SOME PREY PREFERENCE FACTORS FOR A RED-TAILED HAWK

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SEVERAL studies have reported selection against conspicuous prey. Dice (1947) reported differential selection against conspicuous phenotypes of mice (*Peromyscus maniculatus*) and Kaufman (1974a) showed that Barn Owls (*Tyto alba*) and Screech Owls (*Otus asio*) selected against conspicuous phenotypes of old field mice (*Peromyscus polionotus*). Metzgar (1967) reported that Screech Owls preferred transient white-footed mice (*Peromyscus leucopus*) over resident ones in a laboratory experiment. Metzgar suggested that transient mice may be more active and thus more conspicuous to a predator than residents. Prey activity was suggested as a conspicuousness factor by Cushing (1939) and Ingles (1940). Kaufman (1974b) reported support for a prey activity explanation. He allowed Barn Owls to select either an active (live) or inactive (dead) house mouse (*Mus musculus*) in a field enclosure. The owls preferred significantly more of the live mice. The purpose of the present study was to examine further the role of activity in prey selection. The first of three experiments reported here examined the role of prey activity when a Red-tailed Hawk (*Buteo jamaicensis*) was offered a choice between two live prey animals. The second experiment examined changes in prey activity preferences when the hawk was offered two comparatively large prey animals. In the third experiment the hawk was offered two prey of different weights, to determine if this would affect the selection against more active prey.

METHODS

One adult male Red-tailed Hawk was used, housed in an outdoor 8.0 × 7.5 m enclosure 2.3 m high. The sides of the enclosure were covered with plywood and the roof was covered with wire mesh. The hawk was perched on a dowel 1 m high at the north end of the enclosure. Two plywood prey pens were placed in the corners of the south end of the enclosure. These measured 2.6 × 1.3 m with 0.6 m high sides. Plexiglass was used in the end facing the hawk in order to give the hawk maximal visibility of the prey items. Two metal tubes 2.5 m long and 15 cm in diameter were positioned so that prey items could be simultaneously pushed into the prey pens from outside the enclosure. The floors of the prey pens were marked off in 10-cm square grids. House mice (*Mus musculus*), domestic chicks (*Gallus domesticus*), and laboratory rats (*Rattus norvegicus*) were used as prey. During each prey presentation trial, an observer, stationed in a blind above the south end of the enclosure, recorded the number of grids each animal crossed until one was taken by the hawk. This terminated the trial. The prey item chosen, the latency to strike, and the total grid crossings for both prey items were recorded for each trial. Grid

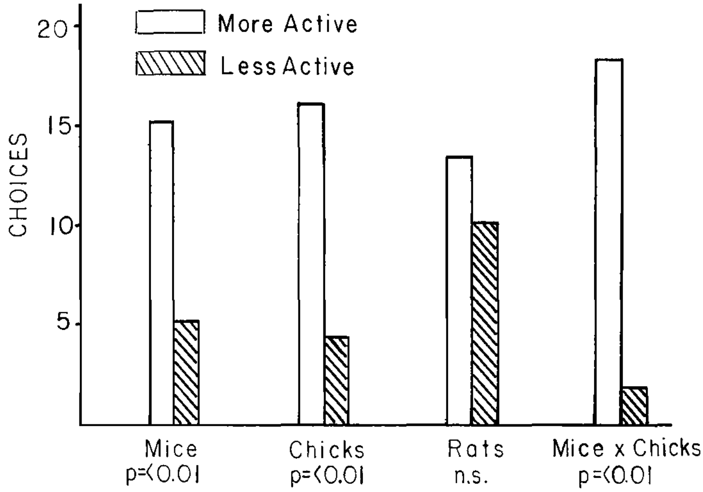

Fig. 1. Prey choices as a function of prey activity for four conditions. Open bars are more active animals and closed bars are less active animals. Significance determined by a sign test for two proportions (Bruning and Kintz 1968).

crossing was considered an index of activity of the prey animals. The prey item not chosen was removed while the hawk ate the chosen animal.

EXPERIMENT 1

To determine if the hawk preferred the more active prey, 84 trials were conducted in 4 series. Prey were randomly assigned to prey pens and those not chosen on a given trial were used during later trials. No prey animal was used for more than four trials. In the first series, 20 trials were run using adult house mice as prey. Two trials, 6 h apart, were conducted every day for 10 days. Mice were presented in same-sex pairs with no weight difference between two mice on a given trial exceeding 4 g. The hawk maintained its weight at approximately 850 g throughout this and the following procedure. In the second series of trials 20 pairs of 5- to 15-day-old chicks were presented. Chicks were matched by weight (approximately 35 g) but not by sex. In order to magnify the differences in activity levels between chicks, a 0.5 mg/kg intraperitoneal injection of chlorpromazine (CPZ, a major tranquilizer) was given to one of each pair of chicks 15 min before the trial. The position of the injected chick was randomly alternated throughout this series. The third series of trials was conducted with 24 pairs of rats. They were matched by sex and weight for each trial. Rats weighing from 125 to 385 g were used, but on any single trial the difference between the two rats never exceeded 12 g. The hawk's weight during the rat trials was held to 864 g ($\pm$ 5 g) by holding its intake to approximately 110 g of whole rat per day. To maintain this intake level, one trial was given every 3 days for the heaviest rats and one trial per day with the lighter rats. This method was considered preferable to removing half-eaten carcasses because removal may have disrupted the hawk's natural feeding behavior. The fourth series of trials tested activity preferences between mice and chicks. One chick and one mouse were pre-

TABLE 1

MEAN GRID CROSSINGS FOR PREY ANIMALS DURING 84 ACTIVITY PREFERENCE TRIALS

Prey	More active	Less active
Mice (N = 20)	102	61
Chicks (N = 20)	62	20
Rats (N = 24)	43	18
Mice and chicks (N = 20)	87	52

sented on each trial. Twenty trials with random positioning of these species were conducted using the same procedure as the first three series. Only 5- to 8-day-old chicks were used to keep the weight differences between species within 5 g. A 0.5 mg/kg CPZ ip injection was given to the mice on ten trials to reduce their activity, as the mice were normally much more active than the chicks.

Results.—On all but the third series of trials (rats) the hawk chose significantly more of the higher activity animals (Fig. 1). The preference for the more active of two prey items was consistent even when CPZ treated; less active animals were nearly immobile or behaving as if sick or dying. The mean number of grid crossings for high and low activity animals is shown in Table 1. Mean latencies to strike in minutes were 3:25 for mice, 3:54 for chicks, 4:20 for rats, and 3:45 for mice vs. chicks. These differences were not significant. There was no significant position preference for either prey pen, with 39 choices on the left pen and 45 on the right. Further analysis of the rat choice data (series 3) revealed a lower mean weight (141 g) of rats that were high activity choices. The mean weight for rats in low activity choices was 220 g. In this series the hawk apparently chose the less active rat when the choice was between heavier animals. In order to explore this possibility further, another experiment was performed.

EXPERIMENT 2

Using the same delivery and recording system as above, the hawk was presented with 18 pairs of female rats. The rats were divided into six weight classes in 50-g increments, from $<$ 100 g to $>$ 300 g. Three pairs were presented in each weight class on a semi-random schedule. Choices were recorded and these data were combined with the rat data from experiment 1 by including rats that fit the appropriate weight classes.

RESULTS.—Fig. 2 shows the relationship between rat weight, activity, and hawk preferences. Generally the hawk took the more active rat unless their weights exceeded 200 g. In choices involving rats over 200 g, the hawk significantly preferred the less active animal ($P = <0.05$). The latencies for some heavy rats exceeded 10 min; no latency beyond 7 min was recorded for rats $<$200 g. Fig. 2 also shows greater variability of choice with heavier rats. This may be due to a reduction of the high weight-low activity preference over several trials. In experiment 1 no higher activity, $>$250 g rat was ever taken, but in the last experiment, two such rats were chosen.

EXPERIMENT 3

Twenty pairs of chicks were used, each pair consisting of a comparatively large CPZ treated (less active) chick and a comparatively small, untreated chick. Weight

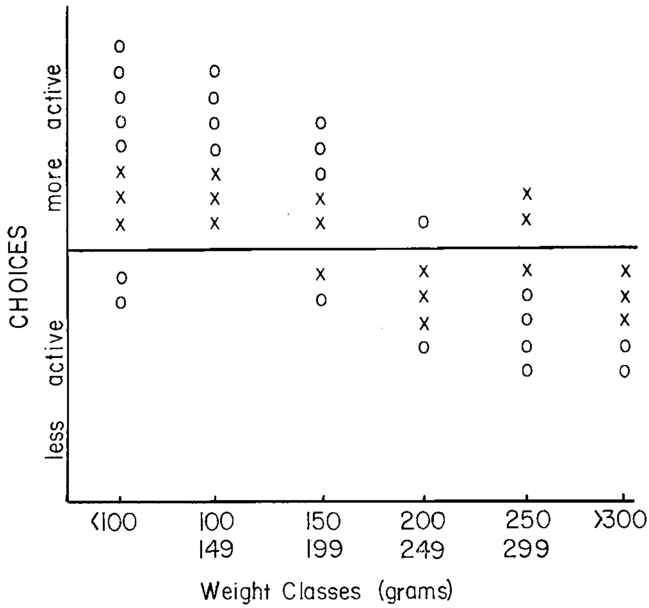

Fig. 2. Prey choices as a function of the weight of rats. Circles are Experiment 1 rats and crosses are Experiment 2 rats.

differences were never less than 55 g. The mean weights for the chicks were 42 g for the smaller and 117 g for the larger. The chicks were introduced into the prey pens as in the previous experiments and the side with the large chick was randomized. As the role of size preference was to be tested independent of activity preference, all of the large chicks were injected with 0.5 mg/kg CPZ ip to hold their activity levels below normal.

RESULTS.—The hawk chose the larger chick in 15 trials and the smaller chick in 3 trials. This difference was significant ($P = <0.01$). Two trials were terminated before a choice because the large chicks escaped from the prey pen. Mean latencies to strike were not significantly different from the chick latencies in experiment 1. Activity levels were higher in the small chick group with a mean number of grid crossings of 214 per trial while the mean crossings for the large chicks was 85. The hawk took one large chick that was completely immobile and lying on its back. This was the only instance of a preference for immobile prey in all three experiments.

DISCUSSION

In the first experiment the hawk preferred the more active of two prey animals when no other differences were apparent between them. Relative activity may have operated by itself as a prey conspicuousness factor in this experiment. This result extends the findings of Metzgar (1967) and Kaufman (1974b), who suggested that activity played some role in the selection of prey by the owls in their studies. White and Weeden (1966) also reported that the activity of Willow Ptarmigan (*Lagopus lagopus*) appeared to attract Gyrfalcon (*Falco rusticolus*) predation. These authors noted that ptarmigan freeze when a Gyrfalcon alights near them. Freezing behavior may be an example of a prey response to predator selection against conspicuously active prey. The mechanism responsible for the hawk's high activity preferences in the present study may be a response to a stimulus chain set up by the prey. Once a predator has begun attending to a given prey animal, its intention movements toward the prey or some physiological response, such as arousal, may reinforce further attention and eventual attack. The hawk's attention rarely appeared "locked on" to the more active prey during the trials. It appeared to compare both animals, stepping from one side of the perch to another, watching each one closely. The attacks were sudden and difficult to predict by the observer; further research into predator preferences could investigate physiological changes during these comparisons. If choice is related to arousal, the heart rate, for instance, could be monitored while the hawk compares the available prey items. The results of the second experiment may suggest the existence of a mechanism in the Red-tailed Hawk that is related to the potential formidability of its potential prey. A large rat is certainly capable of injuring a raptor the size of a Red-tailed Hawk and there may be some advantage to selecting the less active and therefore possibly less formidable opponent. Over many trials this preference for the less active animal may be replaced by a high-activity preference if the hawk is successful in subduing these larger animals. The variability in the heavier weight classes in experiment 2 may be explained on this basis. Further experiments are needed to examine this question. Experiment 3 showed a clear preference for heavier, less active chicks. Comparing the chick data in experiment 1, showing a strong preference for the more active prey, with the third experiment where the larger chicks were less active and still preferred, may demonstrate a tendency in the hawk to select the apparently more profitable prey item in terms of relative biomass. Testing these preferences under different conditions of food deprivation would determine the point at which a prey animal becomes too large and preferences switch to the smaller prey.

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