

ENEMY RECOGNITION BY THE SONG SPARROW

BY MARGARET M. NICE AND JOOST TER PELKWYK

Plate 8

IN connection with the study of inborn and learned behavior in the Song Sparrow (*Melospiza melodia*) an attempt was made to experiment on fear reactions in hand-raised birds, particularly on the question as to what it is that constitutes an 'enemy' to these birds. The Song Sparrow is a favorable subject for tests because the number of notes, either of 'alarm' or 'fear,' varies with the degree of excitement. In this we have an objective criterion of the degree of fear. Hand-raised Goldfinches (*Spinus tristis*), on the other hand, were either indifferent when tested, or flew wildly about the cage; it was easy to see what frightened them, but impossible to make a comparative study of the effectiveness of different stimuli.

As stimuli in our tests we used live animals, mounted birds, and cardboard models. For the loan of the mounted birds we wish to thank Mr. E. R. Blake and Mr. Rudyerd Boulton of the Field Museum of Natural History, Mr. Charles Rogers of Princeton University, and Mr. Earl Wright of the Chicago Academy of Sciences.

OBSERVATIONS BY OTHERS

Several experimental approaches have recently been made to an analysis of the predator-prey relation from the standpoint of the predator (Tinbergen, 1940); but often the assumption seems to have been that the prey is passive. We know, however, that the prey has its special methods of defense, such as threatening, flight, hiding, or making use of protective coloration. Observations and experiments on enemy recognition are scattered. Bolles (1890) carried a captive Barred Owl (*Strix varia*) into the woods and recorded the reactions of the birds toward it; the majority of the birds "scolded" it, doing so more vigorously in summer than in winter. Thorndike (1899) experimented on instinctive reactions of young chicks, finding no instinctive fear of cats. "There develops in the first month a general fear of novel objects in motion." A tame Carrion Crow (*Corvus corone*) and Jackdaw (*Corvus monedula*) were noted by Hertz (1926) to react to every new object with fear, but as soon as the object proved

to be harmless, the fear changed into curiosity and after that to aggressiveness. Various creatures were put into a cage with a "hungry chicken snake" by Kellogg (1931); fear was shown by wild adult English Sparrows (*Passer domesticus*), but none by an adult Canary, nor by chicks less than a week old. The fear of snakes is often assumed to be inborn. Experiments by Antonius (1939) show, however, that the well-known snake-fear in apes and monkeys is probably not inborn, but learned from companions. No inborn fear of snakes was found by Rand (1937) in two hand-raised Blue Jays (*Cyanocitta cristata*); a dog was at first ignored by the birds, but after one was 38 days old, it flew up out of the dog's reach. Brückner (1933) states that very young chicks were afraid only of loud noises and of the loss of balance. Toward rabbits they behaved indifferently at first, but at the age of three weeks they reacted with distinct fear.

There are a number of experiments using birds of prey or models of the same. Lorenz (1935: 356) mentions the violent reaction of a hand-raised *Passer domesticus* to the first owl the bird ever saw; he states that the Magpie (*Pica pica*) instinctively recognizes a predatory animal, but that the Jackdaw, that lives in flocks, does not. A mounted owl (*Asio otus*) and hawk (*Accipiter*) provoked fear in a tame Hooded Crow (*Corvus cornix*) and hand-raised Jackdaws (Strausz, 1938). Plaster models of the heads of these birds, painted or white, also provoked fear when the head looked in the direction of the Crow or Jackdaw. The birds were much less disturbed when the mounts and models had their backs turned. A mounted Jackdaw aroused curiosity or was ignored. Although the effect of the mounted owl and hawk was very great at first, after repeated experiments or if the objects were left for some time in the cage, the birds gradually became indifferent. Krätzig (1939) found in young of the Hazel Hen (*Tetrastes bonasia rupestris*) no signs of fear before the age of ten days; after that they showed marked fear reactions to dogs and hawks. Goethe (1937), Tinbergen (1939), Lorenz (1939) and Krätzig (1940) describe experiments in which cardboard models of various shapes were moved through the air along wires. Goethe noted a specific reaction in young Blackcocks (*Lyrurus tetrrix*) to models of birds of prey; there was a sexual differentiation in chicks as young as twenty days, the females seeking cover, the males assuming a defensive attitude. The experiments of Lorenz and Tinbergen showed that young Grey Geese (*Anser anser*) react from about the eighth week on; the form of the model was not as important with these birds and with ducklings as with young Turkeys (*Meleagris*

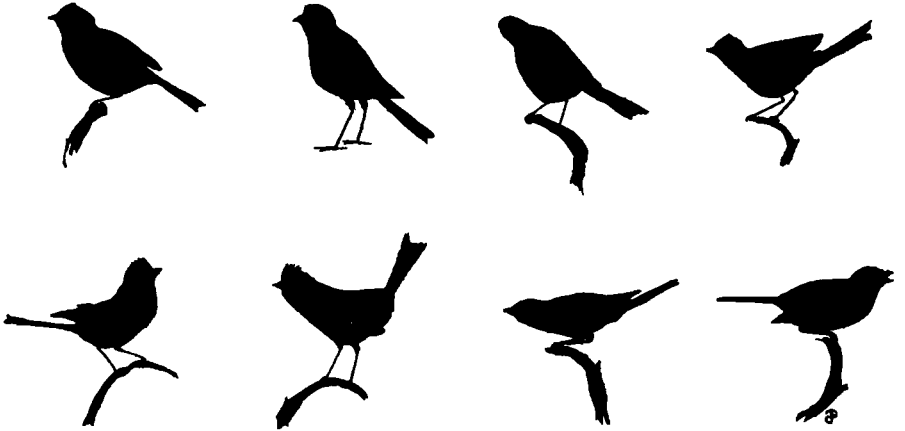


FIG. 1.—Attitudes of Song Sparrow in alarm, fear and fright. From left to right (upper row): 1. unalarmed; 2. alert; 3. turning head to look; 4, 5. alarm (wings and tail flipped); 6. strong alarm; 7. fear; 8. fright (panting).



FIG. 2.—Cardboard models of owls. From left to right: 1. model at half scale; 2. 'head' model; 3. 'best' model; 4. 'head' model without eyes; 5. 'outline' of 'head' model; 6. model with shading on the sides.

gallopavo) and Krätzig's Rock Ptarmigans (*Lagopus mutus*). With both these species a model with a short neck and long tail (*Accipiter*) provoked strong fear reactions, but the same model was largely ignored when pulled overhead with the long end forward (goose). Young hand-raised ptarmigans were frightened by a live dog, but paid no attention to models of mammals. Kelso (1940) found that young Screech Owls (*Otus asio*) showed fear at the sight of the skin of a Crow (*Corvus brachyrhynchos*) when it was moved.

In a letter Mrs. Amelia Laskey describes some observations made on a hand-raised Mockingbird (*Mimus polyglottos*): "Jan. 11, he fights everything that comes his way including the dog, his shadow, his reflection, and other birds that I hold near him excepting a dead Screech Owl. To that he gives a pronounced fear reaction, flying in frightened, fluttering manner as far back in his cage as possible when he sees the owl. He attacked a Sparrow Hawk through the wire." On June 11, she wrote: "When I had the Saw-whet Owl (*Cryptoglaux acadica*), he showed fear of it. One evening the owl was free in the room and flew to a perch above the Mockingbird's cage. The Mockingbird craned his neck repeatedly to watch the owl who was four feet above his cage, giving sharp staccato *chi-chick* calls repeatedly. The owl bent its head a number of times to look at the Mockingbird, but showed no special interest even when the room lights were dimmed. After the owl was taken out of the room all lights were switched off. In about ten minutes the Mockingbird began to give the staccato calls again. I went quickly to the room, turned on bright lights and saw the Mockingbird crane his neck and turn his head sideways looking toward the spot where the owl had perched."

A curious phenomenon has been mentioned by the Heinroths (1924-32), namely, that some birds are afraid of colors, some of blue, others of red. Among the former they cite one of a brood of five Red-backed Shrikes (*Lanius collurio*), three of a brood of five Gray Wagtails (*Motacilla flava*), a Jackdaw, a Yellowhammer (*Emberiza citrinella*) and a Cockatoo. Tree Pipits (*Anthus trivialis*) were afraid of red. A pair of Goldfinches, taken from the nest at the age of two days by Wm. E. Schantz and later brought to Chicago, were afraid of a dark-blue box top, flying wildly in the cage whenever it was shown. They feared some other blue objects, but not miscellaneous objects of other colors. Another pair raised by Mr. Schantz, showed fear only to black paper. In our experiments with Song Sparrows we did not observe a fear for any color.

BEHAVIOR OF THE SONG SPARROW WHEN ALARMED

Three chief stages of fear may be distinguished in the Song Sparrow:

Stage	Note	Postures
'Alarm'	<i>tchunk</i>	Crest raised; tail raised and flipped; wings flipped; restless change of location.
'Fear'	<i>tik</i>	Feathers compressed; neck elongated; body crouched.
'Fright'	<i>tik-tik-tik</i>	Flies and hides; flutters in attempt to escape; pants with open bill.

These categories show 'alarm,' 'fear' and 'fright' in their extreme form; in milder cases some of the characteristics are not shown. In the first stage all characteristics except the raised crest may be displayed separately in situations that are obviously not concerned with alarm. The note *tchunk* is the 'ordinary' note of the male Song Sparrow on his territory, and is seldom heard from the female except in the nesting season; it is typically given by her directly after she has left the nest during incubation and more vigorously in connection with the approach of an enemy to the nest. It often seems to have an element of 'protest' in it. Sometimes it seems to be given by the male as a matter of 'self-assertion.' (With the hand-raised males it is often given while bathing; here it might be interpreted as vocal self-assertion while temporarily hampered by wet feathers.) It appears to be analogous to the 'rain-call' of the Chaffinch (*Fringilla coelebs*), as described by Sick (1939), which often expresses discomfort or anxiety, and also appears to be a special expression of territory advertising.

Wing- and tail-flipping may accompany 'pleasurable' excitement, as when the pair hunt for a nesting site. Raising the crest nearly always appears to express some alarm or apprehension. It has been characteristic of the underling male with the hand-raised birds.

The rhythm with which the notes are given and the species of note vary with the degree of excitement. To illustrate this, three examples will be given with wild Song Sparrows in Massachusetts in 1940.

June 12: the observer in searching for a nest which contained newly hatched young came within a few meters of it; the female gave 48 *tchunks* and five *tiks* in one minute. The observer left, walked 50 meters and hid; the bird then gave 32 *tchunks* in a minute. Two days later when the nest was visited, the female gave 56 *tchunks* in a minute; as soon as the observer was out of sight she gave 35 in a minute.

July 11: one parent was 'scolding' a cat, 8 meters from the nest containing 6-7-day young; at first the cat was looking at the Song Sparrow, later it turned its back and chewed a weed. In three consecutive minutes the bird gave 51 notes a minute: in the first minute 1 *tchunk* and 50 *tiks*, in the next 15 *tchunks* and 36 *tiks*, in the third, 47 *tchunks* and four *tiks*.

June 30: a mounted Barred Owl was fixed near a tangle in which were a Song Sparrow and young that had recently left the nest. The adult gave 64 *tiks* in the first minute, 63 in the next and 65 in the third.

The first bird showed alarm: strong alarm with 56 *tchunks* a minute and moderate alarm with 32-35 a minute. The second bird showed fear first, later alarm: fear with approximately 51 *tiks* a minute, and alarm with approximately 51 *tchunks*. The third bird showed fear with 64 *tiks* a minute.

REACTIONS OF SONG SPARROWS IN NATURE TO ENEMIES

In a letter Richard Pough informs us that the chief enemies of Song Sparrows among the hawks and owls are, in order of importance: Cooper's and Sharp-shinned Hawks (*Accipiter cooperi* and *velox*), Long-eared and Screech Owls (*Asio wilsonianus* and *Otus asio*), Pigeon and Sparrow Hawks (*Falco columbarius* and *sparverius*), Marsh Hawk (*Circus hudsonius*) and Red-tailed Hawk (*Buteo borealis*). Sherman (1911) found that Juncos (*Junco hyemalis*) and Song Sparrows were the most frequent victims of a nesting pair of Screech Owls which she studied in Iowa.

Song Sparrows were studied for nine years in the field on Interpont, Columbus, Ohio (Nice, 1937); the enemies most frequently recognized by the birds were the cat and the Cowbird (*Molothrus ater*). Other enemies that might have taken toll of the Song Sparrows were: snakes, dogs, rats, opossums, weasels, skunks, red squirrels, chipmunks, Pheasant (*Phasianus colchicus torquatus*), Bronzed Grackle (*Quiscalus quiscula aeneus*), Blue Jay, Accipiters, Sparrow Hawk, Screech Owls. Reactions of the birds to a number of enemies were observed.

Snakes.—A large garter snake lying 60 cm. below 1M's nest with newly hatched young was treated with curiosity by 1M; he hopped around it and gave it a peck. The following year 1M's mate on five occasions was seen to attack small snakes in the vicinity of her nest containing young; sometimes she was silent, but twice she gave sputtering notes. 1M was present in one instance, but remained indifferent.

Rabbits.—Cottontail rabbits were consistently ignored, except that once a female gave the threat note to a young rabbit sitting near her nest containing eggs.

Cats.—Cats were consistently greeted with *tchunks* given at a rapid rate (strong alarm), the *tchunks* being taken up by all the Song Sparrows in the neighborhood. Once parents with young ten days out of the nest gave *tik-tik-tik* at a cat.

Dogs.—Dogs were ignored unless they approached near the nest, when *tchunk* was given. On several occasions dogs broke up nests, killing the female and (or) young.

People.—Usually people are greeted with *tchunk* when they come near the nest. When the young are about ready to leave the nest and shortly afterward, the parents, especially the female, are apt to use *tik* as well as *tchunk* and also a variety of miscellaneous notes, that are only used in connection with disturbance over young. Occasionally *tchunk* is used in the winter when a Song Sparrow has been startled by the sudden appearance of a person. *Tik-tik-tik* has been recorded from Song Sparrows in relation to people when the birds are in a heightened state of excitement over mate or young. It was given by a male a few days after being joined by a mate, and by 4M when both his first and his second mate in 1935 were trapped and the bander came to get them. It was given by 5M and 4M with young two days out of the nest, and by the latter when one of his young, a week out of the nest, came near the observer. It was also given by a female when a person approached her well-grown Cowbird foster-child.

Cowbird.—During the nesting season Song Sparrows react to the presence of the female Cowbird on their territories with emphatic *tchunk*-ing. If the Cowbird comes near the nest, the pair attack her. One pair were seen doing this in the presence of one of their young that was six weeks old. Records of alarm over the presence of Cowbirds range from March 30 to July 14. A male that was known to be a juvenile bird by the character of his singing reacted strongly from April 18 on to the visits of courting Cowbirds to the chief tree in his territory. Ovenbirds (*Seiurus aurocapillus*), although heavily parasitized by the Cowbird, do not recognize this bird as an enemy (Hann, 1937).

Bronzed Grackle.—Twice individuals of this species were observed near Song Sparrow nests, the parents of which were reacting with strong alarm.

Robin.—On one occasion Song Sparrows were *tchunk*-ing at a Robin (*Turdus migratorius*) near their nest. Smaller birds in such situations were driven off.

Sparrow Hawk.—Once (March 15) the Song Sparrows gave *tik-tik-tik* when a pair of *Falco sparverius* appeared; on another occasion (November 2) they gave *tchunks*; twice (February and October) they fell silent, and finally, when one of these falcons flew at two fighting males, they hid. In the vicinity of the falcon's nest the Song Sparrows were indifferent and this was also true in general throughout the nesting season. Three times a falcon was seen trying to catch a small bird without success, but twice individuals were seen eating small birds.

Marsh Hawk.—All Song Sparrows stopped singing and many said *tik-tik-tik* when a large female flew over slowly on March 1.

Sharp-shinned Hawk.—The Song Sparrows gave *tik-tik-tik*, hid, and remained 'frozen' for some minutes.

Red-shouldered Hawk.—On August 17, 1940, in Pelham, Massachusetts, a *Buteo lineatus* was seen to fly over a swamp; a few minutes later the observer reached this locality and heard loud *tchunks* given rapidly by a male Song Sparrow seated on top of an alder. In four different minutes from 12.25 to 12.36 he gave the following number of *tchunks* a minute: 108, 92, 76, 64. His mate in the meantime gave 27 *tchunks* and five *tiks* in one minute, 24 *tchunks* in another. The observer left the swamp and at 12.40 the male gave 18 *tchunks* in one minute. The pair had young recently out of the nest; their excitement was undoubtedly due partly to the very recent sight of the hawk and partly to the presence of the observer. The male was unusual in giving *tchunks* at such a very rapid rate instead of using *tiks*; the next highest record we have for number of *tchunks* per minute is 70 from Y.

Owls.—There was no opportunity to observe the reaction of wild Song Sparrows to these birds, except the test already mentioned with the mounted Barred Owl.

Reaction of small birds to owls, cats, and some other enemies has a biological function; the 'alarm' notes are understood by birds of many other species; a number gather and, following the enemy with loud cries, make it impossible for it to come unheralded upon its prey.

EXPERIMENTS WITH ADULT HAND-RAISED BIRDS

The subjects.—Most of the experiments were done with the male Y, but some results were obtained on the male D and the female J before their deaths by accident in March 1940. Y was taken from the nest in Pelham, Massachusetts, on August 1, 1938, at the age of five days. D was taken from the nest in Augusta, Michigan, on June

20, 1939, at the age of six days. J was taken from the nest when about eight days old in Columbus, Ohio, August 12, 1939, by Mr. W. E. Schantz and brought to Chicago in November. The males had the liberty of the study until December 1939, when it became necessary because of territorial fighting to keep one or the other caged. J was kept in a large cage 60 by 90 by 120 cm. in size, later used for Y in the experiments carried out in May 1940. D and Y were always experimented on separately, but this was not true with J. She was present when Y was tested with the mounted Barred Owl on February

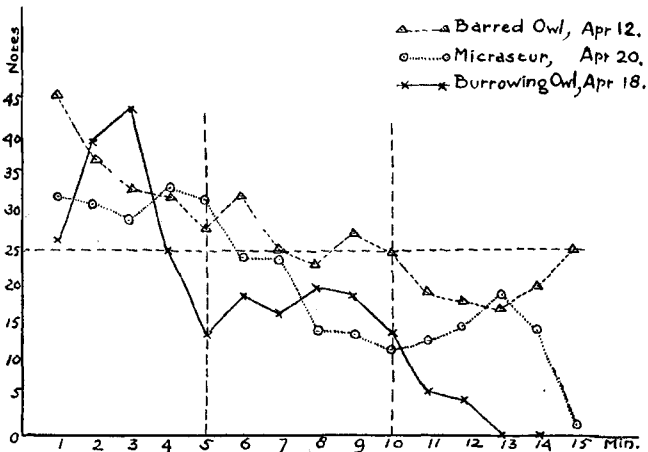


CHART 1.—Diagram showing the number of *tchunks* per minute given by Y to three mounted birds: Barred Owl, Burrowing Owl, falcon (*Micrastur*), each shown for 15 minutes at about four meters from the cage. This illustrates the decrease in the reaction during an experiment.

I and 25, when he was tested with the teddy-bear on February 25, and when D was shown the teddy-bear February 9.

Experiments.—Five series of tests were carried out:

1. Live animals brought within 1.5 meters from the cage or even released into the cage: snakes, rat, rabbits, dogs, cats.

2. Moving models: mounted Barred Owl with moving wings, flying models outside the window, models brought suddenly to the cage.

3. Series of objects, mostly mounted birds, each shown for 15 minutes on a victrola about four meters from the cage: Barred Owl, hornbill, Ruffed Grouse, Burrowing Owl, falcon, kite; also a teddy-bear and a large pitcher (Chart 1).

4. Series of objects, mostly cardboard, shown on the victrola with white cardboard as a background; each shown for three minutes with

five-minute intervals between tests. The models (Plate 8, fig. 2) were largely of owls, but included a duck, quail, hawks, and a shorebird. In each experiment one object was used as a standard, and reshown at intervals to test the level of the bird's reaction. The sequence of the models was such that strong and weak stimuli alternated, so that every test showed as much as possible the reaction to that particular model (Charts 2 and 3).

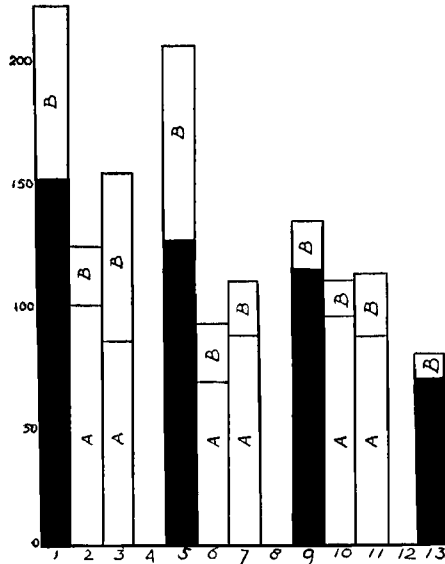


CHART 2.—Diagram showing the number of *tchunks* during the three-minute tests (A) and five-minute intervals (B) on May 19. The same model ('head' model) was shown after every three tests, giving a standard of reactionability during the experiment. 1, 5, 9, 13, 'head' model (Plate 8, fig. 2, no. 2); 2, duck; 3, kite; 4, 8, 12, 'outline' of 'head' model (Plate 8, fig. 2, no. 5); 6, shorebird; 7, Duck Hawk; 10, model with shading on the sides (Plate 8, fig. 2, no. 6); 11, quail.

5. Mounted Barred Owl on the piano in the front room. Also the same situation without the owl.

The series of tests falls into two groups: the two first are experiments with moving enemies, the three last with stationary enemies.

In interpreting the reactions of our subjects we use the criteria for 'fear' and 'fright' mentioned previously. As to 'alarm,' in general we found the rate of the notes fell into three fairly distinct classes: 10-15 a minute (weak alarm), 25-30 a minute (moderate alarm), and about 50 a minute (strong alarm). In three minutes the number of *tchunks* in weak alarm ranged from about 40-65, in moderate

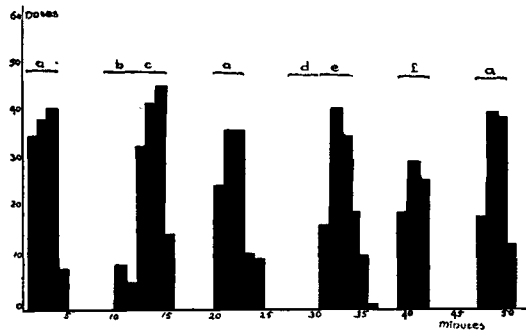


CHART 3.—Diagram showing number of *tchunks* per minute during one series of tests (May 17). The time and duration of the tests are represented by lines at the top of the chart. *a*, represents the 'best' model (Plate 8, fig. 2, no. 3); *b*, the 'outline' of the 'head' model (Plate 8, fig. 2, no. 5); *c*, the 'head' model (Plate 8, fig. 2, no. 2); *d*, the 'outline' of the owl model at half scale; *e*, the owl model at half scale (Plate 8, fig. 2, no. 1); *f*, the 'head' model upside down.

alarm about 80–120, and in strong alarm about 130–200. The three-minute records are not as clear cut as the one-minute ones, since Y would seldom start *tchunk*-ing the first moment the experiment began, and sometimes he did not start for a full half-minute or more; in these cases the decision as to whether the reaction should be classed as moderate or strong alarm had to be based on the number of *tchunks* given in the second and third minutes.

Since the majority of the tests lasted three minutes, we use this period as our standard in the following report and unless otherwise stated the number of *tchunks* mentioned was that given in three minutes.

Moving Enemies

In general the reactions are stronger to moving than to stationary objects. The birds had never before had experience with the first three animals shown in the tests, so we conclude that the reactions are partly inborn.

Snake.—Two garter snakes (*Thamnophis sirtalis*) 30 and 70 cm. in length were shown within one-meter distance. Both moved rapidly and the smaller one was allowed in the cage. Y reacted by craning his neck, but showed no signs of alarm.

Rat.—Two active white rats, one half grown, the other fully grown, were brought to Y's cage and the smaller one allowed in the cage. Y reacted by elongating himself, the characteristic attitude of curiosity, but showed no alarm.

Rabbit.—A large black-and-white rabbit was placed next Y's cage, where it hopped about. Y flew back and forth high in the cage, panting with open bill (fright), but gave no note. The rabbit was removed and shown again in the same place after eight minutes; at this time it was quiet. Y gave 107 *tchunks* in three minutes (moderate alarm).

Dog.—On April 1 a medium-sized, active, white dog was brought within a meter of the cage; Y flew about as high as he could (fright), but gave no note, until two minutes after the dog was removed, when he gave 25 *tchunks* in one minute. On September 18, a young chow was brought to the cage; Y flew wildly back and forth; the dog was removed and Y gave a few *tiks*. In a day or two Y became indifferent to the puppy.

Cat.—No reaction was ever given to cats seen out the window. On September 17, 1939, three small kittens were brought in and placed near the cage; Y reacted with moderate alarm. On April 15, 1940, a medium-sized black cat was held one and a half meters from the cage, where it moved somewhat, purred and coughed. Y reacted by raising his crest and flipping his tail and gave the following number of *tchunks* during the five-minute test: 10, 20, 12, 0, 0 (weak alarm). During the summer Y was cared for by Mrs. Dorothea Ewers who kept him on an outdoor screened porch; on several occasions Mrs. Ewers heard him giving *tik tik*, whereupon she went out and chased a cat from the railing.

On September 23, a small gray-striped kitten was placed next his cage. Y was disturbed, flying back and forth high in the cage, but gave only six *tchunks*. To a small white kitten he behaved in a similar manner, but gave 72 *tchunks* and three *tiks* in three minutes.

Birds outside the window.—Sometimes the Song Sparrows show fright reactions, giving *tik-tik-tik* and hiding, apparently stimulated by the sight of some bird in the sky. On May 27, a Starling (*Sturnus vulgaris*) flew rapidly by at 10 to 15 meters distance; Y gave the *tik-tik-tik* note, flew to the side of the cage and hid (fright). On September 27 a Blue Jay appeared outside, screaming; Y gave a series of *tiks* for about a minute.

Mounted Barred Owl with movable wings.—On May 16 when the model was stationary, Y showed strong alarm (133 *tchunks*). After a five-minute interval the owl was again shown, but this time the wings were moved up and down. Y showed fear (94 *tiks* and 20 *tchunks*) and tried to escape. On May 27 with the model stationary Y gave 113 *tchunks* and three *tiks*; then the wings were moved and Y showed fear with 70 *tiks* in one minute, in the meantime flying back and forth in the cage.

Flying models.—Flying models were shown outside the window, one in the shape of an *Accipiter*, the other a rectangle. At the first sight Y showed momentary fear. As long as the models moved slowly, there was no distinct reaction. If the models were rapidly moved, Y showed fear at both. Apparently sudden movement and not form frightened him.

Models brought suddenly to the cage.—Several objects were shown suddenly and with movement for about four seconds. They were presented in the following order: mounted Burrowing Owl, rectangular piece of cardboard, small cardboard model of owl (Plate 8, fig. 2, no. 1), unpainted side of the same model, painted side, piece of cardboard. Y reacted with fright to the mounted owl and the painted side of the model, but was attentive and, during the last test, slightly alarmed by the piece of cardboard and the unpainted model.

Stationary Enemies

In none of the experiments with the stationary models did the birds show any greater reaction than strong alarm. All experiments were characterized by a gradual decrease of the reaction. This is well illustrated in charts 1 and 2.

Mounted Barred Owl.—On February 1, the mounted Barred Owl was shown in the study; Y was strongly alarmed, while the female J elongated herself. On February 25, it was displayed on the victrola; Y was strongly alarmed; with tail flipping and crest raised, he gave about nine *tiks* and 60 *tchunks* in a minute. J raised her crest and flirted her tail (she never gave the notes *tchunk* or *tik*). After five minutes the owl was removed, but Y gave about 36 *tchunks* a minute for the next two minutes. From April 2 to 12, tests with mounted birds were given every other day; on the latter date the owl was shown and evoked only moderate alarm with 114 *tchunks* in the first three minutes; however, there was no cessation of *tchunks* during the 15-minute experiment, 405 being given in this period; of the eight objects shown it was only with the owl and the hornbill that *tchunks* were given throughout the 15 minutes. On May 15, the owl was used as the standard in the series of three-minute tests; the number of *tchunks* given showed a marked decrease, namely, 138, 102, 73.

Interestingly enough, this mount invariably evoked strong alarm in both Y and D when it stood on the piano in the front room. This was true on five occasions from February 6–15 when D saw it in this situation and six times between March 23 and May 24, when Y had this experience. For example, on April 12, Y went into the

middle room, reached the point from which he caught sight of the owl, and with crest up and tail flirited, gave 202 *tchunks* in 225 seconds, and flew back into the study. On four of Y's six visits an exact record of *tchunks* was kept; the counts were high: 166, 158, 214, 161.

Apparently the birds were conditioned after these experiments to the situation, for they showed alarm merely at the sight of the piano, when the owl was absent. D showed strong alarm on the afternoon of February 15, when he found the owl absent after six visits during the previous nine days on all of which the owl had been present. On April 4, Y reacted with moderate alarm to the absence of the owl, after having seen it March 23 and April 1. His reaction to its reappearance on April 12 has already been described. On his next visit, May 8, the owl had been removed; he entered the room keeping his eyes on the spot where the owl had been displayed, and showed strong alarm, giving 180 *tchunks* in the first three minutes, after which he fell silent, gradually gave up signs of alarm, and nine minutes after entering the room began to sing softly within three meters of the piano. The owl was present at his next three visits (May 20-24), but absent May 31; on this occasion Y gave the following number of *tchunks* per minute: 49, 38, 22, 15, 5, 2, after which he returned to the study.

After more than four months Y was still conditioned to this spot. During most of the summer he had lived in another house. He had not seen the owl on the piano since May 24. On October 1, he entered the front room, at once showed strong alarm with crest and tail raised, keeping his eyes on the end of the piano. He gave 148 *tchunks* in three minutes, left the front room and gave nine more before he returned to the study.

In the fall we used a different mounted specimen and found the reaction of Y to this specimen much weaker than it had been to the first specimen or to the cardboard models of owls. On October 11, at the end of a short series of tests he showed only weak alarm (44 *tchunks*) to the mount, although the 'best' cardboard model (Plate 8, fig. 2, no. 3) was as effective as in the spring (115 *tchunks*). In our eyes this second mount seems a poor specimen. On October 16, we placed this owl on the piano; Y, on entering the room, raised his crest and flirited his tail and gave 42 *tchunks* in the first minute and 43 in the second, after which he flew back to the study where he gave 13 more *tchunks*.

Other mounted birds.—Tests were made with a number of mounted birds for the sake of comparison with the reactions to the mounted

Barred Owl. In general these birds caused less-marked alarm. A mounted hornbill, about 40 cm. long, grayish in color, evoked the strongest reaction of any of these specimens, causing strong alarm in Y at the first test (154 *tchunks*), and moderate alarm (117 *tchunks*) at the second. A kite (*Chondrohierax*) caused moderate alarm (123 and 118 *tchunks*). A falcon (*Micrastur*) and a Burrowing Owl (*Speotyto*) evoked moderate alarm (93–109 *tchunks*), although in one test (May 22) Y showed no reaction to this owl, which, it should be noted, was a decidedly poor mount. A Ruffed Grouse (*Bonasa umbellus*) gave inconsistent results: strong alarm at the first test (April 1) and weak (47 *tchunks*) five days later; on May 22, it evoked 70 *tchunks* in the first test and none in a second test ten minutes later.

Observations in Nature show that Song Sparrows on their territories react with strong alarm to the visits of female Cowbirds. On September 26, a mounted female Cowbird was placed 30 cm. from Y's cage; Y gave 83 *tchunks* (moderate alarm). On October 6, we compared the reaction to the mounted Cowbird with that to a mounted Starling (*Sturnus vulgaris*); Y showed weak alarm to the former (37 *tchunks*) and moderate alarm to the latter (90 and 116 *tchunks*). It seems probable that the strong alarm shown to Cowbirds in Nature is based on experience.

Cardboard models.—Since the reaction to the Barred Owl was so much more pronounced than to the other birds, we asked ourselves what the difference might be to the Song Sparrow between the owl and the other birds. In an attempt to answer this question we made a series of models, cut out of cardboard and painted on one side with India ink and crayon. These models were shown on the victrola in three-minute tests.

The 'best' model (Plate 8, fig. 2, no. 3) was as far as possible a copy of the mounted owl. Y reacted to this model as much as to the mounted owl in the same situation, showing for the most part moderate alarm (94, 115; 148, 128, 102, 124; 103, 97, 98; 121; 116 *tchunks* on five different days). The same model was shown with the eyes covered; Y gave 93 *tchunks*. A piece of plain cardboard of the same shape was shown; Y gave 16 *tchunks* in the first test and one in the second. To find out whether the size of the owl was important, we made a reproduction of the 'best' model at half scale (Plate 8, fig. 2, no. 1). Y showed moderate alarm with 92 *tchunks* on May 17 and weak alarm with 34 *tchunks* five days later. To a piece of cardboard with the same outline Y gave no reaction. The model we used most often as a standard was the 'head' model (Plate 8, fig. 2, no. 2), a reproduction of the head of the 'best' model with a slender

unpainted body. This model proved to be almost as effective as the 'best' model, evoking mostly moderate alarm (119; 133, 107, 94, 114; 97, 92, 94; 152, 125, 114, 68; 83, 72; 53; 72; 91, 10 *tchunks*). These series, obtained on eight days between May 15 and 27, illustrate the decrease in the intensity of the reaction during this period. Two tests made in the fall showed moderate alarm (93 and 97 *tchunks*). A piece of plain cardboard of the same shape as the 'head' model (the 'outline') (Plate 8, fig. 2, no. 5) provoked *no* reaction in nine tests and very weak alarm (14 *tchunks*) in one. *So there is a remarkable difference between the results with the painted and unpainted models.*

We attempted to analyze this difference and in this way to find the essential feature in the owl. The 'head' model without eyes (Plate 8, fig. 2, no. 4) evoked moderate alarm (104 *tchunks*). The 'head' model placed upside down brought 76 *tchunks*. Reactions were similar to a model of which only the left half was painted (77, 82 *tchunks*). A model with only some shading on the head evoked 53, 27 and 0 *tchunks*, and when eyes were added no reaction was given. A model with only some shading on the breast brought 13, 66 and 0 *tchunks*. A model with a dark border around the outline evoked no reaction, but a similar model with some shading along the outline, so that it seemed to be rounded (Plate 8, fig. 2, no. 6) brought 94 *tchunks*. A piece of cardboard of the same size as the 'head' model was gradually changed and shown at intervals. *Eyes, bill and disks around the eyes brought no reaction, but as soon as some shading was added that gave contour to the model, Y showed moderate alarm, uttering 85 tchunks.* Similar models were made of various birds: duck, kite, duck hawk, quail and shorebird; all of these caused some alarm (67-99 *tchunks*). Tests on October 11 gave the following figures: shorebird, 64 *tchunks*; duck hawk, 118, 99.

Other objects.—In order to interpret the results obtained with the mounts and models, it is of interest to know how the birds react to new objects in their environment. Ordinarily the hand-raised Song Sparrows have been indifferent to new objects brought into the room. Some objects, however, evidently have a special meaning, as have some of the cardboard models. On February 9, a teddy-bear about 30 cm. high was placed a meter and half from the cage; D showed strong alarm (33 *tchunks* in 30 seconds), while J raised her crest. In similar tests Y showed moderate alarm on April 4 (108 *tchunks*) and weak alarm on April 15 (58 *tchunks*), but on October 8 he reacted with strong alarm (127 *tchunks*) and the next day with moderate alarm (84 *tchunks*). To a 20-cm.-high pewter pitcher Y

reacted with moderate alarm for two minutes, giving 67 *tchunks*, after that becoming indifferent.

Notes of owls.—Birds in Nature sometimes respond to notes of hawks and owls and even to imitations of these. On October 11, Mr. J. Murray Spiers gave excellent imitations of the hoots of Great Horned, Barred and Barn Owls and also of the cry of the Red-shouldered Hawk, without eliciting any response from Y.

Experiments with Goldfinches.—A few experiments were made with two hand-raised Goldfinches when they were one year old. A series of objects was shown but no reaction was given to the teddy-bear, nor to any of the cardboard models, but the mounted Barred Owl evoked fright, both birds flying rapidly about. After a five-minute interval the 'best' model was shown again; now the birds flew back and forth. Somewhat similar reactions, but weaker, were shown to the other models, the male evincing much more concern than the female. With this species it is difficult to measure the degree of excitement.

EXPERIMENTS WITH YOUNG SONG SPARROWS

During three summers Song Sparrows have been raised by hand, being taken from the nest at the age of five to seven days. Situations to which these birds instinctively responded with escape reactions were: threatened capture, movement of the immediate environment, approach of very large moving objects, evidence of fright in companions, sight of birds flying overhead, the specific fear note, and sounds resembling it.

During their fourth week one brood (Y and his brothers) did not recognize a cat or a dog as an enemy; the same was true with the male A when 75 to 80 days old. A horned toad (*Phrynosoma*) and ground squirrel (*Citellus tridecemlineatus*) to which the brood were introduced at the age of one month evoked curiosity.

During 1940, a mounted Barred Owl was shown to four young birds: to three of them at intervals from 7 to 21 days, to A at 7, 17, 21, 28, 32, 37, 50 and 62 days. Three of the cardboard models of owls were also shown during the last three experiments. All tests gave negative results. When A was three months old he was shown a series of models and the mounted Cowbird, Starling and Barred Owl. To none of these did he react except in two instances: he gave 61 *tchunks* in three minutes to the outline of the owl with the dark shading (Plate 8, fig. 2, no. 6), but in a second test gave no reaction; to the Cowbird he gave 52 *tchunks* at the first showing, but no reaction in the second. A has been shown the owl once a month up to

the age of seven months and is still indifferent. Unfortunately A has always been a sub-normal bird; this is clearly shown by the fact, that, although his wing measurement shows him to be a male, he has never sung, while the four other hand-raised birds sang a great deal in their first fall and winter.

The experiments with the adult Song Sparrows cannot be explained without postulating an inborn pattern, but possibly this pattern appears late.

DISCUSSION

Apparently the Song Sparrow recognizes enemies by both inborn and learned patterns. In Nature the behavior of the adults is of great importance for the forming of conditioned patterns in the young. Simultaneous presentation of a natively inadequate stimulus (cat, Cowbird) and the unconditioned stimulus (alarm of the adult) may result in conditioning to the originally inadequate stimulus.

Evidently inborn is enemy recognition of large, new, moving objects, and specifically of an owl.

Evidently learned, either from personal experience or from reactions of others, is enemy recognition of cat and Cowbird. On the other hand, the birds may learn in one or both ways what is *not* an enemy. The experiments show decrease of inborn reaction when nothing happens after the enemy has been shown. A similar process may be involved in the absence of alarm shown for rabbits and often for Sparrow Hawks (*Falco sparverius*) in Nature.

Conditioning was certainly an important factor in the experiments. Why did the situation in the front room bring such a marked reaction? One of the factors was undoubtedly the familiarity of the environment in the study and the unfamiliarity of that in the front room. Most of Y's experiences in the study had nothing to do with enemies, but after March 23 the owl was the most important element of the front room for Y. Lorenz (1935: 205) describes how his Ravens (*Corvus corax*) were conditioned against places where they had been frightened. The experience of Mrs. Laskey shows how quickly a Mockingbird was conditioned to the place where an owl had perched.

Although the victrola evidently had a neutral tone when displaying indifferent models, there was, however, probably some influence from the owl that was reflected in the reaction to other mounts and to some of the models. It is not clear if the characteristics of the owl pattern—head and shading—are characteristics of the inborn owl pattern or merely elements of previous experience.

SUMMARY

1. A survey is given of previous observations on the relation 'enemy-prey' from the viewpoint of the prey. Fear reactions to owls have been reported in hand-raised individuals of *Passer domesticus*, *Corvus monedula*, *Mimus polyglottos*, and to hawks in *Corvus monedula*, *Tetrastes*, *Lagopus*, geese and ducks.

2. In the Song Sparrow it is possible to differentiate stages of 'alarm,' 'fear,' and 'fright.'

3. In Nature, the most important enemies of the Song Sparrow are probably cats, hawks and owls.

4. Cats arouse strong alarm from Song Sparrows in Nature. Young hand-raised birds showed no alarm, while an adult male showed moderate alarm in September and weak alarm the following April, but after experience with cats in the summer he showed strong alarm.

5. In Nature Sparrow Hawks (*Falco sparverius*) occasionally aroused alarm or fear, but were usually ignored. Other hawks provoked fright. With the hand-raised male, stationary models of hawks evoked moderate alarm, rapidly moving models fright.

6. A wild Song Sparrow showed fear in the presence of a mounted Barred Owl. Young hand-raised birds up to the age of three weeks gave no fear reaction to a mounted owl. Adult hand-raised males showed strong alarm to a stationary model of an owl and fear to moving models.

7. Tests with cardboard models showed that the pattern of the owl is a totality in which the head and shading are most important.

8. Other mounted birds and cardboard models evoked moderate or weak alarm.

9. In Nature the Cowbird (*Molothrus ater*) evokes strong alarm from Song Sparrows on their territories. It is questionable if this is based on an inborn pattern. The hand-raised male Song Sparrow, tested in autumn, showed only moderate and weak alarm to a mounted female Cowbird.

10. Snakes evoked curiosity in a hand-raised Song Sparrow and also in a wild male. Small snakes were treated as nest enemies by a wild female.

11. Memory has been shown to be of great importance in enemy recognition. In our experiments we found that the memory of circumstances connected with strong alarm persisted after several months (the piano without the owl).

12. 'Unpleasant' experience with an enemy will intensify the reaction, while indifferent experience will weaken the reaction.

13. We think that owls are recognized by Song Sparrows in Nature largely through an inborn pattern, hawks through fast movements, and cats and possibly Cowbirds after conditioning.

REFERENCES

- ANTONIUS, O.
1939. Ueber die Schlangenfurcht der Affen. *Zeitschr. f. Tierpsych.*, 2: 293-296.
- BOLLES, F.
1890. Barred Owls in captivity. *Auk*, 7: 101-114.
- BRÜCKNER, G. H.
1933. Untersuchungen zur Tierpsychologie, insbesondere zur Auflösung der Familie. *Zeitschr. f. Psych.*, 125: 1-110.
- GOETHE, F.
1937. Beobachtungen und Erfahrungen bei der Aufzucht von deutschem Auerwild. *Deutsche Jagd*, 1937, 6 and 7.
- HANN, H. W.
1937. Life history of the Oven-bird in southern Michigan. *Wilson Bull.*, 49: 145-237.
- HEINROTH, O. AND M.
1924-32. *Vögel Mitteleuropas*. Berlin.
- HERTZ, M.
1929. Beobachtungen an gefangenen Rabenvögeln. *Psychol. Forsch.*, 8: 336-397.
- KELLOGG, W. N.
1931. A note on fear behavior in young rats, mice and birds. *Journ. Comp. Psychol.*, 12: 117-121.
- KELSO, L.
1940. Antipathy in the Screech Owl. *Auk*, 57: 252-253.
- KRÄTZIG, H.
1939. Untersuchungen zur Biologie und Ethologie des Haselhuhns. *Ber. Schlesischer Ornith.*, 24: 1-25.
1940. Untersuchungen zur Lebensweise des Moorschneehuhns (*Lagopus l. lagopus*) während der Jugendentwicklung. *Journ. f. Ornith.*, 88: 139-165.
- LORENZ, K.
1935. Der Kumpan in der Umwelt des Vogels. *Journ. f. Ornith.*, 83: 137-413.
1939. Vergleichende Verhaltensforschung. *Zoologischer Anzeiger, Supplementband*, 12: 69-102.
- NICE, M. M.
1937. Studies in the life history of the Song Sparrow. I. *Trans. Linn. Soc. New York*, 4: 1-247.
- RAND, A. L.
1937. Notes on the development of two young Blue Jays (*Cyanocitta cristata*). *Proc. Linn. Soc. New York*, no. 48: 27-59.
- SHERMAN, A. R.
1911. Nest life of the Screech Owl. *Auk*, 28: 155-168.
- SICK, H.
1939. Ueber die Dialectsbildung beim "Regenruf" des Buchfinken. *Journ. f. Ornith.*, 87: 568-592.
- STRAUSZ, E.
1938. Versuche an gefangenen Rabenvögeln. *Zeitschr. f. Tierpsych.*, 2: 172-197.

THORNDIKE, E. L.

1899. The instinctive reactions of young chicks. *Psych. Rev.*, 6: 252-291.

TINBERGEN, N.

1939. Why do birds behave as they do? *Bird-lore*, 41: 23-30.

1940. "Die Ethologie als Hilfswissenschaft der Oekologie", Vortrag. *Journ. f. Ornith.*, 88: 171-177.

5708 Kenwood Avenue

Chicago, Illinois

and

University of Chicago

Chicago, Illinois