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June 19 32

I hereby recommend that the thesis prepared under my supervision by L. May Wilmoth

entitled "Configurational and Trial and Error Learning - A Comparison"

be accepted as fulfilling this part of the requirements for the degree of Doctor of Philosophy in Education

Approved by:

L. A. Pechstein, Advisor

Ruth Streitz

Gordon Hendrickson

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CONFIGURATIONAL AND TRIAL AND ERROR LEARNING - A COMPARISON

A dissertation submitted to

The Graduate Faculty of the Teachers College
of the University of Cincinnati

in partial fulfillment of the
requirements for the degree of

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by

L. May Wilmoth
B.A. Arkansas State Teachers College 1925
M.A. Peabody College for Teachers 1926

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CHAPTER I

THE PROBLEM AND ITS SETTING

A. Introduction

One of the problems which has been predominate in the interest of psychologists from the beginning of its scientific inquiry is that of how organisms learn. Possibly learning as such extends a greater challenge to the psychologist than any other phase of human activity. As a result of this interest there has been much evidence assembled as to the behavior of animals and humans in learning situations; yet little agreement as to interpretation has been reached. The natural question to raise then is, how does learning take place?

In an attempt to answer this question, Thorndike long ago, through his ingenious study of animal behavior, advanced the theory of learning by trial and accidental success. In describing one of his cat's behavior, he says:

> It bursts out at once into the activity which instinct and experience have settled on as suitable reactions to the situation. .... The one impulse out of many accidental ones which leads to pleasure, becomes strengthened and stamped in, and the futile impulses are gradually stamped out. [1]

This statement in substance accounts for learning by trial, error, and accidental success operating through the law of effect until

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[1] E.L. Thorndike, "Animal Intelligence," Psychological Review Monograph, Vol. II (June, 1898), p. 45.

the right act is firmly established. It further implies that learning takes place gradually rather than suddenly.

In a more recent publication he maintains somewhat the same point of view. He says:

> This purely associative learning by trial and success, to respond in this, that and the other way, is the same in nature from minnow to man. [2]

Again he says:

> What is any given set or attitude or disposition or mind made out of? .... it is that all these are in the last analysis made out of connections and readinesses, whereby satisfyingness and annoyingness are attached to certain events .... [3]

This theory had its birth in the experimental laboratory. It has dominated educational practices for the past two decades.

Another theory which has arisen as a protest against trial and error learning is developed by the Gestalt school of psychology. It proposes to explain behavior in terms of insight. It sets up many criteria of insight. Those which seem clearest and most applicable to learning are:

a. The suddenness with which an activity is done or with which a change in behavior takes place.

b. The ability to respond to a part in terms of the whole.

c. The transposition of general properties from one situation to another.

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[2] E.L. Thorndike, Human Learning, p. 166. New York: The Century Co., 1931.

[3] Ibid., p. 121.

d. The complete discarding or reordering of habitual responses.

Kohler says:

Insight is a complete solution with respect to the whole layout of the field. [4]

Koffka has no doubt more clearly defined the term in the following statement:

.... The manipulation of things with reference to their important material relations can be employed as a criterion of behavior with insight. [5]

These two writers are the leading exponents of this theory which had its beginning with the experimental work of Wertheimer in 1912. They have boldly challenged other theories as to their adequacy for explaining learning, and especially Thorndike's theory.

The leaders of the two schools claim inability to see or understand the other's point of view or his approach to the problem of how learning takes place.

Koffka [6] implies that all learning is by insight. It cannot be used as a supplementary method to trial and error learning, but must displace it altogether. His understanding of trial and error learning is that by this method nothing new can be learned. In speaking of Thorndike's animals, he says:

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4 Wolfgang Kohler, The Mentality of Apes, p. 198. New York: Harcourt Brace and Co., 1925.

5 Kurt Koffka, The Growth of the Mind, p. 217. New York: Harcourt Brace and Co., 1925.

6 Ibid., pp. 179-205.

The animal had not the slightest notion why its behavior is being modified; the whole process, in which the successful acts are preserved and the unsuccessful acts gradually eliminated, is purely mechanical. This is the principle of trial and error. [7]

According to Koffka the animal is engaging in a set of blind acts which can never account for learning.

Wheeler maintains even a stronger position. He says:

.... The child should be able perfectly and easily to solve each new problem the first time it is attacked. When he must resort to trial and error and random procedure, it is evident he is not ready for the problem. [8]

On the other hand Thorndike is equally as sure of the position which he maintains. He says:

I read the facts which psychologists report about adjustment, configurations, drives, integration, purposes, tensions, and the like, and all of these facts seem to me reducible so far as concerns their powers to influence the course of thought or feeling or action, to connections and readinesses. Learning is connecting. The mind is man's connecting system. Purposes are as mechanical in their nature and action as anything else is. [9]

Again he says:

I cannot give evidence for or against the alleged physiological configurations or discuss their usefulness. For I cannot imagine at all clearly what they are supposed to be. [10]

The students of psychology are naturally stimulated to raise such questions as the following: Can learning behavior be explained

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7 Kurt Koffka, op. cit., p. 155.

8 Ramond Holder Wheeler, Science of Psychology, p. 115. New York: Thomas Y. Crowell Co., 1929.

9 E.L. Thorndike, Human Learning, p. 122. New York: The Century Co., 1931.

10 Ibid., p. 125.

by the theory of trial and error alone? Is it possible to explain it in terms of insight alone? Do animals as well as humans exhibit both types of learning? Are concepts built up by both trial and error and by insight? And do the previous experiences of the organism in any way aid in explaining either of these theories?

Turning to the investigation by these two schools one finds the experimental evidence yielding conflicting results. Some of the most outstanding ones are set forth in the summary below.

B. Summary of Investigations

Kohler's experiments with chimpanzees have attracted wide attention. Believing that animals were capable of solving problems by insight alone, he in turn set his experiments in keeping with this principle. He designed his experiments so that

> .... The objective, the obstruction and the total field of possible roundabout routes are in plain sight. [11]

The animal became acquainted with the whole situation. Thus he claimed that an animal placed in a situation such as the one mentioned above was able to apply its knowledge and thereby behave intelligently. In describing two of his subjects' behavior, he says:

> Tschego first tries to reach the fruit with her hand; of course, in vain. She then moves back and lies down; then she makes another attempt, only to give it up again. This goes on for more than half an hour. Finally she lies down for good, and takes no further interest in the objective. The stick might be non-existent as far as she is concerned, although they can hardly escape her attention as they are in

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[11] Wolfgang Kohler, The Mentality of Apes, p. 11. New York: Harcourt Brace and Co., 1925.

her immediate neighborhood. But now the younger animals, who are disporting themselves outside in the stockade, begin to take notice and approach the objective gradually. Suddenly Tschego leaps to her feet, seizes a stick, and quite adroitly pulls the bananas until they are within reach. In this manoeuvre she immediately places the stick on the further side of the bananas. She uses first the left arm, then the right, and frequently changes from one to the other. [12]

Again he says:

Koko was, as usual, fastened to a tree with a collar and chain. A thin stick was secretly pushed into his reach; he did not notice it at first, then he gnawed at it for a minute. When an hour had elapsed, a banana was laid upon the ground, outside the circle of which his chain formed a radius, and also beyond his reach. After some useless attempts to grasp it with his hand, Koko suddenly seized the stick, which lay about one metre behind him, gazed at his objective, then again let fall the stick. He then made vigorous efforts to grasp the objective with his foot, which could reach farther than his hand, owing to the chain being attached to his neck, and then gave up this method of approach. Then he suddenly took the stick again, and drew the objective toward him, though very clumsily. [13]

Kohler interprets this as learning with insight. On close reading, one is made to wonder if the whole story has been taken into account. That is, would further analysis reveal that learning by insight is a type of behavior in which trial and error may play an important role? Since he suggests that it is not, the desire to find out should be further encouraged and stimulated.

Turning now to another type of experiment we find that insight is made the sole basis for describing behavior.

The purpose of Maier's [14] experiments was to learn whether or

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12 Wolfgang Kohler, op. cit., p. 32.

13 Ibid., p. 34.

14 Norman R.F. Maier, Reasoning in White Rats. Comparative Psychology Monograph, Vol. VI (May, July, 1929), p. 10.

not rats could solve problems without trial and error. He designed nine experiments, varying the set-up for each experiment. Since all were similar, one which was typical of his whole group of experiments will be referred to.

A (1). A large table was divided into halves by a barrier made of cardboard. The food box was placed on one corner of the table, directly opposite the starting point of the animal, but it could be entered only after scaling the pasteboard wall - going to b at the far corner of the table, and proceeding from here over a complex rectangular maze, and finally reaching the food box. The animals were familiar with the table and the wall and were taught to run the maze. The table and maze were then connected. The problem was for the rat, by use of its previous experiences, to connect the two situations and find the way to food.

Maier claimed that trial and error and chance have no part in explaining the behavior of the rats in solving this type of problem. Would further interpretation and analysis of such facts as are given below provide a place for trial and error also? In describing Rat A's behavior, he says:

> 1. A - Around side of cage - back and forth on table near the cage - at p (50) - A - tries to get around cage (80) - 15 - over wall at p (100) - directly to box - at b (125 - F (147). [15]

In experiment G, the purpose was to determine whether the rat would use the floor to bridge a gap between itself and food. He

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[15] Norman R.F. Maier, op. cit., p. 11.

[15a] Numbers in parentheses indicate seconds of elapsed time.

describes Rat C's behavior thus:

> Rat C - at cage looks down to floor (45) washes (50) looks down to floor - (70) reaches through cage at food with forefoot - looks down toward floor (150) climbs on cage (160) digs at paper under cage - trying to get under, bites and pulls at paper (200). [16]

This type of behavior continued 327 seconds before the animal reached food. Probably there are just reasons for students to wonder if insight is a fundamental type of behavior in which trial and error may have a subtle part.

Helson [17] has shown that rats respond to a visual structure; thus animals trained to go to a certain light B, instead of a less bright light A, go to light C instead of B when C is brighter than B. In a general description of a rat's behavior he says:

> The rat very quickly learned to go toward the food box and to try the second box if the first choice is wrong.

This study gives place to the fact that the animals respond by what probably may be insight, and denies that trial and error has any part in the learning.

In a study of insight in a spatial complex Hsaio Hung Hsaio designed a maze for his rats. It was constructed as follows:

> There were paths leading to the food box. R 1 and R 2 led to a common pathway and a common door which opened into the food box. R 3a, third path, followed a different route and led to the food box through a different door. More training was given over R 1 and R 2 than R 3. This was done to build up a strong desire for R 1 and R 2. The problem was to discover whether a rat can get insight when two paths having a common section are closed, that both of these are

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16 Norman R.F. Maier, op. cit., p. 52.

17 Harry Helson, "Insight in White Rats," Journal of Experimental Psychology, Vol. X (1927), pp. 388-89.

useless and that only a third alternative R 3, not in this common section, leads to food. [18]

He concluded that there was little evidence, if any, of insight present. Hence trial and error explained the learning.

In an effort to further study insight in the white rat, Tolman and Honzik [19] repeated Hsaio's experiment with a larger number of rats, using an experimental set-up that was the same in principle but differed some in design. That is, the rat had the alternative of a third route when he found the other two blocked. They stated that in one of their modifications of Hsaio's maze there was some evidence of insight but nothing conclusive. There was no attempt to study learning from the two points of view.

Paul E. Fields [20], in a study of the "concept" of triangularity in the white rat, using a discrimination apparatus of the Lashley type, required the animals to react to the shape of the triangle and disregard other figures when presented with it. The change in position caused a reversal in response. A miscellaneous arrangement of geometrical design revealed that the rat still responded to triangularity. From his study he concluded that rats have ability to form concepts "or to respond to a large number of retinal patterns and to qualities

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18 Hsaio Hung Hsaio, "An Experimental Study of Rat's Insight Within a Spatial Complex," University of California Publication in Psychology, Vol. IV, No. 4 (1929), pp. 57-77.

19 E.C. Tolman and C.H. Honzik, "Insight in Rats," University of California Publication in Psychology, Vol. IV, No. 4 (1930), pp. 215-32.

20 Paul E. Fields, "The Development of the Concept of Triangularity in the White Rat," Proceedings of the Thirty-Ninth Annual Meeting of the American Psychological Association (September, 1931), pp. 683-84.

inherent in them."

This study points out that the rat is capable of a certain kind of behavior. It emphasizes responding to a detail. It gives no place to relationship in the learning or to the types of learning present.

Gengerelli [21] in a study of abstraction in white rats used the unit adjustable maze. The problem was to discover if rats trained to go to the left or right in this maze would make an intelligent choice when this opening was blocked. That is, if they had been accustomed to go to the left, would they make an intelligent choice to the right or reverse the old habit if the situation demanded it? He concluded that the rat was capable of responses of certain generalized nature provided the two situations presented elements which were similar to those in which it was previously trained, but he made no definite claim for either type of behavior.

In the studies on concept formation in human subjects, the recent emphasis has been upon what concepts are formed rather than how they are formed. The term "concept" is employed to mean the generalized idea that we have about things; that is, what do they mean to us? It is here held that concepts are built up by, and as, we abstract ideas from our experiences.

Piaget, in his method of personal interview, was able to ascertain what concepts the child had formed at different ages. As a result of this, he divided the periods of concept formation into three stages.

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[21] J.A. Gengerelli, "Studies in Abstraction with White Rats," Journal of Genetic Psychology, Vol. XXXVIII (December, 1930), pp. 171-202.

He says:

> In the first stage everything is alive and moves. The names of things are in the thing. During the second stage the names of things are everywhere or nowhere. Anything can feel that moves. In the third stage, names are regarded as in the voice, then in the head, and then in the thought itself. [22]

Shaffer [23] attempted to discover by the free association method what concepts children had of such words as "republic", "government", "society", and others of similar generalized meaning. His study showed that children did not always have the correct concept. His study differed from the problem to be proposed here in that it paid no attention to how these concepts were formed.

Heidbreder [24], in an experimental study to determine the rigidity or flexibility of thinking in college students, used a number of geometric figures and miscellaneous forms arranged on cards. On each card was placed one large figure and two small ones. For example, the square had beside it a ";" and "⁘". The subject was required to place one of the small figures in the large one. The experimenter then announced right or wrong. She concluded that thinking was present in various forms in complex situations. These forms varied in different situations.

This study attempted to find out how, and what kinds of, thinking took place. The others mentioned were concerned with what

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22 Jean Piaget, The Child's Conception of the World, p. 72. New York: Harcourt Brace and Co., 1929.

23 L.F. Shaffer, "Measuring Children's Concepts," Journal of Educational Psychology, Vol. XIX (January, 1928), pp. 41-44.

24 Edna Heidbreder, "An Experimental Study of Thinking," Archives of Psychology, Vol. II, No. 73 (1914), pp. 104-68.

concepts are formed or what has been learned.

The above survey points to the magnitude of the issue and the interest it has attracted. Aside from the writers mentioned above, others have manifested an interest in the controversy through their writings. The most noted ones of these are Woodworth [25], Hsaio [26], Tolman [27], and Ogden [28]. However, only one of these, notably Ogden, has suggested that more experimental evidence is needed.

Hence an enormous field for research awaits the inquisitive mind. The issue regarding fundamental points of view may be summarized as follows:

a. To the configurationist learning by trial and error does not exist.

b. To Thorndike learning is a process of forming connections in simple and complex situations by the trial and error process.

c. In the studies on concept formation the interest has been centered around the study of what concepts have been formed rather than how they are formed. Humans and animals have been used as subjects for experimentation by both schools. But there has not been a deliberate attempt to approach the issue experimentally in order to discover to

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25 R.S. Woodworth, Contemporary Schools of Psychology. New York: The Ronald Press, 1931. Pp. vi + 225.

26 H.H. Hsaio, "A Review of Gestalt Psychology," Psychological Review, Vol. XXXV (July, 1928), pp. 280-97,

27 Edward Chase Tolman, "A Behavioristic Theory of Ideas," Psychological Review, Vol. XXXIII (September, 1926), pp. 352-69.

28 Robert Morris Ogden, "The Gestalt Hypothesis," Psychological Review, Vol. XXXV (March, 1928), pp. 136-46.

what degree both methods of learning may be present in learning situations or to compare humans and animals in their use of trial and error and insight in solving parallel or identical problems. Hence these two rival theories present a number of problems, one of which will be the concern of this study.

C. The Problem

The problem is to make an experimental comparison of trial and error learning and configurational learning, these terms being interpreted as has been set forth in the writings of Thorndike and the Gestalt psychologists respectively. Specific questions on which this investigation proposes to throw some light may be listed as follows:

1. Are configurational and trial and error learning two distinct types of learning?

2. Is trial and error learning present in problems requiring insight?

3. What are the differences as between species and groups of the same species in the use of the two methods of learning?

4. What is the degree of agreement and difference as between species and groups of the same species in the use of the two methods in solving parallel or identical problems?

5. What cues, e.g., visual, kinaesthetic, etc., are employed in the solution of the problems?

D. Definitions

Certain terms will be used freely throughout this study. To be sure that uniform meaning may be attached to them, they are defined

herewith:

Configurational. Configurational learning is a response to a pattern of stimuli. It is perceiving an object or idea in its relation to other objects or ideas. It is used in this study as synonymous with insight.

Sudden. The term sudden will be used throughout this study to mean an instant change in behavior or the immediate solution of the problem.

Trial and error. Trial and error learning will refer to those random movements which the organism makes in response to a situation.

Analysis. The functional meaning will be applied to this term in the study. Functional analysis preserves the whole. Each part or detail emerges from the whole and is seen as a subordinated whole of the greater whole.

Insight. Learning by insight will refer to (a) that behavior which enables the organism to suddenly reconstruct its behavior in keeping with the exigency of the situation, and (b) the ability to perceive relationships.

Concept. The term concept will be employed to mean the generalized idea that we have about things.

CHAPTER II

TRIAL AND ERROR AND INSIGHT LEARNING - A COMPARATIVE ANALYSIS

A. Introduction

So far as published evidence goes, there is none in which human and animal subjects have been used to make a comparative study of the two methods of learning.

The subjects selected for this experiment were twenty children from the elementary grades, twenty adult students of college sophomore level, and ten white rats.

In the search for a learning situation, the concept middle-sizeness was decided upon. It was chosen because it seemed to the writer to make possible a learning problem which might conceivably be solved by insight, by trial and error or by a combination of the two methods. It would prove adaptable to both animal and human subjects and to a variety of materials. It may be interpreted as a problem in concept formation. The exact detail of execution of this program is subsequently set forth in the present chapter. In anticipation, the general statement may herewith be made. All subjects throughout the investigation were faced with the problem of learning to react selectively to a middle-sized stimulus in comparison with two other sizes, one large and one small.

B. The Two Types of Learning and Concept Formation in White Rats

1. Experimental Procedure

Subjects. -- The animals chosen for this study were white rats. Four males and six females of the Wistar stock were selected. The males were adult age when brought to the laboratory; the females were approximately three months of age. These animals were bought from the animal laboratory of the Department of Zoology of the University of Cincinnati. They had been caged in this laboratory, where they had not had any experience with any previous learning situation.

Place. -- The experiment was conducted in the animal laboratory of the Teachers College of the University of Cincinnati. It began January 14, 1932, and ended February 19, 1932. The experimental hours were in the afternoon of each day in the week except Sunday.

The Learning Situation. -- In order to set up a situation in which middle-sizeness was controlled and at the same time preserve the abstractness connected with the concept, the experimenter chose the middle number of the three numbers, 0.5, 2.5, 4.5, arranged in ascending order, such that the difference between the first and second and the second and third was constant. This procedure set up three numbers in a proportion such that the middle-sized number is the mean proportion between the two extreme numbers. All the possible distinct permutations of this proportion were used in designing the learning patterns which appear on the 18" x 12" wooden panels. (See Figure 7, p. 44). Because of this, the middle-sized number appeared in six different relations with respect to the two extremes. This made up a learning

series hereafter called Series A.

In order to further complicate the problem, a second series of three numbers, 2.5, 4.5, 6.5, designated as Series B, was chosen with the constant difference the same as in Series A. The proportions of the second series were so chosen that the last number of the first series was used as the middle-sized number in this set. These two series made up the learning situation for the animals and children.

In the crucial tests, which will be fully described in the subsequent discussions, the constant difference was maintained.

Laboratory Apparatus. -- To carry out the experiment it was necessary to design laboratory apparatus which would (a) be applicable to both humans and animals, (b) preserve the concept middle-sizeness set forth above, and (c) give ample opportunity for either or both types of learning in question to function.

The laboratory apparatus consisted of two laboratory tables 4' x 3'; five tunnelways 2'4" x $3\frac{1}{2}$", respectively; a board wall 18" x 56"; nine board panels 18" x 12" (see Figure 7, p. 44); a wire food box 15" x 12", and a control box. Each panel was made so that it would fit in the center of the board wall. (See Figures 1, 2, p. 18.) In these panels middle-sizeness, together with the other extremes, appeared in the heights of the tunnelway entrance from the starting table. This middle-sizeness was present and preserved in the step or approach which always led to the tunnelway entrance with middle-sized height; this created a unit made up of middle-size height of the entrance and middle-sized length of approach. The subject responded to this unit.

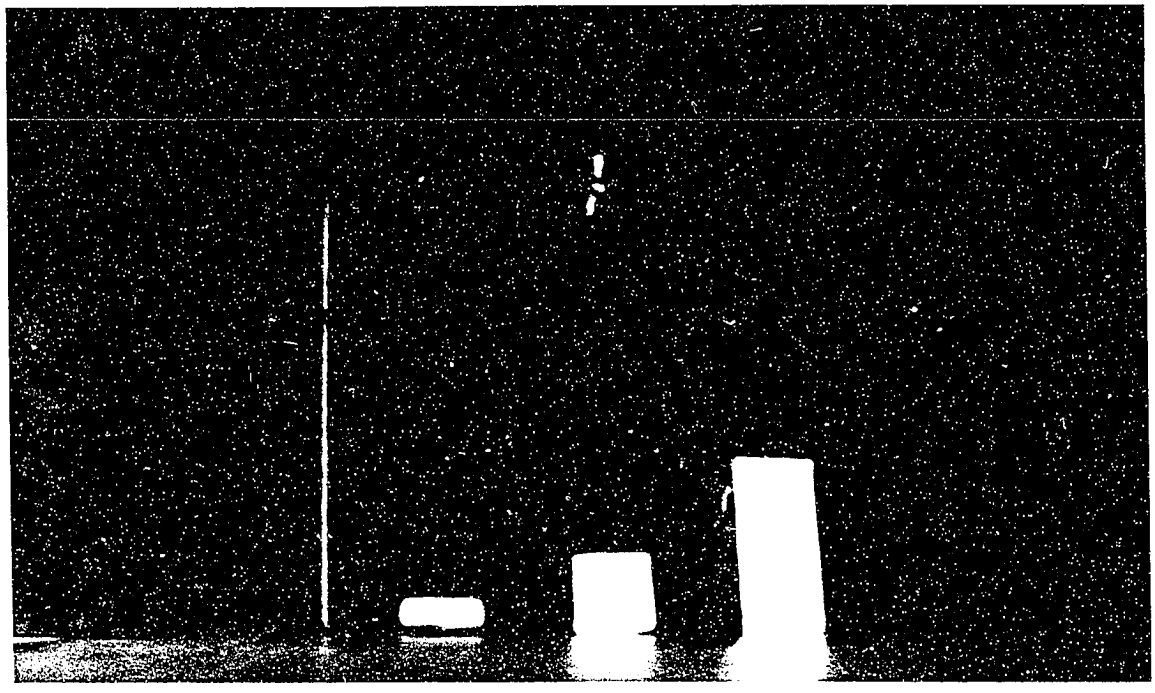


Fig. 1 = [illegible]

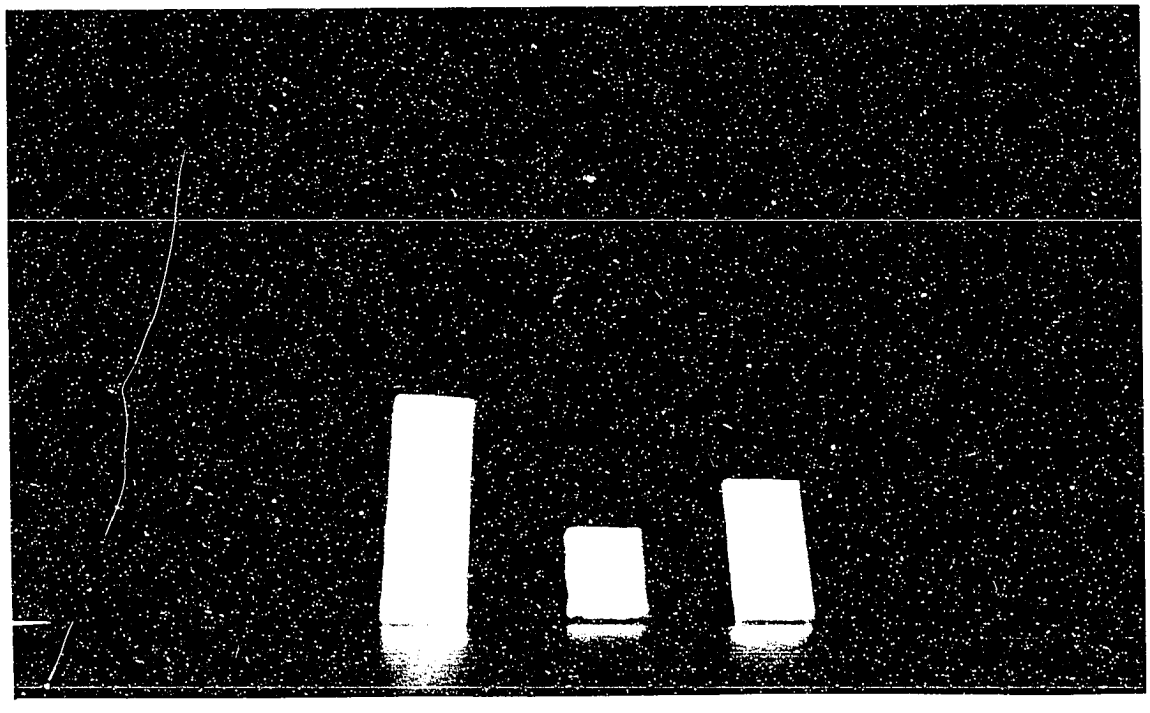


Fig. 2 = [illegible]

The heights were grouped to make the learning patterns. They were arranged so that middle-sizeness was in a different position in each pattern. These patterns made up the learning problem. Each of these patterns could be reversed at will by turning the panels over. By reversing the panel middle-size was placed in a new relationship with respect to the other two sizes. A description of each series follows. Series A includes all those patterns which could be designed by making use of all possible distinct arrangements of the three numbers occurring in the proportion 0.5, 2.5, 4.5 inches. Series B included all those patterns which could be designed by making use of the six distinct arrangements of the three numbers occurring in the proportion 2.5, 4.5, 6.5 inches. Series C (one of the crucial tests later to be fully described) included all those patterns which could be designed by making use of the six distinct arrangements of the three numbers occurring in the test series of the proportion 3.5, 5.5, 7.5 inches. For Tests D and E the proportions of Series B were used.

The approaches to the tunnelway entrances were steps made of wood and covered with ordinary screen wire. The step for each entrance extended from the top of the starting table to the base of the tunnelway entrance. Each was attached with an adjustable hinge and could be removed at will. The width of each step was two inches. The relative heights are shown in the accompanying illustrations. (See Figures 1 - 6, pp. 18, 21, 23.) The tunnelways were constructed of soft pine lumber; the board wall and the panels were made of three-ply redwood. The board wall, the tunnelways, the panels, and one set of steps for test Series D were painted black. The other steps were painted white. The laboratory tables were covered with black oil

cloth.

The tunnelway, which was enterable only over the middle-sized step, had a flip door at the opposite end made of heavy black paper and set on with hinges so that the animals could open it easily and go to the food box. This door was so adjusted that no light entered the tunnelway when it was closed. The other tunnelways were permanently closed at the end. (See Figure 3, p. 21.) Repeated observation by the experimenter and her faculty advisers failed to reveal any light entering the long tunnelways except through the entering aperture. In other words, the apparatus effectively prevented the animal's getting any visual cues from inside the tunnelways that would guide it in making a choice. Olfactory cues were controlled by dusting food on the steps and in the tunnelways and placing bowls of food at points in the room other than in the food box.

The complete experimental set-up is shown in the following illustration . (See Figure 3, p. 21). This gives the arrangement for the procedure. The two tables were placed end-to-end two feet apart; the board wall was clamped to the end of the starting table opposite the starting point X. The tunnelways connected the starting table and the food table. The problem for the rat was to reach the food box Y when placed at the starting point X. This could be done by choosing the middle-sized tunnelway from the pattern of each trial. For example, when the rat was placed at point X on the starting table and was facing the patterns 0.5, 2.5, 4.5 (see Figure 3, p. 21) he was to choose 2.5, traverse the tunnelway to the escape door Z,

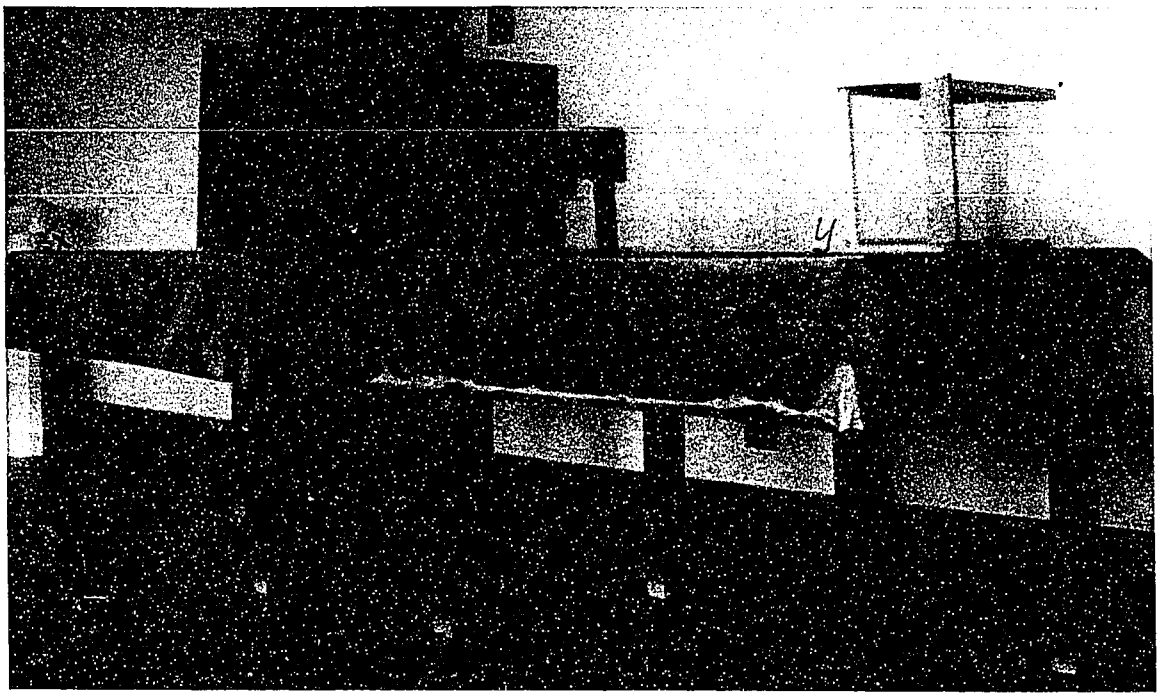


Fig. 3 - [illegible]

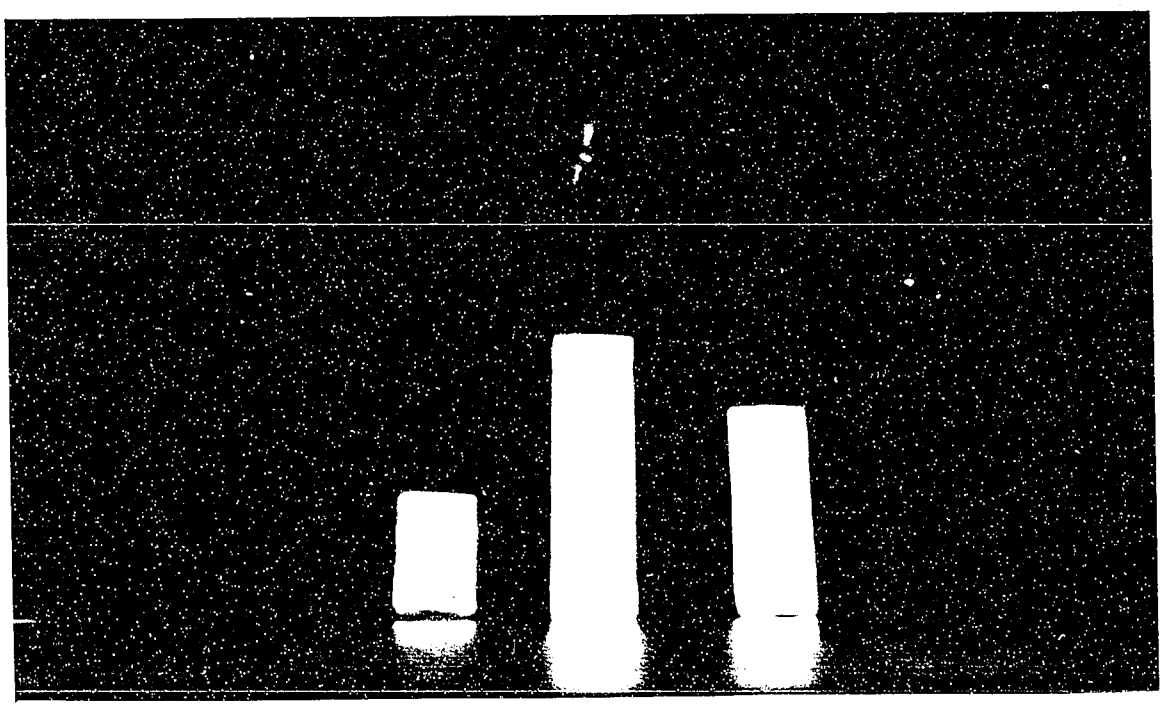


Fig. 4 - [illegible]

flip it open with his nose, jump down on the food table and enter the food box at Y. Each rat had been fed in the food box for three days before he was given his first trial and every day thereafter until his learning was completed, but he was not familiar with any other feature of the set-up. The whole detail of the problem was totally new, the animal being only familiar with the food table and feeding situation.

2. Conduct of Experiment

Method. -- Turning to the method used in the actual experimentation, the animal was taken from the control box and placed at X on the starting table for each trial. When it had finally made the successful choice and entered the food box, it was allowed to take a bite of food before being placed in the control box on the floor to wait for the next trial.

Records. -- Records were kept of time and errors and descriptive analysis. Time for each trial was scored in seconds and was recorded from the time the animal was placed at X until he reached the food box Y. Errors were counted by tunnelways; the subject made an error when its body was completely in either of the closed tunnelways. A general description of the animal's behavior was also kept. Since there was no form of punishment used, the animal could enter the wrong tunnelway as many times as it wished in any one trial.

Procedure. -- The animals were divided into two groups, which for convenience were called Group I and Group II. Since the problem was for the animal to respond to middle-sizeness, regardless of its

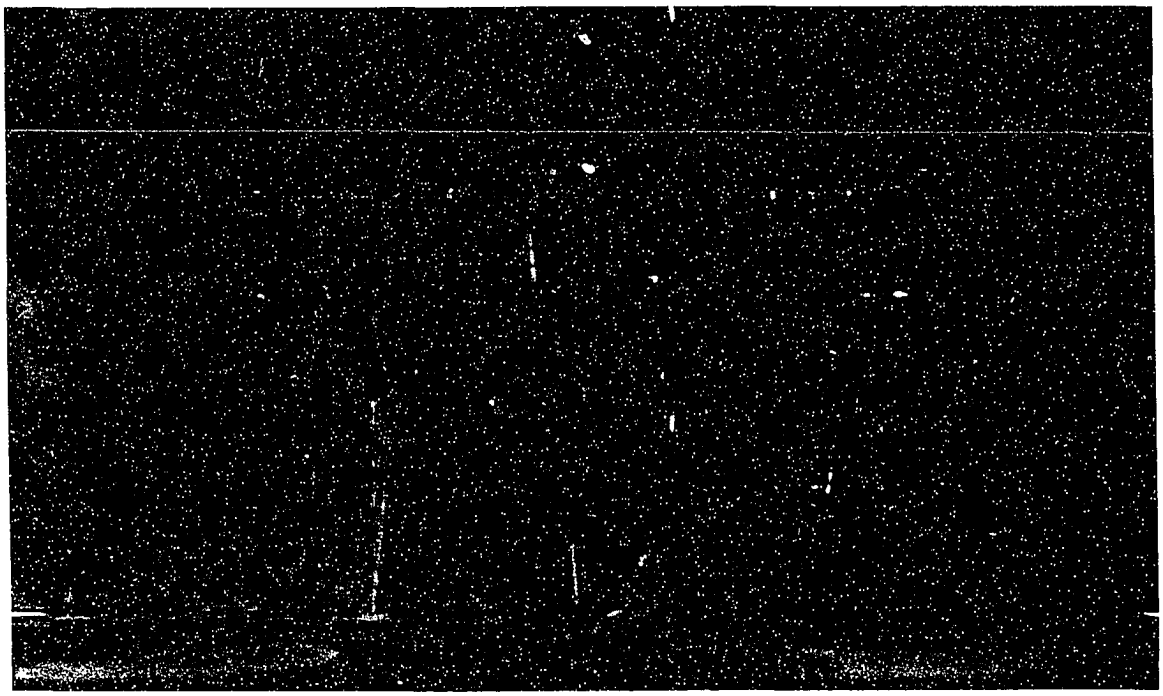


Fig. 8 = Invalid Test

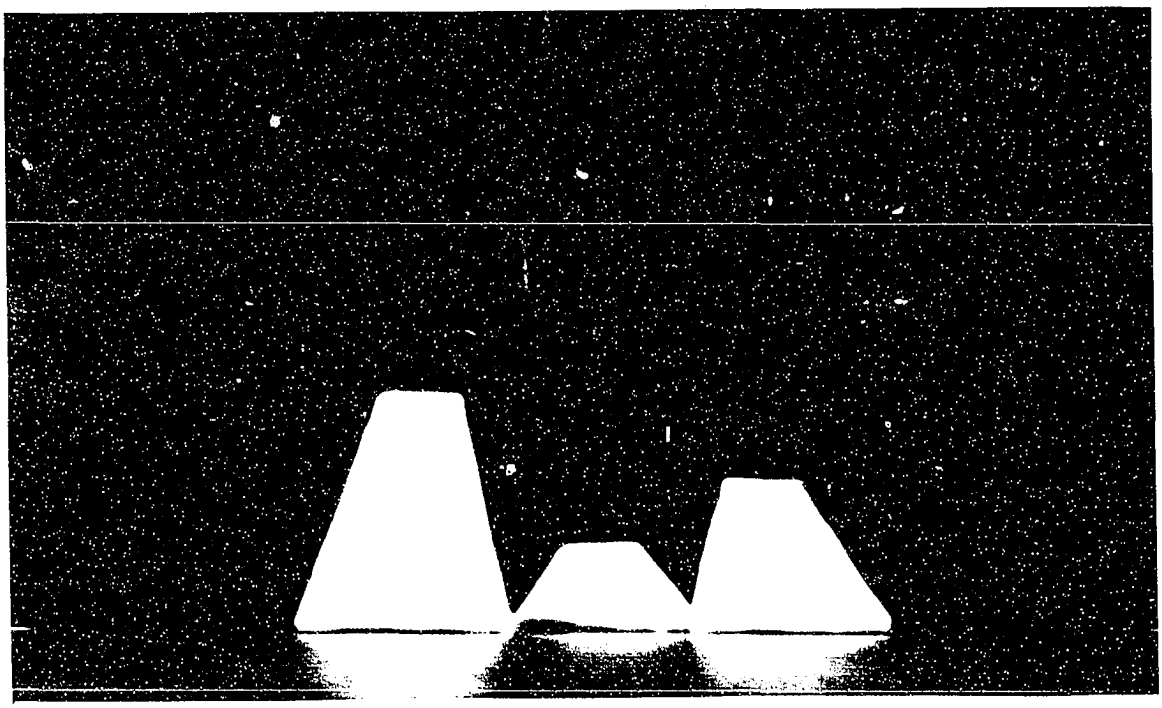


Fig. 9 = Invalid Test - Invalidated Top

position or size in the pattern, the learning series were arranged so that one group of animals would learn the whole problem, or both proportions. This would emphasize the law of reaction advanced by the configurationist which claims that learning is to be studied as the response of the organism as a whole to the total problem or arrangement of stimuli. This was designated as Method I. In Method II the group would learn half the problem or one proportion. This would permit middle-sizeness to change in position only in each pattern. It would further afford opportunity for building up a specific habit or bond to one particular middle-size, and thus conform to the principles of trial and error learning.

3. The Learning

Arrangement of Patterns. Group I learned by Method I. That is, the stimulus patterns changed in size and position after each trial. For example, in trial one, each animal responded to 0.5, 2.5, 4.5; in trial two, each animal responded to 4.5, 6.5, 2.5. Since each animal was given twelve trials per day, it responded to each pattern twice each day. But in no case was the learning upon the following day begun on the last pattern of the previous day's work.

The following table gives the arrangement of the day's work for this group.

TABLE I

LEARNING PATTERNS GROUP I METHOD I

0.5	2.5	4.5
4.5	6.5	2.5
4.5	0.5	2.5
2.5	4.5	6.5
2.5	4.5	0.5
6.5	2.5	4.5
4.5	0.5	2.5
4.5	6.5	2.5
0.5	2.5	4.5
6.5	2.5	4.5
2.5	4.5	0.5
2.5	4.5	6.5

Group II learned by Method II; that is, the patterns of Series A changed in position only after each trial. The purpose of this method was to determine whether the more frequent occurrence of the response to 2.5 as middle-sizeness in this series would reduce it to a mechanical process, hence provoking this same response when required to respond to 4.5 as middle-sizeness in Series B. Likewise this method would test whether a constant proportion is more easily learned than a changing proportion. The arrangement of the patterns for the twelve trials is listed below.

TABLE II

LEARNING PATTERNS GROUP II METHOD II

0.5	2.5	4.5
2.5	4.5	0.5
4.5	0.5	2.5
0.5	2.5	4.5
2.5	4.5	0.5
4.5	0.5	2.5
0.5	2.5	4.5
2.5	4.5	0.5
4.5	0.5	2.5
0.5	2.5	4.5
2.5	4.5	0.5
4.5	0.5	2.5

It will be noticed at once from the above list that each pattern appeared four times in one day's work, while in Method I each pattern appeared but twice in one day's work.

Criterion of Learning. -- After choosing the two learning series and the two methods of procedure, it was necessary to set up a learning criterion. Each series of each method was considered learned when the subject responded correctly eleven out of twelve trials for two successive days on its respective series.

4. The Test

The Learning Test. -- It is apparent that after the criterion of learning was reached, further tests of the degree and manner of learning were desirable. Therefore, two tests were projected. The first of these was designated as the learning test. The learning test for each group was each pattern of the learning series of that group reversed. Reversing the pattern would reveal whether the animal had learned by seeing relations or by position, as middle-sizeness appeared in a different position and a different relationship to the other two in the pattern. The criterion for this test was eleven correct responses in twelve. The test series for each group is given in the table on the following page.

TABLE III

FIRST TEST SERIES - LEARNING PATTERN REVERSED

Group I Method I			Group II Method II		
4.5	2.5	0.5	4.5	2.5	0.5
2.5	6.5	4.5	2.5	0.5	4.5
2.5	0.5	4.5	0.5	4.5	2.5
6.5	4.5	2.5	4.5	2.5	0.5
0.5	4.5	2.5	2.5	0.5	4.5
4.5	2.5	6.5	0.5	4.5	2.5
2.5	0.5	4.5	4.5	2.5	0.5
2.5	6.5	4.5	2.5	0.5	4.5
4.5	2.5	0.5	0.5	4.5	2.5
4.5	2.5	6.5	4.5	2.5	0.5
0.5	4.5	2.5	2.5	0.5	4.5
6.5	4.5	2.5	0.5	4.5	2.5

Having reached the criterion for successful learning set on its respective test series, each group was then required to respond to the learning series of the other group. When this criterion was reached, each animal in each group then responded to a second test consisting of three other tests specified as crucial tests.

Crucial Test. -- The purpose of the crucial tests was:

a. To determine beyond question whether the subjects had formed the concept middle-sizeness.

b. To discover how they had formed this concept.

In an effort to disclose the facts bearing directly upon the

answers to the above statements, three crucial tests - Series C, Series D, and Series E - were designed.

In the first test the proportions of the rectangular steps were increased as follows: 2.5 was increased to 3.5; 4.5 was increased to 5.5; 6.5 was increased to 7.5. This required the animal to select middle-sizeness in a proportion in which 3.5 was the confusing element. It fell between 2.5 and 4.5, and resembled very much 4.5. Furthermore, an increase in the proportion probably produced a greater problem than a decrease in proportion, since the rat's field of vision is not great. In a second test the rectangular steps in the proportion 2.5, 4.5, 6.5 were painted black. This made the figure and ground look the same and would presumably test whether the animal was responding to amount of brightness as such or to the mathematical ratio of the length of the middle-sized step to the other two steps (see Figure 5, p. 23). In the third test, the amount of brightness was increased by making trapezoidal steps with width at the bottom in 2.5, 4.5, 6.5 proportion increased, with the form at the top and the length remaining constant. This would test whether the form and amount of bright structure were potent factors in the solution of the problem. A comparison of the rectangular steps in learning with the trapezoidal steps in testing will make clear the problem involved (see Figures 2 and 6, pp. 18 and 23).

Since there were only six distinct permutations in any series, the trials were reduced to six for each of these test series and the patterns arranged to control position also. One test was given each day and the criterion was five correct trials in six. The following

table shows the order in which each test was presented.

TABLE IV

CRUCIAL TEST PATTERNS GROUP I, AND II

Rectangular Steps - Proportion Increased			Rectangular Steps - Black		
3.5	5.5	7.5	4.5	6.5	2.5
5.5	7.5	3.5	2.5	4.5	6.5
7.5	3.5	5.5	6.5	2.5	4.5
5.5	3.5	7.5	4.5	2.5	6.5
7.5	5.5	3.5	2.5	6.5	4.5
3.5	7.5	5.5	6.5	4.5	2.5

Trapezoidal Steps - Width Increased		
6.5	2.5	4.5
2.5	4.5	6.5
4.5	2.5	6.5
6.5	4.5	2.5
4.5	6.5	2.5
2.5	6.5	4.5

5. Results

Group I Method I. The total number of trials that it took for each animal of this group to learn the problem is shown in the accompanying table.

TABLE V

TOTAL LEARNING TRIALS FOR EACH SUBJECT GROUP I METHOD I

Subject Rat No.	Trials Required
4	120
5	216
6	120
7	132
8	60
Mean	129.6

Inspection of the above table reveals considerable variation in the number of trials required for each subject to learn the problem.

The graph of the time curve (See Graph I, p. 33) shows progress in learning in terms of the harmonic mean time based on the time score for each day (See Table XXX, Appendix). The complete record of the time in seconds from the beginning of the learning program until the close is shown in the appendix (See Table XXIV, Appendix). This table shows the great reduction in time of the subsequent trials over the initial trials. For example, Rat. 4, on his initial trial, took 4500 seconds to reach the food box. The second trial required fifty seconds.

The mean time for each trial was sixty-eight seconds. For the second day the mean time was fifty-two seconds. The curve continues to fall until the seventh day, when an average of seven seconds is reached. The subject maintained approximately this level until the criterion of learning was reached on the tenth day's work. The error curve shows a sudden fall to the zero point on the fourth day, with a marked tendency for the subject to remain near this. The first crucial test produced a slight rise in both the time and error curve (See Graph II, p. 35).

Rat 5 no doubt found the correct tunnelway by chance, as his initial trial took only 385 seconds. However, the average time for the remaining eleven trials for that day was ninety-three seconds. On the sixth day the curve fell to five seconds and remained at approximately this point for the remainder of the time. A reduction of the errors to two on the fifth day (See Graph II, p. 35), shows decided agreement in results. It is interesting to note how long it took this subject to reach the criterion. This is probably an indication of indifference or of growing stale to the problem. Since the subject reached the criterion set on each of the tests, this shows evidence of insight in the solution; i.e., that success was not secured in terms of fixed habits of response.

The performance of Rat 6 is not very different from the first two mentioned. The initial trial required 1150 seconds to find the correct tunnelway. The average time for each of the other eleven trials for that day was twenty-four seconds. The curve then had a rapid descent until the sixth day, when six seconds was the average

Graph 1

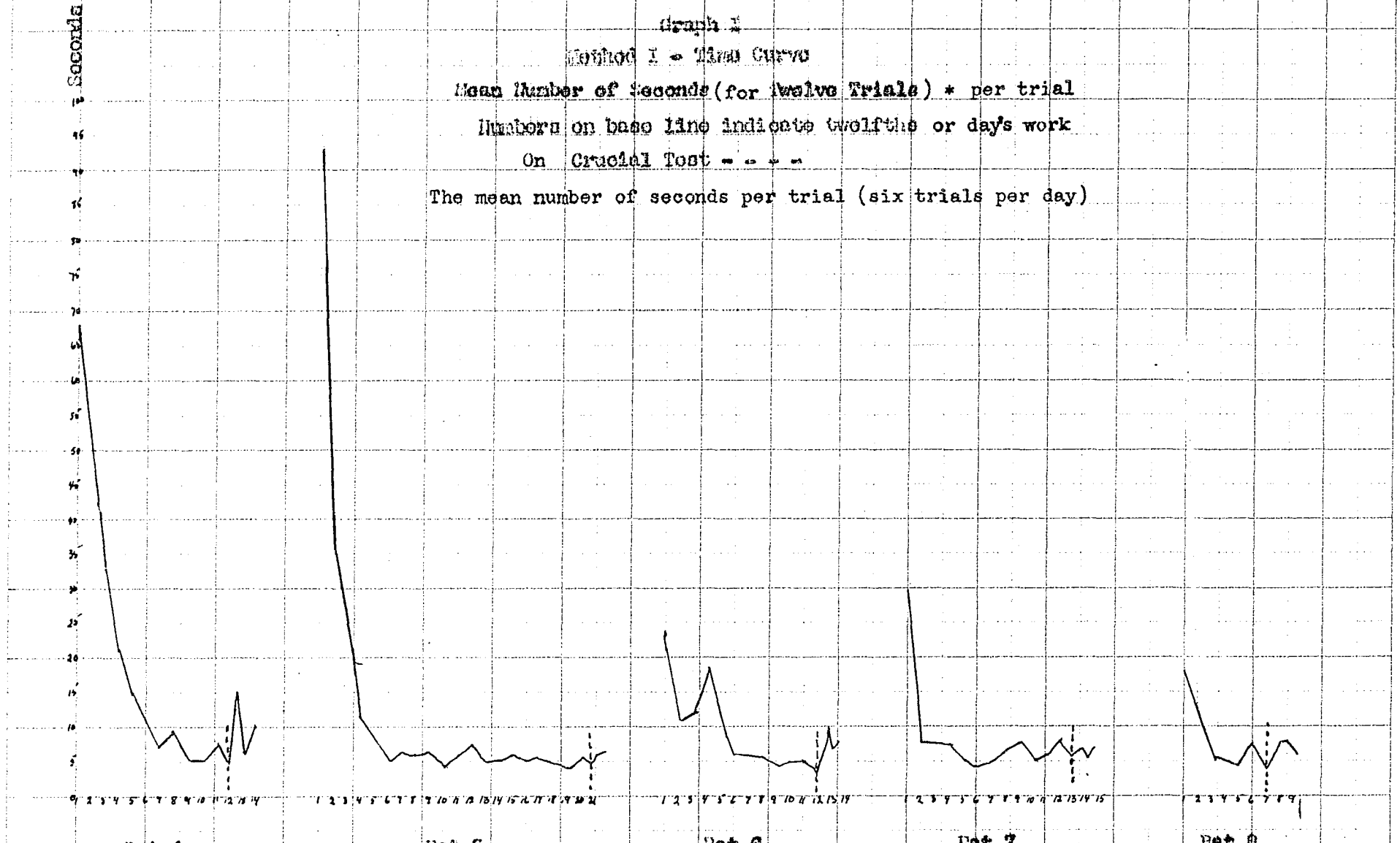
Method I - Time Curve

Mean Number of Seconds (for Twelve Trials) * per trial

Numbers on base line indicate twelfths or day's work

On Crucial Test - - - -

The mean number of seconds per trial (six trials per day)



* The initial trial of the first twelve was omitted in computing the means.

for each trial. The curve (See Graph I, p. 33) remained at this point and below until the crucial test situation produced a short ascent in the time curve. This shows evidence of taking time to adjust to the new situation and responding adequately to it.

The error curve of the same rat (See Graph II, p. 35) falls to one on the seventh day, followed by a steep ascent on the eighth day, from which it falls to zero on the ninth day. After this it fluctuates between one and zero for the remainder of the experimental period.

The initial trial for Rat 7 required 210 seconds. The other eleven trials for the day required an average of thirty seconds. On the second day there was a rapid descent of the curve (See Graph I, p. 33) to seven. It remained at this point or below for the remainder of the experiment. The error curve (See Graph II, p. 35) shows marked agreement with the exception of the steep ascent on the sixth day; the two plateaus following this with sudden falls point to growth of more insight into the problem. The error curve for each trial (See Graph III, p. 38) shows that this subject had a low error record from the beginning. This presumably demonstrates insight with respect to the learning situation.

The performance of Rat 8 surpassed that of all others of the group (See Table XXIV, Appendix). The initial trial of 690 seconds falls to eighteen seconds (See Graph I, p. 33) in the remaining eleven trials for that day. There was a sudden descent to six seconds on the third day and the curve remains at approximately this point except for the test periods which caused a slight ascent. The error curve (See Graph II, p. 35) shows a sudden fall on the third day, at which point

Graph II

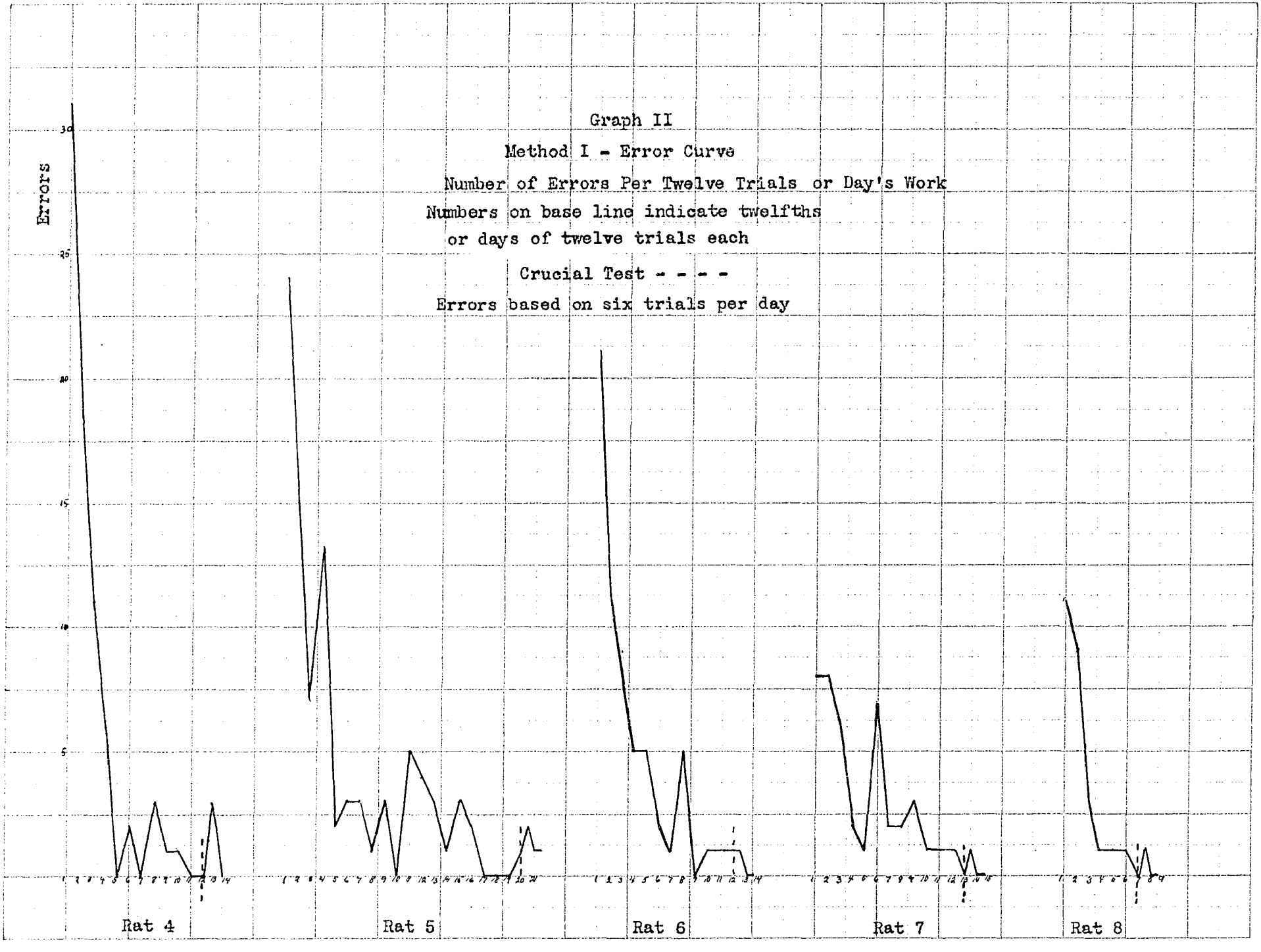
Method I - Error Curve

Number of Errors Per Twelve Trials or Day's Work

Numbers on base line indicate twelfths or days of twelve trials each

Crucial Test - - - -

Errors based on six trials per day



it remains for the remainder of the experiment. This curve further shows a very low error record for this subject throughout the entire experimental period. These last two subjects presented very few errors; besides, their performance reached a high point early and remained so until the close of the experiment. They are very striking examples of rapid development of insight into the problem; however, reference to the error curve shows that this was preceded by a trial and error or exploratory period.

Group II Method II. -- It will be recalled from the discussion of the procedure that Group II was trained to Series A with the proportions changing in position only with each trial. It will be further noted that both Groups I and II responded to the same pattern in the first or initial trial (See Table IV, p. 30). The results of Group II are shown in the table below (See Table VI). The number of trials required by each subject for learning and the mean number of trials for this group are presented.

TABLE VI

TOTAL LEARNING TRIALS FOR EACH SUBJECT - GROUP II METHOD II

Subject Rat No.	Trials Required
2	264
3	132
9	156
10	216
11	120
Mean	177.6

The record shows Rat 2 to have taken the greatest number of trials to reach the criterion set. The time for the initial trial was 3634 seconds. This was the longest time period for the initial trial in this group and ranks second for the entire group of ten. Each of the other eleven trials for this day had an average time of sixty-four (See Graph III, p. 38). On the second day the curve descended to twenty-nine seconds, but the third day showed a sharp ascent. On the sixth day both the time and error curve descended to a low level. They remained on practically a long plateau for the remainder of the experiment. This indicates a noticeable insight into the problem on the sixth and seventh days (See Graph IV, p. 40). This subject met the criterion on the first learning test, pattern reversed, but failed upon transfer to Series B to reach the criterion of learning; hence, training was continued until that was reached on the twenty-second day.

The prolonged activity which remained at almost a plateau from the seventh to the twenty-first day seems to indicate impaired vigor or energy with respect to the problem, rather than incapacity to learn. This is further demonstrated by the low error record which was held by the subject throughout the period (See Graph IV, p. 40). When transferred to the crucial test series, this animal responded adequately to each. This points very clearly to the fact that the response of the subject had not become mechanical or fixed. Yet there was ample opportunity for habits to be definitely fixed, since the learning consisted in responding to one series changing in position only, and extending over a long period of time.

Graph III

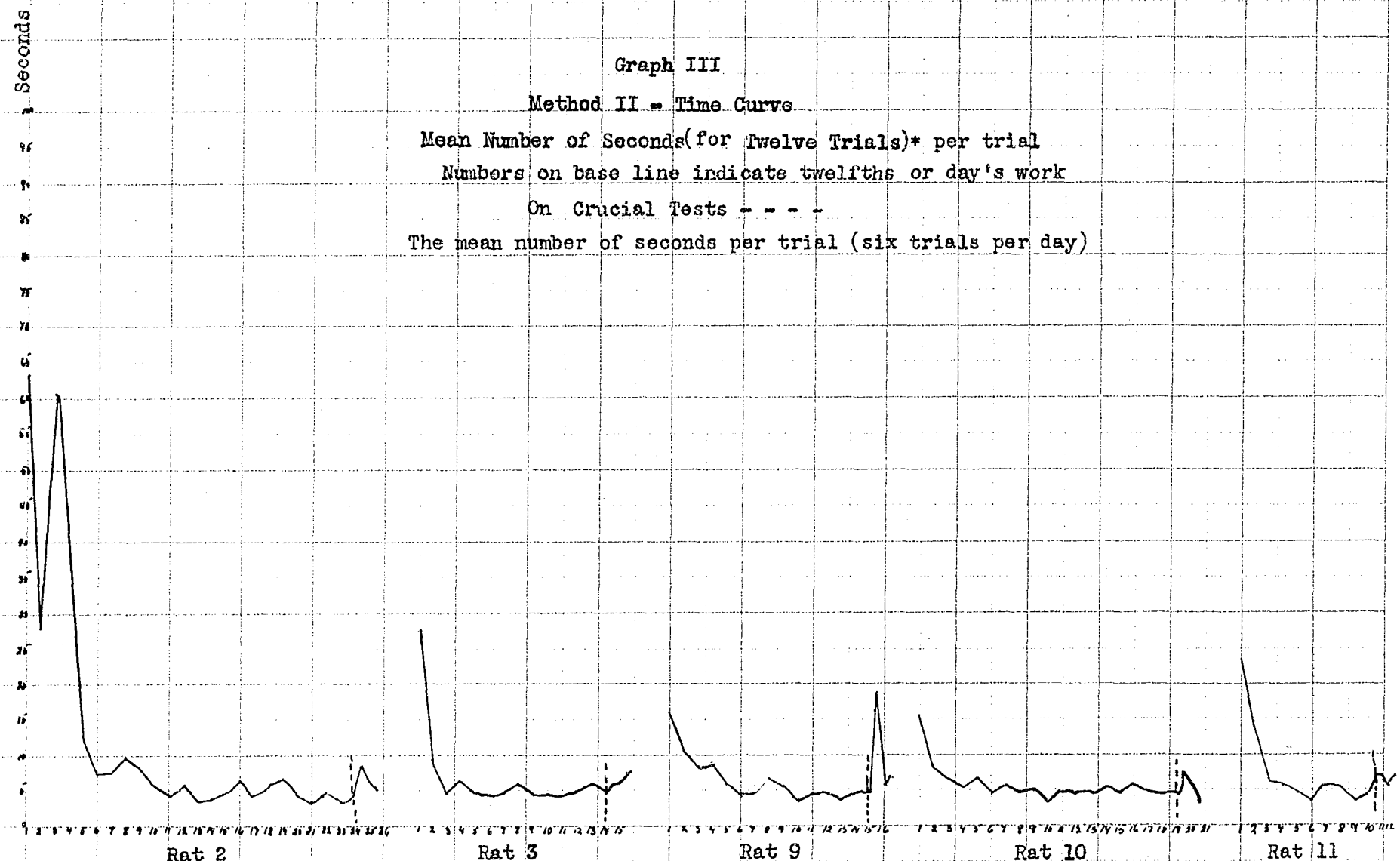
Method II - Time Curve

Mean Number of Seconds(for Twelve Trials)* per trial

Numbers on base line indicate twelfths or day's work

On Crucial Tests - - - -

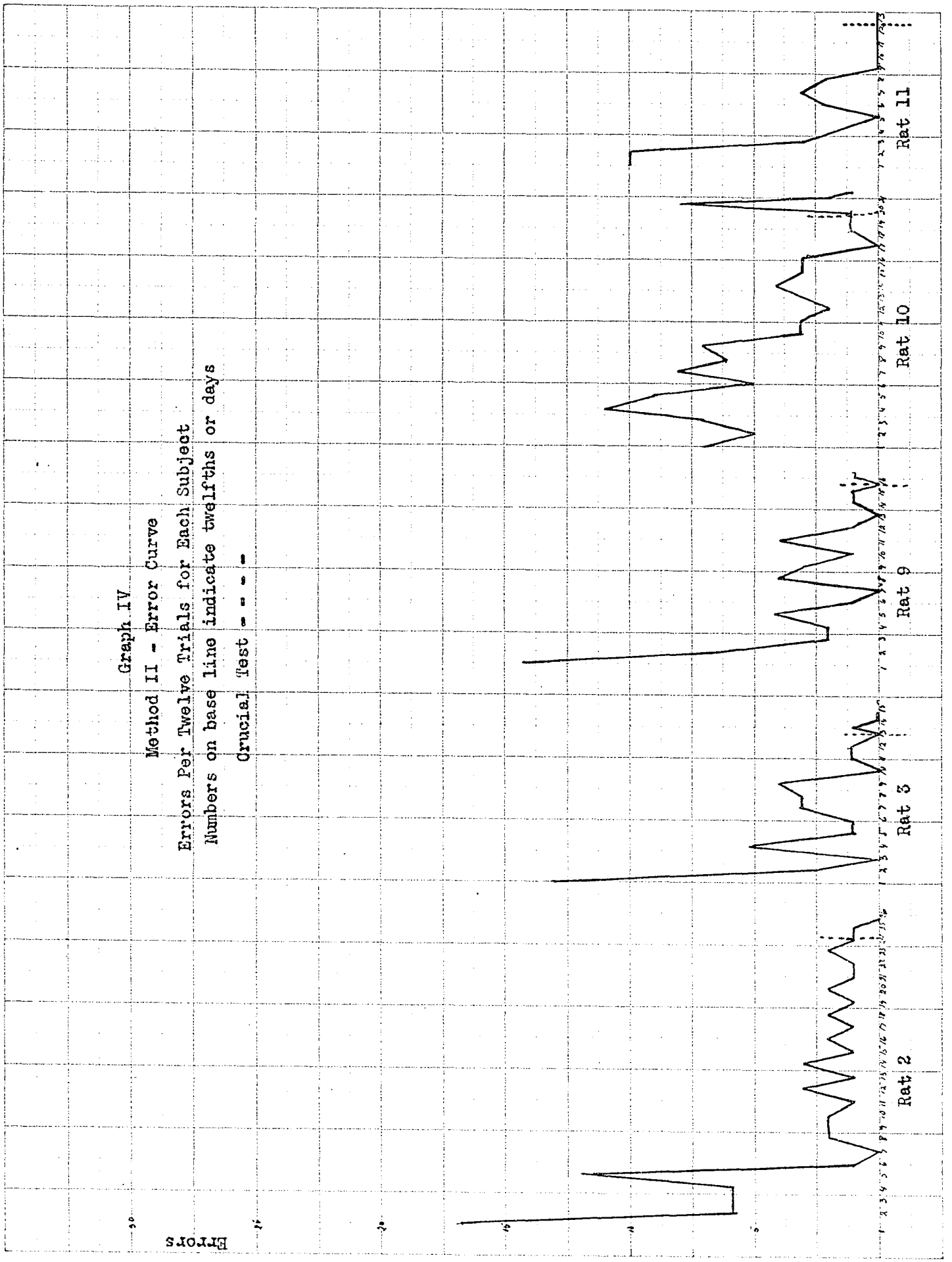
The mean number of seconds per trial (six trials per day)



* The initial trial of the first twelve was omitted in computing the means.

The initial trial of Rat 3 was one hundred seconds, probably for chance reasons. That is, it found the escape door at once through its efforts to explore the total situation. The average for each of the other eleven trials for that day was twenty-eight seconds (See Graph III, p. 38). On the third day the average performance record descended to five seconds and maintained approximately this record for the remainder of the time. There was, however, a slight ascent of the curve on the tests. The error curve (See Graph IV, p. 40) drops to zero on the third day but ascends again to five errors. This fluctuation of the error curve between five and zero continues until the tenth day when there was a sudden fall and the criterion was reached. This fluctuation indicates confusion with respect to the problem. Since the test at the end of this period failed to cause any increase in errors, we have produced another instance of behavior as a dynamic process. That is, the behavior of the subject in the new situation is determined by the forces or stimuli playing upon it, and its response will be modified in terms of the changing situation it encounters.

The time curve of Rat 9 begins at sixteen seconds (See Graph III, p. 38) for each of the eleven trials following the initial trial of 611 seconds. On the third day the curve falls to eight seconds. The criterion of learning was reached on the seventh day. But when the pattern was reversed, there was a breakdown in behavior (See Table XXV , Appendix). Five more days of training were necessary before the criterion was reached. A ninety per cent record was reached when the animal was transferred to the test on Series B. The crucial



test produced a slight ascent in the time curve. The error curve and time curve both show (See Graph III and IV, pp. 38 and 40) that the criterion was reached. This indicates that the learner was observing before responding.

The beginning of the time curve of Rat 10 was fifteen seconds, which is practically the same as Rat 9. The initial trial was 1090 seconds. This animal was a fast runner, as will be noted from the curve (See Graph III, p. 38). This accounts in part for the high error record, shown in the error curve (See Graph IV, p. 40). The curve of errors per trial (See Graph VI, p. 56) shows a rather high and consistent error record throughout. There is little evidence of learning before the tenth day. The curve falls suddenly on that day and remains approximately at this level until the sixteenth day, when there is a further drop. The criterion of learning was attained on the eighteenth day. The first crucial test shows a breakdown in behavior, but in the last two the criterion is reached. As will be pointed out later, this animal revealed slowness in the solution of the problem. The error table by tunnelway (See Table VIII, p. 59) shows a strong preference for the 0.5 tunnelway. In other words, there was a strong tendency to follow the line of least action. Descriptive analysis, in the subsequent discussions, will show that fast running and failure to make observation and comparison also played their part in prolonging the learning period and producing a high error record.

It is interesting to note that Rat 11's initial time record was much higher than that of Rat 10; also, that the time curve starts at a higher point (See Graph III, p. 38), twenty-three seconds for

each of the first eleven trials following the initial trial. The error curve (See Graph IV, p. 40) also begins at a higher point and remains on a plateau for two days. The sudden fall from this point to the zero level demonstrates rapid maturing of insight. The ascent in the curve of errors on the sixth and seventh days is considered to be a result of the animal's being fed by mistake. It is interesting to note that she made ten correct choices out of twelve on these two days and never entered the food box. She made the correct choice, went to the food table and played until the experimenter took her up. As soon as she was hungry again the curve descends to the zero point and remains until the problem is finished. It is further interesting to observe that the record of this animal (barring the accidental feeding) is directly comparable with Rat 8 in Group I (See Graphs I and II, pp. 33 and 35). Another point of interest for this group is (See Table XXV , Appendix) that the behavior of each animal in this group, except Rat 10 and Rat 2, broke down when the pattern was reversed. The star on the error table indicates the point at which this occurred and the number of trials which were necessary to reach the criterion again. Each subject then reached the criterion when transferred to Series B. Rat 2 reached the criterion when the pattern was reversed but broke down when transferred to Series B.

Descriptive Analysis. -- Any learning experiment affords many possibilities for utilizing observations which cannot and need not be treated quantitatively. This, however, does not minimize their importance. Often they may be of even greater importance than the quantitative data. Many of the responses which will be reported here

occurred numerous times in the same subject and in all subjects. In fact, those subjects and those trials which were most characteristic of the group have been selected for this description.

Referring to the explanation given in the beginning of this experiment, it will be recalled that Series A was the proportion 0.5, 2.5, 4.5; Series B was the proportion 2.5, 4.5, 6.5. If both proportions are mentioned in explaining the animal's behavior, it is learning by Method I. If one proportion is mentioned, it is learning by Method II. Each proportion will be stated in the order that it was presented to the subject.

With all these animals there was a marked tendency to get acquainted with the situation. They explored before making the right choice. A detailed description of the learning behavior follows. The rats and trials selected for full description were chosen for the following reasons:

a. The subjects chosen represent ones which are typical for the group.

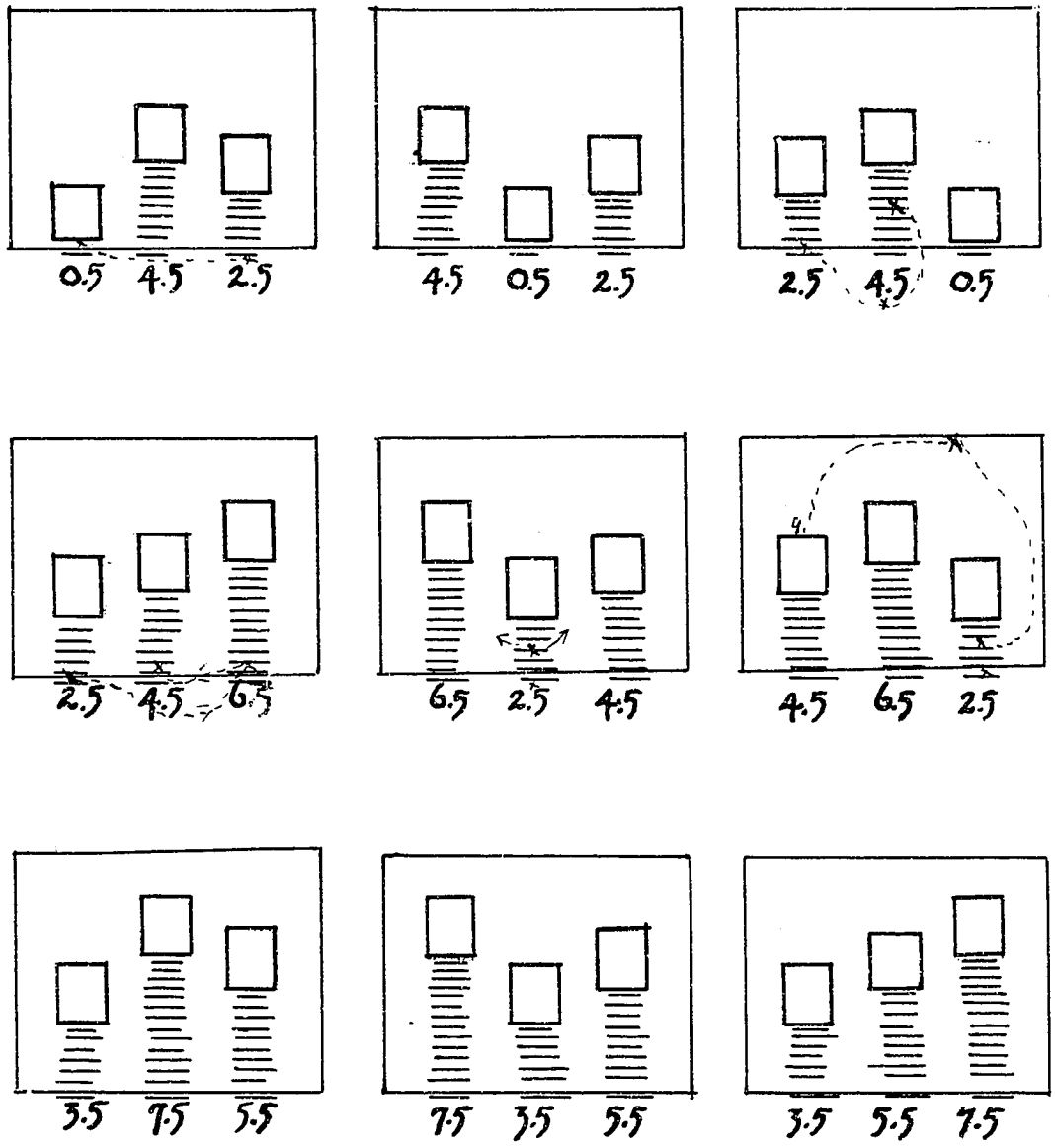
b. The initial trials present behavior exhibited in a totally new situation.

c. The other trials were chosen to show progress in behavior.

d. Since all could not be chosen, an effort was made to approximate a random sample that would be typical or representative.

Rat 5. Day 1, Trial 1. Pattern 0.5, 2.5, 4.5. Time: 385 seconds. He approached the entrances of the tunnelways, entered 2.5 at once and went to escape door, returned to entrance door after twenty seconds, explored, returned to starting table, across 0.5 to

FIGURE 7
PATTERNS - LEARNING AND TESTS



(Figures below openings are perpendicular distance from bottom of opening to table in inches not length of wire steps.)

edge of table, in 0.5 remained thirty seconds, returned to 2.5, tried escape door, put feet down on food table, but withdrew into tunnelway. He then returned to the entrance table, explored entrance of 4.5, returned to 2.5, went through escape door to food box at the end of six minutes and twenty-five seconds.

Day 1, Trial 2. Pattern 2.5, 4.5, 6.5. Time: 300 seconds. In the second trial this animal responded to the pattern 2.5, 4.5, 6.5. He went straight ahead to the entrance doors, entered 4.5, returned to starting table, entered 2.5 for four minutes, returned to starting table, entered 4.5, found escape door, returned to starting table, entered and explored 6.5, returned to starting table again, entered 4.5, went to the escape door a second time, entered the food box after five minutes.

Day 2, Trial 3. Pattern 4.5, 0.5, 2.5. Time: 69 seconds. The subject went straight ahead into 2.5, failed to find escape door, returned to starting table, entered and explored 0.5, returned to starting table, entered 4.5, out on starting table again, returned to 2.5, lifted escape door and went straight to food box at the end of one minute and nine seconds.

Day 2, Trial 6. Pattern 6.5, 2.5, 4.5. Time: 44 seconds. Responding to the 6.5, 2.5, 4.5 proportion in trial six, this subject explored at starting point for five seconds, entered 2.5 and 6.5 in turn, returned to starting table, entered 4.5 through escape door to food box in forty-four seconds.

Rat 7. Day 1, Trial 1. Pattern 6.5, 2.5, 4.5. Time: 210 seconds. This rat explored the table for twenty seconds, then entered

2.5, returned to entrance table, circled about over the table, went to edge of table, looked down at the floor, returned to 2.5, entered after fifty-five seconds, returned to the starting table, explored, returned to 2.5 after three minutes, went to escape door, tried it, lifted it, jumped down on food table, explored table, entered the food box after three minutes and thirty seconds.

Day 1, Trial 2. Pattern 4.5, 6.5, 2.5. Time: 56 seconds. She approached the entrances, entered 2.5, returned to the starting table, entered 4.5 after forty-five seconds, found escape door, hesitated before jumping down (a strange jump for the animal) after five seconds jumped down, entered the food box at the end of fifty-six seconds.

Day 2, Trial 3. Pattern 4.5, 0.5, 2.5. Time: 25 seconds. This animal entered 4.5, returned to table after ten seconds, entered 0.5 for fifteen seconds, returned to starting table, entered 2.5 after twenty seconds at escape door, through to the food box in thirty seconds.

Day 3, Trial 1. Pattern 0.5, 2.5, 4.5. Time: 35 seconds. This animal ran over the table for thirty seconds, then suddenly turned and entered 2.5, going straight to the food box.

Rat 8. Day 1, Trial 1. Pattern 0.5, 2.5, 4.5. Time: 690 seconds. This animal solved the problem more quickly than any of the other animals. However, on the initial trial her behavior compared well with the others here mentioned. The first day she entered 2.5 after thirty-five seconds of exploring the table, returned to the starting table after forty seconds, entered 2.5 after one minute,

returned to starting table, sniffed, explored over the table five minutes, returned to entrance of tunnelway, ventured body half in 2.5, returned to starting table, explored table over and over again, ventured half in 0.5 after seven minutes, in 2.5 at the end of eleven minutes, found the escape door, ventured onto food table, reached food box at eleven minutes and thirty seconds.

Day 1, Trial 6. Pattern 6.5, 2.5, 4.5. Time: 168 seconds. In responding to this pattern she lingered at the starting point, then approached 2.5 and 6.5, entered 6.5 and remained for fifteen seconds, returned to the starting table, entered 4.5 again. After one minute she returned to starting table, entered 4.5, came out immediately, entered 4.5 again, after thirty-four seconds found the escape door, ventured onto food table, entered food box in one minute and nine seconds.

Rat 11. Day 1, Trial 1. Pattern 0.5, 2.5, 4.5. Time: 41 minutes and forty seconds. This animal was taught the problem by Method II. In trial one she went straight ahead from starting point, looked in 2.5, ventured body half in after two minutes and five seconds, returned to starting table, explored, sniffed, body half in 0.5 again, returned to the starting table and began a continuous round of exploring; after six minutes ventured into 2.5 the length of her body, returned to the starting table, sniffed, looked, entered 2.5 after fourteen minutes and thirty seconds, hastened out as if afraid, into 2.5 again after nineteen minutes and thirty seconds, returned to starting table, explored again, approached the entrance, hesitated at length, entered 2.5 after forty minutes at escape door made exit, out onto food table, climbed up on top of the tunnelway

(see Figure 3, p. 21), explored, returned to food table, went to the food box after forty-one minutes and forty seconds.

Day 1, Trial 5. Pattern 2.5, 4.5, 0.5. Time: 100 seconds. She entered 4.5, remained eleven seconds, returned to the starting table, entered 0.5, remained fifteen seconds, returned to the starting table again, entered 2.5, found the escape door, out of the tunnelway onto food table, entered the food box after one minute and forty seconds.

Rat 9. Day 1, Trial 1. Pattern 0.5, 2.5, 4.5. Time: 10 minutes and 11 seconds. When she was placed at the starting point, went straight to entrances of the tunnelways, halted, turned away and began to explore the starting table (every point was thoroughly examined). After four minutes and thirty seconds she entered 2.5, withdrew as if afraid; after five minutes she ventured the length of her body into 2.5. She returned to starting table and continued to explore for one minute. She then returned to entrances of tunnelways. After seven minutes she went to the escape door and tried it. She then returned to the starting table, seeking excitedly for three minutes, entered 2.5, went to the escape door, lifted the door, looked out, jumped down on table, entered food box after ten minutes and eleven seconds.

Day 1, Trial 3. Pattern 4.5, 0.5., 2.5. Time: 90 seconds. On this trial she entered 0.5 at once, returned to the starting table after fifteen seconds, explored table and 4.5 for fifty seconds, entered 0.5 again, returned to starting table, then entered 2.5 again, through escape door to the food box in one minute and thirty seconds.

Day 1, Trial 8. Pattern 2.5, 4.6, 0.5. Time: 85 seconds. She entered 4.5, then returned to starting point, explored table twenty seconds, returned to entrances, entered 0.5, returned to starting table, entered 0.5 again, returned to starting table, entered 2.5 and after one minute and twenty-five seconds, she went to food box.

Surveying the above analysis of each rat's behavior just as it occurred in the situation, one notices that the behavior is very similar in each subject. This is also typical of the behavior of each group as a whole. Comparing the time on the initial trial (See Table XXIV, Appendix) with the second trial for Rats 4, 6, 7, 8, 2, 9, 10 and 11, one sees clearly that there is a marked reduction in the time required from the first to the second trial. For Rats 5 and 3, the difference is not great. Further observation of the time table shows that learning from trial to trial was progressive rather than sudden. The reduction of time from one trial to another may be evidence of flashes of insight which the subjects were gaining with respect to the goal.

The records show that this type of behavior was accompanied by another type of behavior which began at different points for each animal. This became most obvious at the points mentioned in the following descriptions. The animals actually halted outside the tunnelways before making a choice. They were actively choosing middle-sizeness in relation to the other two sizes. The sudden changes from the wrong entrance step back to the table, and then to the correct one point to the fact that the animals were responding to a relationship in terms of the goal. Our attention will be directed to these changes at this point.

Rat 9. Day 2, Trial 24. Pattern 0.5, 2.5, 4.5. Time: 35 seconds. This rat dashed straight ahead onto the step of 0.5 (See Figure 7, No. 1, p. 44), halted, turned to 2.5, went to the escape door, returned to starting table, ran over table thirty seconds, turned and suddenly entered 2.5, through escape door to food box at end of thirty-five seconds. On trial twenty-nine, pattern 4.5, 0.5, 2.5, this same animal dashed straight ahead, on step 4.5 halted, whirled to 2.5, then 0.5, looked suddenly, turned, chose 2.5, went straight to food in five seconds. On the thirty-second trial, pattern 2.5, 4.5, 0.5, this animal approached the entrance from starting point, half up step of 4.5 (See Figure 7, No. 3, p. 44), halted, looked; after four seconds she suddenly whirled around to table, turned again, entered 2.5, went straight to the food box at the end of sixteen seconds.

Rat 8. Day 2, Trial 24. Pattern 2.5, 4.5, 6.5. Time: 5 seconds. She went quickly to 4.5, turned (See Figure 7, No. 4, p. 44), suddenly to 2.5, observed excitedly, whirled completely around, two feet on step 6.5 (nervous as if sensing a problem), looked over 4.5, then to 2.5, turned back, entered 4.5 through the escape door to the food box in five seconds.

The above behavior is typical of the behavior of this animal on the third day. The problem was learned at that point, since on the two days following she had eleven perfect trials in twelve for each day.

Rat 5. Day 3, Trial 38. Pattern 4.5, 6.5, 2.5. Time: 20 seconds. This rat rushed in front of 2.5, looked, turned right to

table, turned again under step 6.5 to 4.5, entered tunnelway, through the escape door to food box in twenty seconds.

Rat 7. Day 2, Trial 24. Pattern 2.5, 4.5, 6.5. Time: 15 seconds. She approached the entrances, halted on step 2.5, looked toward 4.5 and 6.5, descended step 2.5, took 4.5, and went straight to the food box in fifteen seconds.

Day 3, Trial 34. Pattern 6.5, 2.5, 4.5. Time: 10 seconds. On this trial she approached the entrance, body half in 2.5, backed out quickly, turned on step, looked at 6.5, turned again, looked at 4.5, entered it after six seconds and was in the food box in ten seconds. On the first learning test (See Table III, Method I, pattern reverse) this animal approached the entrance of pattern 4.5, 6.5, 2.5 and halted at 2.5 (See Figure 7, No. 6, p. 44), ascended the entrance step, halted again, (seemed nervous and confused). She then returned to starting table, returned to 2.5 again, scaled the wall to point X, halted, looked down at 6.5, 4.5, then made the circle X - Y, entered 4.5, was in the food box in fifteen seconds. On one of the crucial tests (rectangular steps-black) this same animal went straight to entrance steps, stopped, looked, turned away, returned to starting point, turned again, went straight to entrance of 4.5, halted, looked, then entered.

The two divisions of the descriptive analysis given above correspond to the learning curves which have been mentioned in each discussion. To say that any particular trial of any animal marked the exact point of the change would be erroneous. These data point to the fact that the change began to be most obvious on the second

day for some subjects and on the third and fourth days for others. The error tables (See Tables VII and VIII, pp. 58 and 59) and the error graphs (See Graphs V and VI, pp. 55 and 56) point out the low error record which was being held by each subject. These tables and curves further show that learning was progressive from day to day but reached a low point on the fourth and fifth days. This was held for the remainder of the time. This does not mean that there were no more errors made, but it does point to the fact that the subjects were behaving in a manner which might be called intelligent with respect to the situation.

Since this marked change of behavior was present in the entire group, it suggests further that the animals were then trying to decide what to do, rather than merely moving at random. A careful examination was apparently being made. Establishing a meaningful goal produced a conflict between this and other goals. Their observation of the total situation was essential before reaching this goal satisfactorily. Random movements were resolved into a different kind of activity. The reaction curves and the time and error tables (See Tables XXIV and XXV, Appendix), as has been pointed out, are different before and after this behavior begins. The reaction is more uniform. The wide irregularity in the curve is reduced to approximately that of uniformity. The fluctuation of the error record is between zero and one, with zero the most characteristic. Old responses were discarded and replaced by new ones. Evidence from both objective data and descriptive analysis justifies the assumption that the animals had decided upon what to do to reach the goal.

This does not mean that no more errors were made, but the errors were made with the goal known. The fact that these animals were capable of seeing relationships and of a sudden change in behavior justifies the statement that the animals are capable of behavior with insight (See criterion a, p. 2).

6. Comparative Discussion

The number of trials required by Group II for mastering the problem is greater than the number of trials required by Group I (See Tables V and VI, pp. 31 and 36). This brings out the fact that in a changing proportion relationships are more rapidly developed.

Comparing the total number of errors on the tunnelways for each twelve trials (See Table VII, p. 58 and Table VIII, p. 59), we find more errors being made by the subjects of Group I than by the subjects of Group II. These data further show that the errors were being eliminated more rapidly. That is, for Group I the errors more nearly approach the zero point on the third and fourth days, while for Group II these errors more nearly approach the zero point on the fourth and fifth days. The error table further shows that all the subjects of Group I, except Rat 5, reached the criterion when the first test was presented. Three of the five subjects of Group II, namely, Rats 3, 9, and 11, failed to reach the criterion when the pattern was reversed. Rat 2 reached the criterion when the pattern was reversed, but broke down when transferred to Series B. This points to the fact that relationships were harder to form in a pattern with middle-sizeness changing in position only.

There is a marked tendency for each group to favor 0.5 on the

first five days, and Group I favors 2.5 on the pattern of Series B. This probably may be an indication of the tendency of each animal to follow the line of least action [1] until a goal is established. From the descriptive analysis, it is further interesting to note that comparisons of the entrance step to the tunnelways were made before the animals responded.

Graphs V and VI (See pp. 55 and 56) show the errors for each animal per trial for the first sixty trials. The writer arbitrarily chose the point 60 as the terminator of the graph because the curve would fluctuate between zero and one (See Table XXV , Appendix) with zero errors as the most characteristic performance, or the mode from this point on. Hence, the curve would follow this same form for each subject for the remaining number of trials.

The deduction from these error curves is two-fold. When comparing the two curves we see that Group I has more errors in the beginning and that they have fewer plateaus than Group II. The plateaus of Group II are somewhat longer than those of Group I. This points to the fact that it was harder to form relationships in a pattern changing in position only.

Comparing these graphs of single errors by trials with the composite error curve (See Graphs I and III, pp. 33 and 38), we notice an interesting feature. That which seems to be sudden insight from the composite error curve is a product of many movements of trial and error

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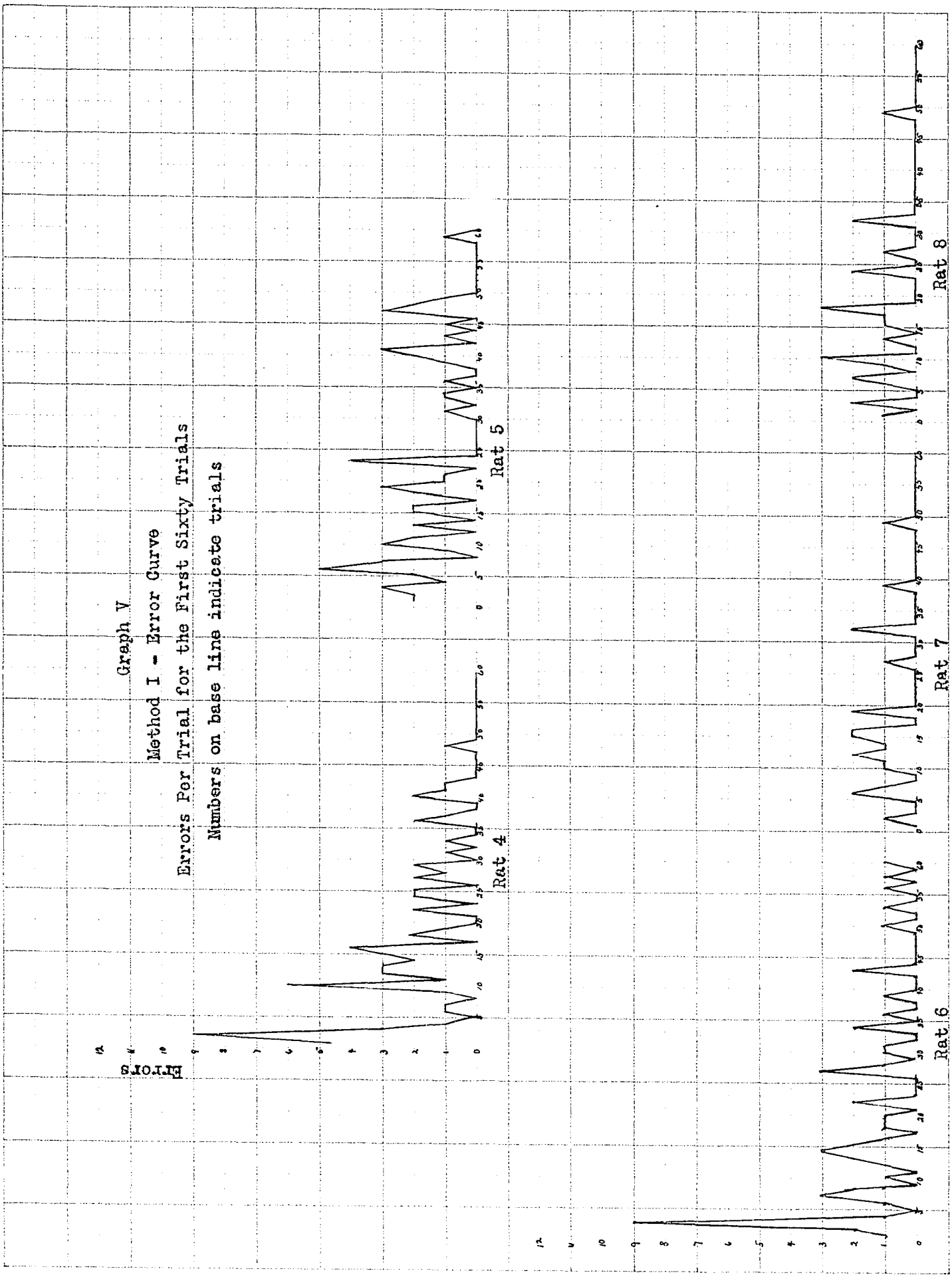
[1] Ramond H. Wheeler, Science of Psychology, pp. 255-58. New York: Thomas Y. Crowell Co., 1929.

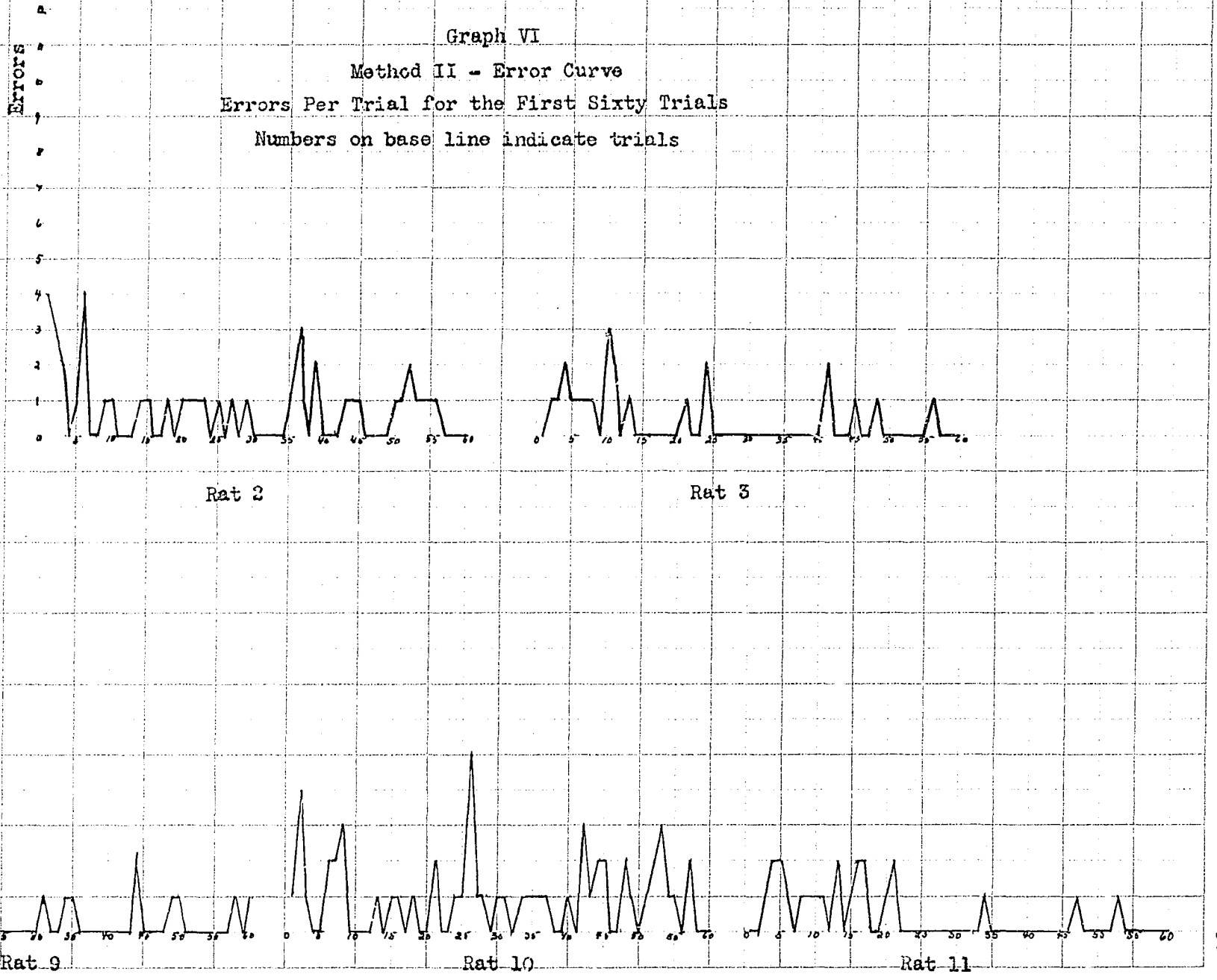


Graph VI

Method II - Error Curve

Errors Per Trial for the First Sixty Trials

Numbers on base line indicate trials



and insight combined. This is shown by the detailed error curve. For example, Rat 4's error curve (See Graph V, p. 55) shows a high error record until the fifth trial. Then there is a sudden fall to zero. This fall indicates flashes of insight. The curve has a similar fall after the fifteenth trial. All the other animals show similar records.

Furthermore, it indicates maturation of these behavior processes until a solution of the problem is realized. The solution is a function of the trial and error and exploratory period, and not sudden and complete in any case. This is shown by the plateaus in the learning curve. The sudden fall of the curve to the zero point following these plateaus indicates maturation or growth which has taken place with respect to the learning situation.

TABLE VII

TOTAL NUMBER OF ERRORS PER TWELVE TRIALS BY TUNNELWAY - GROUP I METHOD I

12ths.	Rat 4 Error on				Rat 5 Error on				Rat 6 Error on				Rat 7 Error on				Rat 8 Error on			
	0.5	2.5	4.5	6.5	0.5	2.5	4.5	6.5	0.5	2.5	4.5	6.5	0.5	2.5	4.5	6.5	0.5	2.5	4.5	6.5
1.	10	6	5	10	8	7	5	4	10	6	3	2	2	4	0	2	4	3	1	3
2.	3	8	3	5	7	4	5	2	4	5	1	2	3	1	2	2	3	3	0	3
3.	2	4	4	1	3	1	0	0	3	4	1	1	3	3	0	0	1	1	0	1
4.	1	3	0	2	0	4	1	5	1	1	2	1	2	0	0	0	1	0	0	0
5.	0	0	0	0	1	0	1	0	1	2	1	1	1	0	0	0	1	0	0	0
6.	2	0	0	0	0	1	1	1	1	1	0	0	4	0	5	1				
7.	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	2				
8.	1	1	0	1	0	0	1	0	0	2	2	2	0	0	1	1				
9.	1	0	0	0	2	1	0	0	0	0	0	0	0	0	1	2				
10.	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0				
11.					0	0	0	0					1	0	0	0				
12.					0	1	1	2*												
13.					0	1	0	1												
14.					0	1	0	1												
15.					1	0	1	1												
16.					1	0	1	1												
17.					0	1	0	1												
18.					0	0	0	0												
Total	20	23	12	19	24	22	17	20	23	21	10	9	17	8	9	10	10	7	1	7

* Point at which the pattern was reversed. This subject broke down.

TABLE VIII

TOTAL NUMBER OF ERRORS PER TWELVE TRIALS BY TUNNELWAY - GROUP II
METHOD II

Twelfths	Rat 2 Errors on 0.5	4.5	Rat 3 Errors on 0.5	4.5	Rat 9 Errors on 0.5	4.5	Rat 10 Errors on 0.5	4.5	Rat 11 Errors on 0.5	4.5
1.	11	5	9	4	11	3	10	3	11	1
2.	6	0	2	2	4	4	7	0	6	3
3.	4	2	0	0	2	1	7	2	1	0
4.	4	2	4	1	1	1	7	4	2	1
5.	4	4	1	0	3	1	8	2	1	0
6.	0	1	1	0	1	1	4	1	1	0
7.	1	1	*2	1	0	0	5	3	*2	0
8.	2	1	3	0	*3	2	5	1	1	1
9.	1	1	2	2	1	2	4	3	0	1
10.	0	2	0	0	0	1	3	0	0	0
11.	1	0	1	0	3	1	2	1		
12.	3	1			1	0	1	1		
13.	1	0			0	0	2	1		
14.	0	0					2	2		
15.	*0	0					2	1		
16.							1	0		
17.							0	0		
18.							*0	0		
Total	38	20	25	10	30	17	70	25	25	7

* Point at which the pattern was reversed. Three subjects broke down at this point.

Rat 2 was transferred to Series B for a learning period on the sixteenth day because he failed the learning test of this group. This error period showed confusion between 0.5, 2.5, and 4.5. Six more days of training were required.

The accompanying table is a composite picture of the harmonic mean of the time in seconds for each trial of the learning and test series.

TABLE IX

HARMONIC MEAN OF TIME IN SECONDS - LEARNING AND TESTS

	Group I Method I					Group II Method II				
	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
Learning	11	8	7	8	7	7	5	5	5	6
L. Test	9	5	4	6	5	4	5	5	4	5
C. Test	10	5	7	6	7	7	7	8	5	6

Comparing the individual records shown in this table, one notes that some of the subjects in Group I Method I on the average take more time per trial to respond than the subjects of Group II Method II. This indicates more deliberation before responding and points to the fact that longer time per trial may be a factor in shortening the total learning time. Also, the more complex problem requires more time in the beginning for forming adequate responses.

Comparing the actual time in seconds of the performance of each animal on the crucial tests, we find that for most of the animals the time for making each response is increased (See Table X, p. 61). Each of these tests was a new situation in itself.

TABLE X

TIME PER TRIAL FOR EACH ANIMAL ON CRUCIAL TEST

	Rectangular Steps - Proportion Increased									
Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
1.	25	3	20	15	10	8	15	115	8	10
2.	25	4	10	5	5	15	10	15	15	9
3.	10	5	10	7	7	15	3	8	5	5
4.	7	5	10	6	10	10	7	30	20	
5.	20	5	10	5	10	5	5	145	20	10
6.	45	4	15	10	5	7	5	14	30	5
	Rectangular Steps - Black									
1.	30	15	10	45	20	10	12	15	8	20
2.	30	5	15	5	5	7	5	5	6	5
3.	12	7	5	7	5	4	7	5	6	5
4.	5	5	5	4	8	6	7	4	11	
5.	10	17	7	7	7	5	4	11	7	5
6.	7	4	4	10	5	7	5	5	3	15
	Trapezoidal Steps - Wider									
1.	30	7	6	7	8	10	11	12	5	8
2.	30	7	7	7	18	5	4	10	3	7
3.	12	7	8	4	7	8	4	8	4	8
4.	5	6	10	5	5	4	25	5	3	4
5.	10	20	11	8	10	5	11	10	5	4
6.	7	7	5	4	7		5	4	4	4

This demonstrates that the test really was a problem that required observation and deliberation before a response was made. Examples of this have been mentioned above in the descriptive analysis of each animal's behavior.

This table further shows that Group II took somewhat longer per trial than Group I, but all the subjects in Group II responded to each test adequately except Rat 10. It failed on the first crucial test but passed the other two. Rat 4 in Group I reached only a fifty per cent performance on the first crucial test, but the criterion was reached in the other two. As a whole, all subjects in each group met the crucial test situation adequately. Rat 5 and Rat 2, which have long learning curves, made an adequate transfer to each of the test series; that is, they reached the criterion set.

These data certainly point definitely to the fact that the subjects had learned the problem. Even Group II which had taken the longest time for learning demonstrated that the problem had been learned.

Moreover, these tests throw light on the type of behavior which was required in the learning task. More will be said on this point in the following discussion.

7. Interpretation

One of the purposes of the crucial tests mentioned earlier was to determine what cues the animals had used in forming the concept middle-sizeness. When the animals were presented with Series C, they demonstrated that they could respond to a new pattern in which the

proportions had been increased actually and relatively. One of these proportions resembled 2.5 and 4.5 previously responded to, but which now had to be abandoned for a new element in a new pattern. This new element became the means to the end and was a new experience for the rats. The formation of this new relationship in the new situation demonstrated insight.

The response to the black steps demonstrated that the animals were responding to middle-sizeness as such and not to amount of brightness.

To further determine whether it was middle-sized intensity of the middle-sized step in the learning which the animal was responding to, a set of steps was designed with width at the bottom increased. In this series middle-sized intensity was not preserved. This increase in width and intensity points to the fact that the solution was middle-sizeness in relation to two other sizes and not intensity.

The descriptive analysis as set forth in the preceding pages of this experiment does not reveal learning as a process of stamping in of one act and the stamping out of another. Quite the reverse was found true. It will be recalled that Group II responded to middle-sizeness in one proportion throughout the learning problem, changing in position only. According to the laws of frequency and recency the middle-sized response (2.5) would have been so set that it would be responded to in any other situation. This did not prove true, for most of the animals, when transferred to the test situation in which 2.5 had to be discarded and 4.5 responded to, met almost immediately the criterion set. A further test of this truth was revealed when the crucial test, Series C,

was responded to and the criterion reached by all but Rat 10 and Rat 4. For Group I frequency was not a factor, because the patterns changed with each trial. If frequency had been a factor, the animals would have been thrown into a state of confusion after each trial with errors increasing. However, just the opposite was true, for errors were eliminated in this group even more rapidly than in Group II. The law of recency did not determine the behavior, because this group always finished the day's run on a pattern of Series B in which it responded to 4.5 as the middle-sized one and began each day by responding to a pattern of Series A with 2.5 as the middle-sized one. The evidence here seems to demonstrate clearly that learning is not explained in terms of a series of automatic responses, but that learning is a result of seeing relationships of one proportion to two other proportions. The animal dissected from the total pattern or Gestalt a detail in its relation to other details and the goal.

Although frequency played a part in the formation of the habits of response, it did not determine the animal's behavior when the pattern was reversed or when the proportions were increased. His behavior was still intelligent and adequate in that the middle-sized one was chosen in these strange situations. His old habits were broken down or discarded and the response was made in terms of the problem presented.

However, the data of this experiment do not warrant the discarding of trial and error movements or the exploratory movements as of no value. To say that the first thirty-six trials in this experiment were blind trial and error or random movements is erroneous. They were movements in response to a total pattern, a complex of stimuli, and probably involved many urges, such as the curiosity urge, the urge to

get acquainted and explore, the freedom urge, and the hunger urge, each with a potency all its own. The high stress set up by this complex of stimuli resulted in many trial and error movements which were soon resolved with respect to one particular urge, the hunger urge, which remained prepotent. Both the descriptive analysis and the quantitative data show that at this point the situation took on meaning. The response was the selection of the element middle-sizeness within the total behavior pattern with respect to the food goal and the release of the hunger tension.

Random or trial and error movements were accompanied by acts of observing and comparing the middle-sized approach with the other two. This period reveals maturation of the learning process, and in this experiment was the basis of what may be called insightful behavior.

Observations of the learning curves show numerous plateaus followed by sudden descents in the curve. These plateaus represent in the animal inadequate insight or the inability to see relationship in the total pattern at those points. The sudden descent represents adequate maturation for the solution of the problem.

The descriptive analysis from both groups suggests the points at which insight, that is, observing relationship, became most evident and was then playing a greater part than random movements. The descriptive analysis further shows that the animal was then looking the situation over before making a response. It was considering each detail in relation to the total stimulus-pattern. In other words, the detail middle-sizeness was deriving its properties from the other

features of the pattern.

It was noticed above that Group I was superior in performance to Group II. This demonstrates the fact that the animals were capable of forming relationships more rapidly when presented with the whole problem, the total configuration.

Again, this learning cannot be explained in terms of position habits. The learning test demonstrated this very beautifully. The subjects of each group responded to the patterns in reverse order with middle-sizeness in a different position in relation to the rest of the pattern. On the crucial test, Series C, the pattern was reversed again so that position response was controlled.

Therefore, these data justify the assertion that the rats learned this problem because of their ability to successfully modify their behavior in a total configurational pattern which required that they use their knowledge of the spacial whole in making adequate adaptations.

The term "sudden" meaning instantaneous solution, as used by the exponents of the Gestalt theory, indicates that there is no problem for the subject; therefore, no insight is present because the solution is already known. But a real Gestalt is a function of the trial and error and exploratory period and takes meaning from it. That is, the animals when placed at X responded by trial and error to the total pattern or situation, for a strange volley of stimuli was playing upon them. The awareness of a goal demanded that these movements be resolved into meaningful patterns of responses. These modifications of behavior come gradually and demonstrate flashes of insight with respect to the problem.

Since the rat responded to the quality middle-sizeness, it has

demonstrated that it is capable of forming abstractions from a configurational pattern.

To try to explain this learning by the theory of visual or memory images which are peculiar to the rat is to plunge into neurological principles of comparative neurology and psychology which are far beyond the scope of this problem, and of which there is little known. However, to say that the animals responded to the relationships presented in a way which shows intelligence and insight is within the limits of the objective data.

8. Summary

1. The rat is capable of learning to choose the middle-sized proportion in its relationship to two other proportions in a configurational learning pattern. It is also capable of choosing correctly when middle-sizeness changes in both size and position in a series of patterns.

2. These data do not show learning as a sudden accomplishment the moment the situation is presented, but as a gradual process.

3. These experimental findings demand that the behavior of the rat be explained both by trial and error and by insight learning.

4. There were different degrees of insight exhibited by each rat in the learning situation.

5. Partial or complete insight is a function of the process of maturation or trial and error learning, and is not to be understood apart from it.

6. The animals responding to a changing pattern learned the

problem in fewer trials than the group responding to a constant pattern. However, this difference is negligible.

7. The terms trial and error and exploratory (finding out) movements are essential in describing behavior in this learning situation.

8. Olfactory cues played no part in learning this problem.

9. Past experiences of the animal had no direct and specific influence on the learning.

C. The Two Types of Learning and Concept Formation in Children

1. Introduction

In order to further study trial and error and insight learning, the same learning apparatus which was used with the rats was used with the children. This type of experiment would yield data which would be comparable in nature, and throw added light on the two theories of learning.

This part of the experiment was conducted in one of the rooms in the Twenty-Third District School of the Cincinnati Public Schools.

Children of 100 I.Q., as measured by the Pintner-Cunningham Intelligence Test, were selected for this experiment. Six children, a boy and a girl from each of the first three grades, were used.

2. General Procedure

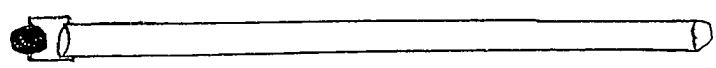
The Learning Problem. -- The learning problem was the same as for the animals (See Tables I and II, pp. 25 and 26). The children were divided into two groups, a boy and a girl from each grade. Group I

learned by Method I, and Group II learned by Method II. The rats were required to do eleven out of twelve trials correctly for two successive learning periods. The children were required to do eleven out of twelve correctly for one period. It was not necessary to have the children repeat, since their learning of this problem was, in its final stage, seemingly more steady and regular than for the rats. When this criterion was reached, they were transferred to the crucial test series.

Records. -- The data were recorded in time, errors, and trials. General descriptive analysis and introspective reports of the children were kept.

Method. -- The apparatus was set up just as it was for the animals, except that the tables were at the proper height for children and placed side to side two feet apart, instead of end to end. The backboard was clamped to the side of the table; then screens were set up to prevent the child from getting any visual cues from seeing the apparatus. A stick made of rolled cardboard, four feet long and one inch in diameter was introduced. This stick had a colored rubber ball attached to one end (See Figure 8 below) so that it would roll. This would enable the child to reach the end of the tunnelway and open the door, and also to give a definite objective response that could be observed and recorded.

Figure 8



The child and the experimenter were in the room alone. The learning situation was motivated by converting it into a game. The child was told by his teacher that he was to play a game. On entering the room the experimenter said: "Have you come to play the game with me?" The child was then placed in front of the table at point X (See Figure 1, p. 18). This was directly in front of the learning pattern. The experimenter said: "This game is called Opening the Door." Then the following directions were given. "In one of these tunnelways there is a door that will open. I want you to take this ball (the experimenter gave the child the stick) and roll it up the step of the one which you think it is. If the door doesn't open, try another one. The game is to roll the ball into the right one first every time until you open the door eleven times one right after the other. Watch carefully and see how quickly you can win." For emphasis the experimenter repeated the last two sentences preceded by the caution "remember."

When the child had had his trial, he was asked to hide his eyes while the pattern was changed.

3. Results

Objective Results. -- The table on the following page shows the total number of trials that was required by the members of each group on the learning and all tests. This table shows that there is some advantage of one method over the other. Each child of Method II, however, except H, had given verbal expression to the fact that he knew the door was always in the tunnelway which had the middle-sized step before the proportions were changed. However, it is interesting to note (See Graph VII, p. 74) that D.F. told the experimenter on the

TABLE XI

TOTAL NUMBER OF TRIALS REQUIRED FOR LEARNING THE PROBLEM

	Method I			Method II			Mean
Grade	1	2	3	1	2	3	
Subject	R.S.	D.S.	K.G.	D.F.	H.	E.T.	
Trials	66	42	42	78	54	54	56

twentieth trial that the door was in the middlesized one, yet she made two mistakes when presented with the proportion of Series B. That is, she made one error in the thirty-seventh and forty-first trials. This necessitated twelve more trials to reach the criterion. She also made one on the test Series D (steps wider). The other two subjects of this group had a different record.

H made nine errors in the first twelve trials and one on the fourteenth. He then made a perfect transfer to Series B in the next twelve trials and all the test series.

E.T. in the third grade had the lowest error record of the group. The error curve and the error table (See Table XXVII, Appendix) show that she also made a perfect transfer to the changing proportion.

R.S., a first grader of Method I, had the highest total error record for the first twelve trials of any child in either group. The error curve (See Graph VII, p. 74) shows his complete record. He did not reach perfect performance, however, until the last two of the test series.

Observing the error curve again, we notice D.S., a second grade girl, has only six errors in a total of forty-two trials. The error

curve falls to zero and remains at this point. K.G., a third grade boy, shows a similar record of performance.

The time table for this group (See Table XII, p. 73) gives the mean time per day's work of twelve trials each. The initial trials for the subjects of Method I are as follows: R.S., thirty-five seconds; D.S., twenty-five seconds; and K.G., twenty seconds. It took longer for the first responses than for either of the following trials. The time table (See Table XXVI, Appendix) shows very little fluctuation in time.

For Group II the time is more irregular. The initial trial for D.F. was ten seconds; for E.T., ten seconds; and for H, five seconds. These initial trials are comparatively small. This is possibly due to chance; that is, the child entered 2.5 at once and found the door. Thereafter the time increased because the subjects explored the other tunnelways. In all cases when exploration begins the time slows down. With both of these groups observations came at different points.

The harmonic mean, when the total time for each twelve trials is considered, is presented in Table XIII (See p. 75). This shows that some of the subjects of Method I required more time each trial to respond than those of Method II. Method I stimulated and encouraged greater observation than Method II. This difference in time is not significant, however.

TABLE XII

HARMONIC MEAN OF TIME PER TWELVE TRIALS

Twelfths	Method I			Method II		
	R.S.	D.S.	K.G.	D.F.	H.	E.T.
1	15	8	10	12	9	9
2	7	6	6	6	5	6
3	6	≠5	≠5	5	5	5
4	5	4	6	8	≠6	≠5
5	≠9	6	6	5	7	5
	8			≠6	5	4
	6			7		
				5		

≠ Beginning of crucial tests.

Graph VII

Error Curve

Number of Errors Per Twelve Trials

Numbers on base line indicate twelfths or days

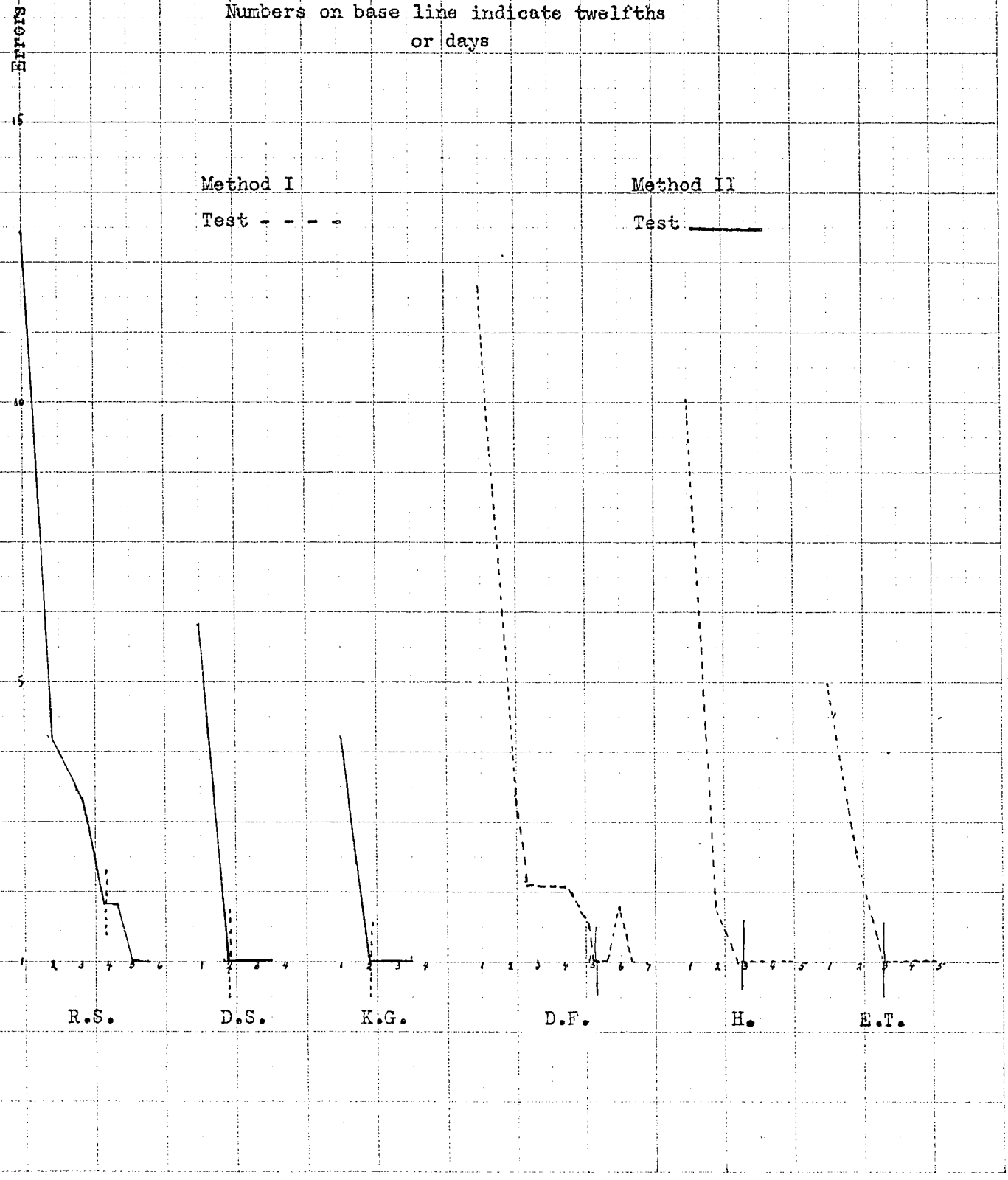


TABLE XIII

MEAN TIME IN SECONDS FOR EACH TRIAL, BASED ON LEARNING AND TEST COMBINED

	Method I			Method II		
Grade	1	2	3	1	2	3
Subject	R.S.	D.S.	K.G.	D.F.	H.	E.T.
Time	8	7	7	6	6	5

The following table (See Table XIV, p. 76) shows the errors by tunnelways. This table further indicates the point where all errors were eliminated. D.F. and R.S. have the highest error record. D.F. had two errors after the thirty-seventh trial. One of these occurred on the 4.5 tunnelway in the patterns of Series A, and one on the 2.5 tunnelway of Series B; not a single error occurred on 6.5 This points to the confusion that arose between 2.5, which she had responded to in the first thirty-six trials and 4.5 which was now the middle-sized one half the time.

Descriptive Analysis and Introspective Reports. -- K.G., Boy, Third grade. He was a quiet boy with a playful smile. He was careful from the beginning. It took him twenty seconds to make his first response. He would always hesitate when the experimenter gave him the ball before he made his choice. He made his last error on the eleventh trial. When asked how he knew which one the door was in, he said, "It was always the middle one." He said, "I thought you were fooling at first and that you were going to put it in another one, but I watched these (pointing to the steps) and I found that it was in the one that

TABLE XIV

TOTAL NUMBER OF ERRORS PER TWELVE TRIALS BY TUNNELWAY, METHODS I AND II

Twelfths	Grade Subject	Method I												Method II					
		1 K.G. Errors on				2 D.S. Errors on				3 R.S. Errors on				1 D.F. Errors on		2 H. Errors on		3 E.T. Errors on	
		0.5	4.5	2.5	6.5	0.5	4.5	2.5	6.5	0.5	4.5	2.5	6.5	0.5	4.5	0.5	4.5	0.5	4.5
1.		1	2	1	0	1	2	1	2	3	4	2	5	7	5	5	5	3	3
2.		0	0	0	0	0	0	0	0	0	1	2	1	2	3	1	0	1	1
3.										0	1	2	0	0	2	*0	0	*0	0
4.										0	1	0	0	*1	1				
5.														0	0				
Total		1	2	1	0	1	2	1	2	3	7	6	6	10	11	6	5	4	4

* Point where each subject of Method II was presented with Series B. D.F. broke down at this point.

was between (pointing to 0.5 and 4.5) and that one, or the middle one."

E.T., Girl, Third grade. She was an active, overgrown child with keen observation. When presented with the ball she rolled it straight into 2.5 at once. On the second trial she tried the other two. On the third trial she took 2.5 at once again. On the fourth trial she tried 0.5 and 4.5 again. She began to observe but still made an error sometimes. The last error was made on the fourteenth trial.

When asked by the experimenter what she was going to name the one which had the door that would open, she said, "It is the middle-sized one." Then the experimenter asked her how she found out; she said, "The first time I came in I opened the door of the middle-sized one; the next time I tried others; then another time I tried others, but I found it was always in the middle one."

H., Boy, First grade. He was quiet and careful. He studied the situation from the beginning of the second trial. On the second trial when an error was made, he turned to the experimenter and said, "May I have another turn?" From this point on he looked the situation over before choosing. In the tenth trial he held the ball over the step 4.5 for three seconds, observing the others closely before choosing. By the sixteenth trial all errors were eliminated except one on the second trial of the first crucial test. The records of these tests show that there was deliberation before a choice was made.

When the experimenter asked him how he found out which one the door was in every time, he said, "It is always the one between the

little one and the big one. This one is the least (pointing to step of 0.5); this one is the biggest (pointing to step 4.5); and it is always in this one, the one between." He never could get the word middle-sized. This is not, however, to discredit his solution, for he made a good record.

D.F., Girl, First grade, at first seemed frightened. She did not say a word to the experimenter for some minutes. Finally she burst into a chatter about a game which she played with her father and brother at home in which she had to hide her eyes. She was elated when she got the correct one and often asked, "How many have I won?" When asked what she was going to name the one which had the open door, she said, "What will I name it? " turned away from the experimental table and then came back and said, "I know; it is the middle-sized one." When the experimenter asked her what she meant by this, she put one finger on the step of 0.5 and said, "This is the little one;" then on 4.5 and said, "This is the big one; and this is the middle-sized one" (pointing to 2.5). D.F. responded quickly, which may account for her errors.

D.S., Girl, Second grade. D.S. was an enthusiastic child. She played the game as if it were affording her the greatest joy. She observed closely on the initial trial which required twenty-five seconds to make the response. On the sixth trial she made two errors and required twenty seconds to make the response. At this point she discovered the middle-sized one. When the experimenter asked her how she knew which one had the open door, she said, (handling the steps with interest) "Oh, I knew a long time ago that it was the middle-sized one."

Then the experimenter asked what she meant by the middle-sized one, and she said, "I mean the one between the big one and the little one."

R.S., Boy, Third Grade. He was a quiet, shy child, but anxious to get the correct solution. He observed but did not get any cues to the solution. He had the highest error record in the group and never entirely eliminated them until the last two test series. He was nervous and often confused in each trial. Very often he whispered something to himself. When he got eleven correct responses, the experimenter asked him how he found out which one had the open door. He seemed devoid of any ideas of relationship. He pointed to the middle-sized one and said, "It is always this one." The experimenter asked, "What could you call it?" His reply was, "I don't know." Any other question which the experimenter asked brought the same reply. On the crucial test, Series D (steps black) he said, "Well, you have different steps now."

4. Discussion and Interpretation

In the above tables and graphs it is interesting to note that the difference in performance in the two groups is not outstanding, but exists. When the error table and error curve were studied, we noticed that Group I had some advantage over Group II. By the second day's work or second twelve trials, the difference is still more marked. However, it should be noticed that each child in each group went through a finding out, or exploratory period. This exploratory period was cautious in some and quick and random in others. D.F. was a good example of many quick, random movements at first. Possibly this type of movement may be labeled trial and error in its most rigid sense.

R.S. is a good example of learning where memorizing a detail resulted in learning it. He gave no evidence of seeing relationships. It is possible, however, that there was some degree of insight, although his behavior and verbal responses do not verify this. It could have been present in part, however.

K.G. is a good example of cautiousness in his exploratory movement. It was the natural thing to try other tunnelways; however, this was always done with care.

The careful explorers indicate more rapid learning than those who responded quickly. This effort to get acquainted with the total situation is applicable to all and significant in that it throws light on the future behavior. The time curve and composite time table show that Group I required somewhat more time per trial than Group II. This was because Group I was getting acquainted with the total problem. It required more caution to respond to middle-sizeness changing in position and size than to respond to it changing in position only. Group I gains, however, on Group II in the total time that it took to complete the problem. This is only suggestive and would no doubt vary with other groups.

The curve of errors for each twelve trials shows the progress of learning for each subject. For the six subjects the curve shows gradual descent for a short period and then a fall to the zero point. This gradual fall (See Table XXVI, Appendix) in the learning curve represents the period of trial and error learning. The sudden fall in the curve to the zero point represents the point at which the subject discovered a meaningful detail in the total pattern. It was not,

however, apart from the period that preceded it, but a product of that period and might be considered evidence of insight.

The curves of D.F. and R.S. are very much alike but very different from the others. It is further interesting to note that R.S. was learning by Method I and D.F. was learning by Method II. Though R.S. has a shorter learning curve, probably by sheer chance, he learned much less than D.F. He was the only child of this group that failed to form the concept called for in the learning situation. D.F. learned the concept by the twentieth trial. But when transferred to Series B, confusion arose. This was probably a result of careless or inadequate observation. This curve shows many trial and error movements and partial insight.

The errors made on each tunnelway (See Table XIV, p. 76) show no particular preference for any one tunnelway by any subject. It shows, however, that some advantages over Method II are had by Method I. There was a greater chance for confusion to occur in Method I because the subjects were responding to 2.5 as middle-sizeness in one situation and to 4.5 in another, with each appearing in the other as a closed tunnelway. But what actually happened was that fewer errors occurred. That the subjects in Group I saw the changing proportions in toto is a possible explanation of this difference. It further suggests that a situation which demands the rapid and continuous readjustment or reconstruction of one's behavior might be a potent factor in producing the most efficient learning.

The descriptive analysis mentioned elsewhere shows that every child but D.F. was a careful observer of the situation from the first

or second trial. H often held the ball over one step until he could study the other two. His explanation shows clearly that in learning he was responding to the total pattern or configuration. D.S. is another striking example of this exact comparison before abstracting the middle-sized one from the whole. K.G. and E.T. are striking examples of purposeful errors; that is, they were positively reacting to all the tunnelways. Each was equal in power in eliciting responses, but after the exploratory or finding out period, these were resolved in favor of the middle-sized one. This further suggests that errors may be striking evidence of insight in learning. More will be said about this when the other groups are discussed.

These introspective reports further show that the child was responding to middle-sizeness of length of approach to the tunnelway, and to that in relation to the other sizes. Barring R.S. who was unable to give any introspective explanation, the ability to form an abstract concept seems to be about equal for these children. The difference is in the time that it required to form the concept. This is evident and significant. Since all children in this group were of one hundred I.Q., this difference in time which it took to learn is probably a result of experiences and personality differences.

5. Summary

1. Selected children of the first, second, and third grades formed the abstraction middle-sizeness from a learning situation which preserved this concept.

2. Both trial and error and insight were present in the learning situation.

3. These trial and error movements were exhibited as random and exploratory movements.

4. Insight may be complete or partial; it may be gradual at first but complete in the end.

5. Some errors are purposeful and may in themselves be evidence of insight.

6. The children acquired the concept which the situation demanded.

D. A Further Study of Concept Formation in Children

1. Introduction

In order to build up another situation in which middle-sizeness was controlled but appeared in a different concrete relationship, four right circular cylinders whose diameter and altitude had the relationship which appeared in the set of three numbers forming the bases for the construction of the panels in the first experiment were constructed. That is to say, a constant difference was maintained between the diameters of the first cylinder and that of the second and between the second and that of the third, and likewise for altitude.

A test series constructed on these same principles consisted of three right equilateral triangular pyramids and three right rectangular parallelopipeds.

2. General Procedure

Apparatus. -- The apparatus consisted of the above solids and a small table and two chairs. The solids were constructed of heavy

construction paper in the proportions given below. Four circular cylinders whose heights were 2 7/8 inches, 3 2/8 inches, 3 5/8 inches and 4 inches, respectively, were used as the learning series. 2 7/8, 3 2/8, and 3 5/8 made Series A; 3 2/8, 3 5/8, and 4 made Series B.

For the test series the proportional heights of the parallelopipeds were 2 inches, 2 1/2 inches, and 3 inches, respectively. The right equilateral pyramids were 2 1/4 inches, 2 1/2 inches, and 2 3/4 inches, respectively.

For convenience in keeping records and tabulating the data, each solid was assigned a numerical value. Thus in the learning series, the solids were numbered from the smallest to the largest in the following order: 1, 3, 5, and 7. Series A was made up of solids 1, 3, and 5. Series B was made up of 3, 5, and 7. This made it possible for 3 and 5 to alternate in their respective functions in the two series.

For the test series the parallelopipeds were assigned the numbers 2, 4, and 6, and the right equilateral pyramids were assigned the numbers 8, 10, and 12, the middle number being the middle-sized one in each group.

The patterns as they were presented in each trial are given in the following table.

TABLE XV

LEARNING PATTERNS AS THEY WERE PRESENTED IN EACH TRIAL

Method I	Method II
3, 1, 5	3, 1, 5
3, 5, 7	5, 3, 1
5, 3, 1	1, 5, 3
7, 3, 5	3, 1, 5
1, 5, 3	5, 3, 1
5, 7, 3	1, 5, 3
5, 1, 3	3, 1, 5
7, 5, 3	5, 3, 1
1, 3, 5	1, 5, 3
5, 3, 7	3, 1, 5
3, 5, 1	5, 3, 1
3, 7, 5	1, 5, 3

Test Patterns as Presented in Each Trial

Parallelopipeds	Pyramids
2, 4, 6	8, 10, 12
6, 2, 4	12, 8, 10
4, 6, 2	10, 12, 8
6, 4, 2	12, 10, 8
4, 2, 6	10, 8, 12
2, 6, 4	8, 12, 10

Subjects. -- The subjects for this experiment were fourteen unselected children from the first, second, and third grades of the Twenty-Third District School of the City of Cincinnati. The children were of 100 I.Q., or approximately so, as measured by the Pintner-Cunningham Test. There were three of the group, however, whose I.Q. lay between 120 to 130. Comparisons of these variations will be mentioned in the subsequent discussions.

Procedure. -- The same technique as to arrangement of trials

and grouping of subjects was used in this experiment as was used with the first experiment. That is, the fourteen children were divided into two groups designated as Group I and Group II. Group I learned by Method I; Group II learned by Method II. Twelve trials were considered a day's work.

Criterion of Learning. -- The criterion of learning was eleven correct responses in twelve for the learning series, and five correct responses in six for the two test series.

Errors. -- An error was made when the child picked up the wrong solid in the learning or test series.

Conduct of Experiment. -- The experiment was conducted in one of the rooms in the school mentioned above. The child was told that he was to go to this room to play a game. On entering the room the experimenter and the child were seated on opposite sides of a small table. The child was asked to turn his head and hide his eyes while the experimenter prepared the game. When "ready" was announced, the child turned around and the experimenter gave the following directions. "This game is called finding the penny. Under one of these cylinders a penny is hidden. You may look under each one until you find it. The game is to find the penny eleven times one right after the other. Watch carefully and see how quickly you can win. Begin." At this point the child began the search for the penny; and when he found it, he was asked to hide his eyes again while the experimenter hid it for another trial.

3. Results

Discussion and Interpretation. -- The results of this experi-

ment are given consideration under the same headings as the results of the foregoing experiment, namely, number of trials, time per trial, the number of errors per trial by choice of solids, and lastly, descriptive analysis and introspective responses.

TABLE XVI

TOTAL NUMBER OF TRIALS EACH SUBJECT REQUIRED TO LEARN THE PROBLEM

	Group I Method I							
Subject	E.S.	M.L.	B.Hi.	D.B.	R.G.	E.Sh.	F.S.	Mean
Trials	60	60	36	36	108	84	84	67
	Group II Method II							
Subject	E.G.	N.O.	F.C.	L.S.	B.H.	E.B.	P.F.	Mean
Trials	84	108	84	36	60	60	108	77

The total number of trials that was necessary for each subject to complete the problem is set forth in the above table (See Table XVI). Comparing the actual number of trials and the mean number of trials, we see that Method I has some advantage over Method II in number of trials. This is not pronounced.

Some advantage of Method I over Method II as learned by this group of children is in seeing relationships in a changing proportion. Some of these children who reached the criterion on Method II, with middle-size changing in position only, broke down when transferred to the changing proportion. The objective data show the results before and after the transfer (See Tables XVIII, XIX, pp. 92 and 93, and XXIX, Appendix). It

will be further noticed from the tables that the three superior children have the same number of trials in each method. This suggests that method may not be so essential for superior children in solving this particular problem. In fact, for L.S. there was practically no problem, which means that there was little learning that took place. For the eleven children of 100 I.Q., or approximately that, the problem is more difficult. But even so, there are still individual differences present which would further indicate that the problem by either method was not of equal difficulty for children of approximately the same mental age level. The progress in learning is shown in the time table (See Table XVII, p. 89). There is marked agreement between the initial trial and the mean for each individual of these two groups. That is, the initial trial tends to range between three and five seconds. This agrees strikingly with the average time for each trial for each day's work. This further points to the fact that the response was quick and random in the beginning for some subjects.

The ascent in time (See Table XXVIII, Appendix) indicates the trials in which the subject was taking time to observe before making a choice.

B.Hi. began this careful observation in the fifth trial. All errors were eliminated by the twelfth trial. The required criterion was reached in the next twelve trials.

A striking example of careful observation in the beginning trial was D.B. She required forty seconds for her initial response and eleven seconds as the mean time for the remainder of this day's performance. In other words, there was a careful study of the situation

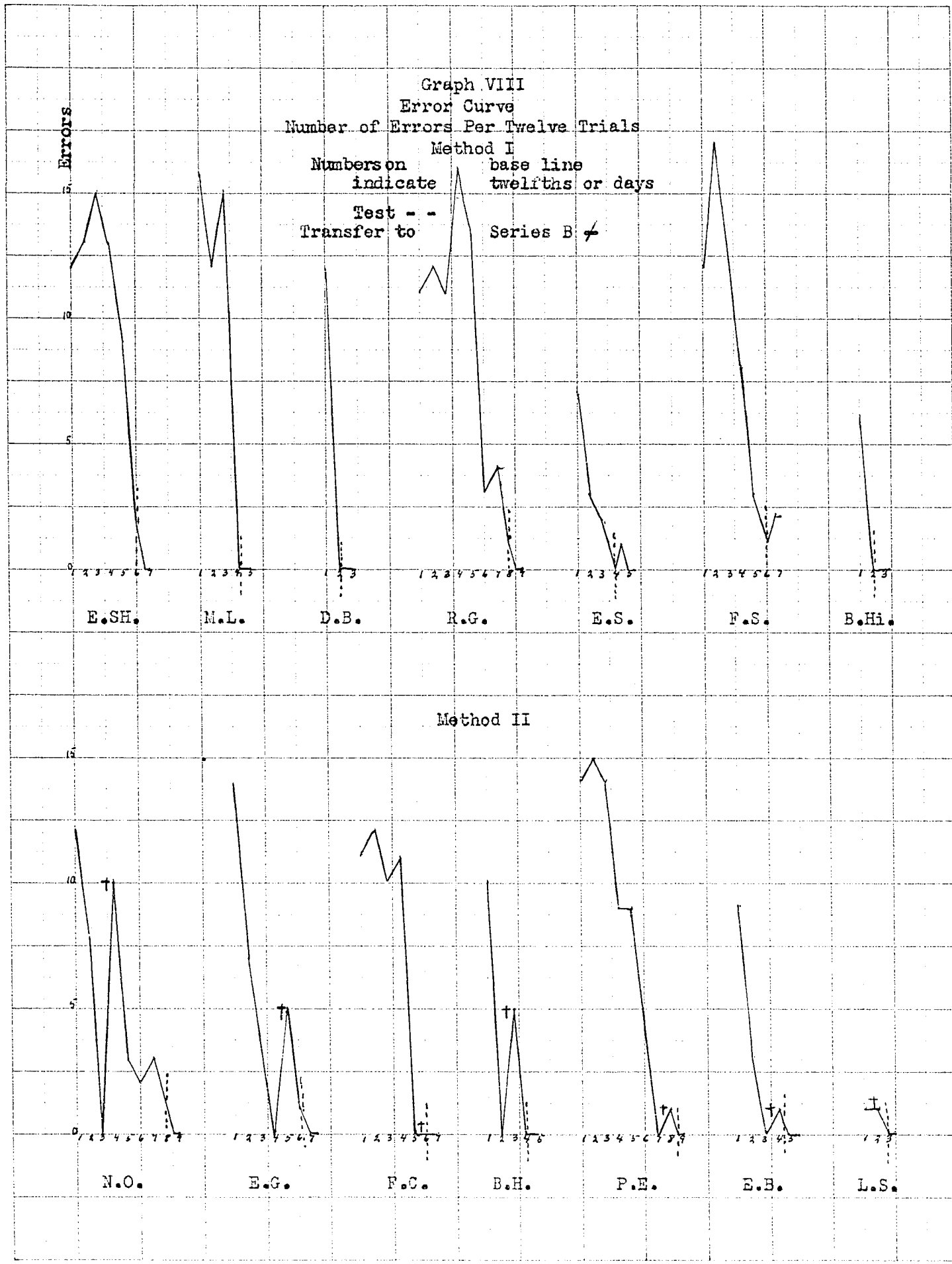
TABLE XVII

MEAN NUMBER OF SECONDS FOR EACH TWELVE TRIALS

Trials	Method I							Method II						
	E.Sh.	M.L.	D.B.	R.G.	E.S.	F.S.	B.Hi.	N.O.	E.G.	F.C.	B.H.	P.F.	E.B.	L.S.
1.	6	5	11	5	5	4	6	4	4	4	3	4	4	3
2.	4	4	4	4	6	5	4	4	5	4	3	4	3	3
3.	5	4	≠ 4	4	4	4	≠5	3	4	4	5	3	3	≠4
4.	9	4	5	6	4	6	4	4	3	4	5	4	5	4
5.	6	≠2		6	5	5		4	5	3	≠1	8	7	4
6.	4	4		8	5	5		4	4	4	4	3	5	
7.	≠ 8	4		10	5	5		4	≠3	≠4		4	5	
8.	6			≠ 5		5		4	4	5		≠3		
9.				4				≠4				4		
10.				5				4						

≠ Beginning of crucial test

Graph VIII
Error Curve
Number of Errors Per Twelve Trials



in the beginning before a response was made. This suddenly falls to four seconds on the second twelve trials and remains at this point for the remainder of the learning period.

In some cases the crucial test produced a slight ascent in time. This indicates that there was a further challenge in these tests, and that the situation demanded observation. In no case did a single child react to the test situation before observing it. Some observed more quickly than others, but in all cases it was careful. In other words, action was slower when the pattern or configuration was new in form even though it was the same in principle.

Directing our attention to the error records, we notice that the error curve has many sharp ascents and descents in the beginning (See Graph VIII, p. 90). This indicates that one solid operates as a goal with the same strength as every other one. The table of errors substantiates this statement (See Table XVIII, p. 92). The sharp ascents and descents preceding a sudden fall, as in E.Sh., M.L., N.O., and E.G., show that confusion had arisen between the resemblance of 3 and 5 which occurred as the middle-sized solid. Suddenly its relationship was seen in the pattern. When this occurred there was a sudden fall to the zero point. This further indicates complete insight into the solution of the problem. Observation of the graph further shows that this happens early and completely for some and later and partially for others. R.G., M.L., and E.Sh. are examples of continued confusion between 3 and 5. Finally this is overcome by seeing the relationship of the two solids in the configuration, and the concept is formed. F.S. and E.S. suffer confusion throughout the learning and test period, though the criterion is reached and the concept is formed. This has a

TABLE XVIII

ERROR SCORES FOR EACH TWELVE TRIALS FOR THE VARIOUS PATTERN COMBINATIONS SHOWING FREQUENCY OF CHOICE OF SOLIDS - GROUP I METHOD I

Twelfths	E.Sh. Solids				M.L. Solids				D.B. Solids				R.G. Solids				E.S. Solids				F.S. Solids				B.Hi. Solids			
	1	5	3	7	1	5	3	7	1	5	3	7	1	5	3	7	1	5	3	7	1	5	3	7	1	5	3	7
1.	3	3	3	3	3	3	6	4	4	2	4	2	2	4	2	3	1	4	1	1	1	3	4	4	2	2	1	1
2.	2	2	3	5	3	3	3	3	0	0	0	0	1	3	4	4	1	3	1	0	6	3	3	4	0	0	0	0
3.	3	4	4	4	4	2	4	4					2	3	1	3	0	1	1	0	2	4	3	4				
4.	3	4	3	3	0	0	0	0					3	5	3	3	0	0	0	0	3	0	2	4				
5.	5	1	2	1									4	2	6	2					0	1	2	0				
6.	0	0	0	0									0	1	3	0					0	0	0	0				
7.													0	1	3	0												
8.													0	0	1	0												
Total	16	14	15	16	10	8	13	11	4	2	4	2	12	19	23	15	2	8	3	1	12	11	14	16	2	2	1	1

TABLE XIX

ERROR SCORES FOR EACH TWELVE TRIALS FOR THE VARIOUS PATTERN COMBINATIONS SHOWING FREQUENCY OF CHOICE OF SOLIDS - GROUP II METHOD II

Twelfths	N.O. Solids				E.G. Solids				F.C. Solids				B.H. Solids				P.F. Solids				E.B. Solids				L.S. Solids			
	1	5	3	7	1	5	3	7	1	5	3	7	1	5	3	7	1	5	3	7	1	5	3	7	1	5	3	7
1.	5	6	1	0	8	6	0	0	6	5	0	0	5	5	0	0	6	5	0	0	5	5	0	0	0	1	0	0
2.	4	5	0	0	3	4	0	0	7	5	0	0	0	0	0	0	7	7	1	0	1	2	0	0	*0	0	1	0
3.	0	0	0	0	4	0	0	0	4	6	0	0	*0	0	5	1	9	5	0	0	0	0	0	0				
4.	*2	2	3	3	0	0	0	0	6	5	0	0	0	0	1	0	5	6	3	0	*0	0	1	0				
5.	0	2	1	0	*2	0	2	0	0	0	0	0					3	2	4	0								
6.	0	1	1	0	0	0	1	0	*0	0	0	0					1	2	0	0								
7.	1	1	1	0													0	0	0	0								
8.	0	1	0	0													*0	1	0	0								
Total	12	18	7	3	17	10	3	0	23	21	0	0	5	5	6	1	31	28	8	0	6	7	1	0	0	1	1	0

* Up to this point errors were possible on 1 and 5. When transferred to the learning series of Group I errors were possible on 1, 5, 3, and 7.

profound educational and social significance in that some subjects are capable of forming concepts but suffer confusion when the situation demands clear-cut differentiation in the different relationships in which it occurs. This type of response indicates partial insight into the problem, while D.B., B.Hi., F.C., P.F., M.L., L.S., and E.B. are examples of complete insight into the problem.

Descriptive Analysis and Introspective Reports. -- The following summary sets forth the cases which are characteristic of this group.

R.G., Boy, Second grade. In the beginning R.G. showed no evidence of observation. He rushed ahead looking under one cylinder after the other as fast as possible. He had a tendency to take the one to the right first. On the forty-seventh trial he began talking about a game which he had played at home that was similar to this one. On the fifty-second trial he began to study the situation, taking fourteen seconds to respond as against three and five seconds before. When he began to study the situation, errors decreased more rapidly, but it took several trials before a perfect score was realized.

E.S., Boy, Second grade. E.S. Manifested just the reverse type of behavior. He took ten seconds each for the first two responses, and observed very carefully each pattern. He laughed freely and often said, "Oh, it's this one this time," and then would make a choice.

B.Hi., Boy, First grade, made rapid random responses on the first trials; then on the fourth trial he took forty-one seconds to study the pattern before him. On the eleventh trial he looked at the

experimenter and said, "I believe that penny is under the middle-sized one most of the time." On the twenty-fourth trial, after having a perfect score of eleven out of twelve, he remarked, "Why it was always under the middle-sized one." When asked why he looked for it under the others, he said, "I wanted to be sure you were not fooling me."

M.L., Girl, First grade. M.L. was very shy. She responded quickly at all times and for a long time she always took the one to her right. Evidently the solution came suddenly, as there was no evidence of careful observation up to the thirty-sixth trial, but the following twelve and the test series were all responded to perfectly.

B.H., Girl, Third grade. B.H. was very outstanding in her remarks. She took thirty seconds to make her first choice. Then she picked up 1 in the 3, 1, 5 pattern and said, "Oh my, not there." Then she did the same for 5. When she took 3 she said, "There it is." Most every response was preceded by "oh, uhm." When she made an error on 5 in the twelfth trial, she said, "Oh, I always want to look under that one." She was interested in her score and often said, "I wonder how many I have now." On the twenty-eighth trial she said, "Oh, you change them, don't you?", meaning the penny was under a different one each time. A statement on the thirty-second trial showed that she was still confused. She turned, smiled, and said, "Oh"; then looked under 3 in the 7, 5, 3 pattern: "Oh," said she, "I thought it would be there." On the first test series (red parallelopipeds) she said, "Oh, it's red this time. Red is my favorite color." On the second trial; "Oh, it is still red." Such responses as those

mentioned above were characteristic of her entire learning period.

P.F., Girl, Third grade. P.F. is another excellent example of random responses. That is, she hastened, picked up one cylinder after the other in turn. She showed no evidence of careful observation or that she was trying to find cues. This random behavior continued until the forty-seventh to the sixty-fourth trial, when she began to take more time to study the patterns. Careful glances of the eye over the situation showed that comparisons were being made. When she began to study the patterns, errors were then made less frequently and perfection was reached.

L.S., Girl, Third grade, made only two errors in the entire learning situation. When asked how she found out that the penny was under the middle-sized one she said, "I noticed the first time I found it that it was the middle-sized one; then I turned my head and tried another one the second time, for I wanted to be sure; but it was wrong. The third time I tried the middle-sized one again and found the penny, so I continued to look there each time."

The above introspective reports suggest how the children were forming the concept middle-sizeness from the learning situation. As has already been pointed out, this came more quickly for some than for others. The amount of observation in the initial trial was a determining factor in forming the concept.

Further observation of the introspective reports shows that there are two types of errors. There are errors which arise from confusion and errors which are purposeful. L.S., E.B., and B.Hi. are good examples of subjects who made purposeful errors. That is, they

responded purposely to the new element to be sure of its relation to the total problem. Purposeful errors are in themselves evidence of insight and should be sharply distinguished from errors which are made through confusion, of which N.O., E.G., and B.H. are good examples.

Further observation of the above description shows that many subjects took time to study the situation. When the subject began to take cognizance of the pattern as a whole, time was increased; that is, action was slowed down. This statement is corroborated by the time and error tables. E.Sh., D.B., and B.Hi. are good examples of careful observers. That is, immediately following the increase in time, the error record had a sudden decrease. The random movements gave place to a meaningful response and that response was to middle-sizeness seen in relation to the total configuration.

Neither the introspective responses nor the descriptive analysis shows any preference for any particular solid. Each was responded to at first, but later the confusion was between 3 and 5. The table of errors further substantiates this statement.

Each subject at some time during the learning period made an attempt to get cues from the experimenter as to which would be the correct response. That is, the movements of the experimenter were studied.

The individual differences in the learning curve corroborate strikingly the introspective remarks of the subject and the descriptive statement. B. Hi. who solved the problem in the first twelve trials told the experimenter that the penny was under the middle-sized one. His learning curve is also short, indicating a quick solution. B.H.'s

remarks (See Introspective Summary) point very clearly to the state of confusion from which she was suffering when trying to form the concept.

Comparing these responses with the objective data presented in the foregoing discussion, one readily sees that trial and error movements mark the beginning of learning. The search for the penny involved trial and error responses until the correct solid was seen in relation to the total configuration. During the trial and error period any solid was equally potent in eliciting a response; but when the subject began to compare, the elements were being discerned in the total situation. Thus a process of differentiation set in whereby the response to the middle-sized solid emerges. It was a response elicited by the stimulus of the total configuration and not from any single detail. The learning which has taken place here is the opposite of association. To learn by association is to build up in serial order a number of responses which finally form the total pattern. This was somewhat exemplified in Group II Method II, and suggests that learning situations which are designed so as to be learned as a unit are easier than learning by serial responses.

These objective data further show that the problem was not solved until some degree of insight into it was gained. Most of the subjects exhibited complete insight following the trial and error period, while the others manifested partial insight. That is, confusion of relationships continued after the concept was formed. However, these errors are not the random errors which were present at the beginning of the learning period.

4. Summary

1. Both trial and error and insight learning were exhibited in this learning situation.

2. The subjects of Group I Method I tended to learn the problem more quickly than those of Group II Method II. The evidence for this, however, is too small to be significant.

3. The subjects formed the concept for which the learning situation was designed.

4. A relationship between concept formation and intelligence was evident.

5. Purposeful errors were made, these in themselves indicating behavior with insight.

5. Comparative Analysis of Animal and Human Learning

In order that each group of subjects for this experiment might be further compared with the other, a composite learning curve was constructed for each group. These curves were constructed by the Vincent [2] method.

Comparing these curves, one readily sees the wide variation in time as between humans and animals at the beginning of the learning period. This difference is negligible for the human subjects throughout and for all groups at the termination of the learning period. The

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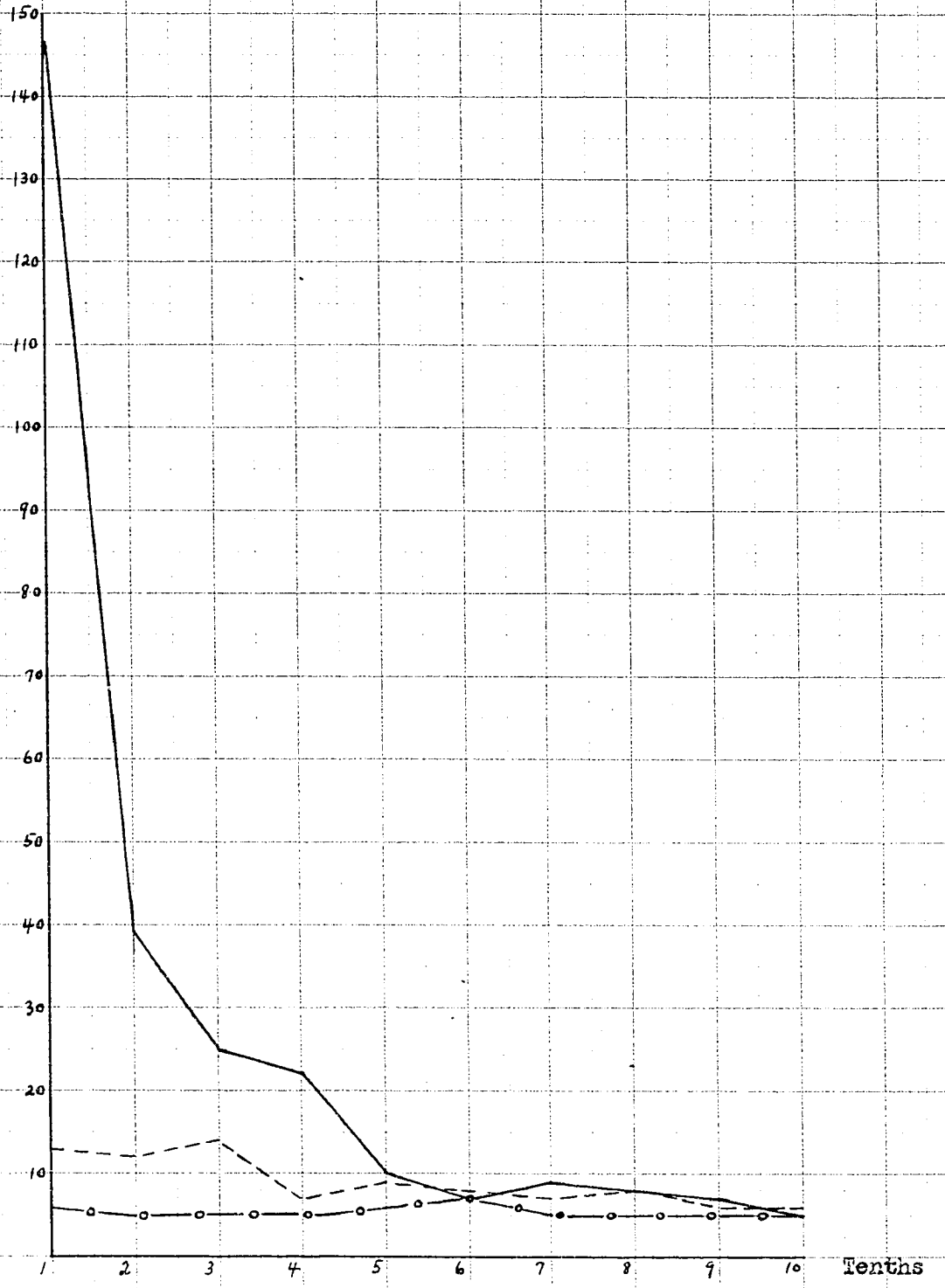
2 Vincent, Stella M. "The Function of the Vibrissae in the Behavior of the White Rat," Behavior Monograph, Vol. I, No. 5 (1911-12), pp. 7 - 81.

Graph IX

Progress of Time in Seconds Based on Each Tenth

Rats ———
Selected children - - - -
Unselected children -o-o-o-o-o



Graph I

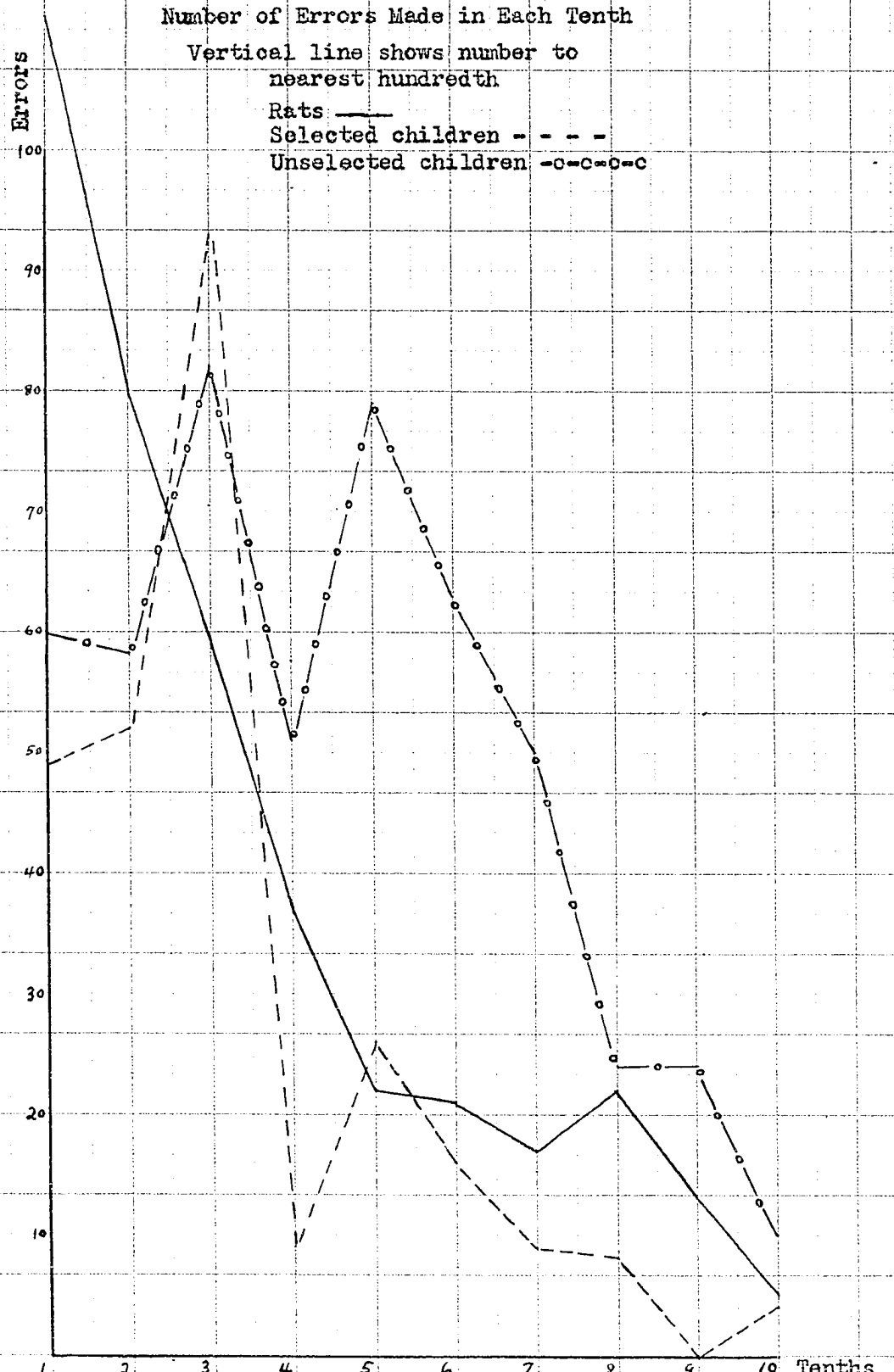
Number of Errors Made in Each Tenth

Vertical line shows number to nearest hundredth

Rats ——

Selected children - - - -

Unselected children -c-c-c-c



error curve also shows marked differences between humans and animals in the beginning. With children the ascents and descents are sudden, while with the animals the ascent is gradual. The error curve further shows that the geometric solids made the hardest learning problem.

A glance at the individual learning curve of the three groups reveals essential likenesses and differences.

1. Each curve and the error tables show a period of trial and error learning for each group.

2. There are plateaus followed by a sudden fall in the learning curve.

3. There was a slight ascent in the time curve when the crucial test situations were presented.

4. The animals have the longest time and error curve and the highest time and error scores.

5. Unselected children have the second longest time and error curve.

6. Selected children have the shortest curves of the three groups. This suggests that the problem which was used with the animals was easier for them, comparatively speaking, than the problem which was set for the other group of children.

7. Both animals and children exhibit similar learning behavior in the initial stages of learning. That is, there are random and exploratory movements. The children, because of superior powers of observation, are capable of sensing the situation and eliminating errors more rapidly.

8. The animals gained their knowledge of the situation through kinaesthesis and vision only, so far as objective observation could

show. The children apparently profited by verbal instruction, employing keen visual powers and by drawing on past experiences.

9. The children did not show any tendency for position response. Some of the animals did. Rat 2 and Rat 10 are examples.

10. On the whole the children demonstrated complete insight;[3] that is, a perfect solution. R.S. and F.S. are exceptions.

11. On the whole the animals had complete insight into the solution; Rat 4 and Rat 10 are exceptions.

12. The time tables show that the children on the average responded more quickly than the animals. This is because the child's keen visual powers enabled him to look the situation over more quickly.

13. The children were more definitely motivated from the beginning than the animals. The child was told what he was to do; the rat had to find out by finding the food box the first time.

14. The error scores of the children, taking the group as a whole, decreased more rapidly than the error scores of the animals. This shows the advantage the child had over the animal in grasping more quickly what the situation demanded.

15. Both species showed slightly better performance on the changing proportion than on the constant proportion.

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[3] Augusta Alpert, "The Solving of Problem Situations by Pre-School Children," Teachers College Contribution to Education, No. 323, p. 41, 1928.

16. The two theories of learning are essential in explaining the behavior of both humans and animals in this learning situation.

17. The learning curves of animals and human subjects give the same general picture for the initial period of learning.

E. The Two Types of Learning and Concept Formation in Adults

1. Introduction

The learning situations for children and animals were identical and parallel. For the animals and the first group of children the situation was identical in nature. That is, the same experimental apparatus was used for both humans and animals. In a further study of concept formation in children the learning situation was identical in principle only.

In an effort to further study the two theories of learning, a group of twenty college sophomore students was selected.

A definite attempt was made to produce a learning situation which would reduce the learning behavior of adults to a level that would bar the use of previous experiences as nearly as possible. That is, the situation was a new one, and the response was one which the subject had not been required to make to this particular stimulus before. The problem was met in utter ignorance, forcing the response to be the learner's own discovery just as with the animals and the children.

For college students to form the concept "middle-sizeness," the situation must be difficult enough in its nature to force the learner to respond in a new way which he himself has invented. Further-

more, the stimulus must be such that the learner might respond in many ways, out of which will ultimately come the desired response.

2. General Procedure

The Learning Situation. -- As a means of arousing this behavior the following experiment was devised so that the abstract concept middle-sizeness was maintained wholly in the abstract in both arithmetic and algebraic symbols.

The Learning Series. -- For the learning series three real numbers were chosen in the same manner as those for the first experiment; that is, a constant difference was maintained between the first and second and the second and third. But extra precaution was taken in order to control the abstractness of this concept and the concept itself. That is, the numbers were so chosen that in a group of three numbers all the numbers were either even or odd. Having chosen one group of three numbers, two hundred and ten groups were then established in the same manner. This formed a learning series consisting of two hundred and ten groups of three numbers each. The following table is composed of the first twenty groups of the learning series and is incorporated here to make clear its nature (See Table XX, p. 106).

TABLE XX

EXAMPLE OF LEARNING PATTERNS FOR ADULT STUDENTS

19	23	15
24	12	18
19	3	11
33	29	25
22	18	14
31	23	27
33	27	21
20	8	14
10	2	18
15	9	21
16	10	4
15	23	7
17	15	13
12	20	4
25	21	29
17	23	29
29	25	21
26	22	30
63	55	59
67	71	63
16	12	14

The Test Series. -- For the test situations four series of numbers were designed. Each series consisting of twenty different groups made a separate test situation. The first test situation was similar to the learning situation but was made up of three place numbers for each group (See Table XXI, p. 108), and another series was made up of three four place numbers for each group.

In the third test the situation was made more abstract in its nature by the use of algebraic symbols. Three variables, e.g, X, Y, and Z, were so chosen that whenever three exponents which comprised a group of three numbers chosen as in the first experiment were used as the exponents of the proper symbols, that is X^1, Y^2, Z^3, it would be possible if occasion demanded to assign arithmetic numbers to these symbols and thereby obtain a group of three numbers meeting the general criterion of the three numbers in the first experiment. Other groups of symbols having different bases and different exponents were then established (See Table XXI, p. 108).

As a fourth test series, five numbers were chosen such that the difference between any two successive numbers was constant. Middle-sizeness in this group always appeared in the third number of the sequence, arranged in monotonically increasing order. However, in presenting the test series this order was not preserved, and the middle-sized number could appear in any one of five positions.

Apparatus. -- The apparatus for this experiment consisted of a metronome for keeping time constant and a Line-a-time machine (See Figure 9, p. 109) for exposing a group of the numbers for each trial. When the lever on the right was pressed down, a new line, that is, a new group of numbers, was presented to the learner. The experiment

TABLE XXI

EXAMPLES OF PATTERNS FROM THE FOUR TESTS

Test 1			Test 2		
777	780	783	2521	4731	6941
959	953	947	8500	8910	8705
128	124	120	1798	1386	1583

Test 3			Test 4				
A	B^3	C^2	14	12	13	16	15
PY^{21}	XL^9	ZY^{15}	20	19	18	21	22
$(A-B)^3$	$(D-E)^{15}$	$(C-D)^9$	24	20	23	22	21

was conducted in the educational psychology laboratory at a time that was convenient for the student.

Procedure. -- The twenty subjects for this experiment were members of the introductory courses in educational psychology in the Teachers College.

The procedure here differs from the procedure in the above experiments. The subjects in this experiment learned the problem in one sitting with the time kept constant by the metronome. A preliminary experiment revealed the fact that three seconds would be ample time for any one trial of the learning series.

The subject was seated in front of the Line-a-time machine (See Figure 9, p. 109) and given the following directions:

"Each time this lever is pressed down you will be presented

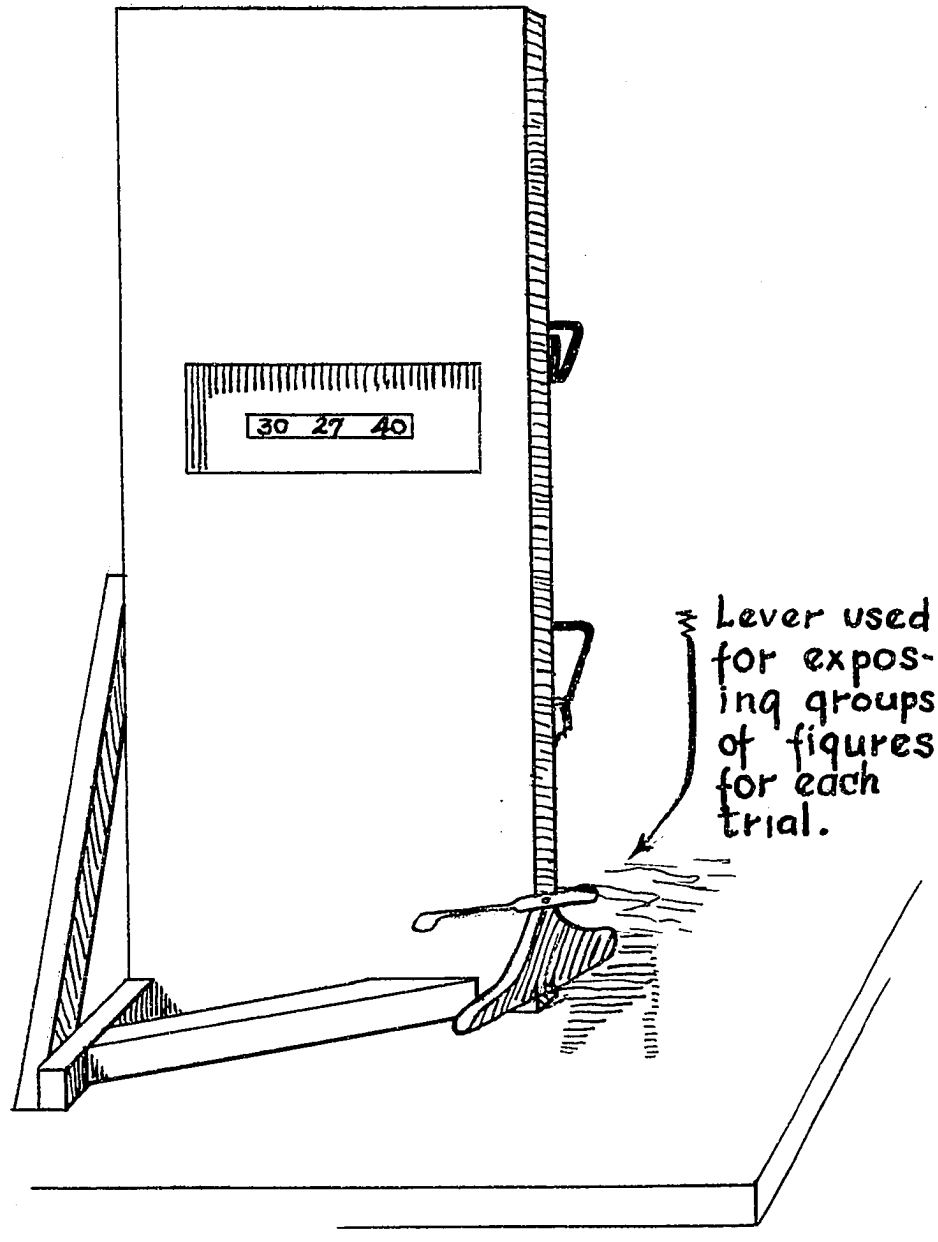

FIG. 9. A LINE-A TIME EXPOSURE MACHINE

with a group of three numbers. One of these numbers is always right. I want you to guess which one it is. When you guess right, I'll say 'right.' When you guess wrong, I'll say 'wrong.' You will continue to guess until you have ten right in succession. When you have ten right in this group we will try other groups. You will be given three seconds for each guess. Give careful attention to how you learned which is the right number."

When the student had learned the problem and had responded to the tests, he was asked to write answers to the following questions:

1. How did you learn which was the right number? Describe in detail.
2. What emotional disturbances were you conscious of?
3. What influence did the announcement of right and wrong have upon you?
4. Which of the test series did you find most difficult?

Records. -- Records were kept of right and wrong responses that were random responses and those that followed patterns.

For a student to follow a pattern such as upper right, center, then left, or two left, one center, one right, showed more insight than if he just guessed at random, because he was following the announcement of "right" and was surmising that it was right because it was a pattern. Two wrong responses following the breaking up of one of these patterns were counted as insightful errors. In fact, it showed more insight to follow what had resulted in "right" in previous trials than to guess at random. When the pattern was broken by the announcement of "wrong" by the experimenter, random guessing was resorted to again until another pattern was discovered. The learning proceeded in this way until the learner began to seek relationships in

the group itself; then a sudden discovery of the middle number was realized. The introspective reports corroborate this method of checking errors.

The Criterion of Learning. -- When the subject had made ten correct responses in succession, the problem was considered learned. Then each of the test series was presented in the order mentioned above and the criterion here was ten correct responses in succession on each test. The time for Test 1 and Test 2 was five seconds for each trial. For Test 3 and Test 4 it was seven seconds for each trial. The student was then asked to answer the four questions listed above.

3. Results

Discussion and Interpretation. -- The merits of trial and error learning as compared with learning by insight are beginning to command more of our attention and consideration. As we shall point out in the following discussion, insight cannot be considered as an independent mode of behavior per se, but it is better understood when considered in relation to the "trial" and "error" processes.

The results of this experiment which are of primary interest are those which are recorded in Table XXII (See Table XXII, p. 112). The errors are listed under random errors, and insightful errors. The random errors were a result of sheer guessing. The errors that were accompanied by insight were those which followed the breaking up of a pattern by the position of the middle-sized number changing. The evidence of each form of behavior was recorded in the following manner.

Each page of the learning series was composed of twenty-one groups of three numbers each, as shown in Table XX. A record of right

TABLE XXII

THE APPROXIMATE AMOUNT OF EACH TYPE OF BEHAVIOR PRESENT IN THE LEARNING SITUATION

Subjects	Total Number of Trials	The Number of Trials When It Was Evident (a) That the Errors Were Random	(b) That the Errors Were Accompanied by Insight, That Is, They Followed the Breaking Up of a Pattern	The Number of Trials When a Right Response Was (c) Due to Chance	(d) Following Insight, That is, Pattern of Numbers	(e) Made After the Concept Was Formed	The Per Cent of the Total Behavior of Each Learner Which Was Trial and Error	The Per Cent of the Total Behavior of Each Learner Which Was Due to Insight	Per Cent of Total Behavior of Group Due to Trial and Error	Per Cent of Total Behavior of Group Due to Insight	Mean Number of Trials
1	23	5	1	0	7	10	22	78			
2	29	4	2	2	11	10	21	79			
3	30	4	9	0	7	10	13	87			
4	37	14	3	7	3	10	57	43			
5	40	12	5	10	3	10	55	45			
6	43	12	5	10	6	10	51	49			
7	45	6	9	12	8	10	40	60			
8	110	38	20	10	32	10	44	56			
9	115	40	30	19	16	10	51	49			
10	123	30	37	6	40	10	29	71			

TABLE XXII (Continued)

Subjects	Total Number of Trials	The Number of Trials When It Was Evident (a) That the Errors Were Random	(b) That the Errors Were Accompanied by Insight, That Is, They Followed the Breaking Up of a Pattern	The Number of Trials When a Right Response Was (c) Due to Chance	(d) Following Insight, That Is, Pattern	(e) Made After the Concept Was Formed	The Per Cent of the Total Behavior of Each Learner Which Was Trial and Error	The Per Cent of the Total Behavior of Each Learned Which Was Due to Insight	Per Cent of Total Behavior of Group Due to Trial and Error	Per Cent of Total Behavior of Group Due to Insight	Mean Number of Trials
11	147	53	40	22	22	10	51	49			
12	162	51	42	34	25	10	53	47			
13	165	36	66	20	33	10	34	66			
14	185	59	52	27	37	10	47	53			
15	220	78	59	44	29	10	55	45			
16	226	55	79	25	57	10	35	65			
17	251	76	44	50	71	10	50	50			
18	304	96	104	7	87	10	34	66			
19	321	109	101	33	68	10	44	56			
20	338	116	96	55	61	10	50	50			
									42	58	141

and wrong responses of each subject was kept to correspond to each page of numbers. The middle number on these pages formed different patterns. For example, 19, 18, 11 formed one pattern. The pattern then changed to 29, 18, 27. Any two errors a subject made following the breaking up of such a pattern were considered errors of insight, because to follow the same plan which had been successful was evidence of more insight than guessing at random. All other wrong responses were a result of random guessing and chance. All right responses which were made by following one of these patterns and which were made after the concept was formed were considered a result of insight. All othere were a result of chance and random guessing.

These data are assembled in Table XXII in such a way as to give all detailed data for each individual and the composite picture of the group.

The amount of each type of behavior which was present was determined.

The per cent of the total behavior of each individual which was due to trial and error was found to dividing the sum of a + c (See Table XXII, p. 112) by the total number of trials in each case. The per cent of the total behavior of each individual which was due to insight was found by dividing the sum of b + d + e by the total number of trials. This table shows the record of each individual and of the group as a whole. For example, subject number three exhibited the greatest amount of insight in learning the problem, and number fifteen demonstrated the least amount of insight. The total picture shows, however, that there is approximately 58 per cent of the behavior

that is a result of insight, and in all cases this is accompanied by trial and error behavior.

From the above data one sees the two types of behavior present in about equal amounts until the relationship is seen. After this insight plays the dominant role until the criterion is reached. In each case the change in behavior came suddenly; that is, the solution was seen at once, and in this we have evidence of insight.

Another test of insight came when the learner was presented with the tests. The natural question was: Would the concept formed function in these new situations? The concept did function in nineteen of the twenty cases, one of the subjects failing to reach the criterion on Test 3 and Test 4.

4. Introspective Analysis of the Learning

For the introspective reports the learner analyzed his own behavior. Those which were typical are reported here, and further substantiate the objective data.

Number 2. "I guessed first the highest number and then the lowest. When both were wrong I chose the middle number which was correct. After finding the way of doing it, I still made errors by not observing carefully enough."

Number 8. "I first tried to discover some pattern through the column. For instance, I began on the upper right and went to center and then to left. I tried several of these patterns without success. After a while, I noticed the number between the other two in size was right. Then I tried to see if the smallest number was correct when

it appeared on the left. This was wrong; I then discovered the middle number in size was correct."

Number 10. "At first I thought the place of the figure determined whether it was right. For example, the first right should be in the middle, the second to the right, the third to the middle and the fourth to the right, but that didn't work. Then it suddenly dawned upon me that the size of the figure determined what it was. So I tried the smallest, the largest and the middle-sized number; the middle-sized number proved to be right."

Number 11. "I tried many pattern combinations then I guessed at random. Then I tried the highest and the lowest number of the group. I then tried the middle number in value which proved true."

Number 14. "I tried several number patterns such as the second number in one row followed by the second number in another. When I found position did not seem to work, I looked at the numbers themselves, then I hit upon the middle value. When that worked several times I continued."

Number 16. "I thought at first the numbers were right according to the column. I thought that the correct number was in the first column twice then in the third column once because it worked that way for awhile. Then after a while (random guessing) I got three right and noticed that it was the middle number in relation to the other two in the group."

Number 18. "First I guessed at random, then I tried zig-zagging, trying to figure out patterns. This did not work. Then I guessed for awhile. Then I noticed that there was a definite interval

between the numbers. After a few mistakes, I found that the correct number was half-way between the others - and at last found it was the middle number."

Number 20. "At first I was merely guessing; then I tried number patterns. After many attempts I tried relationships of numbers. Then I found the relation was the middle number."

These reports show that trial and error learning witnessed the beginning. They further show that the learner was following those cues or patterns which brought the announcement of "right" oftener than "wrong." This was insightful behavior even though it was following a false cue. These reports further show that the learning situation was so set that the subject was compelled to get the solution by seeing the relationship within the group. Reacting in a serial order failed to give the solution. It always emerged from the total pattern.

5. The Influence of Right and Wrong on Learning

The responses of those subjects who experienced the influence of saying "right" and "wrong" are listed below.

Number 2. "Saying 'right' and 'wrong' served as a guide in the solution."

Number 3. "Saying 'right' encouraged me slightly. Saying 'wrong' discouraged me slightly."

Number 4. "'Right' and 'wrong' aided in discovering the right number."

Number 7. "The answer of 'wrong' was very discouraging at the beginning, but 'right' or 'wrong' had very little effect upon me after

I got started on the right task."

Number 9. "Saying 'wrong' made me angry."

Number 11. "Saying 'wrong' made me angry."

Number 12. "Saying 'right' encouraged me."

Number 13. "Saying 'wrong' discouraged me. Saying 'right' encouraged me."

Number 15. "I said the middle number because you said 'right.'"

Number 16. "At first 'right' and 'wrong' meant nothing, but after I saw the relationship, I paid attention."

Number 18. "The answer 'right' encouraged me. The answer 'wrong' annoyed me."

Number 20. "The answer 'right' encouraged me. The answer 'wrong' displaced my number pattern, then I guessed until I found right again."

This shows that sixty per cent of the learners were definitely influenced by the announcement of "right" or "wrong." The other forty per cent are not mentioned because they felt no definite reaction when "right" and "wrong" were announced. The announcement of wrong always meant that the learner's pattern or cue which he was following was broken up; consequently, a greater effort was made to follow the announcement of "right." In other words, the announcement of wrong brought distress [4] to the learner.

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[4] E.L. Thorndike, Human Learning, p. 40. New York: The Century Co., 1931.

6. Tests

When faced with the test situations most of the students said, "Well, I guess this is something different; I'll see," or "This is the same thing; I'll see." Therefore, their first responses were exploratory; that is, they were getting acquainted with the new situation. The behavior playing the role here was of the exploratory trial and error type, because in making the transfer to the new situation the learner was attempting to become familiar with all of its aspects. This points to the fact that trial and error behavior may be present in operating a concept even when it is definitely known. Consequently the errors made (See Table XXIII, p. 120) are indications of more insight, rather than lack of insight. In fact trial and error behavior accompanied insightful behavior and could not be sharply distinguished from it in many cases. That is, most errors occurring in the test situations were purposeful. Referring to the table of errors (See Table XXIII, p. 120), one sees at once that the test situation in which most errors occurred was Test 3. This was the algebraic symbols. The following introspective analyses of the test situations corroborate these statements. The algebraic symbols were more abstract and also more complex.

Introspective Reports. -- Number 2. "The algebraic symbols were the hardest because responding to the numbers and letters together was hard."

Number 3. "The group of five numbers was the hardest."

Number 4. "The group of five numbers gave the most trouble."

TABLE XXIII

TABLE OF ERRORS ON CRUCIAL TESTS, SHOWING FREQUENCY OF ERRORS FOR EACH INDIVIDUAL, AND THE TOTAL NUMBER FOR THE GROUP

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total Errors on each test	Mean	S.D.	σ_M
Errors on Test 1	0	0	1	2	0	0	0	1	4	2	0	0	4	0	3	0	2	2	1	0	22			
Errors on Test 2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	3			
Errors on Test 3	1	8	0	1	3	8	1	0	0	1	1	1	2	0	0	1	5	6	3	1	43			
Errors on Test 4	0	3	0	2	0	3	1	0	0	0	2	1	1	0	0	0	4	0	2	0	19			
Total Errors per Subject	1	11	1	5	3	11	2	2	4	3	3	2	7	0	4	1	11	8	7	1	87	5	3.74	.83

Number 9. "The hundreds were the hardest for me."

Number 10. "The algebraic symbols were the hardest because letters and figures were confusing."

Number 13. "The hardest test was the algebraic because I considered the letter and the symbol."

Number 14. "The algebraic series was the hardest."

Number 15. "The group of five numbers was the most difficult, because there were more figures to see."

Number 16. "The algebraic symbols were more difficult because the letter and symbol were considered."

7. Emotional Reactions

Emotional disturbances are not always apparent to the observer; therefore, the introspective reports of the subjects are illuminating in many cases. In most cases a tenseness was obvious to the experimenter; however, that is not as valuable as the following statements which give the specific disturbance from which some of the subjects suffered. Those who suffered no emotional strain are not mentioned.

Number 1. "I suffered a slight strain because of the consciousness of being timed."

Number 2. "The feeling of not grasping the situation always stirs me to more intense effort. As I distinctly dislike the feeling of being unable to grasp the meaning of any situation, I will concentrate more deeply to avoid this feeling of inferiority."

Number 4. "I was slightly disturbed because I thought I would be slower than the average."

Number 7. "I became too anxious after finding the solution, causing mistakes."

Number 9. "I was angry."

Number 11. "I felt bewildered and angry."

Number 13. "After trying for some time and not succeeding I was nervous and anxious to find the right system."

Number 15. "I worried because it made me feel ignorant."

Number 18. "I was worried when I couldn't get the number. I became excited when I was successful."

Forty per cent of the learners were frank to admit that they were conscious of an emotional reaction accompanying the learning situation. This is significant because it shows that the subjects were not only struggling with a new learning situation but with an emotional reaction also which was playing a role in the learning.

8. Summary

1. College students of sophomore level exhibited both trial and error and insight learning in forming the concept middle-sizeness.

2. The amount of insight present in this experiment compares favorably with the amount present in the other experiments of this study.

3. The law of effect influenced at least sixty per cent of the group.

4. New methods of response were immediately initiated when the situation evoked them.

5. Random errors and purposeful errors play an important role in this learning situation.

CHAPTER III

SUMMARY AND CONCLUSIONS

A. Factual Conclusions

The problem as stated in the beginning has been solved and the questions which were raised with respect to it have been answered. From the experimental findings a number of conclusions are herewith made.

1. Insight and trial and error learning are two types of reactions, but neither can be sharply distinguished from the other; instead, one supplements the other in any complex learning situation.

2. Both methods of learning are functioning, and for both animals and humans, when the concept middle-sizeness is being learned.

3. In the beginning behavior is mainly of the trial and error type, but both methods of reaction are found at any state.

4. Insight is most evident for both animals and humans towards the terminal portion of the learning period.

5. There is more trial and error behavior present in animals than in humans in the same learning situation.

6. Individual differences obtain in both species and in groups of the same species.

7. On the whole with both humans and animals the solution comes gradually, finally merging into complete insight with respect to the problem.

8. Crucial tests warrant the conclusion that animals use visual

and kinaesthetic cues in solving the problem.

9. Presenting the learning activity as a whole has slight advantage over presenting it in part.

B. Theoretical Conclusion

Since the purpose of this present study has been to throw light on the two theories of learning, certain statements relative to them seem justified.

In the first place "sudden" meaning immediate solution as soon as the problem is presented, means that there is no problem, hence no learning takes place.

The experimental findings of this study point to the fact that where the solution is virtually known as soon as the problem is presented, there is in reality no learning.

Behavior enacted in such situations demonstrates neither insight nor trial and error behavior; rather a series of responses already known and already organized.

On the other hand learning is not to be reported as merely a series of trials, errors, and accidental successes through which a series of specific bonds are formed between situation and response. Learning is a dynamic process which calls for reconstruction of behavior, making possible many responses. Such complex learning situations call out behavior for which both the law of use and effect are inadequate as full explanatory categories.

Learning may take place in serial order, i.e., by learning the parts. Or, learning may take place by the emergence of the parts

from the whole, so that the part is seen at all times in its relation to the whole unit of activity. The experimental findings of this research point to the latter as slightly more favorable for learning.

Therefore, trial and error responses play a conspicuous role in learning. They precede, accompany, and supplement insight. They are not mechanical responses as have been asserted by critics, but flexible, lending themselves to immediate reconstruction when the situation demands it.

Finally, there seems to be no reason for antagonism between the two theories, as such. Both types of behavior are present throughout the entire series of experiments, and an interpretation in terms of one exclusively can be made only by ignoring the facts.

The conclusions stated are universal for this research, holding alike for lower animals and humans, and for both motor and intellectual ("verbal" or "linguistic") problems.

C. Educational Implications

On the basis of the above findings, the following implications for education are tentatively proposed:

1. Learning has its beginning in trial and error movements; that is, in learning to row a boat, play a piano, or to reason, apparently random or useless activity may be expected to appear. Likewise learning may be expected to emerge or end as organization or insight often highly conscious.

2. Learning problems which are solved instantly should be looked upon with skepticism. They afford no opportunity for learning or growth. Furthermore, they have not challenged the learner.

3. Children should be given many opportunities to form abstract concepts through experiences in highly concrete and vital situations and hence secure general modes of response for subsequent employment in additional life situations.

4. Learning situations should be designed so that less opportunity for learning of the serial type will be present, and hence, a larger possibility for the whole problem or unit of activity to condition the learner's behavior.

5. The principle of confusion which was so evident in the experiment with children in forming the concept middle-sizeness, has profound educational and social significance. That is, confusion which arises with respect to the formation of right relationships in the use of concepts may point to the origin of many breakdowns which come in education and society.

6. Educational and social situations might be so designed and controlled that desired concepts and ideals may be formed.

D. Problems for Further Investigation

In the course of this experiment problems have emerged which, if solved, would throw added light upon the two theories of learning, yet would not, so far as the writer can judge, affect the conclusions of this study. Those which seem most significant for further research are:

1. Retention in relation to concept formation in rats.

2. A comparative study of concept formation in dull, normal, and superior children.

3. The relation of chronological age to concept formation in

rats.

4. A comparative study of learning by trial and error and by insight in superior children.

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APPENDIX

TABLE XXIV

TIME IN SECOND PER TRIAL FOR EACH SUBJECT

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
1	4500	385	1150	210	690	3645	100	611	1090	2500
2	50	355	102	56	45	664	115	100	185	55
3	20	20	10	105	130	690	75	103	123	35
4	30	90	86	20	11	135	130	21	25	60
5	80	95	20	16	9	125	22	5	16	100
6	46	270	29	168	69	105	50	11	10	16
7	60	330	35	22	85	45	70	10	75	19
8	71	50	58	19	8	40	31	85	125	19
9	260	75	11	20	14	1600	19	50	15	10
10	660	165	20	29	38	24	15	25	10	14
11	670	65	20	65	15	20	45	7	7	55
12	310	45	45	150	9	28	8	62	15	10
13	240	179	20	16	22	14	150	7	22	18
14	45	46	38	40	6	36	23	5	25	46
15	135	69	50	30	25	20	27	14	8	12
16	144	110	25	46	7	37	17	8	11	7
17	46	20	30	8	31	30	11	10	27	11
18	73	44	23	8	6	58	4	20	19	15
19	35	58	20	25	26	26	5	19	6	14
20	35	75	20	15	10	102	6	15	35	12
21	50	23	9	7	12	23	13	15	6	11
22	55	50	10	15	16	49	25	6	6	14
23	23	18	30	5	20	24	4	36	4	12
24	60	20	7	6	24	29	15	22	4	13
25	65	105	5	3	8	270	30	35	30	20
26	55	35	15	8	5	65	11	11	15	13
27	65	35	12	10	5	61	5	5	5	10
28	50	31	35	70	4	290	5	15	5	5
29	82	30	12	4	8	42	15	5	5	27
30	25	25	6	10	5	184	6	5	10	10
31	50	50	45	22	6	60	5	12	5	5
32	29	10	12	10	25	27	3	6	4	5
33	26	22	20	7	5	30	5	10	10	36
34	15	29	11	10	10	105	2	8	5	4
35	40	15	35	5	9	2310	10	4	34	4
36	22	19	10	12	5	85	5	12	25	4
37	40	25	13	25	63	12	37	75	37	6
38	35	20	19	5	4	150	6	15	4	25
39	12	11	16	11	9	40	4	5	5	6
40	50	35	16	8	5	25	5	15	9	5
41	100	110	32	6	5	19	19	6	4	5
42	45	85	15	26	3	45	10	6	105	90
43	15	40	10	10	7	60	4	7	2	3
44	11	30	55	5	7	45	5	4	10	3
45	35	25	20	7	5	22	6	11	43	4

TABLE XXIV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
46	11	82	35	8	4	35	5	4	4	8
47	15	16	15	5	7	20	5	27	4	4
48	150	10	50	5	7		5	70	20	5
49	75	105	37	10	22	14	10	6	10	10
50	20	32	15	4	3	15	7	5	5	5
51	10	15	66	6	27	35	5	10	27	7
52	30	6	8	8	3	60	3	4	3	4
53	45	10	8	6	4	46	4	5	44	4
54	20	10	10	25	5	15	4	6	5	8
55	9	32	25	5	4	10	3	6	6	6
56	7	12	25	4	4	15	12	3	5	4
57	15	18	11	5	5	10	4	4	15	4
58	10	7	10	5	7	11	4	5	4	3
59	20	10	4	6	6	9	5	5	4	4
60	10	7	13	6	3	5	4	14	10	5
61	5	11	11	10		11	7	10	10	6
62	16	22	10	5		20	10	6	3	4
63	22	6	10	10		16	4	4	7	6
64	17	5	5	5		10	4	4	10	3
65	5	7	20	3		6	4	4	4	3
66	7	5	4	6		18	4	4	10	4
67	20	5	15	15		6	4	3	5	3
68	5	20	6	4		6	2	6	3	3
69	7	5	5	5		5	4	4	7	4
70	6	5	4	2		4	30	3	5	3
71	6	15	6	3		30	3	3	4	3
72	6	4	6	5		5	3	4	4	5
73	30	65	14	16		30	13	20	6	85
74	15	9	9	5		9	6	4	4	5
75	9	5	5	5		4	5	12	5	5
76	4	5	5	5		5	3	4	5	3
77	10	10	6	3		10	10	4	4	15
78	7	5	4	4		6	3	4	20	5
79	8	5	5	4		5	4	4	5	5
80	4	8	8	3		5	4	4	5	5
81	7	4	6	5		13	6	4	45	4
82	10	10	4	15		8	5	3	3	5
83	5	7	10	4		22	4	4	6	15
84	8	5	5	10		27	3	15	7	6
85	9	15	12	7		21	6	65	16	22
86	10	10	7	5		5	110	7	4	11
87	15	5	7	9		6	11	11	30	11
88	6	4	7	6		8	4	5	10	4
89	4	6	5	8		20	3	47	5	4
90	15	6	30	12		6	11	7	10	15
91	13	62	6	10		7	4	4	4	5
92	10	10	5	11		6	4	8	4	5

TABLE XXIV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
93	26	8	8	4		30	7	4	5	4
94	10	6	4	10		25	5	4	5	3
95	8	5	6	3		30	7	8	5	3
96	8	5	6	5		15	4	4	4	15
97	7	9	6	20		20	53	25	8	20
98	26	22	5	7		8	5	7	30	6
99	5	45	3	7		10	7	4	4	11
100	5	9	3	7		5	5	4	14	3
101	5	5	4	10		5	4	10	4	3
102	5	5	5	20		9	3	3	3	3
103	5	4	3	6		10	4	4	5	3
104	5	4	5	7		10	15	10	3	3
105	5	5	5	3		16	3	3	4	3
106	5	5	5	8		14	3	6	6	15
107	8	4	3	5		6	5	9	3	3
108	5	5	5	5		7	6	3	4	3
109	9	11	5	6		10	20	6	15	7
110	5	5	5	5		6	5	3	3	3
111	6	5	4	15		15	15	3	8	5
112	7	6	6	5		3	3	4	5	3
113	5	5	19	5		10	3	5	3	3
114	7	5	4	8		4	6	3	5	3
115	4	5	4	11		6	3	3	5	3
116	5	5	4	5		7	3	6	3	3
117	6	4	3	3		4	7	3	7	3
118	5	3	4	6		11	4	4	3	9
119	5	6	3	4		3	4	4	3	4
120	5	4	3	3		6	7	3	5	4
121		8		6		10	7	5	10	
122		7		4		5	4	3	3	
123		4		10		4	4	40	5	
124		4		6		3	3	3	5	
125		4		9		5	11	3	3	
126		11		5		5	3	10	5	
127		5		7		2	3	3	4	
128		7		3		6	4	3	3	
129		4		6		4	4	4	5	
130		4		6		10	4	4	14	
131		7		4		7	11	5	4	
132		4		8		5	3	4	11	
133		10				7		4	5	
134		28				6		5	3	
135		25				5		4	4	
136		9				7		4	4	
137		5				5		4	4	
138		25				5		5	5	
139		7				3		4	6	
140		5				4		5	4	

TABLE XXIV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
141		5				10		4	5	
142		5				8		3	7	
143		15				7		7	4	
144		5				11		4	43	
145		6				4		5	10	
146		4				4		3	3	
147		6				4		4	5	
148		20				3		4	6	
149		7				3		3	3	
150		5				4		4	6	
151		5				5		3	4	
152		4				3		4	5	
153		5				4		3	6	
154		6				3		3	3	
155		4				3		3	8	
156		5				3		4	4	
157		6				5			7	
158		5				6			4	
159		7				4			10	
160		5				3			5	
161		5				3			4	
162		5				4			4	
163		5				3			44	
164		50				4			4	
165		3				4			4	
166		4				4			4	
167		15				3			7	
168		5				3			10	
169		4				7			4	
170		15				3			5	
171		6				4			5	
172		5				3			4	
173		10				6			8	
174		15				3			8	
175		5				2			5	
176		5				20			3	
177		5				5			5	
178		5				2			3	
179		4				7			7	
180		5				6			3	
181		8				5			15	
182		3				25			4	
183		10				5			6	
184		15				40			3	
185		4				7			10	

TABLE XXIV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
186		7				5			4	
187		5				5			5	
188		4				30			4	
189		4				5			5	
190		11				5			6	
191		4				11			12	
192		4				5			10	
193		5				4			5	
194		5				5			5	
195		5				10			5	
196		5				5			5	
197		5				6			4	
198		8				4			5	
199		6				4			4	
200		12				7			4	
201		4				3			5	
202		5				3			4	
203		8				3			3	
204		5				4			3	
205		7				4			4	
206		4				5			4	
207		4				3			5	
208		4				7			4	
209		5				10			4	
210		4				8			5	
211		5				4			3	
212		4				20			7	
213		4				8			4	
214		5				3			3	
215		4				4			3	
216		35				5			5	
217						9				
218						6				
219						15				
220						5				
221						15				
222						5				
223						5				
224						5				
225						5				
226						4				
227						6				
228						7				
229						5				
230						5				

TABLE XXIV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
231						4				
232						6				
233						4				
234						6				
235						4				
236						3				
237						4				
238						3				
239						3				
240						4				
241						4				
242						3				
243						4				
244						.5				
245						11				
246						5				
247						3				
248						10				
249						3				
250						4				
251						3				
252						4				
253						4				
254						4				
255						6				
256						4				
257						6				
258						5				
259						7				
260						8				
261						4				
262						4				
263						7				
264						5				

TABLE XXIV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
					Learning Test					
1	6	4	7	15	15	4	6	25	3	8
2	15	5	4	20	6	4	72	9	10	8
3	4	5	32	8	25	5	16	4	3	4
4	6	4	4	7	32	4	20	5	4	6
5	7	4	14	8	8	4	4	4	4	3
6	23	5	4	7	15	3	3	4	3	4
7	15	5	3	8	5	3	11	4	4	3
8	8	5	11	5	8	4	3	8	8	5
9	3	5	3	6	5	4	4	4	3	5
10	8	5	3	15	5	4	3	4	4	4
11	6	4	6	5	6	4	4	4	8	4
12	5	5	3	6	5	3	4	5	4	5
1	5	18	6	13	6	5	15	6	4	15
2	8	25	4	4	4	5	5	10	15	11
3	9	5	4	7	4	5	6	4	3	6
4	4	5	3	6	4	4	4	5	7	11
5	3	7	5	5	4	4	4	3	8	6
6	4	5	4	6	4	4	4	10	4	10
7	3	7	3	5	4	5	4	4	4	5
8	3	5	3	6	4	4	5	5	12	5
9	4	5	4	5	4	3	5	3	4	4
10	4	4	4	7	3	4	4	8	4	6
11	4	5	4	18	3	7	4	4	4	15
12	5	5	4	7	4	6	4	3	4	7

TABLE XXV

ERRORS PER TRIAL FOR EACH SUBJECT

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
1	5	2	1	0	0	4	0	0	1.	0
2	9	2	2	1	0	3	1	0	4	0
3	3	3	9	0	3	2	1	3	1	1
4	1	1	1	0	0	0	2	2	0	2
5	0	2	0	0	0	1	1	0	0	2
6	1	5	1	2	1	4	1	1	2	1
7	1	3	3	1	2	0	1	0	2	2
8	0	0	2	0	0	0	1	3	3	0
9	1	1	0	0	1	1	0	1	0	1
10	6	3	1	1	4	1	3	1	0	1
11	1	2	0	1	0	0	2	3	0	1
12	3	0	1	2	0	0	0	0	0	1
13	3	2	1	1	1	0	1	0	1	0
14	2	0	3	1	0	0	0	0	0	2
15	3	2	2	2	1	1	0	0	1	0
16	4	2	1	2	1	0	0	0	1	1
17	0	0	0	0	1	0	0	0	0	2
18	2	2	1	0	0	1	0	2	1	1
19	1	3	1	2	0	0	0	0	0	0
20	0	1	1	0	3	1	0	0	0	0
21	0	1	0	0	0	1	1	2	2	1
22	2	1	2	0	0	1	0	1	0	2
23	0	0	0	0	2	1	2	3	0	0
24	2	4	0	0	0	0	0	0	1	0
25	2	0	0	0	0	1	0	0	1	0
26	0	0	0	0	0	0	0	0	5	0
27	2	0	3	1	1	1	0	0	1	0
28	1	0	1	0	0	0	0	0	1	0
29	2	0	0	0	0	1	0	0	0	0
30	0	0	1	2	0	0	0	0	1	0
31	1	1	1	1	0	0	0	1	1	0
32	0	0	0	0	2	0	0	0	0	0
33	1	1	0	1	0	0	0	0	1	0
34	0	1	2	1	0	0	0	1	1	1
35	0	0	0	0	0	0	0	1	1	0
36	2	1	1	0	0	3	0	0	1	0
37	1	0	0	0	0	1	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0
39	0	0	1	1	1	2	0	0	0	0
40	2	1	0	0	0	0	1	0	1	0
41	1	1	2	0	0	0	2	0	0	0
42	1	3	0	0	0	0	0	0	3	2
43	0	0	0	1	0	1	0	0	1	0
44	0	1	2	0	0	1	0	2	2	0
45	0	0	0	0	0	1	1	0	2	0

TABLE XXV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
46	0	1	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	1
48	1	3	0	0	0	0	1	0	2	0
49	0	1	0	1	1	0	0	1	1	0
50	0	0	1	0	0	1	0	1	0	0
51	0	0	0	0	0	1	0	0	1	0
52	0	0	0	0	0	2	0	0	0	0
53	0	0	1	1	0	1	0	0	3	1
54	0	0	0	0	0	1	0	0	1	0
55	0	0	0	0	0	1	0	0	1	0
56	0	0	1	0	0	1	1	0	0	0
57	0	0	0	1	0	0	0	0	2	0
58	0	0	1	0	0	0	0	1	0	0
59	0	1	0	0	0	0	0	0	0	0
60	0	0	1	0	0	0	0	1	1	0
61	0	0	0	3		0	0	1	1	0
62	0	2	1	0		0	0	0	0	0
63	1	0	0	2		0	0	1	1	0
64	0	0	0	0		0	0	0	0	0
65	0	0	1	0		0	0	0	0	0
66	0	0	0	0		0	0	0	1	0
67	1	0	0	2		1	0	0	1	0
68	0	0	0	0		0	0	0	0	0
69	0	0	0	2		0	0	0	1	0
70	0	0	0	1		0	1	0	0	0
71	0	1	0	0		0	0	0	0	0
72	0	0	0	0		0	0	0	0	1
73	0	2	1	0		2	0	0	0	0
74	0	1	0	0		0	1	0	0	0
75	0	0	0	0		0	0	0	1	0
76	0	0	0	0		0	0	0	1	0
77	0	0	0	0		0	1	0	0	1
78	0	0	0	0		0	0	0	2	0
79	0	0	0	1		0	0	0	1	0
80	0	0	0	0		0	1	0	0	0
81	0	0	0	0		0	0	0	2	0
82	0	0	0	1		0	0	0	0	0
83	0	0	0	0		0	0	0	0	1
84	0	0	0	0		0	0	0	1	0
85	0	0	1	0		1	0	1	1	0
86	0	0	1	0		0	1	0	0	0
87	0	0	0	1		0	0	0	1	1
88	0	0	0	0		0	0	0	1	0
89	0	0	0	0		1	1	3	0	0
90	0	0	3	1		0	0	0	1	0
91	1	1	0	0		0	0	0	0	1

TABLE XXV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
92	0	0	0	0		0	1	1	0	0
93	0	0	1	0		1	0	0	1	0
94	2	0	0	0		0	0	0	0	0
95	0	0	0	0		0	0	0	0	0
96	0	0	0	0		0	0	0	1	0
97	0	0	0	0		0	1	0	1	0
98	0	1	0	1		0	0	0	0	0
99	1	2	0	0		1	2	0	2	0
100	0	0	0	1		0	0	0	0	0
101	0	0	0	0		0	0	1	1	0
102	0	0	0	0		0	0	0	1	0
103	0	0	0	1		0	0	0	0	0
104	0	0	0	0		1	1	2	0	0
105	0	0	0	0		0	0	0	1	0
106	0	0	0	0		0	0	0	0	1
107	0	0	0	0		0	0	0	0	0
108	0	0	0	0		0	0	0	1	0
109	0	0	0	0		1	0	0	0	0
110	0	0	0	0		0	0	0	0	0
111	0	0	0	1		1	0	0	1	0
112	1	0	0	0		0	0	0	0	0
113	0	0	1	0		0	0	1	0	0
114	0	0	0	0		0	0	0	0	0
115	0	0	0	0		0	0	0	1	0
116	0	0	0	0		0	0	0	0	0
117	0	0	0	0		0	0	0	0	0
118	0	0	0	0		0	0	0	0	0
119	0	0	0	0		0	0	0	0	0
120	0	0	0	0		0	0	0	1	0
121		0	0	0		0	0	0	0	
122		0	0	0		0	0	0	0	
123		0	0	0		0	0	3	0	
124		0	0	0		0	0	0	1	
125		0	0	0		0	0	1	0	
126		0	0	0		1	0	0	0	
127		0	0	0		0	0	0	0	
128		0	0	0		0	0	0	0	
129		0	0	1		0	0	0	0	
130		0	0	0		0	0	0	1	
131		0	1	0		0	1	0	0	
132		0	0	0		0	0	0	1	
133		0				1		0	0	
134		3				1		0	0	
135		1				0		0	0	
136		0				0		0	0	
137		0				1		0	0	

TABLE XXV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
138		1				0		0	0	
139		0				0		0	0	
140		0				0		1	0	
141		0				0		0	0	
142		0				0		0	0	
143		0				0		0	0	
144		0				1		0	2	
145		0				0		0	0	
146		0				0		0	0	
147		0				0		0	0	
148		0				0		0	1	
149		2				0		0	0	
150		0				0		0	0	
151		0				1		0	0	
152		0				0		0	0	
153		0				0		0	1	
154		0				0		0	0	
155		0				0		0	1	
156		0				0		0	0	
157		0				0			0	
158		0				0			0	
159		0				0			0	
160		0				0			1	
161		0				0			0	
162		0				0			1	
163		0				0			0	
164		2				0			0	
165		0				0			0	
166		0				0			0	
167		0				0			1	
168		0				0			1	
169		0				0			0	
170		2				0			0	
171		1				0			0	
172		0				0			0	
173		0				0			0	
174		0				0			1	
175		0				0			0	
176		0				0			0	
177		0				0			0	
178		0				0			0	
179		0				0			2	
180		0				0			0	
181		0				0			0	
182		0				1			0	
183		0				0			1	

TABLE XXV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
184		0				0			0	
185		0				0			0	
186		0				0			0	
187		0				0			0	
188		2				1			0	
189		0				2			0	
190		0				0			0	
191		1				0			0	
192		0				0			0	
193		0				0			0	
194		0				0			0	
195		0				0			0	
196		0				0			0	
197		0				0			0	
198		0				0			0	
199		0				1			0	
200		0				0			0	
201		0				0			0	
202		0				0			0	
203		0				0			0	
204		2				0			0	
205		0				0			0	
206		0				0			0	
207		0				0			0	
208		0				0			0	
209		0				0			0	
210		0				0			0	
211		0				0			0	
212		0				1			0	
213		0				0			0	
214		0				0			0	
215		0				0			0	
216		0				0			0	
217						0				
218						0				
219						1				
220						0				
221						1				
222						0				
223						0				
224						0				
225						0				
226						0				
227						0				
228						0				

TABLE XXV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
229						0				
230						0				
231						0				
232						0				
233						1				
234						0				
235						0				
236						0				
237						0				
238						1				
239						0				
240						0				
241						0				
242						0				
243						0				
244						0				
245						0				
246						0				
247						0				
248						0				
249						0				
250						0				
251						0				
252						0				
253						0				
254						0				
255						0				
256						0				
257						0				
258						0				
259						0				
260						1				
261						0				
262						0				
263						0				
264						0				

TABLE XXV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
					Learning Test					
1	0	0	0	0	0	0	0	0	0	0
2	0	1	0	0	0	0	1	0	0	1
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	0	0	0	0	0
5	0	0	0	1	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	1	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	1	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	1	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	2	0	0	0	1
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	0	1
11	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	1

TABLE XXV (Continued)

Trial	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
Proportions Increased										
1	0	0	1	0	0	0	0	0	0	0
2	1	0	0	0	0	1	0	0	1	0
3	0	0	0	0	0	0	0	0	1	0
4	0	0	0	0	0	0	0	0	3	0
5	1	2	0	0	0	0	0	0	1	0
6	1	0	0	1	0	0	0	0	2	0
Rectangular Steps - Black										
1	2	0	0	0	1	1	0	0	1	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	1	0
5	0	1	0	0	0	0	0	1	0	0
6	0	0	0	0	0	0	0	0	0	0
Trapezoidal Steps - Width Increased										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	1	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	1	1	1	0
6	0	0	0	0	0	0	0	0	0	0

TABLE XXVI

TIME IN SECONDS PER TRIAL FOR EACH SUBJECT

Trial	D. F.	H.	E. T.	R. S.	D. S.	K. G.
1	11	5	10	35	25	20
2	10	15	35	29	20	17
3	20	6	15	10	6	12
4	5	20	30	10	20	10
5	23	20	15	22	20	16
6	17	6	5	17	5	7
7	40	20	5	25	6	7
8	6	8	15	8	6	8
9	17	15	25	22	6	8
10	11	8	6	17	7	11
11	22	4	5	15	5	15
12	25	11	5	16	5	7
13	15	4	5	8	5	7
14	21	15	5	7	5	6
15	7	5	15	10	10	7
16	15	5	6	7	17	4
17	9	4	6	15	5	7
18	5	5	6	10	6	5
19	5	5	6	8	6	5
20	5	5	5	15	10	6
21	5	5	5	7	6	12
22	4	5	6	14	6	5
23	5	5	6	16	5	5
24	4	5	5	15	6	5
25	4	5	5	22		
26	5	10	4	9		
27	5	5	5	10		
28	5	5	4	5		
29	5	6	5	6		
30	5	5	5	15		
31	5	5	5	6		
32	5	5	5	5		
33	6	5	5	5		
34	8	5	5	5		
35	4	5	5	5		
36	5	7	5	5		
37	10			5		
38	9			5		
39	7			22		
40	8			6		
41	10			7		
42	10			10		
43	5			10		
44	5			15		

TABLE XXVI (Continued)

Trial	D. F.	H.	E. T.	R. S.	D. S.	K. G.
45	8			5		
46	8			7		
47	12			15		
48	12			6		
49	8					
50	7					
51	6					
52	9					
53	4					
54	5					
55	4					
56	5					
57	5					
58	5					
59	4					
60	4					

Crucial Test

1	5	6	5	20	7	5
2	5	10	5	8	5	8
3	6	8	6	18	5	6
4	7	5	5	7	5	4
5	10	5	5	10	4	5
6	8	5	4	45	5	5
1	10	10	5	10	5	6
2	12	5	5	7	3	6
3	12	6	5	10	4	5
4	4	6	5	8	5	6
5	3	7	5	8	5	8
6	5	5	5	7	5	5
1	5	5	4	8	5	6
2	4	7	5	5	6	5
3	8	6	5	6	5	5
4	8	5	5	6	5	6
5	4	6	3	5	6	5
6	5	5	5	5	8	6

TABLE XXVII

ERRORS PER TRIAL FOR EACH SUBJECT

Trial	D. F.	H.	E. T.	R. S.	D. S.	K. G.
1	0	1	0	1	1	1
2	1	2	1	2	2	1
3	1	0	0	0	0	0
4	0	2	2	0	1	0
5	2	2	0	2	2	1
6	1	0	0	2	0	0
7	2	2	0	2	0	0
8	0	0	1	0	0	0
9	1	1	2	2	0	0
10	0	0	0	1	0	0
11	2	0	0	1	0	1
12	2	1	0	1	0	0
13	2	0	0	1	0	0
14	2	1	0	0	0	0
15	0	0	2	0	0	0
16	1	0	0	0	0	0
17	0	0	0	0	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	0	0	0	1	0	0
21	0	0	0	0	0	0
22	0	0	0	1	0	0
23	0	0	0	1	0	0
24	0	0	0	0	0	0
25	1	0	0	1		
26	0	0	0	0		
27	0	0	0	0		
28	0	0	0	0		
29	0	0	0	0		
30	1	0	0	1		
31	0	0	0	1		
32	0	0	0	0		
33	0	0	0	0		
34	0	0	0	0		
35	0	0	0	0		
36	0	0	0	0		
37	1			0		
38	0			0		
39	0			1		
40	0			0		
41	1			0		
42	0			0		
43	0			0		
44	0			0		

TABLE XXVII (Continued)

Trial	D. F.	H.	E. T.	R. S.	D. S.	K. G.
45	0			0		
46	0			0		
47	0			0		
48	0			0		
49	0					
50	0					
51	0					
52	0					
53	0					
54	0					
55	0					
56	0					
57	0					
58	0					
59	0					
60	0					

Crucial Test

1	0	0	0	1	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
1	0	0	0	0	0	0
2	1	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0

TABLE XXVIII

TIME IN SECONDS PER TRIAL FOR EACH SUBJECT

Trial	E.Sh.	M.L.	D.B.	R.G.	E.S.	F.S.	B.Hi.	N.O.	E.G.	F.C.	B.H.	P.F.	E.B.	L.S.
1	3	6	40	6	10	3	6	5	10	6	30	15	3	5
2	11	6	10	5	10	3	5	6	2	5	6	5	10	10
3	5	6	12	4	5	3	3	4	5	4	4	5	8	3
4	4	6	25	6	4	5	4	5	5	4	5	4	3	4
5	10	5	5	5	3	8	15	3	10	6	5	5	5	5
6	6	6	12	3	4	5	11	4	5	3	2	4	10	2
7	10	3	5	4	10	3	15	5	8	5	4	7	2	2
8	5	4	15	6	5	5	4	3	6	3	3	4	3	2
9	7	5	16	5	5	6	6	4	4	4	3	5	4	3
10	6	6	27	3	5	4	9	4	6	3	3	2	6	5
11	3	5	12	4	8	6	11	3	3	6	4	6	4	2
12	5	3	40	3	4	6	4	4	3	4	3	6	6	4
13	4	5	15	3	8	6	4	5	10	5	4	6	2	2
14	2	5	5	5	5	5	3	3	8	3	3	3	4	5
15	3	3	5	5	4	8	3	4	4	4	4	4	6	3
16	5	3	5	4	4	6	4	4	6	3	4	5	6	6
17	4	5	4	5	10	4	3	4	6	5	4	6	5	2
18	6	5	4	3	4	5	5	4	5	4	3	5	2	4
19	5	3	3	4	8	5	4	5	5	7	5	5	4	5
20	7	4	5	5	5	7	3	3	4	4	3	3	4	3
21	8	5	2	4	4	4	5	3	3	4	2	4	3	5
22	11	5	4	5	5	4	4	4	6	2	4	5	4	2
23	5	3	4	3	5	6	5	4	3	5	3	5	2	4
24	4	3	4	4	5	2	4	3	5	4	5	4	4	4
25	3	7		4	4	3		3	11	6	4	5	3	
26	2	4		4	5	6		3	5	3	6	5	4	
27	5	3		3	5	3		3	5	4	2	4	5	
28	7	4		4	4	4		3	5	4	10	5	5	
29	9	4		3	4	5		3	10	6	5	5	3	
30	9	6		3	4	4		3	3	3	6	2	4	
31	6	2		5	4	3		3	7	6	4	4	3	
32	15	5		4	3	3		4	3	4	9	2	4	
33	5	5		6	4	3		4	3	4	5	3	4	
34	9	5		5	5	6		3	4	3	6	3	2	
35	7	4		4	4	4		3	3	4	3	9	2	
36	10	3		4	5	7		3	4	3	6	7	4	
37	11	3		8	4	3		6	2	6	4	6	4	
38	10	4		4	5	6		4	5	6	6	3	6	
39	11	3		4	4	4		4	3	4	5	6	5	
40	10	5		5	4	10		5	8	3	4	2	5	
41	15	3		4	4	6		3	3	5	5	5	4	
42	10	5		8	5	5		5	5	4	4	3	21	
43	6	5		6	3	3		5	2	5	5	7	4	
44	17	4		5	4	8		3	3	4	6	2	4	
45	12	4		6	5	9		4	3	3	5	5	3	

TABLE XXVIII (Continued)

Trial	E.Sh.	M.L.	D.B.	R.G.	E.S.	F.S.	B.Hi.	N.O.	E.G.	F.C.	B.H.	P.F.	E.B.	L.S.
46	11	4		11	3	7		4	2	4	6	5	5	
47	11	4		7	3	11		3	4	4	4	12	5	
48	3	4		7	4	5		4	3	4	4	8	4	
49	8			5		3		3	5	4		7		
50	4			3		5		4	10	3		5		
51	15			6		6		5	4	4		6		
52	9			14		9		4	8	4		8		
53	7			20		4		3	3	4		9		
54	5			10		5		4	3	4		6		
55	12			6		6		3	7	5		10		
56	6			4		4		4	15	4		9		
57	9			5		8		5	6	4		15		
58	11			12		4		5	6	4		11		
59	10			4		6		5	4	3		9		
60	4			12		5		4	6	4		8		
61	4			22		6		3	4	3		14		
62	4			10		4		3	4	5		22		
63	5			8		4		4	3	5		14		
64	5			6		4		4	6	4		10		
65	2			7		6		3	5	4		6		
66	4			9		8		4	4	5		6		
67	3			13		5		4	4	4		3		
68	6			8		4		4	5	5		5		
69	4			9		5		5	3	5		5		
70	3			9		6		5	5	6		4		
71	5			8		5		4	2	4		3		
72	5			5		4		3	5	4		2		
73				5				5				5		
74				8				3				3		
75				13				4				2		
76				12				4				4		
77				35				5				3		
78				15				4				3		
79				11				5				2		
80				10				4				3		
81				15				5				4		
82				6				6				3		
83				10				4				2		
84				8				5				4		
85				10				4				3		
86				20				5				2		
87				18				4				3		
88				20				4				4		
89				10				4				11		
90				4				5				6		

TABLE XXVIII (Continued)

Trial	E.Sh.	M.L.	D.B.	R.G.	E.S.	F.S.	B.Hi.	N.O.	E.G.	F.C.	B.H.	P.F.	E.B.	L.S.
91				3				4				4		
92				3				4				6		
93				3				4				5		
94				3				4				4		
95				4				4				3		
96				5				3				6		

Crucial Test

1	5	2	4	10	15	5	3	5	7	5	7	5	3	5
2	4	2	4	2	3	6	4	4	3	4	3	3	5	4
3	4	3	5	4	4	6	3	4	2	6	4	4	3	3
4	4	4	3	4	4	4	3	3	7	4	8	3	2	3
5	4	4	4	6	5	4	3	5	7	5	3	3	2	5
6	3	4	4	4	5	4	3	4	2	3	4	3	3	4
1	5	3	5	5	5	5	6	5	10	5	5	5	5	4
2	5	3	5	3	5	4	4	4	4	5	5	4	3	5
3	2	4	4	3	5	3	4	5	5	5	4	4	41	3
4	3	4	4	4	3	4	4	5	4	4	4	4	4	4
5	3	4	5	5	5	6	4	5	2	5	5	5	4	3
6	3	4	5	3	4	4	3	3	4	5	4	4	5	3

TABLE XXIX

ERRORS PER TRIAL FOR EACH SUBJECT

Trial	E.Sh.	M.L.	D.B.	R.G.	E.S.	F.S.	B.Hi.	N.O.	E.G.	F.C.	B.H.	P.F.	E.B.	L.S.
1	0	2	2	1	1	0	0	2	2	2	2	0	0	0
2	2	2	0	1	2	0	0	1	0	0	2	1	1	1
3	0	1	2	0	1	0	0	1	2	1	0	1	2	0
4	0	2	1	2	0	1	0	2	2	0	2	0	0	0
5	2	1	0	2	0	1	1	0	2	2	2	2	1	0
6	2	2	1	0	0	2	1	1	1	0	0	1	2	0
7	2	0	1	0	0	0	0	1	2	2	0	2	2	0
8	0	1	0	2	0	2	0	0	1	0	0	0	0	0
9	2	2	1	2	1	1	1	1	0	1	0	1	0	0
10	1	2	2	0	0	1	1	2	1	0	0	1	1	0
11	0	1	2	1	2	2	2	0	0	2	0	2	0	0
12	2	0	0	0	0	2	0	1	1	1	2	1	1	0
13	0	2	0	1	1	2	0	2	2	2	0	2	0	0
14	1	1	0	2	0	1	0	0	1	0	0	0	1	0
15	0	0	0	1	0	2	0	1	0	1	0	2	1	0
16	2	0	0	1	0	2	0	2	2	0	0	0	1	1
17	1	1	0	2	2	1	0	0	0	2	0	2	0	0
18	1	2	0	0	0	1	0	1	0	1	0	1	0	0
19	1	0	0	0	1	2	0	2	1	2	0	2	0	0
20	2	1	0	2	0	2	0	0	1	0	0	0	0	0
21	2	2	0	1	0	1	0	0	0	1	0	1	0	0
22	2	2	0	1	0	1	0	1	0	0	0	2	0	0
23	0	1	0	0	0	1	0	0	0	2	0	2	0	0
24	0	0	0	1	1	0	0	0	0	1	0	1	0	0
25	0	2		2	0	1		0	1	2	1	2	0	
26	0	1		1	1	2		0	0	0	2	0	0	
27	1	0		0	1	0		0	1	1	0	1	0	
28	2	0		1	0	1		0	1	0	2	0	0	
29	2	1		0	0	2		0	0	2	0	2	0	
30	1	2		0	0	1		0	0	0	1	0	0	
31	2	0		2	0	0		0	1	2	0	1	0	
32	1	1		0	0	0		0	0	0	0	1	0	
33	0	2		1	0	1		0	0	1	0	2	0	
34	2	2		2	0	2		0	0	0	0	2	0	
35	2	2		0	0	1		0	0	2	0	2	0	
36	2	1		0	0	2		0	0	0	0	1	0	
37	2	0		2	0	0		2	0	2	0	2	0	
38	0	0		1	0	0		1	0	0	1	2	1	
39	2	0		0	0	0		0	0	1	0	1	0	
40	1	0		2	0	1		2	0	0	0	0	0	
41	0	0		1	0	1		0	0	2	0	2	0	
42	1	0		1	0	2		2	0	1	0	0	0	
43	1	0		2	0	0		1	0	2	0	2	0	
44	2	0		0	0	1		0	0	0	0	0	0	
45	2	0		1	0	1		1	0	1	0	1	0	

TABLE XXIX (Continued)

Trial	E.Sh.	M.L.	D.B.	R.G.	E.S.	F.S.	B.Hi.	N.O.	E.G.	F.C.	B.H.	P.F.	E.B.	L.S.
46	2	0		2	0	1		0	0	0	0	1	0	
47	0	0		0	0	1		0	0	2	0	2	0	
48	0	0		2	0	1		1	0	0	0	1	0	
49	1			2		0		0	1	0		2		
50	0			0		0		0	1	0		0		
51	2			2		0		1	0	0		0		
52	2			2		1		0	1	0		0		
53	0			2		0		0	0	0		1		
54	0			1		0		0	1	0		0		
55	0			1		0		0	0	0		0		
56	0			0		0		0	0	0		0		
57	1			1		1		1	0	0		2		
58	2			2		0		1	0	0		1		
59	1			0		1		0	0	0		2		
60	0			1		0		0	0	0		1		
61	0			1		0		0	0	0		1		
62	0			0		0		0	0	0		2		
63	2			0		0		0	0	0		0		
64	0			0		0		0	1	0		0		
65	0			0		0		0	0	0		0		
66	0			1		1		0	0	0		0		
67	0			0		0		0	0	0		0		
68	0			0		0		0	0	0		0		
69	0			1		0		1	0	0		0		
70	0			1		0		1	0	0		0		
71	0			0		0		0	0	0		0		
72	0			0		0		0	0	0		0		
73				1				1				0		
74				1				0				0		
75				0				0				0		
76				0				0				0		
77				0				0				0		
78				0				0				0		
79				0				0				0		
80				1				0				0		
81				0				1				0		
82				0				0				0		
83				0				0				0		
84				1				1				0		
85				1				0				0		
86				0				1				0		
87				0				0				0		
88				0				0				1		
89				0				0				0		
90				0				0				0		

TABLE XXIX (Continued)

Trial	E.Sh.	M.L.	D.B.	R.G.	E.S.	F.S.	B.Hi.	N.O.	E.G.	F.C.	B.H.	P.F.	E.B.	L.S.
91				0				0				0		
92				0				0				0		
93				0				0				0		
94				0				0				0		
95				0				0				0		
96				0				0				0		
							Crucial Test							
1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
2	0	0	0	1	0	2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	2	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE XXX

MEAN TIME PER TRIAL FOR EACH DAYS WORK OF TWELVE TRIALS

12th	Rat 4	Rat 5	Rat 6	Rat 7	Rat 8	Rat 2	Rat 3	Rat 9	Rat 10	Rat 11
1	68	93	24	31	18	64	28	16	15	23
2	52	40	10	70	12	29	9	11	8	14
3	34	25	11	8	6	61	5	8	6	6
4	21	12	19	7	6	38	6	8	5	6
5	14	8	10	6	5	13	5	5	6	5
6	11	5	6	5	†8	8	4	4	5	4
7	7	6	6	5	4	8	5	5	6	6
8	9	6	5	6	*8	10	5	6	4	5
9	6	6	4	7	7	8	5	5	5	4
10	6	5	4	5	7	6	4	4	3	4
11	†7	5	†4	6		5	4	4	5	†5
12	4	8	4	†7		6	†6	4	5	7
13	*15	5	*10	6		4	4	4	5	*7
14	7	6	6	*7		4	*5	†5	5	5
15	10	6	7	6		4	6	4	5	7
16		5		7		7	7	*19	6	
17		5				4	7	7	4	
18		5				6		5	4	
19		†5				6			†4	
20		6				4			4	
21		*4				4			*7	
22		7				5			5	
23		6				3			3	
24						†4				
25						4				
26						*9				
27						6				
28						6				

† Learning Test

* Crucial Test. The mean time per trial for each day's work is based on six trials per day. Hence, the points on the graphs for the crucial test are at the mid point of the twelfths. For example, for Rat 4 the point fifteen seconds falls halfway between twelve and thirteen on the graph. This holds for all subjects.