NATURAL COLOR PREFERENCES OF THE DOMESTIC CHICKEN AND THE EUROPEAN QUAIL

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ABSTRACT

NATURAL COLOR PREFERENCES OF THE DOMESTIC CHICKEN AND THE EUROPEAN QUAIL

by David T. Kee

The fact that birds exhibit apparent color preferences has been noted since the latter half of the nineteenth century. This study was undertaken to attempt to determine for two members of the family Phasianidae, the Domestic Chicken (Gallus domesticus) and the European Quail (Coturnix coturnix), (1) their natural color preferences, (2) differences between sexes as to color preference, and (3) the effect of peck order on color preference.

The test animals were fed from a specially constructed feeder. The feeder contained seven interchangeable colored insert boxes which held correspondingly colored food. Each insert box was illuminated by incident light passing through a cellophane filter which corresponded in color to the food contained therein.

A one-way analysis of the variance of two or more sample means was applied to the data collected on color selection, position of the colored insert boxes in the experimental feeder, and intensity of the incident light

illuminating the insert boxes.

Individual unconditioned chickens show a marked preference for green-colored food under the test conditions. The position of the green-colored food within the experimental feeder and the intensity of the incident illumination seemingly had no effect on their choice.

The sex of the Domestic Chicken had no effect on color preference. Male and female chickens both showed a marked preference for the green-colored food.

When tested in groups of four, Domestic Chickens showed a preference for green-colored food. The position of the colored food and the incident illumination seemingly had no effect on their choice.

When tested in groups of two, four, or six, European Quail showed a preference for green-colored food under the test conditions. The position of the colored food and the incident illumination seemingly had no effect on their choice.

The peck order may be of importance in that it insures the utilization of all the foods present. The dominant and most subordinate individuals were most successful in utilizing the preferred food. The peck order may be of importance, under wild conditions, in preventing the development

of a high degree of food specialization.

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INTRODUCTION

The fact that birds exhibit color preference has been realized for many years. During the latter portion of the nineteenth century Renshaw (1877) reported that sparrows were pecking yellow crocuses while leaving all other varieties untouched. Tegetmeier (1877) immediately replied that this was not antipathy toward or preference for yellow but was an example of imitative behavior. Tegetmeier's reasoning came from the fact that he disliked yellow crocuses and therefore had planted only blue and white varieties. These were left untouched until a sparrow happened to sample one; thereafter havoc was wrought on his blue and white crocuses by the sparrows. White (1891) believed the birds pulled the yellow crocuses because they preferred yellow rather than having antipathy to it. During the same period Stokoe (1877) stressed the idea that color may be more important than taste in regards to food selection by birds. Stokoe, quoting from Gilbert White's "Observations on Nature," stated: "Birds are much influenced in the choice of food by colour, for though white currants are a much sweeter fruit than red, yet they seldom touch the former till they have devoured every bunch of the latter."

Birds may also show preferences for certain colors in their nest construction. Three pairs of sparrows decorated their nests with the yellow flowers of laburnum (White, 1877). These nests were repeatedly destroyed by man but were reconstructed each time and again decorated with the yellow blooms. Smith (1928) reports that Baltimore Orioles (Icterus galbula) were furnished with red and white strings for construction of their nest. The orioles would utilize all the white string provided but would not use the red. The House Wren (Troglodytes aedon) exhibits a preference for a red or green bird house (McCabe, 1961). McCabe found that 72 of 98 nests were constructed in houses of these colors. Blue, yellow, and white bird houses were also available.

People had assumed for many years that birds could detect color, but it was not until 1915 that it was positively shown that they possessed this ability. Yerkes (1915), using elaborate equipment for that period, showed that the "Ring Dove (Turtur risorius)" could differentiate between red-black and red-green. He concluded also that there may be a sex difference in color selection as he obtained much better results with the male than the female. Lashley (1916), using Domestic Chickens (Gallus domesticus)

conditioned to certain colors, found that they could readily distinguish color changes within the range of the human spectrum. He also concluded that color brightness had little apparent effect on the fowls' color determination.

The members of the family Trochilidae are often involved in discussions of color preference. Pickens (1935) found that the Ruby-throated Hummingbird (Archilochus colubris) preferred red over all other colors. Nearly a third of all feedings utilized red blooms though only four percent of the blooms were red (Pickens et al., 1931). Pickens (1951) also mentions the possibility of red flowers having evolved by unconscious selective pollination by these birds. Greenwalt (1960), from personal observations, agrees that trochilids show a marked preference for red. He has observed these birds attempting to feed from the red knobs of his camera equipment, a red tie that he was wearing, and the red alcohol within a wall thermometer. Other investigators (Sherman, 1913; Bené, 1941, and Lyerly et al., 1950) indicate that hummingbirds do not show a definite innate color preference but may show a conditioned preference. Bené also claimed that there was no justification in believing that the partiality to red by hummingbirds, or of the family Trochilidae as a whole, could be regarded as a phylogenetic trait.

Tinbergen (1953), testing the reaction of the Herring Gull (*Larus argentatus*) to colored eggs, found that red eggs elicited the pecking response, and in turn the shape of the egg elicited the brooding response. Thus, the eggs were not deserted or destroyed. The red bill of this species elicits the pecking response in the young. Presenting colored eggs to Mourning Doves (*Zenaidura macroura*) does not inhibit or affect incubation in any way (McClure, 1945). Marples (1931) indicates that some birds may be color blind, probably living in a world of greys, as the Ringed Plover (*Charadrius hiaticula*) is unable to recognize its eggs by color.

Young chicks and ducklings appear to have a natural preference for certain colors in their pecking response (Hess 1954, 1956). Hess found that chicks appear to have an equal preference for either orange or blue, while ducklings have a preference for green.

The avian eye may or may not be adapted for color vision. The presence and relative number of cone elements is the deciding factor. Diurnal birds, which utilize chromatic vision, have an abundance of these elements in their retinas, while nocturnal species have relatively few cones (possibly none in the Apterigidae) but an abundance of rods.

The eye of diurnal birds may be said to be cone dominated.

A peculiar feature of the avian eye is the presence of colored, highly refractive oil droplets located within the cones. The droplets are of red, orange, yellow, or green and may act as filters which may reduce the sensitivity of the eye to the blue region of the spectrum. The oil droplets may form a mechanism whereby hue discrimination can be modified and improved in certain spectral regions (Walls, 1942). The droplets form an adaptive mechanism whereby hue discrimination is varied from species to species according to the demands of feeding habits and environment (Donner, 1960).

The preference or antipathy of birds for a color has been utilized from an economical standpoint. Kalmbach (1943, 1946) reports using colored poisons to reduce rodent populations without harming the avian life in the same areas. He found that when properly used, green-colored poisons effectively reduced the rodent populations without causing any bird mortality. However, the use of colored seeds for planting had no effect as a repellent for Ring-necked Pheasants (*Phasianus colchicus*) in Ohio (Dalmbach *et al.*, 1948).

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This study was undertaken to determine for two members of the family Phasianidae, the European Quail (*Coturnix coturnix*) and the Domestic Chicken (*Gallus domesticus*), (1) their natural color preferences, (2) differences between sexes as to color preference, and (3) the effect of peck order on color preference.

MATERIALS AND METHODS

Experimental Cage: The experimental cage was a wooden frame structure measuring 74 x 37 x 34 inches. The sides, ends, and top were covered with one-inch chicken wire; the floor was made with 0.63 inch hardware cloth. The cage was supported on 23-inch wooden legs. The top and one end were hinged. At the front of the cage was a platform measuring 37 x 8 x 1 inches which supported the experimental feeder.

Removable sheet-metal pans were placed on a wooden frame four inches below the wire floor of the cage. These pans collected any food spilled from the experimental feeder.

The experimental cage was installed in a room measuring 8 x 12 feet having a northern exposure. One window facing the north was the only natural source of light.

Experimental Feeder: The experimental feeder was constructed of 0.75 inch plywood and measured 32 x 6 x 18 inches (Plate I, Fig. A). The inside of the feeder box was partitioned into seven equal-sized compartments measuring approximately 4 x 5.5 x 11 inches. In the center of the anterior wall of each compartment was a 3 x 3 inch window whose lower edge was 2.75 inches above the base of the feeder. On the inside wall, 5.5 inches from the top, was a 0.25 inch shelf used to

support a sheet of clear window glass measuring 31.5 x 5.5 x 0.25 inches. This glass shelf was used to support colored filters which are discussed later. The inner walls of the box above the glass shelf were lined with aluminum foil which served as a reflecting surface. The top or lid of the box was hinged and had an electrical socket installed 10 inches from each end. Two 60-watt incandescent bulbs were used for illumination.

The front of the box was equipped with a series of perpendicular slots, whose function was to hold colored inserts in front of the individual compartments.

A series of colored inserts measuring 4 x 11 inches with a 3 x 3 inch window corresponding in position to the window of the feeding box was used (Plate I, Fig. c). The hue (color), value (lightness), and chroma (purity) of each insert were standardized by use of the Munsell Color Charts (Munsell, 1929). The colors were: R/4/12 hereafter referred to as red, YR/7/8 hereafter referred to as orange, Y/8/12 hereafter referred to as yellow, GY-G/6/4 hereafter referred to as green, B-PB/3/8 hereafter referred to as blue, and RP/3/10 hereafter referred to as violet. The inserts were uniform in size and could be placed in front of any internal compartment at random.

Plate I. Experimental Feeder and Inserts

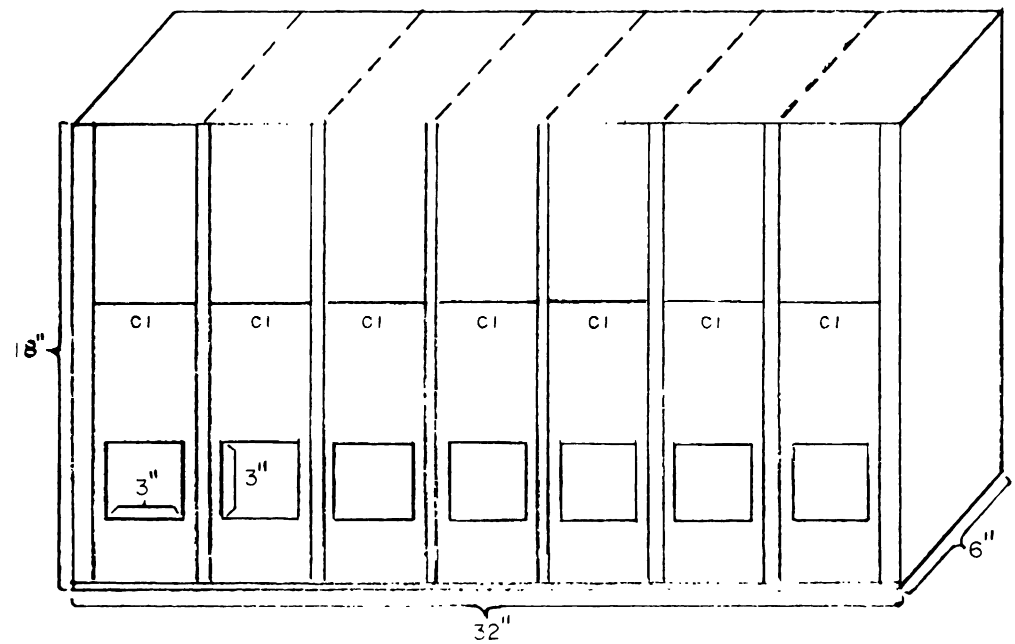

Figure A, Experimental Feeder

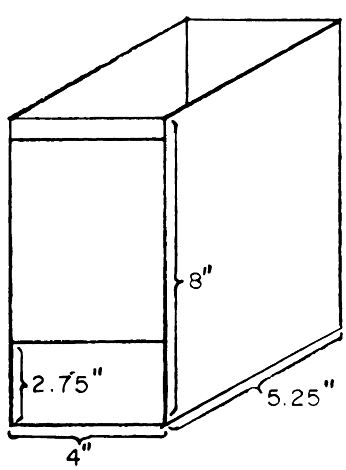

Figure B, Feeder Insert Box

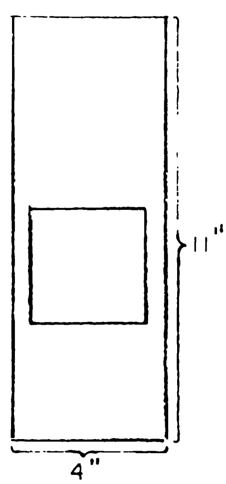

Figure C. Colored Insert

A series of filters measuring 5 x 5 inches was constructed of colored cellophane. The filters were of red, orange, yellow, green, blue, and violet. The wave lengths of the transmitted light were not determined. The filters were placed on the previously mentioned glass shelf above the individual compartments in such order as to correspond by color to the colored inserts.

Six insert boxes measuring 4 x 5.25 x 8 inches were used to hold the test foods (Plate I, Fig. B). The front of each box was open except for the lower 2.5 inches. The lower portion was equal in height to the lower level of the windows of the experimental feeder. The inner surfaces of each box were painted the same hue, value, and chroma of their corresponding colored inserts. Since the insert boxes had equal measurements they could be interchanged randomly in the compartments of the experimental feeder.

Food: The food utilized was fine cracked corn which was colored as nearly as possible to correspond to the six hues of the colored inserts of the experimental feeder. The coloring agents employed were red, yellow, green, and blue commercial vegetable dyes.

Procedures: The colored food was placed in correspondingly color insert boxes and weighed. Each insert box would contain between 530 and 600 grams of food.

Numbers were assigned to colors as follows: red 1, orange 2, yellow 3, green 4, blue 5, violet 6, and 7 to a blank. The position in the experimental feeder of any given color was then determined by referring to a table of random numbers. Each insert box in each experimental trial thus occupied an unbiased position. The colored insert, insert box, and filter was then placed in its proper position.

After the experimental feeder and test bird, or birds, were placed in the feeding cage, they were left undisturbed for 6 hours in case of chickens and 12 hours in case of quail.

Following this elapse of time the experimental feeder was removed, the food weighed, and the weight loss for each insert box recorded.

The experimental birds had a tendency to spill a large portion of the food presented. A correction factor was employed to compensate for this and to obtain the amount of food consumed. The correction factor was based on the assumption that if 50 percent of the total weight loss came from a single insert box, then 50 percent of the spillage came from that box. On two trials, samples of the spillage

were separated by color and weighed. The assumption was found to hold with relatively little error. The correction factor for each insert box was then subtracted from the total weight loss for each to obtain the amount of food consumed. This value was then recorded.

Analysis: The statistical test applied to the data collected was a one-way analysis of the variance of two or more sample means. This test was applied to the data for color selection, feeding position in regard to the experimental feeder, and the incident illumination projected on the food.

This statistical test will show only if a heterogeneity exists between the categories, not where it is. When a heterogeneity was present, the percent of food consumed for each color was plotted on a histogram to reveal its position.

Experiments:

1. Color Preferences of Individual Unconditioned Domestic Chickens.

The experimental birds were subjected to the experimental feeder without having had any previous experience with it. As far as could be determined these birds had never been exposed to any colors except the browns and

white of the holding pen. The experimental birds ranged from 4 to 12 weeks of age. The object of the experiment was to determine the color preference of the unconditioned chicken.

2. <u>Color Selection by Groups of Experienced Domestic Chickens and Unconditioned European Quail</u>.

Here the groups of experimental birds consisted of four chickens or two, four, or six quail. The chickens had had previous experience with the experimental feeder but the quail had not. The object of the experiment was to determine the effect a group of individuals had on the overall color selection.

3. <u>Color Preferences of Unconditioned Domestic Chickens by Sex</u>.

Data recorded in the experiment involving the individual unconditioned chickens were utilized in this experiment. The object of this experiment was to determine if any differences in color preference exist between the sexes of the species involved.

4. <u>The Effect of the Peck Order on Color Preference in Groups of Individuals</u>.

This experiment was conducted with three groups composed of four chickens in each group, all of which had shown a

preference for the same color on previous tests. The test birds were all adults. Each of the three groups utilized was allowed to establish a peck order prior to testing. Then the number of pecks each individual made at each colored feeder was recorded. Prior to testing, the birds were without food for a period of 12 hours. Data were recorded for only the first five minutes the experimental feeder was in the experimental cage. The object of the experiment was to determine the effect of the peck order on the color preference of the groups and the effects upon the individual members.

RESULTS

The results of these experiments are presented below in the same order as described in the section on Materials and Methods.

Experiment 1. <u>Color Preference of Individual Unconditioned Domestic Chickens.</u>

Tables I, II, and III present the results of the individual chickens' selection of food by color. A one-way analysis of variance of the means on each of the three test groups indicates the presence of heterogeneity at the one percent level. Figures 1, 2, and 3 indicate that the heterogeneity exists in the green area of the spectra. Green was the preferred color of food in each of the three test groups, ranging from 42.1 to 53.0 percent of all food consumed. The test groups consisted of birds of different ages. The individuals comprising group "H" were 4 to 5 weeks of age, group "J" were 8 to 9 weeks of age, and group "I" were 11 to 12 weeks of age. There was no significant difference in food selection by color between the groups.

Tables IV, V, and VI present the results of food consumption according to position in the experimental feeder. A one-way analysis of variance indicates that there is no

heterogeneity present at the one percent level. The experimental birds did not show a preference for any individual feeder because of its position in the experimental feeder.

Tables VII, VIII, and IX present the results of food consumption according to the incident light intensity directed upon the food. The light intensities were one, two, three, four and ten candle power. A one-way analysis of variance indicates that in groups "H" and "J" there is no heterogeneity present at the one precent level. The analysis of group "I" does indicate slight heterogeneity in the three candle power range. This test is probably biased, however, as green, the preferred color, did not appear at random among the different candle power magnitudes. The green feeder appeared in the three candle power range 9 times out of 12 or 75 percent of the time. The experimental animals, with the exception of test group "I", did not show a preference for any individual feeder because of the intensity of the incident light.

Experiment 2. <u>Color Selection by Groups of Experienced Domestic Chickens and European Quail</u>.

Tables X, XI, and XII present the results of food selection by color in groups of four chickens. A one-way analysis of variance indicates the presence of heterogeneity

Table I. Food Consumption in Grams by Color for Individual Unconditioned Chickens, Group H

EA	Red	Orange	Yellow	Green	Blue	Violet	
H-1	9.1	0.1	0.4	12.0	0.1	0.0	
H-2	12.6	0.7	7.2	2.2	0.1	1.8	
H-3	0.5	1.2	0.4	4.9	3.0	0.8	
H-4	9.5	5.6	13.6	8.4	2.7	4.4	
H-5	2.3	3.4	1.7	2.8	3.8	3.8	
H-6	0.9	0.2	0.1	7.1	0.1	0.9	
H-7	0.3	0.1	0.2	16.0	5.9	0.2	
H-8	0.1	0.0	0.7	7.1	0.1	0.1	
H-9	4.2	0.7	2.6	7.7	1.3	2.1	
H-10	1.3	0.9	0.0	15.2	0.2	2.4	
H-11	11.6	0.3	1.8	12.0	2.6	0.5	Total
EX	52.4	13.2	28.7	95.4	19.9	17.0	226.6
$\bar{X}$	4.76	1.20	2.61	8.67	1.81	1.55	20.60

EA = experimental animal, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 7.49$ Critical $F_{.99}$ (5 and 60 d.f.) $= 3.34$

Table II. Food Consumption in Grams by Color for Individual Unconditioned Chickens, Group I

EA	Red	Orange	Yellow	Green	Blue	Violet	Total
I-1	5.1	2.1	1.2	12.4	2.5	0.3	
I-2	0.4	0.0	0.8	17.3	1.2	0.9	
I-3	0.5	0.9	0.0	15.6	2.2	0.5	
I-4	0.0	0.1	0.5	8.0	1.3	4.9	
I-5	1.8	0.5	0.8	1.6	3.3	9.8	
I-6	0.4	0.7	1.1	1.3	0.0	1.4	
I-7	0.8	0.0	0.0	0.0	2.2	1.0	
I-8	1.2	2.3	1.5	20.3	1.7	8.0	
I-9	1.8	2.1	1.2	17.7	0.0	11.2	
I-10	16.0	1.0	0.0	15.1	2.6	4.8	
I-11	7.5	0.4	0.0	4.7	0.0	0.0	
I-12	0.0	0.0	0.9	15.1	1.0	0.0	
EX	35.5	10.1	8.0	129.1	18.0	42.8	243.5
$\bar{X}$	2.96	0.84	0.67	10.76	1.50	3.57	20.30

EA = experimental animal, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 11.06$ Critical $F_{.99}$ (5 and 66 d.f.) = 3.31

Table III. Food Consumption in Grams by Color for Individual Unconditioned Chickens, Group J

EA	Red	Orange	Yellow	Green	Blue	Violet	Total
J-1	1.2	0.3	0.2	6.1	0.0	0.2	
J-2	0.7	0.0	0.0	11.9	0.7	6.7	
J-3	0.7	2.9	3.0	5.2	0.9	3.1	
J-4	5.7	1.6	0.0	0.5	0.0	2.2	
J-5	0.0	0.5	0.0	13.9	2.2	1.0	
J-6	0.4	1.7	1.0	8.0	1.9	0.2	
J-7	1.9	8.7	3.6	4.9	3.8	2.6	
J-8	2.1	1.3	0.8	3.1	0.0	1.9	
J-9	0.8	0.0	5.6	1.7	0.0	1.1	
J-10	0.1	1.6	2.8	11.1	5.1	11.7	
J-11	0.0	0.0	0.8	20.8	0.0	0.0	
J-12	0.0	0.0	0.0	1.1	0.0	2.0	
EX	13.6	18.6	17.8	88.3	14.6	32.7	185.6
$\bar{X}$	1.13	1.55	1.48	7.36	1.22	2.73	15.47

EA = experimental animal, EX = total consumption, $\bar{X}$ = average consumption/trial.

F = 6.63   Critical $F_{.99}$ (5 and 66 d.f.) = 3.31

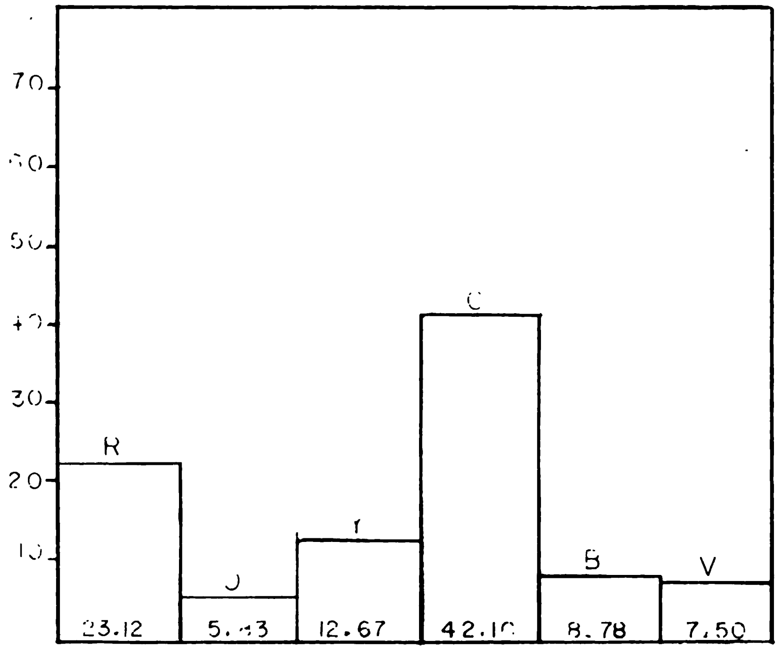

Figure I. Percent Food Consumption for Individual Chickens, Group H

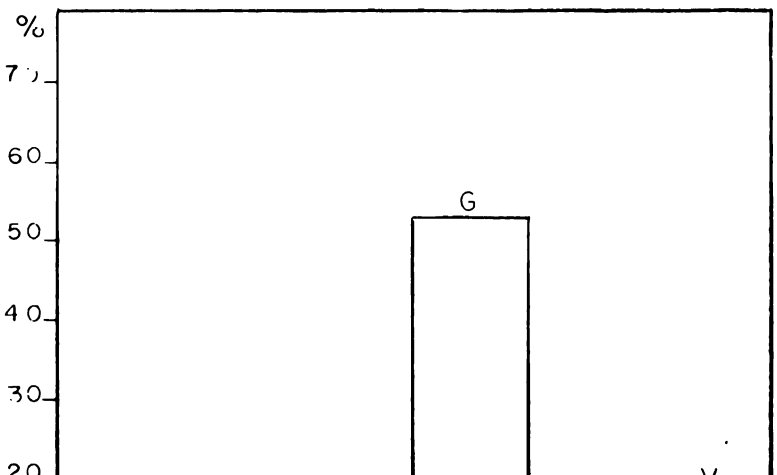

Figure 2. Percent Food Consumption for Individual Chickens, Group I

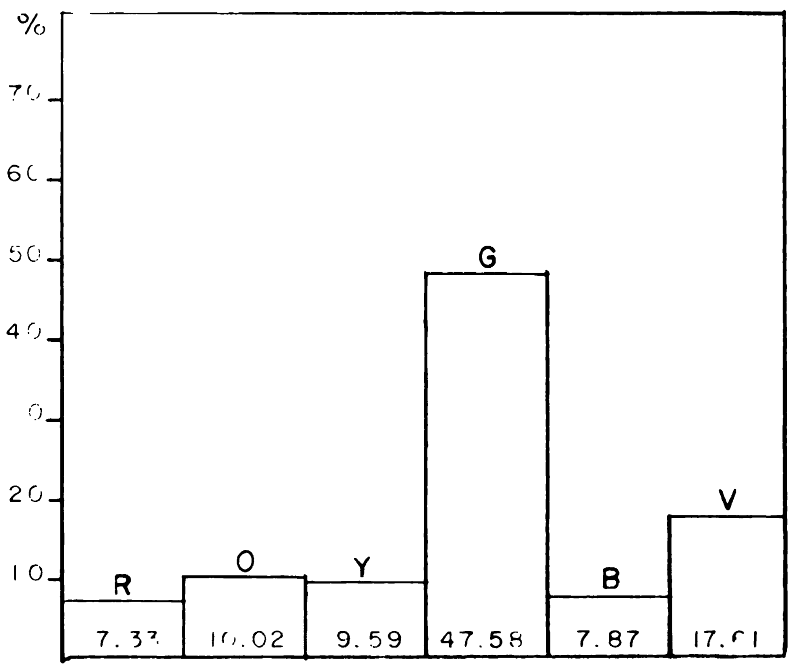

Figure 3. Percent Food Consumption for Individual Chickens, Group J

Table IV. Consumption in Grams by Feeder Position for Individual Unconditioned Chickens, Group H

EA	W-1	W-2	W-3	W-4	W-5	W-6	W-7	
H-1	0.1	0.4	0.0	---	0.1	9.1	12.0	
H-2	7.2	12.6	2.2	0.1	1.8	0.7	---	
H-3	0.5	0.4	1.2	0.8	---	4.9	3.0	
H-4	---	2.7	9.5	4.4	13.6	8.4	5.6	
H-5	3.8	2.3	2.8	3.4	1.7	3.8	---	
H-6	0.1	---	7.1	0.9	0.2	0.9	0.1	
H-7	0.1	0.2	0.2	5.9	0.3	16.0	---	
H-8	0.1	0.1	---	0.1	0.7	7.1	0.0	
H-9	2.6	4.2	2.1	7.7	---	1.3	0.7	
H-10	0.0	---	0.9	15.2	2.4	1.3	0.2	
H-11	2.6	11.6	---	0.3	0.5	12.0	1.8	Total
EX	17.1	34.5	26.0	38.8	21.3	65.5	23.4	226.6
$\bar{X}$	1.71	3.83	2.89	3.88	2.37	5.95	2.93	20.60

EA = experimental animal, EX = total consumption, $\bar{X}$ = average consumption/trial, W-- = experimental feeder window.

$F = 1.10$ Critical $F_{.99}$ (6 and 60 d.f) = 3.12

Table V. Consumption in Grams by Feeder Position for Individual Unconditioned Chickens, Group I

EA	W-1	W-2	W-3	W-4	W-5	W-6	W-7	Total
I-1	0.3	---	2.5	2.1	5.1	12.4	1.2	
I-2	---	17.3	0.8	1.2	0.4	0.9	0.0	
I-3	0.0	0.5	0.9	0.5	2.2	15.6	---	
I-4	8.0	0.1	4.9	---	1.3	0.5	0.0	
I-5	0.8	0.5	1.8	1.6	3.3	9.8	---	
I-6	---	0.0	0.7	1.1	1.4	1.3	0.4	
I-7	0.0	---	0.0	2.2	1.0	0.8	0.0	
I-8	---	8.0	1.2	1.5	20.3	1.7	2.3	
I-9	11.2	0.0	2.1	17.7	1.8	1.2	---	
I-10	1.0	2.6	16.0	15.1	4.8	---	0.0	
I-11	7.5	0.4	0.0	---	0.0	4.7	0.0	
I-12	0.0	15.1	0.9	1.0	0.0	---	0.0	
EX	28.8	44.5	31.8	44.0	41.6	48.9	3.9	243.5
$\bar{X}$	3.20	4.45	2.65	4.40	3.47	4.89	0.43	20.30

EA = experimental animal, EX = total consumption, $\bar{X}$ = average consumption/trial, W-- = experimental feeder window.

F = 0.80 Critical $F_{.99}$ (6 and 65 d.f.) = 3.09

Table VI. Consumption in Grams by Feeder Position for Individual Unconditioned Chickens, Group J

EA	W-1	W-2	W-3	W-4	W-5	W-6	W-7	
J-1	---	1.2	0.2	6.1	0.3	0.2	0.0	
J-2	6.7	0.7	0.7	0.0	11.9	0.0	---	
J-3	2.9	---	0.9	5.2	3.1	3.0	0.7	
J-4	1.6	0.5	0.0	5.7	---	0.0	2.2	
J-5	2.2	---	13.9	1.0	0.0	0.0	0.5	
J-6	0.4	---	1.9	1.7	1.0	8.0	0.2	
J-7	3.6	8.7	3.8	2.6	4.9	---	1.9	
J-8	3.1	2.1	0.8	1.9	1.3	---	0.0	
J-9	0.8	0.0	---	1.7	1.1	0.0	5.6	
J-10	0.1	2.8	11.1	5.1	1.6	11.7	---	
J-11	20.8	---	0.0	0.0	0.8	0.0	0.0	
J-12	---	0.0	1.1	0.0	2.0	0.0	0.0	Total
EX	42.2	16.0	34.4	31.0	28.0	22.9	11.1	185.6
$\bar{X}$	4.22	2.00	3.13	2.58	2.55	2.29	1.11	15.47

EA = experimental animal, EX = total consumption, $\bar{X}$ = average consumption/trial, W-- = experimental feeder window.

F = 0.61 Critical $F_{.99}$ (6 and 65 d.f.) = 3.09

at the one percent level. Figures 4, 5, and 6 indicate that the heterogeneity exists in the green area of the spectra. The green-colored food was the preferred food of the experimental animals. It constituted 29.4 to 32.4 percent of the diet.

Tables XIII, XIV, and XV present the results of food consumption by feeder position for the three test groups. A one-way analysis of variance indicates no heterogeneity at the one percent level. The test animals did not show a preference for feeding from any individual feeder because of its position.

Tables XVI, XVII, and XVIII present the results of food consumption in relation tothe intensity of incident light falling upon the test foods. A one-way analysis of variance indicates no heterogeneity is present. The intensity of the incident light falling upon the test foods did not affect the experimental animals' choice of food.

Tables XIX, XX, and XXI present the results of food selection by color for the European Quail. A one-way analysis of the variance indicates the presence of heterogeneity in each of the three test groups. Figures 7, 8, and 9 indicate that the heterogeneity exists in the green region of the spectra. The green-colored food constituted between

Table VII. Food Consumption in Grams by Incident Light Intensity for Individual Unconditioned Chickens, Group H

	1 CP	2 CP		3 CP		4 CP	10 CP		
	0.1	12.0	0.7	9.1	5.9	0.4	0.0	0.2	
	3.0	7.2	0.0	12.6	16.0	0.4	0.1	0.3	
	3.8	0.5	1.8	0.1	0.1	3.4	2.2	0.7	
	0.1	2.7		0.8	4.2	0.1	1.8	7.1	
	0.1	5.6		4.9	7.7	0.3	1.2	2.1	
	0.2	3.8		4.4	15.2		9.5	0.9	
	2.6	0.1		8.4	1.3		13.6	2.4	
		0.1		2.3	11.6		2.8	0.5	
		0.0		0.9	12.0		1.7		
		2.6		0.9			7.1		
		1.3		0.2			0.2		
EX	9.9	38.4		119.3		4.6	54.4		226.6
$\bar{X}$	1.41	2.74		5.68		0.92	2.86		20.60

CP = candle power, EX = total consumption, $\bar{X}$ = average consumption/trial.

F = 1.18 Critical $F_{.99}$ (4 and 61 d.f.) = 3.62

Table VIII. Food Consumption in Grams by Incident Light Intensity for Individual Unconditioned Chickens, Group I

	1 CP	2 CP		3 CP		4 CP	10 CP		
	0.3	1.2	0.0	12.4	1.2	2.5	5.1	2.1	
	8.0	0.9	1.7	17.3	15.1	2.1	0.8	1.8	
	11.2	0.0	2.3	1.2	4.7	0.5	0.4	16.0	
	0.0	0.0	0.0	0.5	15.1	2.2	0.9	4.8	
		0.1	1.0	15.6	1.0	1.3	4.9	0.0	
		0.0	2.6	0.5		3.3	1.8	0.9	
		0.8	0.0	1.6		1.1	0.7	0.0	
		0.5	7.5	1.3		1.5	1.4		
		9.8	0.4	2.2		0.0	0.0		
		0.0	0.0	0.8			1.0		
		0.4	0.0	8.0			1.2		
		0.0		17.7			20.3		
EX	19.5	29.2		116.2		14.5	64.1		243.5
$\bar{X}$	4.88	1.27		6.84		1.61	3.37		20.30

CP = candle power, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 3.70$ Critical $F_{.99}$ (4 and 67 d.f.) = 3.61

Table IX. Food Consumption in Grams by Incident Light Intensity for Individual Unconditioned Chickens, Group J

	1 CP	2 CP		3 CP		4 CP	10 CP		
	0.0	0.2	1.9	1.2	2.1	0.0	0.2	0.8	
	6.7	0.7	0.8	6.1	1.9	0.9	0.3	1.3	
	2.2	2.9	0.0	0.0	1.7	5.7	0.7	1.1	
	2.2	0.7	0.0	5.2	5.1	1.9	11.9	11.1	
	0.2	1.6	5.6	3.0	0.0	1.7	3.1	1.6	
	3.1	0.0	0.1	0.5	0.0	3.8	0.0	0.0	
	0.0	0.5	11.7	1.0		2.8	13.9	0.8	
	20.8	0.4	0.0	0.0		0.0	0.0	1.1	
	0.0	3.6	0.0	8.0			1.0	2.0	
		8.7	0.0	2.6			4.9		
EX	35.2	39.4		38.4		16.8	55.8		185.6
$\bar{X}$	3.91	1.97		2.40		2.10	2.94		15.47

CP = candle power, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 0.46$ Critical $F_{.99}$ (4 and 67 d.f.) = 3.61

Table X. Food Consumption in Grams by Color for Groups of Four Experienced Chickens, Group X

EG	Red	Orange	Yellow	Green	Blue	Violet	
X-1	21.0	10.0	27.6	56.7	6.1	24.2	
X-2	12.5	10.1	30.3	60.6	2.7	40.7	
X-3	30.5	26.9	22.3	58.9	32.4	39.2	
X-4	34.8	37.3	8.0	44.9	11.2	11.2	
X-5	35.2	30.3	19.3	52.3	18.8	37.1	
X-6	47.7	38.1	63.3	78.6	14.4	50.3	
X-7	20.7	2.1	21.9	69.8	16.9	31.7	Total
EX	202.4	154.8	192.7	421.8	102.5	234.4	1308.6
$\bar{X}$	28.91	22.11	27.52	60.26	14.64	33.49	186.94

EG = experiment group, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 10.01$ Critical $F_{.99}$ (5 and 36 d.f.) = 3.58

Table XI. Food Consumption in Grams by Color for Groups of Four Experienced Chickens, Group Y

EG	Red	Orange	Yellow	Green	Blue	Violet	Total
Y-1	27.5	24.9	19.0	42.3	31.6	36.0	
Y-2	12.5	8.1	20.2	30.8	9.7	37.7	
Y-3	20.5	3.1	22.6	58.8	17.1	30.5	
Y-4	18.1	14.3	18.8	45.7	30.6	22.7	
Y-5	22.5	35.1	40.3	61.2	21.8	28.3	
Y-6	33.9	36.4	10.4	43.7	12.6	16.5	
Y-7	19.5	23.6	31.4	41.8	12.6	10.1	
EX	154.5	145.5	162.7	324.3	136.0	181.8	1104.8
$\bar{X}$	22.07	20.78	23.24	46.33	19.43	25.97	157.83

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 7.09$ Critical $F_{.99}$ (5 and 36 d.f.) = 3.58

Table XII. Food Consumption in Grams by Color for Groups of Four Experienced Chickens, Group Z

EG	Red	Orange	Yellow	Green	Blue	Violet	
Z-1	9.0	4.0	10.9	78.0	60.7	34.3	
Z-2	19.1	14.5	17.9	45.5	33.1	23.5	
Z-3	41.5	4.0	23.8	45.9	26.1	21.8	
Z-4	63.3	7.4	9.7	67.0	11.0	20.2	
Z-5	7.9	7.9	17.8	27.6	21.3	19.8	
Z-6	6.7	45.3	37.8	64.0	5.0	12.2	
Z-7	22.7	35.1	40.7	54.4	24.9	31.5	
Z-8	17.5	21.1	35.0	40.9	10.5	6.0	Total
EX	187.7	139.3	193.6	423.3	192.6	169.3	1305.8
$\bar{X}$	23.46	17.41	24.20	52.91	24.07	21.16	163.21

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 5.55$ Critical $F_{.99}$ (5 and 42 d.f.) = 3.49

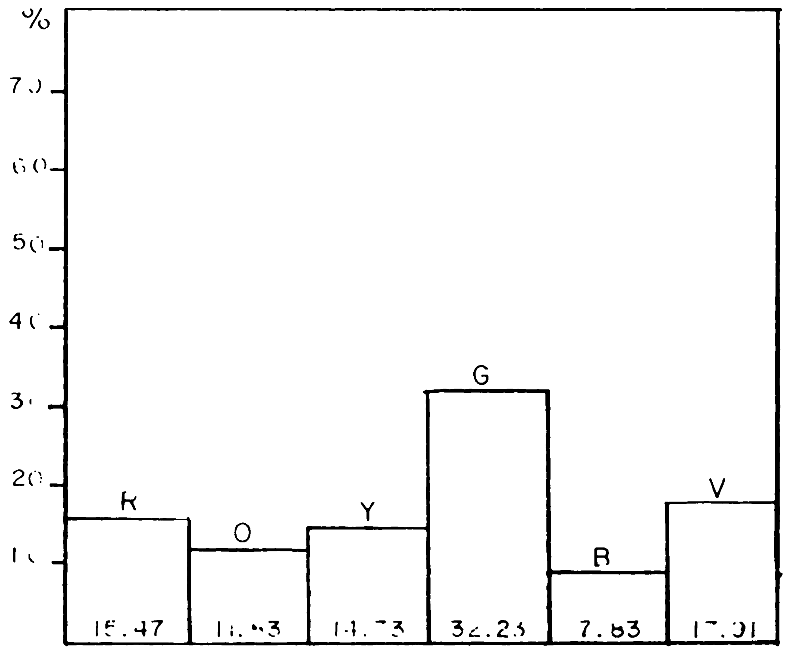

Figure 4. Percent Food Consumption for Groups of Four Chickens, Group X

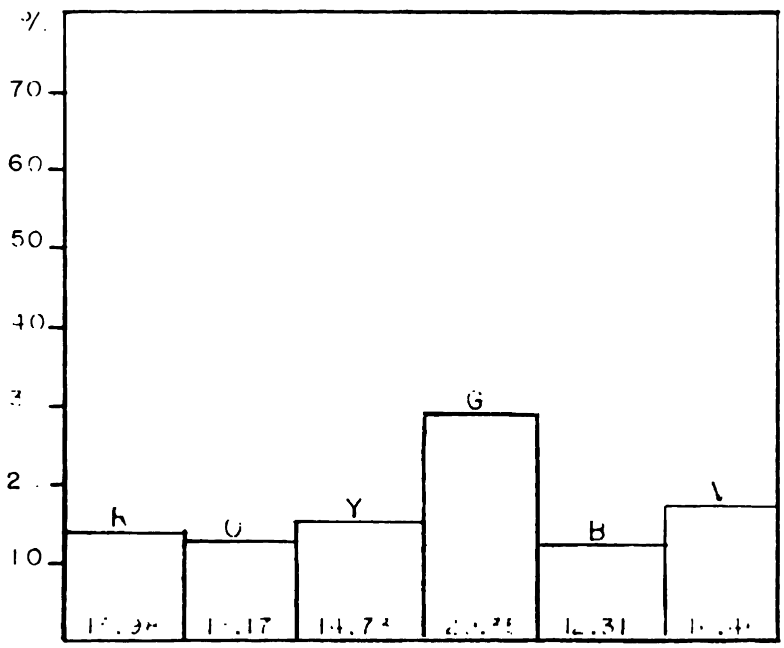

Figure 5. Percent Food Consumption for Groups of Four Chickens, Group Y

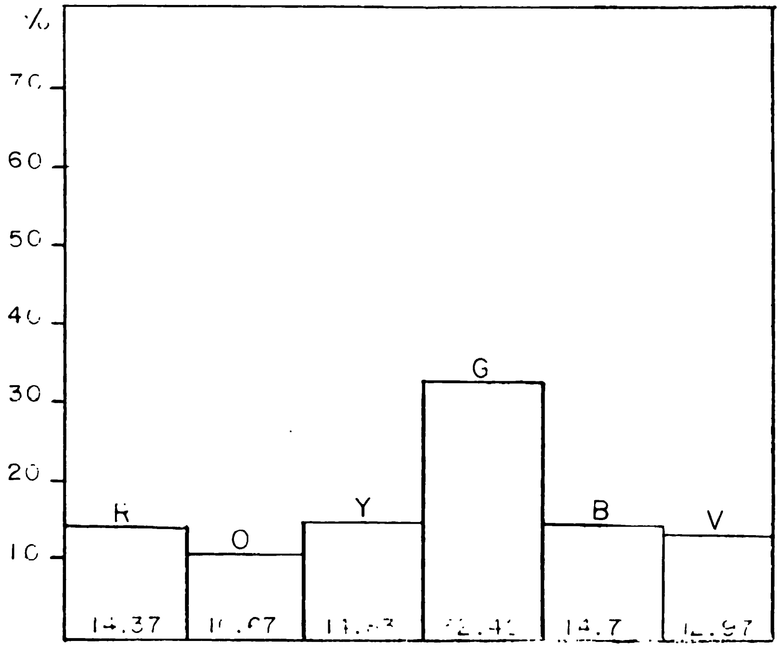

Figure 6, [illegible] umption for
Groups of Four Chickens, Group Z

Table XIII. Food Consumption in Grams by Feeder Position for Groups of Four Experienced Chickens, Group X

EG	W-1	W-2	W-3	W-4	W-5	W-6	W-7	
X-1	6.1	27.6	10.0	---	56.7	24.2	21.0	
X-2	2.7	12.5	60.6	40.7	10.1	---	30.3	
X-3	22.3	39.2	30.5	---	58.9	26.9	32.4	
X-4	8.0	44.9	34.8	11.2	11.2	37.3	---	
X-5	35.2	30.3	37.1	52.3	19.3	---	18.8	
X-6	14.4	78.6	38.1	---	63.3	50.3	47.7	
X-7	69.8	21.9	31.7	---	20.7	16.9	2.1	Total
EX	158.5	255.0	242.8	104.2	240.2	155.6	152.3	1308.6
$\bar{X}$	22.64	36.43	34.69	34.73	34.31	31.12	25.38	186.94

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial, W-- = experimental feeder window.

$F = 0.47$ Critical $F_{.99}$ (6 and 37 d.f.) = 3.33

Table XIV. Food Consumption in Grams by Feeder Position for Groups of Four Experienced Chickens, Group Y

EG	W-1	W-2	W-3	W-4	W-5	W-6	W-7	Total
Y-1	31.6	36.0	27.5	42.3	19.0	---	24.9	
Y-2	20.2	12.5	8.1	---	37.7	30.8	9.7	
Y-3	17.1	58.8	30.5	---	3.1	22.6	20.5	
Y-4	18.8	45.7	---	30.6	22.7	14.3	18.1	
Y-5	22.5	28.3	61.2	---	40.3	35.1	21.8	
Y-6	43.7	10.4	---	33.9	36.4	12.6	16.5	
Y-7	41.8	10.1	31.4	12.6	23.6	19.5	---	
EX	195.7	201.8	158.7	119.4	182.8	134.9	111.5	1104.8
$\bar{X}$	27.96	28.83	31.74	29.85	26.11	22.48	18.58	157.83

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial, W-- = experimental feeder window.

$F = 0.47$ Critical $F_{.99}$ (6 and 37 d.f.) = 3.33

Table XV. Food Consumption in Grams by Feeder Positions for Groups of Four Experienced Chickens, Group Z

EG	W-1	W-2	W-3	W-4	W-5	W-6	W-7	Total
Z-1	10.9	---	4.0	78.0	34.3	9.0	60.7	
Z-2	23.5	---	33.1	14.5	19.1	45.5	17.9	
Z-3	---	4.0	45.9	23.8	21.8	41.5	26.1	
Z-4	67.0	---	7.4	20.2	9.7	11.0	63.3	
Z-5	7.9	21.3	17.8	19.8	27.6	7.9	---	
Z-6	---	5.0	6.7	12.2	37.8	64.0	45.3	
Z-7	31.5	54.4	40.7	35.1	24.9	---	22.7	
Z-8	21.1	17.5	6.0	10.5	---	35.0	40.9	
EX	161.9	102.2	161.6	214.1	175.2	213.9	276.9	1305.8
$\bar{X}$	26.98	20.44	20.20	26.76	25.02	30.55	39.55	163.23

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial, W-- = experimental feeder window.

$F = 0.83$ Critical $F_{.99}$ (6 and 41 d.f.) = 3.27

25.0 and 54.2 percent of the diet of the quail under the experimental conditions.

Tables XXII, XXIII, and XXIV present the results of food selection by feeder position. A one-way analysis of variance reveals no evidence of heterogeneity at the one percent level. Position had no effect on the choice of food by the quail under the experimental conditions.

Tables XXV, XXVI, and XXVII present the results for food consumption by the quail in relation to the intensity of the light falling upon the test foods. A one-way analysis of variance reveals no evidence of heterogeneity at the one percent level. The incident light intensity had no effect on the choice of food by the experimental animals.

Experiment 3. Color Preferences of Unconditioned Domestic Chickens by Sex.

Table XXVIII presents the results on food selection by color by individual unconditioned female Domestic Chickens. A one-way analysis of variance indicates the presence of heterogeneity at the one percent level. Figure 10 reveals the heterogeneity to be in the green area of the spectra. The green food constituted 60.6 percent of the diet of the females.

Table XXXIX presents the results of food selection by

Table XVI. Food Consumption in Grams by Incident Light Intensity for Groups of Four Experienced Chickens, Group X

	1 CP	2 CP	3 CP'	4 CP	5 CP	
	6.1	24.2	12.5	27.6	10.0	
	2.7	21.0	40.7	21.9	56.7	
	32.4	30.3	39.2		60.6	
	18.8	22.3	26.9		10.1	
	14.4	8.0	44.9		30.5	
	69.8	35.2	11.2		58.9	
		30.3	37.3		34.8	
		50.3	52.3		11.2	
		47.7	78.6		37.1	
		16.9			19.3	
		2.1			38.1	
					63.3	
					31.7	
					20.7	Total
EX	144.2	288.3	343.6	49.2	483.0	1308.6
$\bar{X}$	24.03	26.21	38.18	24.60	34.50	186.94

CP = candle power, EX = total consumption, $\bar{X}$ = average consumption/trial.

F = 0.86 Critical $F_{.99}$ (4 and 37 d.f.) = 3.87

Table XVII. Food Consumption in Grams by Incident Light Intensity for Groups of Four Experienced Chickens, Group Y

	1 CP	2 CP	3 CP	4 CP	10 CP	
	31.6	24.9	36.0	10.4	27.5	
	9.7	20.2	42.3	33.9	19.0	
	17.1	20.5	12.5		8.1	
	21.8	18.8	30.8		37.7	
	43.7	18.1	58.8		30.5	
	16.5	22.5	22.6		3.1	
	41.8	12.6	45.7		22.7	
			30.6		61.2	
			14.3		40.3	
			28.3		36.4	
			35.1		31.4	
			10.1		23.6	
			12.6			
			19.5			Total
EX	182.2	137.6	399.2	44.3	341.5	1104.8
$\bar{X}$	26.03	19.66	28.51	22.20	28.46	157.83

CP = candle power, EX = total consumption, $\bar{X}$ = average consumption/trial.

F = 0.46 Critical $F_{.99}$ (4 and 37 d.f.) = 3.87

Table XVIII. Food Consumption in Grams by Incident Light Intensity for Groups of Four Experienced Chickens, Group Z

	1 CP	2 CP	3 CP	4 CP	10 CP	
	60.7	10.9	78.0	33.1	4.0	
	23.5	17.9	9.0	14.5	34.3	
	26.1	4.0	45.5	23.8	19.1	
	67.0	11.0	41.5	35.1	45.9	
	31.5	63.3	20.2	24.9	21.8	
		7.9	19.8		9.7	
		21.3	7.9		7.4	
		5.0	12.2		17.8	
		45.3	54.4		27.6	
		22.7	17.5		6.7	
		21.1	10.5		37.8	
		40.9	35.0		64.0	
					40.7	
					6.0	Total
EX	208.8	271.3	351.5	131.4	342.8	1305.8
$\bar{X}$	41.76	22.61	29.29	26.28	24.49	163.21

CP = candle power, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 1.05$ Critical $F_{.99}$ (4 and 42 d.f.) = 3.80

Table XIX. Food Consumption in Grams by Color for Groups of Four Experienced European Quail

EG	Red	Orange	Yellow	Green	Blue	Violet	
A-1	0.0	0.0	1.5	34.5	14.5	7.3	
A-2	1.6	2.2	4.5	37.3	16.8	5.7	
A-3	1.5	1.6	5.6	28.9	28.5	2.5	
A-4	0.8	0.7	2.5	13.4	12.5	7.2	
A-5	7.2	0.0	0.0	15.1	17.5	14.4	
A-6	0.6	2.4	3.5	17.2	9.3	13.4	
A-7	4.3	0.0	1.1	46.1	19.1	12.3	
A-8	15.7	4.7	3.8	4.7	12.8	14.1	
A-9	0.0	0.0	0.4	7.7	30.8	2.8	
A-10	7.7	0.7	0.0	4.2	1.0	0.0	
A-11	9.0	2.2	2.0	27.8	7.3	4.9	
A-12	4.2	2.4	1.7	25.8	6.0	13.6	
A-13	5.3	1.4	0.6	11.8	3.9	31.3	
A-14	1.0	1.7	1.6	20.0	11.5	22.6	
A-15	0.9	0.5	0.2	26.0	5.5	15.9	
A-16	5.1	0.6	0.3	27.2	7.3	13.7	
A-17	5.3	0.0	0.0	8.4	11.0	8.2	
A-18	0.0	0.0	0.0	28.8	8.5	20.1	
A-19	15.6	11.7	10.8	19.9	15.7	7.6	Total
EX	85.8	32.8	40.1	404.8	239.5	217.6	1020.6
$\bar{X}$	4.52	1.73	2.11	21.31	12.61	11.45	53.72

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 22.82$ Critical $F_{.99}$ (5 and 108 d.f.) = 3.19

Table XX. Food Consumption in Grams by Color for Groups of Six Experienced European Quail

EG	Red	Orange	Yellow	Green	Blue	Violet	
B-1	6.6	0.6	3.8	24.4	20.2	1.2	
B-2	3.3	2.6	20.5	35.9	33.4	20.2	
B-3	1.5	0.8	20.1	37.3	33.5	34.0	
B-4	0.5	2.1	2.9	19.7	12.2	21.7	
B-5	1.4	1.7	42.4	48.4	2.2	5.2	
B-6	0.1	2.0	32.4	30.7	2.1	10.0	
B-7	0.3	5.2	28.4	32.1	24.5	20.6	
B-8	4.4	2.1	12.2	31.8	31.7	33.5	
B-9	2.9	8.6	8.4	13.2	13.1	11.1	
B-10	3.4	44.5	11.1	49.9	10.9	41.7	
B-11	6.1	22.7	6.4	49.7	54.0	20.5	
B-12	10.5	4.2	38.0	21.7	43.5	5.5	
B-13	24.4	5.9	46.1	16.5	31.2	4.9	
B-14	24.3	5.9	33.9	27.9	34.4	30.0	
B-15	4.0	8.1	24.3	37.2	33.2	34.4	
B-16	25.7	4.7	21.5	19.0	28.5	30.8	
B-17	35.3	12.6	10.2	20.9	62.3	19.4	
B-18	5.2	1.4	5.0	7.4	37.3	38.9	
B-19	13.8	1.8	2.4	18.0	28.2	27.6	Total
EX	173.7	137.5	370.0	541.7	536.4	411.12	2170.5
$\bar{X}$	9.14	7.24	19.47	28.51	28.23	21.64	114.24

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 9.74$ Critical $F_{.99}$ (5 and 108 d.f.) = 3.19

Table XXI. Food Consumption in Grams by Color for Groups of Two Experienced European Quail

EG	Red	Orange	Yellow	Green	Blue	Violet	
C-1	0.0	0.0	0.0	24.3	0.1	2.5	
C-2	0.4	0.2	0.3	0.6	1.1	18.5	
C-3	0.0	0.1	7.3	0.0	0.4	2.5	
C-4	1.4	5.5	9.0	20.1	3.0	2.1	
C-5	0.3	0.2	1.4	2.7	1.0	8.7	
C-6	0.2	0.2	0.2	14.1	4.3	6.8	
C-7	0.9	5.9	4.2	14.9	0.6	0.8	
C-8	0.0	0.0	0.0	9.1	0.1	4.3	
C-9	0.0	6.6	0.0	17.0	0.3	0.2	
C-10	11.2	5.1	1.0	33.9	4.0	2.1	
C-11	0.4	0.4	0.5	22.4	1.1	9.5	
C-12	0.0	0.0	0.0	13.7	12.0	0.2	
C-13	0.0	0.0	0.0	12.3	6.4	0.7	Total
EX	14.8	24.2	23.9	185.1	34.4	58.9	341.3
$\bar{X}$	1.14	1.86	1.84	14.24	2.65	4.53	26.25

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 11.97$ Critical $F_{.99}$ (5 and 72 d.f.) $= 3.28$

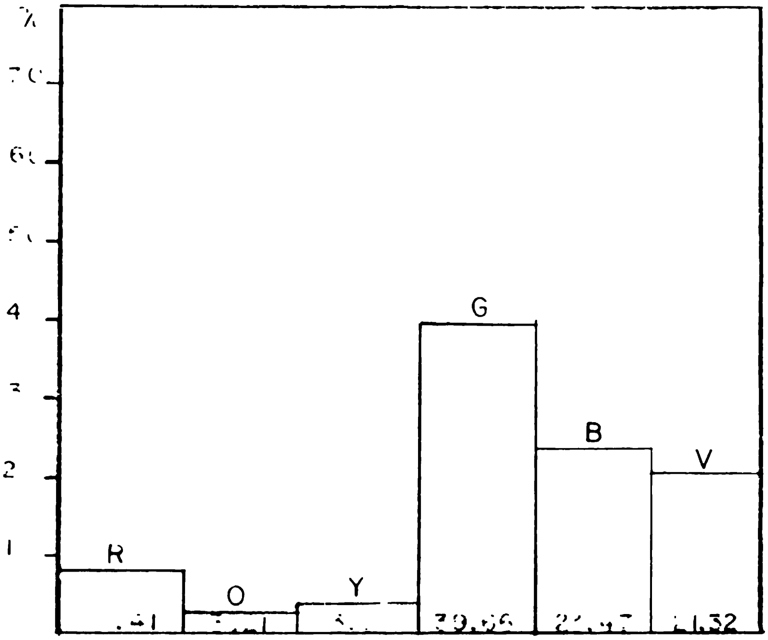

Figure 7. Percent Food Consumption for a Group of Four European Quail, Group A

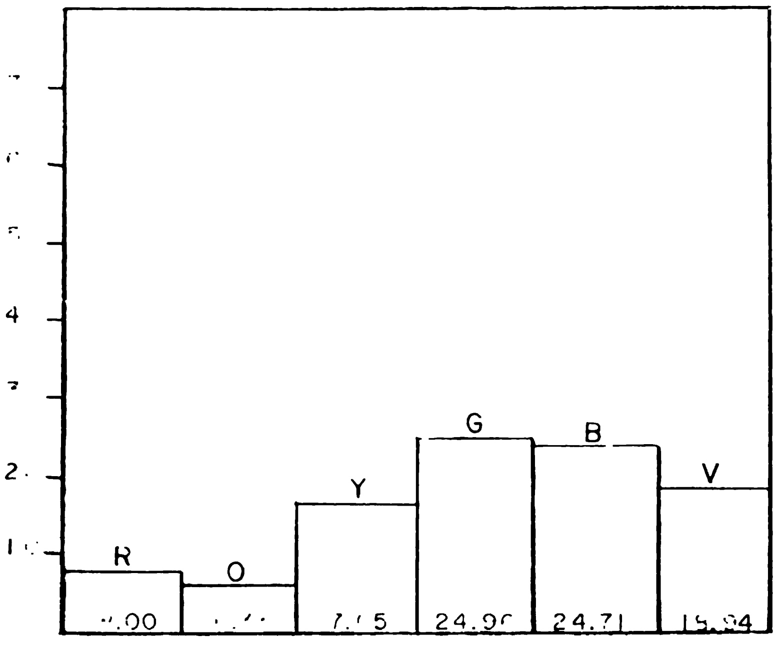

Figure 8. Percent Food Consumption for a Group of Six European Quail, Group B

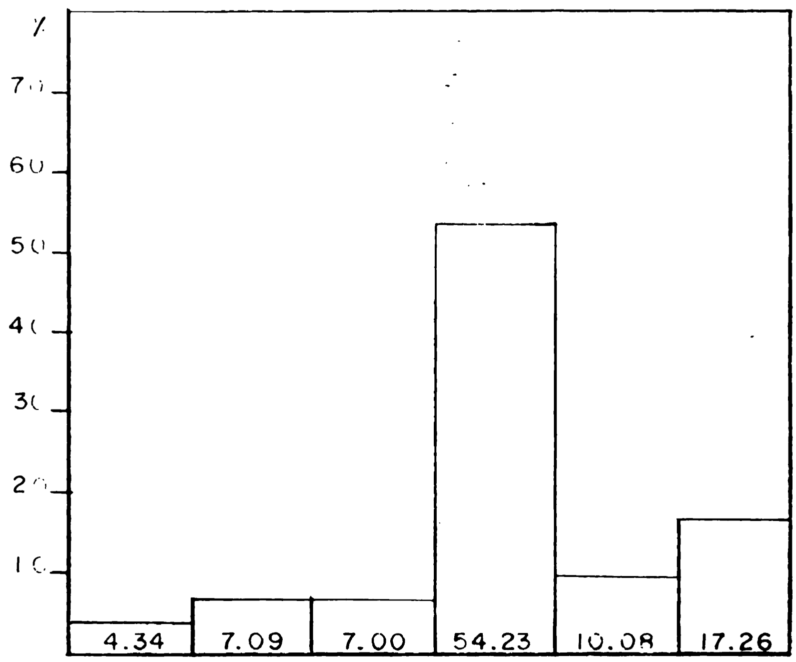

Figure 9. Percent Food Consumption for a Group of Two European Quail, Group C

Table XXII. Food Consumption in Grams by Feeder Position for Groups of Four Experienced European Quail

EG	W-1	W-2	W-3	W-4	W-5	W-6	W-7	
A-1	34.5	14.5	1.5	---	7.3	0.0	0.0	
A-2	2.2	---	1.6	37.3	16.8	5.7	4.5	
A-3	28.5	1.5	---	28.9	2.5	5.6	1.6	
A-4	---	13.4	12.5	0.8	2.5	0.7	7.2	
A-5	14.4	7.2	15.1	0.0	17.5	0.0	---	
A-6	9.3	2.4	13.4	17.2	0.6	---	3.5	
A-7	19.1	46.1	12.3	4.3	---	0.0	1.1	
A-8	14.1	3.8	4.7	---	15.7	12.8	4.7	
A-9	0.4	0.0	---	7.7	2.8	0.0	30.8	
A-10	0.7	1.0	4.2	---	7.7	0.0	0.0	
A-11	9.0	4.9	2.0	7.3	2.2	27.8	---	
A-12	2.4	6.0	4.2	13.6	---	25.8	1.7	
A-13	0.6	3.9	---	31.3	11.8	1.4	5.3	
A-14	11.5	1.7	1.6	---	20.0	1.0	22.6	
A-15	---	0.5	0.9	0.2	5.5	15.9	26.0	
A-16	0.3	0.6	5.1	13.7	---	7.3	27.2	
A-17	11.0	0.0	5.3	8.2	0.0	---	8.4	
A-18	0.0	20.1	0.0	8.5	28.8	0.0	---	
A-19	15.7	11.7	19.9	7.6	---	10.8	15.6	Total
EX	173.7	139.3	104.3	186.6	141.7	114.8	160.2	1020.6
$\bar{X}$	10.22	7.74	6.52	12.44	9.45	6.75	10.01	53.72

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial, W-- = experimental feeder window.

$F = 0.75$ Critical $F_{.99}$ (6 and 108 d.f.) $= 2.98$

Table XXIII. Food Consumption in Grams by Feeder Position for Groups of Six Experienced European Quail

EG	W-1	W-2	W-3	W-4	W-5	W-6	W-7	
B-1	6.6	0.6	1.2	---	3.8	20.2	24.4	
B-2	20.5	20.2	33.4	2.6	3.3	---	35.9	
B-3	0.8	20.1	34.0	37.3	1.5	---	33.5	
B-4	21.7	2.1	2.9	0.5	12.2	19.7	---	
B-5	42.4	---	2.2	1.7	48.4	1.4	5.2	
B-6	32.4	---	0.1	30.7	10.0	2.0	2.1	
B-7	28.4	5.2	---	0.3	20.6	32.1	24.5	
B-8	31.8	31.7	4.4	---	2.1	12.2	33.5	
B-9	13.1	8.6	11.1	---	13.2	2.9	8.4	
B-10	11.1	41.7	3.4	---	49.9	10.9	44.5	
B-11	54.0	49.7	22.7	---	6.4	20.5	6.1	
B-12	38.0	21.7	---	5.5	10.5	43.5	4.2	
B-13	24.4	5.9	16.5	4.9	---	31.2	46.1	
B-14	30.0	24.3	27.9	33.9	---	5.9	34.4	
B-15	37.2	34.4	33.2	24.3	4.0	8.1	---	
B-16	19.0	28.5	---	30.8	25.7	4.7	21.5	
B-17	20.9	---	12.6	19.4	35.3	10.2	62.3	
B-18	1.4	---	7.4	37.3	5.0	38.9	5.2	
B-19	13.8	2.4	27.6	---	18.0	1.8	28.2	Total
EX	447.5	297.1	240.6	229.2	269.9	266.2	420.0	2170.5
$\bar{X}$	23.55	19.81	15.04	17.63	15.88	15.66	24.71	114.24

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial, W-- = experimental feeder window.

$F = 1.18$ Critical $F_{.99}$ (6 and 108 d.f.) = 2.98

Table XXIV. Food Consumption in Grams by Feeder Position for Groups of Two Experienced European Quail

EG	W-1	W-2	W-3	W-4	W-5	W-6	W-7	Total
C-1	0.0	0.0	0.1	24.3	0.0	2.5	---	
C-2	18.5	0.4	1.1	---	0.2	0.3	0.6	
C-3	0.0	7.3	0.1	0.4	0.0	---	2.5	
C-4	3.0	5.5	2.1	20.1	---	1.4	9.0	
C-5	8.7	1.0	0.3	2.7	1.4	0.2	---	
C-6	---	0.2	14.1	4.3	0.2	6.8	0.2	
C-7	14.9	4.2	0.6	0.8	0.9	5.9	---	
C-8	---	9.1	0.0	0.0	0.0	4.3	0.1	
C-9	6.6	17.0	0.0	---	0.0	0.2	0.3	
C-10	5.1	11.2	2.1	1.0	33.9	4.0	---	
C-11	0.4	---	0.5	0.4	9.5	1.1	22.4	
C-12	0.2	0.0	---	0.0	12.0	13.7	0.0	
C-13	0.0	0.0	12.3	0.7	---	0.0	6.4	
EX	57.4	55.9	33.3	54.7	58.1	40.4	41.5	341.3
$\bar{X}$	5.22	4.66	2.78	4.97	5.28	3.37	4.61	26.25

EG = experimental group, EX = total consumption, $\bar{X}$ = average consumption/trial, W-- = experimental feeder window.

F = 0.22 Critical $F_{.99}$ (6 and 71 d.f.) = 3.07

Table XXV. Food Consumption in Grams by Incident Light for Groups of Four Experienced European Quail

	1 CP	2 CP		3 CP		4 CP	10 CP		
	34.5	14.5	0.6	0.0	1.0	16.8	1.5	20.0	
	28.5	0.0	3.9	37.3	13.7	12.5	7.3	0.9	
	7.2	2.2	5.3	1.5	8.2	0.8	1.6	5.1	
	14.4	5.7	1.7	28.9	20.1	0.0	2.5	5.3	
	9.3	4.5	22.6	5.6	8.5	17.5	2.5	0.0	
	19.1	1.6	0.5	13.4	7.6	4.3	15.1	0.0	
	4.7	0.0	15.9	0.7	10.8	3.8	13.4	28.8	
	14.1	2.4	26.0	7.2		0.2	0.6	19.9	
	5.5	3.5	0.3	17.2		30.8	12.3		
	11.5	1.1	0.6	4.7		0.0	46.1		
	11.0	12.8	7.3	0.0			15.7		
	0.0	0.4	27.2	0.0			2.8		
		0.7	8.4	7.7			0.0		
		1.0	0.0	4.9			4.2		
		0.0	15.7	7.3			7.7		
		0.0	11.7	27.8			2.0		
		9.0	15.6	13.6			2.2		
		2.4		25.8			4.2		
		6.0		31.3			11.8		
		1.7		1.4			1.6		Total
EX	159.8	232.8		306.2		86.7	235.1		1020.6
$\bar{X}$	13.32	6.29		11.34		8.67	8.40		53.72

CP = candle power, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 0.46$ Critical $F_{.99}$ (4 and 67 d.f.) = 3.61

Table XXVI. Food Consumption in Grams by Incident Light for Groups of Six Experienced European Quail

	1 CP	2 CP		3 CP		4 CP	10 CP		
	33.5	6.6	10.9	20.2	4.9	33.4	1.2	16.5	
	21.7	0.6	44.5	35.9	24.3	20.1	3.8	27.9	
	5.2	20.2	20.5	37.3	5.9	0.5	3.3	33.9	
	2.1	24.4	6.1	1.5	34.4	12.2	34.0	4.0	
	24.5	20.5	38.0	19.7	8.1	2.2	2.9	25.7	
	33.5	2.6	43.5	1.4	30.8	1.7	48.4	12.6	
	13.1	0.8	4.2	30.7	4.7	0.3	0.1	35.3	
	30.0	2.1	24.4	2.0	19.4	33.2	10.0	7.4	
	34.4	42.4	5.9	32.1	10.2	24.3	20.6	5.0	
	37.2	32.4	31.2	12.2	37.3	2.4	4.4	18.0	
	19.0	28.4	46.1	13.2	27.6		2.1		
	20.9	5.2	28.5	2.9	1.8		11.1		
	62.3	31.7	21.5	41.7			3.4		
	28.2	31.8	1.4	49.7			49.9		
		8.6	38.9	54.0			22.7		
		8.4	5.2	21.7			6.4		
		11.1	13.8	5.5			10.5		Total
EX	365.6	662.4		591.1		130.3	421.1		2170.5
$\bar{X}$	26.11	19.48		20.38		13.03	15.60		114.24

CP = candle power, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 1.63$ Critical $F_{.99}$ (4 and 67 d.f.) = 3.61

Table XXVII. Food Consumption in Grams by Incident Light for Groups of Two Experienced European Quail

	1 CP	2 CP		3 CP		4 CP	10 CP		
	18.5	0.0	4.3	24.3	5.9	0.1	0.0	0.0	
	2.5	0.0	6.6	0.4	9.1	1.1	0.2	0.0	
	3.0	2.5	0.2	0.3	17.0	7.3	0.1	0.0	
	8.7	0.6	5.1	0.4	11.2	0.2	0.0	0.0	
	14.9	0.0	4.0	20.1	33.9	4.2	2.1	2.1	
	0.1	5.5	0.4	1.4	0.0	0.6	0.3	1.0	
	0.3	9.0	1.1	2.7	0.2	0.0	1.4	22.4	
	9.5	1.0	0.0	0.2	0.7	0.5	14.1	0.4	
	12.0	6.8	0.0	4.3	0.0	12.3	0.2	13.7	
	0.0	0.2	6.4	0.8		0.0	0.9		Total
EX	69.5	53.7		132.9		26.3	58.9		341.3
$\bar{X}$	6.95	2.69		6.99		2.63	3.10		26.25

CP = candle power, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 1.78$ Critical $F_{.99}$ (4 and 73 d.f.) = 3.59

color by individual unconditioned male Domestic Chickens. A one-way analysis of variance indicates the presence of heterogeneity at the one percent level. Figure 11 indicates the heterogeneity to exist in the green area of the spectra. The green-colored food constituted 42.5 percent of the food consumed by the males.

Experiment 4. The Effect of the Peck Order on Color Preferences in Groups of Individuals.

Table XXX presents the combined data of three different peck orders composed of four Domestic Chickens. The numbers of each block represent the total number of pecks taken in each feeder position by the rank of the bird in the hierarchy.

The feeder position number refers to its position in regards to the green feeder, i.e., a feeder position one being adjacent to green and consisting of one or two feeders depending upon the position of green in the experimental feeder. All experimental birds had shown a strong preference for green in the previous experiments involving individual birds.

The dominant individual in each case continues to select the green food, which elicited 77.9 percent of all pecks. The dominant individual becomes very antagonistic towards

Table XXVIII. Food Consumption in Grams by Color for Individual Unconditioned Female Chickens

EA	Red	Orange	Yellow	Green	Blue	Violet	
H-1	9.1	0.1	0.4	12.0	0.1	0.0	
H-3	0.5	1.2	0.4	4.9	3.0	0.8	
H-6	0.9	0.2	0.1	7.1	0.1	0.9	
H-7	0.3	0.1	0.2	16.0	5.9	0.2	
H-8	0.1	0.0	0.7	7.1	0.1	0.1	
H-11	11.6	0.3	1.8	12.0	2.6	0.5	
I-2	0.4	0.0	0.8	17.3	1.2	0.9	
I-3	0.5	0.9	0.0	15.6	2.2	0.5	
I-6	0.4	0.7	1.1	1.3	0.0	1.4	
I-11	7.5	0.4	0.0	4.7	0.0	0.0	
I-12	0.0	0.0	0.9	15.1	1.0	0.0	
J-1	1.2	0.3	0.2	6.1	0.0	0.2	
J-2	0.7	0.0	0.0	11.9	0.7	6.7	
J-3	0.7	2.9	3.0	5.2	0.9	3.1	
J-4	5.7	1.6	0.0	0.5	0.0	2.2	
J-5	0.0	0.5	0.0	13.9	2.2	1.0	
J-12	0.0	0.0	0.0	1.1	0.0	2.0	Total
EX	39.6	9.2	9.6	151.8	20.0	20.5	250.7
$\bar{X}$	2.33	0.54	0.56	8.93	1.18	1.21	14.75

EA = experimental animal, EX = total consumption, $\bar{X}$ = average consumption/trial.

F = 20.56 Critical $F_{.99}$ (5 and 96 d.f.) = 3.52

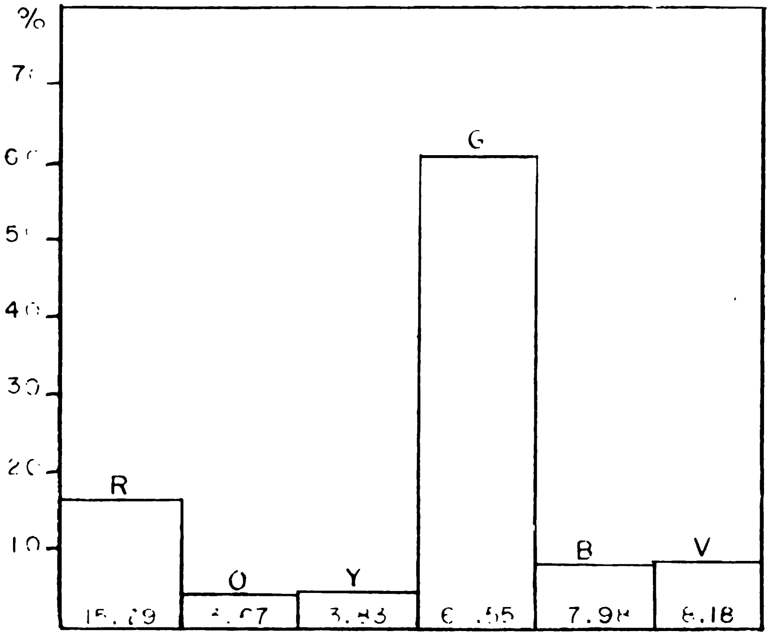

Figure 10. Percent Food Consumption for Individual Female Chickens

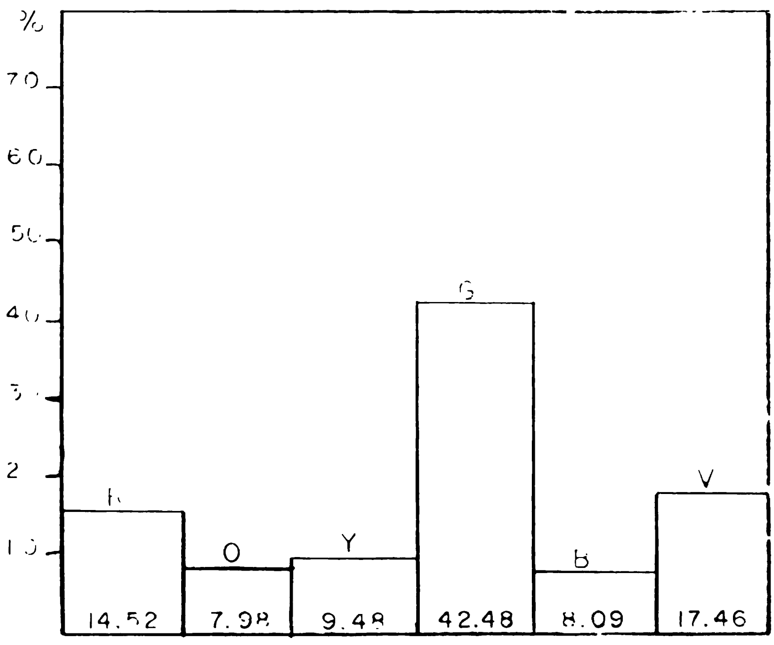

Figure 11. Percent Food Consumption for Individual Male Chickens

Table XXIX. Food Consumption in Grams by Color for Individual Unconditioned Male Chickens

EA	Red	Orange	Yellow	Green	Blue	Violet	Total
H-2	9.1	0.1	0.4	12.0	0.1	0.0	
H-4	9.5	5.6	13.6	8.4	2.7	4.4	
H-5	2.3	3.4	1.7	2.8	3.8	3.8	
H-9	4.2	0.7	2.6	7.7	1.3	2.1	
H-10	1.3	0.9	0.0	15.2	0.2	2.4	
I-1	5.1	2.1	1.2	12.4	2.5	0.3	
I-4	0.0	0.1	0.5	8.0	1.3	4.9	
I-5	1.8	0.5	0.8	1.6	3.3	9.8	
I-7	0.8	0.0	0.0	0.0	2.2	1.0	
I-8	1.2	2.3	1.5	20.3	1.7	8.0	
I-9	1.8	2.1	1.2	17.7	0.0	11.2	
I-10	16.0	1.0	0.0	15.1	2.6	4.8	
J-6	0.4	1.7	1.0	8.0	1.9	0.2	
J-7	1.9	8.7	3.6	4.9	3.8	2.6	
J-8	2.1	1.3	0.8	3.1	0.0	1.9	
J-9	0.8	0.0	5.6	1.7	0.0	1.1	
J-10	0.1	1.6	2.8	11.1	5.1	11.7	
J-11	0.0	0.0	0.8	20.8	0.0	0.0	
EX	58.4	32.1	38.1	170.8	32.5	70.2	402.1
$\bar{X}$	3.24	1.78	2.24	9.49	1.81	3.90	22.34

EA = experimental animal, EX = total consumption, $\bar{X}$ = average consumption/trial.

$F = 10.09$ Critical $F_{.99}$ (5 and 102 d.f.) = 3.20

Table XXX. The Effect of the Peck Order on Color Utilization as Shown by Total Pecks Relative to Feeder Position from Green

Rank in Peck Order / Feeder Position From Green	Green	1	2	3	4	5	6
1	1160	70	100	95	45	15	15
2	255	270	75	150	115	125	50
3	325	175	170	160	65	70	40
4	670	180	50	155	70	115	20

birds No. 2 and No. 3 of the peck order when they approach the green feeder. The individuals occupying the center of the peck order were forced to utilize feeders other than the previously shown preferred green.

The No. 4, or the lowest ranking bird of the peck order, was second in ability to utilize the preferred green food. In each case this position in the peck order was occupied by a very submissive individual. This bird would repeatedly occupy the green feeder position during the periods when the dominant bird was antagonistically driving birds No. 2 and No. 3 away from the area of the green food. The No. 4 bird would immediately give up the green feeder position upon the return of the dominant bird without any sign of antagonism. The small amount of feeding by birds No. 2 and No. 3 from the green feeder generally took place after the dominant bird appeared satiated.

When a group of birds is tested together the intermediate members of the peck order are forced to the less preferred colors.

This results in an increase in the percentage of unpreferred colored food consumed and a decrease in the percentage of the preferred green food.

DISCUSSION

The role of preferred colors in regard to food selection has been discussed periodically in the literature for nearly a hundred years. The early references pertaining to selection of yellow by sparrows in feeding and for nesting materials are of interest, but may be viewed with some scepticism. The publications of Renshaw (1877) and White (1877) appear to result from casual observation and seemingly are lacking in scientific experimentation.

Pickens (1931, 1935) hypothesized that hummingbirds possessed a natural preference for red flowers. Greenwalt (1960), from his observations in the field, agreed with Pickens. Sherman (1913) could detect no color preference by hummingbirds feeding from colored vials. He noted, however, that inter-specific antagonism occurred when several individuals were simultaneously in the area of the feeders. This may have accounted for the absence of color preference being observed. Bené (1941) also found no evidence of a preferred color although he did present the hypothesis that color preferences may be the result of conditioning. Lyerly _et al_ (1950) found no color preference by a single Mexican Violet-eared Hummingbird (_Colibri thalassinus_) held in a cage. However, this bird appeared to have an aversion to yellow and the feeder position was observed to have an effect on the feeder chosen by the bird. Statistical analysis was not applied by the above mentioned authors to their data.

In my experiments, single unconditioned Domestic Chickens, feeding undisturbed from the experimental feeder, showed a strong preference for green. The green-colored food made up 42.1, 53.0, and 47.6 percent of the diet of the three test groups which consisted of 11, 12, and 12 individuals respectively. The relative positions of the six colored feeder inserts in the experimental feeder had no significant influence on the color choice of the individual birds.

The incident light intensity illuminating the food had no significant effect on the food preference in two of the three test groups. Analysis of the data of the single positive test group indicated that the incident light might be a factor in the selection of food. The data show, however, that the preferred green color did not occur randomly with regards to the various light intensities available. The green feeder insert occurred 75 percent of the time under the three candle power illumination. Comparison of the single significant "F" score with the "F" scores of the two non-significant groups showed it was at least threefold

greater. Hence, this test is considered biased.

Yerkes (1915), while conducting color discrimination experiments on the Ring Dove, found that the male bird consistently gave more positive results than the female. He believed that a difference in color discrimination or preference between the sexes may exist. He states, however, that his two experimental animals were of different temperaments. This factor, coupled with the small sample size, lends scepticism to his hypothesis.

In my experiments, the sex of the Domestic Chicken had no effect on the color preference in food selection. Both sexes exhibited marked preference for the green-colored food, which made up 60.6 percent of the diet of the females and 42.5 percent of the diet of the males. A difference in color preference may exist between the individuals of the species, which can not be explained by sex.

The Domestic Chicken and the European Quail, when fed in groups, showed a preference for the green-colored food. The diet of the quail consisted of 39.6, 25.0, and 54.2 percent of green-colored food. The diet of the chickens, when fed in groups, consisted of 34.2, 29.4, and 32.4 percent green food in three trials.

An average decrease of 15.6 percent in the consumption greater. Hence, this test is considered biased.

Yerkes (1915), while conducting color discrimination experiments on the Ring Dove, found that the male bird consistently gave more positive results than the female. He believed that a difference in color discrimination or preference between the sexes may exist. He states, however, that his two experimental animals were of different temperaments. This factor, coupled with the small sample size, lends scepticism to his hypothesis.

In my experiments, the sex of the Domestic Chicken had no effect on the color preference in food selection. Both sexes exhibited marked preference for the green-colored food, which made up 60.6 percent of the diet of the females and 42.5 percent of the diet of the males. A difference in color preference may exist between the individuals of the species, which can not be explained by sex.

The Domestic Chicken and the European Quail, when fed in groups, showed a preference for the green-colored food. The diet of the quail consisted of 39.6, 25.0, and 54.2 percent of green-colored food. The diet of the chickens, when fed in groups, consisted of 34.2, 29.4, and 32.4 percent green food in three trials.

An average decrease of 15.6 percent in the consumption of green food was noted in comparing the data on individual chickens with those of groups of chickens. The decrease appears to be the result of the influence of the peck order. The dominant individual was antagonistic towards the other members of the group relative to their respective rank when the preferred feeder was approached. This results in a more complete utilization by the other birds of all the colored foods available. One might infer that this could be beneficial to wild birds in that a high degree of food specialization might not develop. The dominant and the most subordinate individuals appear to be most successful in the utilization of the preferred color of food.

Bené (1941) suggested that there is no justification for believing that color preferences in the family Trochilidae may be regarded as a phylogenetic trait. Kalmbach et al (1946), utilizing colored rodent poisons, found that wild birds possessed an aversion to green. However, they fed on the yellow and uncolored poisoned foods and died. The affected birds all belonged to the family Icteridae with the exception of one species of Alaudidae. The experiments conducted on two members of the family Phasianidae indicated a strong preference for green.

The possible preference for red by some Trochilidae, the apparent aversion to green by the *Icteridae*, and the preference for green by certain *Phasianidae* suggested that color preferences may be a phylogenetic trait. This hypothesis should not be abandoned until more complete studies, involving closely and distantly related families, have been conducted.

SUMMARY AND CONCLUSIONS

1. Color preference in two species of <u>Phasianidae</u>, the Domestic Chicken and the European Quail, was studied by measuring the consumption of food which was artificially colored red, orange, yellow, green, blue, and violet with commercial vegetable dyes.

2. The test animals were fed from a specially constructed experimental feeder. The feeder contained seven interchangeable colored insert boxes which held the experimental food. Each insert box was illuminated by incident light passing through a cellophane filter which corresponded in color to the food contained therein. The incident light intensity was one, two, three, four, and ten candle power.

3. A one-way analysis of the variance of two or more sample means was applied to the data collected on color selection, position of the insert boxes in the experimental feeder, and intensity of the incident light illuminating the insert boxes.

4. Individual unconditioned Domestic Chickens showed a marked preference for green-colored food under these test conditions. The position of the green-colored food within the experimental feeder and the intensity

of the incident illumination seemingly had no effect on their choice.

5. The sex of the Domestic Chicken had no effect on color preference. Male and female chickens both showed a marked preference for the green-colored food.
6. When tested in groups of four, Domestic Chickens showed a preference for green-colored food. The position of the green-colored food within the experimental feeder and the intensity of the incident illumination seemingly had no effect on their choice.
7. When tested in groups of two, four, or six, European Quail showed a preference for green-colored food under the test conditions. The position of the green-colored food and the intensity of the incident illumination seemingly had no effect on their choice.
8. The peck order may be of importance in that it insures the utilization of all the colored foods presented. The dominant and the most subordinate individuals were most successful in utilizing the green-colored food. The intermediate members were forced to utilize the least preferred colors.
9. The peck order of birds, under wild conditions, may be of importance in preventing the development of a high

degree of food specialization.

10. Color preferences exhibited by birds may be a phylogenetic trait.

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