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The Influence of Explicit Instructions to Plan Upon Perfomance

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THE INFLUENCE OF EXPLICIT INSTRUCTIONS TO PLAN UPON PERFORMANCE.

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The Influence of Explicit Instructions to Plan Upon Performance.

The purpose of this investigation is to study the measurable influence of explicit instructions to plan upon the performance of complex tasks as contrasted with performance of the same tasks under such spontaneous tendency to plan as may be present without explicit instructions.

The subjects used in this experiment were sixty children between the ages of eleven and fourteen years. This group was divided into an experimental group of fifteen boys and fifteen girls and a control group of the same number of boys and girls. The subjects in the control group were paired with the subjects in the experimental group according to sex, age and I. Q.

After the pairing was completed, the subjects of both groups were asked to perform two tasks. The first task consisted in arranging fifty sticks of different lengths, colors and thicknesses in ten boxes in the best possible order. The second task was the construction of a bird-house out of several parts. These tasks were selected because they require definite steps to be followed in their solution.

Standard procedure was followed throughout, except in the case of the experimental group, who received explicit instructions to plan their work.

A record of each child's performance was kept. The time required by him to complete the tasks, the number of moves and the number of trials were recorded. Also, any evidence of planning or not planning was noted and an attempt was made to study the effect of such behavior upon the performance of the subject.

Planning as referred to in this experiment is synonymous with reflective thinking, or thinking with an aim or purpose or end toward which the thinking tends. It is the kind of thinking especially adapted to solving complex problems as opposed to random thinking which leads to no particular or definite termination.

In productive thinking, planning is necessary in order to attain the end of thought, which is the solution of the problems of everyday life. Random thinking is a metaphorical Pandora's box, out of which fly many of the ills humans are heir to. Reflective thought, on the other hand, is the only hope left with which we may right these wrongs, political, social, economic and educational, let loose by random thinking.

We assume with Porteus, Goddard, Binet and others that the capacity to plan is related to intelligent solutions

of problems. By our instructions to plan we hope to enable the subject to direct his activities with foresight, and to plan according to ends-in-view, or purpose of which he is aware. In short, we hope to convert action that is largely impulsive into intelligent action.

One of the first investigators to point out that planning is a most important capacity in intelligent behavior was Stanley Porteous (41:65). In discussing characteristics of the feeble-minded, he states that, generally speaking, they cannot be trusted to engage, unsupervised, in work requiring forethought in planning, care and judgment in execution. He says that the feeble-minded have a place in industry, but it is in doing work which takes plain, straight-forward, piece-meal effort, wherein there is no need to envisage the whole, nor to make the necessary adjustments so that the finished result will harmonize with a preconceived plan, for these are beyond feeble-minded capacity. If any individual is found who is capable of doing these things, it is almost certain that he is not a mental defective, no matter how inferior his abstract intelligence may be.

In a later chapter S. Porteus (41:66) says, "In their attempt to adjust themselves to the general social as well as the school situation, the most outstanding weakness of the defective seemed to be lack of planning capacity.

They seem unable to keep the end of a task clearly in mind, or to adopt a critical attitude towards their own work and to make the adjustments necessary to the fulfillment of the plan or design as originally conceived."

H. H. Goddard agrees with Porteus (41:66) in describing the capacities of the highest grade feeble-minded when he notes their ability to do good work, but only under directions. He claims they are unable to plan anything.

The value of a man's life and the effectiveness of his work, according to Wm. F. Book (8:24), depend (1) on the character of his ideals or purposes and plans; (2) on the intensity of his desire for realization of these, or on the strength and persistence of his determination to carry them out; (3) on the amount of energy and health at his disposal for their realization and (4) on the kind and amount of knowledge and skill which he has acquired to aid him in finding the best way of obtaining them.

Concerning planning, Wm. H. Burton (6:558) says, "One of the marks of intelligence and special ability is foresight and anticipatory planning. The stupid, the careless, the shiftless and lazy do not plan."

In 1921 the Editor of the Journal of Education asked seventeen leading investigators to contribute to a symposium on, "What I conceive intelligence to be and by what means it can best be measured by group tests."

Many of these men included the capacity to plan in their definition of intelligence. E. L. Thorndike (22:124) in his discussion of intelligent behavior states, "It would, however, be difficult and probably unwise to try to separate off sharply the responses concerned with directly sensed situations from responses concerned with planning, or those concerned with concrete features of things and men from those connected with ideas and symbols. The power of response to ideas rather than direct experience may be called the more intellectual variety of intellect."

L. M. Terman (22:127) conceives an individual as intelligent in proportion as he is able to carry on abstract thinking. "Add a large measure of ability to associate abstract ideas into complex systems and a pick-and-shovel man can design a new type of engine, draft the plans for a skyscraper or discover a curative serum."

F. N. Freeman (22:133) would include, among other things, in a definition of intelligence, the judicious managment of the processes of learning or reflection; the adoption of intellectual purposes and the adaptation of means to their satisfaction; and sensitiveness to significant connections between experiences which illuminate one another or which are effective in building up systems of thought.

L. L. Thurstone (22:201) distinguishes between the bright and the profound intellect. The former aims for effect-

iveness in the immediate present, while the latter deals with earlier and more abstract relations in its adjustments. Such a profound mind is concerned with the analysis of temporarily remote ends. He conceives intelligence to be the capacity to inhibit instinctive behavior in an unfinished stage of its formation and to modify it at that stage by means of an imaginal stimulus which is relatively remote from that which is immediately and perceptually present. The imaginal stimulus in intelligent behavior becomes conscious as an alternative to be controlled, accepted or rejected rationally.

Herbert Woodrow's (22:207) concept of intelligent behavior is simply the degree to which it attains success, but success has no real value except by some reference to want, desire, intention, plan or purpose.

Michael Maher, S. J., (31:583), too, in comparing animal behavior with that of human or rational behavior, states that brute creatures do not exhibit any individual free variation in method and plan of action, and that intellectual progress, which ought to mark the presence of personal intelligence. From this statement of Maher's it is evident that he agrees with other authors that the capacity to plan is related to intelligence.

Very few attempts have been made to test planning ability as such. In 1912 M. R. Fernald and W. Healy (12) experimented with a series of tests of planning ability and by means of an ingenious puzzle-box they presented a problem

in which success was dependent upon working through a series of operations in proper sequence. By manipulating a button-hook through a hole in the side of a box, rings attached to various strings could be released and the box opened, the subject being able to plan the operations by looking at the mechanism through a glass top. The test was scored on speed, but the record was so affected by the manual dexterity required that it did not constitute a good test of planning and so never came into general use.

In 1922 D. R. Morgenthau (34) made a study of, "Some Well Known Mental Tests," which she compared and evaluated. In the course of her work she made an experimental study to secure a measure of planfulness by using various parts of a number of tests. The elements in each test that seemed to measure planfulness were selected. These were divided into two separate sets and results compared. The correlation was .763 between the two tests, which was fairly high, since seventeen was the highest score on each section. She does not claim this to be a criterion to prove that the tests actually measured the trait which she presupposed it would. She does claim, however, that it is better than any single test, because it includes a variety of materials.

The most recent work in the field of testing planning ability is that of Stanley D. Porteus (41:67). His subjects were low-grade, feeble-minded children. He measured the time required for them to get out of a locked room, the

problem being complicated for the more intelligent by making them go through certain preparatory steps before the key to the room could be obtained and used. It was found that this method admitted of a rough classification of children by ability. Those of the lowest grades could merely turn the key and open the door, children of better planning capacity were able to climb on a chair and obtain the key when it hung out of reach. Still others learned after several demonstrations how to obtain a second key, unlock a cupboard, climb on a chair, and procure the door key. Beyond proving that defectives were particularily slow at learning the sequence of steps in a complicated situation, the test was of little value as it could not be properly standardized.

Another series of tests conducted by Porteus (41:67) used street plans as testing material. The problem set the defective was to follow directions so as to make his way on the plan from one designated point to another. This proved to be more of a test of memory for directions than planning, but it was while drawing an imaginary system of roads, in the form of the present nine-year design of the maze tests, that the idea of using a series of mazes occurred to the experimenter.

The problem of finding a way out of a printed maze, in which blind alleys occurred at various points, seemed to Porteus very much more a test of planning capacity than merely following instructions. A series of these tests was made in

1919 and revised in 1933. Their author claims they measure the capacities of forethought and planning, prudence and mental alertness in meeting new situations.

Attitudes.

Percival Symonds (48) reviews the meaning of the term "attitude" in a paper entitled, "What is Attitude?" In the writings of educators and psychologists he found the term referred to as (1) great organic drives, more familiarly known as purposes or plans; (2) muscular set or adjustment; (3) generalized conduct; (4) neural set or readiness to make certain reactions; (5) emotional concomitant of action; (6) the feeling concomitant to action; (7) verbal responses indicating liking or disliking, acceptance or rejection. This author concludes that none of these refer to conduction units which yield a peculiar type of reaction that may be called an attitude. He thinks the term is a duplicate of skill or habit, or that it refers to particular features of reaction units.

Read Bain (5) defines attitude as acquired and conditioned action patterns that motivate human social behavior, and says that attitudes which do not motivate adjustment (or maladjustment) have little significance for human beings. His attitude theory rests on the fact that the stimuli capa-

ble of activating the neuromuscular mechanisms, whether innate or acquired, are very numerous and very variable. Under appropriate conditions, almost any stimuli may be substituted for the stimuli originally adequate to activate any given action pattern. While the functional motor mechanisms, innate or acquired, are relatively stable, many quite diverse stimuli may be integrated with these specific responses. The result is a new total stimulus-response action pattern which is partly original but which in most human behavior is largely the result of experimental conditioning in cultural situations. The problem of human motivation is the problem of acquired responses. This writer believes that the term attitude and opinion refer in a general way to types of acquired action-patterns that are definitely concerned with human motivation.

As previously stated, an attempt was made in this experiment to establish an attitude of planning through explicit instructions to plan. The term attitude as used in this study is similar to attitude as defined in an experimental account of a study of conscious attitude by H. M. Clark (10). This author defines attitude as ideas or meanings which have been set off in the organism by external and preceding or accompanying determination. These ideas, he says, do not characterize the particular situation, but do characterize the particular and the immediate nature of the responding organism. They may, therefore, vary the nature of the response which the situation brings about. Attitudes are in-

tellectual and emotional. In both case the attitude is a meaning or idea developing in the organism from a situation in the enviroment. The intellectual attitude modifies the response in the direction of the modifying idea. The emotional attitude modifies the response, but this modification is due not only indirectly to the idea causing the emotion, but directly to the emotion. It is the intellectual attitude with which the present study is concerned.

Clark began his study of attitudes not from concern about the nature of consciousness that makes up the attitude, but from the concern about the objectively determinable modifications of response brought about by the presence of the particular attitude. This is the aim of the present investigation also.

Clark's investigation studied both the intellectual and the emotional attitude. The idea selected for the first study was that generalization was to be expected from a series of separate problems being solved. For the second study the idea selected for investigation was that one is better or poorer in the performance of a particular task than other members of one's group. Both these ideas were studied in relation to the changes produced in conscious functioning and behavior at the time of learning and in relation to their value when recall was attempted. The problem was also to find out if individuals of different mentalities and different chronoligical ages reacted in the same manner to

these variations of attitude, and to discover the effect of the attitude when the generalization had different degrees of complexity. In every case the subject was led to believe that the problem of learning was being investigated and not that the attitudes were under observation. They were also paired for intelligence so as to eliminate this as a factor explanatory of differences in performance.

In the study of intellectual attitude, nonsense material was used. The attitude was brought about by variations in the instructions accompanying the main problem. In one group, the subjects were given no instructions; the second group were instructed to seek a generalization; and the third group was given the generalization outright. Clark's first group was similar to the control group and his second group to the experimental group of the present study.

Group one, the author calls the trial-and-error group. Group two displayed a tendency to plan either native or because some element in the situation caused them to try a plan. This often resulted in getting off on the wrong track, after which they seemed unable to discard the unsatisfactory plan. Group three seemed to have a tendency from the first to plan, and after a few unsuccessful trials hit upon a satisfactory plan and discarded immediately those which did not work.

The writer concludes that if subjects are divided into two groups, one of higher and one of lower I. Q., the

chance of learning with any given attitude is dependent in part upon intelligence. He found, also, that the attitude resulting from no information as to progress made gave better conditions for learning than attitudes resulting from the knowledge of failure or success.

Stella B. McCharles (32) studied the effect of certain attitudes on the ability to solve problems. Each group was given instructions calculated to produce a different attitude, such as pugnacity, friendliness, alertness, relaxation, and no attitude at all, except the problem. Groups while maintaining a certain attitude solved the Yerkes Multiple Choice Problems. Questions were asked to determine whether they had been able to take and maintain the attitude. A significant difference was found in the results obtained from the groups tested. The pugnacity attitude promoted definitely a higher efficiency in solving problems.

S. Sandersen (43) found in an experiment to study intention in motor learning that the intention to learn is the essential factor in the learning process. The tasks set were learning to trace a stylus maze and a number sheet of identical pattern. The specific mental set was instilled in the learner by specific instructions without his awareness of future application. To one group instructions to learn the pattern were given, and to another group instructions to work quickly. When both speed and pattern group shifted from number sheet to maze, to be learned for speed, the pattern

intention proved superior. Less transference occurred from maze to number sheet, with no superiority for the pattern.

An experimental study of observational attitudes was made by O. D. Anderson (3). His problem was to determine some of the factors which may enter in to modify the formal instructions of an experiment. He presented the subjects with colors and tones, and directed them to note and characterize both the initial way of taking the experience and also any change in the mode which might occur in the period of perception. Five attitudes were found; the casual survey, inquiring survey of objects, critical survey of subject as subject, particularizing survey of objects, personal evaluation of objects as failing to conform to some conventional standard.

In a second part of the same experiment the subject was given characterizations of these attitudes and told to assume one and report on the course of the experience occurring under it. It was found impossible to maintain the particular attitude throughout a period of stimulation any longer than five to ten seconds; the performance demanded by the formal instructions appeared about half the time.

The investigator points out the inadequacy of formal instruction even with trained subjects. It is also evident to him that the view which regards performance as a "response" unequivocally determined by stimulus is inadequate.

W. Peters states that two attitudes are possible to observe in an experiment. These are the <u>leptisch</u>, or passive, and the <u>ktetische</u>, or active, the latter being induced by more difficult tasks and tending to give better results. He claims that some observers naturally assume one attitude and some the other.

To test and in general substantiate these statements of Peters, G. Luntowski (27) conducted an experiment in which the subjects were required to divide a given linear distance into three equal parts by shifting beads on a string. The subjects were young adults of both sexes.

Ten observers in this experiment were given no directions as to the attitude to be assumed or method used. They were questioned as to how they performed it when they had finished. Out of eighty-two experiments, sixty were carried out wholly actively and eleven wholly passively. Seven subjects observed actively four times as frequently as passively and the remaining four subjects were more passive than active. The active group showed more generalized body movements, corrected the position of the beads more often, and took longer for the task. They had more restricted attention span, tended to break the space into sections successfully, and were rarely conscious of the whole. They used only one hand, while the passive group moved the beads simultaneously with both hands. The errors were smaller in the active group.

In the second part of the same experiment four active subjects and three passive subjects were selected. An equal number of instructions favoring active and passive attitudes were given in variable order, the statements of the subjects again taken following the tasks. The active instructions were followed every time successfully in almost all cases. The passive instructions were followed completely by only one subject every time, seventy per cent of the time by five subjects and never by the remaining subjects. The same differences were noted as to the time, errors, etc. as were found in the first experiment.

The author concludes that while most subjects tend strongly to one attitude, the active can usually be assumed.

The difference of progress that would be developed by an attitude of mechanical grasping as compared with the natural attitude of learning was studied by S. Aoki (2). A story was read to three groups of subjects. The first group was instructed to learn it mechanically, the second group to grasp the general meaning, and the third group to reproduce the contents in answer to four prepared questions. Aoki noted that reproduction was most difficult for group one, that group two grasped the material as a whole, and that group three did the best job of reproducing. From these results he concludes that analytical instruction is not effective because it results in an attitude of mechanical grasping of the material to be learned.

Frances Wells (51) found in the course of an extensive study of affective experience that feeling varies markedly with the nature of the mental attitude or "set" which the subject adopts immediately before the stimulus is presented. This led her to study the effect of certain specific attitudes upon feeling. These attitudes were the critical affective, the critical perceptive, and the naive or common-sense attitude. Three different groups of subjects were given three different sets of instructions. Group one received general instructions requiring a description of the total experience from beginning to end. Group two received specific attitudinal instructions in which the subjects were required to adopt a particular observational attitude as defined in the instructions. Group three received no instructions whatever. All subjects were asked to give an introspective report. The effect upon reaction to the stimulus is reported in the case of each attitude. The results show that the attitude toward which one approaches an affective situation plays an important part in determining ones reaction to it. The nature of the affective reaction varies widely under different attitudes.

G. Meyers (33) studied the effect of the examination set on memory. His subjects were instructed to study for a particular kind of examination such as true-false, completion, multiple-choice or essay. He found that for recognition tests

of immediate memory, set is of slight importance. For recognition tests of delayed memory or for recall tests of immediate or delayed memory, recall sets are superior to recognition sets. For completion type of recall examination set is superior throughout. For recall of facts in organized fashion, the essay type of examination is best.

The work of H. Helson (18) is based upon the fact that mental sets have usually been attributed to their connection with or effect upon past experience and association. This view, the author states, is expressed by D. Starch, who says, "The particular meaning given a group of sensations is determined not only by the general uses of previous experiences but also by the particular system of past associations dominant in the mind at the time; that is, meaning is determined by the present setting of the mind."

Helson's opinion is that when instructions evoke a response which has not been made in the past or one which would never have been expected on the basis of the subjects' past behavior, the theory which allows such factors as set or instructions merely to select or act in accordance with past experience is untenable. He thinks psychologists are prone to emphasize those cases in which past experience helps us in meeting new situations and to neglect the equally numerous cases in which past experience prevents us from making adequate adjustments to novel demands. Past experience and associations

must be made effective by factors inhering within the situation confronting the organism or else they may fail to function or may be a positive hindrance.

To prove his position the author exposed normal playing cards and test cards (altered in various ways). The subjects were asked to name the card. Those who were very familiar with cards felt certain that they could not be wrong in reporting the card as belonging in a certain suit. In these cases past experience made it hard to see clearly and freshly what is novel in a situation.

From his results Helson's conclusions are that instructions, calling for now one kind of activity, now another, determine the type and adequacy of the response more than do practice, richness of association, or past experience. This is explained by the fact that the instructions determine what resources the organism will use in solving its problems through their effect upon set and type of activity used. If past experience and associations are to be effective in determining present responses, they must be organized, directed and set into action by the operation of some factor contained within the stimulus situation.

Suggestion.

Whether the mental set or attitude which one attempts to establish will modify the subjects' response, depends in

part upon the suggestibility of the subject. What is the value of this suggestibility?

A. Vierkandt (50) in a paper which he calls, "New Views of the Nature of Suggestion," says that the popular idea of suggestion rests on two false assumptions. First, that man's normal behavior is rational, and second, that human beings are independent units making independent judgments and decisions. He says verbal suggestion is thought to consist in a sort of crippling of mental life.

Vierkandt insists that in reality man is not an isolated rational creature. Verbal influence is natural and universal, not abnormal. From childhood man accepts without resistance the views of those around him. The child is unconditionally credulous. Only by experience does he learn to be critical. Even adults are critical only in a limited way. We accept the beliefs of a person we trust and think we are judging independently on rational grounds. He suggests abandoning the term suggestion for influence.

A. Herzberg (20), who has made an analysis of suggestion phenomena and the theory of suggestion, says that suggestions are not based on single unified mechanism, but arise from inter and contra action between very numerous and varied, partly inhibitory and partly favorable factors. These lie in the suggestee, in the suggestor, in the environment and in the content and type of reports by outsiders.

Those inherent in the suggestee are specific tendencies such as easy involvement of the sleep centers, special wishes, experiences, views, habits, and after-effects of experiences recently undergone. Such factors favor or hinder very definite attitudes and are thus specific content factors. Further we find the basic tendency to believe and obey, the emotional resonance, a desire for comradeship and subordination. As inhibiting factors we find the instincts of aggression, avoidance, resistance and leadership. These determine the adoption or rejection of given attitudes. They are not specific but plastic. The habit of critical thought also acts as an inhibitory factor.

There are three types of influence according to Herzberg. The first is directed toward critical thought and takes place through reason. The second takes place on the basis of specific tendencies, wishes and habits of the suggestee. The third type, which is irrational, takes place upon the basis of plastic factors. This last is suggestive only and on condition that it takes place in spite of the personal strivings, experiences, views and habits of the recipient.

The first type of influence mentioned by A. Herzberg is the kind which we hoped to exert upon the subjects of the present experiment. Binet defines this influence or suggestion as obedience to a mental influence coming from another.

Numerous studies have been made to determine the nature of suggestion and its effect upon reaction. These experiments have studied suggestibility in relation to motor reactions, or to sensations or beliefs. Only such as are in some manner related to the present study will be reviewed.

As early as 1896 M. H. Small (46) experimented with children and found that two-hundred-ninety-one out of three-hundred-eighty-one were affected by illusions of smell, of taste, and of sight. To produce the illusion of smell the experimenter sprayed water into the air and asked the children to write down the name of the perfume they smelled. For the illusion of taste he used sugar, salt and distilled water. A toy camel with a string around its neck was used for the illusion of sight. When a windlass was turned the camel seemed to be pulled, but in reality it remained stationary. Small concluded from the results of this study that suggestibility in children is a universal condition, very high in degree, and largely in control of those who know the child mind.

The suggested effect of printed mottoes on the estimation of linear magnitude was investigated by J. Brand (9). His subjects were required to reproduce lines varying in length from twelve to thirty-four inches, which were represented by intervals between two pegs. The subject reproduced the interval by spacing two smaller pegs on a ledge near him. The words "short" and "long" were printed on cards

and shown to the subject as the work progressed. The word "short" in the motto tended to produce a negative error, while the word "long" tended to produce a positive error. Because the correlation with intelligence was high the author says that the subject must have ability to carry out the suggestion made to him before it can be effective.

J. C. Bell (7) showed by experiment that, in general, suggestion affects the reproduction of triangles. A black-lined box in the form of a truncated pyramid was used in this experiment. The subject looked through this box at cards and reproduced the forms seen on them. Suggestions such as "make high", "make low" affected the reproduction.

H. S. Langfeld (25) used a modified Whipple tracing board to study voluntary movements under positive and negative instructions. A wire was attached to a stylus and put through the coat sleeve of the subject. Ten trials were given. Such suggestions as "Go down the middle of the groove", or, "Do not touch the sides", were given. Langfeld noted that instructions of either kind tended to break up accustomed attitudes and were useful only when they supplemented the natural attitudes.

In England in 1921 A. Aveling and H. L. Hargreaves (4) used seven tests in their study of suggestibility. The first was the hand-rigidity test. The subject was instructed to hold out his hand and fix his eyes on the hand of the experimenter. The experimenter gradually made his hand become

very rigid. The subject would then report a feeling of tightening in his own hand. The second test was suggestion by progressive lines. The subject had to say if one line was shorter or longer than the previous one. Suggestion by illusion of warmth was the third test used. Here the subject had to distinguish between the relative warmth of lamps held in each hand. The fourth test was the hand levitation test. The subject placed his hand palm down on the table and the experimenter placed his hand over it. He then gradually raises his hand from the subject's and suggests "Your hand is light", "It is leaving the table. The fifth test is the suggestion by progressive weights, in which the subject must report the difference in weights after the first four. To induce a strong degree of suggestion the fidelity-of-report method was used. In this test two colored pictures were used and questions concerning facts not found in the pictures were asked. The last test was contradictory suggestions as to lengths of lines made by the experimenter.

In the course of the experiment Aveling and Hargreaves found that certain cases proved very suggestible to all tests, or nearly all, while others accepted practically no suggestions. This, they think, points to the fact that suggestibility is strongly marked in some subjects.

Margaret Otis (38) says, "To accept a suggestion shows an absence of the ability to resist. It is a lack, a passive state. Resistance is something positive, is an

ability or trait and must correspond to the quality, number, or mode of functioning of the nerve cells and fibres of the nervous system. This ability is called by Binet auto-criticism, by Dewey self-confidence, by Woodworth good judgment and by Morgenthau planfulness. It is the ability to see the whole situation, instead of reaching to the most obvious part of it."

Otis tested suggestibility in 1045 children in the preliminary test and 377 in the test proper. The Otis test is similar to the Army Alpha Tests. The author says that Binet furnished the spirit and the form of it. The tests include comparison of lines, twenty directions to be carried out, and true and false statements. Directions are given orally. The suggestions are sometimes direct and sometimes indirect. For example, the directions might be, "Sixteen sentences will be read. Most of them are false. Draw a line under the word true, if the statement is true, and one under false, if it is false." Or the directions might be, "Here are some colors. Most people like green best. Draw a line under the color you like best."

Two-thirds of the subjects in this experiment resisted suggestion. From the testing, Otis concludes that there is a trait which may be called ability to resist suggestion. The relation of this trait to general intelligence is high. It distinguishes the normal mind from the abnormal one. Chronological age is an important factor affecting resistance to suggestion.

I. C. Sherman (44) made a study based upon an experiment tried with sixty children from six to sixteen years old. Her aim was to find what effect verbal suggestion had upon perseverance in a task which has been given up as unsolvable. A puzzle-box was placed before the subject, who was told that by manipulating its three levers in the proper order the box could be opened. Such suggestion as "I am sure you can get the box open," "You almost had it several times," were made. A child whose time on the second trial tended to be long in comparison with the first trial was regarded as more suggestible. From the results, the experimenter found that verbal suggestions were more effective with the youngest and oldest of the group, and less effective in the intermediate ages.

Varying types of experimental situations were used by R. S. White (52) in an endeavor to select some which would give a measure of a child's response to suggestive stimuli. One-hundred-thirty-six children of from three years to seven made up one control and two experimental groups. The experimenter found that most children are suggestible to a certain degree, although a few appear to be uninfluenced by a visual suggestibility of the type used. Negative suggestibility is rare. Suggestions similar to the child's own method of reaction re-enfore his tendency and make opposing suggestions less effective. The extent to which the suggestions are followed depend upon their obviousness and the ease of per-

forming the movements involved. Children are not consistent in their acceptance or rejection of suggestions. No sex differences were apparent, but suggestibility increased slightly between the ages of three and seven.

Four-hundred-four children were given the Margaret Otis test of suggestibility by E. S. Hurlock (21), and these scores were compared to scores made on the National Intelligence Test and with reference to race, age, and mental difference. In general, suggestibility of children appeared less than popularly supposed. White children were slightly superior to negro boys and girls in resistance to suggestion. Older children were superior to younger, and those of higher mental age to those of lower. These group difference, however, were small and unreliable. More striking differences appeared in individuals of the same group.

Problem Solving.

The solution of a problem involves a typical process of thought. This process in many respects is similar to that used in the acquisition of scientific data. Numerous general discussions by authorities are available concerning the nature of the thought process as it relates to problem solving.

One of the early authorities on scientific procedure is K. Pearson (39:46). In discussing the nature of thought he says that the immediate sense-impression is to be looked upon as the spark which kindles thought, which brings into play the still remaining impresses of past sense-impressions. These stored impressions are linked together in so many ways that we are not able to recognize the relation between an immediate sense-impression and the resulting train of thought. Nor can we trace back a train of thought to the immediate sense-impression from which it starts. Yet the elements of thought are certainly the permanent impresses of past sense-impressions, and thought is started by immediate sense-impressions. Thought once excited, the mind passes from one stored impression to another. It classifies these impressions, analyzes or simplifies their characteristics and forms general notions of properties and modes. Thought then passes from perceiving to conceiving.

The amount of mental association in our individual selves depends on the variety and extent of our stored impressions, or on the individual capacity for thinking, or on the form and development of the brain. The same type of brain receives the same sense-impressions and forms the same "constructs". Two normal perceptive faculities construct practically the same universe. The universal validity of science depends upon the similarity of the perceptive and reasoning faculties in normal civilized men.

Science is in reality a classification and analysis of the contents of the mind; and the scientific method consists in drawing comparisons and inferences from the stored impresses of past sense-impressions and from the conception based upon them.

In order that a conception may have scientific validity it must be self-consistent and deducible from the perceptions of the normal human being. Inference follows perception and when scientifically valid is one that could be drawn by every logically trained normal mind were it in possession of the conceptions upon which the inference has been based.

Watt in speaking of the problem or "aufgabe" says an act of thought is a sequence of experiences whose procession from its first term, the stimulus, has been determined by a psychological factor (that is by the problem). As a conscious experience this psychological factor is past and gone, but it still persists as an appreciable influence.

Ach agrees with Watt. He says that the observer's consciouness during the fore period is dominated by a purpose. The idea of end subexcites its correlated reproductive tendencies, and is therefore accompanied by awareness of meaning. The tendencies so aroused are further brought into relation with the idea of object, which they accordingly influence in the sense of the idea of end. The establishment of these relations between idea of end and idea of object

he terms a purpose.

John Dewey (11:68) says that the problem fixes the end of thought, and the end controls the process of thinking. He defines problem as, "the discovery of intervening terms, which when inserted between the remoter end and the given means will harmonize them with each other."

The difficulty resides in the conflict between conditions at hand and a desired and intended result, between an end and the means of reaching it. The object of thinking is to introduce congruity between the two.

The third step in the solution of a problem, according to Dewey, is a suggestion of a possible solution. Regarding this step, he says that suspended belief depends on the presence of rival conjectures as to the best course to pursue. Because of this, cultivation of a variety of alternative suggestions is an important factor in good thinking.

The fourth step is the development by reasoning of the bearings of the suggestion. The process of developing the implications of any idea with respect to any problem Dewey calls reasoning. Reasoning sets out from an idea and develops the idea to a form more apposite to the problem even if it does lead to rejection. The development of an idea through reasoning helps at least to supply the intervening terms that link together into a consistent whole apparently discrepant extremes.

Further observation and experiment leads to the acceptance or rejection of the development of the implication of the suggestion. If experimental results agree with the theoretically or rationally deduced results, the confirmation is so strong as to induce a conclusion.

Johannes Lindworsky, S. J., (26:264) discusses problem solving under the head of productive thinking. He points to Selz who has proven that a presented task does not make all possible associated images appear with the task stimulus. Individual images do not emerge unconnected, but instead they call into consciousness the methodical procedure which we earlier learned to apply to the solution of the task. The image of the procedure operates as an anticipating schema, and this furnishes us not with something diffuse, but rather with servicable images which form a complex schema. This complex is compared with the task, and if by an apprehension of relation its agreement with the task is recognized, it becomes accepted; otherwise, a further methodical search is made.

In general, for Lindworsky, we are concerned with bringing together the means and the goal. He gives O. Selz's four possible instances: (1) The goal to be attained and the means leading to the goal can be recognized and be present in the thinker's consciousness. Material relations, that is to say, reproduction of a complex, are the chief considerations here. (2) If the goal is given, and a means of obtaining its

purpose is still unrecognized, by means of reproductions of complexes, various means are called to memory, which can if need be, come into consideration, and those are tested individually as to their fitness. A conclusion releases us from the domination of association, although the emergence of the conclusion very frequently depends upon the associative conditions. (3) If our memory does not include useful means, we are dependent upon the favor of chance. In this case, as before, we consider all things from the standpoint of their suitability for our purpose. (4) Finally, a means and its end can be offered to us accidentaly as something real, but not as something for which we strive.

Lindworsky concludes that complex completion, apprehension of relation, and volitional processes, are the three factors which bring direction, arrangement and abbreviation into productive thinking. If, without both the latter factors, or with only elementary associations, we wished to comprehend something, it would be absolutely impossible.

Regarding problem solving, Thorndike (49:159) thinks there is co-operative action of many connections. Under the guidance of some mental set many tendencies start working. Some of the responses produced thereby are discarded altogether; some are put aside to be given influence later; some are used together to determine the next step. As thinking progresses each of its constituent responses is subject to certification or validation.

Thorndike defines correct thinking as the right weighing of elements, held in the right relations and connected with the right associations. He says wrong thinking results when the process of validating is too easy-going to detect and correct the mistakes made in attaching weight to elements, putting them in relation and having them evoke right associations.

Charles H. Judd (23:169) describes the problem in the following manner. In a new situation, the first impression is a vague, somewhat confused view, including in a loose aggregation a large number of items. The eye rests on one item after another and the observer cultivates discriminating familiarity with the details of various objects. After analysis has made the mind familiar with certain items, a process of organizing synthesis begins. In the third stage of experience, the observer sees in their proper relations the objects that make up the whole. Each object takes its place as part of the whole and yet retains its individuality. This is the stage of true comprehension. Analysis and insight into relations make a thing understandable.

H. Gruender, S. J., (14:328) develops fully the scientific method as it may be applied to the problem of the thought processes. The first step, he says, is the preliminary observation. The second step in the method is the formulation of a tentative hypothesis. The third step in the inductive method is deductive reasoning. The fourth and last step is

the verification of the conclusions drawn from our hypothesis. The last step is performed by comparing these conclusions or "expectations" with the facts already collected in the first step. If the data there obtained is insufficient for a complete verification of our conclusions, we must plan a new set of experiments and go back to the laboratory for further research. Thus we may succeed in the complete verification of our hypothesis.

It is well, however, this same author warns, not to be too hasty in proclaiming our hypothesis established. The conclusions deduced from rival hypotheses must also be tested in a similar manner. On doing this, we may find that at least some facts agree just as well with the hypothesis of others as with our own. This indicates the need for further research. The same is true when we find that many of the facts are in agreement with our hypothesis but others are not. Then some change in our hypothesis must be made to meet these difficulties, and thus we must go over again the work of the second, third and fourth steps. Only when all the facts ascertained are in agreement with our hypothesis, and all rival hypotheses plainly fail to meet their difficulties, have we assurance that our hypothesis plainly is the true explanation of the facts observed. Then our hypothesis becomes a general proposition concerning the nature of the object which we have been investigating.

Victor H. Noll (35) has contributed a very complete exposition of the habit of scientific thinking and its importance in the life of the average human being. He claims that present-day troubles and ills are caused by false, prejudiced and generally unscientific thinking. The orgy of speculation, get-rich-quick schemes, harmful beauty aids and quack remedies are due to unscientific thinking. Our social organization, our political machinery, our economic structure, and our educational system are unsatisfactory and unstable for the same reasons.

One of our major objectives of education is, he says, the development of attitudes, because as emotionalized reaction patterns they are strong motivating factors. Our attitudes toward home, toward social and political institutions, toward the natural environment and toward the achievements of science, determine much of what we do and how we act. Attitudes are based on habits of thinking. They are more or less automatic, depending upon how deeply they have been planted. They are constant to the same situation; they are acquired, not inherited, and they may be modified through experience.

Because attitudes cannot be observed directly but only in their manifestation in behavior, the writer gives a subjective analysis of the scientific thinking attitude.

He assigns six fundamental habits to thinking scientifically. The first is the habit of accuracy in all

operations. This habit is necessary in all high-grade scientific research, but is no less desirable in everyday life. The second is the habit of intellectual honesty. This includes sticking to facts, and refraining from exaggeration. It involves submerging personal bias and prejudice. The third is the habit of open-mindedness. This includes constant revision and editing of opinions and conclusions through the reception and accumulation of additional data, and is most adapted to scientific research. The habit of suspended judgment is the fourth fundamental habit of scientific thinking, This implies the habit of actually lookimg for new facts and waiting for all available ones before coming to a final conclusion. This habit seems especially dependent upon mental maturity for its development. He says that children are notably prone to jump to conclusions without sufficient facts to substantiate them. The fifth habit is the habitual search for true cause-and-effect relationships. It indicates a functioning connection of the universal operation of the law of cause and effect. The habit of criticism, including self-criticism, is the final habit necessary to scientific thinking. This includes looking at suggested explanations, natural occurrences, and proposed remedies with a critical eye. It does not mean fault-finding, but the habit of exercising all the powers of careful judgment and evaluation.

Noll presents the possible objection that the habits of thinking just analyzed are those to be expected of the

trained scientist and not the average person. He answers the objection with the statement that in their highest state of refinement this may be true, but it is necessary for the average person to acquire each of these habits in amounts substantial enough to make them function in everyday life.

In a second paper Noll (36) discusses teaching the habit of scientific thinking. He repeats that these habits are important in the everyday life and thinking, not only of the scientist, but of everyone. Then development in a greater degree than now exists in every individual would go far, he thinks, toward the attainment of a more satisfactory adjustment of economic, political, and social problems than we have yet been able to effect.

This author says that experience has shown the futility of exhortation and admonition. Materials and methods of instruction must be organized definitely for this purpose. He suggests the collaboration of teachers of natural science and teachers of social science as an attack upon unscientific thinking in the field of social situations.

Concerning the method to be used, Noll says that no one method is peculiarly and solely appropriate for the teaching of scientific habits of thinking. No method of itself will guarantee the attainment of a goal, unless the goal is made the objective of that method.

The six habits of thinking, the author says, should be taught directly as such. There is no reason for leaving

so important an objective to chance. Practice must be given in the formation of these habits in specific situations, and in all possible situations. They should be generalized and made meaningful and desirable to the pupil to insure efficiency and permanency of learning. This latter aim can be accomplished without cheapening these values in the least, if we use the material at hand in an intelligent way. As an example of how this might be done, Noll suggests a study of present-day heroes and heroines such as Edison or Earhart. The importance of habits of scientific thinking as a factor in their success could be used as a motivating influence.

The study of the problem from an experimental standpoint has demonstrated the validity of theoretical writings on the subject. The conclusions of Edgar J. Swift (47) concerning the psychology of learning, though not on that of the problem as such, are significant in the light of our present study. He found in teaching children to throw a ball, that to children future benefit is at least a poor recompense for present misery. Remote interests often count for very little with children. He discovered, also, that the suggestion of "a good way to do a thing" saves time, but must be made when the learner feels the need for them. Overstrained attention is a hindrance rather than a help.

Henry Ruger (42) questions one of the findings of Swift, who maintains that variations in method are most effective when they are not attended to. In Ruger's experiments

with solving mechanical puzzles there seemed to be a natural tendency to vary which could be hindered or favored in various ways.

Of special significance in the determination of the occurrence of variations in the puzzle experiments was the personal attitude of the subject. Two unfavorable attitudes were noted; the submissive, or suggestible, and the self-attentive.

The suggestible attitude was very marked in two of Ruger's subjects. These subjects seemed to be especially sensitive toward any movement of the experimenter which might give an indication as to the course to be pursued. In such cases there is a lack of confidence in the self, but the attention is directed not to the self but to some other person. The suggestions of the other person are accepted uncritically. This attitude and the self-attentive attitude are not favorable to efficiency.

A third attitude, which Ruger says increases in dealing with novel situations, is what he terms the problem attitude. This is one of self-confidence as opposed to the self-distrust of the other two attitudes. This self-confidence is expressed in a high level of intellectual activity and attention. Attention is directed to the thing to be done rather than to self. This attitude is accompanied by a compensating tendency toward critical evaluation of variations, a flexible holding of assumptions and suggestions, and a

rigid testing of them. These various factors entering into this attitude were noted by Ruger to be connected with efficient forms of response. The ideal of efficiency, he says, involves the active search for methods of control.

In 1918 John P. Herring (19) attempted to measure some abilities in scientific thinking. He was motivated to this study by the conviction that civilized society needs more scientific thinking. His ultimate aim was to focus attention sharply upon scientific method as the proper method of children's study both in the ten abilities tested, and in all other abilities which are not important or feasible. His immediate aim was to increase the consciousness and effectiveness of the use of ten scientific abilities. Regarding the first aim, Herring says that we must teach children how to study, to handle problems, to work methodically.

This investigator names ten abilities which are necessary in the scientific solution of problems. These are the ability to judge the relative value of different problems, the ability to judge whether a problem can or cannot be solved, the ability to distinguish a good definition from a bad one in defining the terms of a problem, the ability to locate ambiguity, to know when statistics are needed in proof of a statement or in the solution of a problem, to select facts that relate to the problem, to distinguish good from bad comparison, to recognize the presence of something foreign in a class, to arrange the members of a class in useful sequence, and to judge if

data is sufficient for the purpose.

Herring tested eighteen hundred grade pupils. To these he presented statements whose answers tested the various abilities just mentioned. The author concludes that in the past too much emphasis has been placed on measuring the content of the different subjects studied. He suggests that while the measurement of scientific ability is set with difficulty, still it is dealing not mainly with memory, nor addition, nor spelling, nor punctuation, important as these are, but with the noblest intellectual function, judgment.

Thomas Russell Garth (13) made a study related to that of Ruger's which demonstrated the use of the method of trial-and-error in solving problems. In Ruger's experiment the elements were largely physical, while in the case of the riddle experiment conducted by Garth, the elements were mental. Garth's aim was to show the similarity and possible identity which is brought out on a comparison of the method used in riddle solving and the method used in learning by trial-and-error. He selected ten riddles such as, "If your aunt's sister is not your aunt, then what kin is she to you?"

From the results obtained Garth concludes that one must believe in the trial-and-error character of the method employed in riddle solution. Speedy guessing tends to militate against success and rare associations characterize this kind of guessing. Too slow a speed in guessing also results in failure. Moderate guessers are most often successful in the

solution of riddles.

John C. Petersen (40) investigated problem solving in the playing of a game. A game in which fourteen beads mounted upon a steel wire was played. Two persons draw alternately, each being permitted to take one or two beads at a time. He who gets the last draw wins. The subject always draws first. He can always win by taking two beads at the first draw and enough at every draw following to make the sum of his draws and the experimenter's preceding draw equal to three. The learning process consists in finding the correct response for each situation and in connecting every situation with its appropriate response. New series of problems may be had by varying the number of beads.

Petersen divided the learning process as observed in his experiment into three stages. First, the abstraction of elements from the problematic situation, then the combination of essential elements into higher conceptional units, and thirdly, the application of these higher unitary processes to situations other than those out of which they arose.

Each stage begins with diffusion and multiple response, and progresses through elimination and the preservation and gradual co-ordination of essential responses. Trial-and-error is the method of procedure in all stages, but the materials among which variations occur are somewhat different, and the field of variations is progressively narrowed in the latter stages.

In the early stages of learning, according to Petersen, those elements which occurred most frequently in closest temporal contiguity were generally the first to be combined in higher units. Certain situation and response elements which occurred most often and in closest proximity to other elements became so closely associated with the latter as to serve as symbols through which the various elements were co-ordinated and their subsequent recall much facilitated.

In the latter stages of learning, symbols representing well arranged concepts were called in by association. Through the medium of these symbols, and again by means of specific associations, meanings were transferred from previously known to newly discovered elements. Association of this sort at first functioned slowly and imperfectly, but continued repetition brought about a facility and even automaticity of functioning comparable to that of sensori-motor co-ordinations.

Edna Heidbreder (16) conducted an investigation of the thinking process. She constructed a test to fit the assumption that thinking is an activity, which by some means other than overt motor reaction, produces responses which are adequate, novel and invented. It consisted in marking geometrical figures according to instructions.

She divided the behavior of the subjects into participant and spectator behavior. In spectator behavior there is action without any hypothesis being tried out. In

participant behavior the subject tries out a hypothesis.

Spectator behavior is accompanied by general observational activity during which the organism is set for registering impressions. A secondary form of this behavior is found when the subject is more definitely aware of what is going on. He makes an effort to focus his observations. He may use a hypothesis he knows is wrong but one which has given some success, trying to find wherein it is right or wrong. A third form of spectator behavior Heidbreder calls the momentary form. The subject falls into this form for a single reaction. He thus becomes absorbed in an activity not directly connected with the overt reaction, and, as a result, the two lines of conduct become disassociated. This last is typical of spectator behavior in general in the sense that the overt activity does not represent the main activity.

Spectator behavior may be characterized best as primarily a cessation of participant activity when no hypothesis is available, and secondarily, a state of affairs which may facilitate processes of summation. It is a distant general attitude toward the problem. It may function as a preparatory reaction to the process of summation, which in turn may supply the raw material for new theories of action.

Heidbreder says the general function of analysis in problem solving seems to be to reduce the supply of content by singling out possible significant features; that is, recurring features, new or different features, features to which

the organism has been in the habit of responding, and features associated with success or failure.

Concerning synthesis, she says it is most likely to occur when the subject is facing a new situation, either when he is making his first response to a problem, or when he is making a fresh start in its solution. Synthesis results in the production of higher units of various orders and the selection of relevant material by means of mental sets.

This investigator says that new responses may occur as the result of observation, summation, removal of interference, clues, generalization, and "thinking out" the solution. She finds good evidence for the production of new responses through the summation of impressions not specifically attended to. This suggests a possible function of spectator behavior.

The solution of a problem is, according to Heidbreder, a very definite event in a subject's activity in spite of the fact that it is not effected by any special process or group of processes. She gives nine methods of reaching a solution to a problem. These are by cleavage responses, plus participant variations, by participant variations alone, by deliberate analysis, by simply occurring, by clues, by summation, by a generalization of two generalizations, by original search and by convergence of two responses.

Heidbreder (17) performed a second experiment to show the difference in the thought processes of children and adults. Her subjects were children from three years of age to ten years of age, and ten adults. The problem consisted in selecting a box that contained a doll from among a number of boxes. In the first experiment, the doll was in the right-hand box; in the second, it was in a flowered box; in the third, the farther plain box; and in the fourth, the nearer dotted box. The boxes were presented until five correct responses were made.

The investigator concludes that the activity involved in problem solving includes several modes of reaction, which show a gradual development with increasing maturity. There was a gradual emergence of general form, pattern, or mode of procedure, which became more definite but never rigidly set as age increased. This pattern appeared in the midst of great diversity or reaction so far as the particular procedures and the concrete materials of thought were concerned. This was revealed by reaction-time curves and behavior differences which indicated a narrow set and somewhat more uniform procedure in adults than in children.

Responsiveness to problems, as such, increases with age according to Heidbreder. As age increases so does development from less adaptive to more adaptive modes of response. There was a change, too, through the age group from

a more subjective to a more objective attitude toward the problems as a whole. Four-year-olds responded totally to the problem situation.

Augusta Alpert (1) investigated the solving of problems by pre-school children after the manner of Koehler. She hung a toy balloon out of reach and varied the means by which the child could secure the toy. A hollow block, a chair, and a box could be used to solve the problem.

Concerning insight into a problem, Alpert says that the subject gains insight when a change occurs in him which caused the material in hand to undergo a definite change from a disorganized, meaningless mass, to an organized meaningful arrrangement of parts. When this happens, the subject is said to have insight. The solution itself thus becomes the criterion of insight. The moment of insight may be sudden, or a glimmering apprehension, and is found in all degrees from elusive and indefinite dimness to clear and convincing definiteness.

This investigator found eight factors responsible individually or in combination for the partial or complete inhibition of insight which effect the solving process. Self-consciousness decreases attention to the problem. It imposes motor inhibition and mental inhibitions, so that even when insight is present it is prevented from consummating in action. Lack of confidence interferes with the maturing of insight. The extent to which the subjects allow any one

"mind set" to usurp their attention, to just that extent do they lessen the chances of seeing the problem in the right perspective. This "mind set" Alpert terms "fixations". Lack of interest, discouragement, and excitability are unfavorable to insight because attention is diverted from the problem. Lack of observation and emotional immaturity results in little or no activity.

The general conclusions from the study are that problem-solving-activity is determined by the nature of the problem situation. It is trial-and-error, or deliberate, according to the set-up. Exploration and elimination was the most frequent response and yielded the greatest number of solutions. Solution is arrived at only when insight is gained. No solution results from chance. Arousal of insight and its consummation in solution are favored by emotional, temperamental, and mental factors.

A study of overt trial-and-error in problem solving of pre-school children was made by Genevieve L. Harter (15). Her aim was to determine the ability of pre-school children to solve a problem situation without overt trial-and-error. Each test involved a solution in which one step or stage of the process must be completed before the succeeding step. The first step was the obstacle peg test, in which the subject had to fit pegs into grooves. The canal-box test required the subject to get a ball out of a box through a hidden door.

Finally, a pulley test was given. At the farthest end of the pulley was a box containing a top. This could be reached by screwing two sticks together, which were lying near the subject.

Harter concludes that pre-school children exhibit considerable overt trial-and-error in solving problems. The successful were older chronologically and mentally. The number of randon moves were reduced on the second trial. Those who succeeded made fewer moves than those who failed. However, the failure group had a longer time in which to make moves than the successful group, who were limited by the solution.

Norman R. Maier (28) investigated the solution of a problem and its appearance in consciousness. He gave his subjects the task of solving a problem having four possible solutions. Two cords hung from the ceiling and reached the floor. One hung near a wall and the other from the center of the room. The directions were to tie the two ends together. Anything in the room could be used that would help in the solution of the problem. The subject had to solve the problem in four different ways. Trials were timed and introspective reports given concerning the means of solution.

Maier's results lead him to believe that the perception of the solution of a problem is like the perceiving of the solution of a hidden figure in a puzzle picture. In both cases the perception is sudden, there is no conscious

intermediate stage, and the relationship of the elements in the final perception are different than those which preceded. Changes in meaning are involved. The manner in which one tries to solve a problem, that is, the reasoner's direction, is dependent on what he sees the difficulty to be.

When a person attempts to solve a problem, Maier says, he sees the difficulty to be of a certain sort. Past experiences are then organized in such a way as to overcome this difficulty. Behavior or lines of thought which are directed at the overcoming of a certain difficulty may be characterized as the "direction" in which a person is thinking. Only when the direction in thinking was an attempt to overcome the correct difficulty were suggestions successfully used. "Directions" thus determine which experiences will be facilitated and which will be blocked or inhibited.

The "direction" set up when a person is trying to solve a problem seems to be a field of strain, according to Maier. The field of strain determines the organization of experiences, and must inhibit certain past experiences and facilitate others.

In reasoning, this field of strain is set up by the desire to solve the problem, and the knowledge of the end, the attainment of which offers certain difficulties. Whether or not a problem is to be solved depends on whether the field of strain is adequate; that is, whether the individual is trying to overcome a practical difficulty and whether a

certain combination of parts of past experiences will result when the field of strain is adequate.

In a second experiment Maier (29) attempted to discover whether habitual activity actually inhibits the formation of the solution of a problem, or whether such activity merely comes in when there is nothing else to do. To one group of individuals he gave the suggestion to try and rid themselves of persistent habits and direction in their thinking and to maintain an attitude of receptiveness for new approaches to the problem. A second group were not given the suggestion. Group one were significantly better at problem solving than group two.

Maier says that these results indicate that reasoning involves the inhibition of persisting habits as well as the ability to form solution-patterns.

An experimental study of insight is reported by Y. Kubo (24). Eleven experiments of maze running and problem solving were selected and arranged, from one that could be done by mere trial-and-error procedure, to one that could not be done without insight.

The results showed that insight in man is much more complex than in animals. Human behavior is guided not only by insight in the narrow sense of grasping of essential relations, but also by foresight. Problem solution in man may be analyzed into ten steps. These steps are similar to those mentioned by previous investigators. Success or failure,

quickness or slowness, and exactness or not solving, depends on the observer's intelligence and experience. Moreover, the attitude and the character of the observer have great effect on the solution.

Victor H. Noll (37), whose contributions to the subject of the scientific attitude have already been reported, assumed that the results of training in scientific thinking could be measured. He proposed to measure the extent to which scientific thinking functions, not entirely or even predominantly in the laboratory, but in life situations, and in terms of common experience.

On this basis, tests were constructed to test the six habits of scientific thinking enumerated by him in a previous paper. For example, the test for accuracy consisted in answering questions concerning the Earth and Mars from an accurate observation of a diagram of these two planets. The rest of the test was a true-and-false test, each statement of which tested one of the remaining five habits of scientific thinking.

The tests were given to three-hundred-eighty-three boys and girls in grades eight to twelve. The results showed that thinking becomes more scientific as children mature. Even the high scores are not advanced enough in scientific thinking.

As recent as 1936 Norman R. F. Maier (30) conducted an experiment in problem solving by pre-school children. His aim was to determine to what extent children are capable of

reorganizing their experiences; that is, integrating or combining isolated experiences.

Booths were placed at the ends of pathways arranged in the form of a swastika. One of the booths contained a toy wind-mill house. When a penny was dropped in the chimney, the house would play a tune. The child was conducted to this booth in the first part of the experiment. In the second part, he was told to find the wind-mill house after having been started from a different booth. The child's response was regarded as correct if he entered no wrong alleys beyond the elbow turn.

Sixty-one and five tenths per cent demonstrated ability to recognize past experiences. Sex was unimportant. The ability to recognize past experience did not become marked until about seventy months of age, when over seventy per cent of the children demonstrated the capacity.

Maier considers these results only a preliminary survey. They show, however, that ability to combine the essentials of two isolated experiences so as to reach a goal is rather late in maturing. The ability matures at widely different ages, and the time of its appearance is related to mental age. The results support the contention that the ability to reorganize past experiences to form new combinations is independent of the ability to form associations. When the former ability becomes functional, we should expect more originality and less sterotypy. Increasing age should cause the

originality factor to become more and more dominant.

When the various positions taken by the authors reviewed on the subject of the process of thought involved in problem solving are summed up, a lack of uniformity becomes apparent. Some of these authors formulate a definite number of steps which they imply necessarily belong to every act of problem solving. Others declare that no special process, or combination of processes, is necessarily involved in the solution of a problem. Still other investigators in this field hold to a theory that contains a certain factor, which is presented as the essential or most important element in the thought process. These factors are association of past sense-impressions, trial-and-error, perception of relations, relating means to goal, attitude and character. Very often these factors are not well defined and their exact function is not made clearly discernible.

The associationists place elementary associations foremost in thinking. They claim that the whole mental life of man, the most abstract reasoning included, is the result of the combination, liberation, and substitution of mental elements, and thse elements are sensations and images. This theory ignores or reduces to a sensory-level-process the apprehension of relations and the volitional processes which other writers say are also necessary to efficient thinking. These two latter factors involve knowledge which is not the immediate effect of sensible objects acting on the senses,

but which a matter of intellectual interpretation.

Those who hold trial-and-error as the principal element of the thought process insist that impulsive, hit-or-miss action in a situation of which the subject understands nothing, leads to correct solution of problems. They depend on a lucky accident which they say leads to insight into the problem. These writers fail to account for what happens immediately after the lucky accident. They neglect to mention such facts as direction of attention, the testing of reproduced complexes as to their suitability, the recognition of the terms of the relations, and the perception of relations.

Then there are the authors who insist upon something more than elementary association or trial-and-error as factors in comprehension. They declare that images do not appear unconnected when the task is presented. Instead they call into consciousness images that form a complex schema. This they say is only one step in the total process. This complex schema is compared with the task, and if by apprehension of relations its agreement with the task is recognized, it becomes accepted; otherwise, a further methodical search is made. As to trial-and-error, they admit that when our memory does not include useful means we are dependent upon chance, but in this case, also, all things are considered from the standpoint of their suitability to the purpose.

Chapter Two.

The Experiment.

The preliminary work leading up to the experiment proper consisted first in getting two problems that actually required planning for their solution. The color-box evolved from a problem in which varied colored paper cut into different lengths and thickness was used. In this problem the subject was required to arrange these fifty pieces of paper in the best possible order. It soon became evident that the paper slips would be impractical when used by sixty children. The round wooden sticks were found to be satisfactory. The colors of the sticks now had to be determined. Red was thought to be unwise, because of the possibility of color-blindness interfering with the problem. Blue, white, lemon and orange were finally decided upon. The sticks were given three coats of enamel. When they become soiled from use they can be washed and restored to their original color. Now, the next task was to devise a series of boxes into which to arrange the sticks. Small card-board boxes were first glued together on a flat surface. After experimenting with these, it was discovered that too much time was consumed in removing the sticks from this type of box. The concave wooden box was then found

to do away with this difficulty. The fingers fitted into the box easily and the sticks could be removed without difficulty.

The problem was then presented to sixteen children who were not used in the actual experiment. From the performance of these subjects, a basis of scoring the color-box was obtained.

The time limit arrived at for the color-box was ten minutes. This approximated the median of the sixteen scores for the color-box. A bonus of five points was allowed for each minute under ten. Because the average number of trials for the sixteen cases was approximately two and one half, a penalty of five points was assessed for trials over two. From the fact that seven subjects out of sixteen made less than thirty moves, and one made an even thirty, one half point for each move over thirty was judged to be a fair penalty.

The errors made by the sixteen subjects in the preliminary study established a basis for scoring the actual performance on the color box. Failure to arrange the sticks in correct rows occurred fourteen times. Failure to arrange them according to thickness happened six times, and according to color four times. From these results, the relative difficulty of the various steps in the solution of the problem was apparent. Ten points were deducted for failure to arrange the sticks according to rows, twenty points for failure to arrange them according to thickness, thirty points for color and forty for length.

The preliminary work that resulted in the construction of the bird-house began with an experiment in which a toy doll-house was used. The problem consisted in constructing the house out of several separate walls. This problem was given to several subjects to solve before its deficiencies for the purpose in mind was noted. One of these was that while it was difficult to put together, it did not require definite steps for its solution. It was feared that some subjects might be familar with the house as it was a popular toy sold by a well known manufacturer. Both of these obstacles were overcome by the construction of the bird-house used in the experiment proper. Its special features make it unfamilar, and definite steps are necessary for its correct construction. This problem was presented to the same sixteen subjects and the procedure described for the color-box was followed. A time limit of twenty minutes was set on the construction of the bird-house, since this approximated the median of the sixteen subjects completing this problem. A bonus of one half point for each minute under twenty was also given.

A summary of the errors shows fourteen failures to place the inside nut in position. The perch was put under the house five times and on top of the house three times. It was also put in the wrong hole once and turned over twice. The rod was reversed eight times. Eleven subjects out of sixteen had trouble with the perch, rod and inside nut. From these

results, it was decided to deduct ten points when the perch was not screwed down, twenty points if it was put under the house and thirty if it was put on top. For all other minor errors, five points were deducted, and for unforeseen major errors ten points were deducted.

In the experiment proper these two problems were presented to sixty children to solve. These sixty subjects were divided into two groups, a control and an experimental group. The individuals in the control group were then paired with those in the experimental group for age, sex and I. Q., in order to eliminate these factors as explanatory of performance.

To secure as accurate a pairing as possible, the Kuhlman-Anderson Test, Fourth Edition, Grade Six, and Grades Seven and Eight, were given. The average I. Q. for the girls in the control group was 101, and in the experimental group 100. For the boys' control group the average I. Q. was 101, and for the experimental group 102. The average mental age for the boys and girls of each group was twelve years.

In order to secure a measure of planfulness, the Porteus Test, Vineland Revision, and Kohs' Block Design Tests were administered. These last two tests were selected because they seemed best fitted to evaluate planning capacity. The scores of all three tests were then averaged. Although this average score cannot be called an intelligent quotient, it does give an average measure of the factors which we have

tried to control in the pairing of our subjects. The scores of the three tests and the resulting pairing are shown in tables one and two.

Each individual of both the control and the experimental group was given the same problems to solve. These problems were chosen because they required definite steps to be followed in their solution, and planning these steps improved the performance. A record was kept of the time by means of a stop-watch. The number of trials and the number of moves were also recorded. To facilitate the scoring, a move was recorded when one of the five sticks of any certain length, color and thickness was put in or taken out of a box. The placing of the remaining four sticks of the same length, color and thickness were not considered as moves. In each case a qualitative description was attempted from the observable performance of the subjects. Standard instructions, procedure, and scoring were followed in order to reduce the usual variables found in all experimental and test situations. Both groups received the same instructions, with one exception. The experimental group received explicit instructions to plan the tasks, which were preceded by a brief instruction on the value of planning. This procedure was not followed in the case of the control group.

The first problem consisted in arranging fifty sticks of different lengths, thickness and colors in ten boxes, in the best possible order.

Table I

Mental Ages ~ Boys					Mental Ages ~ Girls				
	Control Group		Experimental Group			Control Group		Experimental Group	
S	Years	Months	Years	Months	S	Years	Months	Years	Months
1	14	8	14	6	1	15	1	14	6
2	12	8	12	8	2	15	1	13	10
3	13	1	13	6	3	13	10	14	4
4	13	0	12	11	4	12	5	13	5
5	12	9	13	3	5	13	0	13	6
6	12	0	11	6	6	12	7	13	6
7	12	2	12	5	7	13	3	12	6
8	12	8	12	4	8	12	7	12	3
9	12	5	12	0	9	12	1	12	0
10	13	4	12	11	10	12	4	11	7
11	12	11	12	7	11	12	2	12	2
12	12	10	12	2	12	11	4	11	10
13	11	10	11	0	13	12	6	12	8
14	11	5	11	7	14	12	2	11	2
15	11	5	11	5	15	11	2	11	10

TABLE II

Boys Scores

	Control Group				Experimental Group			
S	Kuhlmann Anderson	Porteus Maze	Kohs Block Design	Average	Kuhlmann Anderson	Porteus Maze	Kohs Block Design	Average
1	128	122	126	125	126	109	131	122
2	115	95	110	106	113	111	115	113
3	115	119	152	128	119	121	123	121
4	112	123	112	115	106	108	143	119
5	107	101	109	105	111	118	110	113
6	106	105	106	105	102	93	88	94
7	104	113	136	117	110	128	150	129
8	101	100	95	98	103	109	103	105
9	98	96	92	95	99	108	105	104
10	99	97	112	102	97	106	107	103
11	98	104	95	99	101	100	97	99
12	93	107	108	102	96	100	98	98
13	82	66	71	73	85	88	70	81
14	81	106	114	100	85	79	104	89
15	76	102	81	86	78	103	72	84

Girls Scores

	Control Group				Experimental Group			
S	Kuhlmann Anderson	Porteus Maze	Kohs Block Design	Average	Kuhlmann Anderson	Porteus Maze	Kohs Block Design	Average
1	126	104	122	117	119	108	131	119
2	124	138	139	133	117	109	107	111
3	115	117	116	116	116	108	112	112
4	109	109	107	108	111	121	115	115
5	110	99	100	100	109	92	100	100
6	109	99	97	101	107	100	100	102
7	101	96	104	100	103	113	104	106
8	99	104	101	101	99	108	106	104
9	96	104	117	106	98	108	98	101
10	94	113	115	107	96	96	99	97
11	94	113	97	101	92	110	98	100
12	94	92	86	90	91	100	101	97
13	88	80	105	91	93	93	95	93
14	85	68	63	72	79	61	83	74
15	84	69	76	76	84	99	85	89

The empty boxes were placed before the subject as shown in the photograph. The fifty sticks were thoroughly mixed in the cover of the box and placed conveniently near. The following instructions were then given:-

Color-Box Instructions for Control Group.

Here is a stunt for you to do. It is just hard enough to be fun. Arrange these sticks in the boxes in the best possible order. There are different ways of doing it, but only one way is the best possible order. Arranging things in order, means putting them where they belong. If a boy comes home from school and throws his books in the coal bin, his coat under the bed and his galoshes on the table, we would not say he was orderly. But, if he set his books on the table, hung his coat on a hook, and left his galoshes out in the hall, we would call him a very orderly boy, because he had put each thing in its proper place.

This is just what you are to do here. Put each stick in its proper place.

Color-Box Instructions for Experimental Group.

Here is a stunt for you to do. It is just hard enough to be fun. Arrange these sticks in these boxes in the best possible order. Before you try it, make a plan of work for yourself. You will do it much better and quicker, if you do.

Planning helps everybody. It saves them time and labor. Your mother has to plan what she will need to buy before she goes to the store. When you are going to a picnic, you make plans about who will bring the lunch and when and where you will meet.

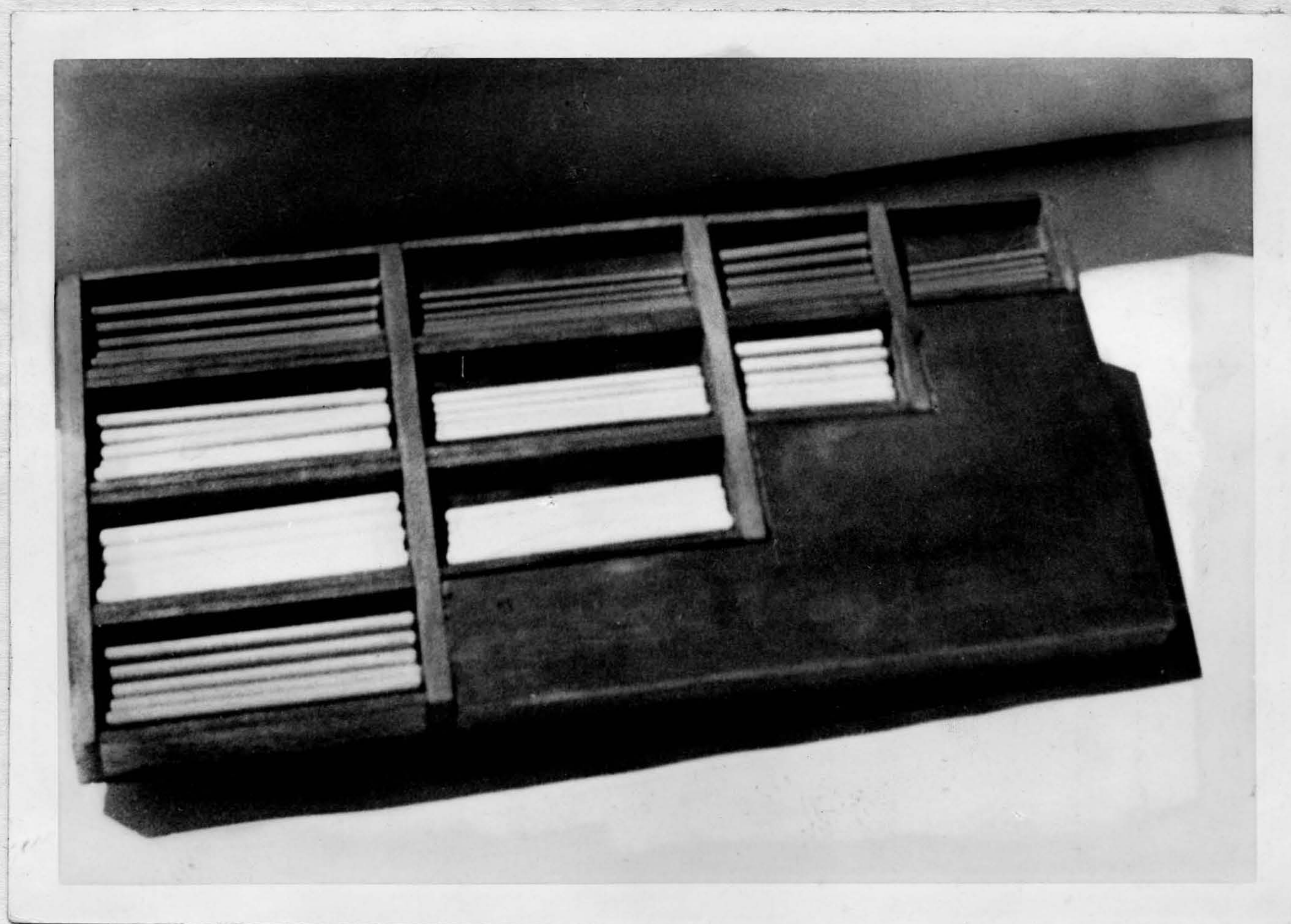
All great men make plans before they go to work. Before Columbus discovered America, he had to plan about ships and money. Washington planned his battles before he fought them. Colonel Lindbergh planned his flight across the Atlantic Ocean. He planned what route he would take, how much gas he would need, and how long the trip would take him. Now you plan how you will do this stunt and then arrange these sticks in these boxes in the best possible order.

Arranging things in order means putting them where they belong. If a boy came home from school and threw his books in the coal bin, his coat under the bed, and his galoshes on the table, we would not say he was orderly. But, if he set his books on the table, hung his coat on a hook, and left his galoshes in the hall, we would call him a very orderly boy, because he had put each thing in its proper place. That is just what you must do here. Put each stick in its proper place. Remember to plan first, then work.

After the instructions were given, one minute was allowed to elapse before the signal "go" was pronounced. This was thought advisable in order to give the experimental group time in which to follow the planning instructions. The control group, however, was also given the minute before actual work was begun, in order to keep the procedure uniform. When the subject indicated he was satisfied with the arrangement of the sticks, he was told to look them over carefully and see if they were in the best possible order. If he decided they were not, he was permitted to change the arrangement. If he agreed they were in the best possible order, the sticks were turned out of the box by the experimenter and another trial was given, providing that the sticks were not in the best possible order. The trials continued until the time limit set for the experiment was reached.

When correctly solved, the boxes in the first row on the left, and reading from top to bottom, should contain successively five long, fat sticks of blue, lemon, white and orange. The second row should contain five long, thin sticks of blue, lemon and white. The third row must have five short, fat sticks of blue and lemon, and in the last row there must

Color-Box.



be five short, thin sticks of blue.

For a perfect solution of the color-box a score of one hundred was given. Ten points were deducted for failure to arrange the sticks in the correct rows. For failure to arrange them according to thickness, twenty points were deducted from one hundred. A penalty of thirty points was given for failure to arrange the sticks according to color, and forty points were deducted for failure to arrange them according to length. The time limit set for the solution was ten minutes. A bonus of five points was allowed for each minute under ten. Thirty seconds or over were considered as a whole minute. Five points were deducted from one hundred for any number of trials over two. One point was deducted for each move over thirty.

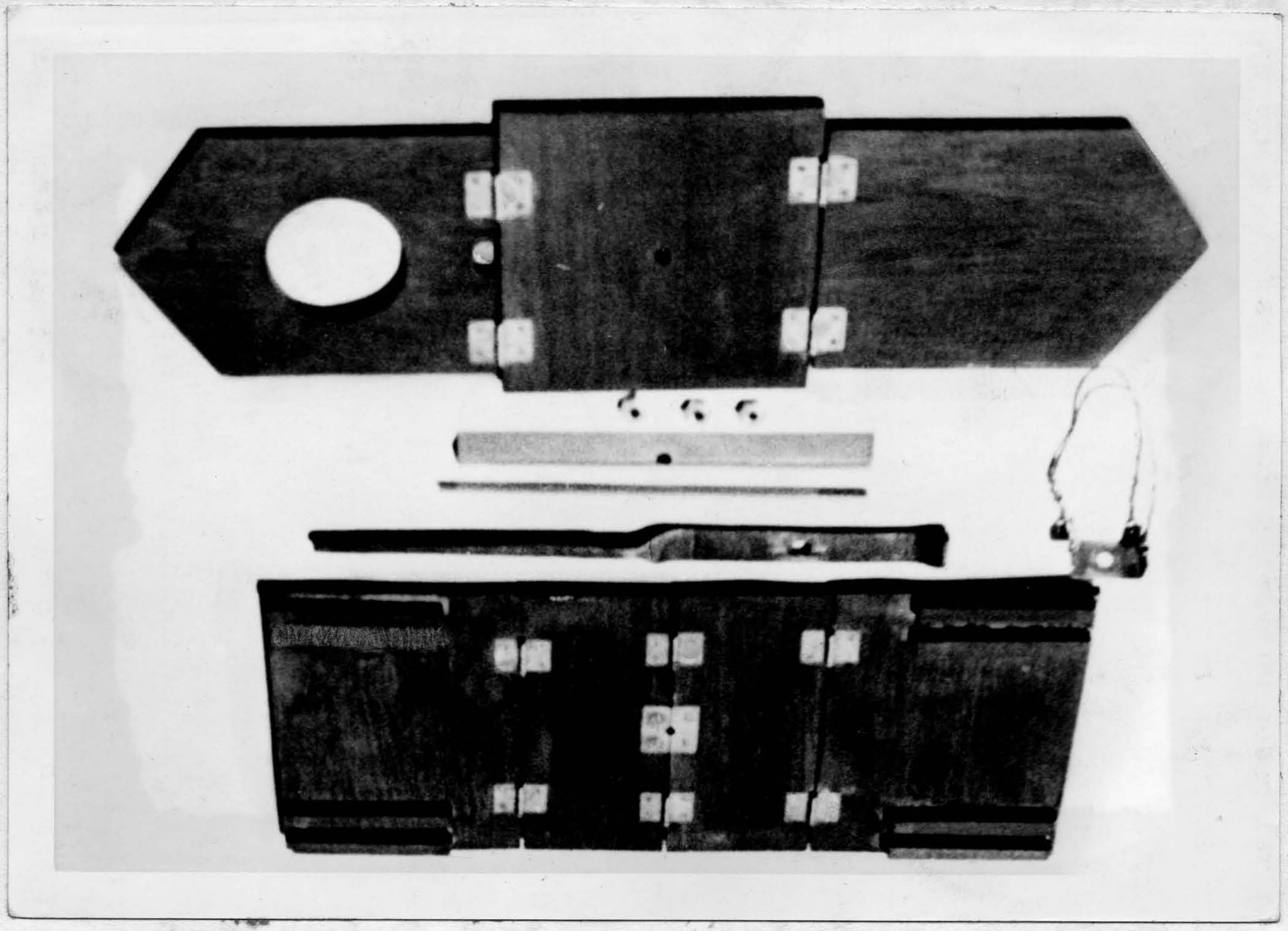
The second problem with which the subjects were presented was the construction of a bird-house. The parts of the house were placed on a table in the order shown in the photograph. The subjects' task was to follow the instructions as given below and solve the problem.

Bird-House Instructions Given Control Group.

One summer John's family went to live in his uncle's country home while his uncle was away on business. His uncle wrote him a letter asking him to put this bird-house together and hang it on a tree in the front yard. John succeeded in putting it together and hung it on the tree in the yard.

Do as John did. Put the house together so it can be hung up.

Bird-House Parts.



Bird-House Instructions Given Experimental Group.

One summer John's family went to live in his uncle's country home while his uncle was away on business. His uncle wrote him a letter asking him to put this bird-house together and hang it on the tree in the front yard.

John began to plan how he would get the bird-house together. He knew that planning ahead would save him time and trouble. When his plans were all made, he succeeded in putting the house together and hung it in the front yard.

Now, do just as John did. First, make a plan, then begin to put the house together so that it can be hung up.

The parts of the house as represented in the photograph, and reading from top to bottom, are the floor, three screws, the ridge, the rod, the perch and the roof. The piece on the right of the picture is the hook. This arrangement was part of the standardized procedure and did not vary from one subject to another.

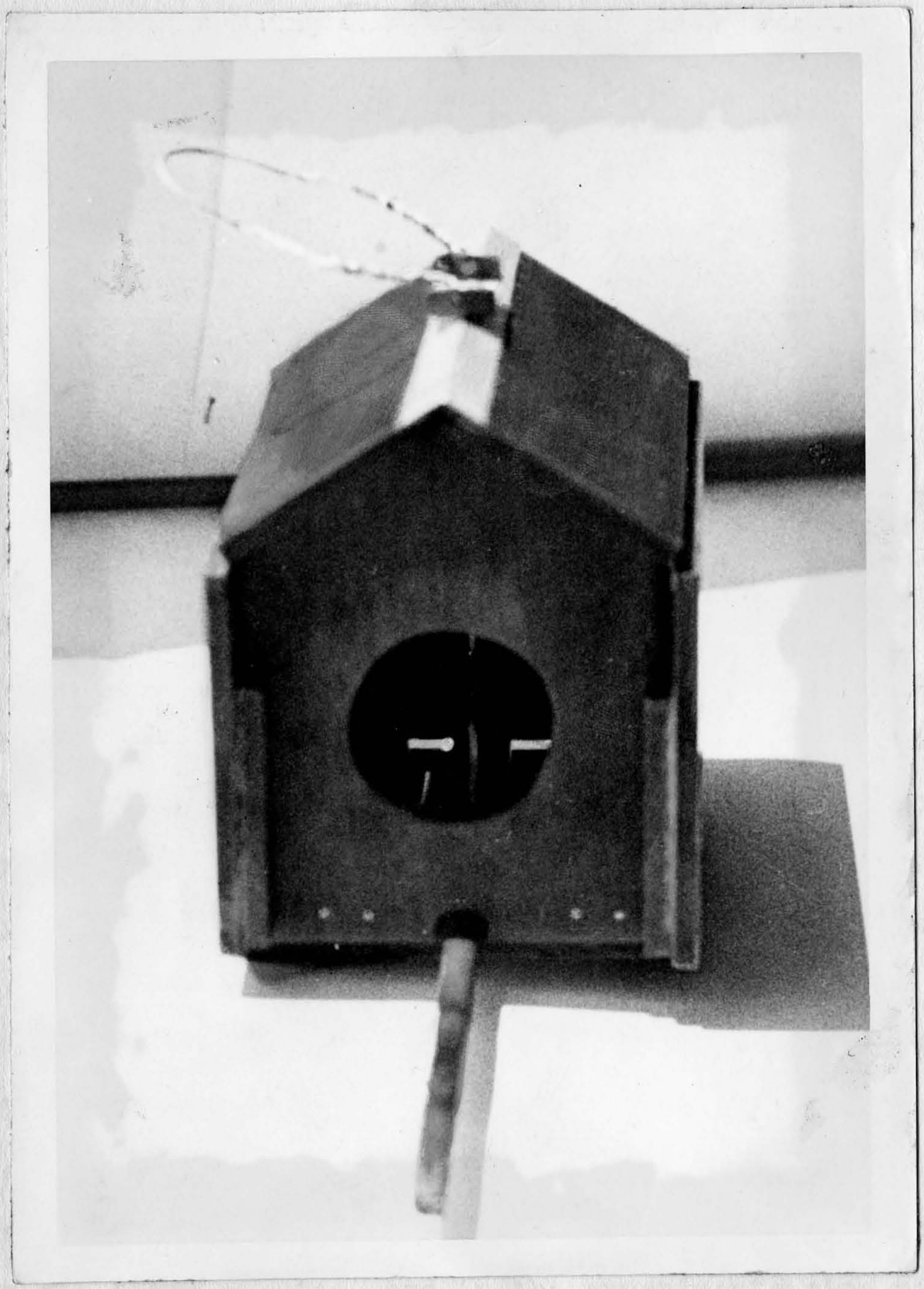
The correct solution of this problem consisted in putting the perch through the smaller of the two holes in the front of the house. This had to be done by inserting the rounded end of the perch into the hole from the inside of the house. The second step was to put the rod through the holes in the perch and the middle of the floor. Here the subject encountered two hidden difficulties. The rod was threaded on both ends to receive the nuts, but one end contained more threads than the other. In the correct position, the end threaded the most must be placed at the bottom of the house. Before putting the rod in position, however, it was necessary to screw one of the nuts on to this end of the rod

as far up as possible. This nut held the perch firm. If not screwed down, the perch would drop, due to a nail which was set in the end of it. Now a second nut must be screwed on the end of the rod under the house. The roof was put in place next, the edges of the front and back walls fitting snugly into the grooves arranged for them on the side walls. The rod would go through the hole in the roof only when the latter was in a certain position. The ridge must next be placed on the top of the house. Finally, the hook must be put on the end of the rod protruding up from the top of the house, and a nut screwed on the rod in order to hold the hook in place and make it possible to hang the house up.

For a perfect solution of the bird-house problem a score of one hundred was given. The time limit set for working the problem was twenty minutes. A time bonus of two points was given for every minute under twenty in a perfect performance. When the perch was in the correct position, but not screwed down inside, ten points were deducted from one hundred. If the rod was reversed, five points were taken off. If the perch was put under the house, the penalty was twenty points. If the perch was put on top of the house, thirty points were assessed. Five points each were taken off, if any of the remaining parts were out of place or not used. A penalty of sixty-five was imposed for not using the perch. Unforeseen major errors, such as placing the ridge under instead of on top of the roof, or putting the perch through the

large hole instead of the small one, were penalized ten points. Five points were deducted for unforeseen minor errors, such as turning the perch on the wrong side.

The Bird-House.



Chapter Three.

The Results.

(The Color-Box)

The following scores will contrast the performance of the subjects in the control group with that of the subjects in the experimental group.

The average score made on the color-box by the girls in the control group was 68. The girls in the experimental group in this same experiment made an average score of 77. The boys' average score on the color-box for the control group was 87, and for the experimental 90. The per cent of improvement shown by the entire experimental group over the entire control group was 7.74. The median score of the girls' control group was 81, while that of the experimental was 85. In the boys' control group the median score on the color-box was 90 and the median for the experimental was 115.

The average time for the successful boys in the control group was six minutes. In the experimental group the average time for the boys who succeeded was five minutes. The average time for the girls in the control group who solved the problem was eight minutes, and in the experimental nine minutes. The average number of trials for all boys and girls of both the control and the experimental groups was two. The average

TABLE III

COLOR BOX SCORES					
BOYS			GIRLS		
S	CONTROL GROUP	EXPERIMENTAL GROUP	S	CONTROL GROUP	EXPERIMENTAL GROUP
1	135	130	1	26	78
2	120	120	2	90	69
3	125	130	3	81	110
4	120	80	4	97	55
5	115	-23	5	83	85
6	130	69	6	-50	90
7	140	115	7	113	79
8	60	77	8	53	115
9	87	78	9	81	-20
10	66	-3	10	90	105
11	-46	120	11	90	86
12	90	130	12	35	25
13	44	140	13	118	95
14	46	32	14	4	92
15	28	135	15	69	76

Table VI

Trials and Moves on Color Box

Control Group								Experimental Group							
Boys				Girls				Boys				Girls			
S	I.Q.	Trials	Moves	S	I.Q.	Trials	Moves	S	I.Q.	Trials	Moves	S	I.Q.	Trials	Moves
1	128	1	26	1	126	3	79	1	126	2	25	1	119	3	37
2	115	2	35	2	124	2	29	2	113	2	22	2	117	3	46
3	115	2	30	3	115	3	34	3	119	1	25	3	116	2	26
4	112	2	24	4	109	2	38	4	106	3	35	4	111	2	65
5	107	2	29	5	110	3	47	5	111	3	88	5	109	3	22
6	106	1	18	6	109	2	100	6	102	3	46	6	107	3	40
7	104	1	12	7	101	2	32	7	110	2	29	7	103	2	41
8	101	3	35	8	99	2	67	8	103	3	38	8	99	2	29
9	98	2	48	9	96	3	34	9	99	2	42	9	98	2	100
10	99	4	44	10	94	2	26	10	97	2	73	10	96	2	29
11	98	3	111	11	94	1	27	11	101	2	23	11	92	3	44
12	93	3	40	12	94	3	80	12	96	1	13	12	91	3	90
13	82	5	61	13	88	2	32	13	85	1	15	13	93	2	45
14	81	5	59	14	85	2	66	14	85	3	63	14	79	3	38
15	76	3	37	15	84	3	46	15	78	1	14	15	84	3	39

number of moves for all the girls in the control group was foty-nine, and in the experimental the girls' average was forty-six moves. The boys averaged forty moves in the control group and thirty-six moves in the experimental.

In the boys' control group correct solutions were made by nine subjects, or 60% of the group. The individuals of this group who had high I. Q.'s tended to make high scores on the color-box. The correlation between intelligence quotients and scores made on the color-box was .81. In the boys' experimental group, eight, or 53-1/3%, made correct solutions. The correlation between intelligence and scores made on the color-box by these boys was so low as to be negligible.

In the girls' control group, four subjects, or 26-2/3%, made correct solutions. The correlation between the I. Q. of the girls in this group and their scores on the color-box was .05. In the girls' experimental group, eight, or 53-1/3%, correctly solved the color-box. The correlation here was -.08. 48-1/3% of the sixty subjects successfully solved this problem.

The correlations just recorded are not reliable because of the smallness of the groups. They do show, however, the general trend of these two groups. Correlations were also found for the entire control group and for the entire experimental group, including both sexes. The rank difference method was used in calculating these correlations. This result was converted to the product-moments scores from which

the probable error was figured.

The correlations between the I. Q. and color-box scores for the control group was .44 $\pm$ .16 and for the experimental .02 $\pm$ .08. Between the Kohs and the color-box scores the correlation was .57 $\pm$ .08 for the control and -.11 $\pm$ .10 for the experimental. For the Maze and the color-box scores the correlation was .46 $\pm$ .10 for the control and .08 $\pm$ .04 for the experimental.

During the minute allowed before actual work began, the experimenter noted any signs of planning on the part of the subjects. Nine boys in the experimental and six in the control group very evidently compared sticks and boxes. Among the girls, six in the experimental and two in the control group showed signs of comparing sticks and boxes, or otherwise planning. Of these twenty-three who gave evidence of planning the work, twelve successfully solved the problem, while eleven succeeded in partially solving it.

In every case the subject followed a plan of work. This plan was sometimes inadequate and a new one was tried or the same one repeated. The arrangement of the sticks in the correct rows was failed on most frequently. This difficulty was not even overcome by the successful subjects until they had first arranged the sticks according to length, color and thickness.

Ten of the subjects in the control group arranged the sticks according to length, color, and thickness, but not

according to rows. Three subjects started to put one of each of the four colors in each box, but they were unable to follow this plan through. One boy's plan was to arrange the colors together artistically as he had been taught to do in the art class. A girl in this group started to work on a plan of arranging the sticks in diagonal rows instead of in horizontal rows. Another subject put thicks and thins of one color in one box. Thirteen of this group followed the correct plan, but no one of them was successful immediately.

Ten in the experimental group arranged the sticks according to length, color, and thickness, but not according to rows. Another attempt was made at a diagonal arrangement of rows by a member of this group. One boy's plan was to put two of each color in each box. A second boy attempted to place a lemon-colored stick in each box with two sticks of the same color, but of different thicknesses, on either side of it. One of the girls in this group tried the plan of alternating the four colors in each box. Sixteen of this group followed the correct plan, but also were not immediately successful.

(The Bird-House)

The average score made by the girls in the control group on the bird-house was 66. The girls in the experimental group made an average of 83. The boys' average on the bird-house for the control group was 100, and for the experimental

Table IV

Bird House Scores-Girls							
Control Group				Experimental Group			
S	Score	Exploratory Moves	Constructive Moves	S	Score	Exploratory Moves	Constructive Moves
1	122	4	17	1	126	10	11
2	112	31	18	2	80	20	29
3	108	23	22	3	120	21	14
4	102	16	37	4	85	30	31
5	30	25	16	5	110	31	24
6	15	32	7	6	75	38	9
7	85	21	24	7	70	38	11
8	85	35	22	8	118	22	14
9	85	18	33	9	85	19	25
10	85	33	14	10	75	19	16
11	25	20	9	11	126	12	17
12	0	40	9	12	30	26	17
13	80	15	35	13	90	21	37
14	30	36	10	14	25	42	27
15	30	39	24	15	30	27	8

TABLE V

Bird House Scores — Boys							
Control Group				Experimental Group			
S	Score	Exploratory Moves	Constructive Moves	S	Score	Exploratory Moves	Constructive Moves
1	116	3	41	1	75	14	38
2	80	16	25	2	25	31	26
3	126	12	15	3	122	13	21
4	112	8	30	4	124	6	15
5	104	19	33	5	80	24	10
6	20	11	7	6	30	21	23
7	114	5	35	7	80	2	26
8	15	29	23	8	120	9	13
9	120	13	21	9	80	24	28
10	122	3	26	10	122	17	4
11	102	30	34	11	85	11	31
12	124	7	24	12	116	16	22
13	95	13	26	13	134	2	17
14	132	2	14	14	116	13	12
15	130	7	13	15	112	14	24

94. The per cent of improvement made by the entire experimental group over the control was 6.6.

The median score of the boy's control group was 114, and of the experimental group 80. The girls' median score in both the control and the experimental was 85. The average time of those who successfully solved the problem was eleven minutes for the boys of the control group and ten minutes for the experimental group. The girls in the control group solved the problem successfully in an average of seventeen minutes, while those of the experimental group averaged ten minutes.

Eleven boys in the control group, or 73-1/3%, solved the problem correctly. In the experimental group, eight boys, or 53-1/3%, were successful. Four girls, or 23-2/3%, in the control group, and five, or 33-1/3% in the experimental, succeeded in solving the problem correctly.

The correlation between the I. Q. of the girls in the control group and their scores on the bird-house was .69. In the experimental group the coefficient of correlation for the girls was .52. The boys of the control group and the experimental group who have high I. Q.'s tend to make low scores on the bird-house. In the case of the control group the correlation is -.35, and for the experimental -.20.

The correlation between the boys' bird-house control group and color-box control group was -.11. In the experimental group several boys who made high scores on the bird-house, also made high scores on the color-box. The correlation

was .16. The correlation was positive between the girls of both groups and their scores on the bird-house and the color-box. For the control group the correlation was .28, and for the experimental it was .26.

The correlations for the entire control and the entire experimental groups were found between the I. Q. and the bird-house scores. In the control the correlation was .10 ± .10, and in the experimental .03 ± .11. The correlation between the Kohs and bird-house scores was for the control .53 ± .08, and for the experimental .16 ± .09. The Maze was correlated with the bird-house scores and for the control group it was found to be .46 ± .09 and for the experimental .11 ± .10.

The scores made on the standard tests by the sixty subjects included in both the control and experimental groups were correlated. The correlation between the Kuhlman-Anderson and the Maze was .60 ± .06. Between the Maze and the Kohs the correlation was .73 ± .04. The Kuhlman-Anderson and the Kohs correlation was .72 ± .04.

A composite score was found from the scores made by each group on the color-box and the bird-house. These composite scores were correlated with the scores made by the same group on the standard tests. The correlation of the composite scores made in the color-box and the bird-house with the scores made on the Maze was for the control group .55 ± .08 and for the experimental .11 ± .10. For the Kohs and composite

scores the correlation was .70 ± .06 for the control and .12 ± .10 for the experimental. Between the composite score and Kuhlman-Anderson the correlation was .36 ± .11 for the control and .11 ± .10 for the experimental.

TABLE VII.

Correlation Coefficients Between Color-Box and Bird-House and Standard Tests.

	Control Group.			Experimental Group.		
	Color Box.	Bird House.	Composite	Color Box.	Bird House.	Composite
Kuhlman-Anderson	.44	.10	.36	.02	.03	.11
Porteus	.46	.46	.55	.11	.16	.11
Kohs	.57	.53	.70	.11	.11	.12

Chapter Four.

Interpretation of Results and Summary.

A survey of the correlations shows a consistent tendency toward high correlations in the control group and low correlations in the experimental group. The only variable in the two groups was the instructions to plan given to the experimental group. This, then, would seem to be the cause of the low correlation in this group.

The composite color-box and bird-house scores when correlated with the standard tests were also high for the control and low for the experimental group. This high correlation in the control group argues well for the worth of the color-box and bird-house as valid problems. It might also indicate that both these problems test to a fairly high degree the same abilities as the standard tests.

The low correlation between Kuhlman-Anderson and bird-house control group scores may be the result of the mechanical ability required for the solution of the problem. The ability may vary in individuals having the same I. Q. The color-box, on the other hand, calls for a generalization which may account for its high correlation with the Kuhlman-Anderson tests.

The results obtained then indicate that the type of

instructions used in the experiment interfered with the correct solution of the problems. The non-effectiveness of the instructions in producing the desired results may have been due to the fact that they were given only once and were too brief. It is possible that instructions to plan which could be varied and given over a longer period would be more effective.

The two problems employed proved to be excellent means of investigating the problem-solving methods of children. Their special degree of difficulty permitted the experimenter to study the various levels of behavior of which the subjects were capable.

A striving toward a definite goal dominated the performance of all the subjects. This was noticeable in the eagerness with which they began to work as soon as the signal to start was given. They seemed in haste to verify a tentative hypothesis which they had formed. After repeated failures, the subjects often resorted to a trial-and-error method. This mode of procedure frequently resulted in the attention being directed to certain important facts, the comprehension of which was necessary to the correct solution of the problem. An example of this can be drawn from a typical performance in solving the color-box. The subject would place the sticks in the boxes at random, having no guiding plan in mind. These random moves resulting in focusing the attention on the difference in the thickness of the sticks, or the similarity of the number of sticks. As soon as the terms of the relations

were recognized, their relation to one another was quickly perceived. In other words, the relation of the sticks to the boxes was apprehended.

Similar examples can be found in the solution of the bird-house. After several failures, random manipulation of the various parts directed the attention to such salient features as the difference in the threading of the ends of the rod or a means of holding the perch firmly. These discoveries led eventually to the correct construction of the house. In many cases random movements did not have the favorable results just reported. They very often resulted in a low score due to these additional moves and the time required to perform them and did not tend to insight into the problem.

The cause of failure for the experimental group seemed to be not so much that they did not perceive the relations, but that the terms of the relations were not cognized in themselves. For example, the perch was not recognized as a perch in many cases. Often it was entirely overlooked. Its relation to the house as a whole, of course, was also disregarded. In the color-box problem, the different lengths, number, and thickness of the sticks were not noted, and thus their relation to the boxes was not recognized.

In some few cases the instructions helped in the correct solutions of the problems. This seemed to happen when the ideas of "order" and "bird-house" were definitely a part of the individual's conscious processes. That is, when past

experiences had given them a fairly wide conception of the terms "order" and "bird-house", they were equipped to proceed to the formation of a hypothesis. Planning the steps in the testing of the hypothesis was evidently possible for these subjects and the planning helped in their success.

The performance of Marvin B. in the experimental group is a case in point. This boy solved the color-box but failed to solve the bird-house. He is always extremely careful about his personal appearance, and his predominating character trait is preciseness. He plays often with his sister and does not care for boys' games. His home training has provided him with a wide experience in orderliness, which might account for his success in solving the color-box.

In the same group, Harry L. and Merritt D. failed to solve the color-box, but did solve the bird-house. Their failure might be attributed to lack of experience. The experimenter has had occasion to visit the home of Harry L. and found it was very disorderly. Merritt D. is very careless about his personal appearance, and also comes from a carelessly kept home. These children have little or no training in keeping things in order and could almost be expected to fail on the color-box problem, as the concept of order has not become functional.

The only boy in the control group who correctly solved the color-box but failed to solve the bird-house was Willard B. This boy is very docile, never giving any trouble,

and is always very particular about his personal appearance. He is supervised exactly and often by his mother, who visits the school regularly to receive a report of Willard's conduct from his teachers. This constant checking tends to make him almost effeminate. Here again, training and experience seems to be a factor in the correct solution of the color-box.

Among the girls, examples of the effect of experience upon performance were also found. Dorothy N. in the control group was successful in solving the color-box but not the bird-house. She has been the kindergarten teacher's helper for two years. Her work in the kindergarten, where many small things are constantly being put in order, has perhaps helped her informing a universal idea of order, which surpassed the idea of order that the other children of her group had formed.

In the experimental group, one girl who failed to solve the color-box solved the bird-house. This girl reports that she plays with her brother and likes baseball and automobiles. She also has had a bird at home. The experimenter suggests that these factors may have made it possible for Geraldine D. to solve the bird-house problem with greater facility.

The predominating character trait that a child brings to the solving of a problem affects the result. Many children grow up without learning to try new things alone. They are timid and panic-stricken in new situations and lack self-confidence and self-assurance. Home training and school

experiences are responsible. If a child is successful in what he does, he is willing to try new tasks, but, if he fails, he hesitates to try the next step. Some children meet new situations with interest, zest, and confidence, while others meet them with fear, excitement, shrinking or worry. While every effort was made to establish good rapport, one attempt could not be expected to correct habits of years' standing. Examples of the effect of predominant character traits were noted in the course of the study.

In the experimental group, four girls, all very diffident, quiet, and retiring, succeeded in solving the color-box but failed in solving the bird-house. This problem required a persistent effort in the face of repeated failures. These subjects seemed to be overcome by the knowledge of their inability to solve the problem. This was evident from the remarks made by them as the work progressed. Such remarks as, "I cant do this," "I'd make a fine carpenter," were accompanied by repeated attempts to secure the experimenter's opinion of the work. This lack of self-confidence resulted in many aimless moves and final failure.

Renee L., the other subject who was successful in the color-box and not the bird-house, is an independent, self-assured person. She ordinarily decides quickly and often finds it necessary to revise her decisions. She worked continuously in an unhesitating manner on both problems. Her very assurance, however, caused her to be a little impetuous. Because of this

she often spent time in testing hypotheses which proved to be wrong and immediately started to test out a new hypothesis before gathering all the data. This method increased the number of moves and lengthed the time required to complete the problem, resulting in failure.

Ruth P., Julia C. and Loretta S., the three girls in the control group who failed on the color-box but solved the bird-house, had I. Q.'s respectively of 126, 124 and 115. They are the three highest of the group. These three girls failed apparently because in each case they were so sure that their idea of "good order" was the best possible one that they felt no hesitation or need for change. Each had a definite plan. Julia C. arranged the sticks diagonally. Ruth P. arranged them according to colors and rows. Loretta A. attempted to put one of each color in each box. These subjects succeeded in the bird-house because the steps in the solution of the problem are such as to indicate why a judgment is wrong, and they quickly revised their erroneous judgment.

In summary, it may be said that several factors affected the results obtained. Some of these have been noted in the control group and others in the experimental. Often the same factors affected the behavior of both groups. In some cases special factors caused the behavior of the boys to vary and did not change the girls' reaction to the same problem and vice versa. Some of these factors were self-consciousness in the case of two girls and one boy. Lack of confidence, discouragement, and loss of interest was noted

in the behavior of several girls while solving the bird-house problem. Lack of past experience was another cause of failure for the boys in the solution of the color-box problem and for the girls in the bird-house problem.

The greatest single factor affecting the results, however, was the instructions to plan. As has been stated, the correlations found are consistently high for the control group and low for the experimental. This would indicate that the instructions to plan interfered with the correct solutions of the problems. This interference of the instructions is also indicated in the average score on the bird-house made by the boys of the experimental group. This score, which is 94, is six points lower than the boys' control group scores for the bird-house. Eleven boys in the control group successfully solved the bird-house problem, while only eight were successful in the experimental group. Nine boys in the control group successfully solved the color-box problem, but only eight boys in the experimental group were successful.

Besides these scores which show that the instructions interfered with the performance, we have others which indicate that they were helpful in the solution of the problems in certain instances. The average score on the color-box and bird-house for the girls in the experimental group is larger than the average score made by the girls in the control group. The median score on the color-box made by the experimental group is higher than the median for the control. Also, twice as many girls successfully solved the color-box problem in the experi-

mental group as solved it successfully in the control. Five girls succeeded in solving the bird-house in the experimental group and four in the control. Since the instructions to plan was the only variable in the experimental group procedure, it may be said to have improved the performance in the cases stated above.

From the above summary it will be evident that our instructions to plan, while they frequently interfered with, often helped in the performance and sometimes had no effect at all upon it. In view of these results, we conclude that the influence of instructions to plan upon performance is unpredictable. The effectiveness of such instruction depends upon the degree to which they can be made to become the habitual response which a subject makes to a problem situation. A single short instruction cannot do this. Such an instruction succeeds or fails according to the intelligence, past experience and character of the subject. If the instructions are to be effective in all cases, they must be stamped in by frequent repetitions over long periods of time.

Summary.

An attempt was made in this experiment to study the measurable influence of explicit instructions to plan upon the performance of complex tasks as contrasted with the performance of the same tasks under such spontaneous tendency to plan as may be present without explicit instructions. The first problem

consisted in arranging fifty sticks of different lengths, thickness, and colors in ten boxes in the best possible order. The second problem required the subjects to construct a bird-house out of several parts.

A record was kept of the time, number of trials and number of moves. For each problem a qualitative description of the performance was attempted.

The results indicate that the instructions were in some cases helpful and in others they definitely interfered with the performance. In still other cases they had no effect at all upon the performance. It is concluded from these results that the influence of a single short instruction to plan is not predictable. Its effectiveness depends upon the degree to which it is stamped in and becomes the habitual response that a subject makes to a problem situation.

Color Box

Name ______________________ Date of Birth ______________

Address ______________________ C.A. ______________

Date ______________________ I.Q.-O. K. P. Av.

No. Trials	No. Moves		Total Moves

Time ______________ Total Trials ______________ Total Moves ______________

Bird House

Name ____________________ Date of Birth ____________________

Address ____________________ C.A. ____________________

Date ____________________ I.Q.-O. K. P. Av.

Parts	Order of Selection												
1.Floor													
2.Perch													
3.Rod													
4.Nut													
5.Roof													
6.Ridge													
7.Hook													

Time __________ Exploratory Moves __________ Constructive Moves __________

Total

Kohs' Block Test

Name ______________________ Date of Birth ______________

Address ______________________ C.A. ______________

Date ______________________ I.Q. ______________

Design	Time Min.	Time Sec.	Moves	Score Points	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

Total Points ______________

M.A. ______________

Porteus Maze Test

Name ______________________ Date of Birth ______________

Address ____________________ C.A. ______________

Date ______________________ I.Q. ______________

Test	No. of Trials	Inverted	Failed	Credits
5 yr.				
6 yr.				
7 yr.				
8 yr.				
9 yr.				
10 yr.				
11 yr.				
12 yr.				
14 yr.				
Adult I				

Test Age ______________

Test Quotient ______________

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