RESPONSES OF BROODING NIGHTHAWKS TO A DISTURBANCE STIMULUS

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A great number and variety of birds, when brooding, respond to an intruder at or near the nest by engaging in behaviors tending to make the bird conspicuous to the intruder and to divert the intruder from eggs or young (after Simmons, 1955). "Distraction display" is the term most commonly used to denote this type of response, although other names, such as "diversionary display" (Armstrong, 1949), have also been employed. "Diversionary behavior" is used in this paper because the term is most descriptive of the apparent function of the responses described and because it is doubtful whether some of these responses are displays in the sense of Tinbergen (1952: 28–30).

Diversionary behavior has long intrigued students of birds. Armstrong (1947, 1949, 1954), Simmons (1952), and Skutch (1955) have surveyed and discussed much of the literature in this area. Useful as some of this literature is, most of it is of an anecdotal nature, based upon scattered and casual observations, often lacking precision and objectivity. Simmons (1955) has stressed the need for systematic, objective investigations of diversionary behavior. The studies of Williamson (1949), Simmons (1951), Armstrong (1952), Brown (1962), and Stephen (1963) represent the type of extended investigation and careful analysis which is needed.

The aims of the present study were to describe in detail the spectrum of responses seen in the diversionary behavior of the Common Nighthawk (*Chordeiles minor*) and to describe and measure the variation in response, through the nesting cycle, of these birds responding to a standardized stimulus. Such data may allow clearer insights into the functional aspects of diversionary behavior.

The Common Nighthawk was chosen because it exhibits well developed diversionary behavior and because it often nests on flat, gravel roofs, permitting unobstructed observation in a relatively constant environmental situation.

All observations were made in Madison, Wisconsin, in the nesting seasons of 1963 and 1964.

Procedures

In all, 11 nests were studied, 5 of them from 12 June to 14 July 1963, and 6 from 22 May to 17 July 1964. (The term "nest" is used in this paper to denote the site of egg[s] or young; the nighthawk does not construct a nest but lays its egg[s] directly upon the substrate.) The nests were studied from the time they were discovered until they were abandoned or the young fledged, thus some were observed for only 1 day and some up to 30 days. Preliminary observations and experimentation were carried out with four of the nests in 1963. Standardized procedures (described below), which provided the quantitative data, apply to seven nests, one in 1963 and six in 1964.

All nests were on gravel roofs which were rimmed partially or wholly by stone walls or parapets 1.3 to 5.0 feet high and 1.0 to 2.0 feet wide. The roofs varied from 18 to 48 feet above ground level. The roof surfaces were of fine gravel or roofing compound and were largely unobstructed; occasional skylights, pipes, and other structures projected 1 to 5 feet above the roof. Of the 11 nests, 9 were within 3 feet of a wall; 2 were in central areas of the roofs near small sheltering objects (an old broom-head and a vertical metal pipe).

A total of 131 observations was made under standardized conditions, scattered through the nesting cycle. Nests were discovered at various stages of the nesting cycle and some were later destroyed or deserted. For clutches of two eggs, the day of hatching was taken as the day on which the first egg hatched.

I was able confidently to identify all birds studied as being females, primarily on the basis of their non-white throat patch. Sex identification plus individual plumage characteristics made it possible to be certain that the same bird was being studied at each nest throughout the observation of that nest.

Motion pictures were used in analyzing some of the responses.

Standardized conditions and procedures.—One observation was made each day at each nest. For each nest the observation occurred at approximately the same time each day. The possibility that other persons disturbed the nests between observations was remote since special permission or keys were required to go onto the roofs.

During each response observation I, constituting the standardized stimulus object, wore the same clothing: white shirt, khaki trousers, and black shoes. I also wore eyeglasses and in most cases a small portable tape recorder hung under my right arm. Upon coming onto the roof, I approached the nest in an erect posture, with arms bent at the elbow, at a steady pace of approximately 2 feet/second. The approach was made along a straight line to the nest and, whenever possible, from a constant direction so that I would present a "stimulus input" for approximately the same length of time each day. The distance between the nest and me, when I first came within sight of it, was recorded as the "approach distance." Within a few days after hatching, the young moved about the roof from day to day, thus causing some variation in the approach.

"Flushing distance" was my distance from the nest when the bird flushed. At the moment of flushing I began recording the bird's actions on a second by second basis for 60 seconds. In one case (nest G), where the female never flushed, the 60 second interval began from the moment of the first marked response (vocalization, wing droop, etc.). The distance from the nest at which the female settled after flushing was noted as the "settling distance." (If the bird settled at two or more different distances in the 60-second period, the settling distance was taken as the mean of these distances.) While recording, I continued to advance to approximately 1.5 feet from the egg(s) or young, this taking from 1 to 30 seconds. Once at the nest, I stood still, only turning my head to follow the bird's actions. When the 60 seconds of recording were completed I began walking backwards at the same speed and along the line of approach, leaving the roof at the point where I came onto it.

TABLE 1

SUMMARY OF DATA ON ALL NESTS STUDIED UNDER STANDARDIZED CONDITIONS[1]

Nest	Observation period and time	Portion of nesting cycle observed	Mean approach distance (ft.)	Mean flushing distance (ft.)			Mean settling distance (ft.)		
				Early period (−18 to −6)	Middle period (−5 to +5)	Late period (+6 to +23)	Early period (−18 to −6)	Middle period (−5 to +5)	Late period (+6 to +23)
A	20 June–13 July 1963 (0820–0950)	−1 to +23	115.1	—	16.7	19.0	—	15.7	16.1
B	23 May–21 June 1964 (1250–1311)	−14 to +15	52.5	5.9	3.6	5.2	31.8	14.8	14.4
C	2 June–26 June 1964 (1229–1239)	−18 to + 6	125.0	40.7	22.3	25.0[2]	32.1	10.5	8.5[2]
D	27 May–8 June 1964 (1311–1324)	−10 to + 2	29.8	15.4	5.2	—	17.4	11.5	—
E	24 June–4 July 1964 (1249–1312)	−15 to − 5[3]	49.9	4.3	6.0[2]	—	11.5	12.0[2]	—
F	2 July–17 July 1964 (1300–1315)	−17 to − 3[3]	160.1	11.5	5.2	—	7.2	10.5	—
G	4 June–18 June 1964 (1322–1340)	−11 to + 3[3]	89.9	—	—	—	—	—	—

[1] − and + values refer to the number of days before and after hatching, respectively.

[2] Single observation.

[3] Estimated with maximum error of ±2 days.

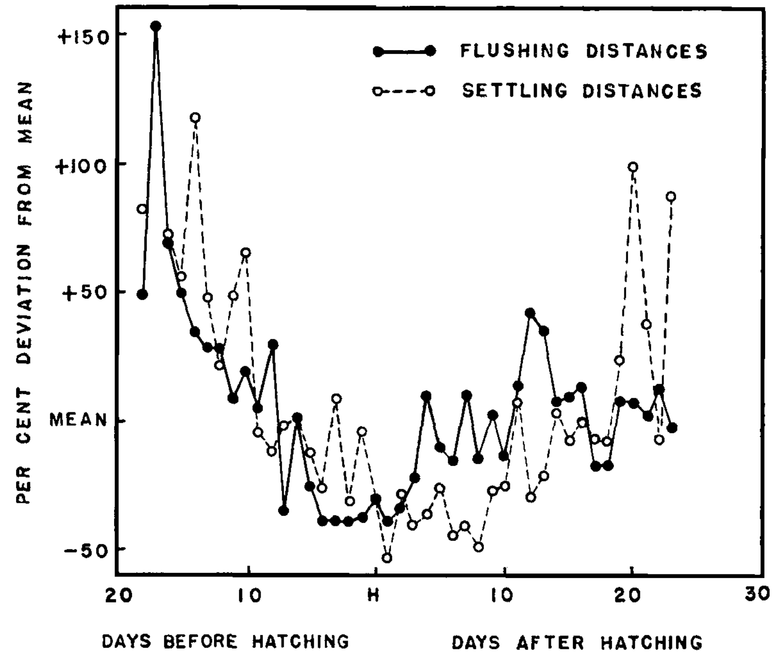

Figure 1. Composite curves showing changes in flushing and settling distances on consecutive days at Nests A–F. Distances on the six days prior to desertion at Nests E and F are not included. H = hatching day.

Incidental disturbances such as street noises, low-flying aircraft, and passing birds occasionally disrupted the otherwise reasonably static experimental situation.

Usually, I recorded my observations on a tape recorder as they were made. In a few cases written notes were made. Information on nest position, weather conditions, and the bird's behavior before and after the 60-second interval were also noted. In all cases, the data were transcribed on the day they were recorded.

Distances recorded during the response observations were estimated. My accuracy was independently checked with 45 tests for distances up to 70 feet; error varied from 9 to 14 per cent of the distance estimated.

No tabulating or graphing was done for a nest until all the data were gathered for that nest, in order to avoid an unconscious bias in the daily recording of data.

RESPONSES

Distances and directions of flushing and settling.—Both flushing and settling distances tended to decrease steadily from egg laying to hatching and to increase slowly as the young developed (Figure 1). Absolute distances varied considerably from nest to nest (Table 1), but all showed the same trends. At nests E and F, which were deserted before hatching, flushing and settling distances increased during the six days

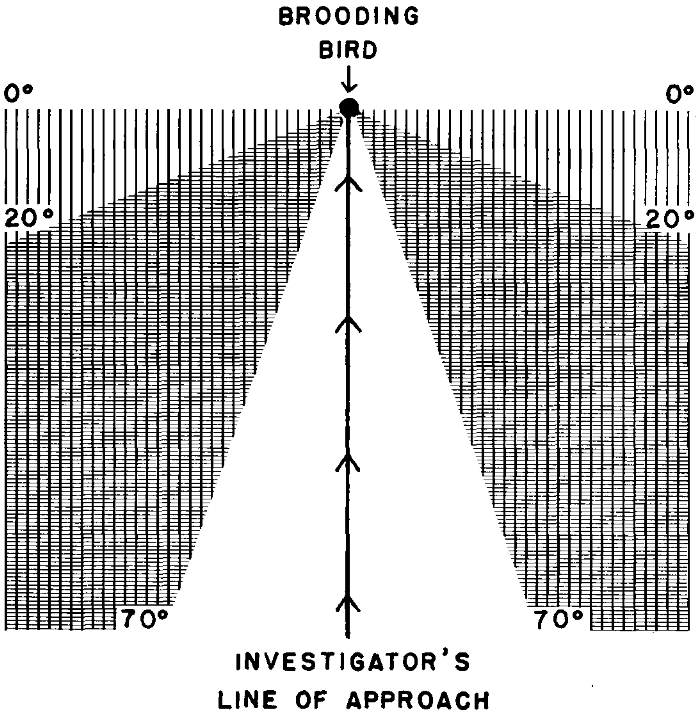

Figure 2. Zones in front of the nest site of Common Nighthawks, into which most birds flushed or settled when disturbed. See text for details.

prior to desertion, although in both cases the birds had previously conformed to the general pattern.

Certain patterns were noted in the direction of flushing and in the area of initial settling. In 98.5 per cent of the cases the birds either flushed into (and then disappeared from view) or flushed and settled in two 70° zones in front of a line drawn through the nest site at right angles to the line of approach (Figure 2). Further, 80 per cent of all cases were in the 20°–70° sectors of these 70° zones. In several instances a bird, after settling initially in a specific sector on one side of me, flew into the same sector on the opposite side. Frequently, after initially settling in one of the 20°–70° sectors, the bird moved back toward me or the nest as I moved to the nest or stood next to it; these shifts in position invariably took the bird into or near one of the 0°–20° sectors.

In 56 per cent of the observations, a wall or walls stood to one side of me as I approached; in all these instances, regardless of which direction the bird was facing prior to flushing, it flushed to the "open" side;

in the remaining 44 per cent of the cases at least portions of the right and left sides were open and, in these cases, 90 per cent of the birds flushed to the side they were facing.

After flushing, birds usually settled in sight of me on the roof or the top of the roof-bordering wall. However, the bird at nest B produced five exceptions. In one case the bird settled on top of a lamp post 55 feet from the nest, in three cases on electrical wires 30–40 feet from the nest, and in one case on a sloping roof 25 feet from the nest. In the latter four cases I noted some form of display after the bird settled. In all five cases the bird settled near or slightly below roof level, where it could see me but not the nest.

The 131 standardized observations yielded no clear and consistent correlation between flushing distances and air temperatures, cloud cover, or wind velocity.

Types of responses.—In the standardized, 60-second, observation periods I saw seven types of responses. The components of each type are listed in Table 2. The characteristic feature of each type of response was as follows:

Type 1. Bird leaves field of vision of investigator.
Type 2. Bird flies about nest area.
Type 3. Bird merely settles in sight of investigator.
Type 4. Bird settles in sight of investigator and droops wings (Figure 3, A).
Type 5. Bird settles in sight of investigator and holds wing(s) outstretched (Figure 3, B and C).
Type 6. Bird settles in sight of investigator with outstretched wings and lunges toward investigator (Figure 3, D).
Type X. Bird does not flush.

The response types (1 through 6) are arranged in order of the increasing conspicuousness of the responding bird to the intruder, a conspicuousness based on apparent size (including proximity of the bird to the intruder), contrast with background, movement, and sound.

Response Types 1 through 3 primarily reflect increasing proximity. I have also assumed that a bird settling and remaining within sight of an intruder (Type 3) approaching on the ground is more conspicuous to the intruder than a bird flying about (Type 2) which displays greater movement but is only occasionally visible to the intruder. The increasing conspicuousness of response Types 3 through 6 is primarily a result of increasing complexity of movement, silhouette enlargement, and vocalization. Proximity of the bird to the intruder also tends to increase from Type 3 through 6. The proximity factor in Type X equals or surpasses

TABLE 2

CHARACTERISTICS OF THE TYPES OF RESPONSE IN DIVERSIONARY BEHAVIOR OF THE COMMON NIGHTHAWK

	Response type						
Response component[1]	*1*	*2*	*3*	*4*	*5*	*6*	*X*
Moves less than 1.5 feet off nest	0	0	0	0	0	0	+
Flushes from nest	+	+	+	+	+	+	0
Leaves field of vision of investigator	+	0	0	0	0	0	0
Flies about nest area	0	+	0	0	0	0	0
Settles in sight of investigator	0	0	+	+	+	+	+
Flies from one settling point to another	0	0	–	–	–	–	0
Flies toward investigator	0	0	0	–	–	–	0
Runs toward investigator	0	0	0	–	0	–	0
Lunges or hops toward investigator	0	0	0	0	0	+	0
Hops vertically	0	0	0	0	0	–	0
Vocalizes ("chucking")	0	+	0	0	0	0	0
Vocalizes ("hissing plus clicks")	0	0	0	–	–	+	0
Fluffs feathers on head and body as well as wing coverts	0	0	0	+	+	+	+
Spreads tail	0	0	0	–	+	+	–
Moves tail slowly from side to side	0	0	0	0	–	–	0
Rocks body from side to side	0	0	0	–	0	0	0
Droops wings	0	0	0	+	0	0	–
Pushes wing(s) out and in	0	0	0	–	0	0	0
Holds wing(s) outstretched	0	0	0	0	+	+	0
Quivers or shakes wing(s)	0	0	0	–	–	+	0
Flaps wing(s)	0	0	0	0	0	–	0
Rigidly bows wing(s)	0	0	0	0	–	+	0

[1] 0 means the component does not occur, – that it may occur, and + that it invariably occurs.

that of Types 5 and 6, but in complexity of response, Type X seems to lie between Types 3 and 4.

Vocalizations occurred in conjunction with certain types of response (Table 2). A "chucking" vocalization consisted of a series of soft staccato sounds. A "hissing plus clicks" vocalization consisted of a prolonged (two to three seconds) "hiss" accompanied by a rapid series of distinct "clicks." "Hissing plus clicks" tended to occur in repeated bursts.

The "hissing plus clicks" vocalization was usually synchronized with periods of body-rocking, tail or wing movement, lunges, or hops. A lunging, wing-flapping or hopping component seen in Type 6 responses was never observed without vocalization.

During the "hissing plus clicks" vocalization the mouth of the bird was always held at least partially open and was held completely open in Type 6 responses. When completely open, the large mouth was quite conspicuous; the inside of the mouth ranges in color from pale pink to bright red, apparently as a result of the varying dilation of blood vessels of the lining as correlated with ambient temperature (Cowles and Dawson, 1951).

Although in brooding birds the large eyes are almost completely closed,

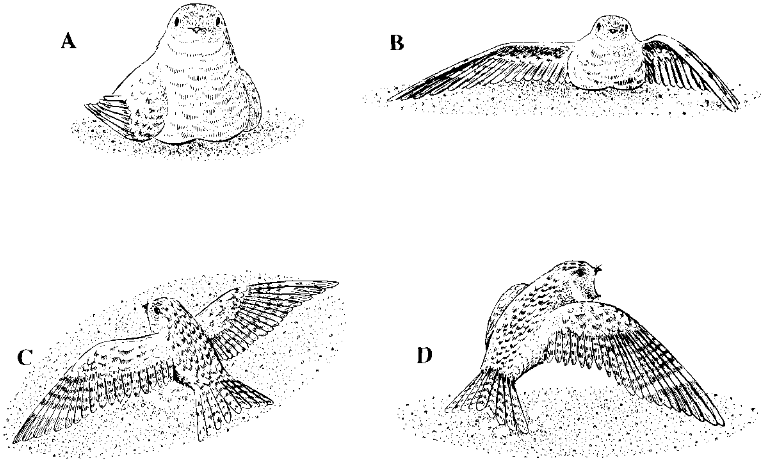

Figure 3. Responses of brooding female Common Nighthawks to disturbance. A, Type 4; B and C, Type 5; D, bird lunging at intruder in Response Type 6. All drawings are based on 16 mm motion picture frames.

with only a narrow "strip" of eye showing between the lids, the eyes were open after flushing, being especially widely opened and prominent during Type 5 and Type 6 responses.

During the stationary phases of all response types the bird's body touched the substrate. When a bird was running in Type 4 responses its body was slightly off the substrate and its short legs gave the run a marked wobbling aspect; runs in Type 6 responses occurred with the body close to the substrate. During most responses the position of head and body in relation to substrate did not differ strikingly from that of a normal resting bird. However, the anterior portion of the body and the head tended to be high in responses of Type 6 and occasionally depressed in those of Type 5.

Apparently the body-rocking and the side-to-side tail movement in responses of Types 4, 5, and 6 have the same muscular basis; they seem to be a result of the bird's shifting its weight from one foot to another. Seemingly when outstretched wings prevent body-rocking, only tail movement results. The relatedness of the two displays was clear when a bird went gradually from an outstretched wings and side-to-side tail movement response to a drooped wings and rocking response.

Analysis of films showed that when the bird's body was lifted off the substrate in a lunge, the tips of the outstretched wings and the fanned tail served as "props" or leverage mechanisms in the initiation of the lunge.

In responses of Types 3, 4, 5, 6, and X the bird faced toward me by

TABLE 3

RESPONSE TYPES ON CONSECUTIVE DAYS AT NESTS OF COMMON NIGHTHAWKS[1]

Nest	*Interval*[2]	*Response type*
A	a	5 **6** 6 6 6 6 6 6 6 5 5 5 5 5 5 5 5 5 5 5 5 3 3 5 3
	b	5 **6** 6 5 5 5 5 6 6 5 5 5 5 5 3 5 5 3 5 3 3 3 3 5 3
	c	5 **6** 6 5 5 5 5 6 6 5 5 5 5 5 3 5 5 3 5 3 3 3 3 5 3
	d	5 **6** 6 5 5 5 5 6 6 5 5 5 5 5 3 5 5 3 5 3 3 3 3 5 3
B	a	3 1 3 1 3 4 4 4 6 5 4 3 5 5 **6** 6 6 4 6 6 6 6 6 1 6 6 6 6 6 6
	b	3 1 3 1 3 4 4 4 6 5 4 3 5 5 **6** 6 6 4 5 6 6 2 2 1 6 6 6 5 5 5
	c	3 1 3 1 3 4 4 4 5 5 4 3 5 5 **5** 5 6 3 5 5 5 3 4 5 6 5 5 5 5 5
	d	3 1 3 1 3 4 4 4 5 5 4 3 5 5 **5** 5 6 3 5 5 5 3 4 5 5 5 5 5 5 5
C	a	3 – – 3 3 4 4 4 4 4 4 4 4 4 5 4 4 4 **4** 6 5 5 3 5 5
	b	3 – – 3 3 5 3 3 4 4 2 4 4 4 5 4 4 4 **4** 6 5 5 5 3 6
	c	3 – – 3 3 5 3 3 4 4 3 4 4 5 5 4 4 4 **4** 6 5 6 1 3 6
	d	3 – – 3 3 5 3 3 4 4 3 4 4 5 4 4 4 4 **4** 6 5 6 1 3 6
D	a	4 4 4 4 4 4 4 4 4 4 **5** 6 6
	b	4 4 4 4 4 4 4 4 4 4 **5** 6 6
	c	3 4 4 4 3 4 4 4 4 4 **5** 6 6
	d	3 4 3 3 3 4 4 4 4 4 **5** 6 6
E	a	5 6 4 4 4 4 4 4 4 4 3 – – – – "H"[3]
	b	4 6 4 4 4 3 4 3 4 4 3
	c	4 4 3 4 4 3 3 3 4 3 3
	d	4 4 3 3 3 3 3 3 4 3 3
F	a	1 3 1 1 1 6 6 6 6 1 6 4 6 4 6 – – "H"[3]
	b	1 3 1 1 6 6 6 6 6 1 6 6 6 1 6
	c	1 3 1 2 6 6 6 6 6 1 6 1 6 2 4
	d	1 3 1 2 6 6 6 6 5 1 6 1 5 2 4
G	a	X X X X X X X X X X X **X** X X X
	b	X X X X X X X X X X X **X** X X X
	c	X X X X X X X X X X X **X** X X X
	d	X X X X X X X X X X X **X** X X X

[1] Boldface symbols represent the day of hatching. Hatching day for nest G was estimated with maximum error of ± 2 days.

[2] Four successive 15-second intervals (a–d) in a standardized test of 60 seconds. Each interval is assigned the response type predominant in that interval.

[3] Nest deserted before hatching. "H" represents the estimated day of hatching, with maximum error of ±2 days.

orienting its body toward me or by "looking over its shoulder." In responses of Type 6 the bird invariably oriented its whole body to face me directly.

The flights toward the investigator in responses of Types 4 through 6 were five feet or less above the substrate; the bird sometimes flew directly toward me (as close as two and one half feet) and then away from me.

I often saw the "vertical-tail and labored flight" described by Tomkins (1942) when I flushed birds from the nest, especially preceding Type 5 and 6 responses. However, this was not invariable and frequently it was difficult to distinguish between a "vertical-tail flight" and the braking position of the tail prior to the bird's landing when it had fluttered only a few yards from the nest and then settled. Therefore, this response component was not included in the response types.

During the preliminary phase of this study, a response of one female with newly hatched chicks was seen in which the female backed off the young with outstretched wings held at a 45° angle, fluffed her feathers, spread her tail, gave the "hissing plus clicks" vocalization, and "teetered" about with her body off the substrate; this response can be considered a variant of Type 5 and resembles a display described by Pickwell and Smith (1938: 205) and Sutton and Spencer (1949: 142).

On a few occasions, as a bird flushed from a nest it audibly defecated.

The responses described here probably do not represent the entire repertoire of responses of brooding nighthawks to a disturbance stimulus. Doubtless, other responses exist for the species. However, the responses I have described appear to be the most common types and I would expect other responses to be variants of these basic types.

Circumstances of occurrence of responses.—The response types seen at each nest under standardized conditions are given in Table 3, and their relative frequencies in each of three periods (early, middle, and late) of the nesting cycle are shown in Figure 4. There was a clearly increased frequency of responses of Types 5 and 6 in the middle (5 days before through 5 days after hatching) and late (6 through 23 days after hatching) periods ($p < 0.001$). (All probabilities were obtained by Chi-square.) Type 4 decreased in frequency from the early (18 through 6 days before hatching) and middle periods to the late period ($p < 0.001$); Type 3 was least frequent in the middle period ($p < 0.01$), Type 2 was equally infrequent through all periods ($p > 0.30$), and Type 1 was significantly most frequent in the early period ($p < 0.001$).

The birds at nests E and F both showed a general increase in response Types 1 through 4 during the six days before deserting (Table 3). This parallels the change observed in the flushing and settling distances at these nests in the same period and suggests that both developments represented a prelude to nest desertion.

Although the type of response at nest G was the same throughout the observation period (Table 3), some variation did occur. Wing drooping and vocalization were maximal on the first day of observation and during the period from the day before hatching through the second day after hatching. Likewise, the response, in terms of eye opening, vocalization, head turning, etc., began when I was at greater distances from the nest during the first few days of observation and again near the hatching day.

In any given 60-second response period, as many as three response types could occur (Table 3). In most such instances, each response type was of a lower number than its predecessor. When characteristic components of more than one response type were seen in 15 seconds, these components usually characterized numerically adjacent types.

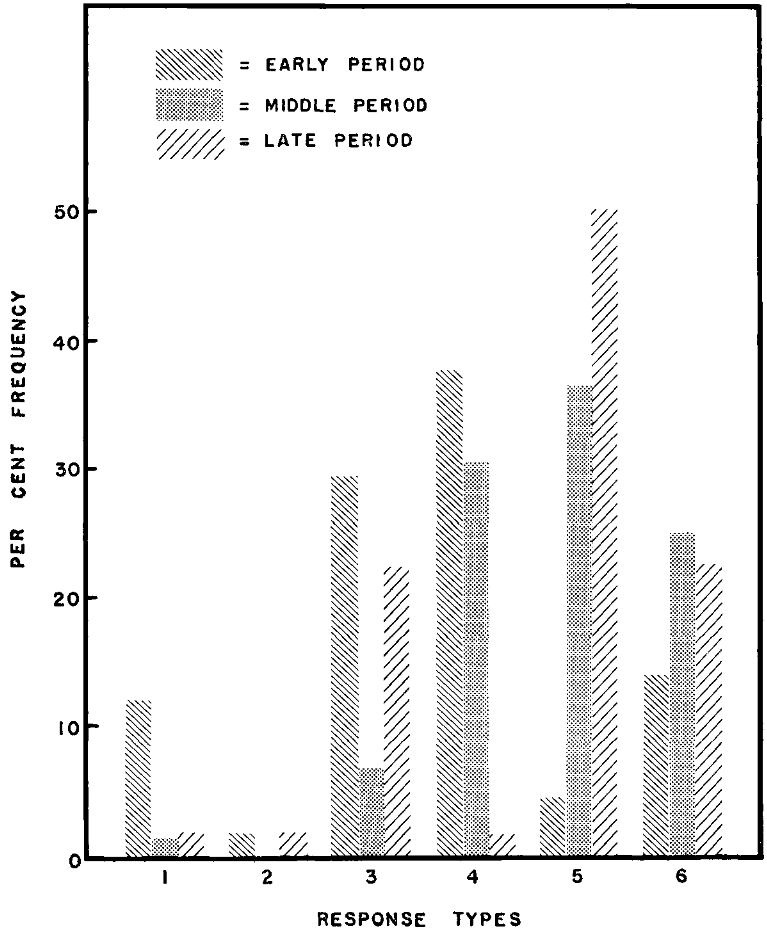

Figure 4. Frequency of response types at Nests A–F during the early, middle, and late periods of the nesting cycle. Early Period = 18 through 6 days before hatching. Middle Period = 5 days before through 5 days after hatching. Late Period = 6 through 23 days after hatching. Per cent frequencies are based on the 15 second-interval observations listed in Table 3. Responses observed on the 6 days prior to desertions at Nests E and F are not included. Response Type X is not included because the only nest (G) at which this type was seen could not be observed through the three periods of the nesting cycle.

Related observations.—During the incubation period of all normal nests, the female, when present in the area, was invariably found on the egg(s). When young 1–19 days old were present, the female was always either covering them (completely or partially) or she was no more than three feet from them. With young 20 or more days old, the female was found at distances up to 40 feet from the young.

Usually, after the female flushed, the young remained completely immobile through the observation period. However, in four instances, chicks one to five days old were seen to move about and emit "peeps" after the female left them. In at least two cases this movement and vocalization of the chicks were associated with air temperatures of 26°–32°C and with exposure of the chicks to direct sunlight.

With high air temperatures, and eggs or very young chicks in direct sunlight, the female often returned to brood more quickly than otherwise after I began my retreat. For example, on four successive days in which temperatures were *ca.* 32°C and eggs were in direct sunlight, the female returned to them each day about one half minute after my retreat began; on the day before and the day after the 32°C period, when the temperature was 21°–27°C and scattered clouds were present, the female took approximately two minutes to go back to her eggs after my retreat began.

Several times, after a 60-second observation had been completed, I was preceded by the female along my path of retreat—the bird staying variable distances (usually 10–30 feet) behind me and giving responses of Type 3, 4, or 5 between short flights. Similar "leading" behavior, often described in the literature for this and other species, was also elicited (during the preliminary phase of investigation) by my moving toward a bird after it had flushed and settled on the roof. The direction the bird took at such times was invariably away from the nest. If I stopped following the bird and approached the nest again, the female often flew toward me, sometimes passing me and alighting just ahead of me.

I saw male Common Nighthawks during some of the observation periods, but only when the female flew off the roof or around the nest area following flushing. In these instances the male repeatedly gave the familiar "peent" vocalization and occasionally performed dives at the nest roof.

Discussion

If my arrangement of response types accurately represents increasing conspicuousness of the responding bird, then this study indicates that conspicuousness is greatest at, and just after, hatching and that there is a slow reduction in conspicuousness as the nesting cycle nears its end. A similar variation in proximity (and thus, apparent size) through the nesting cycle is seen in the distances at which the birds settled (Table 1). This pattern of variation of conspicuousness of the responding bird to the intruder agrees, essentially, with what is suggested by observations of several other species of birds (see Armstrong, 1956: 648), and with what was seen more clearly in Little Ringed Plovers (*Charadrius dubius*) (Simmons, 1955: 134) and in Mallards (*Anas platyrhynchos*) (Stephen, 1963).

The adaptive significance and selective advantage of a responding bird being most conspicuous, and therefore, supposedly, the diversion being most effective, at and soon after hatching, might relate to the fact that the nest may be most vulnerable to predation at this time. Prior to hatching the cryptic coloration and small size of the eggs (Gross, 1940: 200) provide excellent "protection"; and again, as the young approach fledging, their running and incipient flying ability constitute increasing capacity to escape a predator.

The occurrence of shortest flushing distances at and just after hatching might be functionally significant. A cryptically colored and motionless bird, such as a brooding nighthawk, presumably would be less frequently detected, and thus, fewer nests would be destroyed, if the bird flushed less quickly when an intruder approached during the period of presumed maximum vulnerability of the nest.

The flushing and settling pattern seen in Figure 2 may also have survival significance. The consistent manner in which birds moved initially into the 0°–70° areas, and more particularly, into the 20°–70° areas, suggests that these birds would show this same general pattern even if their nests had been in an open area (e.g., in the middle of a roof or open field). Therefore, if a brooding bird conformed to this pattern and flushed to the side or to the rear of an approaching intruder, the intruder which tended to follow the bird would most effectively be led away from the nest.

Because I think the data of this study lend themselves most appropriately to a limited functional analysis, I have not based my analysis on the concept of response intensity with its concomitant motivational implications. However, since the phenomenon of habituation must be considered here, response intensity must briefly be included in this discussion.

It is difficult to assess the effect of habituation on the responses observed in this study. Yet, some of the data conceivably indicate habituation. Response complexity (intensity?) decreased during the first few days of observations at nest G. Rather sharp initial declines (declines in response intensity?) were seen in the settling distances at nest B as well as in the flushing and settling distances at nests C and F; these seemingly represent departures from the gradual declines observed at other nests as hatching approached, in which latter cases shorter distances presumably arose primarily from increasing response intensity. However, it is difficult to find more than these few suggestions of habituation in my data. But, as Thorpe (1951: 12) has pointed out, ready habituation to a potential predator would be clearly dysgenic. Since habituation is a relatively permanent waning of a response due to lack of reinforcement (Thorpe, 1963: 61) one is prompted to seek the reinforcement(s) which would minimize or eliminate habituation in the response of a brooding bird to the human intruder. Hinde (1954) has quoted Verplanck as suggesting that the withdrawal of an owl serves to reinforce the mobbing response of Chaffinches (*Fringilla coelebs*) in nature. Perhaps withdrawal of the human intruder is, similarly, a reinforcement for responses of brooding nighthawks. Also, the mere complexity of the human as a stimulus object as well as the 24-hour intervals occurring between its appearances may have forestalled rapid habituation to it.

ACKNOWLEDGMENTS

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SUMMARY

In 1963 and 1964 observations of the behavior of brooding females were made at 11 nests of the Common Nighthawk (*Chordeiles minor*). At 7 of these nests a standardized stimulus object (the investigator dressed and moving in a consistent manner) was presented daily. Distances and directions of flushing and settling of the bird were recorded for all presentations of the stimulus object. Seven types of response, each representing a different degree of conspicuousness of the bird, were recognized.

Responses involving maximum conspicuousness occurred at and shortly after hatching and I think that such behavior would most effectively divert the intruder during the period in which the nest is presumably most vulnerable to predation.

Shortest flushing distances (my distances from the nest when the bird flushed) occurred at and shortly after hatching; this pattern might result in fewer nest destructions by predators as a result of fewer nest "betrayals" by flushing birds.

Brooding birds consistently flushed toward and settled in areas to the sides of and behind the advancing investigator. This pattern may aid in diverting an intruder from the nest.

LITERATURE CITED

ARMSTRONG, E. A. 1947. Bird display and behaviour. London, Lindsay Drummond Ltd.

ARMSTRONG, E. A. 1949. Diversionary display, 1, 2. Ibis, **91**: 88–97, 179–188.

ARMSTRONG, E. A. 1952. The distraction displays of the Little Ringed Plover and territorial competition with the Ringed Plover. Brit. Birds, **45**: 55–59.

ARMSTRONG, E. A. 1954. The ecology of distraction display. Brit. J. Anim. Behav., **2**: 121–135.

ARMSTRONG, E. A. 1956. Distraction display and the human predator. Ibis, **98**: 641–654.

BROWN, R. G. B. 1962. The aggressive and distraction behaviour of the Western Sandpiper *Ereunetes mauri*. Ibis, **104**: 1–12.

COWLES, R. B., AND W. R. DAWSON. 1951. A cooling mechanism of the Texas Nighthawk. Condor, **53**: 19–22.

GROSS, A. O. 1940. Eastern Nighthawk (*Chordeiles minor minor*). Pp. 206–244 *in* Life histories of North American cuckoos, goatsuckers, hummingbirds and their allies. U.S. Natl. Mus., Bull. 176.

HINDE, R. A. 1954. Factors governing the changes in strength of a partially inborn response, as shown by the mobbing behaviour of the Chaffinch (*Fringilla coelebs*), II. Proc. Roy. Soc. London, Sect. B, **142**: 331–358.

PICKWELL, G., AND E. SMITH. 1938. The Texas Nighthawk in its summer home. Condor, **40**: 193–215.

SIMMONS, K. E. L. 1951. Distraction-display in the Kentish Plover. Brit. Birds, **44**: 181–187.

SIMMONS, K. E. L. 1952. The nature of the predator-reactions of breeding birds. Behaviour, **4**: 161–171.

SIMMONS, K. E. L. 1955. The nature of the predator-reactions of waders. Behaviour, **8**: 130–173.

SKUTCH, A. F. 1955. The parental stratagems of birds. Ibis, **97**: 118–142.

STEPHEN, W. J. D. 1963. Some responses of female Mallards to disturbance by man. J. Wildl. Mgmt., **27**: 280–283.

SUTTON, G. M., AND H. H. SPENCER. 1949. Observations at a nighthawk's nest. Bird-Banding, **20**: 141–149.

THORPE, W. H. 1951. The learning abilities of birds. Ibis, **93**: 1–52, 252–296.

THORPE, W. H. 1963. Learning and instinct in animals. Second edit. Cambridge, Harvard Univ. Press.

TINBERGEN, N. 1952. "Derived" activities; their causation, biological significance, origin, and emancipation during evolution. Quart. Rev. Biol., **27**: 1–32.

TOMKINS, I. R. 1942. The "injury-feigning" behavior of the Florida nighthawk. Wilson Bull., **54**: 43–49.

WILLIAMSON, K. 1949. The distraction behaviour of the Arctic Skua. Ibis, **91**: 307–313.

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