

delay in snowfall, the chain of events might be delayed, as well as in areas without autumn snow. If this sequence does occur, ineffective dietary changeover might cause mortality in regions that are snow-free in autumn.

To evaluate part of this hypothesis I collected 32 Spruce Grouse (*C. c. canace*) along the Northwest Miramichi River (47° lat. 65° long.), New Brunswick, between 16 October and 8 November 1975. Snow did not fall prior to or during the collection period. Crops of all grouse collected contained only or mostly conifer needles. Although Spruce Grouse spend more time in trees when autumnal snow is present (Alberta data), the New Brunswick data show that snow cover is not necessary for birds to spend at least enough time in trees to feed on needles. Also, an early dietary changeover in areas

with snow-free autumn weather should reduce the possibility of mortality associated with a sudden onset of winter weather. Hence, whether dietary changes precede or result from gut changes (Moss, J. Wildl. Manage. 36:99-104, 1972; Pendergast and Boag 1973) probably becomes less important in relation to the effects of dietary change on survival in autumn and winter.

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COLOR PREFERENCE AND SHORT-TERM LEARNING BY STELLER'S JAYS

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The purposes of this study were to establish color preference in the selection of food by Steller's Jays (*Cyanocitta stelleri*) and to determine how long a short-term negative stimulus associated with the most favorite color would alter the natural color preference scheme. Natural color preference by the Steller's Jay probably reflects the colors of its natural foods and therefore may be difficult to change on a long-term basis. If, however, a sufficiently large, yet constant, population of birds could be enticed to feed on an unnatural bait, color preference (independent of food source) and short-term learning behavior could be studied.

Our observations were made in Camp Laurels, Tilden Regional Park, Alameda Co., California. The study area was within a grove of trees near a dry river bed. Steller's Jays in Tilden Park are quite tame and have acquired the habit of foraging on the picnic grounds; consequently, it is a simple matter to lure them to a particular spot for observation. Since the area is relatively open, birds from neighboring territories can see when bait is available and come to it quickly.

Unshelled roasted peanuts were selected as bait for the jays. Batches of peanuts were colored red, yellow, blue and green with food coloring. We placed batches of differently colored peanuts in one or more piles in the middle of a path near the river bed and then retired to a distance of 15-20 ft. The birds appeared to be familiar with peanuts, as they would select the nuts and natural peanuts over any of the colored peanuts.

The study was conducted during a nine-day period in July. Observations were made twice daily, at noon and between 1800 and 1900.

A jay entering the study area typically would alight on a branch in a tree overlooking the pile of peanuts, call, and then fly down to select a peanut. When two or more birds flew to the food, one generally supplanted the others and selected one or two peanuts while the subordinate birds watched from a distance of 2-3 ft.

Most birds would select a peanut and shake it as if to judge whether the kernels were inside. If a rattle could not be heard or felt, they would take one or two more peanuts before flying off. Occasionally, a bird would eat one of the peanuts within the study area by grasping the ends of the peanut with its feet and pecking at the shell to remove the nuts inside. Frequently, while one bird attempted to store two peanuts in its mouth, another bird would quickly pick the nearest peanut from the pile and fly away. We did not include these selections in the data because they were not determined by color.

Generally 20 birds fed in the study area at noon and 12-15 in the evening. Perhaps because of the greater number of birds feeding at noon, competition among birds appeared to be greater at this time. We generally found four to six jays competing near the peanuts at mid-day, but rarely more than three in the evening.

Figure 1 shows the order in which peanuts were selected at noon from four adjacent piles of red, yellow, blue and green peanuts, each containing 25

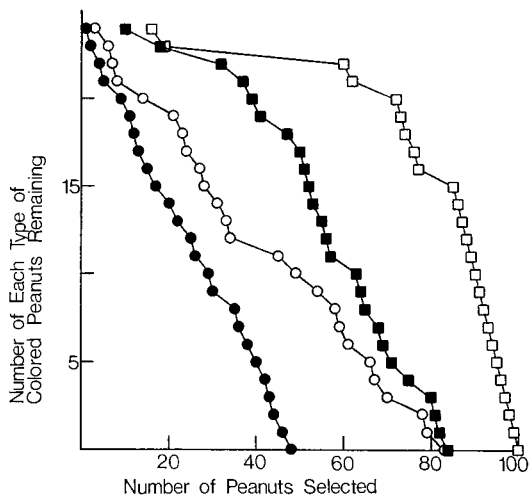


FIGURE 1. Order of selection of differently colored peanuts by Steller's Jays. Four adjacent but separate piles of red (black dots), yellow (white dots), blue (black squares) and green (white squares) peanuts, each pile initially containing 25 peanuts, were set out at noon.

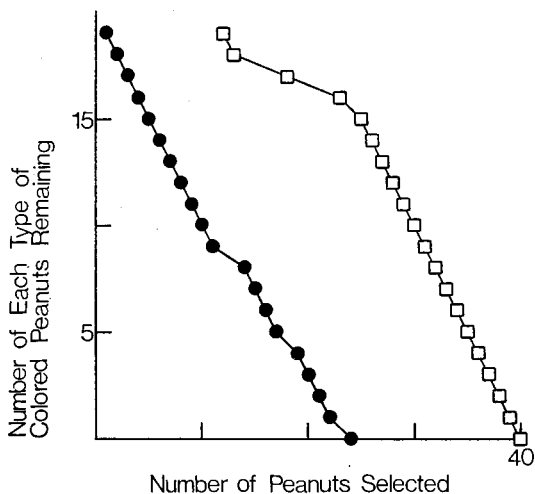


FIGURE 2. Order of selection of red and green peanuts at noon. One pile of 20 red (black dots) and 20 green (white squares) peanuts was set out.

peanuts initially. The red peanuts were selected over the other colors at a rate independent of the relative number of red peanuts in the four piles. The yellow peanuts were the next favorite, with blue and green being the least favored, in that order. The relative preference for blue over yellow increased upon depletion of the red peanuts.

When red peanuts were mixed with those of another color, the red ones were always preferred; the degree of preference, however, was found to depend upon the time of day. Figures 2 and 3 show the order in which 20 red and 20 green peanuts, mixed within one pile, were selected during noon and evening of the same day. The preference for red was stronger at noon, when either the greater number of birds or their tendency to feed at that time increased competition at the feeding site and correspondingly decreased the amount of time a bird could spend in

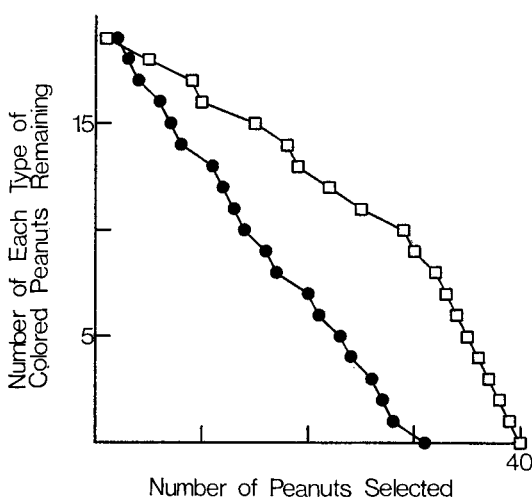


FIGURE 3. Order of selection of red and green peanuts in the evening. One pile of 20 red (black dots) and 20 green (white squares) peanuts was set out.

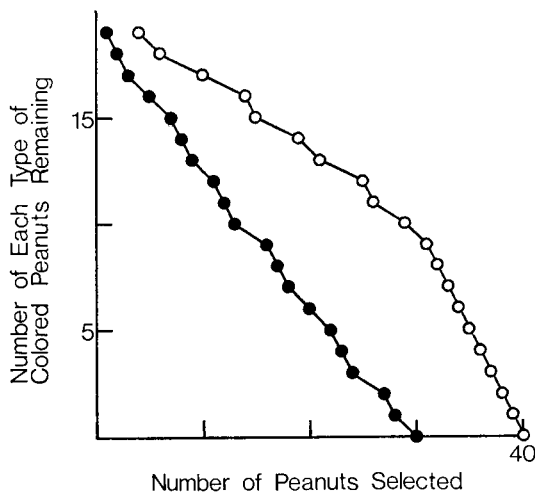


FIGURE 4. Order of selection of red and yellow peanuts at noon. One pile of 20 red (black dots) and 20 yellow (white dots) peanuts was set out.

selecting a peanut. An equivalent situation prevailed for red versus yellow peanuts (Figs. 4 and 5).

We frequently noted that a bird would select the same color that it had just seen another bird select. We could not ascertain the reason for this behavior.

Red-colored shells, from which both nuts had been carefully removed, were used as a means of providing negative feedback for selection of red. For five consecutive visits, a pile of 20 green peanuts and 20 red shells was put out twice to invert the jays' preference of red over green. By the fourth visit the birds were initially selecting primarily green peanuts (Table 1). During the first two visits most of the jays would pick up a red shell, shake it, put it down and repeat this test with red shells once or twice before selecting a green peanut and flying away with it. The num-

TABLE 1. Short-term learning by Steller's Jays to select green over red. A chi-square analysis of the observed number of initial selections to each color shows that, during the first training session, there were significantly more initial selections to red and, during the first testing session, there were significantly more initial selections to green than would be expected by chance.

Number of Training Session	Color of Initial Selection	
	Red	Green
1	22*	8
2	17	14
3	12	17
4	7	24
5	9	22
Number of Tests Following Short-Term Learning		
1	8**	21
2	12	19
3	16	20
4	18	11
5	24	7

* $\chi^2 = 6.53$.
 ** $\chi^2 = 5.83, P < 0.02$.

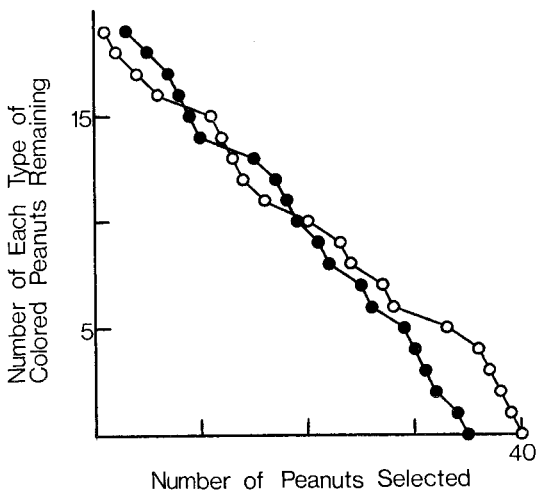


FIGURE 5. Order of selection of red and yellow peanuts in the evening. One pile of 20 red (black dots) and 20 yellow (white dots) peanuts was set out.

ber of tests by shaking of red shells appeared to decrease with each session, as well as the number of initial selections being red.

Following these five learning sessions, we tested the birds for their initial color selection from only five green and five red peanuts. The pile of peanuts was restored to its original composition after every two selections. The purpose of this test was to determine how long the birds would continue to select green over red when provided with no differential reward for green. Within 48 h after the last learning session, the birds reverted to their natural color preference (Table 1).

Our findings support those of earlier studies of avian color preference in demonstrating that color serves as an important discriminator stimulus in the

selection of food (Grant, *Am. Nat.* 100:85, 1966; Collias and Collias, *Condor* 70:273, 1968; Miller and Miller, *Condor* 73:309, 1971). By not varying the position or quality of the food supply, we found that Steller's Jays exhibit a natural order of color preference of red, yellow, blue and green; this order was the same regardless of how many different colors of peanuts were set out. This preference scheme becomes more important when competition for food is increased. As might be expected for an omnivorous bird with opportunistic feeding habits (Hardy, *Condor* 76:102, 1974; Alcock, *Behaviour* 46:174, 1973), we found that the jays could readily be trained to adopt an inverted color preference scheme in response to a short-term negative stimulus. Furthermore, they tended to persist in using this inverted scheme after termination of the negative stimulus. Because we did not mark individual birds, we do not know the constancy of the members of the population under observation. Demonstration of short-term learning by the birds, however, indicates that for the most part we saw the same individuals on each visit.

This particular color preference scheme may, of course, pertain only during the summer season within the locale of this study. Our observations demonstrate, nevertheless, that the jays use this scheme as one of their primary factors in selecting food. They depend upon it even more when competition is keener and abandon it only on a short-term basis if there is a differential reward for doing so. Our findings thus indicate that Steller's Jays, either innately or as a result of long-term experience, are more likely to take advantage of a potential food source if it is red or yellow rather than blue or green. If, however, they encounter a desirable food with a color low on their natural color preference scheme, they quickly learn to associate this color with the particular food and use it as one of the primary visual cues in their search for this food supply.

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FORAGING RATES OF STARLINGS IN TWO HABITATS

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Williamson and Gray (*Condor* 77:84-89, 1975) found that Starlings (*Sturnus vulgaris*) forage in at least four types of habitat. Starlings thus seemed a good species with which to study foraging behavior

in more than one habitat. I hypothesized that Starlings alter their foraging rates in short and tall grass habitats, increasing their speed in short grass as predicted by Cody (*Am. Nat.* 102:107-147, 1968) for different species. Cody did not consider habitat differences when analyzing the foraging behavior of grassland species of birds.

The study was conducted between 0600 and 0930 from 1-28 May 1975 at Griggs Reservoir Metropolitan Park in Columbus, Ohio. Temperatures ranged

TABLE 1. Starling foraging data obtained from two grassland habitats.

Foraging measure	Habitat type		W ^a	P ^b
	Tall grass (≥ 6 cm)	Short grass (< 6 cm)		
Average speed (m/s)	0.1 (25) ^c	0.2 (69)	2.101	0.0174
Duration of average stop	2.8 (25)	1.3 (69)	1.705	0.0401
% of time stationary	31.7 (25)	18.5 (69)	9.500	0.00003

^a Wilcoxon value for Wilcoxon matched-pairs signed ranks test (Siegel 1956).

^b Probabilities associated with the Wilcoxon value (Siegel 1956).

^c \bar{x} (N).