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AN EXPERIMENTAL STUDY OF FEAR: TEST OF AN ALLEGED INNATE SIGN STIMULUS

A Thesis
Presented to
the Graduate Faculty
Central Washington State College

In Partial Fulfillment
of the Requirements of the Degree
Master of Science

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by
Paul Dawson
August 1964

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS

The purpose of the present study was to test the Tinbergen hypothesis that specifically shaped sign stimuli innately arouse fear behavior in certain species of birds (43:77). The literature contains conflicting reports to the effect that a moving overhead model, shaped like a hawk when flown in one direction and a goose when flown in the opposite direction, will elicit fear responses in some species of birds only when flown in the direction such that it resembles a hawk.[1] Tinbergen (44), a European ethologist, found that the fear behavior displayed by certain gallinaceous birds occurred without prior opportunity for learning, and he believed that shape in relation to direction of movement served as a specific sign stimulus for the release of innate fear behavior in his subjects. Later studies by Hirsch (20) and Rockett (37) did not support Tinbergen's hypothesis, although these studies were criticized by Lorenz (27) and Hess (18) on the basis of species differences.

Tinbergen (43, 44) designated as sign stimuli those stimuli within a given situation which elicit innate responses in the organism. He believed that out of the myriad

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[1] See Appendix, Figure 7.12.

of stimuli impinging upon the receptors of the organism, only a select few are capable of eliciting a particular response pattern. The ethologists, including Tinbergen and Lorenz, maintain that numerous behavior patterns of lower organisms are the result of innate response tendencies, which are released by specific sign stimuli in the environment. The method of study advocated by these investigators is that of naturalistic observation, and they appear dedicated to the study of behavior in the lower organisms (Hess, 18).

Hess (18) points out that the Behavioristic influence in psychology has created somewhat of an impasse between psychology and ethology. He states that psychologists have objected to the methods of investigation employed by the ethologists, and have been offended by Tinbergen's statement that ethology is <u>the</u> objective study of behavior (44). Whereas the experimental psychologist believes that only under controlled conditions (preferably in the laboratory) can behavior be objectively studied, most ethologists maintain that laboratory studies often distort or stereotype behavior, and that the proper place to study behavior is in the organism's natural habitat. Hess designates a second factor which has made ethology objectionable to many experimental psychologists, and this is the fact that the ethologists "intrepidly resuscitated the almost dead idea of genetic transmission of behavior characteristics, distinguishing species and breeds within species" (18:140).

Young (46) states that, following McDougall's instinct theory, there evolved an "anti-instinct movement" in psychology during the 1930's, and since this time psychologists have been averse to contend with the term "instinct" either in theory or investigation. Recently, however, ethological methods and evidence have aroused the psychologist's interest in related areas. The phenomenon of imprinting, for example, observed by Spalding in 1873 and first given widespread attention by Lorenz (26), has received a great deal of attention in this country (18).

Lorenz placed much emphasis on the phenomenon of imprinting. He found that the object of parent-directed behavior in many birds is not determined innately, but is fixed irreversibly during a short period following hatching (16). The short period during which imprinting, or parent-directed behavior, occurs in the life of the neonate is termed the 'critical period' (16). The critical period usually extends only a few hours from the time of hatching; it may be prolonged in cases of sensory deprivation following birth; it may be latent, manifesting itself during a later developmental stage (16); and may vary in certain respects from species to species (31). Lorenz emphasized that unlike learned behavior, which is subject to forgetting or relearning, the effects of imprinting are irreversible; and imprinting can occur only during a narrowly delimited period of the life span, whereas learning is not similarly restricted (18). A considerable number of investigators (13, 14, 15, 16, 17, 21, 22, 25, 30, 31, 32, 35, 36) have engaged themselves in the study of imprinting during the past few years, and experimental studies of this phenomenon are numerous in the literature. The imprinting phenomena will be considered further in the design section of the present paper.

CHAPTER II

REVIEW OF THE LITERATURE

In his study of instinctive behavior in lower organisms, Tinbergen (44) reported that a model with symmetrically shaped anterior and posterior wing edges, having a long protuberance at one end of the body axis and a short protuberance at the other end, elicited fear behavior in certain gallinaceous and precocial birds when passed overhead in the direction such that the short protuberance was forward. When passed overhead in the opposite direction, with the long protuberance forward, the model elicited only superficial interest on the part of the birds. Tinbergen believed that the model provided necessary sign stimuli for releasing innate fear reactions, and designated shape in relation to direction of movement as the significant cues within the stimulus complex. He found that as long as the silhouette had a short neck the subjects would show alarm, and that other variables such as shape and size of wings and tail were irrelevant. These results and conclusions seem to have been readily accepted by several authors, as evidenced by the many references to this and similar studies in the literature (5, 8, 12, 18, 19, 24, 28, 29, 40, 42, 44, 46).

It appeared to Hirsch, Lindley, and Tolman (20) that previous studies lacked important controls, and that the derived conclusion concerning the fear behavior in response to an innate sign stimulus was possibly credulous. Hirsch et al. (20) found that the Tinbergen hypothesis was untenable when tested under controlled laboratory conditions. In this study, 24 naive, eight-week old white Leghorn chickens, obtained from a nearby hatchery, were raised together in a 5 X 5 foot enclosure. The Tinbergen silhouette was pulled over the length of a 60-inch-long alley, at a height of 105 inches, during the test for fear. Order of stimulus presentation was counterbalanced (HGHG, GHGH), and approximately 60 seconds were allowed between each stimulus exposure. Although the subjects were raised under group conditions, tests for fear were made with individual birds. The three variables which were studied by this group of investigators were size of stimulus, order of stimulus presentation, and presence or absence of shadow. Instead of shape in relation to direction of movement, Hirsch et al. (20) found four variables to be significant in bringing about fear behavior. These variables were the amount of previous experience with the model, the rate of movement and size of the model, and the presence or absence of a shadow. Generally, the larger models elicited more fear (up to a point); more fear was displayed when the model cast a shadow; an increase in the speed of presentation tended to increase the degree of fear; and prior experience with the model brought about a decrease in degree of fear. This group of investigators discovered that at the optimal exposure time of 1½ to 2 seconds, the fear behavior was extinguished in ten to twelve trials and showed spontaneous recovery after the passage of two to three hours (20:279).

Rockett (37), after completing a study of Tinbergen's sign stimulus for fear in chickens, stated that his findings affirm the conclusion of the Hirsch, Lindley and Tolman study, in that shortneckedness was found to be no more fear-producing than longneckedness with either White Rock or Leghorn chickens under controlled laboratory conditions. In this study, Ss were raised under group conditions and tests for fear were made with individual subjects. Novel aspects of the study included the presentation of a movie to the Ss (in which a hawk was heard to scream), and an informal test with the silhouette on domestic ducks in a nearby pond. The hawk noise elicited no significant degree of fear, while the ducks showed no apparent difference in degree of fear to hawk vs. goose shapes. In the study proper, the silhouette was presented to White Rock and White Leghorn chickens by pulling it overhead on a string track. The study was conducted, in the words of the investigator "informally", and certain controls were obviously lacking.

Whereas Rockett (37), Hirsch et al. (20) criticized the ethologists for lack of control in their studies of sign stimuli for fear, feeling that the ethologists' derived conclusions were somewhat credulous, Lorenz criticized the conclusions drawn from the Hirsch and Rockett experiments. Lorenz felt that the American investigators found different results only because they employed different species of birds, and he believed that their results are meaningless in light of this fact (18). Both Lorenz (27) and Hess (18) maintained that consistent results are possible only if animals of the same species and breed are used. Whereas Tinbergen employed turkeys, pheasants, and greylag geese, Hirsch and Rockett used white Leghorn and White Rock chickens (18:280).

Melzack (28) recently conducted a study of the Tinbergen hypothesis at the London Zoo. This investigator employed mallard ducks, raised individually but not under conditions of complete isolation, and tests for fear were made in an outdoor setting with individual birds. The silhouette, of the dimensions specified by Tinbergen (44), was passed over a straight runway in a circular path at a height of approximately 7 feet. The results of Melzack's study support the Tinbergen hypothesis, in that more fear was displayed to the hawk shape than the goose shape. This investigator feels that the study was poorly controlled, from the point of view of experimental setting, the choice of apparatus for stimulus presentation (a large horizontal metal bar), and incomplete isolation of the subjects. It is difficult to ascertain from what the subjects were isolated, since they apparently had experience with both the experimenter and moving overhead objects prior to their use in the experiment.

The experimental setting is a major point of disagreement between the experimental psychologist and the ethologist, as was previously discussed, and it may well be that the differences in results are in part due to differences in setting. Hirsch et al. stated that "whether or not the differences in results may be due to differences in setting . . . the laboratory versus the barnyard . . . is a question that our results cannot answer" (20:280). Hess (18) points out that it may be well to conduct studies of this nature in both an indoor and outdoor setting. The present investigator recognizes the fact that both species differences and differences in setting may be significant variables, and he feels that certain controls are necessary in such a study. Regardless of whether the experiment is carried out within or outside the laboratory, it is crucial that the investigator be able to identify important variables in the experimental situation. In an outdoor setting such controls are difficult, if not impossible, to achieve. Lorenz argued that laboratory animals often become unhealthy, which may lead to stereotyped behavior (18). This argument will be discussed in the final section of the present paper.

This investigator perceived several questions, relevant to the subject of sign stimuli for fear, which he hoped would be answered by the present study, and which appear to have been either overlooked or inadequately answered by previous investigators. These questions are as follows:

1. Are fear responses in certain species of birds elicited by specifically shaped sign stimuli?
2. Do these fear responses occur only at a certain period of maturational development in the animals?
3. Are the fear responses manifest when the model approaches or when it moves away from the animal?
4. Does familiarity with other members of the species affect the birds' reactions to the model?
5. Will complete isolation during development affect the birds' reactions to the model?
6. Will neonate birds imprint as readily to the model in the Hawk position as in the Goose position?
7. Will the imprinting experience affect the birds' reactions to the model at a later developmental stage?
8. Are there species differences in response to the model?

Some of the preceding questions have been partially answered by previous studies of imprinting, although the answers might not be entirely applicable to the present subject of fear-producing sign stimuli. For example, Hess (17) found a positive correlation between the termination of the critical period and the onset of fear behavior during development. Ramsey and Hess (36) singled this out as a relevant factor in the imprinting process. Jaynes (22), in agreement with Ramsey and Hess, also pointed out that during the imprinting process, fear responses are more frequently manifest when the object is approaching the neonate than when it is moving away. Jaynes believed that the onset of fear, which he found to begin at about age 16 to 25 hours, is responsible for the termination of the critical period. Finally, Lorenz (25) has stated that imprinting is not reversible, and if this is the case we should expect the animals that imprinted to the Hawk model (if any) to show no fear of this model at a later developmental stage.

Previous investigators have either raised the experimental subjects in groups, or tested the subjects in groups. In the Tinbergen study (44), barnyard animals were used as subjects and the birds were apparently tested in groups, while in the Hirsch (20) and Rockett (37) experiments the subjects were raised as a group. None of these studies controlled the possible variable of species familiarity, although the birds were tested individually in both the Hirsch and Rockett investigations. To the knowledge of the present investigator, no previous studies have included attempts to imprint neonates to the alleged fear-producing model. It seems, too, that the variable of age has been overlooked in previous studies. Tinbergen (44) did not specify the age of the subjects which he employed, while age was not recognized as a significant variable by Hirsch or Rockett. In addition, previous investigators have purchased their subjects from nearby hatcheries and transported them to the laboratory. This procedure appears to lack control, and may well have affected the outcome of the experiments.

The present study was designed to achieve a high degree of control, and represents an attempt to overcome at least some of the difficulties inherent in previous studies. Seasonal difficulties, however, limited the scope of this investigation. The investigator had hoped to employ pheasants, chuckars, geese, turkeys, and several breeds of ducks, in order to settle the problem of species differences, but started too late in the season to procure eggs of each kind. A drop in the temperature of the laboratory killed fifteen pheasants and six chuckars, consequently the investigator found that he must be content to employ three breeds of ducks, rather than the various species called for in the initial design. This limitation will be discussed in Chapter V of the present paper.

The present study employed methods similar to those used in previous studies (20, 37) but the design consisted of essentially two separate experiments. The first experiment was concerned with imprinting neonates to the model in in both the Hawk and Goose positions. The second experiment involved the testing of Tinbergen's fear hypothesis under controlled laboratory conditions, using species similar to some of those employed in the original studies by Tinbergen and Lorenz (18:280). Subjects were raised in groups as well as under conditions of isolation. The birds were hatched in the laboratory, raised under controlled laboratory conditions, and tests for fear were made at two age levels in different birds. A complete developmental history was recorded for each subject.

In light of the results from previous studies on the subject of the alleged fear-producing sign stimulus, the present investigator formulated several hypotheses which were to be tested by the two experiments. These hypotheses are presented below.

HYPOTHESES

1. The subjects raised in isolation will show no less fear of the model when it is in the Goose position than when the model is in the Hawk position.
2. There will be no significant difference in the degree of fear shown to the model between the group-raised and the isolated birds when tests for fear are made.
3. The order of stimulus presentation (Hawk-Goose or Goose-Hawk) will make a difference in the degree of fear manifest by the subjects when tests for fear are made.
4. In all groups, there will be no significant difference between the degree of fear shown to the Hawk and the

degree of fear shown to the Goose.

5. The subjects will show a greater fear of the silhouette as it approaches than when it recedes in the test of the sign stimulus.

6. During the critical period, 12 to 24 hours following hatching, the subjects will imprint as readily to the model in the Hawk position as they will to the model in the Goose position.

7. Age of the subjects will make a difference in the degree of fear shown to the model when tests for fear are made.

8. Imprinting neonates to the silhouette (either Hawk or Goose) will affect their reactions to this silhouette at a later period of time in development, as compared with subjects that were not imprinted.

Further questions, or possible hypotheses, will be discussed in the final section of this paper, but at this point the preceding hypotheses appear to be the most crucial. The first hypothesis is intended to ascertain whether or not the birds can discriminate shape in relation to direction of movement without prior opportunity for learning. The second hypothesis takes into account the familiarity variable, overlooked in previous studies. The third hypothesis pertains to the order of sign presentation, and appeared to be important for methodological reasons. Hypothesis four is a general question, highly similar to the first hypothesis, which it was hoped would ascertain whether or not the birds would display differential fear to the Hawk and Goose shapes when all variables were interacting. The fifth hypothesis is based upon the findings of previous imprinting studies, applied to both experiments in the present design. Hypotheses six and eight pertain to the question of innate preferences for objects of parent-directed behavior, and the effect of the imprinting experience upon the subjects' later reactions to the alleged fear-producing model. The seventh hypothesis deals with the question of age differences, brought out earlier in this discussion as a variable neglected in previous studies.

CHAPTER III

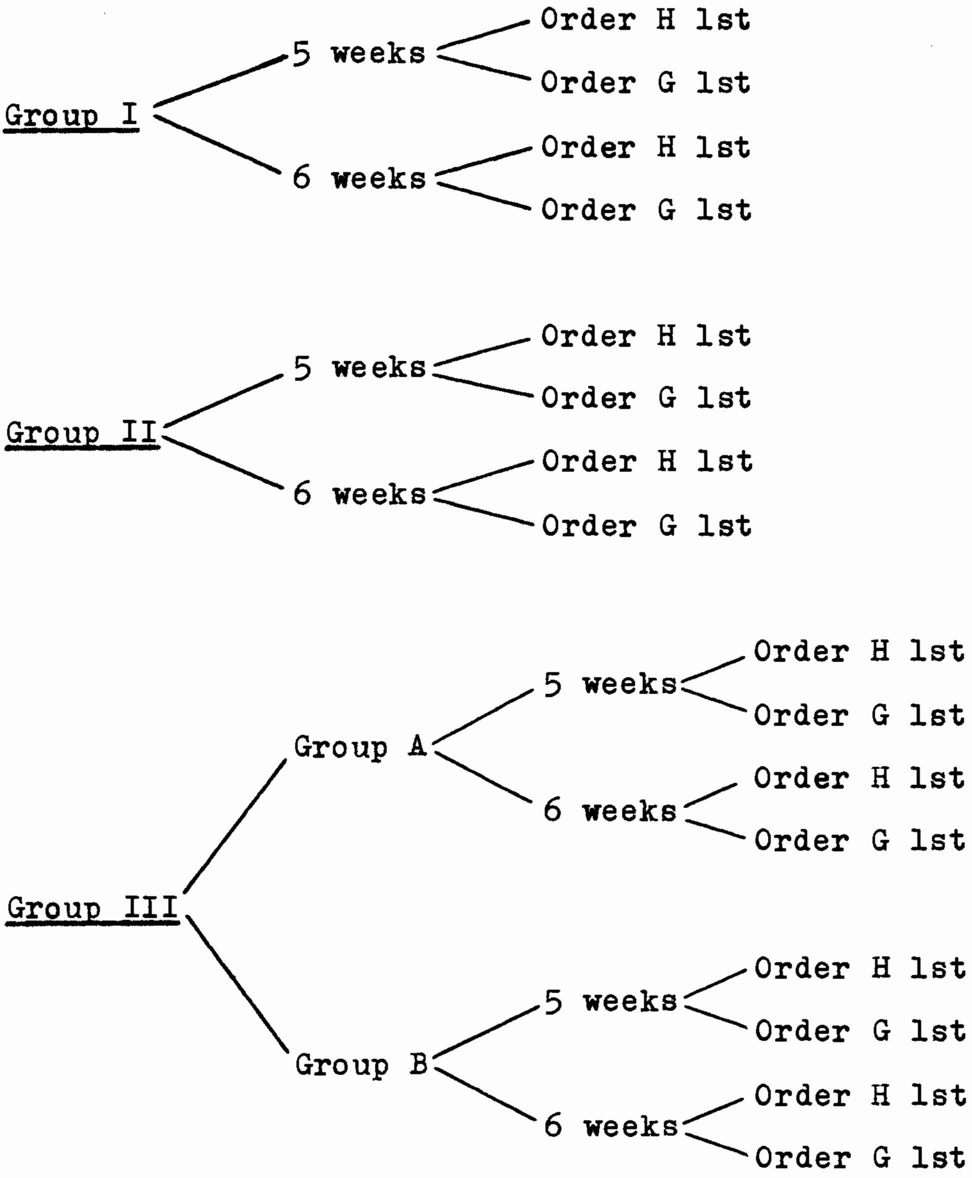
DESIGN, METHOD AND PROCEDURE

Design of Experiments

Essentially there were two separate experiments included in the design. The first was concerned with imprinting neonates, during the critical period, to the silhouette in both the Hawk and Goose positions. Half of the imprinted group (group A) were exposed only to the Hawk model, while the other half (group B) were exposed only to the Goose model. At age five weeks, half of group A and half of group B were tested for their reactions to the Tinbergen silhouette, while the remaining imprinted subjects were tested at age six weeks. The order of stimulus presentation (Hawk-Goose or Goose-Hawk) was counterbalanced.

The second experiment involved a test of the alleged fear-producing model with birds raised either in complete isolation or in a group situation. Half of the isolates and half of the group-raised subjects were tested at age five weeks; the second half of these two groups were tested at age six weeks. Order of sign stimulus presentation was counterbalanced, as was the case with the imprinted subjects. A schematic diagram of the design is presented on the following page (Figure 3.1). This experiment is essentially a 2 X 2 X 3 factoral design.

Figure 3.1. Schematic of Design.



Group I: Isolated birds
Group II: Group-raised birds
Group III-A: Imprinted to Hawk
Group III-B: Imprinted to Goose

Selection of Subjects

The subjects included three breeds of ducks, hatched and raised in the laboratory under controlled conditions. Of the 45 birds employed, there were 9 Muscovy, 19 Black Ducks, and 17 White Peking ducks. Approximately ten birds, in addition to those mentioned above, were employed in a pilot study. Thirteen of the 45 subjects were used in the imprinting experiment, and were subsequently employed in the test of the sign stimulus. Thirty-two subjects, in addition to those birds from the imprinted group, were employed in an experimental test of the alleged fear-producing sign stimulus. Birds of different breeds were fairly evenly distributed among the various groups, as indicated in the design. Twelve subjects were raised under conditions of complete isolation, in 2 X 2 X 1½ ft. cages in a separate animal room. All other subjects were raised in groups, and kept on different levels of a 5-level still-air brooder in a second animal room.

Apparatus and Materials

One 5-level brooder (60 capacity); two circular still-air incubators, with a 75-100 egg combined capacity; two 8 X 10 ft. animal rooms; twenty individual cages, with approximately 2 X 2 X 1½ ft. dimensions; one electric heater; eight individual cages (simulated nests), about 1 X 1 ft. in size; identification tags; and individual record sheets. The materials mentioned thus far were employed in the hatching and raising of subjects.

In the imprinting experiment, the following apparatus and materials were used: an 8-section circular runway, having a 216 inch circumference and a six foot diameter, with a plyboard base and wire mesh sides. The runway was 1 ft. wide, and 10 inches in height. A plyboard base was placed beneath the runway, which was mounted on a 3½ ft. high table in a 8 X 10 ft. wide laboratory room. A 115 volt, 135 amp., 150 h.p. electric motor was concealed beneath the plyboard base at the center of the runway, while the motor shaft projected upward through a small hole in the plyboard. From the motor's shaft was projected a thin wooden extension, which reached a height of 85 inches above the floor of the laboratory. Extending horizontally from this wooden shaft was a thin metal arm which projected out over the runway proper. Four thread-like wires were hung from the horizontal extension, and the silhouette was attached to these wires at a height of 12 inches above the floor of the runway. A series of counterweights, concealed from view, was employed to offset the weight of the silhouette. The Tinbergen silhouette, with symmetrical anterior and posterior wing edges, having a long protuberance at one end of the body axis and a short protuberance at the other end, had a wing span of 18 inches and a length of 10 inches. The short protuberance extended one inch from the nearest wign edge, while the longer protuberance extended 5½ inches from the nearest wing edge. With the exception of the model, which was painted black, all of the preceeding apparatus was painted a dull grey color. The lighting in the laboratory room was diffuse and indirect, so that no shadow was cast by the overhead model as it circled the runway.[2]

The experimenter observed through a one-way window from an adjacent room. In this room was a 1 - 120 volt transformer, connected to a CrayLab timer, by means of which the experimenter controlled the speed of rotation of the silhouette in the next room. A tape recorder was employed to record the subjects' responses, as reported by the experimenter. A microphone amplified vocal responses made by the subjects. A second timer, able to measure intervals as small as 1/60 second, was employed in the control room to measure one of the dependent variables. Information from the tapes was transcribed to record sheets as time permitted.

In the second experiment, where tests of the sign stimulus were made, the following apparatus was used:[3] One-half of the 8-section circular runway employed in the imprinting

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[2] See Appendix, Figure 7.10.

[3] See Appendix, Figure 7.9 and 7.11.

experiment, with the sides extended vertically to a height of 20 inches; the Tinbergen model,[4] raised to a height of 85 inches above the runway base. The runway was placed on the floor of the laboratory. A 42 inch high portable stand, on which the electric motor rested, was employed to gain the necessary height for the model presentation. This stand was draped in a white cloth, to match the all-white laboratory room. Other materials, which were also employed in the imprinting experiment, included two timers, a 1 - 120 volt transformer, a tape recorder, and record sheets. These materials were specified more clearly in the preceding paragraph.

Procedure

Pilot Study. A pilot study was conducted with several Muscovy and White Pekings, prior to running the proposed experiments, in order to check the apparatus and to improve technique. Some minor procedural difficulties were modified through experience in the pilot study.

Imprinting Experiment. Thirteen subjects, including White Peking and Black ducks, were incubated and hatched in the laboratory. Six of these Ss were imprinted to the Hawk (Group A) while seven were imprinted to the Goose model (Group B). Group III was comprised of Groups A and B. The

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[4] See Appendix, Figure 7.12.

procedure was the same for both groups, except that each group was exposed to the Tinbergen silhouette in opposite directions during the imprinting period.

The subjects were selected in a random manner, removed from the incubator immediately following hatching, and placed in individual compartments in an isolated animal room. A constant temperature of approximately 95 to 100 degrees was maintained in the animal room during the twelve-hour drying period following hatching. These compartments were semi-dark and quiet. At age 10 to 14 hours, each animal was removed from its compartment and carried in an enclosed container to the experimental room where it was placed in the imprinting runway under conditions of semi-darkness. When the experimenter had left the room the lights were turned on and the subject was allowed five minutes to adjust to the apparatus. Following the 5-minute adjustment period, the first of three imprinting sessions would begin.

The experimenter took his place behind the one-way window in the adjacent control room, turning on the tape recorder and setting the timer for thirty minutes (the length of each imprinting session). The controls were so set that turning on the larger of the two timers would initiate movement of the silhouette in the experimental room, and would start the smaller timer in motion. The silhouette was made to describe a 360 degree arc, at a height of 11 inches above the runway floor, moving at the rate of approximately 1 ft. every two seconds. It was so arranged that the birds viewed only the under surface of the model, and no shadow was cast as the model moved over the runway. The experimenter recorded each subject's behavior during the first and last five-minute periods of the imprinting session, reporting the number of runway sections traversed by the subject in response to the model (either abient or adient responses), and the amount of time spent in running toward (or away from) the model. Similar recording procedures were reported by Hess (15). Fear behavior, when displayed, was also recorded during these sessions.

At the close of each imprinting session, the subject was removed from the runway under conditions of semi-darkness. The runway was so constructed that gates would trap the subject in a given section of the runway by manipulation from the control room. This facilitated removal from the apparatus in darkness. The subject was then transported in a container to its designated compartment in the animal room. A second and third imprinting session was conducted for each bird, using the same procedure as described above, at ages 16 to 20 and 25 to 30 hours. Following the third imprinting session, each subject was tagged for purposes of identification and placed in the 5-level brooder with other imprinted subjects. Although further isolation would have been desirable, a lack of laboratory space limited this possibility. But since the critical period should have been nearly completed by age 30 hours, the experimenter felt that the chance of further imprinting occurring with the animals in the brooder was greatly reduced.

These same subjects (Group III) were tested for their reactions to the model, half at age 5 weeks and half at age 6 weeks, as described in the next subsection of this paper, to ascertain the effect of the early imprinting experience.

Sign Stimulus Experiment. Forty-five subjects, including 9 Muscovy, 19 Black and 17 White Peking ducks, were divided randomly (as they hatched) into three groups. Group I was designated as the Isolate Group. These subjects were removed from the incubator upon hatching and placed in individual cages in a separate animal room, where they were to remain until employed in the experiment proper. The isolates received only diffuse over-head light in their cages, were fed and cared for by the experimenter only in complete darkness, and had no opportunity for experience with moving objects. Group II were group raised subjects, tagged and placed in the brooder several hours following hatching. These subjects had no experience with moving over-head objects, and remained in the brooder until employed in the experiment proper. Group III has already been discussed. These were the imprinted subjects (Group A and B) employed in the experiment which was described in the preceding section of the paper. The lighting in both animal rooms was controlled so that it roughly approximated those which the subjects would experience in a more natural setting, and the temperature in these rooms remained reasonably high. Loud noises and other possible fear-producing stimuli were controlled.

At age 5 weeks, half of Groups I, II and III were tested individually for their reactions to the Tinbergen silhouette. Each subject was transported from the animal room in an enclosed container, and placed in the semi-circular runway in the experimental room under conditions of darkness. After the experimenter had left the room the lights were turned on, and the subjects were allowed 5 minutes to adjust to the apparatus. A second observer remained in the experimental room to record vocal responses, and to reverse the direction of the model at the midpoint of the trials. He sat behind a screen, unseen by the subjects.[5]

The experimenter took his place in the control room, and at the end of the 5-minute adjustment period he started the tape recorder and timer. The silhouette was made to pass overhead at a height of 85 inches above the floor of the runway, moving at the rate of approximately 1 ft. per

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[5] See Appendix, Figure 7.9.

second. The model passed over the subject 15 times as one stimulus shape, and 15 times as the other stimulus shape. Order of stimulus shape (Hawk-Goose or Goose-Hawk) was alternated for each subject in a random fashion. The observer in the experimental room reversed the direction of the model after the first 15 trials for each subject. Lighting was such that no shadow was cast as the model circled the runway, and the laboratory was quiet during testing. Following the 30-trial test, each subject was removed from the apparatus and taken to a nearby farm. Complete taped records were made of the subjects' behavior during each trial. These records were later transcribed to appropriate record sheets to facilitate interpretation.

At age 6 weeks, the second half of Groups I, II and III were tested for their reactions to the Tinbergen silhouette. The procedure duplicated that described above, with the age variable being the only difference.

Technique for Analysis of Data

The record sheets for the imprinting experiment included space for measures in both time and distance, for each minute of the two 5-minute recording periods. The number of seconds per minute and the number of runway sections traversed per minute by the subject (either abient or adient behavior) were recorded. See Appendix, Figure 7.13 for a sample of the imprinting record sheet.

For the sign stimulus experiment, a 7-item checklist of fear criteria was provided. The experimenter recorded the number of fear criteria displayed by each subject on all 30 trials. With the exception of item number 7, all items checked were equivilent to plus two points. One point was given for each criterion displayed as the model approached the subject, and one point was given for each fear response manifest as the model receded. Item number 7 on the list of fear criteria was equivalent to minus two points (one point for approach and one point for receding). Thus, if all fear criteria were displayed by the subject on each of the 15 trials (in either Hawk or Goose position) a total of 180 points were possible. With the model in the reverse direction, an additional 180 points were possible. See Appendix, Figure 7.14, for a sample of the record sheets employed in the sign stimulus experiment. If subjects displayed fear as the model approached, an A was placed on the appropriate spaces on the record sheet, a B if fear was displayed as the model receded, and a C if fear responses occurred both as the model approached and receded. This coding was employed as the taped records were transcribed to the record sheets. Space was also provided on the record sheets for qualitative description of each subjects' behavior.

The comparisons to be made, and the results of these comparisons, are discussed in the next section of the present paper.

CHAPTER IV

RESULTS OF EXPERIMENTS

The results of this study do not support the Tinbergen hypothesis, in that the hawk stimulus was found to be no more fear-producing than the goose stimulus under controlled conditions.

Intragroup comparisons revealed that order of stimulus presentation was the only significant variable. With order counterbalanced, in no group was there a significant difference in the mean number of fear responses to the hawk versus goose stimuli. Table 4.1 summarizes the t-tests for within group comparisons with the order variable counterbalanced.

Table 4.1. Intragroup Comparisons with the Order Variable Counterbalanced.

Groups	Comparing	df	t	sign. level	direction
All Groups	Hawk vs Goose Fear	40	0.051	-	-
Group I	Hawk vs Goose Fear	10	0.143	-	-
Group II	Hawk vs Goose Fear	15	0.515	-	-
Group III	Hawk vs Goose Fear	12	0.153	-	-

I = Isolates
II = Group raised
III = Imprinted

\- = not significant

All subjects were found to display fear behavior when presented with either the hawk or goose shape, and the data in Table

4.1 indicates that there was no significant difference in the degree of fear shown to the hawk versus goose shape.

More fear was elicited by the hawk when this stimulus came first, and more fear was elicited by the goose when the goose shape was presented first, except in the case of the Isolates. The following comparisons were considered important with respect to the order variable: (1) Hawk fear with the hawk first versus goose fear with the goose first; (2) goose fear with the hawk first versus goose fear order goose first; (3) hawk first, hawk versus goose fear; (4) and goose first, hawk versus goose fear. Table 4.2 should facilitate conceptualization of the preceding comparisons. When major group divisions are ignored, significantly more fear was displayed to the hawk shape than to the goose shape when the hawk was presented first. With 40 df, a t of 2.347

Table 4.2. Schematic Representation for the Possible Comparisons with the Order Variable.

	ORDER	
	Hawk first	Goose first
Hawk fear	A	B
Goose fear	C	D

Comparisons

A vs B	A vs D	C vs D
A vs C	B vs C	B vs D

was obtained, which is significant beyond the .05 level. Under the same conditions, but with the goose shape being presented first, more fear was elicited by the goose shape. With 40 df, t = 2.392, which is significant beyond the .05 level. These, and other comparisons involving the order variable, are presented in Tables 4.3 and 4.4. Taking all groups together, there was no significant difference between hawk fear when the hawk came first and goose fear when the goose came first. Nor was there a significant difference between goose fear when the hawk came first and hawk fear when the goose came first. When Groups I, II, and III are taken individually, the same general results were obtained

Table 4.3. Summary of t-tests involving the Order Variable (all groups together).

Groups	Comparing	df	t	sign. level	Direction
All Groups	Order Goose first Hawk vs Goose fear	20	2.392	*	Goose fear
All Groups	Order Hawk first Hawk vs Goose fear	19	2.347	*	Hawk fear
All Groups	Hawk 1st Hawk fear vs Gs.1st Gs. fear	39	1.234	-	-
All Groups	Hwk.1st Goose fear vs Gs.1st Hawk fear	39	1.018	-	-

* = significant at .05 level

\- = not significant

with respect to the order variable. This will be seen with reference to Table 4.4. It will be noted, however, that in the case of the Isolate Group (Group I), the order variable was not significant with either order hawk or goose first.

Table 4.4. Summary of t-tests involving the Order Variable in Groups I, II, and III.

Groups	Comparing	df	t	sign. level	Direction
Group I	Order Goose first Hawk vs Goose fear	5	0.869	-	-
Group I	Order Hawk first Hawk vs Goose fear	5	0.657	-	-
Group I	Hwk.1st Goose fear vs. Gs.1st Hwk.fear	10	0.928	-	-
Group II	Order Goose first Hawk vs Goose fear	7	1.740	-	(see footnote)[6]
Group II	Order Hawk first Hawk vs Goose fear	7	2.596	*	Hawk fear
Group III	Order Goose first Hawk vs Goose fear	6	2.579	*	Goose fear
Group III	Order Hawk first Hawk vs Goose fear	5	3.558	**	Hawk fear
Group III	Hawk 1st.Gs. fear vs Gs.1st Hwk.fear	11	0.271	-	-

* = significant at .05 level

** = significant at .01 level

\- = not significant

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[6] This value becomes significant when only 1st 5 trials are counted.

This fact might be explained in light of the observation that the Isolates tended to display a high degree of fear throughout the entire thirty trials, whereas an habituation effect was noted in the case of the other groups after nine to ten trials. The habituation effect will be discussed in a later section of the paper, since it appeared to have important methodological implications. (See Appendix, Figures 7.5 and 7.6.)

The results of intergroup comparisons are presented in Table 4.5. These results indicate that the Isolates displayed a greater degree of fear to <u>both</u> the hawk and goose shapes than either the Group II (Group-raised) or Group III (Imprinted) subjects. When the Isolates were compared to the Group-raised subjects with respect to the degree of hawk fear, a t of 2.141 was obtained. With 26 df, this is significant at the .05 level. However, with a correction factor for heterogeneity of variance, there was no significant difference between these two groups in amount of hawk fear. Comparing the same two groups with respect to the degree of goose fear, a significant difference was obtained. With 26 df, t = 2.557, which is significant beyond the .05 level. When the Isolates were compared with Group III (Imprinted subjects) in the degree of fear elicited by the hawk stimulus, a t of 2.526 was obtained. With 23 df, this is significant beyond the .05 level. In comparing the degree of goose fear, using the same two groups, t = 2.557. With the same number of degrees of freedom, this is also significant beyond the .05 level. A comparison of the Group III-A (Imprinted to Hawk) and Group III-B (Imprinted to Goose) subjects revealed no significant difference with respect to either hawk or goose fear.

Table 4.5. Summary of Intergroup t-tests comparing Hawk and Goose Fear.

Groups Compared	Dependent Variable	df	t	sign. level	Direction
Grp.I vs Grp.II	Hawk fear	26	2.141	-	-
Grp.I vs Grp.II	Gse. fear	26	2.557	*	+ Grp. I
Grp.I vs Grp.III	Hawk fear	23	2.526	*	+ Grp. I
Grp.I vs Grp.III	Gse. fear	23	2.577	*	+ Grp. I
Grp.II vs Grp.III	Hawk fear	27	0.520	-	-
Grp.II vs Grp.III	Gse. fear	27	0.154	-	-
Grp.IIIA vs IIIB	Hawk fear	11	0.184	-	-
Grp.IIIA vs IIIB	Gse. fear	11	0.432	-	-

I = Isolates
II = Group-raised
IIIA = Imprinted to Hawk
IIIB = Imprinted to Goose

* = significant at the .05 level
** = significant at the .01 level
\- = not significant

The results of intergroup comparisons lead to the following conclusions: (1) The effect of isolation was to positively accentuate fear of both the hawk and goose stimuli; (2) prior experience with the model (either hawk or goose) did not result in differential fear behavior to the hawk versus goose stimuli. It would possibly be more correct to state the obverse of the first conclusion stated above. That is, familiarity with other birds tends to decrease the amount of fear elicited by both the hawk and goose shapes. This leads to a rejection of the second hypothesis (see page 13). A third conclusion, which supports the first hypothesis, is that the Isolates showed no less fear of the model in the goose position than when it was in the hawk position, although these subjects displayed more fear of both models than did the other two groups. The second conclusion stated above leads to a rejection of the eight hypothesis. That is, imprinting neonates to the silhouette (either hawk or goose) will not affect their reactions to the silhouette at a later period of time in development, as compared with subjects that were not imprinted. This statement, however, needs some qualification, since the imprinting experiment was not entirely successful.

It will be recalled from previous discussion that two measures were employed to determine the degree of imprinting occurring during the critical period. These measures were the number of runway sections traversed by the subject in pursuit of the model, and the number of seconds spent in pursuit during the first and last five-minute periods of each imprinting session. In addition, a coarse measure of fear was employed to note possible differences between the imprinted groups (III-A and III-B) with respect to this variable. Of the six subjects in Group III-A (hawk exposure), only three imprinted to the hawk shape, while three of the seven subjects in Group III-B (goose exposure) imprinted to the goose shape. Table 4.6 summarizes the t-tests comparing Groups III-A and III-B in degree of imprinting during the three imprinting sessions. No significant difference obtained between these two groups when either of the imprinting criteria are applied. This is further evidence for rejection of the eighth hypothesis (page 13). When fear behavior during the imprinting sessions was taken simply in terms of the presence or absence of fear during each five-minute recording period, no significant difference was found between Groups III-A and III-B. With 1 df, a chi square value of 0.101 was obtained, which is not significant at the .05 level.

Table 4.6. Imprinting Experiment: Comparison of Group III-A and Group III-B.

Groups	Dependent Variable	df	t	sign. level	Direction
III-A vs III-B	Runway Sections	11	0.721	-	-
III-A vs III-B	Seconds in Pursuit	11	0.672	-	-

- = not significant

The seventh hypothesis, that age of the subjects will make a difference in the degree of fear elicited by the model, was not adequately tested in the present study. In no group was the age variable found to be significant, but it is still uncertain as to the importance of this variable in the area under consideration in this study. A one-week age difference was perhaps insufficient for the purposes of the study. Extenuating circumstances, discussed elsewhere in this paper, were responsible for this limitation in design. Taking all Ss, irrespective of major group divisions, $t = 0.190$ at age 5 weeks between hawk and goose fear. With 21 df, this is not significant at the .05 level. Comparing hawk vs goose fear for the Ss at age 6 weeks, under the same conditions, $t = 0.234$. With 18 df, this value is not significant at the .05 level. A summary of further comparisons with the age variable will be found in the appendix to this paper. It will be noted that none of these comparisons resulted in a significant t value.

The results of interbreed comparisons are presented in Table 4.7. It was observed that the Muscovy subjects showed more fear of both the hawk and goose shapes than the White Pekings, and more fear of the hawk than was displayed by the Blacks. However, with <u>none</u> of the breeds was there a significant difference in the degree of fear elicited by the hawk versus goose stimuli. This data will be found in the appendix. The breed differences that did occur (see Table 4.7) were in the degree of fear displayed to both model shapes, and the qualitative fear behavior elicited by the silhouette was highly similar with all three breeds.

Table 4.7. Summary of t-tests comparing Breeds.

Groups Compared	Dependent Variable	df	t	sign. level	Direction
Black Ducks vs White Peking	Goose fear	30	1.569	-	-
Black Ducks vs Muscovy	Goose fear	25	1.547	-	-
White Peking vs Muscovy	Goose fear	19	2.990	**	+ Muscovy
Black Ducks vs White Peking	Hawk fear	30	0.822	-	-
Black Ducks vs Muscovy	Hawk fear	25	2.210	*	+ Muscovy
White Peking vs Muscovy	Hawk fear	19	2.588	*	+ Muscovy

* = significant at .05 level
** = significant at .01 level
\- = not significant

With respect to the fifth hypothesis (page 13), that significantly more fear will be elicited by the silhouette as it approaches than when it recedes, an analysis of the data revealed that more fear was displayed with the model in the approach position. Table 4.8 summarizes these results. At first glance these comparisons appear to be meaningless, but reference to an earlier section of this paper (page 27) might obviate this conclusion. It will be recalled that if subjects displayed fear responses only as the model approached, an A was placed in the appropriate spaces on the record sheet; B's were recorded if fear occurred only as the model receded; and C's signified that fear was displayed continuously (in positions A and B both). Since the shape of the stimulus is purportedly the crucial variable, it would appear that the line of vision should make a difference in the elicitation of fear. Perceptual constancy would be ruled out, since (at least in the case of the Isolates) prior experience with the model did not occur. It will be noted that

Table 4.8. Position of the Model and the Degree of Fear.

Comparison	df	t	significance level	Direction
Fear on A vs Fear on B	40	2.0940	*/	Fear on A
Fear on A vs Fear on C	40	10.3533	***	Fear on C

A = fear on approach <u>only</u> */ = significant at .025 level

B = fear when receding <u>only</u> ***= significant at .001 level

C = fear on both A and B

although the position of the model did make a difference in the degree of fear elicited, this was the case for both the hawk and goose model. By reference to Table 4.8, it is also evident that significantly more fear was displayed by the subjects with the model in both the approach and receding positions than in either position alone. With 40 df, t = 10.3533, which is significant beyond the .001 level.

An incidental finding, mentioned earlier in this section, was that there occurred an habituation effect to the model after the first nine to ten trials. This phenomena was also noted by previous investigators (20, 28), although under somewhat different conditions. The habituation effect was less pronounced in the case of the Isolates, however. This group of subjects tended to display fear throughout the entire thirty trials. Figures 7.1 and 7.2 in the appendix to this paper graphically represent this trend. The habituation effect is discussed further in terms of methodology in the next section of this paper. No attempt was made, however, to analyze these results in terms of trend analysis.

Observations subsequent to the experiment proper suggest that strange, or unfamiliar stimuli, elicited as much fear as the hawk-goose model had during the experiment. When objects such as gloves, and pieces of wood and paper, were passed overhead they elicited much fear behavior. Furthermore, the subjects appeared to display much more fear behavior as the experimenter approached to remove them from the runway than they had previously shown to either the hawk or goose shapes. The latter observation would seem to indicate that the experimenter's social stimulus value is in need of investigation.

It was also observed, subsequent to the experiment proper, that the Isolates were unable to form social relationships with other birds, and that they manifested generalized fear to even the most subtle movement or noise. They were afraid, in effect, of strange or unfamiliar stimuli, and in light of their previous isolation almost any stimulus would appear strange.

Results in Relation to Hypotheses

In light of the preceding results, and with reference to the hypotheses stated earlier (page 13), the conclusions to be drawn from the present study are as follows:

1. The first hypothesis is supported, since the subjects raised in isolation showed no less fear of the model when it was in the goose position than when it was in the hawk position.
2. The second hypothesis is rejected, since there was a significant difference in the degree of fear shown to the model between the group-raised and isolated birds, both with respect to hawk and goose fear.
3. The third hypothesis is supported, since order of stimulus presentation (hawk-goose versus goose-hawk) made a

difference in the degree of fear elicited by the silhouette.

4. The results also lead to support of the fourth hypothesis. With order counterbalanced, in no group was there a significant difference between the degree of fear shown to the hawk and the degree of fear shown to the goose stimulus.

5. With respect to the fifth hypothesis, the subjects showed a greater degree of fear when the model was approaching than when it was receding, although more fear was elicited with the model in the C position (approach and receding) than in either the approach or receding position alone. This supports the fifth hypothesis.

6. The sixth hypothesis is not rejected. It was hypothesized that, during the critical period of 12 to 24 hours following hatching, the subjects will imprint as readily to the model in the hawk position as they will to the model in the goose position. This aspect of the study, however, tended to be lacking in several respects (see discussion section.

7. The results lead to a rejection of the seventh hypothesis, in that the age variable was found to be insignificant. This is discussed in a later section of the paper in terms of the methodology.

8. Hypothesis eight is rejected, since imprinting neonates to the silhouette (either hawk or goose shape) had no apparent effect upon their reactions to the model at a later period

of development, as compared with subjects that were not imprinted.

The following five points evolve from a consideration of the results:

1. The subjects displayed no differential fear behavior to the hawk versus goose stimuli under the conditions of the study.
2. Prior experience with the model does not effect the alleged tendency to display differential fear behavior to the hawk and goose shapes.
3. Order of stimulus presentation is a significant factor, seemingly responsible for differential fear behavior to the two stimulus shapes.
4. Familiarity with own breed (or species) made a difference in the degree of fear elicited by the model.
5. Habituation to the fear stimuli occurs after repeated exposure.

These results are not consistent with those of previous studies, especially the studies by Tinbergen (44) and Melzack (28). Possible explanations for this inconsistency are offered in the following section of the paper.

CHAPTER V

DISCUSSION

Methodological Considerations

This section of the paper will deal with certain methodological aspects of the study, in light of the questions posed earlier in the introduction, and in light of the results described in the preceding section.

It was pointed out in the introduction that various investigators obtained different results in their studies of the Tinbergen hypothesis. Several possible explanations were mentioned which might account for such differences. One of these explanations pertained to the difference in choice of setting, the laboratory versus the barnyard (20). It will be recalled that the experimental setting is a major point of disagreement between the experimental psychologist and the ethologist. Whereas, Hirsch et al. (20) criticized previous studies by the ethologists on the grounds that they lacked important controls, Lorenz (27) argued that laboratory animals often become unhealthy and display stereotyped behavior. Hess (18) suggested that studies of this kind should perhaps be conducted in both an indoor and an outdoor setting. This investigator then emphasized the importance of experimental controls, and implied that such controls are difficult to achieve in an outdoor setting.

In response to the criticism by Lorenz (27) that laboratory animals tend to be unhealthy, and consequently manifest stereotyped behavior, this investigator only wishes that Monsieur Lorenz had been present to observe the healthy specimens employed in the study. However, in accord with the Lorenz argument, some minor atypical behavior was observed in the group-raised subjects. These subjects were at first unable to eat coarse food such as pellets, since they were raised on concentrated mash, but eventually learned to eat food of a coarser variety. Apart from this minor behavioral deviation, the subjects in Groups II and III (group-raised) appeared to be quite normal. As was expected, the subjects raised in complete isolation displayed atypical behavior. But this was the intent of the investigator, to employ subjects who were naive, not imprinted, lacking experience either with other birds or with moving objects of any kind, and by definition "atypical".

A second possible reason for differences in obtained results between earlier studies has to do with the question of species differences. Lorenz (27) and Hess (18) both felt that the conclusions derived from the studies by Hirsch (20) and Rockett (37) were meaningless, because different species were employed from those used in earlier studies. They believed that consistent results can be obtained only if subjects of the same species are employed. With deference to Lorenz and Hess, this investigator wishes to mention two points which tend to weaken the argument concerning species differences. The first of these is that even though the present study employed species of ducks which were highly similar to those employed by Melzack (28), the results of this study are discordant with those obtained by Melzack. This part of the argument is, of course, weak, since differences in results might be due to still other differences in methodology (as will be discussed subsequently). However, the basic differences occurring between breeds used in the present study appear to be primarily of a quantitative rather than a qualitative nature, and this is the second point which might weaken the species difference argument. The results of the present study indicate that none of the breeds employed were able to discriminate shape in relation to direction of movement, and in this sense all breeds were similar. Secondly, the qualitative behavior displayed in the presence of the moving overhead model was highly similar from one group to the next. The breed difference that did occur was in the <u>degree</u> of fear displayed, or in the frequency of fear responses elicited by each breed to <u>both</u> stimulus shapes. In light of these considerations, this investigator believes that the argument concerning species differences was possibly overstated by the ethologists, although their argument has much merit if not carried to an absurd extreme. The recognition of species differences is obviously important in research, especially if one is to make generalizations concerning the behavior of other species. But Lorenz, in criticizing the Hirsch and Rockett studies, carries the obverse of his argument to an extreme. In reference to the Hirsch conclusions, Lorenz argues that

> it is just as meaningful as if Dr. Somebody had demonstrated the presence of dark pigments in the hair of wild common hamsters and if someone else were to write that the Somebody theory that there are dark pigments in the fur of wild hamsters has been tested on white laboratory rats and found untenable under strict laboratory conditions. (18:224-225)

In the preceding analogy, an allusion is made to the effect that structural and behavioral differences are one and the same. To say that one species behaves differently than another species in a certain situation is not the same as the statement that one species differs from another structurally. Behavioral differences may result, and obviously do in many instances, from physical differences. But it appears fallacious to conclude that structure is synonymous with function, which is an implicit conclusion in Lorenz's argument above. Suffice it is to say that species similarities accrue as we become more knowledgeable, and these similarities are easily overlooked. When the investigator becomes too involved in breed and sub-breed differences ad extremum, he tends to lose perspective.

In the initial design of this study the investigator planned to employ several other species of birds in order that the question of species differences might be answered. However, as previously mentioned, seasonal difficulties and mechanical failure limited this possibility.

A third methodological consideration relating to differences in results between studies is the manner in which the investigator determines the presence or absence of fear. With respect to the criteria for fear there appears to be similarity between the various studies, and the fear criteria selected are practically the same in each of these studies. An important difference, however, might occur if weighted scores were used in one study and not in another. In the present study all criteria were given equal weight when the data were analyzed, with double weight accorded to each response if elicited both as the model approached and receded. An alternate approach would be to allow more weight to specific criteria which might be judged as more "fear-like", as for example running to shelter (which is actually a *series* of fear responses directed toward a goal). The question is, however, how much weight the so-called "more fear-like" criteria should have. We are defining fear operationally, and consistent results require uniformity in the method of quantification, and in the method by which we record the fear behavior.

A further consideration specific to this study, is whether or not to incorporate the data from all 15 trials in the statistical analysis. Since Hirsch et al. (20) found that the fear behavior extinguished after ten to twelve trials, and the results of the present study suggest the same trend, it might possibly be that such a procedure would mask differences which might otherwise have occurred, or perhaps diminish the significance of variables recognized as being important from the statistical analysis. The important question, then, is whether or not a change in this particular procedure, say by counting only the first five trials (where the most fear occurred), would make a difference in the decision to retain or reject a given hypothesis.

Table 5.1 represents a summary of the statistical analyses based upon the data procured from only the first five trials, compared with the analyses based upon the data of 15 trials. It will be noted that merely a few of the possible comparisons are presented and that in two cases the change in recording procedure did make a difference in decision. In Group II, with order Goose 1st, a change in decision from acceptance to rejection of the null hypothesis resulted with a change in procedure. The second difference in decision occurred with Group I, where the null was initially accepted, because heterogeneity of variance lowered the value of the obtained t-score when a correction was applied. Actually, these supplementary tests did not effect the results in any substantial way.

Table 5.1. Data from first 5 trials vs data from all 15 trials.

GROUPS	VARIABLES		df	Data from all 15 trials		Data from 1st 5 trials		Difference in decision
	Independent	Dependent		t	sign.	t	sign.	
All Gps.	balanced order	goose vs hawk fear	40	0.051	p>.05	0.054	p>.05	no
All Gps.	hawk 1st hawk fear vs gse. 1st gse. fear		39	1.243	p>.05	1.314	p>.05	no
All Gps.	goose 1st hawk fear vs hawk 1st goose fear		39	1.081	p>.05	0.260	p>.05	no
Group II	goose 1st order	goose vs hawk fear	7	1.740	p>.05	2.469	p<.05	yes
Group I	goose 1st hawk fear vs hawk 1st goose fear		10	0.928	p>.05	0.556	p>.05	no
Grp. I vs Group II	familiarity	hawk fear	26	2.141	p>.05	3.401	p<.01	yes
Grp. I vs Group II	familiarity	gse. fear	26	2.557	p<.05	2.389	p<.05	no

The method of stimulus presentation might well affect the results of the study. In the Hirsch study, the silhouette was pulled overhead on a string track at a height of 105 inches, remaining exposed from 1½ to 2 seconds (20:279). The model was made to pass over the runway once each minute during a four-minute period, alternating the shape (hawk-goose) on each successive trial. Thus, each animal was exposed to each stimulus shape two times, with a 58 second interval between trials. A large light bulb was suspended from the ceiling, directly above the runway, to produce shadow conditions. The Hirsch study was conducted in the laboratory. Melzack (28) conducted his first studies at the London Zoo, presenting the model at a height of approximately 7 feet above the runway floor by suspending it from a large horizontal metal bar, which was propelled in a circular path by means of an electric motor. This study was conducted in an outdoor setting. In the present study, the model was presented at a height of 85 inches above the floor of a circular runway, suspended from an extremely thin horizontal rod with 2 lb. test line (transparent). No observers were present in the testing situation, as they were in the preceding studies.

A possible criticism of this study might be raised concerning the fact that only one observer, namely the experimenter himself, was present to record the subjects' behavior, and that this procedure is less than objective. This investigator would beg to differ, lest someone pose the criticism, since both his design and integrity are at stake. The criteria for fear were specified prior to running the experiment, and it was simply a matter of observing whether each subject did or did not display behavior which fit the given criteria. The observer did not shift his attention for a moment during each test, and the method of taped recording data facilitated closer observation of each subject's behavior, since no time was spent during observation recording data on paper. With several subjects, a second observer was employed to note the extent of agreement in recording. Negligible disagreement occurred, to the satisfaction of the investigator.

A further consideration, discussed at length by both Hess (18) and Lehrman (24), pertains to the limitations of the so-called "isolation experiment". This point merits discussion because the present study employed the isolation technique as a crucial part of the design. It will first be pointed out that the isolation experiment has been a favorite with ethologists for some time, and many of their theories are based on the results of such studies. Lehrman (24), in his critique of Lorenz's theory, poses the following question: "What, then is wrong with the implication of the isolation experiment, that behavior developed in isolation may be considered innate if the animal did not practice it specifically?" He then points out that the ethologists repeatedly refer to behavior as being innate if it is displayed by animals raised in isolation. Lehrman says:

> It must be realized that an animal raised in isolation from fellow-members of his species is not necessarily isolated from the effect of processes and events which contribute to the development of any particular behavior pattern. The important question is not 'Is the animal isolated?' but '<u>From</u> <u>what</u> is the animal isolated?' The isolation experiment, if the conditions are well analyzed, provides at best a negative indication that certain specified environmental factors probably are not directly involved in the genesis of a particular behavior. However, the isolation experiment by its very nature does not give a positive indication that behavior is 'innate' or indeed any information at all about what the process of development of the behavior really consists of. (24:343)

A somewhat different point of view is maintained by Hess (18) in his discussion of the isolation experiment, as will be observed in the following quotation.

> The only positive conclusions that can be drawn from the results of a deprivation experiment is that certain behavior elements are <u>not</u> learned, since if an animal is deprived of information regarding the situation to which the behavior pattern is adapted and yet the behavior pattern is executed on the very first exposure to the appropriate situation, then this behavior pattern must be innate. In such a case, we can assert with confidence that the behavior pattern is not learned. (18:219)

Obviously there is certain disagreement between the two authors in the preceding arguments. On the one hand, Lehrman tells us that we cannot legitimately conclude that a behavior is innate on the basis of a deprivation experiment, while Hess asserts that we can positively conclude that a behavior is not learned, and therefore the behavior must be innate. The present investigator is more sympathetic with Lehrman's argument, that the isolation experiment merely provides a negative indication that certain environmental factors are involved in the development of a particular behavior. This investigator also agrees with a second argument expressed by Lehrman (24), namely, that little is gained by dichotomizing behavior into the categories "learned" versus "innate". Lehrman suggests that Tinbergen and Lorenz have tended to categorize certain behaviors as "innate" (preformed, immanent, inherited, based on neural structures) as though the term represented a "solution" to the question concerning the genesis of these behaviors. "Any such theory of 'instinct' inevitably tends to short-circuit the scientist's investigation of intra-organic and organism-environment developmental relationships which underlie the development of 'instinctive' behavior." (24:359) He then points to numerous instances in which behavior patterns were classified as "innate", but later found to involve learning.

The question which now arises is how the preceding discussion affects the interpretation of the results in the present study. In light of the Hess argument, we certainly could not conclude that the ability to discriminate shape (hawk versus goose) is innate, since even the isolated subjects were unable to discriminate between the two forms, and only differences in degree of fear were noted between the isolates and group-raised subjects. If the results had indicated differential fear behavior on the part of the isolates, then Hess could conclude that the fear behavior was not the result of learning, and consequently the "ability to discriminate" would be classified as innate. Assuming the same hypothetical results, Lehrman might ask, "From what were these animals isolated?" He would not conclude that the behavior (fear of hawk only) was innate, since he believes this to be a misleading categorization. It is relatively easy, as Lehrman points out, to discover behavior which may be classified as "innate" (by the more prevelent definitions of innateness), but the investigator would be better off trying to discover the causal determinants of the behavior so classified.

In response to the question "From what were the subjects isolated?", a perusal of the design and procedure of the present study would give an answer. The most evident variables from which the Group I subjects were isolated include experience with moving objects of any kind (except perhaps themselves) or with shadows (since the laboratory lighting eliminated shadows), and familiarity with other birds. These are at least some of the variables not experienced by the isolates, and which were experienced by the group-raised subjects. More subtle variables might have been present, but their identification would be decidedly more difficult. But the question really loses its significance when applied to the obtained results of this study. There is really no point in asking what variables are responsible for the instinctive act (fear of hawk), since the alleged differential fear behavior was not observed, unless the behavior under consideration did not appear due to methodological reasons. Several of the possible reasons have been discussed previously and several more will be discussed subsequently. It might be well now to consider several points mentioned by Hess (18).

One of these points has already been discussed previously (and at some length) in this section of the paper, namely the Lorenz argument concerning the alleged ill-health of laboratory animals. After posing the argument, Hess (18:221) states that:

> . . . even though a deprived animal's health is optimal, he may still not perform the behavior pattern in question simply because it has not been exercised, and as a result some atrophy, similar to that in muscles when they are not used, may have taken place.

An analogy, which Hess states "is particularly apt in making this point clear" (18:221) is then made to the rusty lock that will not open with its key after prolonged disuse.

Because the key does not open the lock this does not mean that the lock needs to "learn" to turn, but simply that it must be put into the necessary physical condition in order to turn when the key is inserted. This investigator wishes to make an equally fallacious analogy with a hypothetical case, in which the results of an experiment failed to support the hypothesis that dogs can fly. Following Hess's logic, we might be led to believe that the dogs were unable to fly because they had no opportunity to display their flying skill prior to their use in the experiment. Needless to say, the Hess argument is at best a poor analogy, and appears to this investigator as a "short circuit" to further scientific inquiry.

A third point made by Hess is that ". . . the stimulus situation in which the animal is tested may not be optimal for releasing the behavior pattern in question." (18:123) To check this possibility, Hess suggests that laboratory animals be placed in a normal environment and "normally reared" animals be placed in the experimental test situation. This suggestion appears reasonable, but to a limited extent. Two questions might be raised. First of all, what is the investigator to conclude if the "normally reared" Ss displayed fear while the experimental Ss did not (or for that matter visa versa)? One would first need to know what Hess means by the term "normally reared". If a normally reared animal is one raised in the barnyard, under decidedly uncontrolled conditions (where the subject has experience with numerous unknown objects and situations) then on what basis does one make the comparison between the laboratory-raised and "normally reared" animals? We would be no better off than when we had begun. The second question is this: Do these animals only discriminate form (hawk vs goose) in certain situations and not in others?" What, in effect, does Hess mean by the terms "optimal stimulus situation"? It would appear that in the barnyard, where there is a myriad of extraneous stimuli, the animals might have more difficulty recognizing the so-called "sign stimuli" than they would in a more restricted laboratory situation. In the barnyard there may be a dozen possible fear-producing stimuli, and the investigator might be hard-pressed to identify the crucial ones in such a situation.

It was noted in the introduction to this paper that previous investigators (e. g. Hirsch and Rockett) had found such variables as the size and rate of movement of the model, the presence or absence of a shadow, previous experience, and living conditions (wild vs. domesticated) to be significant in eliciting fear-like behavior. Only one of these five variables was examined in the present study, that of previous experience with the model. Practical considerations limited the number of independent variables to be studied, since the design became somewhat complex, and limited laboratory space disallowed an increase in the number of subjects which would have been necessary if more variables had been included. The omission of the other four variables listed above should not be taken to mean that this investigator felt them to be any less important. On the contrary, these variables may be quite significant in the production of fearfulness, but still other variables were thought to be worthy of study. The final decision as to which variables to include in the design was based, in part at least, on the fact that previous studies had neglected to consider certain ones which might also be important. These variables were, in addition to previous experience, the age of the birds, the order of stimulus presentation (hawk first vs. goose first), imprintability to both shapes, and lack of experience with either members of own species or moving objects and shadows. In light of the methodology employed in the present study, it would be well to consider two of these variables in more detail. These are age and imprintability.

There is serious question that an age difference of one week was large enough to justify the conclusion that age was not a significant variable in the study. Such a conclusion might possibly be derived from the results upon credulous inspection, but this conclusion would be spurious. To test the hypothesis that age is related to the alleged discriminating ability of the birds, it would be necessary to test subjects at several different age levels, preferably at regular intervals from birth to maturity. The initial design of this study did, however, call for tests at varying ages from three to seven weeks, but the experimenter was obliged to terminate the study earlier than was anticipated. There was much ado concerning the offensive odor which emanated from the laboratory, and the crescendo of protests brought the study to a premature conclusion. The design was modified accordingly with respect to the age variable.

In one sense, at least, the imprinting experiment was not entirely successful. Thirteen subjects were exposed to the silhouette during the critical period, six to the hawk shape and seven to the goose shape, but only six subjects showed overt signs of being imprinted. Three subjects definitely imprinted to the hawk shape, while three imprinted to the goose shape. This fact makes it difficult to extrapolate from the data with respect to the hypothesis about the relative imprintability of the subjects to the hawk vs. goose shape. The conclusion that the subjects imprinted to the hawk as readily as they did to the goose, although valid, remains somewhat tenuous. Even so, the fact that these subjects were "exposed" to the Tinbergen model for prolonged periods of time during a critical period of development, should merit consideration. One could only hypothesize what effect this exposure might have had. It apparently did not affect the differential fear behavior to the two stimulus shapes, since the results indicate no difference between Groups III-A and III-B in either fear of hawk or fear of goose, and there was no observed difference between Groups II and III in this respect. It would be conservative to conclude that early experience with the model during a critical period in the lives of these birds had no observed effect, either on differential fear to the stimulus shapes, or with respect to the degree of fear displayed to either shape.

The discussion has thus far been concerned with methodological considerations of the study, dealing with possible limitations of design and procedure, and with some of the arguments posed by other authors. Considered in the preceding pages were the questions of experimental setting, health of the subjects, species differences, the method of recording and interpreting fear behavior, method of stimulus presentation, the number of observers, the limitations of the "isolation experiment", the "optimal stimulus situation", atrophy due to disuse, the choice of variables for study, the variable of age, and the success of the imprinting experiment.

The following section of the paper will outline the ethologists' theory of instinctive behavior, mentioned briefly in the introduction, and criticisms of this theory will be mentioned.

Theoretical Considerations

Instinct, as a psychological concept, was quite popular prior to the 1930's as a means of explanation of behavioral processes. Following experiments by Kuo (23), Dunlap (46), and others, there appeared an anti-instinct movement in psychology which was greatly influenced by the Behavioristic trend (46). During the 1930's, instinct theories such as McDougall's fell into disrepute. Recently, however, the theories of a group of European zoologists, known as the ethologists, have come to the attention of psychologists in this country, and interest in instinct as an explanatory concept has been revived.

In the following pages the essential characteristics of instinct theories will be presented, and an attempt will be made to point out some of the difficulties inherent in this approach. The instinct theory with which we shall deal is that advocated by the ethologists. The ethologists, as a theoretical camp, are not in complete agreement among themselves on many issues, and for this reason the term "ethological theory" has numerous connotations. It will not be the purpose in this section of the paper to present a thorough analysis of the various theoretical points of view maintained by each member of this camp, but rather we will be concerned more with the Lorenz-Tinbergen theory of instinctive behavior, since these two zoologists are generally considered to be the spokesmen for ethology (18). Furthermore, the present study was designed specifically to test one of the theoretical constructs in Tinbergen's theory, and consequently it is this theory with which we are primarily concerned. Many of the criticisms to be presented, however, would apply to instinct theories in general.

In the introductory section of this paper it was stated that Tinbergen (44) and Lorenz (25) believe that much of the behavior of lower organisms is a consequence of instinctive "response tendencies", which are "released" by specific "sign stimuli" in the animal's immediate environment. One of the most familiar (notorious, to the present author) examples of such instinctive behavior, which was thought to be initiated by a sign stimulus, is the alleged fear behavior of certain species of birds to a predatory hawk (44). Further examples are numerous in the writings of both Tinbergen (43, 44, 45) and Lorenz (25, 26, 27), as well as in other sources (18, 24, 29, 46). In more technical terms, the Lorenz - Tinbergen theory states that specific sign stimuli (discriminative stimuli) initiate "innate releasing patterns". An innate releasing pattern is described as "the innately determined readiness of an organism to respond to a particular combination of external stimuli with a particular behavior". (24:339)

Lorenz asserts that any given pattern of behavior has as a crucial component an instinctive act, which is thought of as a "rigidly determined stereotyped innate movement or movement pattern based on the activity of a specific coordinating center in the central nervous system". (24:338) As an extension of the Lorenz theory, Tinbergen (45) hypothesizes two mechanisms to explain instinctive behavior. One of these mechanisms purportedly accumulates nervous energy during a period of disuse. The energy stored by this coordinating center is normally held under inhibition by a second center, called the "innate releasing mechanism" or IRM, except in the presence of a specific pattern of external stimulation (sign stimulus). In the case of the alleged innate fear of a predatory hawk, the sign stimulus was hypothesized to be the shape (position of wings with reference to head and tail) and direction of movement. Tinbergen (44) asserted that the effect of an external stimulus which elicits the instinctive act (fear behavior) is to release the IRM from its inhibition. It has been observed by the ethologists, however, that the instinctive act will apparently occur without the presence of a sign stimulus. When energy is released from the instinctive center without the presence of an appropriate pattern of stimulation, the ethologists refer to such a phenomena as "vacuum activity". Tinbergen (44) hypothesized that, under these circumstances, the accumulated energy builds up to such an extent that the inhibitory center is unable to prevent its release.

Tinbergen (24, 43, 44) defines an instinctive act as a highly stereotyped, coordinated movement, the neuromotor apparatus of which belongs to the hereditary constitution of the animal; it is genetically determined. Lehrman (24), on the basis of the preceding definition, states:

> It is apparent that Lorenz and Tinbergen regard as the major criteria of innateness that: (1) behavior is stereotyped and constant in form; (2) it be characteristic of the species; (3) it appear in animals which have been raised in isolation from others; (4) it develop fully-formed in animals which have been prevented from practicing it. (24:341)

One of the principle objections to the ethologists' approach is the fact that they tend to dichotomize behavior into the categories of "innate vs learned" or "learned vs maturational". This fact was discussed in the first half of the present section of the paper, and several criticisms were mentioned. Behavior is said to be innate, according to the ethologists' if it meets the criteria which were presented above. Lehrman (24) and others (4, 46) point out, and validly, that many behavior patterns fit these criteria, but this does not mean that the ethologists' interpretation of these patterns as innate offers genuine aid to a scientific understanding of the determinants underlying them. Beach (2) argued that the distinction between instinctive behavior and learned behavior is not helpful in the experimental analysis of animal activities. He points out that various patterns of response have been grouped together under the rubic of instinct because they have been "arbitrarily excluded" from a rather narrowly conceived category called learned behavior, and not because they share any positive characteristics (46). For example, the pecking behavior of a newly hatched chick and the nest-building behavior of the rat both meet the criteria of "innateness", but this categorization offers us little in the way of a scientific explanation. When these behaviors were studied more extensively (23, 46) it was discovered that they could be "explained" in terms of learning (conditioning) and environmental factors (even prior to birth). These two patterns of behavior, both classified as innate, differ with respect to embryonic origin, developmental history, and species in which they occur. To describe them as innate offers little in the way of explanation, and may (if accepted as an explanation) short-circuit further scientific inquiry.

It is obvious that Lorenz and Tinbergen employ instinct as an explanatory concept. Young (46) argues that we should retain the concept in psychology as a descriptive concept, but not as an explanatory concept.

> If we drop the term instinct, we must then find another word to label those remarkably complex patterns of behavior that develop uniformly in

> the members of a species. The term is useful as a descriptive label but it does not explain anything. (46:71)

Beach (2) believes that the so-called instincts do not belong together in a single category. He states that the term instinct might profitably be dropped from our vocabulary in psychology. This investigator is sympathetic with this contention, and agrees with Beach that instead of explaining by words, we could better study (as he has) concrete instances of behavior and examine the antecedent conditions which bring it about. As Young (46) points out, the "drive" concept has largely replaced "instinct" as a means of explaining behavior, yet some psychologists (e.g. Skinner) would now abandon the term "drive". An analysis of the drive concept would perhaps be pertinent at this point, but it is not a digression which we will follow, since it might lead us too far afield.

Tinbergen and Lorenz use the concept of maturation, but not, according to Lehrman (24), as a reference to a process of development; they seem to ignore the process of development. It is misleading to dichotomize behavior, as the ethologists do, into the categories of "learned versus maturational". "The effects of structural factors differ, not only from component to component of the pattern, but also from developmental stage to developmental stage." (24:344) The organism does not, as is often said, develop out of an interaction between heredity and environment. It is important to note that this development results from an interaction between the <u>organism</u> and its environment. Furthermore, the organism is different at each developmental stage.

> To say of a behavior that it develops by maturation is tanamount to saying that the obvious forms of learning do not influence it, and that we therefore do not consider it necessary to investigate its ontogeny further. (24:345)

Lorenz and Tinbergen believe that differences in learning capacity between species are due to "gaps" in the chain of innate behavior, or as a function of "the richness of the animal's instinctive equipment". (24:347) Any given component of behavior is considered to be either "innate" or "not innate". The criteria of innateness were previously stated. But behavior classified by <u>any</u> criteria as innate do not necessarily fall into the same category with respect to either embryonic origin, developmental history, or level of organization. This obvious fact is overlooked by the ethologists when they attempt to dichotomize behavior into the mutually exclusive categories of "innate" and "learned". (24:347)

The ethologists do not, according to Hess (18), deny the importance of learning in many patterns of behavior, and have in fact discussed the interlacing of innate and learned elements of behavior. It is well worth pointing out, however, that the investigator's theoretical orientation gives direction both to his methodology and the manner in which he interprets his experimental results. When the investigator is religiously committed to a particular theoretical point of view, theory can be a handicap. This is not only true of the ethologists but of other theorists as well. The brief history of learning theory provides examples, even though such dedication to theory proved fruitful in terms of the quantity of research. Lehrman (24) discusses several ethological investigations where behavior was described as being "innate", and explained in terms of the Lorenz-Tinbergen theory, but where obvious forms of learning were overlooked. For example, from the original protocols, Lehrman shows that classical conditioning occurred in Tinbergen's investigation of the gaping response in the young thrush. No attempt, however, was made by Tinbergen to interpret the neonates' behavior in terms of learning, even though such an interpretation would be justified on the basis of his observations.

In the preceding section of this paper an allusion was made to the effect that Lorenz (and Tinbergen) believes that behavior having similar functional characteristics must be caused by identical neural mechanisms. This is to say that the neural events underlying behavior are somehow isomorphic with the behavior pattern itself. Support for this view is suggested by the recent experiments on brain stimulation, although the ethologists have relied primarily on argument by analogy to develop their theory. This writer will not attempt a survey of the research on brain stimulation, but feels that this method of inquiry might prove fruitful as a more direct test of the various constructs found in the Lorenz-Tinbergen theory. Lehrman (24), however, believes differently, and cites the early work of Hess on brain stimulation to illustrate his argument.

> In the light of Hess's work there is no doubt that the lower-level details and components of many behavior patterns are coordinated and integrated in the hypothalamus. But it is difficult to see how the shifting locus of this integration can be reconciled with the conception of a center which produces an excitation specific for the behavior pattern concerned. (24:350)

Lehrman finds it difficult also to reconcile the view that the function of a center for an instinctive act depends upon afferent stimulation (from a sign stimulus) with the notion that the center is a place where energy is produced for a particular kind of act. (24:350)

Tinbergen (44) has attempted, on the basis of argument by analogy, to explain the behavior of higher organisms, including humans, in terms of his theory of instinctive behavior. His position seems to be that his theory of animal behavior is basically sound, and since there appear to be many similarities between the behavior of the lower organism and man, at least in an analogical sense, man's behavior may be explained in part by his theory. The ethologists make use of the analogy quite freely, and it has apparently become one of their favorite tools in exposition. This investigator objects to the fallacious nature of this approach for obvious reasons. In the first place, the assumption of analagous behavior-function relationships at various levels of organization is gratuitous. Psychologists have often shifted from one level of organization to another in an attempt to explain behavior, as, for example, when psychologists extrapolate from the results of experiments on rats to explain the behavior of humans. In some cases at least, however, the experimental psychologist has attempted to support this sort of reasoning, where possible, with studies at the human level. Tinbergen, on the other hand, has assumed the role of an "armchair psychologist", and has made no attempt to substantiate his beliefs with experimentation at the human level. When the zoologist assumes the role of the psychologist of human behavior and enters the psychologist's domain as a self-proclaimed authority, someone is certain to object. One of Lehrman's basic criticisms of the Lorenz-Tinbergen theory is that it habitually depends upon the transference of concepts from one level to another, solely on the basis of analogical reasoning. (24:359) Argument by analogy is often a useful tool in debates, but to rely solely on analogy as a means of scientific explanation is obviously unsound.

It might be argued that the ethologists do not rely only on such forms of reasoning to support their beliefs, but that they also employ a "rigorous" method of experimentation to test the constructs in their theories. Hess (18) contends that this is the case. Methodology has been discussed elsewhere in this paper, and criticisms of the ethologist's methods were presented. This investigator maintains that the methodology employed by the ethologists, at least in many of the instances noted from a perusal of the literature, are inadequate. The control which is so necessary to a logical analysis of the data has been found to be lacking (24). With naturalistic observation, the approach employed by Tinbergen and Lorenz, it is difficult, and often impossible, to identify the relevant variables which are the determinants of the behavior being studied. To identify the variables which are the determinants of behavior is the principle function of a behavioral science. (44)

This author concludes that the ultimate test of ethological theory will be found only in well-controlled laboratory studies, perhaps in the experiments on brain stimulation, and unless this fact is realized by the psychologists who accept the ethologists' findings, and by the ethologists themselves, much damage may be done in the way of application of false principles and in terms of needlessly expended effort.

SUMMARY

The present study was designed to test the hypothesis, stated by Tinbergen (44), that shape in relation to direction of movement is a specific sign stimulus for fear in certain species of birds. A model, which resembles a hawk when flown in one direction and a goose when flown in the opposite direction, is the alleged sign stimulus considered in this study.

Forty five subjects, including White Peking, Muscovy, and Black Ducks, were divided into three groups for differential treatment. The various breeds were fairly evenly distributed between the three treatment groups. The variables under investigation included: (1) shape of model in relation to the direction of movement; (2) familiarity with own species; (3) prior experience with the model; (4) age of subjects; (5) the position of the model when fear is displayed; (6) and relative imprintability of the subjects to the hawk versus goose shapes.

The results of this study do not support the Tinbergen hypothesis. Order of stimulus presentation was the only significant variable, and apparently is responsible for the alleged differential fear behavior to the stimulus shapes. With order counterbalanced, in no group was there a significant difference between the degree of hawk and goose fear. The conclusion is that the Tinbergen hypothesis is untenable

under controlled laboratory conditions.

Included in the present study is a review of the literature. The results are discussed in light of previous studies in a later section of the paper.

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TABLE 7.1 Summary data showing means and standard deviations for subjects in all groups combined.

VARIABLES				
Independent	Dependent	N	Standard Deviation	Mean
Order H 1st.	Hawk fear	20	25.12	49.60
Order G 1st.	Goose "	21	27.80	39.33
Order H 1st.	Goose "	20	30.30	28.95
Order G 1st.	Hawk fear	21	23.60	20.29
All vrbles.*	Hawk fear	41	28.25	34.59
All vrbles.	Goose "	41	29.15	34.27
Age 5 wks.	Hawk fear	22	10.00	33.55
Age 6 wks.	Hawk fear	19	24.59	35.79
Age 5 wks.	Goose "	22	28.42	34.77
Age 6 wks.	Goose "	19	30.75	33.68
5wk. H 1st.	Hawk fear	9	29.61	58.66
5wk. H 1st.	Goose "	9	34.00	35.66
5wk. G 1st.	Hawk fear	13	19.08	16.15
5wk. G 1st.	Goose "	13	24.58	34.16
6wk. H 1st.	Hawk fear	11	19.05	42.18
6wk. H 1st.	Goose "	11	26.43	23.45
6wk. G 1st.	Hawk fear	8	29.73	27.00
6wk. G 1st.	Goose "	8	32.05	47.75

*Order counterbalanced.

TABLE 7.2 Summary data showing the means and standard deviations for the Imprinted Group (Group III).

VARIABLES				
Independent	Dependent	N	Standard Deviation	Mean
3-A*	Hawk fear	6	21.59	22.00
3-A	Goose "	6	15.07	22.00
3-B**	Hawk fear	7	22.52	24.57
3-B	Goose "	7	24.74	26.86
Order H 1st	Hawk fear	6	8.78	43.00
Order G 1st	Goose "	7	22.63	31.00
Order H 1st	Goose "	6	15.46	17.17
Order G 1st	Hawk fear	7	10.95	6.50
Blncd.Order	Hawk fear	13	21.19	23.38
Blncd.Order	Goose "	13	20.17	24.62

* = Imprinted to Hawk (Group 3-A)
**= Imprinted to Goose (Group 3-B)

TABLE 7.3 Summary data showing the means and standard deviations for the Isolated Group (Group I).

VARIABLES				
Independent	Dependent	N	Standard Deviation	Mean
Blncd.Order	Hawk fear	12	34.50	53.92
Blncd.Order	Goose	12	37.45	56.08
Order H 1st	Hawk fear	6	35.00	70.50
Order G 1st	Hawk fear	6	32.85	37.33
Order H 1st	Goose	6	38.75	56.50
Order G 1st	Goose	6	40.04	55.67

TABLE 7.4 Summary data showing the means and standard deviations for Group-raised (Group II).

VARIABLES		N	Standard Deviation	Mean
Independent	Dependent			
Blncd.Order	Hawk fear	16	18.68	29.19
Blncd.Order	Goose "	16	19.10	25.75
Order H 1st	Hawk fear	8	15.56	38.88
Order G 1st	Hawk fear	8	17.12	19.50
Order H 1st	Goose "	8	17.89	17.13
Order G 1st	Goose "	8	17.06	34.38
Aged 5 wks	Hawk fear	8	21.17	32.13
Aged 6 wks	Hawk fear	8	16.70	26.25
Aged 5 wks	Goose "	8	19.98	31.13
Aged 6 wks	Goose "	8	17.81	20.38

FIGURE 7.1 Pattern of fear behavior for the Isolated Group over trials 1 - 15 with both hawk and goose fear as the dependent variable.

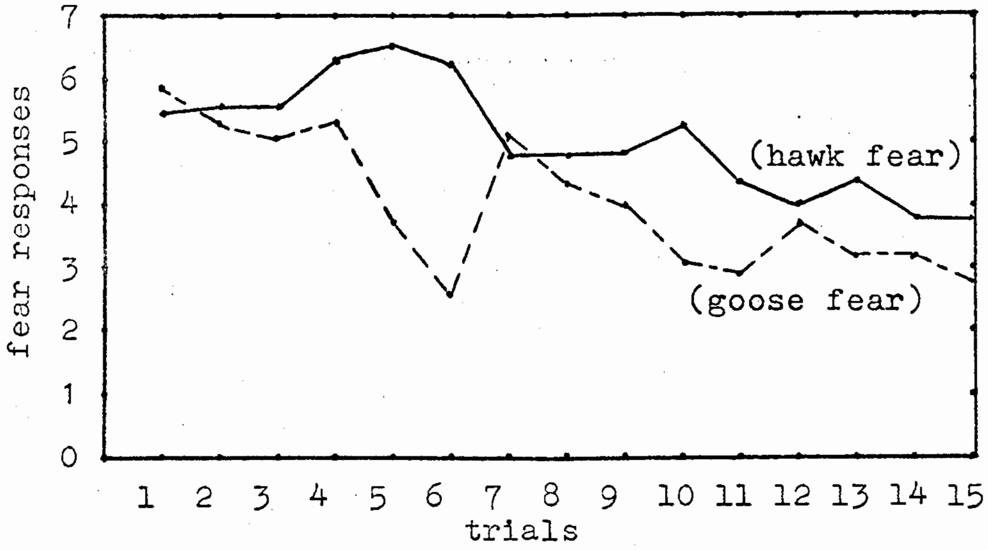


FIGURE 7.2 Pattern of fear behavior for the Isolated Group over trials 16 - 30 with both hawk and goose fear as the dependent variable.

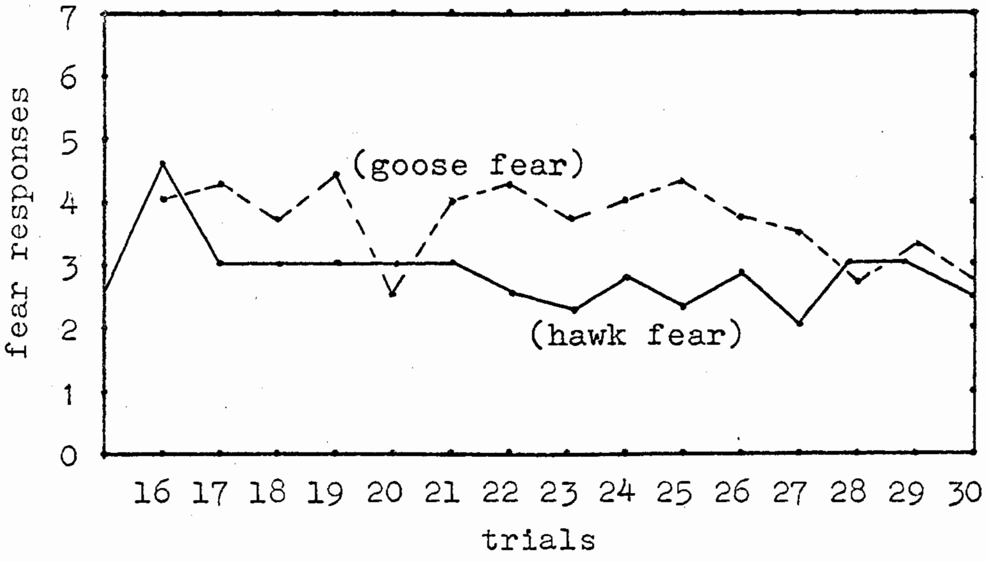


FIGURE 7.3 Pattern of fear behavior for all groups combined over trials 1 - 15 with both hawk and goose fear as the dependent variable.

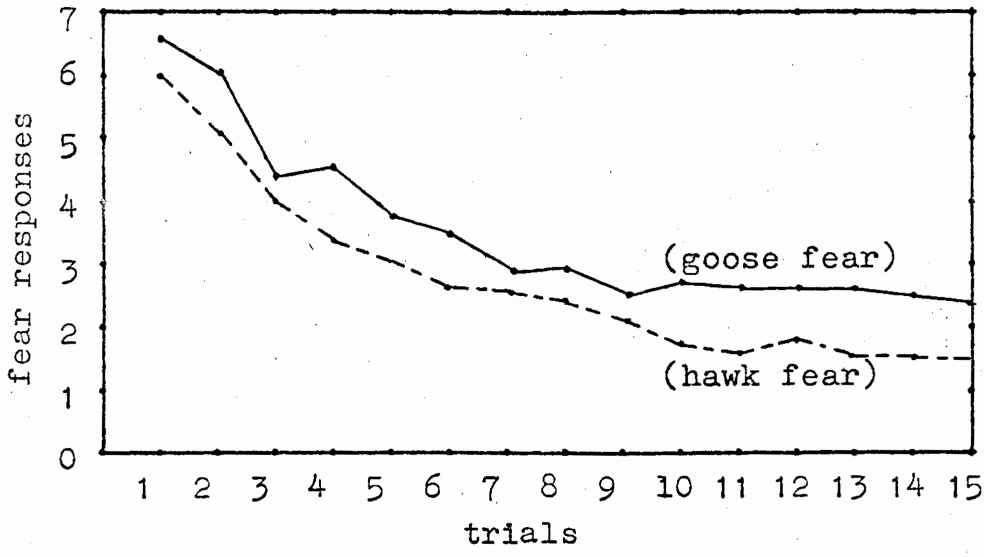


FIGURE 7.4 Pattern of fear behavior for all groups combined over trials 16 - 30 with both hawk and goose fear as the dependent variable.

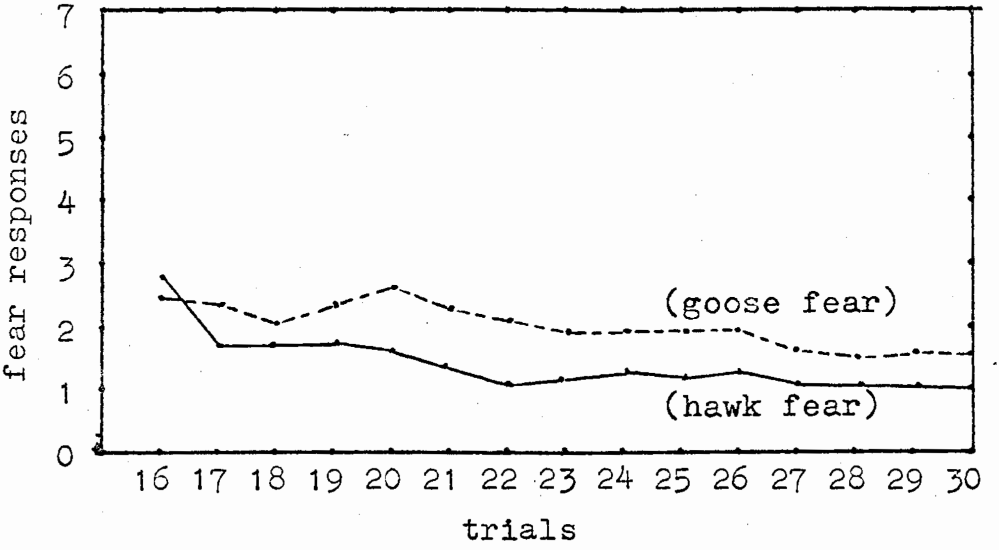


FIGURE 7.5 Pattern of fear behavior, combining hawk and goose fear, comparing Isolates versus Group-raised over trials 1 - 15.

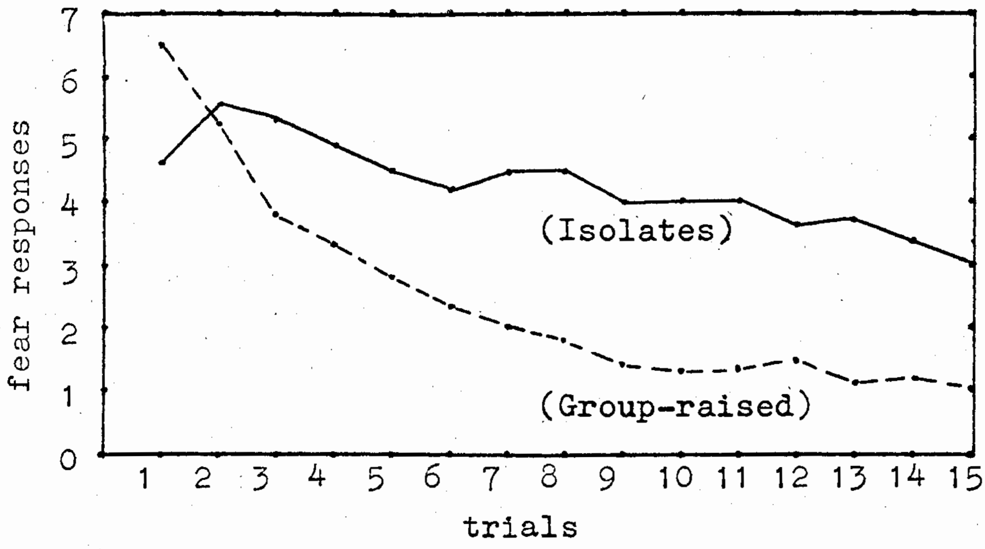
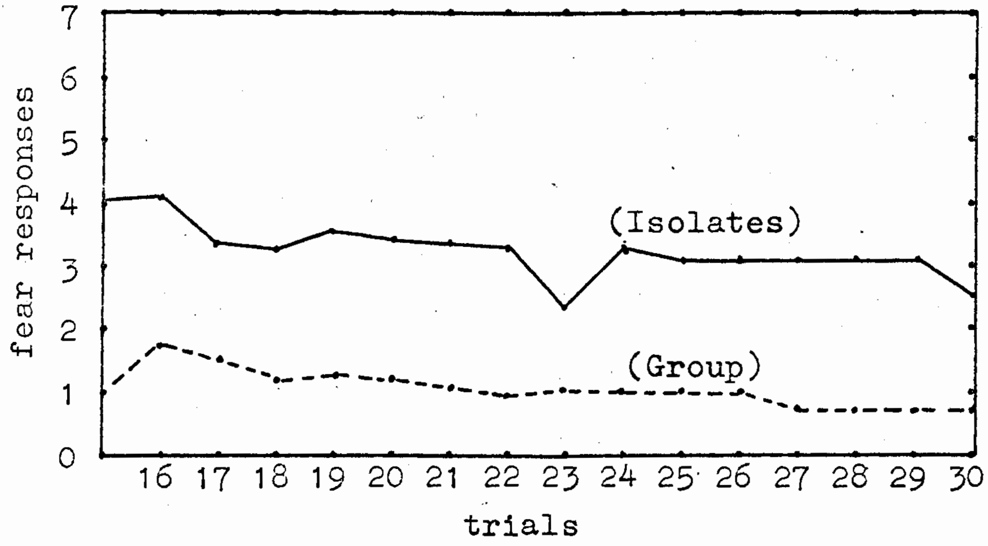
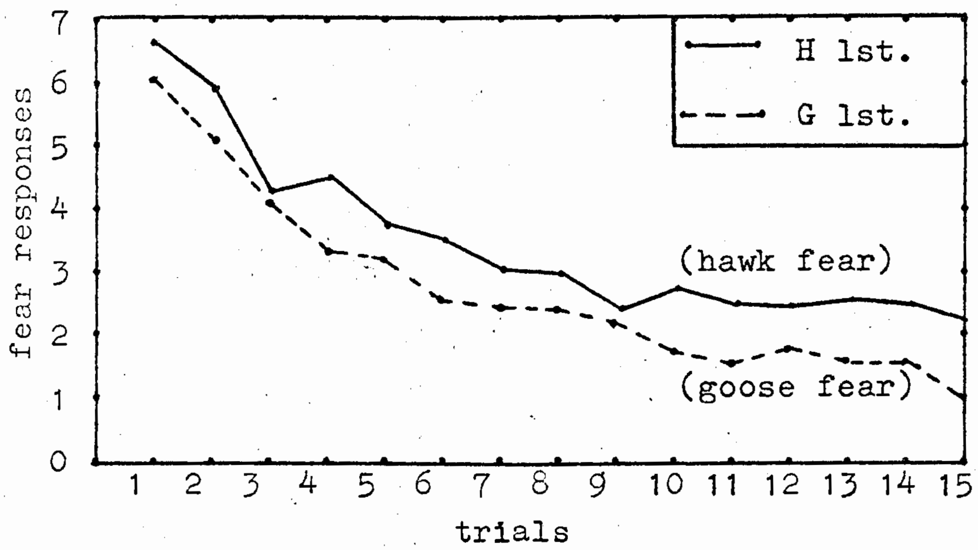


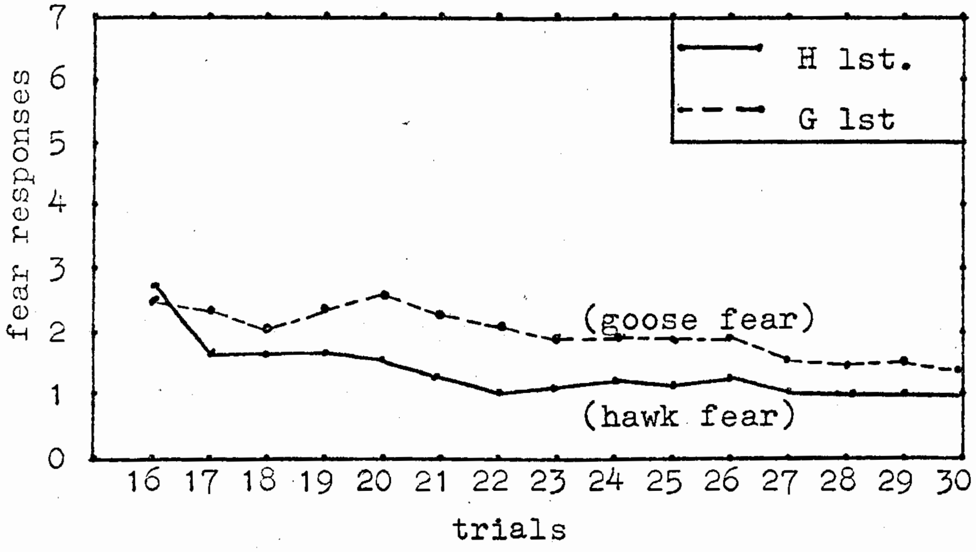
FIGURE 7.6 Pattern of fear behavior, combining hawk and goose fear, comparing Isolates versus Group-raised over trials 16 - 30.



<u>FIGURE 7.7</u> Pattern of fear behavior for all groups combined, comparing hawk and goose fear, with order as the dependent variable (trials 1 - 15).



<u>FIGURE 7.8</u> Pattern of fear behavior for all groups combined, comparing hawk and goose fear, with order as the dependent variable (trials 16 - 30).



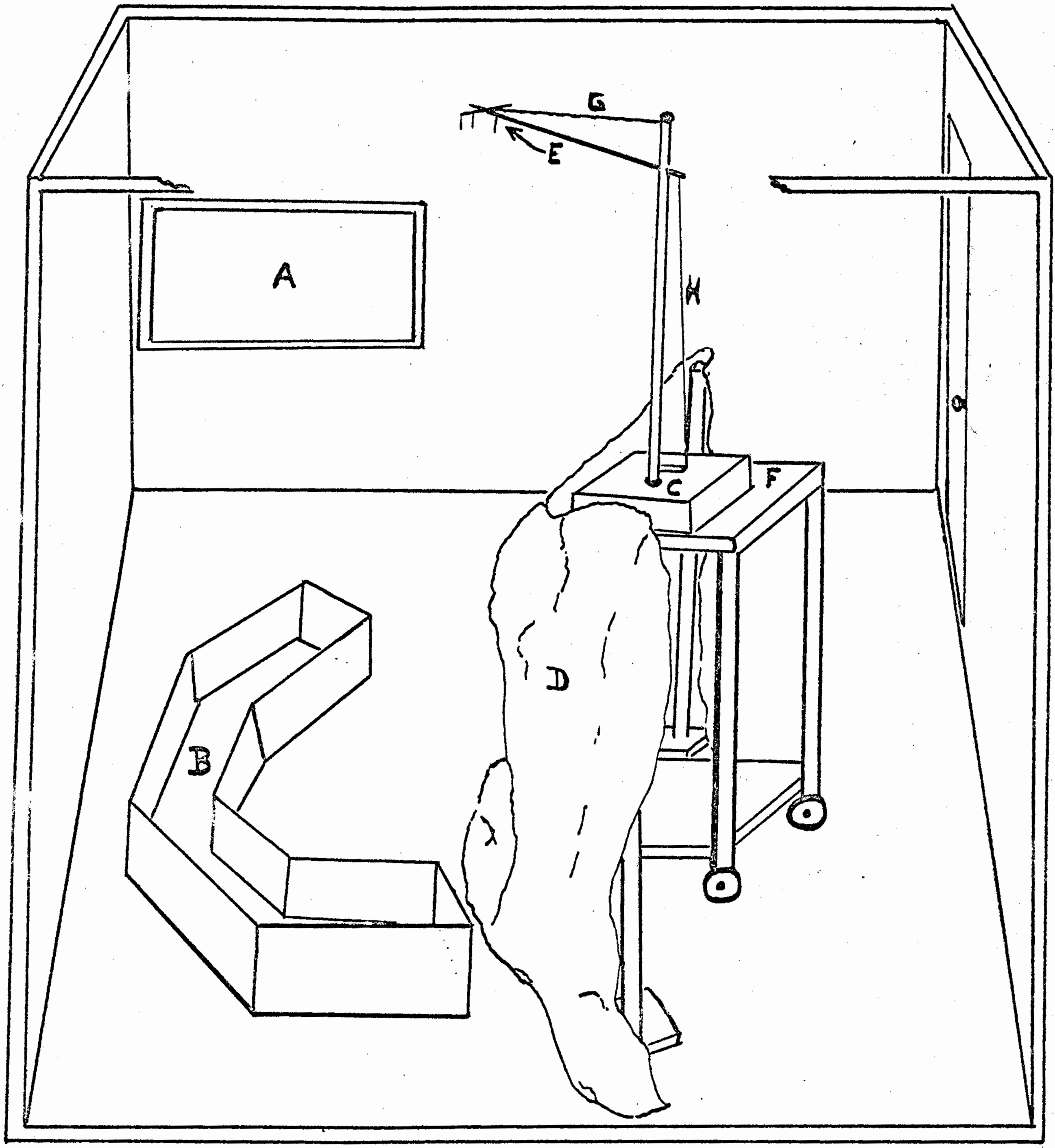


FIGURE 7.9 Schematic of the laboratory situation for the sign stimulus experiment. A = one-way window; B = four-section runway; C = electric motor; D = cloth screen; E = silhouette hung from here; F = portable stand; G = guide wire; and H = stablizing wire. Model moved from left to right as seen in rear (refer to procedure in paper).

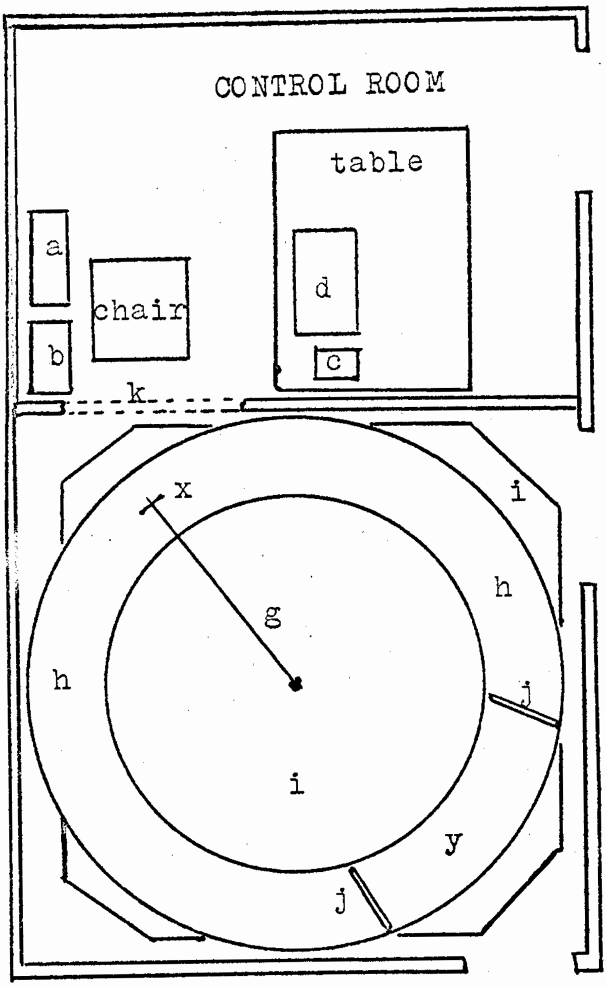


FIGURE 7.10 A schematic of the laboratory and control room for the imprinting experiment. (as seen from above)

The experimenter, seated in the control room, observed Ss' behavior through a one-way window (k). The speed of rotation of the model, suspended from the horizontal bar (g), was controlled by a transformer (a) and timer (b) from the control room. The E recorded data into a tape recorder (d), and timed Ss by means of a second timer (c). Each S was placed in the runway (h) at point y while the model was stationary at point x. Ss were removed from the runway at point y, following the closing of the trap gates (j). The runway rested on a large plywood base (i). The electric motor (silent) was concealed from view beneath the plywood base at the center of the apparatus. A microphone was hung beneath the base to record distress calls.

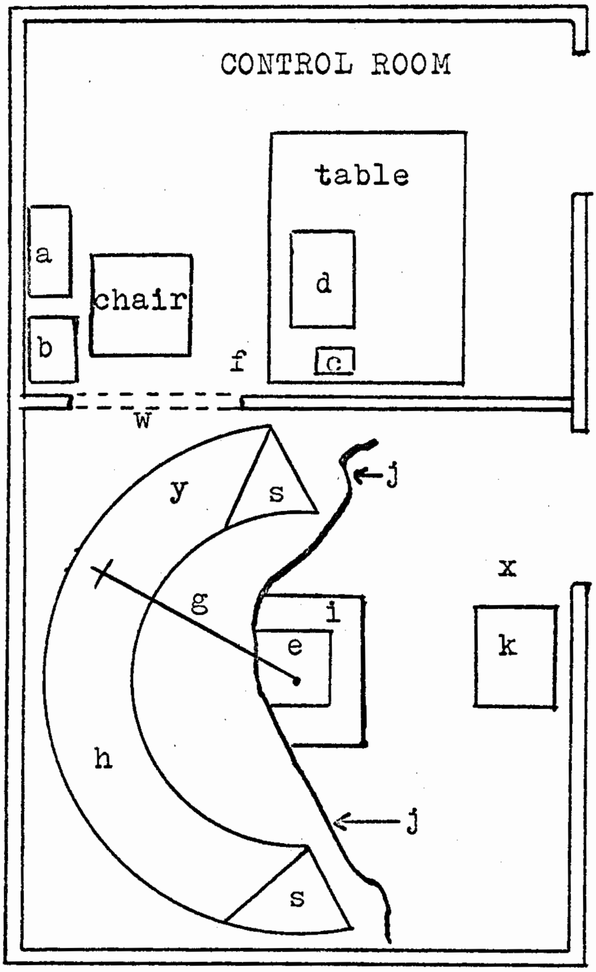


FIGURE 7.11 A schematic of the laboratory and control room for the sign stimulus experiment (see also FIG,7.9).

Symbol	Meaning
a	transformer
b	timer-control
c	timer for recording
d	tape recorder
e	electric motor
f	position of microphone
g	horizontal bar (85 in. high)
h	four-section runway
i	stand for motor
j	cloth screen (75 in. high)
k	stand (for changing model)
x	position of model changed here
y	Ss placed in runway here
s	shelter areas
w	one-way window

THE TINBERGEN SILHOUETTE (29:445)

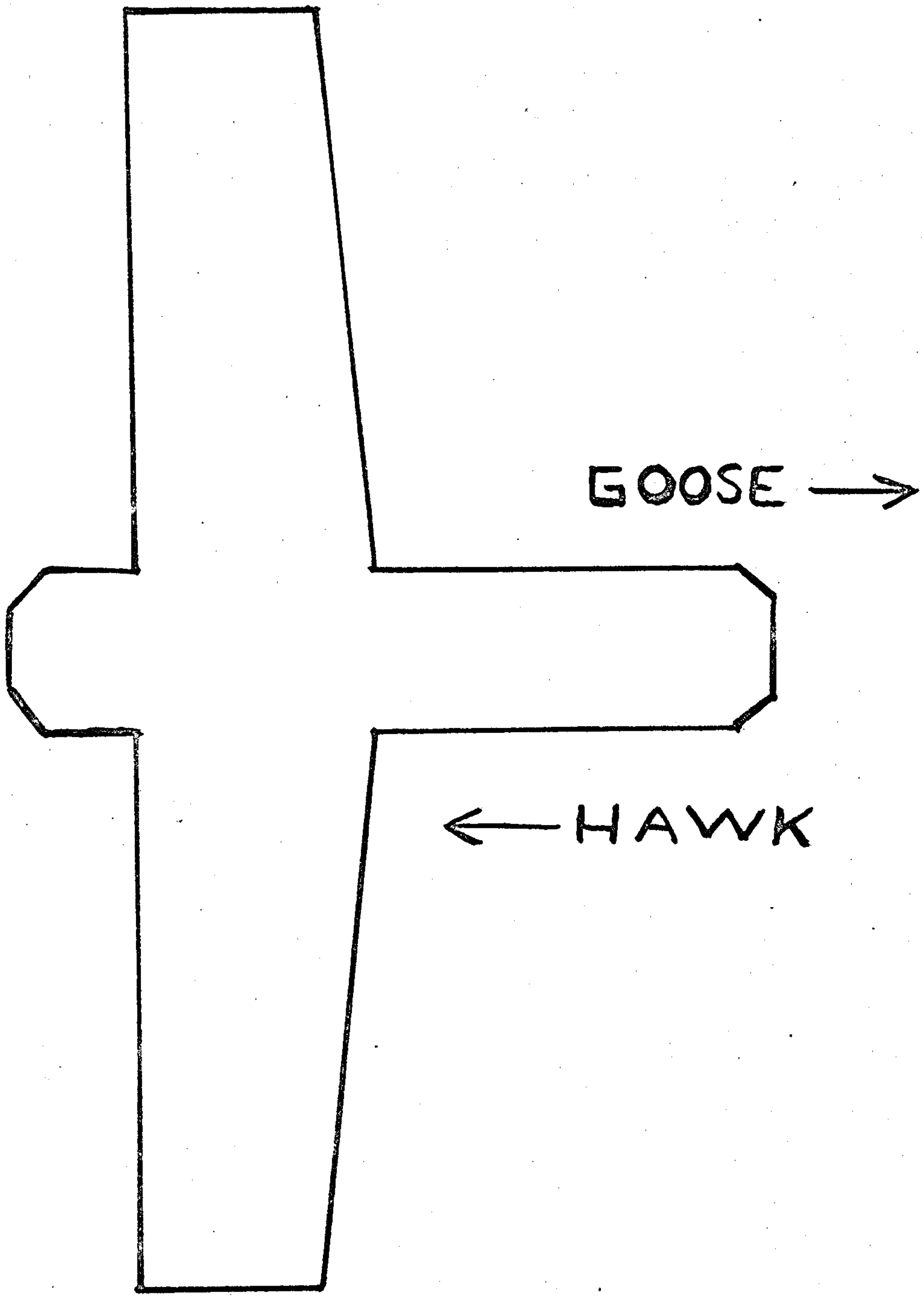


FIGURE 7.12 A scaled drawing of the Tinbergen silhouette, as employed in the sign stimulus experiment.

FIGURE 7.13 Sample record sheet, as employed in the imprinting experiment.

Subject no. # ______ Date: ______________

Breed of bird: ____________________ Time: ______________

Model presented: ________________

First five-minute period

(minute) (feet) (seconds)

1 st. . . . .

2 nd. . . . .

3 rd. . . . .

4 th. . . . .

5 th. . . . .

Other behavior noted:

Second five-minute period

(minute) (feet) (seconds)

1 st. . . . .

2 nd. . . . .

3 rd. . . . .

4 th. . . . .

5 th. . . . .

Other behavior noted:

FIGURE 7.14 Sample record sheet, as employed in the sign stimulus experiment.

Subject no. # _____ Date: __________

Breed of bird: ____________________ Time: ________________

Order of stimulus presentation: _______________

Observations with model in 1 st. direction:

fear criteria	trials														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Distress calls															
2. Wing-flapping															
3. Crouching															
4. Ran to Shelter															
5. Defacated															
6. Very Attentive															
7. Not Attentive															

Observations with model in 2 nd. direction:

fear criteria	trials														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Distress calls															
2. Wing-flapping															
3. Crouching															
4. Ran to Shelter															
5. Defacated															
6. Very Attentive															
7. Not Attentive															

*Further observations of note: