A Study of Successive Discriminations of
Brightness in Chicks

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A. B. University of Oregon, 1922

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Submitted to the Department of
Psychology and the Faculty of the
Graduate School of the University
of Kansas in partial fulfillment
of the requirements for the degree
of Doctor of Philosophy.

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May 20, 1930

The writer wishes to express her
sincere appreciation for the advice,
suggestions and encouragement given
throughout the course of this study
by Professor Raymond H. Wheeler.

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I. INTRODUCTION

It has been amply demonstrated that chickens can respond to constant relationships in changing situations; to relative brightnesses of lights when absolute brightnesses are varied; to constant relationships of size when the actual sizes of objects in the situation are changed, or the objects themselves are of different nature in the altered situations; within limits, to relations of forms. We are justified, then, in assuming that the behavior of chickens displays insight in a high degree in situations simple enough to allow for rather definite, constant relationships in a total situation which is itself "meaningful", that is, which constitutes in its entirety the process of reaching a goal.

In work of this sort done with chickens, the constant factors of the situations presented have been confined largely to simple spatial arrangements. The question arises as to whether similar insightful behavior may be demonstrated in more complex spatial situations which involve a temporal factor, that is, in which the total situation is so arranged that a succession of problems present themselves, not only in a constant relationship to a spatial situation, but also in a fixed relationship to one another.

In pursuit of this problem, a situation was so arranged that, in order to reach a goal of food and companionship, chicks must make three successive choices of brightnesses. The three choice-situations involved were constant in general spatial arrangement and also in the actual brightnesses of the three lights used in each. The problem, therefore, is to discover whether the chicks can learn at the same time to select the correct brightnesses in their successive order, and to disregard exactly the same absolute brightnesses when they appear outside the preferred succession.

By varying the method of introducing the complications of the problem, an effort was made to discover whether more efficient learning took place when the entire situation was presented at the beginning of the experiment, or when new situations were introduced successively as the preceding ones were learned.

II. APPARATUS

1. Description

The multiple choice box (Plate I) used throughout this experiment was a long enclosed box, painted black both inside and outside, and mounted on four legs. It was constructed from one-half inch finished yellow pine boards. The inside measurements of the box were 72 inches in length, 10 inches in height, and $24\frac{1}{2}$ inches in width. This box was mounted upon four wooden legs, 2 inches square and 36 inches long, making the height of the floor of the box 26 inches from the room floor. The top was tightly covered by alternating 5-inch boards and 12-inch doors (E, F, G, H), hinged at their front edges by two 3-inch strap hinges, to the solid 5-inch board. The floor was covered entirely by a close-fitting piece of dead black oilcloth. At the front end, midway in the end board was cut an aperture $6\frac{1}{2}$ inches wide by 7 inches high, with the lower edge flush with the floor. This aperture could be covered by a wooden door (A) hinged at the bottom, which, when opened, formed a straight-angle continuation of the floor. At the rear end of the box was cut an aperture 4 inches in height, flush with the floor and running the full width of the box. This aperture was covered on the outside by two thicknesses of frosted glass, and on the inside with an adjustable piece of cardboard.

Separated by spaces of 12 inches, beginning 1 foot from the front, three 6-inch transverse openings were left in the wooden floor. These were filled with pieces of milk-glass 6 inches wide and 25 inches long. Cut in the oilcloth floor covering, so as to coincide with the milk-glass sections, was a set of three apertures (Plate II), running lengthwise of the glass and crosswise of the box. They were separated from one another by 2-inch spaces covered with oilcloth. The edges of the two outside

PLATE I

spaces were 1 inch from the side walls of the box. The apertures themselves were 4 by 6 inches, with their long axes transverse to the long axis of the box.

Three removable partitions of three gates each were set over the light apertures in the floor so that each gate would coincide vertically with its corresponding light aperture (Plate II, position A), giving each gate an opening 6 inches wide and $7\frac{1}{2}$ inches high. The partitions were built by running a crossbar the full width of the box, $\frac{3}{4}$ inch thick, 2 inches wide, and 24 inches long. Four $\frac{1}{2}$ -inch pine strips, 10 inches long, were nailed to the crossbar so that their width and position corresponded to the oilcloth spaces between the light apertures. A $\frac{3}{4}$ -inch strip of V-shaped sheet iron, 24 inches in length, was screwed to the back of the gate posts with the edge of the metal flush with the floor, and the other lip of metal pointing toward the back of the box, parallel with the floor and three-quarters of an inch above it. At the top of the gateways, at intervals of one and one-fifth inches, were screwed pieces of No. 12 galvanized wire, $7\frac{1}{2}$ inches long, and articulating in quarter-inch screw eyes. Each vertical wire could swing out from the bottom in any direction toward the back of the box, but was prevented from moving forward by the sheet iron door sill. Four V-shaped notches were cut in the rear edge of the doorsill to correspond with the proper position of each vertical wire. At the bottom of each left gate post was hinged another piece of wire which could be swung across the lower ends of the swinging wire bars, and hooked at the bottom of the right gate post. When in position, this held the swinging wires fast. The lock bar itself was concealed beneath the metal lip of the door sill. Each partition of gates could be fastened

into position by wedges at the ends of the cross bar.

Parallel slats, 3 inches long, were placed opposite one another on the two side walls, directly in front of the upper part of each partition. The slats were slanted toward the front of the box at an angle of 35 degrees, in such a position that a mirror, 3 inches wide and 24 inches long, could rest on them, braced against the partition in the rear, so that it exactly reflected the light areas from the floor.

Suspended from the floor of the box and directly beneath the milk-glass openings, were light diaphragm boxes, constructed of $\frac{1}{2}$ -inch boards (Plate I, B, C, D). These boxes were 6 inches wide, and 6 inches high, and ran the width of the box. These boxes were open at both top and bottom and corresponded in position with the three apertures in the floor and with the gateways. Running full length of the diaphragm boxes were metal slides on each lower edge, in which was fitted a second milk-glass filter, and also a press-board diaphragm that could be put into position from either end.

A $\frac{3}{4}$ -inch by 2-inch wooden railing, 15 inches above the room floor, extended from one leg to the next adjacent leg. On the under side of this railing were screwed three 4-inch boards in a transverse position with regard to the box. These fell directly under the diaphragm boxes (See Plate I). In positions on these boards, corresponding to the center of the light sections of the diaphragm boxes, were screwed porcelain, electric light wall sockets, three to each board. A fourth 4-inch board was put into position at the bottom of the frosted glass aperture at the rear of the box, with porcelain wall sockets identically spaced. These twelve sockets were connected in parallel circuit, with three lights to each lateral, from a pair of wires running full length of the box. The

circuit was interrupted by a single-throw knife-switch mounted upon the right front leg of the box. A 370 Ohm, 1.1 Amp. rheostat, mounted on the right side of the top of the box at the front, could be cut into the circuit at will. Fifty watt Nilco frosted lamps were used throughout the experiment in the light boxes and three fifteen watt Nilco frosted lamps were used at the back of the box. The amount of light thrown up through the milk-glass was controlled by holes in the diaphragms.

In the last 18-inch section of the box (See dotted line, Plate II), the floor descended at an angle of 30 degrees, and was covered with $\frac{1}{2}$ -inch mesh hardware cloth. It opened out through an $8\frac{1}{2}$ -inch space into a feeding box, 40 inches long and 29 inches wide. This feeding box was constructed of slats and 1-inch mesh chicken netting.

The brightness of the light areas was controlled by pressboard slides which slipped into the sheet iron slots at the base of the light boxes. In each slide, three apertures were made, each allowing a different amount of light to reach the milk-glass light areas on the floor of the box. The largest aperture was a square of $8\frac{1}{2}$ centimeters, the second, a circle with a diameter of 1 centimeter, and the smallest a pin hole, 1 millimeter in diameter.

The apparent brightness of the brightest light as measured by the Macbeth illuminometer was 27.6 f. c. The brightness of the medium light was 0.515 f. c. The dimmest light was merely a glow, below the threshold of the illuminometer.

With the lighting arrangement as it was, a perfect transposition could not be made. If the brightest light has been reduced to the intensity of the medium light, it would have been impossible to distinguish the

medium from the dim. However, trials were made with three reductions of intensities. Illuminometer readings for the three stages of reductions of the bright and medium lights are as follows:

	Bright	Medium
Stage 1	9.78 f. c.	0.1970 f. c.
Stage 2	5.00 f. c.	0.1062 f. c.
Stage 3	2.95 f. c.	0.0618 f. c.

It will be seen from these figures that the intensities of the lights were reduced, at the first stage, to approximately one-fourth their normal intensities, and in each of the succeeding reductions, to approximately one-half the intensities of the preceding stage.

The description given above applies to the apparatus in its final form, at the beginning of the main series of experiments. A few alterations had been made in it after the beginning of the preliminary series. At the beginning of the preliminary experiments, the light apertures were first made in the form of small circular openings in the floor covering, one and one-fourth inches in diameter. These were replaced early in the series by the larger openings described above, to make the light areas more noticeable. For the same purpose, the mirrors were introduced at the twenty-fifth trial. They were used throughout the preliminary series, and during the early part of the main series. The inclined run-way from the last partition to the feeding box was added only after the completion of the preliminary series. During this series of experiments, the floor was continued from the last partition to the rear wall of the box on the same level as the rest of the floor. This enclosed area behind the last partition was used as the feeding box.

2. Use of apparatus

A chick, removed from the living box and placed on the opened door at the entrance, was allowed to walk into the first compartment, after which the door was closed, leaving an aperture $1\frac{1}{2}$ inches by $6\frac{1}{2}$ inches for observation. The chick, if he were a member of the group working on the whole method, was confronted with a partition at a distance of eighteen inches, in which there were three gates, each lighted by an illuminated area at its base, which was reproduced in the mirror above the gate. The wires of the dimly illuminated gate were free, while the wires of the other two were fastened. There was nothing in the appearance of the three gates to indicate which was the unlocked one. After the chick had passed this partition, by pushing against the wires so that they swung out and allowed him to go through, he was confronted with a second, identically the same, except for the relative arrangement of intensities in the light areas, and for the fact that the free gate was the one of middle brightness. The third compartment was identical with the other two, except, again, for the difference in arrangement of brightnesses, and for the fact that the brightly lighted gate was free. On going through the last gate, the chick stepped out upon an inclined runway leading into the feeding box attached to the choice box, where he got his daily feeding in company with the other chicks. As he went down this runway, he passed under another dimly illuminated area on the level of the floor, an inch in height and extending the width of the box. This, together with the daylight admitted where the choice box and the feeding box joined, served as a means to make the path more definite by increased illumination beyond the end of it. The next time the chick entered the box, its arrangement would be the same except for the positions of the different brightnesses in the light areas, and

the corresponding position of the free gate. These conditions would have been changed between trials.

III. PRELIMINARY EXPERIMENTS

In the preliminary series, the apparatus essentially was as described above except that, instead of an inclined run-way, leading to the feeding-box at the rear of the choice-box, the floor extended on the level from the last partition to the rear of the box. This last compartment, 18 by 24 $\frac{1}{2}$ inches, was used as a feeding box, the food being placed in a low trough at the rear of the box. This arrangement was quite satisfactory at the beginning of the experiments, for seven or eight small chicks could be allowed to remain together in the box after their runs were finished. However, as the chicks became larger, the space would not permit of leaving more than two or three chicks in the feeding box at once. The necessity of removing them so soon after their runs and giving them most of their daily feeding in a different situation reduced the efficiency of the method. It was found quite impracticable, with the larger chickens near the end of the series, both because of their size, and their quarrelsomeness when crowded in such small quarters.

During the preliminary series, alterations were made in the lighting arrangement, the size of the light areas was increased and mirrors were introduced as mentioned above.

Twenty-five white leghorn chicks purchased from a hatchery when five days old, and raised in the laboratory were used in the preliminary experiments. Only thirteen of them were used in experiments exactly comparable with those of the final series.

These preliminary experiments have been treated largely as a means of devising and improving methods. Although conditions were such that the problem was not learned completely, these experiments indicated that the

method finally adopted might give fruitful results.

The two most important modifications of the problem that grew out of the preliminary series were the alteration of the apparatus described above, and the speeding up of the whole training process. Barring practice trials made to accustom them to the apparatus, the preliminary group of chicks made 114 trials, extending over a period of 77 days. They were 21 days old when the regular trials began, and 101 days old when the training was discontinued. The rapid maturing of the chicks made such a protracted period of training very difficult. The chicks, more or less, outgrew the apparatus. They reached such size and state of maturity that it was almost impossible to care for them adequately in a laboratory situation; and many of them, due partly to their maturity, and partly to the unsatisfactoriness of the feeding conditions, became quite indifferent to the experimental situation. In some cases, nervousness and peculiar mannerisms developed. This combination of conditions made it impossible to carry the experiments further.

A third improvement in technique was made in the matter of record taking. As the series advanced, the records of separate trials were elaborated to include more details of the chick's behavior, both qualitative and quantitative.

IV. DESCRIPTION OF THE FINAL SERIES OF EXPERIMENTS

1. The Chicks.

The animals used in this experiment were twenty-two pure-bred white leghorn chicks which were purchased from a hatchery when one day old. They were all subjected to similar conditions of living and feeding, and, when the training began, were all given the same number of trials each day, under as nearly identical conditions as possible.

2. The Experimental Groups.

The chicks were divided into three groups, each of which was trained by a different method.

Group I, the whole method. The seven chicks, four males and three females, belonging to this group, were placed in the apparatus with all three partitions in place. They were thus confronted with the problem of learning as a whole the successive relationship involved in the series of differentially lighted, unlocked gates.

Group II, the serial method. The seven chicks in this group, three males and four females, were at first placed in the apparatus with only the rear partition in place. Since this is the partition in which the brightly lighted gate is always the free gate, their problem was to learn to choose the brightly lighted gate in whatever position it might appear, relative to the other two gates. As soon as this discrimination was established, to the point of nine correct choices out of ten, the middle partition was added. In this partition the unlocked gate is the one lighted with medium brightness. The third partition, in the front of the box in which the dimly lighted gate is the correct choice, was added after nine of ten correct choices had been made in the complete situation which the partial series presented. The

light areas not in use were covered by strips of black cardboard.

Group III. Test Method. The eight chicks of the third group, three males and five females were given a further modification of the problem. All the partitions were put in place, but only the front (dim) and middle (medium) were illuminated. The rear partition was left unlighted, and a strip of black cardboard was slipped under the black oilcloth floor covering so that it covered the light area ordinarily exposed by the holes in the floor covering. To keep the chicks of this group from establishing one particular route through this partition, two of the gates were locked, the one being left open which was illuminated brightly in the same arrangement for the other two groups. The wires of this gate were drawn across and fastened to the back of the frame from which the wires were hung. As soon as nine of ten perfect runs had been completed with this arrangement, the gates were all unlocked, the light areas illuminated as for the same arrangement for the other groups, and a record was kept of the path each chick took as he went through this compartment.

3. Number And Arrangement of Trials.

Work was begun when the chicks were thirteen days old. On the first day they were given two modified trials to accustom them to the apparatus and to finding their food in the feeding box. With the appropriate arrangement of partitions for each group, but with low illumination (25 watt globes in the lighting apparatus) and all the gates free, they were allowed to go through in groups of three or four. The second time they went through alone, or in pairs. The latter method was used only when a chick did not go when placed in the choice box alone.

On the second day, they went through twice, individually, with the exception of two chickens, who were placed in the choice box at the same

time. The apparatus was lighted with 50-watt globes and the slides were in place., producing the differential brightnesses for the gates. All gates were free. The following day they went through once, with all the differential brightnesses, as on the preceding day, but with only the correctly lighted gates free. The change was rather abrupt, and caused a good deal of excitement in the chicks, so two more trials were given on the next day with the wires of the correctly lighted gates fastened back to the upper bar of the gates. From this time on the trials proceeded without any further irregularities. Training continued from this point for one hundred eighty-five trials, covering fifty-six days, an average of 3.4 trials per day. The chicks were seventy-two days old when the experiments were terminated. Thus, at an age twenty-nine days less than that of the preliminary group, the main group had completed seventy-one more trials than were made by the preliminary group.

The number of trials per day varied from one to six. On one day, only one trial was given; two trials were given on nine different days; three trials on eleven days; four trials on twenty-four days; five trials on five days and six trials on two days. One three consecutive days, Feb. 15 to 18, and on one other day, Feb. 23, no trials were given. The experimenting was done from eight-thirty to about eleven each morning and in the evening, beginning at four-thirty. On typical days, four trials were given, which were divided evenly between the morning and the afternoon experimental periods.

Because of the variations in numbers of trials per day, and for convenience of treatment, the data are arranged throughout this paper in

intervals of five trials. Such treatment is probably sufficiently refined to disclose the main trends in the progress of the learning, although unavoidably, it obscures many of the details of the chicks' performances, which could, in fact, only be brought out by a detailed account of each trial, and, in many cases, by nothing short of actual observation of the animal's movements.

4. Records. Records were kept which represented as nearly as the observer was able to do, the main features of each chick's activity during each trial. A drawing was made of the path which the chick followed from the start to the feeding box, showing the number and order of the errors made, and the position in which each error took place. An error was counted each time a chick pushed his head between the wires of a gate, or otherwise attacked it with sufficient force to have enabled him to go through had the gate been free. Very light touches or pecks made at the wires with the bill, in the nature either of uncertain tendencies falling short of a complete attempt to go through the gate, or of a phase of visual exploratory behavior, were not counted as errors. Time was kept for each complete run, beginning as the chick entered the first compartment, and ending as he pushed through the free gate of the last partition. In some cases, where unusually long times were spent in a particular compartment, this time was kept separately. Qualitative records of the chick's behavior were also made whenever this behavior seemed to warrant special note.

5. Changes in Method Made During Series.

Two changes were made in the apparatus and procedure during the course of the series of experiments. The first had to do with the arrange-

ments of light areas, and the second with their reflection in the mirrors.

An attempt was made at the outset to prevent the choices of the chicks from being influenced by the positions of the correct brightnesses. It was therefore arranged that each position of the correct choice, right, middle, and left in each partition, should appear an equal number of times in a chance order, in each six trials. It developed, however, that the chicks began to show a tendency to make errors to the end positions, disregarding the middle position, since, in any series of six trials, the position of one or other of the ends would appear twice as frequently as the middle position. To correct this apparent defect in the arrangement, six more paths were added to the series, so arranged that, in each partition, the middle position appeared as many times as the right and left positions combined.

The second change made was the removal of the mirrors. From the first, the chicks showed a considerable interest in their mirrored images. They often stopped and looked in the mirrors, or jumped at them, sometimes repeatedly in one position or in one compartment. This increased the time required for their runs, and seemed to produce a considerable amount of confusion. A similar result had been noticed upon the first introduction of the mirrors in the preliminary experiments, but it had soon been overcome, and the mirrors were practically disregarded, even when the chicks became so large that they had to lower their heads to go under the mirrors. It was expected that a like effect would be produced in these chicks by the continued use of the mirrors, but when this result had not appeared at the fifty-third trial, they were removed. With the removal of the mirrors, the

partitions were moved up so that they were placed upon the middle of the light areas, instead of at their rear edges, (see Plate II, position B), so that the gates themselves would receive more complete illumination than was possible when the partitions were set on the edges of the light areas.

The difference in the behavior of the two groups of chicks toward the mirrors may have been due to the difference in maturity. With the preliminary group, the mirrors were introduced on December second, when the chicks were thirty-nine days old. With the main group, however, the mirrors were present from the first practice trial on their eleventh day, until February twenty-sixth, their thirty-sixth day of age. It is possible that these chicks might have grown to disregard the mirrors as the earlier group did, but, since they were clearly acting as a distraction, it was thought better to remove them rather than to wait for a possible changed reaction toward them.

V. RESULTS

1. Young chickens can respond to successive relationships of the degree of complexity involved in the conditions of this experiment.

The fourteen chicks of groups I and II were observed throughout the course of one hundred eighty-five trials (disregarding the practice series) in a situation requiring for its correct solution the perception of a series of three mutually related arrangements of brightnesses. Of these fourteen chicks, eleven, or 78.6% had learned the procedure judged by a standard of nine of ten correct, complete responses at the close of the experimental period.

Of the eight chicks of group III for whom the learning problem consisted of a series of two successive choices, all of the six chicks whose trials were continued to the end of the series had learned the problem. The other two, who were very slow learners, were dropped before the end of the series. It is useless to conjecture whether they would have mastered the problem if it had been presented to them continuously until the end of the series. Detailed material will be presented only for groups I and II.

Table I presents a summary of the performance of each chick of group I, showing his errors, successes and average time in each successive group of five trials, together with the averages for all seven chicks, and the per cents of success for the entire group. Although the numerical series of trials, shown in the first column of the table, extends from 4 to 191, trials number 112, 137 and 143 were omitted except with group III, making the actual number of trials for each chick, except where noted, one hundred eighty-five.

Table II presents corresponding summaries for the chicks of group II. It differs from table I in two respects. First, since the problem was presented to this group in a serial fashion, the table shows, by the use of asterisks, the point in the series at which each new partition was added to the apparatus for each chick. Second, since the introduction of new complications were made when the previous one had been solved by each chick at his own rate, a given group of five trials may represent quite different problems as between individuals. For this reason, group averages have not been used.

Inspection of the tables shows a very definite improvement, especially throughout the earlier part of the learning, in the performance of all the chicks, on the basis of all three of the quantitative methods used. Even in those chicks, Numbers 6 and 7 of group I and Number 20 of group II, who did not complete the learning of the problem, much improvement is shown throughout the series. Although failing to reach a standard of performance which indicates consistency of successive choices, yet the performance of all three developed well above what might have been expected upon the basis of chance. The degree to which even these less capable birds responded appropriately to the situation is shown by a comparison of their performances during the first twenty-five and the last twenty-five trials of the series, disregarding the last ten trials, during which the absolute brightnesses were altered. Number 6's record for the first twenty-five trials shows no successes, an average time of 56 seconds per trial and an average of 25.5 errors per group of five trials, as compared with his record for the last twenty-five trials, showing a total of 13 successes, 30 seconds average time, and 4.2 error per group of five trials. In the

TABLE I (a)

ERRORS, SUCCESSES AND AVERAGE TIME FOR EACH FIVE TRIALS FOR CHICKS 1, 2, 3
AND 4 OF GROUP I

Trial Numbers	No. 1 (f)			No. 2 (f)			No. 3 (m)			No. 4 (m)		
	E	S	AT	E	S	AT	E	S	AT	E	S	AT
(1) 4-8	26	0	63	23	0	59	25	0	60	38	0	170
(2) 9-13	46	1	107	29	1	103	38	0	104	27	0	86
(3) 14-18	36	0	120	50	0	117	31	0	111	29	0	128
(4) 19-23	28	1	82	57	0	130	15	0	58	23	0	77
(5) 24-28	24	1	74	48	0	90	69	0	215	20	0	70
(6) 29-33	25	1	64	18	1	49	14	0	41	9	1	62
(7) 34-38	10	1	37	69	1	92	39	0	66	62	0	138
(8) 39-43	34	0	68	32	1	48	16	2	53	46	1	141
(9) 44-48	12	1	118	27	0	49	44	0	114	38	0	96
(10) 49-53	23	1	51	13	0	27 ¹	15	2	53	25	0	106
(11) 54-58	16	0	80	16	0	28 ¹	23	1	53	10	1	58
(12) 59-63	12	0	30	4	2	22	19	1	58	25	0	79
(13) 64-68	25	0	72	12	2	19	36	0	59	8	0	55
(14) 69-73	32	1	53	31	1	52	9	2	39	3	3	45
(15) 74-78	10	1	40	19	1	38	9	0	40	8	2	49
(16) 79-83	9	0	42	11	2	30	7	1	44	4	2	56
(17) 84-88	14	1	41	16	0	44	4	3	38	4	3	54
(18) 89-93	24	0	75	8	1	38	4	3	56	9	2	71
(19) 94-98	6	2	25	4	2	34	2	4	39	2	3	54
(20) 99-103	13	1	32	6	3	33	1	4	27	3	2	51
(21) 104-108	15	2	88	5	3	28	2	3	40	3	3	54
(22) 109-114	14	1	33	5	2	33	0	5	30	8	2	47
(23) 115-119	9	2	30	9	1	31	1	4	17 ¹	1	4	41
(24) 120-124	4	2	28	11	1	29	0	4	20 ¹	3	3	47
(25) 125-129	16	0	45	4	2	30	1	4	21	0	5	57
(26) 130-134	2	3	37	3	3	23	0	5	19	0	5	50
(27) 135-140	21	0	37	5	2	30	1	4	21	5	3	71
(28) 141-146	5	2	24	6	2	22	1	4	23	2	4	71
(29) 147-151	2	4	26	0	5	23	1	4	20	1	4	61
(30*) 152-156	5	2	33	6	1	20	0	5	17	1	4	42
(31) 157-161	0	3	21	2	2	27	1	4	25	5	4	62
(32) 162-166	1	4	26	3	3	27	0	5	23	1	4	47
(33) 167-171	2	3	35	6	3	31	0	5	15	2	4	51
(34) 172-176	0	5	32	1	4	35	0	5	17	0	5	64
(35) 177-181	1	4	37	0	5	19	0	5	19	1	4	53
(36) 182-186	0	5	24	0	5	32	0	5	26	0	5	61
(37) 187-191	0	5	31	3	3	40	2	3	25	1	4	47

E, errors; S, successes; AT, average time

1 Only 4 trials

TABLE I (b)

ERRORS, SUCCESSES AND AVERAGE TIME FOR EACH FIVE TRIALS FOR CHICKS 5, 6, 7
AND AVERAGE OF GROUP I

Trial Numbers	No. 5 (m)			No. 6 (m)			No. 7 (f)			Av. Group I		
	E	S	AT	E	S	AT	E	S	AT	E	%S	T
(1) 4-8	26	0	209	25	0	67	18	1	42	26.0	2.8	96
(2) 9-13	26	0	114	20	0	52	33	0	85	31.3	5.6	93
(3) 14-18	25	0	134	14	0	43	28	1	74	30.4	2.8	104
(4) 19-23	15	1	84	19	0	58	41	0	107	28.3	5.6	85
(5) 24-28	47	3	145	23	0	59	38	0	233	38.4	11.4	126
(6) 29-33	28	0	110	43	0	82	16	2	90	21.9	14.2	71
(7) 34-38	43	0	89	27	1	70	27	1	62	39.6	11.4	78
(8) 39-43	46	0	107	16	1	41	51	0	153	34.4	14.2	87
(9) 44-48	53	0	143	24	2	59	18	2	97	30.9	14.2	96
(10) 49-53	24	0	120	13	1	33	17	1	78	18.6	14.2	69
(11) 54-58	9	1	48 ¹	19	0	55	17	0	58	15.7	8.3	54
(12) 59-63	10	0	36	8	2	27	6	1	34	16.0	17.2	41
(13) 64-68	16	1	72	11	1	24	6	1	26	20.0	14.2	47
(14) 69-73	7	2	47	13	0	27	17	0	39	16.0	26.0	43
(15) 74-78	4	2	32	21	1	46	6	0	31	11.0	20.0	38
(16) 79-83	4	3	32	18	0	40	9	2	35	8.9	28.0	40
(17) 84-88	3	4	42	10	2	43	6	3	24	8.1	46.0	41
(18) 89-93	20	3	67	10	1	53	6	1	38	11.6	32.0	57
(19) 94-98	5	3	38	9	1	46	3	3	32	4.4	52.0	38
(20) 99-103	6	3	37	9	2	42	3	2	32	5.9	48.0	36
(21) 104-108	8	2	45	11	1	43	6	1	38	7.1	42.0	48
(22) 109-114	4	3	30	4	2	32	3	2	42	5.4	48.0	35
(23) 115-119	2	2	24 ¹	6	2	51	6	2	30	4.8	48.0	32
(24) 120-124	0	5	30	5	1	33	3	3	28	3.7	54.0	31
(25) 125-129	2	3	35	10	2	42	5	3	37	5.4	54.0	38
(26) 130-134	2	4	39	8	2	37	3	3	26	2.6	72.0	33
(27) 135-140	4	3	25	7	1	40	4	3	33	6.7	46.0	37
(28) 141-146	1	4	32	10	2	45	11	0	24	5.1	52.0	34
(29) 147-151	0	5	20	11	1	32	3	3	19	2.6	74.0	29
(30) 152-156	0	5	25	9	2	26	7	1	27	4.0	58.0	27
(31) 157-161	0	5	39	4	1	30	1	4	21	1.9	66.0	32
(32) 162-166	0	5	16	5	3	32	1	4	27	1.6	80.0	28
(33) 167-171	0	5	23	6	2	33	4	2	33	2.9	68.0	31
(34) 172-176	0	5	31	2	4	24	2	3	21	0.71	88.0	32
(35) 177-181	0	5	28	4	3	31	0	5	18	0.86	88.0	28
(36) 182-186	0	5	35	1	4	22	5	2	30	0.86	88.0	33
(37) 187-191	0	5	54	5	2	29	2	3	30	1.9	72.0	37

E, errors; S, Successes; AT, average time

1 Only 4 trials

TABLE II (a)

ERRORS, SUCCESSES AND AVERAGE TIME FOR EACH FIVE TRIALS FOR EACH OF THE SEVEN CHICKENS OF GROUP II

Trial Numbers	No.16 (f)			No.17 (f)			No.18 (m)			No.19 (m)		
	E	S	AT	E	S	AT	E	S	AT	E	S	AT
(1) 4-8	8	3	104	6	3	23	7	3	12	1	4	64
(2) 9-13	30	0	351	2	3	9	12	3	36	14	1	37
(3) 14-18	16	2	45	11	2	23	0	5	18	1	4	13
(4) 19-23	17	1	40	2	3	8	0	5	11	0	5	5
(5) 24-28	15	1	49	2	4	10	*35	0	239 ⁵	*21	2	69 ⁶
(6) 29-33	6	2	30	1	4	7	13	1	96	18	0	122
(7) 34-38	3	3	12	0	5	7	6	4	32	12	2	31
(8) 39-43	1	4	11	*11	2	33 ³	15	1	44	7	1	38
(9) 44-48	1	4	8	20	1	165	15	1	37	52	3	64
(10) 49-53	0	5	9	33	1	152	7	4	53	15	2	42
(11) 54-58	*26	0	62	15	1	78	2	4	16	3	4	16
(12) 59-63	37	1	83	39	0	142	21	2	46	23	4	42
(13) 64-68	16	1	51	13	2	45	15	3	48	0	5	16
(14) 69-73	8	1	36	7	2	27	10	2	38	*17	2	47
(15) 74-78	17	0	53	10	1	35	3	2	44	6	2	37
(16) 79-83	11	2	48	9	1	34	8	0	34	7	0	43
(17) 84-88	1	4	32	1	4	25	1	4	20	3	3	46
(18) 89-93	9	2	75	1	4	23	4	2	32	3	3	41
(19) 94-98	1	4	25	2	3	24	2	4	70	2	3	37
(20) 99-103	* 0	5	22 ¹	1	4	14	2	3	18	0	5	36
(21) 104-108	9	1	50	2	4	22	0	5	27	1	4	37
(22) 109-114	8	1	73	1	4	14	*12	3	82 ⁶	1	4	31
(23) 115-119	13	2	53	0	5	20	3	3	50	2	3	34
(24) 120-124	2	3	49	* 8	3	26 ⁴	2	4	34	4	3	36
(25) 125-129	3	2	33	5	0	54 ¹	2	3	75 ¹	2	4	26
(26) 130-134	1	4	30	10	2	64	1	3	32 ¹	0	4	29 ¹
(27) 135-140	7	1	35	13	0	57	0	5	32	0	3	15 ⁷
(28) 141-146	0	5	30	0	5	29	2	4	23	0	5	29
(29) 147-151	0	5	23	0	5	14	5	4	33	1	4	28
(30) 152-156	3	4	27	2	3	29	0	5	17	0	5	22
(31) 157-161	2	4	32	2	3	33	0	5	21	0	5	36
(32) 162-166	0	5	27	1	4	44	0	5	23	0	5	38
(33) 167-171	0	5	42	0	5	38	0	5	10	1	2	15 ⁷
(34) 172-176	4	3	33 ²	1	4	40	1	4	20	2	3	24 ¹
(35) 177-181	0	5	28	0	5	46	2	4	24	1	4	32
(36) 182-186	0	5	39	1	4	76	2	4	20	0	5	36
(37) 187-191	1	4	34	4	2	38	1	4	26	0	5	45

E, errors; S, successes; AT, average time; * group of trials in a course of which a new partition was introduced.

1. Includes 4 trials with 2 partitions and 1 trial with 3 partitions.
2. Includes only 4 trials.
3. Includes 4 trials with 1 partition and 1 trial with 2 partitions.
4. Includes 3 trials with 2 partitions and 2 trials with 3 partitions.
5. Includes 1 trial with 1 partition and 4 trials with 2 partitions.
6. Includes 2 trials with 2 partitions and 3 trials with 3 partitions.
7. Includes only 3 trials.

TABLE II (b)

ERRORS, SUCCESSES AND AVERAGE TIME FOR EACH FIVE TRIALS FOR EACH OF THE SEVEN CHICKENS OF GROUP II

Trial Numbers	No.20 (f)			No.21 (m)			No.22 (f)		
	E	S	AT	E	S	AT	E	S	AT
(1) 4-8	11	2	20	20	3	100	3	3	23
(2) 9-13	1	4	8	11	3	55	8	3	51
(3) 14-18	0	5	8	6	1	28	3	2	13
(4) 19-23	4	2	14	3	4	33	0	5	9
(5) 24-28	*16	2	148 ¹	0	5	47	1	4	22
(6) 29-33	25	0	104	4	3	28	*5	3	45 ¹
(7) 34-38	44	0	85	2	4	8	12	1	41
(8) 39-43	40	1	106	2	3	14	18	1	45 ⁵
(9) 44-48	24	1	68	1	4	13	32	1	101
(10) 49-53	14	0	33	0	5	6	23	1	144
(11) 54-58	15	0	32	*10	1	27	14	1	52
(12) 59-63	6	2	21	25	1	88	5	2	35
(13) 64-68	15	1	32	20	0	51	11	1	57
(14) 69-73	9	1	21	18	2	46	6	2	58
(15) 74-78	4	1	21	17	0	61	3	3	29
(16) 79-83	8	2	22	5	1	52	10	1	47
(17) 84-88	5	4	19	24	0	99	2	3	35
(18) 89-93	2	3	18	2	4	41	7	3	34
(19) 94-98	5	2	18	5	2	43	9	2	36
(20) 99-103	2	3	14	4	3	32	4	3	32
(21) 104-108	5	2	20	0	5	58	3	4	50
(22) 109-114	1	4	9	*10	3	58 ⁴	0	5	29
(23) 115-119	6	1	12	11	2	63	*2	4	38 ⁶
(24) 120-124	2	2	26	5	2	58	37	1	125
(25) 125-129	-	-	- ²	10	1	62	18	0	95 ³
(26) 130-134	*7	1	25 ³	2	3	66 ⁵	8	3	56
(27) 135-140	13	2	23	3	3	67	9	1	59
(28) 141-146	31	0	118	0	5	77	5	3	38
(29) 147-151	2	3	19	1	4	54	2	4	36
(30) 152-156	9	1	25	4	3	59	0	5	27
(31) 157-161	12	1	31	0	5	58	3	3	51
(32) 162-166	4	1	14	0	5	64	2	4	36
(33) 167-171	7	1	20	0	5	46	1	4	24
(34) 172-176	3	2	20	0	5	50	2	4	29
(35) 177-181	7	2	22	0	5	66	0	5	25
(36) 182-186	3	3	25	0	5	65	0	5	26
(37) 187-191	9	2	28	1	4	53	2	3	38

E, errors; S, successes; AT, average time; * group of trials in a course of which a new partition was introduced.

1. Includes 1 trial with 1 partition and 4 trials with 2 partitions.
2. No. 20 did not make this group of trials.
3. Only 3 trials.
4. Includes 2 trials with 2 partitions and 3 trials with 3 partitions.
5. Only 4 trials.
6. Includes 4 trials with 2 partitions, and 1 trial with 3 partitions.

case of Number 7, the improvement is even more marked. Her beginning record shows 2 successes, an average time of 108 seconds per trial and 31.6 errors per group of five trials, as compared with a terminal record of 18 successes, 24 seconds and 1.6 errors. It is more difficult to make a comparison in the case of Number 20 in group II, as the ^{beginning} twenty-five trials were, of course, made in much simpler situations than the final twenty-five. Since, however, Number 20's record shows just ten groups of trials on the completed situation, a comparison can be made between the first and last halves of this part of the series. It must be borne in mind that the time relations in this case are much different from those of the comparisons made above, where 35 days and 129 trials elapsed between the end of the initial and the beginning of the terminal groups of trials compared, while in the case of Number 20, the two groups were consecutive. A slight inaccuracy is also introduced here in Number 20's case due to the fact that two trials were omitted in the first group. Successes in the two groups were the same, 7, average times were 62 seconds for the first as compared with 51 seconds for the second group of twenty-five trials, and 12.4 errors per group of five trials as compared with 6 for the last group. Thus, although Number 20 shows no real improvement in this comparatively short period, that is, no increase in perfect trials, she does show improvement in both the incidental measures, time and errors.

2. There is no substantial difference between the efficiency with which the chicks of groups I and II learned the problem.

It was stated above that of the three chicks that failed to complete the problem at the end of the experimental series, two belonged to group I and one to group II. On the face of it, this appears to show a

marked superiority of the second as compared with the first method. However, the individual differences which will be indicated later between the performances of different chicks within the same group, and the remarkable similarities which will be shown to obtain between the two groups, make it seem doubtful whether this is a valid measure of comparison, especially since the personnel of the two groups represents a random selection of very young chicks. Furthermore, the only unhealthy chick of the fourteen was Number 6 of group I, one of the two chicks that failed to complete the learning. Due to a severe case of diarrhea, his early development was slow and his general vitality was below that of the other chicks.

The discussion of this topic will be presented in three parts. First, the data for group I will be presented in detail; second, a similar treatment will be made for group II; and, third, the performance and general behavior of the two groups will be compared.

A. Group I, the whole method

Plates III and IV represent graphically the course of the learning of all seven chicks of the group combined, in terms, respectively, of errors made and per cent of right trials for each group of five trials. The data for the main curves is presented in Table I, pages 20 and 21. The two graphs present further, an analysis of each of the main curves, showing the errors and the per cents of right trials for each brightness-position. Thus, the main error curve shows the sum of the errors represented in the other three curves at each interval, while the success curve represents what we may term the synchronizing of successful choices, a right trial in the main curve representing three right trials in the subsidiary curves only when they occurred in the relations to one another specified by the

DISTRIBUTION OF AVERAGE ERRORS

FOR CHICKS (7)

OF

GROUP ONE

IN INTERVALS OF FIVE TRIALS

PLATE III.

DISTRIBUTION OF PERCENTS OF RIGHT TRIALS.

IN EACH FIVE TRIAL INTERVALS

FOR SEVEN CHICKS OF GROUP ONE.

PLATE IV.

by
G. A. B.

conditions of the problem. This explains the fact that, whereas the four curves of Plate III maintain a constant relation to one another throughout the diagram, the curve of completely successful trials tends to approach more nearly the course of the subsidiary curves as the number of trials increases.

For the purposes of our investigation, the error curve has less validity than the success curve. It will be seen from the curves that the rapid rise of errors in the fourth and fifth intervals is not accompanied by a corresponding decrease in per cents of success, but on the contrary, the per cent curve continues its steady rise which reaches its peak at the sixth group, where the error curve takes such a steep decline that it would lead one to expect a spurt of success instead of the continuation of the same slow increase. As a matter of fact, the error curve discloses a condition that the curve of right trials does not disclose, that is, the conflict of methods which the chicks were using at this stage of the learning, and which was just beginning to reach its most extreme expression. That the chicks were developing an appreciation of the relative light situation is shown by the steady rise of the success curve, but the individual error records, on the other hand show that they were possessed with another strong tendency to choose the end positions in preference to the middle position, thus running up a large error score in those compartments where the correct brightness was in the middle, by running back and forth, trying repeatedly at both ends of the partition, and disregarding the right choice in the middle. At this point also, the distraction caused by the mirrors had reached rather large proportions. The sharp drop in errors in the sixth group, accompanied, as noted above, by simply a continued easy slope in successes, may have been due to the temporary elimination of the mirrors, made at the thirty-second trial, thus affect-

ing two of the three trials in this group. A further reason for the reduction of errors may have been the good condition of the chicks due to their having been put out in the sun on the previous day. It is quite probable that daily variations of living conditions, which it was not always possible to control adequately, had a considerable influence upon the scores made.

It will be noted that in the next group of trials, the seventh, the error curve reaches its highest peak, and there corresponds a slight falling off of successes. This part in the curve corresponds with the point in the series at which the new arrangement of runs was introduced, doubling the number of centrally located right choices. So great a change in the whole situation, involving, as it did, the doubling of the number of appearances of that choice which was already the most difficult of the three, together with the earlier removal of the mirrors which undoubtedly made a marked alteration in the appearance of the partitions, evidently produced the very large increase of errors and falling off in successes noted above. It is very interesting to note how quickly the chicks began adjusting themselves to the altered conditions, however, in terms of the rapidly falling error curve, and the regaining, within the next group of five trials, their old high point of successes.

In order to find whether the mirrors were of any practical value, they were replaced at the forty-third trial, the last trial of the eighth group, and left until the fifty-third trial, the last one of the tenth group. Although the distraction as evidenced by looking and jumping toward the mirrors was renewed, the error curve was not affected, as it is seen to continue a steady decline through the twelfth group of trials. That

the alteration of this feature of the apparatus had some real influence on the chicks' responses, despite the evidence of the error curve, is shown in the drop in the success curve for the eleventh group, that immediately following the removal of the mirrors. From this point on, a sharp rise shows itself in the success curve, and a fairly constant drop in the error curve, subject, of course, to the variations of conditions involved in feeding, airing, the general physical alertness of the birds, differences in handling and other uncontrolled factors. An extreme example of such effects is shown in the course of the success curve at the twenty-seventh and twenty-eighth groups, where a serious case of over-feeding occurred.

As to the distribution of errors made, as between each of the three differential brightnesses, Plate III shows the curve for the dim higher throughout than the other two curves, and the curve for the bright the lowest in general throughout the diagram. The combined records for the total experimental series shows that, of the total of 3276 errors made by all the birds during the 185 trials, 42.2% were made in choosing the dim light in the first compartment, 36% in choosing the medium light in the middle compartment, and 21% in choosing the bright light in the last compartment. These figures indicate that the bright light was more quickly and easily differentiated out from the whole situation, in terms of its own position in the series than were the other two lights. If it indicated a preferential learning of the bright-response as a unitary, absolute brightness response, not only would the correct brightest-response have been made with fewer errors than the other responses, but it would also follow that the greatest actual number of errors would have been made by choosing the brightest light in preference to the other two lights

when the latter appeared in their right positions in the series. That the early differentiation of the brightest light was a differentiation of the brightest in its relation to the series of brightnesses, is shown by the fact that the error of choosing the brightest light in preference to the right light in any compartment was the most infrequent error made. This error occurred actually 890 times, constituting 27.2% of the total errors, which was 181 times less than the error of choosing the dim in the wrong situation, which constituted 32.7% of the errors. Although this is only a small difference in terms of percentage, it is a very significant one in terms of the fact noted above as to the earlier and more consistent choice of the brightest light in its own place in the series. Errors to the medium light in the wrong relations, constituting 40.1% of the total mistakes made might, in part, be designated "good errors", since this light bears more resemblance in either the first or last partition to the correct light, than does the other light of the three.

The illuminometer readings indicate that the objective brightness of the brightest light was so much above that of the other two lights that one is tempted to infer that the chicks, in differentiating the brightest light more quickly, responded to this further relationship among the lights, which had not been taken into consideration in the planning of the experiment.

Since the performance of the individual animal is entirely obscured in the plotting of group averages, and since it is, after all, with the learning of the individuals that we are ultimately concerned in such groupings, a set of graphs is presented in Plate V, showing the course of the learning in terms of gross errors and successes for four chicks of group I

DISTRIBUTION OF ERRORS and PERCENTS OF SUCCESSES
for FOUR CHICKS
of
GROUP ONE

in intervals of ten-trials.

in terms of intervals of ten trials, to serve as a sample of the course of the individuals' learning.

One of the first characteristics of these curves to strike one is that in all of them except that of Number 1, the error curve rises instead of decreasing as it might be expected to do during the first thirty or forty trials. Examination of the original records of each run shows that all the chicks with the exception of Number 1 were strongly inclined during the period between about the tenth and the fiftieth trial to disregard the middle position when it happened to be the right choice and make repeated attempts at the two end positions. Number 1 made obvious errors of this type in only two trials during this period. Next in order is Number 6, with 7 such errors, Number 3 with 12; Numbers 5 and 7 with 14 each, Number 4 with 15 and Number 3 with 18. Since the first ten trials were practically free of errors of this type, and they increased in the typical case toward the trials between the twentieth and fortieth, sometimes involving as many as twenty or more errors in one attempt at a given partition, this accounts, in part at least, for the peculiar shape of the curves. Number 1, although not showing this tendency during the early period of the learning, did develop it later. Five such performances between the sixty-fourth and seventy-third trials account for the sharp rise in her curve at the seventh interval of ten trials. Another factor which probably affects the curves slightly is that the small chicks early in the learning, occasionally forced themselves between the wires of a locked gate. In tabulating the errors, this sort of performance was counted as two errors, but it is probable that a chick in a similar circumstance that did not squeeze between the wires would have made a larger error score

than that arbitrarily allowed. This behavior was soon overcome as the chicks became larger, and also began to learn the correct way through. Only in the cases of chicks Number 6 and 7 did this behavior persist for any considerable length of time.

The second striking fact which these curves bring to light is the appearance of rather sudden and consistent spurts of improvement. The success curves for Numbers 3 and 5 show this most clearly, and one or two such sharp rises are to be found in each curve. In the cases of Numbers 6 and 7, the two chicks that failed to complete the learning, the rises are less marked and less extensive than for the other chicks.

Another interesting observation to be made from a comparison of these curves with one another is the striking individual differences between chicks in the particulars of form and extent of the curves. The difference between the curves for Number 3 and Number 6, for example, are most striking. Taking for example, a comparison between chicks whose final results in the experiment were more similar, very striking individual differences are apparent between Numbers 1 and 5. The degree of individual difference between the chicks actually learning the problem is shown by the number of trials each made in the series after having reached the test standard of nine out of ten correct trials. Disregarding the last ten trials in which the light relations were changed, Number 2 made only one trial (correct) after having reached the standard. Number 1 made 14 trials (11 or 78.6%—see Table V, page 39 --correct); Number 5, 29 trials (all correct); Number 4, 47 trials (38, or 80.8% correct); and Number 3, 62 trials (57, or 91.1% correct).

B. Group II, the Serial Method

As noted in the first part of this section, results for group II cannot be handled in terms of averages because of the differences in the rate of learning, and consequently the differences in complication of the problem that the chicks were performing during a given period of the learning series. Table II shows the extent of variation; in learning to choose the bright light when a single partition was in place, the standard was reached at the nineteenth by the fastest chick; and at the fifty-second trial for the two slowest; in learning to choose the medium and the bright when two partitions were in place, the final trial of standard performance ranged from the sixty-fifth to the one hundred eleventh trial; for the final standard of choosing the dim, the medium and the bright in their respective serial relations when all three partitions were in place, from the one hundred fifth to the one hundred fifty-third trial. Although Number 20 had not thoroughly learned the M-B combination she was placed, by error, in the completed situation on the one hundred thirty-first trial, and was kept on that arrangement till the end of the series. She failed to complete the learning. The actual number of trials on a given new combination does not in every case correspond exactly with the difference between the final standard trial for that combination and the final standard trial of the preceding set. In some cases the chicks were run a few trials past their standard, to complete a day's runs. Variations of this type are slight, and have not been disregarded in constructing the table.

Plates VI to VIII present sample performances of the seven chicks of group II throughout the training series. Graph A of each plate shows

PLATE VIII.

TABLE III

Number of trial at which each chick of group II reached standard performance for each degree of complication, and per cent of success in trials following final standard.

Chick number	Standard I	Standard II	Standard III	Per cents right in after-period
16 (f)	52	102	150	90
17 (f)	37	115	150	80.6
18 (m)	19	109	138	90.5
19 (m)	22	65	105	83.2
20 (f)	18			
21 (m)	52	109	147	91.2
22 (f)	25	113	153	88

I, II, III represent respectively complications of problem involving one, two and three partitions. Standard, nine right out of ten consecutive trials. After-period, the period of trials following completion of standard performance, on completed problem.

Note: Number of trial based on complete series, including three preliminary practice trials. This is done in order that position of trial can be located in Table II.

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the percent of success for each chick in each group of five trials, and graph B the number of errors made in each five trials. The graphs represent separately the errors and right choices made at each of the three brightness differences.

On account of the repeated reference that must be made to the different complications of the successive brightnesses, the first arrangement, where the bright illumination was the correct choice will be referred

to as B. The second complication will be termed M, and the total situation as represented by the two partitions in conjunction, as M-B. Similarly, the third complication will be referred to as D, and the total situation as D-M-B.

The rather high point at which the B curve sets out in each graph may be accounted for in part at least by the fact that three preliminary practice trials had preceded the regular series. Thus a considerable amount of learning had already taken place at the outset in the simple problem involved in B. In one case (20) the curve of per cent right shows a sharp rise in the second group of five trials; in two cases, (16 and 19) a sharp decline; in four cases (18, 17, 21, 22) the score for the second is the same as for the first interval, with a rise succeeding in the case of 18, and declines succeeding in the other three.

With the introduction of M in every case except Number 20, the per cent of right trials in B falls below its initial level. Inspection of the curves will show that a similar effect is produced in the general response of the chicks with the introduction of D, as well. Table IV shows for each chick, the influence on the total response of the introduction of each new complication. Errors, average time and number of right trials are compared for the first ten trials of B, the last ten trials of B and the first of M-B, the last ten trials of M-B and the first ten trials of D-M-B.

With the introduction of the second partition with the choice of the medium brightness, the possibility of number of errors is increased; the time for each trial might be expected to increase with the addition of another obstruction in the path to the food box, and the chance for completely successful trials is reduced further by the necessity of "synchronizing"

right trials in the two choice situations. Further, and most important of all, the successive factor is introduced here for the first time. Table IV shows, as might be predicted, higher error scores, higher average time, except in two cases (16 and 21, whose average times were far above the general level in the first group of ten trials) and fewer complete right trials in the first ten trials of M-B than in the first ten trials of B. Based on the same argument, a similar reduction of efficiency should be shown with the introduction of the third partition, which increased possibilities of time and errors and added a further complication to the brightness succession. The remarkable thing brought out by Table IV, as well as being shown in the graphs, is that all three of the measures used, instead of showing the expected decrease of efficiency, show an actual increase of efficiency (with a few exceptions to be noted) over that shown with the introduction of the second partition.

TABLE IV

Comparison of responses of chicks before and after introduction of new complications.

	B: first ten trials	B: last 10 trials	M-B: first ten trials	M-B last 10 trials	D-M-B first ten trials
Chick 16					
Total errors	33	1	53	1	15
Average time	232.4	8.3	72.7	27.9	49.4
Errorless trials	3	9	1	9	3
Chick 17					
Total errors	8	3	53	0	23
Average time	16.2	8	129.5	15.7	55.4
Errorless trials	6	7	1	10	1
Chick 18					
Total errors	19	1	47	1	17
Average time	21.9	16.3	149.3	39.5	54.3
Errorless trials	6	9	2	9	6
Chick 19					
Total errors	15	1	49	23 ¹	23
Average time	21.9	7.4	101.1	29.5	46.3
Errorless trials	5	9	1	9	4
Chick 20					
Total errors	12	4	49	8	26
Average time	14.9	9.3	131.2	12.8	27.5
Errorless trials	6	7	1	5	3
Chick 21					
Total errors	31	1	35	1	23
Average time	77.9	9.6	57.5	44.9	65.9
Errorless trials	6	9	2	8	3
Chick 22					
Total errors	11	1	20	2	55
Average time	44.8	22.4	47	34.1	108.5
Errorless trials	6	9	3	9	3

Footnote: This high error score resulted from one badly confused performance. It is not characteristic of the group.

Comparing in detail the performances of each chick in the two situations, it is seen that Number 16 had fifteen errors in the latter as compared with sixty-three in the former situation; 49.4 seconds as compared with 72.7 seconds time, and 3 as compared with 1 complete successful run. Number 17 has 23 as compared with 58 errors; 55.4 seconds as compared with 129.5 seconds time, and the same amount of success, one complete right trial in each situation. Number 18 has 17 as compared with 47 errors, 54.3 seconds time as compared with 149.2 seconds; and 6 as compared with 2 complete successes. Number 19 has 23 as compared with 49 errors; 46.3 seconds as compared with 101.1 seconds; and 4 as compared with 1 right trial. Number 20 has 26 as compared with 49 errors; 27.5 seconds as compared with 131.2 seconds, and 3 as compared with 1 right trial. Number 21 has 23 as compared 35 errors; but his time score is reversed from the general trend, showing 65.9 seconds average time in the D-M-B situation as compared with 57.5 in the M-B situation. In the case of Number 7, the results are the opposite of this trend in two measure and negative in the third, with 55 errors for D-M-B as compared with 20 for M-B; 108.5 seconds for D-M-B as compared with 47 for M-B, and with an equal number of successes, 3 for the two situations. On the whole, then, the introduction of the last complication, caused less disturbance of the learned serial reaction than did the introduction of the serial situation in a simple spatial pattern. These facts argue for transfer of the successive principle to the new situation created by the introduction of a new step in the series.

C. Comparison of performance and general behavior of groups I and II.

The most obvious comparison of the complete performance of the two groups is that based upon the number of repetitions of stimulation given before the complete, correct response was developed to a determined standard

of efficiency. The first column of Table V shows that the completion of the learning for the five chicks of group I that finished, ranged from the 116th to the 180th trial, with an average of 149.4. These figures are based upon the whole number of trials, including the three preliminary, practice trials. For the six chicks of group II that completed the learning the last trials of standard performance range from 105 to 154, averaging at 140.5. Thus in terms of averages, group II shows a slight superiority, and its range is on the whole somewhat lower than that of Group I. In both groups there are two chicks that finished in less than 150 trials, but, while the slowest chick of group II finished at the 153rd trial, there are two chicks of group I whose training period extended well above this point, Number 1, at the 167th, and Number 2 at the 180th.

The second objective measure of comparison is average number of errors for each choice made. The number of actual choices made by the chicks of the two groups is quite different. The problem for group I involved from the beginning three differential choices in each trial, while for the second group, the trials in different parts of the learning period involved one, two or three choices. A comparative error or time score, therefore, must be based upon the number of right choices possible in the learning series of each chick rather than upon the gross number of trials. The actual number of possible right choices for the chicks of group I was 555 in the 185 trials of the regular series. With three chicks, Numbers 2, 4, and 7, one trial each was omitted, and with chick Number 5, two trials were omitted. The other two, Numbers 1 and 6 had 555 possible right choices each. In group II, on the other hand, the number of possible right choices for any given chick depended upon the rapidity with which he completed each part of the learning. The actual possible right choices for this group ranges from 361

TABLE V

Summary of general data for groups I and II

Chick Number	Final trial of standard	No. errors per choice	Ave. time per choice	Per cent right post-standard
(Group I)				
1	167	0.946	16.6	78.6
2	180	1.02	14.1	100.0
3	116	0.77	15.3	91.9
4	132	0.74	23.2	80.8
5	152	0.80	20.1	100.0
6	(not finished)	0.829	14	
7	" "	0.779	16.7	
Ave.	149.4	0.845	17.2	
(Group II)				
16	150	0.689	22.1	90.0
17	150	0.593	19.1	80.6
18	138	0.51	18.8	90.5
19	105	0.497	13.9	83.2
20	(not finished)	0.949	14.3	
21	147	0.572	23.7	91.2
22	153	0.66	20.4	88.0
Ave.	140.5	0.634	18.8	

to 449. Here again group II shows a slight advantage over group I, with an average error score of 0.634 for all seven chicks combined, as compared with 0.845 for all seven of group I. The range for group I is from 0.497 to 0.949, while for group II, from 0.80 to 1.02. The average times per choice for the two groups are almost identical, with only a slight superiority for group I. Average group times are 17.2 seconds for group I as compared with 18.8 seconds for group II, a very negligible difference. The range for group I is from 14 seconds to 23.2 seconds; for group II from 13.9 seconds to 23.7 seconds. The last column of Table V shows the per cent of right trials for each chick for the continuation of the experiment after the arbitrary standard of completion had been reached. The three highest scores, 100% for Number 5 and for Number 2 (only one trial in the latter case) and 91.9% for 3, and the lowest score, 78.6% for Number 1, belong to group I. With the exception of the high score of Number 5, the range for group II is practically the same, extending from 80.6% to 91.2% right trials.

It is quite possible that a large share of whatever superiority these objective measures indicate can as well be attributed to the processes of increasing maturity in the chicks as to the methods employed in the two phases of the problem. The very young chicks in the early part of the experiment were more highly active than they were at later stages of their growth. Their movements were quicker and more headlong. They often rushed at the locked gates and threw themselves against them with enough force to almost upset themselves, while as they grew older, their whole rate of movement, at any rate in proportion to their size of body, was appreciably slowed up, both outside as well as within the experimental situation.

They became less precipitate, and were more cautious in making attempts at the gates. Since the chicks of group II were presented with a much simpler problem during this early period, the alteration in their own normal form of behavior was to their advantage by the time the new complications were added to the problem. Furthermore, their initial adaptation to the general nature of the experimental situation was made under simpler and less confusing circumstances. A further incidental factor may also have been effective in this situation, in that the distraction of the mirrors which had been removed well before any of the chicks of group II had reached the complete complication of the problem, was an influence in every one of the three choices of the chicks of group I from the start.

Group comparisons among small groups of chicks, especially when the work is begun at an early age, have an unavoidable element of unreliability. It is evident from a study of their performances after the experiments have been completed that some chicks have responded more effectively than others under the given conditions of care, handling and stimulation provided by the conditions of the experiments, but it is impossible to equate the groups beforehand in terms of a random selection of very young chicks, all of whom look and act very much alike.

The facts presented in the discussion of the detailed performance of group II indicate that there is less essential difference between the whole method and the serial method as used in these experiments than the names imply. It will be recalled that the performance of group II (see Plates VI to IX) did not consist in the learning of one part, followed simply by the learning of another part of the problem. The introduction of each new complication practically constituted an entirely new problem

in which the previously learned parts took on new relationships, a process which involved temporary decrease in the efficiency of the response to the formerly learned processes themselves. Just as the efficiency of the chicks of group I increased with repetition of the stimulus situation, so the efficiency of the chicks of group II increased in meeting the new, but related problem of the introduction of the third brightness situation as compared with that of the second.

On the whole, then the differences between the total performances of the two groups were very much alike not only in terms of objective measures, but also in terms of the essential nature of the processes of developing adjustment to the main features of the problem presented in common to the two variations of method.

3. Alterations made in the actual intensities of brightness indicate that the responses of the chicks were in terms of brightness relations rather than of absolute brightnesses.

It seemed of considerable importance to discover whether the choices of successive brightnesses were based upon a perception of absolute brightness or were characterized by a response to the relationship existing among the three brightnesses with respect to one another in the perceptual field constituted ^{by} the whole situation of the differentially lighted partition. To this end, the last ten trials of the series, trials 182-191, extending over three days (4 trials each on the first and second days and 2 on the third) were made with the absolute intensities of the lights altered to the degrees described on pages 6 and 7. The first five trials of this group were made with the lights at the first degree of reduction. In the last five trials, the variations were as follows;

second degree, third degree, normal, first degree, second degree. The conditions of the experiment did not permit of alteration of the intensities in direction of increased brightness. As a further check, however, a trial at normal illumination was inserted in the series of reduced illuminations. If the original learning had been based upon absolute brightnesses, this presentation of the learned situation should have brought forth as accurate response in the chicks as it did in the earlier trials.

Reference to Table I pages 20 and 21 and Plate IV, the success curve for the combined individuals of group I, shows that the per cent of right responses for the first five trials under conditions of reduced illumination was 83%, exactly the same as for the two preceding groups of five trials which were made under normal conditions of illumination. In the final group of trials, which included two stages of intensities that were lower than any previously presented, right responses constituted 72% of the total responses made. Although this per cent of success is lower than that of the preceding three groups, it is higher than that of the fourth preceding group of trials, made under normal conditions, where 68% of the complete responses were correct. Two chicks of this group, Numbers 1 and 5 made no errors within the ten trials of altered illumination. For Number 5, this response was exactly similar to that for the preceding ten trials, while with Number 1, the per cent of success for the preceding ten trials was 90%, as compared with 100% for the final ten. For the other five chicks, the comparative efficiency of the response under the new as compared with the old conditions was as follows: for Number 2, 80% as compared with 90%; for Number 3, 80% as compared with 100%; for Number 4, the per cents are the same in the two groups of trials, 90%;

for Number 6, 60% as compared with 70%, and for Number 7, 50% as compared with 80%.

Among the chicks of the second group, Number 16 has 90% successful trials in the last ten as compared with 80% in the preceding ten trials; Number 17 has 60% as compared with 90%; Number 19 has 100% as compared with 78.9%; Number 20, 50% as compared with 40%; Number 21, 90% as compared with 100%, and Number 22, 80% as compared with 90%.

Table VI shows the per cent of success for each bird on each five-trial group for the two transposition groups and the two groups preceding the light alterations. Inspection of the table shows little difference between the actual performance of the chicks in the first five trials of transposition (involving only stage 1) than for the average of the two preceding groups. It is probable that the alteration of intensities was not sufficient to produce any apparent change in the situation for the chicks.

A more marked reduction of efficiency is evidenced in the last group of five, however. Table VII gives the distribution of errors for each bird by trials in this group. Disregarding the actual number of errors made in any individual case, this table shows that five different birds of the fourteen made errors in the situation involving the first stage of reduction, that an average of four birds made errors in the two presentations of the second stage, that 5 birds made errors at the stage 3 illumination, and that 3 birds made errors in the normal illumination.

That the situations of reduced illumination constitute relational situations for the chicks is shown by the fact that three of the birds, Numbers 1, 5 and 19 made perfect scores on all the five trials of the final

TABLE VI

Per cent of success for each chick, last ten trials of normal illumination, and ten trials of reduced illumination.

Group	Chick No.	Normal light		Reduced light	
		Trials 172-176	Trials 177-181	Trials 182-186	Trials 187-191
I	1	100	80	100	100
	2	80	100	100	60
	3	100	100	100	60
	4	100	90	100	90
	5	100	100	100	100
	6	80	60	80	40
	7	60	100	40	60
II	16	60	100	100	80
	17	80	100	80	40
	18	80	80	80	80
	19	75	80	100	100
	20	40	40	60	40
	21	100	100	100	80
	22	80	100	100	60

group, and that, of the birds making errors, there were four, numbers 4, 16, 18 and 21 that made perfect performances in all but one of the five trials. A further interesting fact is that of all the trials involving errors, only two were completely unsuccessful trials, that is, in only

TABLE VII

Number of errors made by each chick in each of the last five trials of reduced illumination.

Group	Chick No.	Trial 187(2)	Trial 188(3)	Trial 189(n)	Trial 190(1)	Trial 191(2)
I	1	0	0	0	0	0
	2	0	2	0	0	1
	3	0	1	0	1	0
	4	1	0	0	0	0
	5	0	0	0	0	0
	6	1	0	2	2	0
	7	1	0	0	0	1
II	16	0	1	0	0	0
	17	1	2	1	0	0
	18	0	0	0	1	0
	19	0	0	0	0	0
	20	5	0	3	1	0
	21	1	0	0	0	0
	22	0	1	0	1	0

Numbers in parentheses in heading indicate the stage of reduced illumination for each trial; (n) represents normal.

these two trials, made by the same bird, Number 20 of group II, were three wrong choices made in one run. All the other imperfect trials included errors in only one of the choices. Errors were made in the choice of the

dim light ten times; in the choice of the medium four times and in the choice of the bright, five times.

If the absolute brightnesses of the original lights were the stimuli to which the chicks had responded from the first, the response to them should, theoretically, not have been confused by the introduction of a few variables. However, we find that three birds made errors in the trial of this group involving normal lighting, whereas, in the last preceding group of five normal trials, the average number of birds making errors was 1.2. Likewise, five birds made errors in the one trial when illumination of the first stage was used, which, by the evidence of the first five trials of transposition, they had not distinguished from the normal brightnesses.

From all the points of view considered, then, percent of success for the group, actual perfect responses made in the altered situations, the limited scope of the errors in the imperfect trials, and the fact that the transposition effect was almost as great upon the absolute brightnesses of the normal illumination, when introduced into the altered series as upon the altered brightnesses, we are justified in assuming that the response of the chicks to each choice situation was an affair of relationships among the brightnesses rather than of choice of a series of absolute brightnesses out of repeated absolute-brightness situations.

VI. DETAILED RECORDS OF INDIVIDUAL CHICKS--QUALITATIVE DATA

The group methods employed in the treatment of the quantitative data obscure so completely the individual characteristics of each chick, that an attempt is being made in this section to present in considerable detail the performances of two of the typically good learners in this problem, and to use for comparison data from one of the slowest birds. It is hoped that some picture may be developed, at least in a schematic manner, of the way in which the individual chick grasped the nature and solution of the problem as presented in this experiment.

In a problem so planned and executed as this one has been, the fundamentally important fact is that the animals learn it. The fundamental question as to the successive relational judgment is answered when we have demonstrated that the animals learned to solve a problem which required for its solution such successively related responses. However, for the general problems of animal psychology, the question of how the animal learns is perhaps a very fundamental one. Here, although the objective data of summarized records are invaluable, one must rely largely upon one's own observation of the behavior while it was occurring, and upon such reports of that behavior as one was able to preserve of such observations. The ideal situation for such observation and report is one much simpler than that involved in this problem, where much significant behavior occurred too subtly to be observed under the rather limited conditions, or too rapidly to be recorded in as great detail as it deserved.

An attempt will be made to indicate, first, the progress of Number 5, of group I by presenting what appear to be characteristic trials at various periods throughout the learning series.

Number 5, like all the other chicks, had gone four times through the choice box, being fed at the end of the trip in the feeding box. On all four occasions, all the gates were free. The first time, there had been a homogenous low illumination in the light area at the base of each gate, which was reflected in the mirrors above the gates. The third and fourth times, the light areas were differently illuminated, one brightly, one dimly and one with a medium intensity in the three light areas before each partition. Time was not kept for these preliminary trials, but a record was kept of the course he took on the third and fourth times. On the first occasion of these two, he went through the gate of middle illumination on the left hand side of the first partition, and through the gates in the middle partitions in the two succeeding partitions, which happened to be the medium and the bright, respectively. The next time, with the lighting arrangements identical with the previous run, he went through the gate in the middle position each time, the dim in the first compartment, the medium in the second and the bright in the third. Thus out of six differentially lighted partitions approached, he went through the gate in the middle positions five times. It is probable that he had no special preference for the medium light which he chose in the very first instance, in that he went directly through the dimly lighted middle gate on the next trial, although the actual situations were identical. At his fifth experience with the apparatus, the appearance was as described above, but only one gate in each partition was unlocked, the dimly lighted one in the first partition, the one of medium intensity in the second partition, and the brightly lighted one in the third.

When placed in the completely functioning apparatus as described above, his behavior was as follows. He stood in the middle of the compartment, near the edge of the center light area (B), then ran toward the right and jumped at the mirror and gate. This being the dimly lighted free gate, he jumped through it. From here, he walked along the right side of the compartment to the right hand light area (B) and stood there for a few moments, pecking at the glass. Then he went to the center gate (M) and touched it very lightly, too lightly to go through although the gate was free, and back to B, throwing himself against it. He drew back, cheeping loudly, but went back to it again, pushing himself as far through as the distance between the wires would allow. When he failed to get through, he drew back and sat down on the floor. After he had remained there for a few moments, he got up, and turned around toward the first partition, standing behind the middle gate in the first partition, facing the entrance and peeping, and finally squeezing himself through into the first compartment again. He but turned and stood was then placed upon the light area, facing the entrance, cheeping. After some little time, he turned about and went to B in the center, squeezing through. In the second compartment, he walked the length of the partition from D on the left to B on the right and back stepping on the light areas, but not touching any of the gates, until he reached D again where he squeezed through the wires. In the third compartment, he went straight ahead from the point where he had pushed through, and went directly through B, which was the free gate, and happened to be in the left hand position. This whole performance required three minutes and thirty-five seconds.

On the next two trials, the right gates were fastened back to

keep the chicks from becoming unduly upset by the complications of the apparatus. The fourth trial, the next regular trial of the series is represented in the first diagram to follow.

Trial 4, Feb. 4.

Time 5'

Stood in middle of compartment, snapping bill and wiping it on floor. Went to M trying twice; to D and stood before the gate; to M looking in mirror and trying once; to D, and back with no attempt. Squeezed between the wires at M.

Went to D, trying twice; to M, looking in mirror; to M, looking in mirror; to D, trying once; to M. Wires of gate were held back for him to go through at about 4' 45".

Went to B without touching; walked length of partition to M, picking at D on return. Went through B. Note: Persistent attempts at left positions. First attempts and all serious attempts on left. Squeezed through wires twice on left. Much looking in mirrors and wiping of bill.

Trial 6, Feb. 8

Time 2' 15"

Wandered about in front of compartment. Went to D, looking in mirror; to B and back to D, repeating performance at mirror; to B again, returning to D and going through.

Went toward D, picking at the wires too lightly to count as an error; to B; to D, repeating pick; to B, trying once; to M returning to B and trying again. To M and through.

Went diagonally across the compartment to M, trying once; to D, squeezing between wires.

Note: No first moves to left as in 2 preceding trials, but squeezing through on left in last partition. First serious gesture in first compartment to D. In second and third compartments, tended to repeat successful preceding choices.

Trial 8, Feb. 8

Time 1' 28"

Stood 12 sec. at entrance, looking around. Walked toward center and turned to D, looking and touching wires with bill twice; back to B and again to D, making gesture toward.

To M, trying once; to D, jumping at mirror B on the way. Jumped at D and went through.

To M and through, with no gesture to any other gate. Only a little wavering before M.

Walked toward M without touching. To B, and through. Note: First move toward correct gate in first and second compartments. Left-going tendency shown in error to B on the left in first compartment. Repeating tendency, shown by first gesture to M in third compartment. Faster

Trial 10, Feb. 10

Time 3' 43"

Started right out from entrance, but stopped at edge of D light area. Looked and preened feathers for 1' 45". Went to B and looked; to M and tried once. Back to D and through.

To B, looking at mirror; to D, trying once; made two trips the length of partition, trying D on first and looking in mirrors at M and D on second. At end of second trip, went through M.

Direct through B.

Note: Repeated first try to right here for third time. Showed tendency to repeat last choice in second compartment, by making both errors to D. Made correct response to B, but no errors to B in other positions.

Trial 12, Feb. 11

Time 1' 51"

Tried B on left, then turned right and went through D. (This may be carry-over of old left-tendency)

Going to second partition along right side, made two round trips, with 2 gestures to M, three tries at D and one at B; went back to D with 2 tries; to B with 1; to M without trying; to B, trying once and back through M.

Direct through B.

Note: Much cautious looking and slight passes toward doors. Five of seven errors in second compartment made to D (right choice in first) although first gesture was to M.

Trial 16, Feb. 12

Time 7' 23"

Whole path in first compartment could not be shown on drawing. Went round trip from D to M 4 times with 2 errors to M. Eleven round trips, to B, with 6 tries to M, 5 tries to D, 2 jumps at mirror in D. Went back and pushed through B (6')

Round trip from M to D, with jump at light and try at B. Through at M.

One try and 1 pass at M. Went to D, 1 try; M, 1 try; back to D, no try; to B and through.

Note: Shows beginning in first compartment of strong tendency developed later to try at each end and not at center.

Trial 18 Feb. 12

Time 53"

Direct through D

Went to D, trying once; toward B, and back to D, trying once; to H, with gesture toward; back to B with jump at mirror and I try; back to M and through.

Direct through B.

Note: First error in second partition to preceding correct light. Correct choice made at once in third compartment, but no wrong choices of B in preceding ones.

Trial 23

Time 1'20"

Stood at entrance, looking and wiping bill on floor. Went to D, touching several times, and almost pushing through; leaving D, went length of partition to B, touching no gate; returned to D and through.

Went to B, trying once. Jumped at D. Back to B; turned and went to H, pushing almost through; back to D, without trying. Returned to M and went through.

Direct to B.

Note: In first compartment, first try to D, but too cautious to go on through. Similar procedure in second, except for try at B.

Trial 24 Feb. 17

Time 1'1"

First errorless performance.

Stood at entrance, wiping bill. Went to D, pushing lightly at gate. Went length of partition to B, returning and going through D.

Jumped at mirror in D; went to M, touching lightly. Went length of partition to B, and returned, jumping at D mirror again and through at M.

Went directly to B. Touched gate and jumped back uncertainly as though frightened. Then went through.

Note: Cautious. Only gesture to other than right gate, one in second compartment, showing repeating tendency inhibited.

Trial 40, Feb. 22

Time 45"

Four round trips from M to D, last time trying lightly at D. Went back half way left. returned and through D.

One error to D, and through.

Direct through B.

Note: In this part of the learning, following the introduction of an increased number of center positions at 36th trial, right and left errors increased to marked degree.

Trial 47, Feb. 27

Time 1'21"

To M and back to D. Returned to M, looking at mirror. To B and back with two tries at M. Through D.

Round trip of partition to D, with no errors. Through M.

First to M, then walked length of partition, trying D once and through B.

Note: Influence of increased center positions still evident, but an improvement in this particular trial. This trial seems to show a little reversion to the old left-going tendency.

Trial 52, Feb. 28

Time 1'12"

Two complete round trips of partition, with 1 try at M and 1 light touch at D. From M to D with 1 error. Repeated. From M to D, with strong gesture to go through. Back to M, one error and through D.

Toward M, and went on to D, trying once. Returned to M; to D, with gesture; to M, and through.

Direct through B.

Note: More left-going tendency, much notice given to mirrors. This is characteristic of trials of this period. Prevalence of this type of behavior led to removal of mirrors.

Trial 54, Feb. 27

Time 25"

Three indifferent runs along partition, with no gestures. Through D on second approach.

Through M direct. Whole movement in right general direction.

Went direct to D, 1 error. Through B.

Note: Mirrors out. Reduction in time and errors.

Trial 55, Feb. 27

Time 16"

Errorless. Direct route except for one excursion in first compartment.

Trial 60, March 1

Time 28"

Hesitated at D, but went to no other gate.

Went first to M and swung wires out, but drew back, and went to D, trying 3 times. Through M.

Went first direct through B.

Note: Shows interesting conflict between two relationships in second compartment. First reaction to M (successive relationship) then to D (repeating relationship).

Trial 98, March 12

Time 24"

Errorless. Direct in second compartment. In first and third, traveled along partitions, looking, but made no definite gestures.

Trial 99, March 13

Time 16"

Very similar to above trial, but more direct.

Trial 104, March 14

Time 20"

Errorless. Directions show some tendency toward repeating previous correct response.

Trial 121, March 19

Time 24"

Two strong gestures to D before going through.

First move toward M, but explored toward D before going through.

Direct through B.

Note: Some hesitation and exploration.

Trial 126, March 18

Time 24"

Slight gesture to M, without touching gate. Exploration of whole partition.

Direct through M.

Direct through B.

Trial 131, March 19

Time 24"

Two strong gestures to D, and an expedition along partition before going through D.

One gesture toward D.

First move toward M, but back and through B.

Note: Hesitation and exploration with hang-over of repetitive tendency.

Trial 145, March 22

Time 15"

Perfect run. Preliminary gesture to gate in first two compartments.

Trial 162, March 29
Direct. Fast

Time 8"

Trial 189, April 2

Time 28"

This is trial at normal illumination which was inserted in the transposition series. It is errorless, but exploratory, and shows an interesting mannerism which developed in several of the chicks later in the series. The points in the diagram represent places where the chick stopped and wiped his bill on illuminated area before the gate without touching the gate itself.

Number 5, the chick an abbreviated record of whose performance is presented in the descriptions and diagrams of the few preceding pages, developed into a large robust rooster, active and alert, but quiet and not so easily frightened and upset as many of the other birds. He was one of the most consistent learners in the problem, and his record shows clearly some tendencies that were present in the performances of all the birds, but not in every case so easily recognized and represented. It remains to summarize some of these main tendencies.

1. Selective methods of adjustment.

From the very beginning, the history of Number 5's performance is one of selective adjustment of increasing organization and efficiency, to a rather complex situation, at first unfamiliar and organized only in the terms of the more obvious relationships of hunger to place of feeding; toward the end, in terms of a complex system of spatial and temporal relationships of the objective situation as they contributed to the reaching of the final food goal.

In making a study of this sort, the experimenter almost unavoidably thinks in terms of the conditions of his experiment as he knows them. Thus, the responses of the animal that are most interesting and significant to him are those that are in the direction of success. The errors which the animal makes are an unavoidable but tedious accompaniment of the process. Such is the attitude involved in the concept of trial and error learning. The lack of organization, the indirection of effort, the randomness of the behavior of the animal in the initial stages of the learning are not in terms of what the animal is doing, but in terms of what the experimenter expects him eventually to do.

Now a study of the performance of Number 5 shows that, from the start, he had definite methods of response, organized with reference to some aspect of the situation in which he found himself, which he used consistently until they were superceded by some other organization, often more appropriate to the conditions of the total situation. In the first trial, disorganized as its activities appear, there was still a rough continuity and order in these activities in relation to the direction of the food box, or of the way of escape through the entrance.

As early as the fourth trial, we find Number 5 trying vigorously and consistently on the left side, repeatedly pushing through between the wires of fastened gates. Other exploratory methods develop throughout, one of the most interesting and persistent of which was the method of trying end positions to the exclusion of middle positions. This method, far from being perverse and stupid, is an appropriate reaction to a situationⁱⁿ which the two end positions come to be perceived in a unitary relationship with center positions, so that the conditions of the situation favor the end relationship twice as strongly as the center relationship. The vigor and persistence with which the chicks responded to this particular relationship was indicated in the previous section by the increase of errors during the period when it was at its height. So persistent and vigorous was this response that some chicks would repeat it twenty-five or more times in succession, sometimes working till they were almost exhausted.

Another method which is evidenced as soon as the brightness situation became differentiated out as a significant part of the situation, is the tendency to repeat in a given compartment the choice which was successful in the previous one. So strong was this tendency that it is shown in

an inhibited form even in the later trials where perfect responses were made in the correct successive relationship, by gestures toward gates that were lighted in correspondence with the preceding free gate.

To assume that organized, differential responses in terms of the successive pattern are not clearly evidenced until the twenty-fourth trial when the first completely correct run was made is to overlook the fact that many of the correct part responses were correct in relation to the successive pattern. The predominance of correct responses to brightly lighted gates had to be made in terms of the relationship of this gate as the last of the three, for in any other relationship, this response would be an error. Furthermore the typical sorts of errors described above constitute in themselves organized, selective adjustments with which the chick meets the problems created by more or less constant factors in the repeated situation

It is quite inconsistent with conventional theories of learning that a chick, having adopted some more or less definite mode of adjustive response, and having used it consistently over a considerable period of time, should abandon it for some new organization of behavior, often more adequate to the total situation. If the progress of learning depended upon the repetition of response, the practice effect from the persistent use of some one particular mode of response would so establish that response that its abandonment in favor of some new organization would be impossible.

2. Cautious exploration.

In the very early stages of the learning, the chicks in most cases attacked the gates with about all the force they were able to use. They

often ran at the gates, throwing themselves against them, sometimes with sufficient force almost to unbalance them, or sometimes they would go at the gate without the running start, forcing themselves as far as possible between the fastened wires, sometimes so far that their bodies would be wedged between the wires and they would have to be extricated and started over again. A differential perception of the gates as gates to go through and gates not to go through seemed in many of the chicks to develop rather early. As early as Number 5's twelfth trial, he is recorded as approaching the gates cautiously, looking and traveling about the compartment in an exploratory way before making attempts. This sort of behavior persisted throughout the learning.

Individual differences were shown in the methods taken in this exploratory behavior. One chick might simply walk up and down the length of the partition; another might approach a gate, touching or picking lightly with his bill against the wires. Two chicks, one of which was Number 5, frequently went from light area to light area, wiping the bill upon the glass. Several of the chicks, one in particular, developed the habit of knocking with the bill on the sheet iron sill of the doors. This tendency passed over by gradual stages into the sort of behavior which we might call mannerisms, individual peculiarities, which from the point of view of the observer have little to do with the situation. One of these which was rather amusing was the habit of one of the fastest birds to begin making the food call the moment he entered the first compartment, and to continue it, at the same time increasing his speed till he reached the food box.

The chicks were frequently observed to hesitate at the entrance, and then make directly for the correct brightness. This sort of behavior was more frequently observed in the early part of the learning, before the

mirrors were removed. The reflected brightnesses above the doors were rather more easily distinguishable from a distance than the light areas which were placed in the floor. Many of the early trials of group II, especially, show this tendency to a marked degree. Number 19, a description of some of whose performances is to follow, was a very active, eager chick. He would sometimes begin to make running movements even before he was placed on the entrance-way to the first compartment, and very frequently made absolutely direct runs from the entrance to the gate of correct brightness.

3. Adaptive behavior of a very significant sort was observed at points in the series where new alterations were made in the stimulus situation.

This point is illustrated on the three pages to follow where reproductions are given of the trials preceding and following the introduction of each successive complication in the problem of group II from the record of Number 19. The general features of response are the same as those discussed for Number 5, with the additional evidence of increased efficiency in the adaptation made to the final complication of the problem as compared with the introduction of the second complication. It is evident that the process of adjustment to the latter situation was in the nature of the solution of a new problem, the features of the situation to which an adaptive adjustment had been made having taken on new relationships and thus become essentially not old learned reactions, but a new problem in terms of the new complete situation. With the introduction of the new D-M-B combination, the adjustment was so much more quickly made and involved so much less disorganization of the earlier learned adjustments that it appears to be more in the nature of an extension of a mode of adjustment already established than of a total reorganization of response.

This trial is selected as representative of the five trials preceding the introduction of the second partition. In two of the five, a perfectly direct course was taken from the entrance to the brightly lighted gate. In the twentieth trial, shown at the left, this is also true, except that a short excursion is made along the partition before going through the gate.

The diagram at the left represents the first attempt of Number 19 after the addition of the middle partition. He went first to B, hesitating and looking in the mirror, then turned to the right and went through M. In the last compartment, he went straight across of D, hesitating a moment in front of the gate. Then he turned toward the left, stopped and wiped his bill on the glass at M, and then on and through B. He showed considerable hesitation, but made no errors. This correct first run was a coincidence that the case of three birds on their first attempts after the introduction of the middle partition.

Number 19 spent 80 seconds before the middle partition. He went first toward M, looking at the gate and at the mirror, then to B, making three attempts, back to M, looking again as before but not touching the gate. He returned to B again making two errors, and back through M. He went directly through B.

Trial 27 Feb. 19

Time 153 seconds

In this trial, Number 19 shows a stronger determination than in the preceding trial to go to B. He ran back and forth across the partition repeatedly, making ten errors to B. One error and two light touches at D and two gestures toward M were made.

In the last compartment, he went directly to M trying to get through, then to B, back to M, with another error and finally through B. Similar high time and error scores persist for the succeeding seven trials, when there is a marked and consistent reduction in both.

Trial 67 March 3

Time 16 seconds

The diagram on the left represents a characteristic run from the five preceding the introduction of the front partition. It shows in the middle compartment, a tendency toward B but no error. In the last compartment, he took a direct path toward B.

Trial 69 March 4

Time 103 seconds

In the first compartment Number 19 went four times to M before making a gesture toward any other gate, he touched D but too lightly to go through, returned to M with another error, then going the length of the partition twice from M to B with two errors to M and a gesture to each of the other gates. In the last compartment he went directly across to D with two errors, to M with one error, back to D with one error, to M again with one error, and then across to the other side and through B.

Trial 70 March 5

Time 30 seconds

In the first compartment after a little preliminary exploration. No. 19's first gesture is toward D. However, he did not go through, but withdrew to M, where he made one attempt and returned to go through D. In the second compartment he went first toward M, but his first error was to D. He showed considerable uncertainty, making a complete excursion along the partition before returning and going through M. In the third compartment there is no error but a strong tendency toward M.

Trial 71 March 5

Time 45 seconds

The diagram on the left represents forty-five seconds of continuous activity. He made repeated excursions the complete length of the partition, making three errors to M and one strong gesture to B, giving little notice to D. The middle compartment shows exploration but no errors. In the last compartment he went toward D but dodged back quickly and stood hesitating a moment at B before going through.

Trial 72 March 5

Time 27 seconds

This diagram represents the fourth run after the introduction of the new partition which was errorless as was the succeeding one.

4. Degree and efficiency in organization of adaptive behavior varies markedly among individual chicks.

The representations of paths for Numbers 5 and 19 were necessarily so sketchy, consisting of samples selected from various characteristic points in the course of the learning, that, to give a better picture of whole course of adjustment, and a further notion of the difference in the use of adaptive modes of response among chicks, detailed graphical representations are made in Plates IX, X, and XI of the performances of Numbers 5 and 19, and for comparison, the record for Number 6, one of the poorest learners. In these graphs, each vertical line represents the errors made in the choice of a particular brightness in each group of five trials. When three such lines appear together, they represent the errors at each of the three brightnesses for five trials. For example, in the first five trials, Number 5 made five attempts to go through the gate of medium illumination in the first partition. During the same five trials, he made, in the second compartment, three attempts at the brightly lighted gate, and six at the dim; and in the third compartment, four to the medium and ten to the dim. The diagram for Number 19 is made upon the same principle, except that in the early stages of the learning, each group of five trials includes choices at only one or two partitions.

Several important points in the case of Number 5 can be summarized from this curve. First, the use of selective modes of adjustive response is indicated by increase of errors from groups two to eight of the type illustrated in the first vertical line of the third group. Errors of this type reach their height in group eight, the group following the introduction of the increased number of center positions. From this point on there is a rapid reduction of errors of this type and an increase in general of successful responses, showing the substitution for this type of response

Plate IX. Detailed error distribution
for Chick No. 5, Group I.

Vertical positions, correct Bright-
nesses for 5-trial groups

D A B

B D A

Choices of wrong brightnesses

Scale 5mm = 1 error
1mm = 1 Second

— Avg. time

Plate X. Detailed error distribution for
Chick No. 19, Group II.

$\frac{h}{m} \frac{b}{s}$

Vertical positions, correct bright-
nesses for S-trial groups

|||

Choices of wrong brightnesses in
each S-trial group

Scale 5mm = 1 error
1mm = 1 second

— Ave. time

Plate XI. Detailed error distribution for Chick No. 6, Group I.

Vertical positions, correct brightnesses
for each 5-trial group

Choices of wrong brightnesses in
each 5-trial group.

Scale 5mm = 1 error

1mm = 1 second

— Ave. time

of the correct response to the serial brightness relationships. It is also evident that the repetition of previous right response, another selective mode of procedure described earlier, constituted the most common error of the later trials. The curve also illustrates the early reduction of errors in the choice of the bright illumination, accompanied by the falling off in the frequency of errors made by choosing the bright light in inappropriate positions. The sharp rise in the time curve for the last group of trials indicates that, although Number 5 made a perfect performance in the selection of the correct relative brightnesses under conditions of altered illumination, more time was used in exploratory behavior than was required for successful choices when the brightness situation remained constant.

The curve for Number 19 shows in more detail than has been possible elsewhere, the influence both on time required for choices and kinds of errors made by the introduction of new complications. His curve shows even more clearly than Number 5's the corresponding development of response to a given brightness both in relation to its right and its wrong positions in the series.

For contrast, the detailed curve for Number 6 is given. Although in the course of the learning, Number 6 made actually more errors than Number 5 made, the distribution of them is entirely different. Whereas Number 5 begins with a very high time score, and runs up a high error score within the first few groups of trials following the beginning of the experiment, Number 6 begins with a relatively low time and error score. He shows a much less sensitive reaction to alterations made in the experimental situation than does Number 5. For example, in groups eight and

nine, those following the change in relative numbers of side and middle positions of the right choices, where Number 5's time and error scores go up sharply. Number 6 for the first time made two groups of five trials without making errors at all three partitions. In the succeeding trials, where Number 5 begins to make a rapid and consistent drop in both time and error score, progressing toward a series of completely successful trials, Number 6 continues a fluctuating score which reduces somewhat, but which fails to reach a perfect performance in any five trials. It is a justifiable inference that the high time and error scores of Numbers 19 and 5 are evidences of insightful, organized behavior, one systematic organization of response succeeding another until the finally adequate adjustment to the situation is reached, the persistence with which the chick attacks the problem in terms of a given organization accounting for the rises in the curve, as well as for the rapid fall as soon as the more adequate adjustment is hit upon. Number 6, on the contrary, rather muddled along, in terms of the rather simple relationships of hunting a way through toward the position of the feeding box. Never, in the course of the learning did he develop an organization of adaptive response complex and definite enough to result in either very good or very bad scores.

VII. SUMMARY

Twenty-two white leghorn chicks were observed over a period of fifty-six days (exclusive of preliminary, practice trials) during which they made one hundred eighty-five trials each in a problem involving successive discriminations of brightnesses. The problem was so arranged that a correct solution involved the successive choices of three different brightnesses, (or, in the case of Group II, two successive choices) involving not only the choice of a given brightness in its place in the series, but the disregarding of exactly the same absolute brightness when it appeared in the other choice-situations of the series.

The chicks were divided into three groups for training, the first being presented the problem by the whole method, the second by the serial method, a modified part method, and the third, by the test method. Detailed results are given for only the first two groups.

It was shown that the learning of a successive pattern of differential brightness, which, under the conditions of the present experiment, amounted to the perception of a temporal pattern, was possible for the chicks. Of the fourteen chicks of the first two groups, eleven had learned the problem by the end of the experimental period. Of the eight chicks of Group III, all of the six whose training was continued to the end of the experimental period had learned the problem involving two successive choices.

The performances of Group I and Group II, on the whole and serial methods, respectively, were practically the same. In two of the measures used, average errors per choice, and average number of trial for reaching standard performance, Group II had a slight advantage over Group I. In

the third measure, average time per choice, Group I had a very slight advantage. The smallness of the differences found, together with the range of individual difference observed to occur within each unselected group of seven chicks, points to the conclusion that the difficulty of the two methods was practically the same.

Further, the qualitative analysis of the behavior of the chicks of the two groups, indicates that there is no essential difference in the character of the learning displayed by the two methods. The introduction of the first new complication for Group II constituted practically the presentation of a new problem in which an entirely new organization had to take place after the order of that necessary at the beginning of Group I. With the introduction of the second complication, there is evidence that the "principle", the general mode of adaptive response which the chicks had adopted with regard to the M-B situation was applied in the new D-M-B situation. Thus, the loss in efficiency with the introduction of the second complication was less than with the introduction of the first, again showing a similarity with Group I in the matter of increased efficiency as the course of the learning proceeded..

Qualitative analysis of the performances of individual chicks showed that their learning could not be explained in terms of mechanical principles, but that it constituted a series of adaptive adjustments which the chick itself made in terms of the repeated stimulus situation. Evidence was found for this view not alone in the sharp and consistent drops in the learning curves of the chicks, but also in the sharp and transient rises of the errors curves which were shown from the qualitative data to represent in general the adoption by the chick of a definite and

persistent modes of adjustive response, to be superceded, except in the case of those chicks which failed to learn the problem, by more adequate adjustments, until a final completely adaptive mode of response was reached. The argument is advanced that, as evidence of organized, insightful behavior, the consistent modes of adaptive response on lower levels of organization that is, those that are appropriate to a situation only partially grasped, are as significant in their sudden development and sudden abandonment, and are of exactly the same order of behavior as the sudden appearance and consistent maintaining of the finally adequate response so much emphasized in most studies of insightful behavior in animals. Much individual difference was shown in the degree and efficiency of such organization of adaptive response as well as in the quantitative measures of the learning. In fact, the amount and nature of the quantitative differences between chicks depends just upon such qualitative differences.

Trials made under conditions of reduced illumination, while not perfect transposition experiments, were yet sufficient to indicate that the choices made by the chicks at each partition were based upon relative rather than absolute brightnesses.

VIII. HISTORICAL ORIENTATION AND CONCLUSIONS

As Bingham (3) points out, there is no ancient history of chicken psychology. Aristotle was interested in the hen only as the producer of the perfect egg. The chicken, being a relatively uncommunicative animal, as compared with the dog or cat, for example, did not lend itself well to the anecdotal method of the pre-experimental period. The psychology of the chick, then, is predominantly the scientific animal psychology of the twentieth century. ^{The} chick was launched on its career as the subject of scientific observations by Thorndike (33,34,35). He studied the chick in simple, crude maze situations. He made observations on the instinctive and emotional reactions of chicks, and observed their reactions to colors. The maze experiment, except in so far as the principle is used in various sorts of discriminations apparatus, for example, in the Watson-Yerkes discrimination box (35), modifications of which have been used in much of the visual work with chicks, has not been very extensively used with these animals. However several studies have been made in maze learning, among which are Grindley's (11, 12) and Liggett's (26). The reason for this is probably that, although young chicks are more satisfactory subjects in such experiments than older ones, they grow so fast as to be very difficult to train over a long period of time long enough to allow for the learning of a maze of any high degree of complexity.

The field of study in which the chick, like most other birds, has figured most extensively, is the field of vision. Outstanding among studies of visual discriminative ability of the chick are the studies of Bingham (2), Cole (7), Johnson (14, 15) and Lashley (25). Bingham as

early as 1913, reports a case of transposition observed in his study of size discrimination in the chick. He further stimulated the discussion of the distinction between form and pattern in animal perception.

A study of the sort reported in this paper would not have suggested itself during the earlier period of animal psychology. Although, its procedure involves a modified maze technique, and makes use of the well demonstrated capacity of chicks to discriminate brightness differences, the more fundamental aspects of the problem would not have presented themselves in a psychological atmosphere where the behavior of chicks in fairly complicated maze situation could have been seriously interpreted as Thorndike describes the performance of his chicks in a rather complicated maze situation (34): "In such a series of associations, the response of one brings the animal into the situation of the next, thus arousing its response, and so on to the end. Three chicks thus learned to go through a sort of long labyrinth without mistakes, the 'learning' representing twenty-three associations." It would have been preposterous even to have suggested that chicks might learn to adjust themselves to a situation which involves the nature of the completed response in the very first reaction. Or, during the period when the interest in the chick's psychology was confined largely to its visual discriminating ability, as such, in one of the most careful and sound pieces of work done, Bingham (2) reported, as an interesting bit of observation, with no especial note of its systematic importance, the fact that chicks could respond to situations which varied as to the actual stimuli presented when the relations between them were kept constant.

Behaviorism, with its mechanical stimulus-response concept, while

it advocated, even in the study of human psychology, the importance of careful observation and report of behavior, was precluded by the limited character of the problems it set, and by its preconceptions of the nature of the responses these situations would invariably call out, from observing the significance of what the animal did in a given situation.

It remained for the more recent development of the study of animal psychology, instigated by the Gestalt movement in Germany and especially by Kohler's studies of apes and chickens (20, 21, 22), to apply the concept of insight to animal behavior. By demonstrating that animals respond rather to relations characterizing a total situation than to particular discrete elements of those situations, that they may be observed to make appropriate, adaptive adjustments to situations of not too great complexity, without having learned them previously, and thus that hard and fast mechanical determination did not give the whole picture of animal behavior, a new field of animal research has been opened up.

Starting from the point of view and background briefly outlined above, this study has proceeded along the following lines.

1. The method of relative choice, found so fruitful in the study of insightful behavior in animals, has in these investigations been pursued and extended in its scope. In the pioneer investigations of this type of reaction it has been methodologically valuable to maintain as simple situations as possible in order that the issue might remain clear cut. To this end, simple spatial situations have been employed using obstruction or transposition techniques or more or less simple cases requiring the use of tools in situations all phases of which were at once apparent to the animal in a unitary field. Although the validity of this sort of reaction

has been demonstrated beyond a doubt in such situations, the question remains as to whether some other sort of behavior is characteristic of the performance of animals in more complicated situations. This investigation, by making use of a problem the very nature of whose solution involves rather complicated spatial and temporal relationships, and which, by the application of the method of transposition technique was demonstrated to involve the relational judgment throughout, demonstrates that under the conditions which it set up, not only is the perception of temporal relationships possible, but, further, the insightful behavior demonstrable in simple situations is equally demonstrable in situations of greater complication.

2. A further aspect of the problem was a study of the performance of groups of chicks trained under the part and the whole method respectively. Studies of the part and whole method have been concerned primarily with the practical problem of their relative efficiency. Although one of the interesting results of this phase of our study was the fact that no very significant differences in efficiency were apparent between the groups trained by the part and by the serial method, the more significant aspect of the results has to do with the nature of the learning rather than with its efficiency or rapidity. Both the quantitative data and the qualitative observations of the performance of the chicks indicate that, under the conditions of this experiment, the part method consists not of the addition of part to unrelated part, but of the nature of an expanding, related, whole, essentially the same, in its nature as related whole developed under the first method.

3. The problem of chance reactions in animal learning has come in

for much discussion of late, for example, in the theoretical discussions of Koffka (19) and Kohler's (20) discussion of the behavior of the animals in his experiments. In this connection, there are strong indications from our data that, when the chicks were placed in situations which, on the basis of a chance theory, should have brought out chance reactions, they actually responded in a manner far more complex and adaptive than any determinations of chance could have accounted for.

4. Katz and Toll (18) and Köhler (20) have made observations on the characteristic modes of behavior of the individuals in their experimental groups of animals. An attempt was made in this study to keep as accurate record as possible of such differences both in speed and efficiency of learning and in the matter of characteristic types of procedure. The individuals differed widely in the speed of the learning, and the consistency of performance after the learning had been completed. Further, they differed in the modes of adjustive response to the partially grasped situation, and in the readiness with which they adapted themselves to newly added complications of the problem. These individual peculiarities (personality trends, to use the terms of human psychology) were found valuable in interpreting the quantitative data of the learning curves. In fact, it is felt that the learning curves themselves mean very little unless their significance is seen in terms of the whole situation of the animal actively adjusting himself, in his characteristic way to the conditions under which he is placed. In other words, learning in chicks is a differentiation out of a total behavior pattern that may be called personality.

5. This investigation indicates that the errors the chicks made were often as good evidence of insightful, adaptive modes of response as the clear evidences of a grasp of the situation such as show in initial

delay, and sudden rises in the curve of success. There is a tendency that has grown out of the need to demonstrate clear and unequivocal cases of insight, to confine the definition of the term to cases of adaptative response that are definitely complete adjustments to the perceived relation of a situation. The results of this investigation indicate that to confine the term to so narrow a field is to leave unexplained a type of errorful behavior which is still not a product of chance or mechanical determination, and which shows itself, upon analysis to be evidence of as complex adjustment as is possible in terms of the situation as the animal perceives it. To class it as behavior without organization or insight because it does not indicate organization of a type so complex as the observer sees as the efficient response, is a very anthropomorphic procedure. A further evidence that such behavior is truly adaptive lies in the observed fact that such partially successful modes of response, although practiced repeatedly, were quickly dropped and superceded by more complex and well organized adjustments as the problem became more well defined.

It is not claimed that these selective, adaptive responses involve any special kind of mental content. It claimed, with Tolman (32) that observation that is objective need not confine itself to a narrowly predetermined, mechanical definition of objectivity, but must, in order to do justice to the facts observed, see them in their broader relationships. Such objective observation concerns itself not alone with the experimental setting as determining the animal's response, but also with the animal itself, a living, goal-seeking organism.

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