

THE CRITICAL PERIOD FOR DEVELOPMENT OF PRIMARY
SOCIAL HABITS AMONG BOBWHITES

By

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CHAPTER I

INTRODUCTION

During the past 40 to 50 years, many studies of animal populations point to the conclusion that food supplies and other environmental factors are not, in many situations, the primary regulators of animal numbers. Instead, various behavioral mechanisms that space individuals or produce stress at high densities are likely to limit populations of vertebrates which have well developed central nervous systems (Christian, 1950; Southwick and Bland, 1959; Warnock, 1965).

Studies of birds have indicated that they possess a wide variety of behavioral mechanisms that tend to space individuals, families and flocks (Collias, 1944). The Canada Goose, Branta canadensis, maintains strong family unity through the fall and winter. Flocks of geese are aggregations of several families. Within the flock, families compete with other families for space at feeding and resting sites (Hanson, 1953). The Ring-necked Pheasant, Phasianus colchicus, provides a contrast in that large flocks congregate during winter months in desirable food and cover situations. There is no family integrity and, according to Errington (1941), no limit to the size of such flocks other than the limits of the available food and cover.

Bobwhites, Colinus virginianus, offer still another example of social organization. Coveys form in the fall and winter. The covey is not derived directly from the family unit, for fall coveys usually

contain the equivalent of two to three families (Stoddard, 1931). We must assume, in the case of Bobwhite, that there has been selection for behavior which produces an optimum group size.

Stoddard (1931) concluded that Bobwhite tend to maintain coveys of constant size even after the families break up in late summer. Errington (1941) suggested that covey size might be maintained by older and more dominant birds, since these birds would be the ones most likely to discourage or accept newcomers to the covey. Errington (1941) also quotes a letter from Emlen in which Emlen suggests that the similarity between clutch size and covey size in quail may not be due to coincidence. This implies that group size among adult quail results indirectly from an imprinting or early learning process.

The word imprinting was used by Lorenz (1937) to describe a period in an animal's life in which primary social bonds are formed. As a result of early experiences, very young animals will readily respond to foster parents, even of another species, as if they were their own. Lorenz (1937) observed this phenomenon when he raised some goslings apart from their parents. When the goslings were a few days old, he placed them back in the presence of their parents, only to have the goslings follow him when he left. Lorenz (1937) was not the first man to describe this phenomenon as Spalding (1873) and William James (1890) recorded observations of a similar nature.

Since the early work of Lorenz (1937), imprinting has received much attention. Scott (1962) mentions a few of the aspects of imprinting. Song-learning in certain birds must occur during a certain period or they will not have a typical or complete song (Thorpe, 1961). Young Rhesus Monkeys, Macaca mulatta, reared in isolation are unable to mate

properly in later life (Harlow, 1961). Adult mice reared in groups during their youth fought more readily than animals that had been isolated (Seitz, 1954). In his conclusion, Scott (1962) stated that there is evidence for believing that

the critical period for primary socialization is also critical for other effects, such as the attachment to particular places, and may overlap with the critical period for the formation of basic food habits.

This paper presents the results of a 2-year study of captive Bobwhites. Two experiments were conducted to determine if the critical period for primary socialization, that period in which a young animal identifies with its parents, is related to the phenomenon of relatively fixed covey size. Experiment I was performed to determine the time and duration of the critical period of imprinting in Bobwhites. The responses of young chicks to a moving object were used to determine the age at which imprinting occurs. Experiment II was designed primarily to determine if learning via an imprinting-like process can be used to explain group size preferences or limits of tolerance for population density among Bobwhites in the wild.

Experiment II was secondarily designed to gather information relating to the age at which individual recognition first appears in Bobwhites. Collias (1944), discussing vertebrate animals in general, stated that the memory of an individual animal for other individuals may determine the size of groups, if the groups are to be stable and organized.

CHAPTER II

EXPERIMENT I

Discrimination Test

In a review of imprinting research, Sluckin (1965) described several types of tests which have been used with success to determine whether or not imprinting has occurred.

In the discrimination test, which was used in this experiment, the subject is trained with one inanimate object and is later tested for choice between the original object and a strange object. Imprinting is considered to have occurred if the animal approaches and follows the original object rather than the new one, provided it can be shown that this choice is not due to some inherent preference of the animal for a particular color or shape. The training ages of birds passing the final test indicate the age-span of the critical period, and the training ages of birds failing the final test indicate the ages that do not fall within the critical period.

Subjects

Bobwhites used in Experiment I were obtained as eggs from the State Game Hatchery located near El Reno, Oklahoma. The eggs were incubated in an incubator owned by the Poultry Science Department of Oklahoma State University.

Construction of Apparatus

A two-room brooder house was used for the experimental area. One room served as a holding area for the newly hatched quail. Corrugated cardboard boxes were divided into two parts by placing a cardboard partition across the center of each box. Cane litter was placed on the floor of each container. The boxes were placed on flat shelves constructed 6 feet from the floor along the walls of the brooder house to prevent the birds from seeing any movement of people through the room. A newly hatched quail was placed in each partitioned unit.

The second room was used as the test room. A runway 8 feet long, 3 feet wide and 2 feet high was constructed. The floor of the runway was plywood and covered with cane litter. Black plastic sheets were used to form the sides of the runway and also to enclose the entire runway area to keep out unnecessary light. The runway was lighted by two 75-watt floodlights which provided a diffuse light on the runway floor. The floodlights were placed 5 feet above the center of the runway and pointed upward so that the runway area received only a small amount of direct light (preliminary tests had indicated that the birds were more responsive when the lights were not aimed directly at the runway).

A moving blue ball, 6 inches in diameter, and a 6-inch red cube were used to train the animals. Hess (1959b) found that red and blue elicited more following among domestic chicks than other colors tested. A small electric motor, located above the center of the runway, powered spring operated shafts at either end of the runway which in turn moved the objects. The objects were placed on the ends of the shafts so that they were 1 inch above the floor of the runway. The motor did not move the objects in a continuous motion but caused them to stop and go in a

jerky circular pattern. Experiments by Sluckin and Salzen (1961) found this type of movement to elicit the most following in domestic chicks. Figure 1 indicates the movement patterns of the objects at each end of the runway.

Test Procedure

Observations were made through a small peephole at eye level in the black plastic which surrounded the test area.

During the training period a partition was placed in the center of the runway so that the bird being trained could see the movement of only one of the objects. Half of the birds were trained to the blue ball and half to the red cube. A bird was trained by removing it from its box and placing it by hand in one end of the runway. Each bird used in the experiment was given a 20-minute training period. After training, the bird was removed from the runway and returned to its isolation box. Notes were made as to whether or not the bird followed the training object. While handling birds, the observer avoided exposure to them as much as possible. Each bird was carried in one hand with the other hand cupped over the bird, the exchange being made as quickly as possible. The birds' ages at the time of training varied from 1 hour to 36 hours after hatching. After a series of 8 to 10 birds had been trained, they were immediately tested in the same order in which they had been trained. During the test the partition in the center of the runway was removed. The point of release is indicated by an X in Figure 1. The tested bird could see both objects at this time. Each bird was given a 3-minute test and records were kept on the behavior of each bird during this time. Birds were given a positive score if they approached and

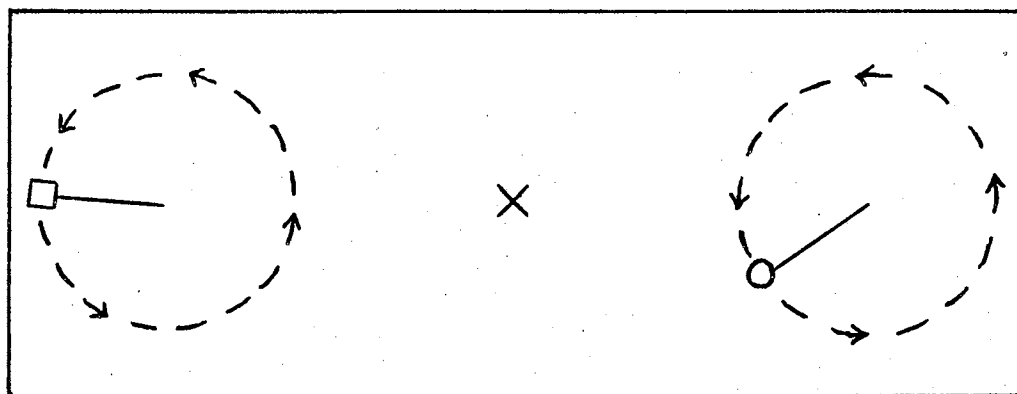


Figure 1. Floor Plan of Test Apparatus, Experiment I

followed the object to which they had been trained and a negative score if they did not follow. If a bird's behavior during the test was questionable, it was given a negative score. After being tested, all birds were placed in a common pen. Eighty-eight birds were trained and tested in this manner.

Results

The results were examined by 6-hour intervals following hatching. The number and percentage of birds receiving positive scores during the 3-minute tests are presented by age at time of training in Table I. Also included in Table I is the calculation of chi-square in an $R \times 2$ table of percentages. The hypothesis being tested was that of independence (or homogeneity) between the age groups. The chi-square value of 27.4, d.f. = 4 at .01 level, would indicate that there were highly significant differences among age groups due primarily to the relatively high percentage in age 1-6 hours.

Birds trained shortly after hatching were most responsive, with many following the stimulus object sometime during the 20-minute training period. This period of increased responsiveness began as soon as the young bird was dry and able to stand and lasted anywhere from 6 to 10 hours of age. As the birds became older, the percentage that followed during the test period declined.

Usually when a bird was imprinted to one of the objects, it would give contentment calls while following that object. These calls can best be described as "whit-whit-whit-to." This behavior contrasted with the lost peep calls and escape behavior elicited when a bird was not contented in the test situation. A paper by Stokes (1967) describes

TABLE I

NUMBER AND PERCENT OF BOBWHITES THAT RECEIVED POSITIVE SCORES
IN EACH 6-HOUR AGE INTERVAL. INCLUDED ARE THE
CALCULATIONS FOR CHI-SQUARE USING AN
R x 2 TABLE OF PERCENTAGES

| Training Age (Hours) | Number Tested | Number Following X | Percent Following p | Products pX |
|---|------------------|--------------------------|---------------------------------|----------------------------|
| 1-6 | 18 | 15 | 83.33 | 1249.95 |
| 7-12 | 22 | 10 | 45.45 | 454.50 |
| 13-18 | 10 | 3 | 30.00 | 90.00 |
| 19-24 | 16 | 5 | 31.25 | 156.25 |
| 25-30 | 15 | 3 | 20.00 | 60.00 |
| 31-36 | 7 | 1 | 14.29 | 14.29 |
| 88 | | SX = 37 | $\bar{p} = 37.39$ | SpX = 2,024.99 |
| | | | $1 - \bar{p} = \bar{q} = 62.61$ | $\bar{p}SX = 1,383.43$ |
| | | | | SpX - $\bar{p}SX = 641.56$ |
| $\text{Chi-Square} = \frac{100(\text{SpX} - \bar{p}SX)}{\bar{p}\bar{q}} = \frac{100(641.56)}{2340.99} = 27.4^*$ | | | | |

*Significant at .01 level

the function of various calls of the Bobwhite and was helpful in this portion of the investigation.

Lost peep calls and escape behavior were not present in birds from 1 to 6 hours old, but in birds 7 hours old and older these responses became more frequent. The lost peep call was the first to appear, with escape responses appearing soon after.

During the test periods there were indications that the birds used in the experiment were unable to discriminate between the two objects used. Some birds which followed the object on which they had been trained also followed the strange object during part of their 3-minute test. When a bird followed both objects it was given a positive score on the basis that it had followed the right object during part of the test.

To determine if the birds had an innate preference for one of the objects, such as a basic attraction to red, the results were grouped (Table II) as to the training object used. The final scores are in terms of positive or negative responses.

TABLE II
POSITIVE AND NEGATIVE RESPONSES TO EACH
TRAINING OBJECT, EXPERIMENT I

| Blue Ball | | Red Square | |
|-----------|----------|------------|----------|
| Positive | Negative | Positive | Negative |
| 17 | 26 | 20 | 25 |

The hypothesis that both objects would elicit a similar number of positive and negative responses was examined by using a chi-square test on the data from Table II. There was no significant difference between the two groups of data (chi-square = 2.43 with 1 d.f.)

Discussion

The results of Experiment I indicate that Bobwhites are very precocial in that several reactions to their environment develop shortly after hatching. When a young bird was less than 1 hour old, it was capable of walking and finding its own food. When the chicks were 7 hours old they began to show fear of strange objects, as evidenced by their escape responses during the tests.

When birds either avoided the test objects or tried to hop from the runway area, the critical period for the following response was considered to be over. Hess (1959a) conducted experiments which indicated that the development of fear responses, which cause an animal to leave the vicinity of strange objects, helps to bring the critical period for imprinting to a close. Scott (1962) states that escape reactions, which are presumably the result of strong fear, prevent contact altogether with strange animals. He also states that fear during the critical period may actually facilitate imprinting.

There was some question as to the type of stimulus object that should be used in an experiment of this nature. Sluckin (1965) gives a review of some of the types of moving objects which have been used in similar experiments. Hess (1959a) concluded that a plain ball, similar to the one used in this experiment, was more efficient at releasing the following response in young domestic chicks than a ball with wing-like

and tail-like structures attached to create a parent-bird appearance. Hinde (1961; from Sluckin, 1965), on the other hand, stated that for some species the best objects were ones that resembled the parents. Whether the Bobwhite is a species which would follow an object resembling another quail better than an unnatural object is not known. The fact that some of the quail chicks in this experiment were unable to discriminate between the two objects used during the test suggests that more distinct objects, either natural or unnatural, should be used. More research is needed to determine what specific features of the stimulus object release the greatest amount of following.

CHAPTER III

EXPERIMENT II

The principle objective of Experiment II was to determine if the size of fall coveys of Bobwhites is determined by earlier learning experience with a group of similar size. Data were collected on the preferences of birds for a certain group size and their ability to recognize individuals from the group in which they had been reared. Although these phenomena may not be the only factors involved in the regulation of covey size, they were investigated because of the similar testing procedure needed to obtain the two types of data. There are probably several other factors which play an equally important role in controlling covey size in wild populations of Bobwhite (Kabat and Thompson, 1963).

Past investigations (Stoddard, 1931; Errington, 1941; Kabat and Thompson, 1963) provide data which indicate that the average Bobwhite covey in the fall fluctuates from 14-17 birds with 15 birds being the most common size. One of the group sizes used in this experiment contained 15 birds, which was assumed to approximate an average covey size. Two other group sizes, containing five and 30 birds, were used for comparison. To increase the reliability of the results, five groups of five birds were hatched, two groups of 15, and one of 30, which provided at least 25 birds to be tested from each group size.

Construction of Apparatus

A necessary requirement for this experiment was visual and auditory isolation of each group from the prehatch period to termination of the experiment. To achieve both types of isolation, special brooder units were constructed.

An enclosure 12 feet by 40 feet was constructed within an existing flight pen. The flight pen consisted of a corrugated metal roof and concrete slab. The walls of the enclosure consisted of an outer siding of 3/4-inch plywood nailed to 2 x 4-inch centered studs. Fiberglas batting, 2 inches thick, was used to fill the cavities between the studs and to insulate the ceiling. Sheetrock was used for the interior wall and ceiling of the enclosure.

Nine brooder units and a testing apparatus were constructed and placed inside the enclosure described above. Five of the brooder units were designed for groups of five birds, two were large enough for groups of 15 birds and the remaining two accommodated groups of 30 birds each.

Each brooder unit was composed of an outer shell of 1/2-inch plywood, a 4-inch cavity between the outer and inner shells filled with sand and zonelite, and an inner shell of 1/2-inch plywood which was 4 inches smaller than the outer shell in all three dimensions. After the outer shell was built, a 4-inch layer of sand was placed on the floor of the box. The inner shell was then placed on top of the layer of sand and centered. The cavity between the walls was filled with sand and zonelite. Both shells were open on top. The top of the brooder was fitted with a lid which was hinged to the top of the outside wall.

The lid consisted, on the bottom side, of a piece of plywood slightly larger than the opening of the inner shell. A shallow cavity was formed above the bottom piece of plywood by nailing 2 x 4-inch lumber on edge around the perimeter of the plywood. The cavity in the lid was filled with zonelite. A piece of plywood of the same dimensions as the outer shell was nailed to the top edge of the 2 x 4-inch pieces to complete the lid. When in position the bottom of the lid just covered the inner shell forming an inner chamber, and the top of the lid sealed the outer shell. Figure 2 is a generalized diagram of the brooder unit design (side view). Each brooder unit was equipped with a porcelain light receptacle. Forty-watt bulbs were used in the small brooders and 60-watt bulbs in the larger units.

Providing fresh air to birds in this environment presented a problem because sound reduction is best attained in an air-tight container. Two holes, 1 1/8-inches in diameter, were drilled through the bottom of each brooder unit. Each hole was fitted with a short piece of plastic hose of the same diameter. A baffle was constructed to reduce sound and was connected to the hoses protruding below the unit. The baffle (Figure 3) was composed of two units, each of which contained four chambers open at one end, lined with bulk fiberglass to absorb sound. One side of the baffle was equipped with a small exhaust fan. During operation, the exhaust fan pulled air from the room into the opposite side of the baffle. Sounds accompanying the air flow were absorbed by the fiberglass before the air passed upward into the main chamber of the brooder. Simultaneously air in the brooder was sucked into the other side of the baffle where sounds emitted inside the brooder were trapped before the air passed back to the room (Figure 3).

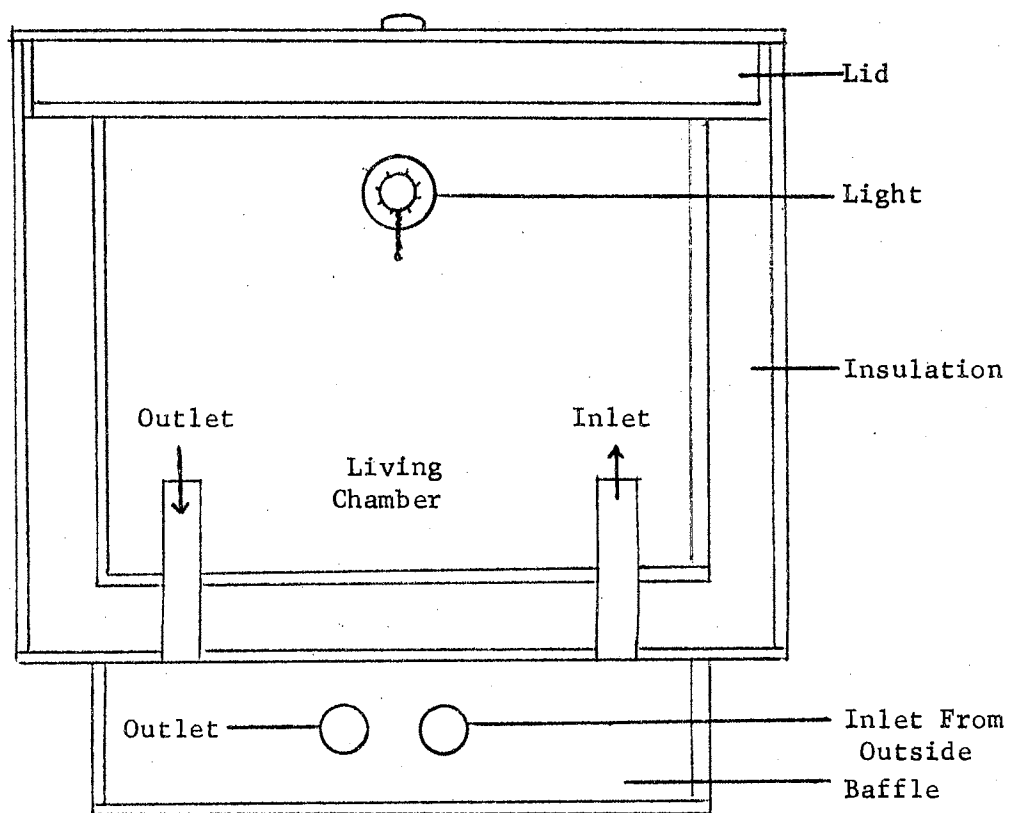


Figure 2. Side View of Brooder Unit, Experiment II

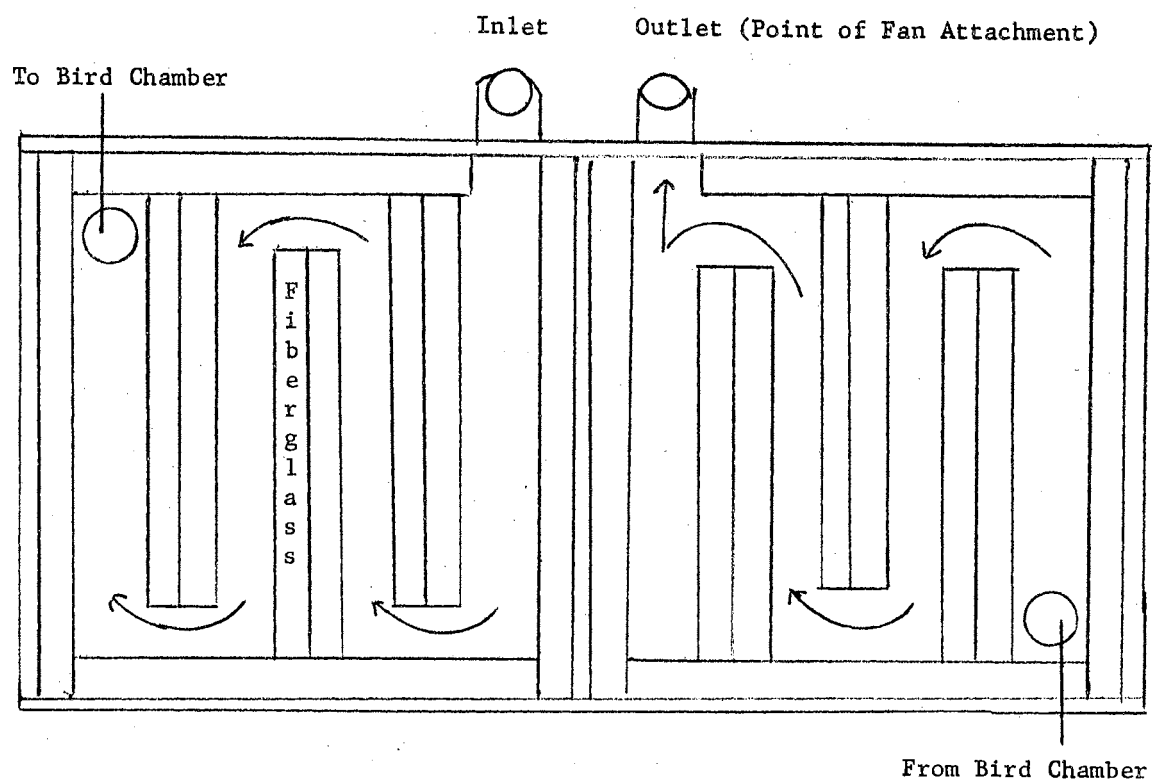


Figure 3. Air Flow Through Baffle, Top View

The baffle was attached to the bottom side of the brooder with shelf brackets (Figure 2). The brooder with the attached baffle was placed on a stand constructed of 2 x 4-inch lumber. The stand is not included in Figure 2.

The testing apparatus used in Experiment II was designed to provide each bird being tested with a choice of either two or three different groups of birds at the same time and the opportunity to move towards the group it most preferred. Figure 4 shows the floor plan of the test apparatus. It is a central hexagonal chamber with outer boxes which can be attached to windows in the chamber walls. During the experiments a single bird was placed in the central chamber. Birds in the three outer boxes were visible from the chamber. The center of the chamber was a neutral area and birds remaining in this area expressed no preference for a particular outer box. The floor space immediately in front of each outer box is labelled "scoring area." Birds moving into these zones were recorded as showing a preference.

The central chamber is a soundproof unit, 27 inches in height. It was similar in construction to the soundproof brooder units described earlier, except sand only, rather than sand and zonelite, was used to fill the cavities between the inner and outer shells.

The three boxes around the central chamber (Figure 4) contained birds used to stimulate the experimental birds during tests. The outer boxes were equipped with rollers so that their position relative to the test box could be rotated between each series of tests. They were constructed of plywood and resembled the inside of the brooder units. The floors of the test apparatus and the stimulus boxes were covered with cane litter (as were the brooder units). Birds were in these stimulus

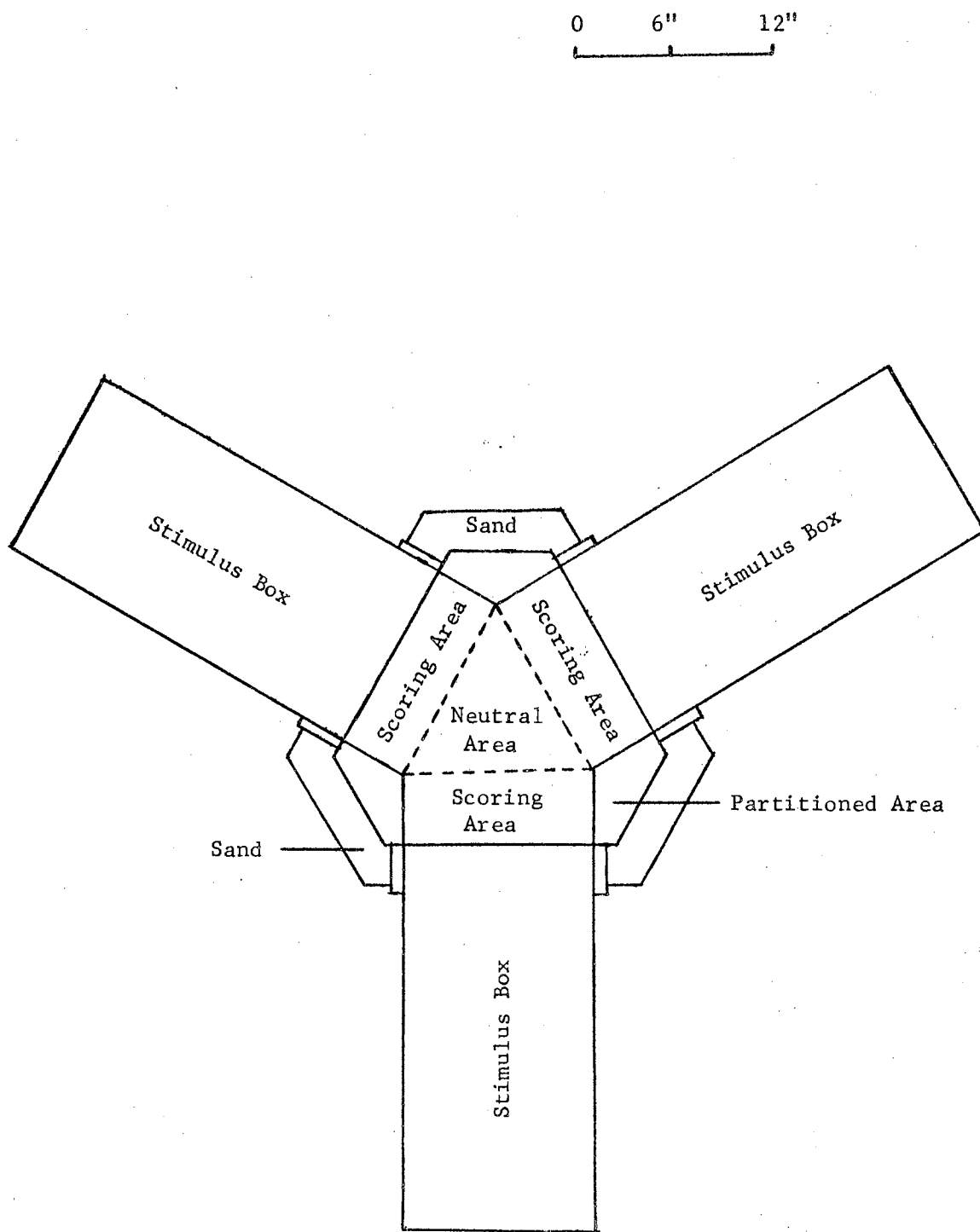


Figure 4. Floor Plan of Test Apparatus, Experiment II

boxes for long intervals which necessitated the installation of a small exhaust fan on each box. The fans were turned on only during intervals between tests as the fans made a small hum when in operation.

Three rectangular windows each 26 inches by 12 inches, were cut into the central chamber at the point where the three stimulus boxes were to be placed (Figure 4). Two types of panels were constructed which could be placed in the three windows of the central chamber. One type of panel consisted of three panes of glass spaced 1/2 inch apart and sealed around the edges. This panel allowed the experimental animal to see the stimulus birds but not hear them. The other panel consisted of wire hardware cloth and allowed the bird being tested to see and hear other birds, but the wire kept them from intermingling. Figure 5 provides a side view of the test apparatus with the nearest stimulus box rolled away and the wire screen panel in place. Figure 6 is a sketch from the inside of a stimulus box with a view across the test chamber toward the other two choices. The experimental area of the test apparatus received no direct light but had indirect light provided by a 40-watt bulb in each stimulus box. During testing periods the lights in the room were turned off. Observations were made while standing next to the test apparatus looking through the observation window in the top of the central chamber (Figure 5). This window could be removed to place the experimental birds into the center of the test apparatus.

Incubation

One incubator was placed in each of the nine brooder units. Extra eggs were placed in each incubator to insure the proper number of birds in each group at hatching. After 18 days of incubation the clutch size

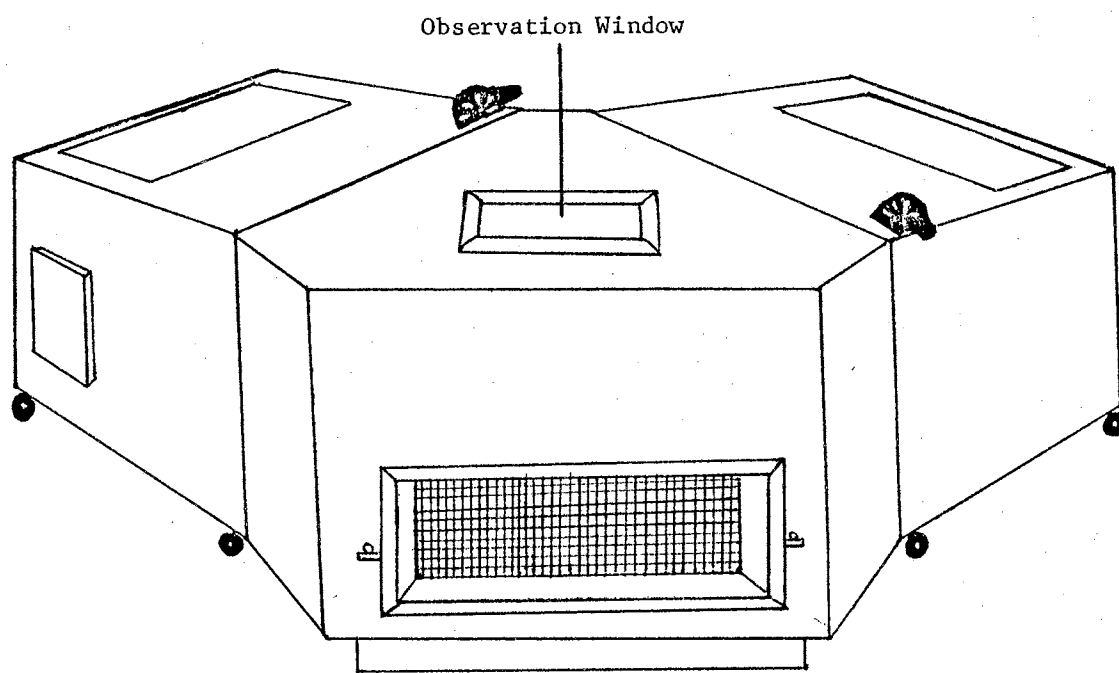


Figure 5. Sketch of Test Apparatus Used in Experiment II

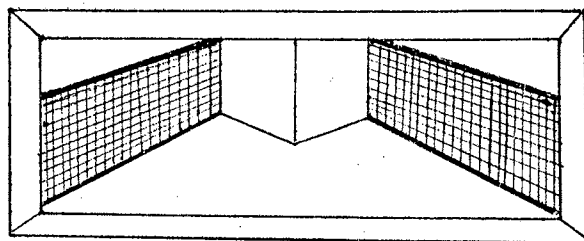


Figure 6. A View From the Inside of the Test Apparatus, Experiment II

in each brooder was adjusted to the desired number. The birds were left in the incubators for 24 hours after hatching, then released into the brooders.

Care and Feeding

The birds were fed once a day with Purina Game Bird Startena in a small tin feeder. Small amounts of clover were provided when the birds were three weeks old. The quail were never observed to consume any clover. Water was available at all times in glass water jars.

Test Procedure

The original objective of Experiment II was to provide a three-choice situation which would consist of a large group containing 30 birds, a medium sized group containing 15 birds and a small group containing five birds. Mortality during incubation and the first week of life, however, necessitated a rearrangement of these three choices to utilize the small number of surviving birds. The 15 bird group was eliminated as one of the choices. The stimulus box which had been designed for them was left empty during the group-size-preference tests but was still considered a third choice as an empty box. A group of 20 birds was used as the large group and a group of 5 birds was used as the small group.

After the experimental birds had been in isolated groups for one week, the birds from the small groups were tested. The glass panel was used in the test apparatus during the first week of testing. The wire screen was used for all tests after the first week of testing.

Each experimental bird was tested for a 5-minute period and the time spent near each choice was recorded. Time spent in the center of the test apparatus was recorded as time spent in the neutral area. To register time at one of the choices the bird had to be within the scoring area (Figure 4) for more than 15 seconds. When each bird had been tested a numbered band was placed on its leg and it was returned to its brooder unit.

When some of the birds were first placed in the test apparatus, they would run to one of the three choices apparently in an attempt to escape the handler. The chance that these responses would interfere with the results was partially avoided by placing each subject in a small, bottomless wire cage in the center of the test apparatus for 30 seconds before its 5-minute test began. This short period served not only to calm the bird but also provided an opportunity for it to see all three choices before it was released. After 30 seconds the wire cage was lifted, allowing the subject to move to one of the three choices unhindered.

After the first week, birds from all three group sizes were tested each week. Tests were conducted once a week for four weeks. At the end of four weeks, further testing had become impractical because mortality in the brooder units had reduced the number of birds below the desired group size. The birds died gradually over the period of testing.

The birds used as stimulus birds were the same age as the birds tested.

Individual Recognition Tests

Birds were tested each week for nine weeks to determine whether or not they were more strongly attracted to brooder mates or strange birds when given a choice. For the first four weeks the tests for individual recognition were made on the day following the group-size-preference tests. Since the same birds were used for group size and individual recognition tests, the positions of the stimulus boxes around the test apparatus were switched between each series of tests.

The test procedure for individual recognition involved placing about half of the birds of a particular brooder in the empty stimulus box (described as the empty box during the group-size-preference tests) to serve as familiar birds. The large and small groups, used as stimulus birds during the group-size-preference tests, were used for the other two choices. The remaining birds of the brooder being tested were then, one at a time, placed in the test apparatus for a 10-minute test period. Time spent near each choice was recorded as described earlier.

After the first four weeks, the number of birds used in the three stimulus boxes was reduced to two in each box. This made a better experimental situation and provided more birds to be tested from each brooder.

Results

The number of eggs which hatched was within three birds of the desired number of birds in each brooder unit (Table III).

TABLE III
HATCHING RESULTS AND ORIGINAL CLUTCH SIZES SET FOR
EACH BROODER UNIT IN EXPERIMENT II*

| Brooder | Desired Group Size | Number of Eggs Set | Number Hatched | Hatching Date |
|---------|-----------------------|-----------------------|-------------------|------------------|
| 1 | ** | ** | ** | ** |
| 2 | 5 | 20 | 5 | May 17, 1967 |
| 3 | 30 | 60 | 30 | May 16, 1967 |
| 4 | 15 | 45 | 18 | May 16, 1967 |
| 5 | 15 | 45 | 15 | May 17, 1967 |
| 6 | 5 | 20 | 6 | May 17, 1967 |
| 7 | 5 | 20 | 7 | May 17, 1967 |
| 8 | 5 | 20 | 3 | May 17, 1967 |
| 9 | 5 | 20 | 5 | May 18, 1967 |

* All eggs were set on the same day, April 23, 1967. The eggs were candled on May 8 and 11. Live embryos in excess of 3-4 above the desired group size were removed on May 11.

** All excess embryos were placed in brooder 1 and after hatching served as the stimulus birds.

The number of birds available for use in the stimulus boxes varied from week to week (Table IV). This variation had an unknown influence upon the responses of the experimental birds each week. The most pronounced change was the shift from several brood-mates and a large group to groups of two in the individual recognition tests. Each test was numbered in the order in which it was conducted.

A total of 138 tests was conducted for group-size preference over a four-week period using birds raised in large and small groups. Of the 138 tests, 69 involved birds from the small groups and 69 were with birds from large groups. During the first week of testing, only birds from the small groups were tested. During test weeks two, three, and

four, birds from all three group sizes were tested; however, in the summary of results, information on birds from the intermediate group size (brooders 4 and 5) was combined with the data for large groups.

TABLE IV
CHARACTERISTICS OF TESTS FOR GROUP-SIZE PREFERENCE AND
INDIVIDUAL RECOGNITION, EXPERIMENT II

| Test No. | Test* Week | Test** | Choices | | |
|----------|------------|--------|---------|-------|---------------------|
| | | | Large | Small | Other |
| 1 | 1 | A | 20 | 5 | No birds |
| 2 | 1 | B | 20 | 5 | Brood-mates (group) |
| 3 | 2 | A | 20 | 5 | No birds |
| 4 | 2 | B | 20 | 4 | Brood-mates (group) |
| 5 | 3 | A | 14 | 5 | No birds |
| 6 | 3 | B | 12 | 5 | Brood-mates (group) |
| 7 | 4 | A | 12 | 5 | No birds |
| 8 | 4 | B | 2 | 2 | Brood-mates (2) |
| 9 | 5 | B | 2 | 2 | Brood-mates (2) |
| 10 | 6 | B | 2 | 2 | Brood-mates (2) |
| 11 | 7 | B | 2 | 2 | Brood-mates (2) |
| 12 | 8 | B | 2 | 2 | Brood-mates (2) |
| 13 | 9 | B | 2 | 2 | Brood-mates (2) |

*The test week is also the age of the birds in weeks after hatching.

**Test: A = group size preference; B = individual recognition.

The group-size-preference test scores of birds from the small and large groups appear in Tables V and VI respectively. The figures listed under the various test choices represent the number of birds which spent the majority of their 5-minute test period in that location. Some birds spent time at all three locations and the location where the

TABLE V
SUMMARY OF GROUP-SIZE PREFERENCES OF BOBWHITES BROODED
IN SMALL GROUPS, EXPERIMENT II

| Group Size Selected | Test-Series Number | | | | | | | | | |
|---------------------------|--------------------|-----|-----|-----|-----|-----|-----|-----|-------------------|-----|
| | 1 | | 3 | | 5 | | 7 | | Combined Tests | |
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Large | 5 | 28 | 10 | 55 | 6 | 33 | 8 | 53 | 29 | 42 |
| Small | 3 | 16 | 5 | 28 | 11 | 61 | 7 | 47 | 26 | 38 |
| Empty Box | 7 | 39 | 1 | 5 | 1 | 6 | 0 | 0 | 9 | 13 |
| No Selection (Neutral) | 3 | 16 | 2 | 12 | 0 | 0 | 0 | 0 | 5 | 7 |
| TOTALS | 18 | 100 | 18 | 100 | 18 | 100 | 15 | 100 | 69 | 100 |

TABLE VI
SUMMARY OF GROUP-SIZE PREFERENCES OF BOBWHITES BROODED
IN LARGE GROUPS, EXPERIMENT II

| Group Size Selected | Test-Series Number | | | | | | | |
|---------------------------|--------------------|-----|-----|-----|-----|-----|-------------------|-----|
| | 3 | | 5 | | 7 | | Combined Tests | |
| | No. | % | No. | % | No. | % | No. | % |
| Large | 7 | 43 | 16 | 61 | 18 | 67 | 41 | 59 |
| Small | 6 | 38 | 7 | 27 | 7 | 26 | 20 | 29 |
| Empty Box | 1 | 6 | 0 | 0 | 0 | 0 | 1 | 1 |
| No Selection (Neutral) | 2 | 13 | 3 | 12 | 2 | 7 | 7 | 11 |
| TOTALS | 16 | 100 | 26 | 100 | 27 | 100 | 69 | 100 |

majority of the time was spent was occasionally less than one half of the 5-minute period.

During the first week, among birds from small groups, there was no apparent preference for any choice. This randomly oriented behavior was interesting since one of the choices was an empty box. In the remaining three weeks the birds began to show more interest in the two boxes which contained birds and less time was spent near the empty box. Although results shown in Table V indicate that no birds spent the majority of their test period in that location (empty box), time was spent in that area. A bird approaching the empty box after the first week would remain there only until it saw birds moving in the other two boxes.

In the third week, both the small and large groups preferred 61 per cent of the time the group size in which they were raised (Figure 7). In the fourth and final week this suggestion of a preference disappeared. The preferences of the experimental groups for the group size in which they were not raised are presented in Figure 8. Birds from the small groups had the highest number of negative responses over all the tests. This is best illustrated in test week two when birds from small groups exhibited a stronger preference for the large group (Figure 8) than the birds that had been raised in the large groups (Figure 7).

A total of 195 tests were conducted to determine the age at which the Bobwhites used in the previously described experiment began to recognize their brood-mates. The results of these tests are presented in Table VII. As in Table VI, each bird is tabulated under the position where it spent the most time during the test.

—— Small Group - - - - Large Group

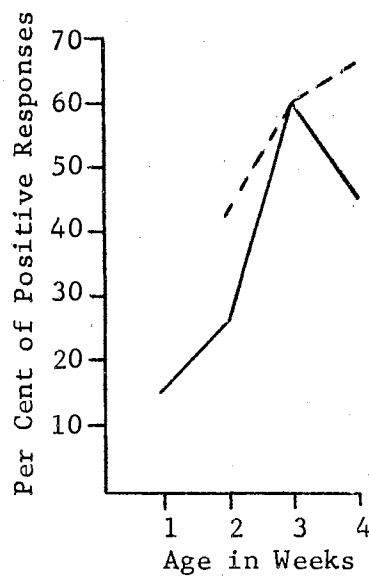


Figure 7. Comparison of Small Group and Large Group Positive Responses, Experiment II

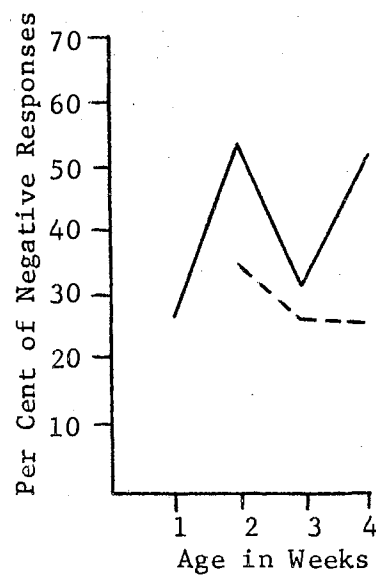


Figure 8. Comparison of Small Group and Large Group Negative Responses, Experiment II

TABLE VII
RESULTS OF TESTS FOR INDIVIDUAL RECOGNITION, EXPERIMENT II

| Test No. | Age in Weeks | Number Tested | Selected Brood-Mates | | Selected Other Choices | |
|----------|--------------|---------------|----------------------|----|------------------------|----|
| | | | No. | % | No. | % |
| 2 | 1 | 19 | 4 | 21 | 15 | 79 |
| 4 | 2 | 14 | 1 | 7 | 13 | 93 |
| 6 | 3 | 21 | 7 | 33 | 14 | 67 |
| 8 | 4 | 22 | 4 | 18 | 18 | 82 |
| 9 | 5 | 22 | 5 | 22 | 17 | 78 |
| 10 | 6 | 30 | 5 | 16 | 25 | 84 |
| 11 | 7 | 25 | 10 | 40 | 15 | 60 |
| 12 | 8 | 20 | 12 | 60 | 8 | 40 |
| 13 | 9 | 22 | 11 | 50 | 11 | 50 |
| | | <u>195</u> | <u>59</u> | | <u>136</u> | |

In test week four, the week in which the number of stimulus animals used was reduced to two per box (Table IV), there was an increase in the number of birds which preferred the neutral position. This was due to the fact that many birds spent the majority of the time period going from choice to choice, spending only about 10-15 seconds at each choice. Although the birds did not spend enough time at each choice to receive credit, they did, in the observer's opinion, behave differently when they were near familiar birds. The experimental birds would go closer to the screen where the brood-mates were housed. In order to collect data for weeks seven through nine, a different scoring system was devised to gather information on the neutral birds. In the last three weeks of testing, the birds used in the stimulus boxes were placed in their particular test positions by another person while the observer waited outside the room. This enabled the observer to determine a

bird's preference for one of the three choices more objectively. The total time spent in each location was still the final criterion, but when the times of several locations were similar, the number of trips to each choice and their behavior at each choice were considered. (The increase in the number of neutral choices is obscured in Table VII because of this change in the scoring system.)

Figure 9 shows a comparison of the group-size-preference tests with the tests for individual recognition. Since the scoring system was changed in test number 11, it is difficult to draw conclusions as to when the birds began to recognize familiar birds.

In test week nine, the last week of testing, several of the experimental birds tried to peck the stimulus birds through the screen. There was no difference, however, between the familiar birds and strange birds as to who received more pecks.

Nearly 75 per cent of the birds which hatched died before the experiment could be completed. To determine the cause of death several of the birds were examined by the Pathology Department of the School of Veterinary Medicine, Oklahoma State University. No evidence of pathological disease or parasites was found; however, the symptoms of rickets were present. Several weeks before death a bird would lose its coordination, its joints would become swollen and diarrhea would often develop. Vit-A-Cin was given to the remaining birds after the cause of death was determined. After the Vit-A-Cin had been in use for 1 week there was some improvement among the crippled birds and also fewer birds became afflicted. The loss of birds eventually made further testing unfeasible.

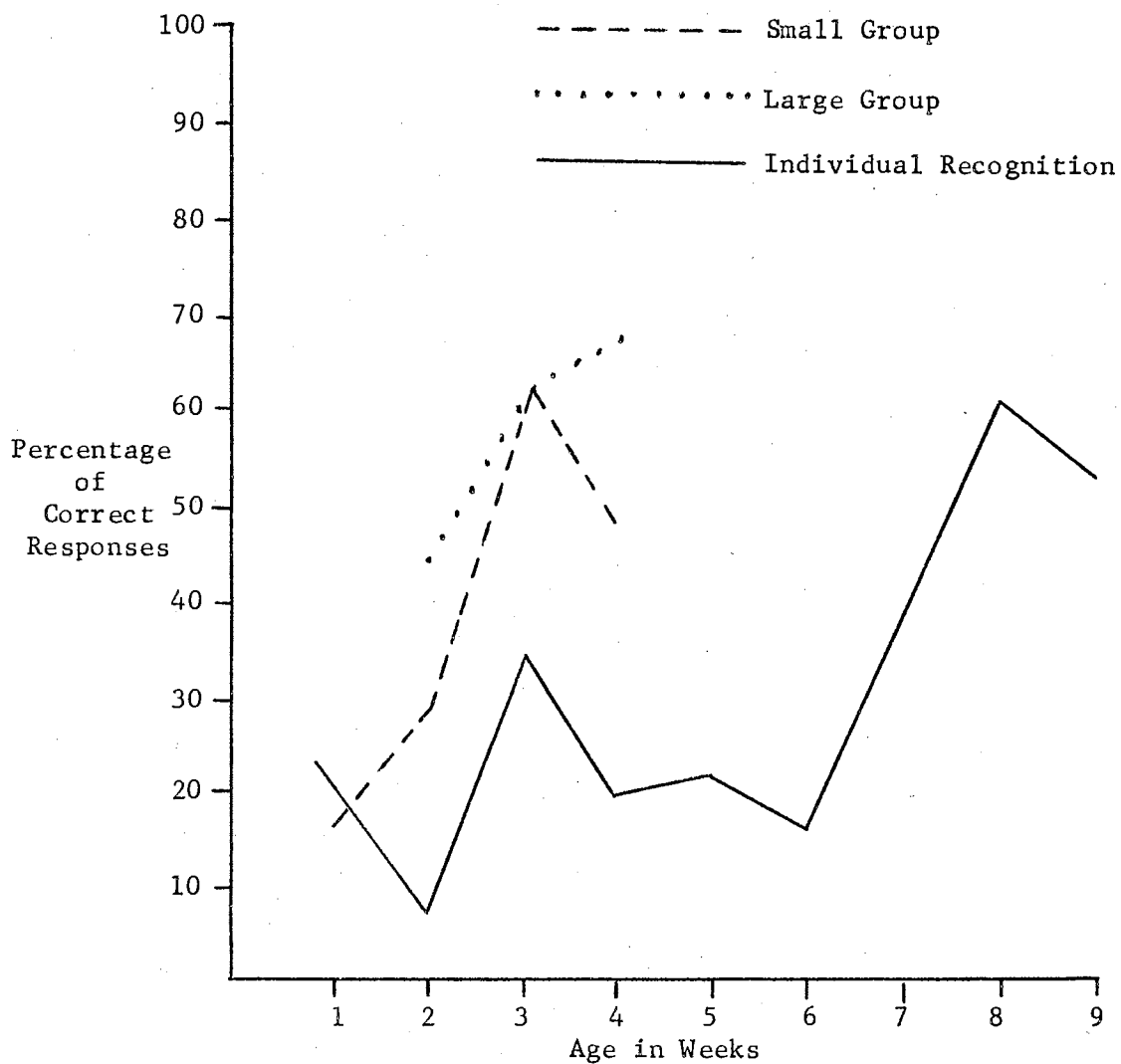


Figure 9. Comparison of Results of Group-Size-Preference Tests and Tests for Individual Recognition

Discussion of Assumptions

Several assumptions were made relative to the design of Experiment II. It was assumed that the experimental birds would exhibit their preferences for a certain choice by spending more time near that particular choice. No data were obtained which would test the validity of this assumption. Since the number of birds available for testing was too small to permit the use of different birds each week, the same birds were tested each week. This procedure assumes that a bird's behavior during testing is not influenced by experiences the bird has had in earlier tests. Schjelderup-Ebbe (1935) found that when a chicken was removed from a stable flock for a period of 8-9 days, its ability to recognize the group on its return was greatly reduced. In the present experiment, birds were in contact with other (i. e., strange) birds in the test situation for very brief periods each week. However, there was an increase in the frequency of "neutral" behavior as the birds matured, suggesting a possible conditioning to the test apparatus. Whether this was due to the birds "remembering" the test apparatus from week to week or a result of their maturation is not known. If it was due to the birds previous experiences, the use of untested birds would be a necessity in future investigations.

Conclusions

The results of the group-size-preference tests were inconclusive. This was due, in part, to inadequate sample sizes but perhaps the absence of any strong correlation between early experience and later choices reflects the influence of factors which were not measured in

this experiment. Tests on older Bobwhites may indicate that a critical period exists at an age which was not used in this experiment.

The testing technique seemed adequate as some tendencies toward recognition of group size were noted. The randomness of choice in the first week of testing was not present in the last three weeks of Experiment II. By the third week of age, birds hatched in large groups were showing a preference for large groups. However, birds hatched in small groups did not show a definite preference for either large or small groups.

Indications of individual recognition did not appear until relatively late in the experiment (8 weeks of age). One could speculate that very little learning relative to social habits had taken place in the isolation of the brooder prior to 8 weeks.

CHAPTER IV

SUMMARY

1. Two experiments were performed to determine if the critical period for primary socialization is related to the phenomenon of relatively fixed covey size in Bobwhites.
2. During Experiment I, Bobwhites, ranging in age from 1-36 hours, were imprinted to either a blue or red object.
3. The highest percentage of following occurred among birds trained during the first 6 hours after hatching.
4. During Experiment II, groups of Bobwhites were isolated in soundproof brooders and later tested for preference between similar group sizes and different group sizes.
5. Birds were tested for recognition of brood-mates as opposed to strange birds.
6. Tests for group-size-preference were inconclusive.
7. Evidence of individual recognition did not appear until 8 to 9 weeks of age, and the numbers of animals being tested at the time were too small to yield statistically significant results.

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