the experiments with colored plates. Here the doves had to approach each plate closely before they could see the grain in the corresponding compartment. The compartments themselves were lined with brown masonite. We recognize the possibility of contrast differences in the other experiments, but contrast differences are still visual cues, and are in this case a function of the color of the backgrounds.

As pigeons discriminate easily between hues in the yellow and blue-green portions of the spectrum (Hamilton and Coleman, 1933); one might expect the doves to discern yellow easily. Mourning Doves may have an aversion to yellow, at least when it is seen outside the usual places in their environment.

Results of this study reinforce Kalmbach's (1943) assertion that birds of several species, including pigeons, are influenced by color in selecting against grain dyed bright yellow or green. Davison and Sullivan (1963) disputed this assertion on the grounds that the aniline dyes used by Kalmbach contained oils with a disagreeable taste. Their criticism may be valid for some of Kalmbach's comparisons of consumption of dyed vs.

undyed grain, but Davison and Sullivan apparently overlooked the fact that the birds also discriminated among grains dyed different colors. Moreover some of Kalmbach's tests were conducted with dyed and natural grain hermetically sealed under glass; odor or taste were thus ruled out (Kalmbach, pers. comm.).

Although our own experiments were not carried out on free-living doves under natural conditions, the results showed that penned doves discriminated readily among background colors when taste could hardly have been a complicating factor. Therefore we suspect that Davison's (1962) statement, repeated by Davison and Sullivan (1963), that Mourning Doves choose their foods by taste, not by color, shape, or surface texture, may be considerably oversimplified. We recognize that our experiments did not separate effects of the several aspects of color. Differences in hue, intensity, chromatic purity, and contrast may all have been factors, but the important points are that the stimuli eliciting the observed responses were visual, and that hue was the central factor. Intensity was highly variable in the two experiments employing natural illumination, and the birds were allowed to feed throughout the daylight hours. Hues employed in the experiments were constant.

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SUMMARY

Three types of experiments were conducted with food presented to Mourning Doves against blue, red, green, and yellow backgrounds. Consumption was highest when the background was blue and lowest when it was yellow. Green was very close to yellow in rank, and red ranked between blue and green. In two of the experiments, painted masonite was the color source; colored lights were used in the other. All except one dove, of a total of 32 tested, consumed the most grain against a blue background; the exceptional bird consumed more food presented against red. Experimental results reinforce other indications that Mourning Doves have an aversion to wavelengths in the yellow range when encountered outside the usual places in their environment.

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