The learning process in young children: an experimental study in association

Julia Allie Kirkwood

State University of Iowa

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THE LEARNING PROCESS IN YOUNG CHILDREN
An Experimental Study in Association

by

Julia Allie Kirkwood

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FOREWORD

In organizing the material for this dissertation, Part I, The Literature on the Experimental Work on the Learning Process, was written andpaged as a discussion entirely separate from Part II, An Experimental Study of Association in Learning of Young Children. The reason for this is the plan to publish the report of the original investigation, Part II, without Part I. 8F
Part I

The Literature on the Experimental Work on the Learning Process

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In the life of any young organism there is no single process that occupies so large a part as the process of learning. Through knowledge and habits, which are the results of learning, the organism adjusts itself to its environment, and the organism that makes the best adjustment is the one that survives. It is learning, or the ability to learn, that is the chief differentiating factor among human beings. The differences between the idiot and the person of genius rest upon the fact that the one does not possess the potentiality for learning while the other possesses a greater-than-average amount of such potentiality. Learning may be regarded, therefore, as one of the most fundamental of all life's processes.

Importance of Learning

When the infant comes into the world, he is faced with what James terms a "buzzing confusion." The environment to the young child is a chaos of sights and
sounds and other sensory stimuli, which, through learning, he is able to understand, interpret, and, finally, control. When the individual does not possess the ability to learn, he is left entirely to the influences of his environment, and the experiences of one day can not help him to make the necessary adjustments that will enable him to meet more adequately the experiences of a later day.

There is a tendency to think of learning in terms of a definite educational situation in which the teacher-pupil relationship exists. This is, of course, a very circumscribed portion of the actual learning situations met during the life of any individual. The large number of acts, such as talking, walking, dressing, and eating, that we perform daily through habit are all the results of learning. The learning occurred at a time far enough removed from the present so that these acts seem to be such an inseparable part of us that we are unable to recall when we could not carry them on at will. Observation of the little child learning to talk, to walk, to dress himself, or to eat, shows that these are very definite and at times quite difficult learning situations.

If the motto to "learn at least one thing every day" were followed literally for a lifetime, we would have some idea of the great amount of learning
that may take place. There is no doubt that the intelligent mind learns more than one thing each day, particularly in the earlier years when the most rapid mental development is taking place. Even a very conservative estimate of the number of things learned by one person of average mental ability during a life of the average span of years would be so large that there would be no other factor in his life that would be of such importance or that had occupied so much time during his life.

**Need for a Thorough Understanding of the Learning Process**

In the educational world, there is no subject which is more widely discussed, upon which so much is written, and upon which so much time, effort, and money are spent as the improvement of the school curriculum and methods of teaching. Teaching and learning are concomitant. If teaching is to be improved, changes and improvements in methods of teaching and organization of the school curriculum must be based upon the psychological factors that underlie the process of learning. Since these psychological factors determine how learning takes place, to organize any program for teaching without adequate consideration of these factors is to attack the problem blindly. Determination on the method of presentation of any subject matter before trying out many and varied methods of presentation in order to discover which ones result in economy of learning means a loss.
in effectiveness in teaching. Since the teacher is in possession of so many facts to be presented to the child in a short time she should also be in possession of the knowledge of how these facts can best be learned by the child with the greatest economy of time. This knowledge can be gained through scientifically organized experiments of learning under controlled conditions with a sufficiently large number of subjects so that the results and conclusions may be valid when applied to educational procedure.
CHAPTER II

TYPES OF LEARNING EXPERIMENTS

The literature on the experimental work on the learning process is sufficiently extensive to show that among experimental psychologists this process has attracted widespread interest, leading to investigations of many types. Despite the varied experimentation in this field, there is such lack of agreement among various investigators that few known factors of the learning process are based upon undisputed experimental data. One of the chief reasons for this seems to be the lack of uniformity of technic among investigators, even when they are using the same type of material as a means of studying how learning takes place.

Learning, although found in many varied forms, may be roughly classified under three types. The first type may be referred to as learning that involves the acquisition of skill, or learning to do. Some of the means of studying this type of learning are tests in telegraphy, typewriting, card sorting, marble distribution, ball tossing, javelin throwing, mirror tracing, and hand movements. The latter four involve learning that is nearer the pure motor type than the first four. The second type of learning may be termed the formation of associations, or the acquisition of information.
Materials used as a means of studying learning of the second type include nonsense syllables, sensible material, substitution, and addition. The third type of learning involves the acquisition of control, or the formation of inhibitions. Maze learning is an example of one method of approach to this type of learning. In all probability, it would be difficult, if not impossible, to state that any form of learning is a clear-cut representative of any one of the three types, since mental action is so complex. This classification, however, serves as a means of grouping certain types of learning experiments which have elements in common. In the discussion that follows, the experimental work will be grouped according to this classification.

**Experiments in the Acquisition of Skill**

**Telegraphy**

One of the first carefully worked out experiments on the subject of acquisition of skill was the study of the learning of telegraphy by Bryan and Harter (56), (57), reported in 1897 and 1899. Their work was based upon information gained by questioning about 200 operators, upon reports from schools of telegraphy, and upon the records of students of the subject. Two of the subjects were tested weekly from the time that they began to practice until they had attained a fair degree of ability as operators. A third person was tested about six weeks after he had begun to
practice. He was tested weekly on his ability to receive (1) letters not making words, (2) letters making words but the words not making sentences, and (3) letters making words and the words making sentences.

Bryan and Harter conclude, as a result of the information gained from those acquainted with the work and the tests made by the experimenters, that the learning curves which represent the sending and the receiving of telegraphic messages take different forms. The sending curves rise rapidly for some time and then gradually become parallel to the base line. The usual receiving curve has a more irregular form and shows two extended flat places where there appears to be little or no progress. This was not true of the letter and word receiving curves, since each of them has the same general form as the sending curve.

Swift (120) reports an experiment in learning to telegraph, carried on with himself as subject. Four hours on four successive days were given to a preliminary study of the Morse alphabet. This was followed by the investigation, which consisted of one-half hour daily practice and a five minute test of skill for thirty-nine days, omitting Sundays. In this experiment, Swift was most interested in studying plateaus and their causes as found in the learning curve. The curve showing the result of this investigation in learning to telegraph has the same general form as has been found for other
investigations, that is, there is on the whole a steady increase in learning, but there are also periods at which there is apparently no progress, where plateaus are shown in the curve.

Thurstone (134) also carried on an experiment based upon progress in learning to telegraph. His subjects were 165 men. Thurstone states that the subjects took a receiving test in telegraphy at every meeting of their class, but he does not state the intervals between meetings. The records cover the first 100 hours of practice. Thurstone's chief object in carrying on this investigation was to answer the question, "Is the distribution of ability for a group of learners symmetrical at all stages of progress?" He found two interesting facts: First, the variability of the group, expressed at the quartile range, increases with practice. Learners separate from each other more and more in attainment as they progress. Second, the two semi-interquartile ranges at any stage of practice are comparable in magnitude. This indicates that the frequency surface of attainment is practically symmetrical throughout the range of practice covered by the observations.

Typewriting

Several investigations of learning to typewrite have been carried on. In the majority of these studies the number of subjects has been very small. Articles by Towne (136), Swift (119), and Schuyler and Swift (111)
each report a study of one case. Thorndike (75) reports a study of two cases, Bradford (53) four, Freeland (149) six, Sturt (166) twenty, Chapman (58) twenty, and Barton (142) twenty-seven.

There are several reasons why it is practically impossible to make a comparison of these various investigations and draw many conclusions that will throw light upon the learning process. In the first place, in making a study of the learning process, it seems advisable to choose a simpler problem than the acquisition of skill in typewriting, since typewriting is an exceedingly complex process that involves both mental and physical elements. The most important factor in making it impossible to compare these studies and to draw valid conclusions, however, is the absolute lack of uniform technique used in carrying on the investigations. One subject practiced one hour, another forty-five minutes, some shorter lengths of time, and for some the length of the practice period was not stated; some of the investigators carried on the experiments in the morning, some in the afternoon, and some did not report the time of day that the practice was given; in some experiments the practice periods were given daily, and in some once a week; the duration of the experiment was different in each investigation; the type of material used as copy for the test varied with each investigator and included a wide range of subject matter and a wide
range of difficulty. In experiments on only one subject the subject was also the experimenter, and reported the results. These and other factors make the conditions under which the investigations were carried on so variable that while each is an interesting contribution to the study of the learning process, as a group they possess little scientific value.

The one point held by all of the investigators is that there is no typical curve for learning to typewrite. Towne, Swift, Schuyler and Swift, Bradford, Chapman, and Barton report that practically all of the learning curves of typewriting show great irregularity. Periods of rapid learning are followed by periods of less rapid advance, a drop occurs at times, and there are periods where progress is at a standstill. Zigzag progress seems to be the natural order of the learning process. Thorndike is the only investigator who reports that the practice curve in typewriting shows rather uniform increments.

Swift (122), two years and thirty-five days after his experiment in typewriting, began an investigation to determine the length of time that would be needed to obtain a degree of skill in typewriting equal to that which he had acquired at the end of his original experiment in this type of learning. The test lasted ten days, with the omission of Saturday and Sunday. At the end of ten days, Swift had attained the same degree of proficiency that had been acquired in fifty days in the
first learning. There is a decided contrast between
the rapidity of ascent of the memory, or relearning,
curve and the original learning curve.

Card Sorting

Card sorting, as a means of studying progress
in learning, has been used by several investigators.
In Pyle's book, "The Psychology of Learning" (24) are
reported the results of two such experiments. In the
first experiment, twelve subjects sorted seventy-five
cards into fifteen boxes for a period of five days,
four sortings the first day and eight sortings on each
succeeding day; in the second, one subject sorted 150
cards into thirty boxes for several months. In the lat-
ter case, Pyle does not state whether one or more trials
were made each day, as in the previous experiment,
whether the trials were on successive days or whether
there were longer intervals between trials, or the exact
length of the duration of the experiment. In regard to
the experiment carried on by twelve subjects, Pyle
simply states that "with each practice, the time re-
quired for sorting the cards became less and less," and
gives two curves that show a steady increase in efficiency.
One curve shows the number of cards sorted per minute and
the other curve shows the number of seconds required to
sort the seventy-five cards. In regard to the experiment
carried on by one subject, the only result Pyle gives is
the statement that "improvement continued for several
In Pyle's most recent book (23), a whole chapter is devoted to the card sorting experiment and an accurate report is given of the results of this experiment with 1,597 girls and 1,326 boys from eight to eighteen years of age. Pyle gives tables and charts to show the age and sex averages and sex differences and separate growth curves for card sorting for boys and girls. When the experiment was repeated with 183 girls and 200 boys who had sorted the cards one year earlier, their improvement was from 11 to 15 per cent greater than their improvement on sorting cards for the first time. Results show that efficiency in distributing cards improved more than motor speed alone.

In order to study a special phase of the learning process by means of card sorting, Pyle (107) had eight college women sort 150 cards into thirty boxes for one hour daily. The aim of the investigation was to observe transfer and interference of training as factors in learning. The boxes into which the cards were to be placed were numbered according to two schemes that used the same figures in different sequences. The subjects were divided into two groups. The first group alternated from the first scheme to the second scheme from day to day for thirty days. The second group used the first scheme for fifteen days, followed by the second scheme for fifteen days. Pyle's conclusion is that it is not economical to try to learn two mutually inhibitory sets of habits simultaneously. The better procedure is to form one and then the other.
Myers (157) investigated, by means of the card sorting experiment, correlations in learning between the initial and subsequent performance and whether practice tends to bring individuals more closely together or to separate them. His subjects were twenty-seven school children. Myers concludes that in card sorting, individuals tend to maintain the same relative position during the learning. The first five trials may, therefore, be considered representative of the subject's learning processes.

Baldwin and Stecher (168) report the results of a study of the learning process in preschool children. This is the first reference on experimental work in the learning of young children that was found in the literature. The subjects were fifty-six children from two to six years of age and the material used was card sorting. Twenty trials were given. There was a steady increase in score with increase in age, and a high degree of correspondence was found between the child's rank on the first and on the twentieth trial. The correlation was +.71205. Children with a good score at the beginning did not make any more improvement than children who started with a low score. The authors offer as an explanation the fact that the child who places many cards during the time given him is probably working near his physiological limit, which can not be increased until he is older and has gained speed in movement and in general motor control.
Marble Distribution

The marble distribution experiment used by Pyle (23) is somewhat similar to the card sorting experiment, but is more complicated. The material consists of a marble-receiving box, a marble-containing box, ninety colored marbles, and a color key. The color of a marble is associated with an animal, and the animal is associated with a position on the sorting box. Pyle has used this material with 750 girls and 727 boys from the ages of six to fourteen. Between these ages both boys and girls more than double their efficiency at sorting colored marbles and associating colors with pictures of animals. At every age in this experiment girls are better learners than boys, but boys improve more from six to seven and from seven to eight than girls. After age eight, the yearly improvement of girls is slightly greater than that of boys.

The marble distribution test could be given to children under six, but Pyle has no subjects younger than six years of age. Since in this test it is not necessary for the subject to know the names of colors, this experiment could be carried on with preschool children. According to the published reports on experiments in the field of learning, Pyle is the only investigator who has used the marble distribution test, although it seems to be valuable as an approach to the study of the learning process. The material used is of such simple construction that the work could be repeated easily with subjects
of the same age range used by Iyle, and younger.

**Ball Tossing**

Swift (124), (121), (123), carried on experiments on learning and relearning ball tossing, and Peterson (100) and Batson (50) repeated Swift’s problem of learning to keep “two balls going with one hand catching and throwing one while the other is in the air.”

In his first experiment on ball tossing, Swift (124) had six subjects, five college students, and one professor. The daily test consisted of ten trials; the subject continued the throwing until he failed to catch one or both of the balls; the number of catches made in each trial was recorded. No practice was allowed between tests. Swift was interested in finding out if there is a typical curve of the acquisition of skill, and, if so, in determining its general form. The curves were plotted so as to show on the vertical the number of balls caught and on the horizontal, the successive days. The curve for learning a feat of muscular skill, in so far as a study of ball tossing may be regarded as typical, is concave toward the vertical axis. This means that progress was first slow and then more rapid. Probably all the curves would turn to the right and show a stage of slow progress as the physiological limit of skill is reached, but apparently none of the subjects approached that limit. Progress was not steady, but always by jumps and with many intervening periods of delay.
The general physical condition of the subject not only greatly influenced the increase in score in ball tossing, but also skill in the performance.

After an interval of twenty-one months, Swift (121) tested the ability of two of the subjects to perform the ball tossing experiment. As in the original investigation, ten trials were given. The scores on the memory tests were in no case inferior, and in all but two instances were superior to the scores made at the close of the original practice. If the score on the first of the memory tests is regarded as representing the approximate skill of the subjects after the lapse of time, succeeding scores will show the rapidity with which the task was relearned. In the ten trials, the subjects gained a facility in handling the balls that they had not excelled - if reached - at any period of the original practice, and this facility, together with scores that they made, shows that they had acquired a skill that exceeded that acquired by the end of the original process. The nervous system had forgotten little or nothing, and the loss of skill indicated by the strangeness of the movements during the first few trials was chiefly muscular.

Six years and seventeen days after the conclusion of the series of experiments by which the skill was first acquired, Swift (123) repeated the experiment. Presumably, the subject was himself. The subject had
had almost no practice since the original learning. The memory test at the end of twenty-one months had showed no loss of skill. The memory test at the end of six years showed that much of the acquired skill had been lost, but the process of relearning was rapid. At the end of ten trials of this latter memory test, the subject had more skill than at the end of the practice of the original investigation.

Peterson (100) repeated Swift's experiment in ball tossing with twenty-eight college students. He changed the technic of the experiment somewhat, as in his work there were two periods of practice, one in the morning and one in the afternoon, each period consisting of 200 catches. Peterson concluded that learning curves of ball tossing are not different from learning curves of other processes. The error curve of ball tossing has a rapid initial decline, as have error curves of various other types of learning. The curve of the average number of catches per trial rises gradually at first and more rapidly later, thus giving it the concave aspect also found by Swift.

**Javelin Throwing**

Murphy (155) studied learning by means of periods of practice of javelin throwing. The aim of his investigation was to test the relative merits of practice on successive and on alternate days in the muscular activity of javelin throwing. Later he compared a group of subjects who practiced twice a day with a group who
practiced once a day. The subjects were girls from a normal training school. Results show that learning periods can be distributed without any loss in learning by giving alternate days' practices and even weekly practices. Better work, for the amount of time expended, can be done through a distribution of three times a week than through a distribution of five times a week. The learning curves for javelin throwing did not follow the normal curve of learning to a marked degree.

**Mirror Tracing**

Dearborn (62), Starch (114), and Snoddy (113) studied the learning process by means of mirror tracing. Hill (73), (74) made studies of learning and relearning mirror tracing. Dearborn (62) reports the method used in the mirror tracing experiment, but gives no results. Snoddy (113) had twenty-one graduate students as subjects and Starch (114) had ten college students. The experiment consisted of tracing the outline of a six pointed star as seen in a mirror. One half of the outline of the star was traced with the left hand, ten complete outlines were traced with the right hand, and then the second half of the outline was traced with the left hand. Two curves, one representing the time and the other the number of errors, follow the usual course of learning since they show very rapid improvement at first, followed by slower progress later. Starch states that improvement in time and errors, aside from the first seven or eight records, is not parallel. The effect of
practice with the right hand upon the left hand is considerable. In comparing the record of the tracing of the first half of the outline of the star with the left hand, before the ten trials of tracing the complete outline with the right hand, with the record of the tracing of the second half with the left hand, an average improvement of 49 per cent was found.

Hill (73) reports an experiment in mirror tracing in which the subjects were five members of a class in college who practiced fifteen minutes daily for two weeks, and eight persons outside of the class, one of whom made drawings for forty-eight consecutive days. Hill criticizes using one-half of the star and later the other half, as Starch did, because of the fact that there is a difference between movement up and movement down. He believes that it is preferable to use the same half of different copies of the same figure. The curves of improvement in time and errors are typical curves as compared with Starch's curves for mirror drawing, that is, they show most rapid improvement during the first trials. The time and errors curves showed correlation.

Another mirror tracing experiment reported by Hill (74) tells of one subject who practiced once a day for fifty days. Three years later, Hill had the subject repeat the experiment in order to compare these results with Swift's results on relearning a skillful act, ball tossing. In addition to tracing the six pointed star,
the subject traced a figure composed of eight semi-circles. A comparison of the progress curves, both for speed and accuracy, indicates that in three or four daily trials three years later the subject had attained her standard for the first learning. At the beginning of the relearning experiment, the subject's status was not far below that of the earlier experiment; the speed was slightly less and the accuracy slightly more. This experiment of mirror drawing shows that little of the previously acquired skill had been lost during the three years' disuse.

Hand Movements

Leuba and Hyde (84) carried on experiments in learning to make hand movements. The subjects were forty-two college students. The experiment consisted of two parts: first, the students transcribed English prose into German script, and second, they transcribed English script into English prose that they had before them in German script. Only German script and not the German language is involved in the experiment. The subjects were asked to do as much work as possible and at the same time to try to write with constant distinctness. Every period of work consisted of four periods of five minutes each. The individual learning curves show the same irregularities that had been observed by Swift and other investigators. The rise of the
curves, very rapid at first, soon decreased considerably; the curves dropped frequently, but no plateaus appeared within the limits of the curves. The curves tended to flatten out.

Experiments in the Formation of Associations or in the Acquisition of Information

The second type of learning experiments are those that involve the formation of associations or the acquisition of information. These experiments deal with what is generally regarded as the more intellectual form of learning. A larger number of learning tests that involve the acquisition of motor skill has been used than learning tests that involve a purely intellectual function.

Nonsense Syllables

Ebbinghaus' nonsense syllables, which have been used as a test in memory, have been used also as a test in learning. Any discussion on the subject of learning must necessarily include, to some extent, reference to the subject of memory, since the latter is a very important factor in learning.

Pechstein (93) carried on an experiment in verbatim learning in which he used the various whole and part methods in order to study the effects of the different methods on the learning of nonsense syllables. Two series of nonsense syllables were used. Series A consisted of thirty-two syllables in consecutive arrangement, Series B of the same syllables in pairs.
There were two whole methods, in which the subject could retrace the material until fairly sure of his grasp, and a third whole method in which such "returns" were prevented. The part learning was done by four part methods: the "pure part" method, in which the parts are first learned as units and then connected; the "progressive part" method, in which every additional unit as it is learned is connected with the material already learned; and two "repetitive" methods in which the learned units are repeated as an introduction to the learning of the next. Results given in terms of time, trials, and errors showed that all the part methods were superior to the whole method for Series A. The wasteful "repetitive" methods were inferior to the whole method for Series B in regard to trials and times, but not in regard to errors. For both series the "progressive part" method is the most efficient in all three respects, trials, errors, and time. Fechstein tried out these same methods of learning in studying the maze problem and concluded that motor learning and learning verbatim obey, in general, the same laws of learning since in both cases the part methods are more efficient than the whole and the same part method is the best in each field.

Smith and McDougall (112) had one group of subjects learn nonsense syllables passively by repetition, and another group as quickly as possible with
full mental activity. The object of the experiment was to study "the influence of conation on the learning process." Conation brings with it a number of other factors, the noting of a syllable's position, or the affective reaction to it. The number of repetitions needed for complete learning was greater with the mechanical method and increased with the subject's practice in passivity. The effects of this method, moreover, measured by relearning and recall, wore off more quickly.

Robinson and Heron (110) studied the effect of variations in length of material on learning of nonsense syllables. Increasing the length of the material resulted in a negative acceleration in the learning curves.

Sensible Material

Experiments show that the learning of meaningful or sensible material is wholly different from the learning of meaningless or nonsense material. The learning of meaningful material is simply a rearrangement of what is known, whereas, the learning of meaningless material is the learning of something that is entirely new. When a series of nonsense syllables is learned, the syllables are connected in the mind by associations depending almost entirely on their contiguity in space or time. In the learning of sensible material, the associations formed depend almost entirely on association with various facts, many of which form no essential part of the material but have been present in consciousness before. The learner builds up in his own
mind a number of series of associations concurrently, and when a new fact is presented to him he places it in what seems to him its correct position in some series already in his mind. Progress on learning meaningful material is more rapid than on meaningless material, and a greater amount of it is retained for a longer period of time.

Dell (64) used the learning of sensible material as a method of investigating whether or not the position of facts in a series has any influence on their likelihood of being remembered, as in the case of nonsense syllables. These experiments were carried on in England. The subjects were given (1) a one and one-half hour lecture entitled "50 Years of Punch", illustrated with lantern slides, (2) a lesson on buds, (3) two courses, one in chemistry and one in nature study extending over three months. In all cases, Dell found that position in the series has a negligibly small influence upon remembering in comparison with the effect due to other causes.

Laird, Remmers, and Peterson (82) studied organization and classification of material as an aid to learning and found that it is more beneficial for meaningful material than for meaningless material.

Thorndike and Upton (132) carried on an experiment for the purpose of observing the process of learning an abstract subject by adult learners when the task is for them of somewhat the same novelty and difficulty as learning algebra or physics is for the
high school pupils who are beginning the study of these subjects. The investigators were interested, also, in finding out how profitable it seems to be for teachers to study themselves as learners of abstract material. The subjects were twenty college graduates, teachers of mathematics. The task was to acquire an understanding of certain elementary laws of electricity and magnetism. The subjects studied the text for six hours and kept notes and solved problems for four hours. The subjects chose any time during one week to do the ten hours of work. They were asked to write down facts concerning the learning process, such as difficulties and means of overcoming them. Not much information was gained from these notes, since unless a person is particularly interested in educational psychology he does not watch his learning process because he is absorbed in the content, and most persons have a tendency to avoid the trouble of making complete notes on observed processes.

At the end of one week, certain questions were asked of all students and a twelve minute test was given. The scores ranged from 12.5 to 0 correct out of 15, with the median of 5. The errors seemed to show as much inadequacy, confusion, and carelessness as one finds in the work of a high school class. The answers indicate a lack of criticalness, as shown by the large number of wrong answers, as compared with the number of omissions and statements of inability to answer. General mental
carlessness was evidenced by the answers. These adults of college training jumped at conclusions instead of mastering each step, became confused, and made computations and statements without realizing what they were doing or why they did it. The chief result of this experiment seems to show that highly trained adults are much more like untrained children in method and procedure in learning than has been supposed. Thinking seems to be not all-pervasive and constitutional, but is, in part, a consequence of specialized habits. The authors believe that the value of this experiment lies in the facts that the results should increase the subjects' appreciation of the pupils' difficulties and sympathy with their efforts and that they add something to our experimental knowledge of the learning process.

Rational Learning

Peterson (101), (103) reports an experiment in rational learning, the material of which he believes will be of value as an intelligence test. The subjects were eighty-one college students. The letters A to J inclusive were numbered in random order from one to ten. The experimenter called out the letters in order and the subject guessed a number for each letter until he guessed the correct one, when the experimenter called out, "Right." This continued until the subject named each number right on the first guess twice through the series in succession from A to J. Results were scored
on the number of errors made, that is, wrong guesses, every number called out being counted a guess, and the number of repetitions from A to J required. Results show a high correlation with intelligence rating, as judged by standing in examinations in general psychology in which the subjects were students. The error curves are similar to those of curves representing other forms of learning, but only the better records show the significant drops that characterize the curve of maze learning.

Substitution

Pyle (24) states that "the type of learning test most extensively used is the substitution test, which is one of the simplest of tests and has a wide range of possibilities in the materials that can be used and the variations that can be made in them." The substitution test is a test of quickness of learning. It determines the speed with which a person can build up new associations. It is in part a memory test, but in addition, by repeating the same impressions over and over, the rapidity with which the subject can build up habitual connections can be determined.

Pintner and Paterson (160) investigated the learning ability of the deaf child by means of the digit-symbol and symbol-digit substitution tests. The experiments were carried on in state schools for the education of the deaf in Indiana, Ohio, and Pennsylvania.
Instructions were given by means of blackboard demonstrations and by having nearly every one of the children work one at a time at the board before beginning the test. Nine hundred ninety-two children, divided almost equally between the sexes, were given the digit-symbol test and 1,049 the symbol-digit. The age range was from eight to twenty-six years; all subjects more than eighteen years were grouped as adults. The results were compared with Pyle's norms for hearing children as given in his "Examination of School Children" (22). This comparison shows that the deaf child is about three years behind the hearing child in learning ability, as tested by the rapidity and accuracy of forming associations between numbers and forms; the deaf boy is equal in learning ability to the deaf girl, differing in this respect from the hearing boy who falls below the hearing girl; the deaf boy approximates the hearing boy more closely than the deaf girl approximates the hearing girl in learning ability; and the congenitally deaf and the adventitiously deaf are equal in learning ability.

A comparison between two methods of learning the same material was made by Gray (68). The material used was his own form of the substitution test. The work with this test covered a period of four years, and about 400 university students took the test as a required laboratory exercise. The test was given by two methods. In the first, the printed sheet with the code
at the top of the page was before the subject during the entire experiment so that he could refer to the code whenever necessary. In the second method, the subject had a printed sheet without the code. The code was explained to the subjects, the alphabet was placed on the blackboard, and the system according to which the number combinations were made up was explained thoroughly. The subjects were given four minutes to study the plan of the code. They were told not to attempt to memorize individual letters, but to study the plan underlying the code. Each group of subjects spent twenty minutes each day for twelve days on this test and a record was kept of each five minute period. The object of the experiment was to compare the two methods of learning; the first method that requires the learning of the letters as separate and distinct entities, and the second method that requires that the different letters be learned as parts of an intricate system that brings into relation all the letters of the alphabet.

Learning curves based upon the second method do not show improvement as early as do curves based upon the first method. The postponement of the improvement is evidently due to the fact that up to this point the time is consumed in mastering the organization of the code and memorizing it. The second method
requires a preliminary period of considerable length for adjustment before the progress of the learning shows in an objective way. Some of the subjects became discouraged during this preliminary period. In the first method, no such preliminary period is necessary, or if it is present, it is much shorter in duration. Retention tests later show that the period of discouragement and the extra effort required by the second method are compensated for by the greater amount of learning that is retained. The distinct advantage of the second over the first method is due, probably, to the fact that the extra effort required brings the learning to a higher level than the first method. The first method may be regarded as a mechanical method and the second a rational method.

Baldwin (142), in testing the learning of delinquent adolescent girls, used Gray's substitution test with slight modification. The subjects were thirty-seven white girls and thirty negro girls between the ages of thirteen and twenty-one in a Pennsylvania reformatory school. The test was given for sixteen consecutive days with the exception of one Saturday and two Sundays, making in all sixteen practice periods of five minutes each. Results show that no individual progresses uniformly, but each gains by irregular increments, with an occasional actual loss.
Munn (154) reports the results of an investigation in which a letter-letter substitution test was used. Of the 180 subjects, the majority were normal school women students and the rest were children of the third, seventh, and eighth grades. The subjects had the key sheet before them during the test. Each subject went through twenty tests, each test consisting of ten rows of letters in mixed order. Munn's conclusions are the same, in general, as those of other investigators in the field of learning. The greater gains in the process of learning are made at the beginning of the experiment. Periods of morning work are more effective than afternoon periods. Short and frequent periods of practice are more valuable than long extended periods. Munn also states that at first children work much slower than adults, but the gains made by children are greater, while the gains of adults are more even and uniform.

**Code Translating**

The code translating test may be regarded as another form of substitution test. Dearborn and Brewer (63) report the results of an experiment on a class of thirty-five students in educational psychology in translating long passages of connected prose into the Civil War Code used in the Goddard and Terman revisions of the Binet-Simon test. The subjects had to construct the code mentally, after the preliminary
explanation, and were given five minute practice periods twice a day for two weeks. Before and after the practice periods, the subjects were given a group of five tests intended to be sufficiently similar to the practice exercise, so as to be reinforced or interfered with by the improvement made in it. The tests selected were the digit-symbol substitution test, a complex dotting test, a number code, a test in digit-letter substitution, and a letter code. There is a small positive correlation between the first tests and the final tests of students in the practice series, that is, students tend to hold the same relative rank in the first trials as in the last trials of practice. There is, also, a small positive correlation between gain in the practice exercise and gain in the tests, with the exception of the last test in the letter code translation, where a small negative correlation indicates interference between the facility gained in translating English passages into the code and the reverse process of translating the code into English.

Addition and Multiplication

Thorndike (127), (129) reports learning tests in multiplication and a series of learning tests in addition (126), (128), (129), (131). Donavan and Thorndike (147) report another learning study based on adding columns of figures; Wells (140), and Dashiell (61) also used addition as a means of studying the
learning process. Starch and Ash (115) made a study of a special type of mental computation. The subject was given a number consisting of two digits and was instructed to add mentally six to this number, then seven to the sum, then eight, and nine in order to the respective sums, then repeat the series of additions, giving the results orally. At the end of each thirty second interval the experimenter announced a new starting number. Twenty-three subjects took part in the experiment. The length of periods of practice varied from thirty minutes to two and one-half hours. A record was kept of amount and accuracy of the work accomplished. The results show that maximum speed is attained by the end of the first twenty-five or thirty minutes, and that during this period improvement is gradual. The maximum speed is maintained during thirty or thirty-five minutes and from then on the number of additions per unit of time begins to decrease gradually and continues to do so until the end of the period. There were fewer errors at the close of the period of work than at the beginning. The slow workers make relatively more errors than rapid workers. The most striking fact shown by these experiments is that mental work, even of a difficult nature and when continued without interruption for as long as two and one-half hours, seems to produce a much smaller lowering in speed and accuracy than is commonly supposed.
Strong (165) used addition as a learning test with a group of children and found that the shape of the learning curves of school children, based upon simple arithmetical combinations, apparently correlates to a very considerable extent with the general intelligence of the children.

**Experiments in the Acquisition of Control**

The third type of learning experiments, the acquisition of control, or the formation of inhibitions, are represented by the maze and puzzle box tests. The maze test could perhaps be included almost as well under the first type of learning, since it also is a motor test, yet certain elements in the maze test distinguish it from the more purely motor tests, such as ball tossing or javelin throwing.

**Maze**

The maze test has been used very extensively. Some of the investigators who have used this test in studying learning in animals are Thorndike (46), Peterson (44), (45), Hunter (38), Kuo (40), Cole (32), Carr and Koch (30); Gould and Perrin (67), Ludgate (42), and Perrin (97) made studies of human learning of the maze problem; and Koch (39), Leichstein (43), (93), (94), Hicks and Carr (72), and Dashiell (61), (32) made comparative studies of animal and human learning of a maze problem. The maze problem has been used so extensively in investigating learning since it is better than any
other test for comparing the learning behavior of man and lower animals when learning conditions are made identical. It is possible by this means to discover by experimental procedure certain principles of animal psychology that may be found applicable in some degree to human psychology and education, since these fields are more complex and more difficult of experimental as well as of theoretical analysis. The maze problem is simple enough so that it may be learned easily; at the same time it requires a large number of trials and the expenditure of a large amount of energy in order to set up the associations and inhibitions needed. The errors are easily noted and recorded, which fact aids in the interpretation of the results.

**Puzzle Box**

The puzzle box test is of a nature somewhat similar to the maze test as a means of studying progress in learning and has been used by several investigators, particularly by Thorndike (46), in the study of animal learning.

**Summary**

The experimental investigations on the three types of learning experiments, the acquisition of skill, formation of associations, and acquisition of control, that have been discussed in this chapter represent almost every type of experiment that has been used as a means of studying the psychology of the learning process.
The range of material used is large and the range of subjects includes animals, preschool children, school children, and adults. Since in most of the investigations the number of subjects has been small and the methods used by the various experiments are not uniform, the great needs in the study of the learning process are to select the tests that seem to yield the best data on how learning takes place, standardize the procedure for administering, scoring, and recording results, carry out these tests in several investigations on groups of subjects sufficiently large so that the results may give valuable data on the learning process, and compare the results obtained by the various investigators.
CHAPTER III
IMPORTANT FACTORS INVOLVED IN THE STUDY OF THE LEARNING PROCESS

In analyzing the results obtained from experimental work in the study of the learning process, many investigators have discussed the influence of certain factors that operate either in individual cases or in the majority of cases, and influence the results. Some of the most important of these factors may be classified as general, since they apply to all forms of learning; others are of a more specific nature. Those discussed herein under general factors are attention, attitude, knowledge of end sought, knowledge of own record, knowledge of own errors, repetition, readiness, the physiological limit of the individual, and the use of associative aids to learning; those discussed under specific factors are transfer of training, methods of learning, learning curves, variability in capacity for learning, and relearning.

**General Factors**

**Attention**

Probably the most important of the several general factors that have a decided influence upon learning is attention. The processes that are to be united through learning must be in the focus of
attention and must, for the time being, monopolize the cerebral activity. Other factors being equal, the individual who practices with the most concentration of attention will be the most rapid learner.

**Attitude**

Another important general factor in learning is the attitude of the subject. The relationship between attitude and learning is due, perhaps, to the effect produced by attitude upon attention. A bad attitude retards learning just as a favorable attitude increases learning.

**Knowledge of End Sought**

It has been shown that a knowledge of the end sought is also a factor in learning. As a rule, the learner makes more progress if he knows exactly what is to be gained by the learning and exactly what the learning is.

**Knowledge of Own Record**

Several investigators have found that a knowledge of the subject's own record is an important factor in the progress of learning, since much greater improvement was made by the subjects who knew their results as compared with those who did not. An accurate record of progress acts as an incentive to the learner to practice at the highest efficiency.
Knowledge of Own Errors

Learning is aided by not only a knowledge of the record, but also by definite knowledge of errors. Unless the subject knows exactly what errors he is making he may continue to repeat the same errors for a number of successive practices and thus increase the difficulty of eliminating these errors.

Repetition

Repetition, or drill, is one of the factors that conditions learning, but it should not be given the important place in learning that has been accorded to it. Repetition is inadequate as an explanation for much of what is learned, as well as for failing to produce successful learning.

Readiness

Thorndike (27) stresses the importance of the factor of readiness in learning, that is, the organism must be "set" for the particular neural response that is necessary at the time of the learning.

Physiological Limit

Progress in learning along certain lines is definitely determined by the physiological limit of the individual. This depends upon his reaction time. As the physiological limit is approached, improvement requires a much greater effort than at the beginning of the learning.
**Associative Aids**

Reed (108) has made a study of the value of associative aids in learning. A classification of the associations shows that with familiar stimuli they usually have a meaning basis, while with less familiar material, they are likely to be sensory. The former type of associations are the more effective aids to learning.

**Specific Factors**

**Transfer of Training**

One of the much discussed questions in connection with the learning process is the problem of transfer of training. That is, what is the effect or influence of improvement in one mental function upon the efficiency of allied mental functions? Thorndike was one of the early experimenters in this field. He tested the efficiency of some function or functions, then gave training in some other function or functions until a certain amount of improvement was reached, and then tested the first function or set of functions. Provided no other factors were allowed to affect the tests, the difference between the test before and the test after training measures the influence of the improvement in the trained functions on the functions tested.

On the basis of the results of a careful investigation on the influence of improvement in one
mental function upon the efficiency of other functions, as follows:

Thorndike and Woodworth (133) conclude:

1. Improvement in any single mental function need not improve the ability in functions commonly called by the same name. It may injure it.

2. Improvement in any single mental function rarely brings about equal improvements in any other function, no matter how similar, for the working of every mental function group is conditioned by the nature of the data in each particular case.

3. Spread of practice occurs only where identical elements are concerned in the influencing and influenced function. Later, from the results of an experiment on the estimation of magnitudes that consists in judging the areas of triangles, circles, trapezoids, and various shapes, Thorndike (133) concludes: "For functions so similar and for cases so favorable for getting better standards and better habits of judging, the amount of improvement gotten by training in an allied function is small. Studies of the influence of the training of similar functions in school and in the ordinary course of life, so far as we have made such, show a similar failure to bring large increases of efficiency in allied functions."

In order to explain cases in which there is apparently some degree of transfer of training, various explanations have been suggested.
Thorndike (133) states that in cases in which there is some improvement, it is not due to any "mysterious transfer of practice, to an unanalyzable property of mental functions," but to a functioning of identical elements in the practice series and in the final test series. This improvement on the whole is small and is limited to activities that closely resemble one another. Thorndike holds that in "transfer" identical elements are always involved in the influencing and influenced function.

Bagley (1) advocates the theory of ideals as an explanation of "transfer." He believes that in order to have a carrying over from one function to another the thing to be transferred must be made a conscious ideal in the mind of the subject.

Other theories emphasize the fact that the subject must formulate certain generalizations in order to effect a transfer of training or explain the transfer on the theory of attention.

Methods of Learning

The various methods that have been used in studying the learning process are the (1) trial and error, (2) whole and part, (3) complete and alternate, and (4) massed and distributed practice periods.

Trial and Error. - The trial and error method may be regarded as the earliest and simplest method of learning and is undoubtedly the most fundamental method
by which the child acquires motor control. It is the only method in habit forming when the movement involved has not been mastered and coupled with the idea of the movement as its stimulus. This fact has made it particularly useful in experiments on learning in animals. Other methods of learning, such as by imitation and by understanding or ideational control, are chiefly supplementary to this primary method.

Whole and Part.—The whole method procedure demands the continuous repetition of an entire body of material until the desired stage of mastery is attained. The part method demands an initial mastery of definite sections of the material and the final connection of these different sections in proper serial order. There are various forms of the part method of learning: (1) in the "pure" part method, the parts are first learned as units and then connected; (2) in the progressive part method, every unit is connected as it is learned with the material already mastered; and (3) in the repetitive part method, the learned units are repeated as an introduction to the learning of the next. Many psychologists who have used the part method in studying the processes of learning have failed to make clear to which of the various part methods they refer. In spite of this lack of uniformity of method, it has been generally concluded that the "whole" method of learning is more advantageous than the "part" method,
for speed of learning, for more nearly correct formations of associations, and for better retention.

**Complete and Alternate.** - Two investigators, Dashiell (61) and Kyle (107), carried on at the same time and unknown to each other experiments to investigate the problem of complete and alternate learning. Their purpose was to answer the question, if a subject is to learn two different habits, is it more economical to practice on them both at the same time as nearly as may be, thus learning them together or "alongside" each other, or to practice on one only after the other has been completely learned by itself? Each experimenter divided his subjects into two groups; the first group completely learned one problem before beginning the other; the second group alternated between learning one problem and the other throughout the duration of the experiment. Both experimenters conclude that the method that allows complete learning of the one habit before the other is attempted is the more economical.

**Massed and Distributed Practice Periods.** - In learning, it is important to know the relationship of the length and frequency of practice periods of the learning. This question was first raised by Ebbinghaus in his work on nonsense syllables. He found that in committing to memory nonsense syllables there was a saving of time in learning and better retention when the learning was spread out over several days than
when it was concentrated into one day. Since Ebbinghaus' work, the results of experimental work in various fields of learning have shown that it is more efficient to have short periods of practice distributed over a long time than to have longer periods of practice distributed over shorter lengths of time.

Pyle (105) found that in habit formation an adult can practice profitably for something like thirty minutes daily. The length of time varies with persons, with the material used, and with the stage of fixation of the habit. If practice is extended beyond thirty minutes there is a relatively small return for the extra time. A second practice on the same day is not quite as beneficial as the first practice, and after a few practices further practice on the same day is useless. Pyle recommends the experimental determination of the relative value of practice of every length of period from one minute to one hour. Starch (116) found, in a substitution test of learning to associate numbers with letters, that it is most economical, within limits, to shorten the periods of work and to distribute them over correspondingly a given period of time. The most favorable length of period for this work seemed to be between ten and twenty minutes. Similar results have been found for motor tests. Murphy's (155) results on practicing javelin throwing show that learning periods can be distributed by giving alternate days' practices, or even weekly practices, without loss in learning.
Learning Curves

Progress in learning is ordinarily shown by a curve. The purpose of such a curve is to show the increase in efficiency due to practice. As a rule, the successive practices are represented on the horizontal axis and the scale for the scores on the vertical axis. A line connecting dots placed at the intersection of each score and its corresponding trial thus represents the learning curve. The rise of the curve indicates the increasing efficiency due to practice. Another type of learning curve in which increased efficiency is shown by the fall in the curve may be plotted by representing the time element on the vertical axis and the number of trials on the horizontal axis. Error curves are also represented by curves that fall as efficiency increases.

The increase in efficiency from practice may be regarded as due to three factors: (1) establishment of the bond between stimulus and response, (2) decreased resistance in the established neural bond, or route, that is, the strengthening of the primary bond through use, and (3) adaptation of the muscles to the special movements required.

Forms.- The form of the learning curve depends upon the material that is being learned. Usually, the initial rise is rapid, with slower increments later. This gives a curve that is convex on its upper side. If learning is slow at first and faster later, the
resulting learning curve will be concave on its upper side. Either of these two types of curves tends to become level as the subject approaches his physiological limit, when any improvement requires a much greater effort than at the beginning of the learning. The curve of learning that increases rapidly at first and then flattens out as practice is continued is regarded as the typical learning curve.

As a rule, there are fluctuations in the learning curve. There may be a sudden increase in efficiency, a slow increase, a plateau, or level place, in the curve that indicates a period without progress in learning, or even a decrease in efficiency. These variations in the curve are due to a number of factors that influence learning, particularly the factors of habituation to the situation and fatigue.

Plateaus and Their Meaning.- One of the most troublesome problems of the learning curve is that of the plateaus. Are plateaus the result of different habit levels, are they due to the automatization of associations, are they dependent upon attention, or may there be some other explanation? Are they necessary for all, for some, or for any type of learning?

Book (52) says that plateaus "represent either a failure in attention and effort...or a period during which attention and effort are wrongly applied, where mistakes are multiplied, and where subsequently the evil
effects of practice in error are being slowly overcome and right habits of attention and execution regained."

Boole's chief reason, aside from introspective analysis, for regarding lapse of attention and effort as the cause of plateaus, is the lessened pulse rate that he found during these delays.

Swift (120) takes exception to Boole's explanation of plateaus on the basis of the subject's failure in attention and effort and states that short arrests of are a day or two, or more, likely to be caused in part by the physical condition of the subject and that the delays increase in length as the limit of power is approached. Another one of the causes of plateaus, as given by Swift, is the fact that time is required for the automatization of associations. Swift notes that plateaus occur just after good progress has been made, when the learner is animated with the enthusiasm of success. Yet, notwithstanding the facts that the mental set is favorable to advance and the learner puts forth much effort, plateaus occur. After this, there is a period when efficiency is greatly increased and is greater than before the plateau occurred. Swift believes that this proves his theory that at the time of the plateau the learner has reached his highest degree of efficiency with the material that the mind has assimilated, and that further progress requires time for the automatization of new associations. Evidently some sort of mental reconstruction has been going on during the interval of
retardation in visible progress. The errors that occur
at the time of plateaus in the curve are due to the con-
fusion resulting from loose, unautomatized associations;
these associations must become automatic before further
progress is possible.

Starch (114) seems to agree with Swift; he
says, "The implication seems to be that the plateaus
during which there is little or no improvement are an
indication of more rapid development in some other as-
pect of the learning process which is not measured by
that particular curve. It seems therefore important in
studies of learning to obtain as many different means
of measuring progress of learning as possible."

Bryan and Harter (57), in studies on the tele-
graphic language, state that "a plateau in a learning
curve means that the lower-order habits are approaching
their maximum development but are not yet sufficiently
automatic to leave the attention free to attack the
higher-order habits" and that "the length of the plateau
is a measure of the difficulty of making the lower-
order habits sufficiently automatic."

Towne (136), Bradford (53), and Swift (119),
in experiments on learning to typewrite, and Batson (50)
in experiments on ball tossing, disagree with the theory
that the lower-order habits are completed before the
higher order habits are begun. They do not believe that
there is any regular order of the formation of these
habits, but that habits of all orders make progress simultaneously, some in a less and some in a greater degree.

Chapman (58), in studying the learning curves of typewriting, found only a few short plateaus that he considered genuine. Hill, Rajall, and Thorndike (75), and Bradford (53), in experiments on learning to type-write, did not find plateaus. They conclude that there is no need for plateaus and that it is not necessary for habits to be developed and perfected in such a monotonous way and that habits do not "suddenly shoot together into new combinations" and thus cause the curve to rise rapidly after a plateau.

Peterson (100) feels that the type of curve drawn by some investigators does away with plateaus that would otherwise show up. He holds that an absence of plateaus may not mean that there were no actual plateaus in the learning, but may indicate that certain kinds of curves tend to conceal plateaus. Plateaus are shown best in the error or the time curves if they occur early in the learning process; if they occur in the latter part of the learning they show best in the average attainment curves, but are practically concealed in the error, or the time, curves. Some methods of plotting show them much better than others. Since it has been found that the appearance of a plateau and the degree of its occurrence depend much upon the type of curve chosen to represent the learning process, Peterson
is rather skeptical of the whole doctrine of plateaus in learning. The plateau may be due purely to the mathematical relations of curves of error to curves of average attainment. Peterson concludes that serious errors have resulted in the interpretation of learning from giving too much significance to the forms of the curves.

Variability in Capacity for Learning

Individual Variability.- It is of psychological and pedagogical interest to study the variability of learning capacity among a group of subjects, both as to the variation among themselves and the variations in learning in the same subjects, depending upon the type of material to be learned. To what extent individual curves of learning and fatigue are typical of all learning by that subject is a matter of great theoretical and practical importance.

With a view to determining whether learning capacity is specific or more or less constant, regardless of material, Pyle (161) gave his subjects tests involving different kinds of material: substitution, nonsense syllables, card distribution, and marble distribution. Pyle states that brains differ in the ease with which bonds are established and that most learning methods involve both general and specific factors; general factors are the bond-forming capacities of the central nervous system and specific factors are other
characteristics of brain, sense organ, and muscle. Pyle concludes that while temporary conditions may affect the efficiency of the learner, there is probably a constant factor that may be called "general learning capacity" that is dependent upon the characteristics of the central nervous system. Pyle believes that if extraneous factors could be eliminated, such as differences in previous training, environment, prejudices, and attitude, the correlation between one type of learning and ability in other types would approach unity.

Racial Variability. Neither the variability in individual learning capacity nor the variability in racial learning capacity has been investigated sufficiently. There are a number of studies of the comparison of the intelligence of various races, but very little investigation has been made of the comparison of the learning capacity of these races.

Pyle (163) made a comparison of learning ability of negro and white children in public schools of Missouri. The results indicate that the mental ability of the negro child, as shown on tests of learning, is about two-thirds that of the white child. About one-fifth of the negroes were equal or superior to the average of the whites and three-fourths of the whites were equal or superior to the average of the negroes. Four hundred eight negroes were included in this study. In a later investigation, Pyle (162) studied the learning capacity of 130 negro children from the fourth to the
seventh grade; white school children were similarly studied. This investigation showed that these negro children had from three-fourths to four-fifths the learning capacity of the white children.

Baldwin's (142) investigation of the learning of delinquent adolescent girls included thirty-seven white girls and thirty negro girls. Results show that the negroes are decidedly inferior. The learning capacity of the delinquent negro girls differs quantitatively and qualitatively from that of the white girls. There is greater irregularity in the learning curves of the negro girls than in the learning curves of the white girls. The work of the negroes is less in amount, less neat, and less accurate. Their marks are more irregular. Many pay little attention to errors; if an error is made, it is very likely to be carried regularly throughout the whole series.

Pyle (164) made a study of the mental and physical characteristics of 500 Chinese children. The digit-symbol and symbol-digit substitution tests were used in order to determine the quickness of learning. Efficiency in these tests is determined by speed of performance, but since the Chinese children were familiar with the Arabic numerals, comparison with Americans in this test is considered legitimate by Pyle. In the substitution test, the Chinese were considerably slower than the Americans. The Chinese boys did better than the girls on this test.
Several investigators have given retention and relearning tests on material learned under experimental conditions from a few months to more than six years previously. The consensus of opinion based upon the results of these tests is that there is a remarkable permanence of learning, as evidenced by the rapidity of relearning. The majority of data shows that after a few trials the record on the retention test equals that at the end of the learning experiment. After this, progress is very rapid and in most cases the subject attains a higher score than at any time during the period of learning. There is a decided contrast between the rapidity of improvement during the retention tests as compared with the original learning process. The majority of these retests have been upon learning experiments that deal with the acquisition of skill, such as typewriting (122), ball-tossing (121), (123), and mirror tracing (74). The only record found of an investigation regarding the permanence of material of a purely intellectual nature is a report by Thorndike (130) on the measurement of retention in the case of algebra, five years or more after the study of this subject. Results in this field indicate also that there is less actual loss of learning than is generally believed.
Summary

There is considerable agreement among investigators as to the beneficial influence on learning of certain of the general factors involved, such as concentrated attention, a favorable attitude toward the material to be learned, a knowledge of the end sought, a knowledge of own record, a knowledge of own errors, readiness of the organism to respond, and the value of associative aids to learning. The majority of investigators believe that the value of repetition as an aid to learning has been over-emphasized.

In regard to the specific factors involved in learning, there is less agreement, on the whole. While some investigators deny that there is transfer of training, others believe that in the case of certain types of material, transfer of training may take place. There seems to be agreement that distributed periods of practice result in more efficient learning than concentrated periods of practice and that complete learning of one task before beginning another is more efficient than the learning of two tasks by alternate periods of practice on each. The trial and error method is characteristic of learning in animals, and to some extent in children, but in most cases of trial and error in human subjects the type of material is the factor that determines the use of this method of learning. There is divided opinion as to whether the whole or
part method is the most effective method of learning. The whole method is the one endorsed by most investigators who have studied this phase of the learning process, although some experimental data are given to show that the part method produces better results with certain types of material. The type of material to be learned seems to be an important factor in determining the relative value of the whole and part methods of learning. The form of the learning curve varies with the type of material that is being learned, but in most instances the curve shows more rapid improvement at first, followed by periods in which the progress is much slower. The meaning of plateaus and whether or not they are typical of all types of learning are still unsettled questions among experimenters. There is an insufficient amount of data available on which to base many facts regarding individual and racial variability in learning. What little is known, however, seems to indicate that the degree of individual variability in learning different types of material is small, and that racial variability in learning capacity is quite marked. Investigators agree that there is remarkable permanence of learning, as evidenced by the rapidity of relearning.
CHAPTER IV
SUMMARY AND CONCLUSIONS

The study of the psychology of the learning process is a field in which much work remains to be done. Although the investigations have been numerous, the outstanding criticism of the work seems to be the lack of uniformity in technic among experimenters, even when they are using the same type of material. The technic and methods of investigating the learning process should be more thoroughly standardized so that when investigations have been carried on they may be comparable with the work of other investigators. It is surprising to find how often in reports of investigations of learning the author does not state how many subjects were used, whether the subjects were adults or children, how long each practice interval was, how long the interval was between practices, and other facts that are essential in evaluating the work and necessary to the repetition of the experiment so that the results may be comparable with results previously obtained by another investigator.

It is a noteworthy fact that very few of the investigators of the learning process have used children as subjects, and an even smaller number have worked with preschool children. In most cases, the subjects have
been college students, generally those in classes of educational psychology. There seems to be an especial need for more investigations in the learning process with school children and preschool children as subjects.

The literature shows a decided lack of agreement among investigators as to the facts found through experimental work on learning. Some of the conclusions in regard to which there is some agreement are as follows:

1. Sensible material is more easily learned and more permanently remembered than nonsense material.

2. Certain factors that assist learning are attention, favorable attitude toward the work, knowledge of end sought, knowledge of own record, knowledge of own errors, readiness of the organism to react, and certain associative aids to learning.

3. As a rule, learning by the whole method is more efficient than learning by any of the part methods.

4. Distributed periods of practice usually result in more efficient learning than massed periods of practice.

5. The results with most materials used indicate rapid progress at first, followed by progress at a slower rate.
6. The learning curve does not indicate improvement at all stages. There are times when apparently no improvement takes place and times when there seems to be a loss in the amount of learning.

7. Relearning is accomplished more quickly than original learning; this shows that even while the material learned is not being used there is a remarkable permanence of learning.
There has been so little investigation of the problem of learning in young children that the literature contains few references that have a specific relation to the present experiment. The references have therefore been grouped under general references and according to the subjects used in experiments in learning, animals, adults, school children, and preschool children.

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Learning in School Children


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Learning in Preschool Children


Part II

An Experimental Study of Association in Learning of Young Children

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PART II
AN EXPERIMENTAL STUDY OF ASSOCIATION IN LEARNING OF YOUNG CHILDREN

CHAPTER I
MATERIALS, FORMS OF PRESENTATION, AND METHODS OF PROCEDURE FOR AN ASSOCIATION REACTION LEARNING EXPERIMENT

In looking over the field of experimental work on the learning process, one finds that the subjects used have been animals, preschool children, school children, and adults. When thinking of learning, one is likely to think of it in connection with children, yet the literature shows that at least sixteen different learning tests have been used with adult subjects, for only with school children, and two with preschool children. Animals have been given, as a rule, either a maze or a puzzle box test to study the progress of their learning. The first test of learning to be used with preschool children was the card-sorting test; later a specially devised test was used by one investigator to study the young child's ability to learn to recognize words. School children have been given learning tests based upon code trans-
The learning process of adults has been studied by means of the following tests: ball tossing, code translating, substitution, maze, typewriting, telegraphy, addition, multiplication, nonsense syllables, sensible material, marble distribution, card sorting, cube formation, mirror tracing, javelin throwing, and hand movements.

As there have been so few investigations into the problem of how children learn, particularly how young children learn, this phase of the study of the learning process is one in which there is need for more experimentation in regard to many of the different factors involved in an analysis of how learning takes place and of the factors that influence the rate of learning. If children are to be taught efficiently, there must be thorough scientific knowledge of the process by which a child learns. This can be derived only from experimental results obtained by placing the child in a controlled learning situation and by analyzing quantitatively and qualitatively the results obtained. It was in the hope of throwing light on some of the problems involved in the learning process of young children that this investigation was undertaken. Some of these problems, such as effect of distribution of prac-
tice and rest periods, the problem of interference and transfer, and relearning, as compared with original learning, have been studied by investigators of learning in animals and in adult subjects. One of the principal motives of the present investigation is a desire to discover whether or not the principles and laws derived from experimentation on learning in animals and adults are equally applicable to learning in children of kindergarten age and younger.

One objection that may be raised against some of the materials used in studying the learning process is that the response by which the learning is studied is in itself too complicated and involves too many factors to be considered an adequate means of studying how learning takes place. For example, typewriting has been used quite extensively as a means of studying progress in learning; it seems advisable to choose a more simple problem than the acquisition of skill in typewriting in making a study of the psychology of learning. Typewriting is an exceedingly complex process involving both mental and physical elements. In the present investigation, the aim was to use as simple material as possible and to have the response of the child as simple as possible.
There are various theories current as to how learning takes place. The theory that has received the widest recognition is the theory that learning goes on through a process of association, a connecting of stimulus and response. A stimulus is presented and a response given. Later presentations of this stimulus will call out the response connected with it. The method used in the study of learning reported upon here is that of the association reaction type of response. The materials, forms of presentation, standard and variant forms, and methods of learning were all planned to study by means of association reaction of the factors in the learning process of young children that have been studied with animals or with adult subjects and to discover experimentally whether there are similarities or differences in the results found in the present investigation and those reported in the literature on learning.

**Material**

The material for this experimental study of learning through the process of association reaction consists of a series of twenty blocks and twenty pictures. The blocks are in the form of common geometrical shapes. After the twenty blocks had been decided
upon, objects were thought of that are in some way similar to the blocks, and simple outline pictures were drawn to represent these objects. With one exception possibly, the pictures are of objects with which every child is familiar. Each picture suggests the block with which it is to be associated in the experiment and this facilitates the formation of associations. The pictures were made with India ink on unruled index cards, 3 by 5 inches. The plan of having a certain similarity between block and picture was decided upon in order that the learning involved would be not too difficult for preschool children. The approach to the study of the problem was made through blocks and pictures because of the universal appeal that these have for young children.

The twenty blocks were devised in such a way that the complete series may be regarded as consisting of two parallel series arranged in approximate order of complexity, from the simpler to the more complex. Each block of Series II, blocks 11 to 20, is a modification, or variant, of the block that parallels it in Series I, blocks 1 to 10. The material was designed in this way purposely in order to allow for variations from the standard form of presentation and for interchanging of blocks associated with the pictures. Figure 1 shows the
Figure 1
The twenty blocks in the association-reaction learning experiment placed so as to show parallel arrangement of the two series.

Figure 2
The order of the blocks as placed before the child for experiment.

Figure 3
The order of the pictures as presented to the child for association with the blocks.

Figure 4
The order of the pictures as placed before the child for a check upon learning.
parallel arrangement of the blocks. This is the order in which the child's responses are given when the twenty correct associations have been formed according to the original method of presenting the material to the child.

Forms of Presentation of Material

The material was presented in several different forms and learned according to various methods in order to investigate some of the important problems involved in the study of the learning process.

Standard Form

The form of presentation of blocks and pictures used with the largest number of children is referred to as the standard form, or block-picture form.

The blocks are placed upon a low table before the child in two rows in the prescribed order, as shown in Figure 2. According to this arrangement, no block is next to the one that precedes or follows it in the experiment, nor just above or below the block that it precedes or follows. The child is seated at one side of the table in front of the middle blocks so that he can reach easily any one of the twenty. The examiner sits opposite the child.

When both child and examiner are seated, the latter says, "See these blocks," and pauses slightly
while she indicates the blocks upon the table, "and see these pictures", indicating the pack of twenty pictures that she holds in her left hand. These are arranged in the order shown in Figure 3. "One of these blocks (The examiner points toward the blocks on the table and puts slight emphasis upon the words underlined here.) goes with each picture. I am going to tell you which block goes with each picture and then I want to see if you can give me the right block that goes with each picture". The examiner holds up, in the left hand, the pack of pictures with the first one, a clock face, on top and says, "When I show you this picture, you must give me this block (The examiner picks up the round block, block 1, with the right hand and holds it beside the picture of the clock face.) Remember (slight pause) this is the block that goes with this picture". The examiner then replaces the block in its former position upon the table. Using the same procedure, the examiner goes through the complete set of twenty pictures and twenty blocks, being careful to replace each block in its correct position before showing the next picture. When the last block has been replaced upon the table, the examiner says, "Now it's your turn. Let's see if you can give me the right block that goes with each picture. Give
me the block that goes with this picture," and the
examiner holds up the first picture. The whole series
of pictures is gone through in this manner, the exam-
er repeating, "Give me the block that goes with this
picture", as each picture is shown and each time replac-
ing the block the child has handed to the examiner so
that in each case the child must choose from the total
number. It was found advisable, after the children had
learned many of the associations and responded almost as
quickly as a picture was shown, to discontinue saying,
"Give me the block that goes with this picture" each time
a picture was shown, and to repeat it only at frequent
intervals throughout the whole series. This was due to
the fact that often a response had been given before the
examiner had repeated more than a word or two of the
phrase.

Each child's record on this learning material
was begun on a Monday in order to have five consecutive
trials before Saturday and Sunday intervened. The ma-
terial was presented to the child once daily until he
had attained three consecutive perfect scores of 20, or
if he had not made three consecutive perfect scores at
the end of the twentieth trial, the test was discontinued.
A large number of the children attained scores of 20
once or twice, and then their scores fell back 1 or 2
Figure 5
Child being shown the series of pictures that correspond with the blocks.

Figure 6
Child responding with a block when the examiner shows a picture.

Figure 7
As a check upon complete learning, the child responds with a picture when a form is shown.
points. For this reason the criterion of three consecutive perfect scores was adopted as a measure of complete learning.

Children Studied Individually. - The majority of children were given the learning material on successive days according to the standard form of presentation. Their records were studied individually and as a group, since most of them fell within the five/year age group and therefore afforded sufficient material for establishing an age norm for this form of presentation.

Children Studied by Pairs: - Learning on Successive Days versus Learning on Alternate Days. - It was decided to present the material on successive days to one group of children and on alternate days to the children in another group, since the problem of the effect of distribution of work periods and rest periods upon learning is one of the most important phases of the learning process and one that has been the subject of much investigation. In order that the records might be comparable, the children were paired off on the basis of approximately the same mental age, height, and weight. One child of each pair learned the material according to the standard form, on successive days; the other child of each pair learned it also according
to the standard form, but on alternate days. In each case a child's record was always begun on a Monday in order to have a comparable distribution of learning periods before Saturday and Sunday intervened. The material was presented to the child on successive or on alternate days until he had attained three consecutive perfect scores of 20, or the test was discontinued at the end of the twentieth trial if the child had not made three consecutive perfect scores. The records were compared in order to determine whether, for this type of learning, presentation of material on alternate days or on successive days resulted in greater economy of learning.

Relearning after an Interval of One Year. - Several investigations that deal with the learning process have included retention tests on material learned under experimental conditions from a few months to a few years previous to the giving of the re-tests. The majority of these studies have dealt with the retention of learning problems that have involved the acquisition of motor skill such as ball tossing, mirror tracing, or typewriting. In the present investigation, a small number of children who had completed the learning of the entire series of twenty pictures and twenty blocks ac-
cording to the standard form were available one year later and were given the material again in order to compare each child's results on learning with his results on relearning after an interval of one year.

**Variant Forms**

**Children Studied Individually and by Pairs:**

**Interchange of Learned Associations.** - With a small group of children who had completed the learning according to the standard form of presentation of material, followed by a check on learning, the form of interchanged, or reversed, associations was used. The pictures are arranged in the same order (Figure 3) and the blocks are placed upon the table in the same arrangement as Figure 2. The object of interchanging the associations is to compare the learning by this method with the child's first learning and to study the factor of interference or transfer. When the first trial is to be given for learning the reversed or interchanged associations, the examiner says, "These are the same pictures and the same blocks but now there is going to be a different block that goes with each picture". (Special emphasis is placed upon the word different)

"I am going to tell you which block goes with each picture and then I want to see if you can give me the
right block that goes with each picture." The examiner holds up, in the left hand, the pack of pictures with the first picture, the clock face, on top and says, "when I show you this picture you must give me this block". (The examiner picks up block 11 with the right hand and holds it alongside the picture of the clock face). "Remember, now, (slight pause) this is the block that goes with this picture". The examiner then replaces the block in its assigned position upon the table. Using the same procedure, the examiner goes through the complete set of twenty pictures and twenty blocks, but this time the pictures of Series I are shown with the blocks of Series II, and vice versa, the pictures of Series II are shown with the blocks of Series I. The order of sequence within each series of blocks and pictures remains the same as when the material is being presented according to the standard form. The interchanged or reversed method by which the associations are learned is always given after the child has completed learning by the standard method.

Children Studied by Pairs: Learning on Series I versus Learning on Series II. - When a child is given the total number of twenty pictures and twenty blocks to learn, that is both Series I and Series II, the effect that the learning of Series I may have upon the learning of Series II
is a factor that is not easily determined. Since Series I and Series II are so comparable, it may be that the learning of the first series facilitates the learning of the second series; on the other hand, the latter part of the material may be more confusing because of the number of blocks and pictures that precede, or a child, particularly one of the very young children, may become fatigued before the twentieth picture and block have been reached.

In order to study experimentally the problem involved, a number of children were paired according to results upon a mental test, and to one child of each pair the blocks and pictures of Series I only were presented; to the other child, the blocks and pictures of Series II only were shown. Figure 8 shows the arrangement of blocks on the table when Series I only is being learned by the child and Figure 9 shows the arrangement of blocks on the table when Series II only is being learned. It is to be noted that the block of each series has relatively the same position as the block with which it is paralleled. For example, the first block of Series I and the first block of Series II are the second from the left on the lower row of blocks; and the third block of each series is the middle block in the upper row. The directions are the same as for the standard form in each grouping. The results of each child's trials were
Figure 8
Arrangement of blocks when series I only is used.

Figure 9
Arrangement of blocks when series II only is used.
compared with the results of the child with whom he was paired in order to study any differences that might occur between learning on Series I and learning on Series II, that is, when results from comparable material are compared on comparable children.

**Possibilities for Further Study**

The material used in this investigation lends itself readily to adaptation to various forms of presentation and to various methods of learning. In addition to the forms of presentation used in this investigation, the block-picture or standard form of learning the material, the picture-block form or check upon learning, the reversed or interchanged associations, and learning only Series I or Series II, other forms of presentation have been planned but not used. One of these variations in presentation of material for learning would consist in having the child learn the material according to the picture-block form of presenting the blocks one at a time to the child and having him respond with the pictures. The check in this case would, therefore, consist of one trial according to the standard form of presentation of material. The material might be presented in another form by arranging the blocks in the same order on the table as for learning, according to the
standard form, but shuffling the cards before each presentation so as to have the pictures mixed instead of in the same order for each trial. Conversely, the pictures could be presented in the original order as for the standard form of learning, and the blocks be placed upon the table in mixed order. These suggested methods of procedure should result in information upon the effect on learning of presentation and sequence of material. In further work with this material, other variations of methods of procedure will suggest themselves, no doubt, as means of studying various phases of the learning process.

Check on Learning

Check on Learning of Standard Forms

When three consecutive perfect scores have been attained, one additional trial of a different type is given as a check upon the learning. The learning situation is now reversed. The examiner places the pictures upon a low table in two rows, as shown in Figure 4, in the order corresponding to the prescribed arrangement of the blocks as shown in Figure 2. The blocks are then shown to the child, one at a time, in the same order as shown in Figure 1. When beginning this part of the experiment, the child stands at the
table with the middle pictures before him. The reason for having the child stand is that the pictures extend sufficiently far toward his right and left to necessitate his walking up and down in order to find the required picture. The smaller child would be unable probably to reach the pictures at the extremes of the two rows if he were seated. When the child has taken his position before the arrangement of pictures upon the table, the examiner says, "These are the same pictures and the same blocks, but now you are going to have the pictures and I am going to have the blocks. When I show you a block, you point to the picture that goes with the block." The examiner has the twenty blocks arranged in order in four piles and picks up block 1 from the top of the first pile. As the block is held up before the child, the examiner says, "Show me the picture that goes with this block". The whole series of blocks is gone through in this way, the examiner repeating the last sentence as each block is presented to the child. One trial only is given in this manner. Since this reversal of the learning situation is used simply as a check on learning, it is not counted in the total number of trials required for complete learning. In order that this record may stand apart
from the records of daily trials of the learning, it is marked "Picture-block" on the top of the score sheet used in this part of the experiment. The number of the trial on the record of the third successive score of 20 is counted as the number of trials necessary for complete learning and this number is used for comparing individual records, and for obtaining averages by groups, mental ages, or by sexes, and in the various correlations.

Check on Learning of Variant Forms

For the check on learning of the variant forms referred to as the interchange of learned associations, the arrangement of the pictures upon the table and the procedure are the same as for the check on learning of the standard forms. Now, of course, when the examiner shows the blocks of Series I, the child responds by pointing to the pictures of Series II and, vice versa, when the blocks of Series II are shown, the examiner responds with the pictures of Series I.

For the check on learning only Series I or only Series II, the pictures are arranged as shown in Figures 10 and II. The pictures are in the same position as the blocks with which they correspond and here, as in the arrangement of the blocks for learning.
Figure 10
Arrangement of pictures when series I only is used.

Figure 11
Arrangement of pictures when series II only is used.
Series I or Series II only, the pictures of each series have relatively the same position.

**Records of Data**

**Scores**

A record of each trial is kept on a specially prepared score sheet on which is printed the name, date, chronological age, mental age, number of the trial, and outlines of the twenty blocks arranged as in Figure 1. When a child hands the correct block to the examiner, the latter places a plus sign upon the corresponding figure on the record sheet. When an incorrect block is given, the examiner draws it upon the score sheet beside the block that should have been given. In the analysis of the data, it is necessary to have this record of the incorrect responses instead of simply the indication of an error by a minus sign, in order to determine not only how many errors are made but exactly what errors are made, which blocks are most frequently confused, and to determine the order of difficulty of the formation of the associations. The method of scoring is 1 point for each correct block; thus the total perfect score is 20.

**Observations**

The blank lower half of the score sheet is headed "Observations". Here the examiner records any-
thing that may be of value in interpreting the results. Usually a few minutes are necessary after each trial for the examiner to write up these observations. Sometimes a few words in regard to many of the observations are jotted down while the child is making responses, but they are always enlarged upon immediately after the completion of each trial. Under "observations" are noted the type of the child's response, whether it is quick or slow, whether the child picks up just any block, a block near at hand, or seems to be searching for a particular one, and whether one or both hands are used, if only one, which one. It is particularly important to record comments made by the child during the experiment. Very frequently a child mentions and points out the similarity of block and picture. Many children remarked upon the ease or difficulty of finding certain blocks. Sometimes, at the end of a trial, a child made comments on the situation as a whole. A very few of the children localized the position of some of the blocks, and, when nearly all associations had been learned, reached directly for the correct block with either right or left hand, according to its position on the table. The child's interest and attention during the examiner's presentation of the series of blocks and pictures and during the child's performance
were recorded. An interesting point noticed in many records was the confusion either between or among the pictures, or between or among the blocks. In several instances, this confusion persisted for several successive trials before it was eliminated and in the case of a few of the children, the confusion reappeared after the correct response had been made once, twice, or more times. The responses before which a child showed considerable hesitation were indicated on the score sheet. A large number of the children named aloud the pictures or the blocks, or both, either while the examiner was showing the material to the child or while he was handing the blocks, to the examiner. Such general items as these and others that refer to specific children only have been recorded on their respective score sheets.

Cumulative Record Card

A cumulative record card has been used in assembling data from the various trials of each child. This record card contains spaces for recording name, chronological age, mental age (Standard-Binet), intelligence quotient, date of birth, date of Binet examination, name of examiner, and dates on which the learning experiment is begun and finished. The forms and methods by which the material may be learned are tabulated. They
are to be checked to indicate on each child's record card the form and method used on his trials, the number of the trial on which the first perfect score is attained, and the number of the trial on which the third successive perfect score is achieved. The card contains also a space for recording the number of days absent and a list of other psychological tests whose scores are recorded for purposes of correlation with the number of trials necessary for learning the associations of pictures and blocks.
CHAPTER II

Subjects of the Experiment

In all, 205 children were given the learning material in one or two of the forms of presentation described above, and according to one or two of the methods. The records of twenty-three of the total number of children could not be included in the analysis of data because the learning had been discontinued on account of absences, or the child had failed to learn completely the material by the end of the twentieth trial and the experiment was, therefore, discontinued. There were two records that were complete but could not be included. Each of these two kindergarten children was one of a pair but the other child of the pair was absent during the entire time the experiment was being carried on with the kindergarten children.

In this study, two years of age refers to children who range in chronological age from one year and six months to two years and five months; three years of age refers to children who range in chronological age from two years and six months to three years and five months; four years refers to children who range in chronological age from three years
and six months to four years and five months; five years refers to children who range in chronological age from four years and six months to five years and five months; and six years refers to children who range in chronological age from five years and six months to six years and five months.

**Children from the Preschool Laboratories**

The 180 children whose records were used in this study were secured from two sources. Seventy children were pupils in the preschool laboratories of the Iowa Child Welfare Research Station. The preschool laboratories comprise two groups of children—one group designated by the term Preschool, includes children whose chronological age range is two to five years of age, and another group of children known as the Junior Primary group whose chronological age range is five to six years. All of the junior primary children, who were subjects of the experiment, fell within the five and one-half year age group, that is, the chronological age range of these children was from five years and no months to age five years and eleven months.

**Children from Five Kindergartens**

One hundred and ten children who were subjects of the association reaction learning material were pupils in five kindergartens of the public schools.
of Mason City, Iowa. The kindergarten children who learned the material according to the standard form of presentation were selected so as to be comparable in chronological age to the junior primary group. The experimental work on learning was done with the kindergarten children in the spring shortly before the close of the school year. As these children, with few exceptions, had passed their fifth birthday before entering kindergarten, approximately seven months previously, it was necessary to select those children who were younger chronologically at the time of entering since those who were older at that time were a few months too old to be included with the junior primary group. This factor of selection may possibly have eliminated the pupils who were not so bright as the brighter pupils are usually the younger. Some of the kindergarten children who were subjects of the variant form of learning the material were a few months older than those selected for learning the material according to the standard form but no child was older than six years and five months, the upper limit of the six year-old group.

**Chronological Age Distribution**

The chronological age distribution of the total of 180 children who completed the learning was
from two years and two months to six years and five months. There are too few subjects at the lower ages for statistical analysis so this is limited to the children of the five and one-half year age group at which the majority of children are found. One child only falls in the two year old group and three are within the chronological age group of three years.

Mental Age Distribution

The mental age referred to here is the mental age derived from the Stanford-Binet mental examination. The 132 children who learned the material according to the standard form of presentation by various methods of learning were each given an individual Stanford-Binet mental examination but the fifty kindergarten children who learned the material according to the variant form known as the single series form, according to which the child learns Series I only or Series II only, were not given Stanford-Binet examinations. The only mental test records of these fifty children were scores on the Detroit Kindergarten Test. Each of the children in the preschool laboratories is given a Stanford-Binet examination as a part of the regular routine work. After the examiner had begun work on the learning experiment with the kindergarten children as subjects, it was found that no mental age ratings were available for
the kindergarten children on the Stanford-Binet tests. Three or four of the children had been given a Kuhlmann-Binet examination. The kindergarten children to whom the learning material had been presented according to the standard form had been selected so as to be of a chronological age comparable with the junior primary children, in order to combine the records of the two groups. There was a Stanford-Binet mental age rating for each junior primary child. It was necessary therefore, to have Stanford-Binet mental ages of those kindergarten children who learned the material according to the standard form of presentation. The examiner gave Stanford-Binet examinations to the sixty-four kindergarten children to whom the material was presented according to the standard form. The records of two of these children were among the number of records discarded because of failure of the subjects to complete the learning within twenty trials.

The only two year-old child in the entire group of subjects who completed the learning had a mental age of three years and eight months. It is the lowest mental age found among the children. The highest mental age was eight years and eight months and was the mental age of a junior primary boy whose chronological age was five years and eight months. This mental age range from three years and eight months to
eight years and eight months, includes the 132 children who learned the material according to the standard form of presentation by the various methods of learning.

Table 1 shows the number and distribution of children for each form of presentation of material and for each method of learning. The number of children on any one form, or method, is not sufficiently large to standardize results according to chronological or mental age groups except at the five and one-half year age on the standard form of presentation of material by the method of learning on successive days.
Table 1

Number and Distribution of Children for Each Form of Presentation of Material and for Each Method of Learning

<table>
<thead>
<tr>
<th>Picture Form</th>
<th>Interchanged Associations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Learn-</td>
</tr>
<tr>
<td>Preschool</td>
<td>32</td>
</tr>
<tr>
<td>Junior Primary</td>
<td>15</td>
</tr>
<tr>
<td>Paired(Daily)</td>
<td>11</td>
</tr>
<tr>
<td>Paired(Alternate)</td>
<td>11</td>
</tr>
<tr>
<td>Unpaired(Alternate)</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kindergartens</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>35</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Paired</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unpaired</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Paired</td>
<td>14</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D Paired</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E Paired</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>10</td>
<td>11</td>
<td>15</td>
<td>7</td>
<td>0</td>
<td>13</td>
</tr>
</tbody>
</table>


CHAPTER III

RESULTS OF EXPERIMENTAL STUDY

An understanding of how the children formed the required associations involved in this association reaction experiment was based upon an analysis of the results in regard to the cues used by the children in forming associations, the order of difficulty, whether the confusions were due largely to confusion between pictures or to confusion between blocks, and whether there was interference or transfer when the learned associations were interchanged. Factors such as distribution of work and rest periods, learning only one half of the material, and relearning were found to have considerable effect upon the length of time required for learning. The quantitative results derived from the children's records were supplemented by comments of the children during the experiment and by observations of the examiner at the time of the child's responses. Statistical results are based mainly upon the standard form of presentation, since the number of children on each of the variant forms is insufficient to justify statistical treatment of the data.
The ages of the children are scattered over such a range that at only one age, age five and one-half years, are there enough children to formulate a tentative norm for an age group.

Each of these factors and the interpretation of the part played by them in the association reaction type of learning will be taken up and discussed separately.

Criteria of Learning

In giving the directions for learning the material used in this experiment, it was stated that one of the criteria of learning is three consecutive perfect scores of 20. If the child has not attained this record by the end of the twentieth trial, the experiment is discontinued. Many of the children attained one, or perhaps two consecutive scores of 20, but failed to score 20 on the following trial. Sometimes the decrease was a matter of 1 point only, but in the majority of instances, the decrease in score was 2 points, and in a very few cases, 3. The reason for the drop of 2 points was that the decrease in score was due to a confusion of two of the parallel forms. For instance, some of the confusions that occurred most frequently were responding
with the six-pointed star when the five-pointed star should have been given, and later, responding with the five-pointed star instead of the six-pointed when the latter would have been the correct one; similarly, the pentagon and hexagon were confused.

In some of the studies found in the literature on the psychology of the learning process, a subject has been considered to have learned a given material when he was able to respond with one perfect trial. The results of the present investigation show that one perfect performance is inadequate as a criterion of learning. In many instances, at the time the subject is able to achieve one perfect trial, the material has just reached the threshold of learning. The associative bonds involved in the process of learning have not as yet become sufficiently strong to warrant a similar performance on successive trials. It was decided arbitrarily before beginning the work on this investigation to set three successive perfect trials as one of the criteria of learning. Results indicate that when the child has given three successive perfect responses the material may be regarded as having been completely learned.
Table 2 shows the number and distribution of children who attained three successive scores of 20 (perfect) and those who attained one score of 20, or two successive scores of 20, then a score less than 20, and later three successive perfect scores. One child who had scored 20 on two successive trials made a score of 18 on the following trial, and maintained this record for six consecutive days, followed by a score of 19, and then attained three consecutive perfect scores. The continuance of score 18 was due to a persistence of the confusion of the pentagon and hexagon blocks. This child secured her first perfect score on the ninth trial, but it was not until the twentieth trial that she had attained the third successive score of 20. Another child who had attained one score of 20, on the following day scored 17 only; this was followed by a score of 20 on each of the next two days, then 18 on the two following days, after which she achieved three successive scores of 20. In the case of this child, the unstable associations were in connection with blocks 10 and 20 and 8 and 17. The first score of 20 had been secured on the eighth trial, but it was not until the sixteenth trial that the third successive score of 20 was secured.
Table 2

Number of Children Attaining Complete Learning and Those Attaining One or Two Successive Perfect Scores Followed by a Decrease and Later Achieving Complete Learning

Preschool Laboratories

<table>
<thead>
<tr>
<th></th>
<th>Three successive perfect scores</th>
<th></th>
<th>Perfect scores followed by a decrease</th>
<th>Number of children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Original learning</td>
<td>Interchanged associations</td>
<td>Original learning</td>
<td>Interchanged associations</td>
</tr>
<tr>
<td>Preschool</td>
<td>24</td>
<td>6</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Junior Primary</td>
<td>14</td>
<td>8</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Paired(Daily)</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Paired(Alternate)</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Unpaired(Alternate)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kindergartens</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>30</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>14</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Paired</td>
<td>14</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Unpaired</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Paired</td>
<td>13</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>D Paired</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>E Paired</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>156</td>
<td>17</td>
<td>26</td>
<td>1</td>
</tr>
</tbody>
</table>
The third successive perfect score was followed by the check upon learning. So few of the children failed to make a perfect score on the check that it is believed that an increase in the number of successive perfect scores fixed as one of the criteria of learning would not improve the results. On the other hand, two successive perfect scores were quite frequently followed by a decrease in score. Therefore, the validity of the criterion of three successive perfect scores, although decided upon arbitrarily, seems justified by results.

Absences as a Factor in Learning

In discussing the method of presentation of material used in this study of learning, it has been stated that each child's record was begun on a Monday in order to have the same number of trials before Saturday and Sunday intervened. Theoretically, this plan would give the same relationship between work periods and rest periods for each child so that the records among the children in each of the groupings would be comparable. As would be expected, a certain number of absences occurred during the time when some of the children were being used as subjects of the experiment. Since the effect of absence on the child's record would
be a factor that can not be measured, and since in any learning situation the distribution of work periods and rest periods is of great importance and must be taken into consideration in an analysis of the data, particularly in the comparison of one child's record with that of another, it was arbitrarily decided before beginning this investigation to discontinue work with any subject who was absent for more than three consecutive days. Some of the children had a total number of absences that amounted to more than three days, but no child's record that was used in this report of the work shows an absence of more than three consecutive days.

In one of the two investigations that are the only published work on learning of young children, the children were given trials once a day five days a week, just as in the case of the children who learned the associations of pictures and blocks according to the standard form of presentation of this material. The authors of this investigation, a card sorting experiment, state that "some of the children were absent for considerable periods, however, and almost all had an occasional day's absence. The larger interruptions, of course, had their effect on the practice curve, but this disturbance was not so serious as might have been
expected." It is further stated, "For about one-third of the children there was an interval of approximately one month between the tenth and eleventh trial which resulted in a decrease of score in some cases." In investigations of learning in which a special study has been made of the influence of distribution of practice periods, particular emphasis is placed on the consideration that must be given to intervals between work periods. The statement that long absences did not have as great an effect upon learning as one might have expected is of no value, since the effect as shown by the results is not stated, and the "disturbance" that "might have been expected" is quantitatively or qualitatively a wholly unreliable criterion based upon personal judgment. The comparison of the learning accomplished by one-third of the children who had an interval of approximately one month between the tenth and eleventh trials (or just at the middle of the total length of practice time, since each child was given twenty trials), with the learning accomplished by two-thirds of the subjects who did not have this one month interval between these two practice periods can hardly be expected to give reliable results. In regard to the effect of a month's absence on the practice curve for
card sorting, the authors admit that there was a decrease of score in some cases, but conclude the discussion with a statement that "this decrease was in general no greater than when only an occasional day was lost." The actual amount of decrease is not stated; neither is it known to how many of the total number of fifty-six children the reference is made by the statement that the one month's absence "resulted in a decrease of score in some cases". In fact, the data given regarding effect of absences on the learning involved is too general; and in the tabulated results, no indication is made as to which of the children had this prolonged absence so that one does not know whether or not to interpret all the decreases in scores from the tenth to the eleventh trial as due to this absence, or to specific conditions that influenced the child's learning at that particular time so as to cause a decrease in score.

Of the 182 children who formed completely the twenty associations involved in the learning experiment herein reported, 127 had not one day's absence. Fifty-four children were absent from one to exactly five times; no child was absent/six times; and one child was absent seven times, which was the maximum;
that is, among the total number of subjects under discussion, there are almost two and a half times as many children who had not a single day's absence as the total number of children who had from one to five days' absence. The influence of absence on progress in learning has, therefore, been reduced to a minimum by discontinuing the experiment with the subjects who were absent more than three successive days. The complete record of number and distribution of absences for each form in which the material has been presented is shown in Table 3.

Quantitative and Qualitative Analysis of Data

Materials

The materials devised for this experiment appealed to the children and interested them very much. The examiner always referred to the material as a "game" when speaking to the children, and to the experimental situation as "playing the game." Many of the children said that they liked to play with blocks and that they liked "the block game" as they called it, although the examiner did not so name it. It is interesting to note that every child who referred to the learning material as a whole, used the blocks as a means of designating it. Frequently when the examiner came into the room
Table 3

Number and Distribution of Absences for Each Method of Learning

<table>
<thead>
<tr>
<th>Groups</th>
<th>Days Absent</th>
<th>Number of children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Preschool Laboratories</td>
<td>15</td>
<td>5</td>
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<tr>
<td>Preschool</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Paired (Daily)</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Paired (Alternate)</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Unpaired (Alternate)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Kindergartens A</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>Kindergartens B</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Paired</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Unpaired</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Kindergartens C</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Paired</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Kindergartens D</td>
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<tr>
<td>Paired</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>127</td>
<td>32</td>
</tr>
</tbody>
</table>

47
where the children were, a child who had already had trials on the material jumped up and asked the examiner, "Am I going to play with your blocks?" or "Can I play the block game now?" During the time when the material was being used, the children asked many questions about the blocks, such as "Who made these blocks?" "Where did you get these blocks?" "Can I take these blocks home?" "I wish I had some of the blocks at home." "How did you make these blocks?" "Who gave you these blocks?"

When the children were not actually seeing the material, the pictures seemed to play a much smaller part in their idea of the "game" than the blocks. None of the children while not in the examining room referred to "the picture game". It was always "the block game". This is due probably to the fact that during the learning, the child responds by picking up each block and handing it to the examiner. The child, therefore, handles the blocks and his attention is directed more to them. While in the examining room, the pictures brought out some comments. These were more likely to be confined to remarks in regard to the pictures as connected with the blocks, however, than to the pictures as pictures; whereas, in the case of the blocks, the blocks
as blocks interested them. A few of the children asked the examiner, "Did you draw these pictures?", "Who made these pictures?", or commented upon the object represented in the picture. When the pictures were mentioned apart from the similarity of blocks and pictures, the comments made were generally in regard to the aesthetic effect or effective tone produced by the picture upon the child. The comment was made very frequently in regard to picture 16, "That's a pretty flower", "I like that flower". The picture of the windmill, picture 19, was another pleasing one. The picture of the flower and the picture of the windmill called forth more comments of this type probably, than any other of the pictures. "I think that's a pretty little windmill", "I like that windmill" or a similar remark was made quite frequently.

Almost every child made some comment upon the similarity of certain of the pictures and their corresponding blocks. The resemblance between pictures and blocks was evident enough for even the youngest of the children to observe and comment upon certain of the resemblances. Frequently a child pointed out a resemblance and then added a comment that no doubt helped to fix the association in his mind. For example, several of the pre-
school children who were learning the material shortly after Christmas remarked upon the similarity of block 3 and the coal car of the train picture with which this block is associated and remarked, "That's like my choo-choo train too" or "I got one like that for Christmas". With many children there was a tendency to repeat during each successive trial comments made on the first few trials regarding the similarity of certain blocks and pictures. The only picture that seemed to be of an object unrecognizable to some of the children was the picture of an old-fashioned writing desk. When a child asked the examiner what the picture was, it was considered permissible to tell him. The fact that this object was more likely than any other to be unknown to the children did not interfere with their ability to form the required association between the picture of the desk and block 12, since very few errors were made on this. In this case the obvious resemblance that serves as a basis for the child's formation of the associations seems to be a good index to the fact that the children were able to pick out correspondence between block and picture, even in case the object represented in the picture was not recognized by the child. One small boy during each of his daily trials ran his finger along the sloping part of block 12 and immediate-
ly after ran his finger along the corresponding part of
the picture, the slanting writing surfact of the desk,
and commented that they were "just alike", or "just the
same". After several days of this repetition the
examiner pointed to the picture and asked the child,
"What is that? What is that a picture of?" The child
responded without any hesitation, "An ice box". Never­
theless, the association of the correct block with this
picture had been made from the first trial and the child
continued to respond correctly each time until learning
had been completed.

**Forms of Presentation**

The material used in this experiment was pre­
sented to the different groups of children according
to three forms, the standard form, and two variant forms:
the form of interchanged associations, and the single
series form, that is, the form by which the child learn­
ed either Series I or Series II. The standard form,
sometimes designated as the block-picture form, is the
one that was used with the largest number of children.
One hundred thirty-two children learned completely the
material according to the standard form and fifty chil­
dren according to the single series form. The other
variant form, interchange of learned associations, was
completed by fifteen children, but they had already learned the material by the standard form on successive days, since this variant form was not used until learning had been completed by the standard form. The 132 children who learned the material by the standard form were distributed as follows:

**Preschool Laboratories**
- Preschool.................32
- Junior Primary............15
- Paired (Daily)............11
- Paired (Alternate)........11
- Unpaired (Alternate).....1

**Kindergartens**
- Kindergarten A............35
- Kindergarten B............15
- Kindergarten C............12
- Total 132

Of the 132 children who learned the material by the standard form, twelve learned it on alternate days and 120 on successive days. Among the latter are the eleven children who learned the material on successive days, but were paired off for the purpose of comparing their learning with that of the children who learned the material on alternate days. In the analysis of the data, the records of the children of the pairs who learned the material by the standard form of presentation on successive days may be included both with those of the children who learned the material on successive days and were not paired, and with those of the
children with whom they were paired who learned the material on alternate days. The thirteen children who relearned the material after an interval of one year are included in the total 132.

Standard Form

Children Studied Individually - The 120 children who are discussed here include these groups:

<table>
<thead>
<tr>
<th>Preschool Laboratories</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Preschool</td>
<td>32</td>
</tr>
<tr>
<td>Junior Primary</td>
<td>15</td>
</tr>
<tr>
<td>Paired (Daily)</td>
<td>11</td>
</tr>
<tr>
<td>Kindergartens</td>
<td></td>
</tr>
<tr>
<td>Kindergarten A</td>
<td>35</td>
</tr>
<tr>
<td>Kindergarten B</td>
<td>15</td>
</tr>
<tr>
<td>Kindergarten C</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>120</strong></td>
</tr>
</tbody>
</table>

The few children who learned the material on successive days and were paired with children who learned it on alternate days were included, since the form of presentation and method of learning are identical with those of the children who were not paired. The factor of pairing does not invalidate in any way their inclusion with the records of the children who were not paired who learned the material by the same form of presentation and same method of learning.
The results of this experiment are scored on the basis of the number of trials required for complete learning and it is this number of trials that is used throughout the statistical analysis. The number of trials necessary for complete learning is understood as meaning the number of the trial on which the third perfect score is attained. The check on learning is not included since this is not an intrinsic part of the learning situation. On the tables where the actual score on each trial is given, the numbers underlined denote the score on the check on learning and is not to be included in computing the number of trials required for complete learning. For the thirty-two preschool children who learned the material according to the standard form of presentation and the method of learning on successive days, the range of trials necessary for complete learning was from five to twenty; for twenty-six junior primary children the range was four to fourteen; and for sixty-two kindergarten children the range was exactly the same. The junior primary group and the group of kindergarten children each includes one child only who learned the material in four trials and one who required fourteen trials in which to complete the learning. In each of these groups,
the majority of children required from five to nine trials in order to form correctly the twenty associations involved in the association reaction type of learning material.

Table 4 shows for each group of children the average number of trials required for learning for various forms of presentation and for various methods of learning. The records on the standard form of presentation of material on successive days include those of children from the preschool, junior primary, and from three of the five kindergartens. The average number of trials for thirty-two preschool children is 13.56; for twenty-six junior primary children, 7.42; and for sixty-two kindergarten children, 7.02. It is interesting to note that the average number of trials required for learning by the preschool children is reduced almost 50 per cent by the junior primary children and the kindergarten children. The average number of trials for junior primary and for kindergarten children is almost identical, the difference being 0.4. Combining the number from the junior primary and kindergartens gives a total of eighty-eight children, five and one-half years of age, whose average number of trials is 7 for complete learning of the
Table 4

Average Number of Trials Required for Learning for Various Forms of Presentation and for Various Methods of Learning

<table>
<thead>
<tr>
<th></th>
<th>Daily</th>
<th></th>
<th>Alternate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Average</td>
<td>Number</td>
<td>Average</td>
</tr>
<tr>
<td>Preschool</td>
<td>32</td>
<td>13.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior Primary</td>
<td>26</td>
<td>7.42</td>
<td>12</td>
<td>5.75</td>
</tr>
<tr>
<td>Kindergarten</td>
<td>62</td>
<td>7.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Variant Form

<table>
<thead>
<tr>
<th></th>
<th>Series I</th>
<th></th>
<th>Series II</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>26</td>
<td>5.61</td>
<td>24</td>
<td>5.79</td>
</tr>
</tbody>
</table>

Average 5.75
material when given according to the standard form of presentation and daily method of learning.

**Children Studied by Pairs: Learning on Successive Days versus Learning on Alternate Days.** - For a comparison of the number of trials required for complete learning when the material was presented on successive days and the number of trials required for complete learning when the material was presented on alternate days, twenty-six children of the junior primary group were paired on the basis of similarity in regard to Stanford-Binet mental age, height, and weight. It was hoped that by having only a slight difference on three variables between the children of each pair that comparable results would be obtained.

After the children had been paired, the first child of each pair was given the association reaction learning material according to the standard form of presentation and on successive days; the other child of each pair was given the same material by the standard form of presentation but on alternate days. Due to absences, it was necessary to discard the records of two of the paired children who were learning the material on successive days and of one child who was learning it on alternate days. One of the children
who completed the learning on alternate days was pair-
ed with one of the children whose record had to be
discarded. When comparing learning on successive days
and learning on alternate days, it was necessary to
discard the record of this child who completed the
learning on alternate days but who was now without a
pair. The total number of paired children was re-
duced therefore, to twenty-two. Although it was dis-
carded for the purpose of comparing learning on suc-
cessive days and learning on alternate days, the re-
cord of the child who was now without a pair was re-
tained for another purpose. This child was one of
the number who was given the material for relearning,
one year after the original learning. His record may
be used for this purpose because here the comparison
is between two records on the same child and is not
a comparison between the records of paired children.
This child's record is designated as "Unpaired (Alter-
nate)" on those tables where the total number of
records used in the various parts of this experiment
is stated.

Table 5 shows the comparison of scores of
junior primary children paired on mental age, height,
and weight for learning on successive days and learn-
### Table 5

Comparison of Scores of Junior Primary Children Paired on Mental Age, Height, and Weight for Learning on Successive Days (S) and Learning on Alternate Days (A)

<table>
<thead>
<tr>
<th>Child Sex</th>
<th>Mental Age</th>
<th>Height</th>
<th>Weight</th>
<th>Method</th>
<th>Number of Trials</th>
<th>Total for complete learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Months</td>
<td>Cm.</td>
<td>Kg.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>F</td>
<td>1</td>
<td>1.3</td>
<td>S</td>
<td>14 19 17 18 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>9 5</td>
</tr>
<tr>
<td>1a</td>
<td>F</td>
<td>1</td>
<td>0.7</td>
<td>A</td>
<td>17 19 20 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>5 5</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>0</td>
<td>1.8</td>
<td>S</td>
<td>9 16 17 20 20 19 20 20 20 20 20 20 20 20 20 20</td>
<td>9 5</td>
</tr>
<tr>
<td>2a</td>
<td>F</td>
<td>0</td>
<td>0.7</td>
<td>A</td>
<td>10 17 20 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>5 5</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>0</td>
<td>2.3</td>
<td>S</td>
<td>12 17 20 20 19 20 20 20 20 20 20 20 20 20 20 20</td>
<td>11 5</td>
</tr>
<tr>
<td>3a</td>
<td>F</td>
<td>0</td>
<td>0.95</td>
<td>A</td>
<td>18 19 20 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>5 5</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>0</td>
<td>2.8</td>
<td>S</td>
<td>12 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>4 4</td>
</tr>
<tr>
<td>4a</td>
<td>F</td>
<td>0</td>
<td>0.75</td>
<td>A</td>
<td>8 16 20 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>5 5</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>0</td>
<td>2.0</td>
<td>S</td>
<td>12 17 16 20 20 19 20 20 20 20 20 20 20 20 20 20</td>
<td>10 5</td>
</tr>
<tr>
<td>5a</td>
<td>M</td>
<td>0</td>
<td>0.7</td>
<td>A</td>
<td>13 16 18 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>5 5</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>1</td>
<td>1.2</td>
<td>S</td>
<td>12 17 18 19 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>8 6</td>
</tr>
<tr>
<td>6a</td>
<td>F</td>
<td>1</td>
<td>0.6</td>
<td>A</td>
<td>17 17 18 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>6 6</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>2</td>
<td>1.7</td>
<td>S</td>
<td>12 14 19 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>8 5</td>
</tr>
<tr>
<td>7a</td>
<td>M</td>
<td>2</td>
<td>1.65</td>
<td>A</td>
<td>14 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>5 5</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>2</td>
<td>0.9</td>
<td>S</td>
<td>12 17 18 19 20 18 20 20 20 20 20 20 20 20 20 20</td>
<td>9 6</td>
</tr>
<tr>
<td>8a</td>
<td>M</td>
<td>2</td>
<td>0.85</td>
<td>A</td>
<td>15 19 20 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>6 6</td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>1</td>
<td>1.0</td>
<td>S</td>
<td>12 14 19 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>6 6</td>
</tr>
<tr>
<td>9a</td>
<td>F</td>
<td>1</td>
<td>0.4</td>
<td>A</td>
<td>12 19 20 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>6 6</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>2</td>
<td>0.0</td>
<td>S</td>
<td>12 9 16 17 16 19 17 20 20 20 20 20 20 20 20 20</td>
<td>14 6</td>
</tr>
<tr>
<td>10a</td>
<td>M</td>
<td>2</td>
<td>0.26</td>
<td>A</td>
<td>12 16 20 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>6 6</td>
</tr>
<tr>
<td>11</td>
<td>M</td>
<td>3</td>
<td>2.17</td>
<td>S</td>
<td>5 9 15 17 17 20 20 20 20 20 20 20 20 20 20 20</td>
<td>8 7</td>
</tr>
<tr>
<td>11a</td>
<td>M</td>
<td>4.1</td>
<td></td>
<td>A</td>
<td>10 13 18 20 20 20 20 20 20 20 20 20 20 20 20 20</td>
<td>7 7</td>
</tr>
</tbody>
</table>

**Range of mental age:** 6 years, 5 months to 7 years, 6 months

**Range of height:** 104.2 to 117.5 cm

**Range of weight:** 15.0 to 23.75 kg

Numbers underlined denote score on check of learning
ing on alternate days. The amount of the "plus" differences for each pair is indicated; that is, the amount of difference in mental age, height, and weight, is placed on a line with the record of the child of each pair who is the older mentally or the heavier or the taller. With two exceptions, pairs 5 and 11, the close resemblances of these paired children is remarkable considering that three variables are involved. Although there is greater difference between the children in the pairs designated as 5 and 11 than between the children in any other pair, they were included as the greater differences are between records of heights and weights in each case rather than between mental age scores which would seem to be the most important of these three factors in a problem involving learning. The records of height and weight were included simply to have the children as comparable as possible but no attempt is being made to show the influence of height and weight as factors in learning. The actual score of each of the twenty-two children on each trial is shown in Table 5 together with the total number of trials for complete learning. The method of learning for the first child of each pair is designated as S to indicate that the material was presented on successive days and
the method of learning for the second child of each pair is designated as A to indicate that the material was presented on alternate days. A comparison by pairs of the total number of trials required for complete learning shows that with one exception, the child of each pair who learned the material on alternate days learned in fewer trials than the child who learned it on successive days. The record of pair 4, in which the exception occurs, shows that the child of this pair who had the material presented on successive days learned it completely in four trials and the child with whom she was paired learned the material in five trials on alternate days. The child who required but four trials in which to learn the material is not only an exception among this group used for comparison of learning on successive days with learning on alternate days, but is an exception among the twenty-six junior primary children who learned the material on successive days, including the records of both the children of the pairs to whom the material was presented on successive days and the children who learned the material on successive days but were not paired. Among the sixty-two kindergarten children comparable to the junior primary group, one child only learned the
material in four trials. Therefore, since two children only of a total of eighty-eight learned the material in four trials, when it was presented on successive days, they must be regarded as exceptional cases. In reference to pair 4, the record of the first child of the pair who learned it in four trials on successive days may be regarded as an exception, whereas, the record of the child with whom she is paired who learned it in five trials when presented on alternate days may be considered an average performance. Of the eleven children who learned the material on alternate days, five children learned it in five trials. Including the record of the child designated as "Unpaired (Alternate)" the average number of trials required for learning the material by the standard form of presentation on alternate days by the total number of twelve children is 5.75 trials. The average number of trials required for learning the material by the standard form of presentation on successive days by the total number of eleven children used in the pairs is 6.75.

Table 6 shows a comparison of the average scores on each trial for learning on successive days and for learning on alternate days. Figure 12 shows
Table 6

Comparisons of Average Scores by Trials on Each Form of Presentation of Material and on Each Method of Learning

<table>
<thead>
<tr>
<th>Trials</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Daily Learning and Learning on Alternate Days</td>
<td><strong>Daily</strong></td>
<td>10.2</td>
<td>14.9</td>
<td>16.5</td>
<td>18.8</td>
<td>19.1</td>
<td>19.0</td>
<td>19.8</td>
<td>19.6</td>
<td><strong>20.0</strong></td>
<td>19.7</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Alternate</td>
<td>11.3</td>
<td>15.4</td>
<td>18.9</td>
<td>19.6</td>
<td>20.0</td>
<td>19.8</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

Learning and Relearning after an Interval of One Year

<table>
<thead>
<tr>
<th>Learning</th>
<th>Relearning</th>
<th><strong>Learning</strong></th>
<th>11.0</th>
<th>15.8</th>
<th>18.7</th>
<th>19.8</th>
<th>19.7</th>
<th>20.0</th>
<th>20.0</th>
<th>19.7</th>
<th>20.0</th>
<th>20.0</th>
<th>20.0</th>
<th>20.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series I</td>
<td>17.8</td>
<td>19.5</td>
<td>19.9</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Series II</td>
<td>17.8</td>
<td>19.5</td>
<td>19.9</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>
Figure 12
Comparison of learning on successive days (---) and on alternate days (---). Average curves.

Figure 13
Comparison of learning (---) and re-learning (---) after an interval of one year. Average curves.
this comparison represented graphically. The solid line represents learning on successive days and the dotted line represents learning on alternate days for the twenty-two children who were paired for the purpose of comparing the number of trials required for completed learning when the material was presented according to the standard form, on successive days with the number of trials required for completed learning when the material was presented according to the standard form and on alternate days. It is interesting to note that in each group of children, the learning curve reaches the perfect score of 20 but does not remain there for three successive trials. The curve that represents learning on successive days shows more fluctuations than the curve that represents learning on alternate days. The curve representing learning on alternate days has reached and maintained three successive perfect scores of twenty by the ninth trial but the curve representing learning on successive days does not reach twenty until the tenth trial after which there is a decrease before three successive perfect scores are attained on the fourteenth trial. Although the total number of cases, twenty-two is small, results on these records show decidedly that for this type of learning, presentation of ma-
terial on alternate days results in greater economy of learning than presentation on successive days.

Relearning after an Interval of One Year. -

The work with the association reaction material was begun in the spring of one year with a small number of children and continued through the whole of the following school year. It was planned to repeat the experiment one year later with those children who were available who had been subject of the investigation at the time the experimental work was begun. Thirteen children who had learned the material by the standard form of presentation exactly one year previously were given it again in order to compare their scores and rate of learning on the original learning, with their scores and rate of learning after an interval of one year. Of the thirteen children, seven had learned it originally on alternate days and six had learned it originally on successive days. For this study of relearning, the material was presented to the child on successive or on alternate days according to which method of learning had been used for the original learning one year earlier. In several instances, the child had been paired the previous year with a child who was no
longer in the school and therefore, not available as a subject for relearning of the material. This however, did not interfere with the child of the pair who was still in the school being a subject for relearning since for the study of relearning, each child's record is compared with his own record of learning one year earlier regardless of whether or not he was one of the children studied in a pair or individually.

Table 7 shows a comparison of scores and number of trials for learning and for relearning after an interval of one year. The scores on each trial of the learning are designated by \( L \) and the scores on each trial of the relearning by \( R \). The total number of trials required for both learning and relearning are shown and also the decrease in number of trials for relearning. Subjects 1 to 12 were in the junior primary at the time of the original learning and in the first grade at the time of relearning; subject 13 was in the preschool at the time of original learning and in the junior primary group at the time of relearning.

With the exception of child 3 who required five trials for learning the material on alternate
Table 7
Comparison of Scores and Number of Trials for Learning (L) and Relearning (R) after an Interval of One Year

Learning on Alternate Days

<table>
<thead>
<tr>
<th>Child</th>
<th>Method</th>
<th>Number of Trials</th>
<th>Total number of trials required</th>
<th>Decrease in number of trials for relearning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>L</td>
<td>10 17 20 20 20 20</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>16 20 20 20 20</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>L</td>
<td>18 19 20 20 20 20</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>19 20 20 20 20</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>L</td>
<td>6 14 20 20 20 20 17</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>18 18 20 20 20 20</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>L</td>
<td>8 16 20 20 20 20</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>15 20 20 20 20</td>
<td>4</td>
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</tr>
<tr>
<td>5</td>
<td>L</td>
<td>8 15 19 20 20 20 20</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>14 18 20 20 20 20</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>L</td>
<td>17 17 18 20 20 20</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>19 20 20 20 20</td>
<td>4</td>
<td></td>
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<tr>
<td>7</td>
<td>L</td>
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</tr>
<tr>
<td></td>
<td>R</td>
<td>19 20 20 20 20</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Daily Learning

<table>
<thead>
<tr>
<th>Child</th>
<th>Method</th>
<th>Number of Trials</th>
<th>Total number of trials required</th>
<th>Decrease in number of trials for relearning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>L</td>
<td>13 17 20 20 19 20 20 19 20 20 20 20</td>
<td>11</td>
<td>3</td>
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<td></td>
<td>R</td>
<td>20 20 20 20</td>
<td>3</td>
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</tbody>
</table>

Numbers underlined denote score on check of learning
days and five trials for relearning the material by
the same method, each child showed a decrease in the
number of trials required for relearning as compared
with the number of trials required for learning. No
child showed an increase in the number of scores re-
quired for relearning the material. On table 7, the
column giving the decrease in number of trials for
relearning shows another interesting point. The to-
tal range of difference in number of trials on re-
learning as compared with learning for the thirteen
children is from 0 to 12. When the two groups of
children are considered separately, those who learn-
ed and relearned the material on successive days, and
those who learned and relearned the material on al-
ternate days, a still more interesting fact stands out.
Of the seven children who relearned the material on
alternate days, one showed neither an increase nor a
decrease in number of trials required for relearning,
four showed a decrease of one trial and two a decrease
of two trials. Of the six children who relearned the
material on successive days, one showed a decrease of
one trial in the number of trials required for relearn-
ing, two showed a decrease of two trials, one showed a
decrease of four trials, one a decrease of eight trials,
and one a decrease of twelve trials. The average of the
decrease in number of trials for relearning of those who learned and relearned the material on alternate days is 1.14 trials and for those who learned and relearned the material on successive days is 4.63 trials. The children who learned the material on alternate days required fewer trials than those who learned it on successive days, and showed a smaller decrease in the number of trials for relearning. The children who learned the material on successive days required a larger number of trials than those who learned it on alternate days, and showed a larger decrease in the number of trials for relearning. The explanation of this may be that the children who learned the material on alternate days made such rapid progress that they soon reached their physiological limit beyond which there is little room for improvement. The decrease in number of trials required for relearning is therefore very small since the original learning was accomplished at approximately maximum speed of forming the required associations. The children who learned the material on successive days made slower progress on the original learning and required so many trials for learning that there was still much room for improvement. The decrease in number of trials required for relearning was therefore, greater.
Table 6 shows a comparison of the average scores by trials for learning and relearning after an interval of one year. Figure 13 represents this graphically. The solid line represents the original learning and the dotted line the relearning after an interval of one year. By the sixth trial, the relearning curve has reached a score of twenty and maintained it for three successive trials. The learning curve has reached twenty for the first time on the sixth trial and after maintaining this score for two trials, falls back before attaining three successive scores of twenty. Figure 14 shows some individual curves representing learning, and relearning after an interval of one year. The former is shown by the solid line the latter by the dotted line. Of the total number of subjects, all but one accomplished relearning after an interval of one year in fewer trials than were required for the original learning and in this one exceptional case, learning and relearning were accomplished in exactly the same number of trials.

As soon as the child had finished the first trial of relearning, the examiner asked three questions. First, "Did you ever play this game before?" If the
Figure 14
Comparison of learning(---) and relearning (-----) after an interval of one year. Individual curves.
child responds "Yes", the second question is asked, "When did you play the game before?" After the child has responded, the examiner asks the third question, "Did you remember how to play the game?" One child only said "No" to the first question and one child said, "I don't know. I don't remember". Each of the eleven remaining children said they remembered "the game". In some cases it was unnecessary to ask the question as several of the children said near the beginning of the experiment that they remembered the game, or that they had played this game before, or that they had played it when they were in the junior primary last year. The youngest child to whom the relearning was given (Child 13, Table 7), the only one who was in the preschool at the time of learning the material and in the junior primary at the time of relearning, showed quite clearly that he remembered not only "the game" but many of the factors of the situation while learning it. When asked if he had ever played "the game" before Robert responded at once, "Oh yes", and when asked, "When did you play the game before?" , he explained in detail by saying, "Oh, a long time ago when I was over at the preschool. When I was in that little room over at the preschool we
played it. We played it on this same table, too".
The place localization was remarkably accurate. The
year previous, the examiner had carried on this learn-
ing experiment in the smallest examining room at the
preschool. The table used was a special kind of table
from the art department. Although Robert was incorrect
in saying it was "the same table, too" that was being
used during the relearning, it was another drawing
table exactly like the one used during the time of the
original learning. When asked, "Did you remember how
to play the game?", Robert responded "Let's see if I
can think of any. I remembered they were placed like
this. I remembered the clock and I remembered this
(picking up block 13) and this (block 2) and this
(block 7) and this (block 14) but some I didn't know".
This child had taken fifteen trials in which to learn
the material but scored twenty on the first trial on
relearning and for the two following trials also.
The check on relearning was scored twenty also so
that each time he was given the material one year
after the original learning, he made a perfect score.

Variant Forms

Children Studied Individually and by Pairs:

Interchange of Learned Associations. - Fifteen chil-
dren, seven from the preschool and eight from the
junior primary group were subjects on the phase of the investigation involving the interchange of associations. Each of the children had completed the learning according to the standard form of presentation of material, followed by a check on learning. The material was then presented according to the directions for learning, when the learned associations are interchanged, as explained in Chapter I. Each child's record on learning when the associations were interchanged was compared with his record on the original learning. Table 8 shows this comparison. The scores for each trial on the original learning are designated by L and those on the learning when the associations are interchanged are designated by I. The total number of trials for original learning and for learning the interchanged associations are shown and the difference in number of trials required for each form of learning is given also.

The problem involved in this part of the investigation is to find out whether there is interference or transfer among the various associations that have been formed, when these associations are broken down and others of a somewhat similar nature are built up. Results indicate that there was very little interference. The learning of the material according to the standard
### Table 8

Comparison of Number of Trials of Fifteen Children for Original Learning (I) and for Learning when the Learned Associations are Interchanged (I)

<table>
<thead>
<tr>
<th>Child Method</th>
<th>Number of Trials</th>
<th>Variation of (I) from (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preschool Children</td>
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<tr>
<td>1</td>
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<td>10 12 14 18 17 18 18 19 18 18 20 18 20 20 20 20</td>
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<tr>
<td></td>
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<td></td>
<td>I</td>
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<td>3</td>
<td>L</td>
<td>3 5 12 15 15 14 18 16 20 20 18 18 18 18 18 19 20 20 20 20</td>
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<td>I</td>
<td>6 7 12 12 17 15 20 20 20 20</td>
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<tr>
<td>Junior Primary Children</td>
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<td>1</td>
<td>L</td>
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<td>8</td>
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<td></td>
<td>I</td>
<td>11 15 20 20 20 20</td>
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</tbody>
</table>

Numbers underlined denote score on check of learning.
form seemed to facilitate the forming of the interchanged associations. Of the fifteen children, nine learned the interchanged associations in a fewer number of trials than was required for the original learning, four required exactly the same number of trials, and two required a greater number of trials. Of these two children, one required one more trial for learning the interchanged associations and the other required two more trials. Using the total number of trials required for original learning and the total number of trials required for learning the interchanged association, the coefficient of correlation was computed by Pearson's rank difference method. It was found to be .83 P.E. ± .06 which is sufficiently high to be interpreted that the learning of the associations according to the standard form assists in the learning of the interchanged associations rather than interferes with their learning.

The children seemed to enjoy very much the interchange of associations. It amused most of them, particularly on the first trial. This trial was given just after there had been complete learning according to the standard form when the child was very sure of which block belonged with each picture. During the first
trial of learning the interchanged associations, when
the examiner held up a picture, several of the children
glanced toward the block that they had learned to as-
sociate with it, and when the examiner picked up a dif-
ferent block, the block that paralleled the one formerly
associated with it, the children frequently laughed aloud.
It seemed to amuse them to be told another block went
with the picture instead of the one they were accustomed
to associate with the picture. Frequently, as the
examiner gave the part of the directions for presenting
the material for learning the interchanged associations
that state, "Remember, now, this is the block that goes
with this picture", the child added, "And this is the
one that used to go with it". If the child responded
this way repeatedly, the examiner usually said, "Yes,
but now there is a different block that goes with each
picture", which is a repetition of a part of the directions
that are given just before beginning the first trial of
learning the interchanged associations. Only two children
commented upon the direct interchanging of the blocks by
say, for example, "This one (block 1) used to go with
the clock and now it goes with the owl, and this is the
one (block 11) that used to go with the owl and now it
goes with the clock". These two children pointed out
the direct interchanging of the blocks in a number of instances. The other children knew that different blocks went with the pictures but apparently did not observe, or at least did not comment upon, the relationship of the block that formerly went with the picture and the block that went with it when the associations were interchanged. Of the fifteen children who learned the material according to the interchange of associations, seven made a higher score on the first trial when learning the material according to the interchange of associations than they had made on the first trial of the original learning by the standard form of presentation; six made a lower score, and two made exactly the same score on the first trial when learning the material either by the standard form or according to the variant form, interchange of learned associations.

Children Studied by Pairs: Learning on Series I versus Learning on Series II. - Since Series I and Series II of the association reaction material are so comparable, it was decided to try out as one phase of the experiment, the giving of Series I to one child of a pair and Series II to the other child of the pair and then compare the results.
Fifty children from four kindergartens were paired for learning the material in this form. The records of two of the children who completed the learning may not be included in the comparison because the children with whom these two children were paired were absent from school the whole time the learning experiment was being conducted among the kindergarten children. Since none of the kindergarten children had been given a Stanford-Binet examination before the examiner began to work with them on the learning experiment, and there was not time enough to give each child a Stanford-Binet, the children used in pairs on the variant form of presentation, learning on Series I versus learning on Series II, were paired on the basis of their records on the Detroit Kindergarten Test. Since this basis of comparison may not be as accurate as comparison on the basis of similarity in mental age (Stanford-Binet), the children of each pair were selected so that there was not more than one month difference in chronological age between the two nor more than one point difference in score on the Detroit Kindergarten Test. In some pairs there was no difference in chronological age, in others no difference in Detroit Kindergarten scores and in other pairs no difference in either chronological age or Detroit Kindergarten score.
Since the children in each pair are the same or almost the same in regard to chronological age, and have scored the same or almost the same on the Detroit Kindergarten Test, one may expect their mental ability to be comparable without assuming too much. In the school system in which these four kindergartens are found, each kindergarten teacher administers the Detroit Kindergarten Test to the pupils in her own classes. In order to keep constant as far as possible any error due to the personal equation of the examiner because of the fact that the kindergarten teachers are not specially trained in the technique of mental testing, each child was paired with another child who was in the same class and had been given the Detroit Kindergarten Test by the same teacher and was never paired with a child from another class who had been given the Detroit Kindergarten Test by another teacher.

The first child of each pair was given Series I only and the second child of each pair was given Series II only. Table 9 shows a comparison of the forty-eight kindergarten children paired on the basis of not more than one month difference in chronological age nor more than one point difference in score on the Detroit Kindergarten Test, and the scores
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<td>M</td>
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<tr>
<td>E3a</td>
<td>M</td>
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</tbody>
</table>

Numbers underlined denote score on check of learning.
obtained by each child on each trial of the learning experiment. The total number of trials required for learning is given also. The letters before the number of each child designates the kindergarten from which the child comes. Results show a marked similarity between the number of trials required by the first child of each pair to learn the ten associations of Series I and the number of trials required by the second child of each pair to learn the ten associations of Series II. The coefficient of correlation between the number of trials required for learning Series I and Series II was \( P.E. = 0.981 \). This was computed by Pearson's rank difference formula. As shown on Table 4, the average number of trials required for learning Series I was 5.61 and for learning Series II was 5.79. The average number of trials required for forming ten associations was found by averaging the average number of trials required for learning Series I and for learning Series II. It was found to be 5.75 trials. It is an interesting point to note that the average number of trials for learning the material according to the standard form of presentation and on alternate days was 5.75 trials, and the average number of trials required for learning only one half of the material on successive days was 5.75 trials. Perhaps the children in the two groups were
Figure 15
Comparison of learning on Series I (-----) and Series II(---). Average curves.
not exactly comparable but the results seem to have 

a significance when viewed from the standpoint of 
effect on distribution of practice periods upon learn-
ing. According to the data presented here, the average 
number of trials required for learning twenty associa-
tions on alternate days was the same as the average num-
ber of trials required for learning ten associations on 
successive days.

Check on Learning

Check on Learning of Standard Forms

Three successive perfect scores of twenty were 
followed by the check on learning. Results show that for 
the material used in this investigation, three successive 
perfect scores is sufficient evidence of complete learn-
ing. As shown in Table 10, of the 182 children who com-
pletely learned the material, 166 attained a perfect 
score on one trial of the check and five children only 
attained less than a perfect score on the check. Eleven 
of the children who had completed three successive per-
fert trials had no check on learning because they were 
absent, the examiner had left to do testing in another 
town, or a vacation began just after the child had com-
pleted the learning.
Table 10
Results of Check on Learning after Three Successive Perfect Scores have been Attained

<table>
<thead>
<tr>
<th>Groups</th>
<th>Completed Original Learning</th>
<th>Completed Interchanged Associations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Perfect Score</td>
<td>No Check</td>
</tr>
<tr>
<td>Preschool</td>
<td>27</td>
<td>2</td>
</tr>
<tr>
<td>Junior Primary</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Paired (Daily)</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Paired (Alternate)</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Unpaired (Alternate)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Kindergartens

<table>
<thead>
<tr>
<th></th>
<th>Completed Original Learning</th>
<th>Completed Interchanged Associations</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Paired</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Unpaired</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Paired</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>D Paired</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>E Paired</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>166</td>
<td>5</td>
</tr>
</tbody>
</table>
Of the 132 children who completely learned the material according to the standard form of presentation, 119 made a perfect score on the check on learning, four scored less than twenty and nine children had no check. Of the thirteen children who re-learned the material according to the standard form after an interval of one year, every one scored perfect on the check.

Check on Learning of Variant Forms

Of the fifteen children who learned the material according to the variant form, interchange of learned associations, each child made a perfect score of twenty on the check.

Of the forty-eight children who learned the material according to the variant form, single series form, by which the child learned either Series I or Series II, one child only failed to make a perfect score of ten on the check. These results are shown on Table 10.

In most instances, the children located the pictures very readily during the check on learning. It was only occasionally that a child walked up and down scanning the pictures while trying to find the one with which to respond.
Learning Curves

One of the factors in the learning process that has been the subject of much discussion is the plateau. Several investigators have tried to solve certain problems in regard to it but no agreement has been reached. In answer to questions such as, What is the nature of the plateau? What is the cause of the plateau and how is it to be interpreted? Is the plateau an essential of all types of learning or is it peculiar to certain types only?

The investigation under discussion brought out some interesting and significant facts in regard to plateaus as found in the association reaction type of learning in the case of young subjects. Table 11 shows the number and distribution of plateaus found in the learning curves of each group of children. Of the 182 children who completed the learning of the material, 113 (62.1 per cent) have no plateaus in their learning curves and sixty-nine have from one to five plateaus. Of the 120 children who learned the material according to the standard form of presentation on successive days, the largest number of children who can be grouped together on the basis of a common factor, seventy-five (62.5 per cent) have no plateaus and forty-
Table 11
Number and Distribution of Plateaus in Learning Curves of Each Group of Children

<table>
<thead>
<tr>
<th>Groups</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Number of Children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preschool Laboratories</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preschool</td>
<td>9</td>
<td>10</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>Junior Primary</td>
<td>11</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Paired(Daily)</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Paired(Alternate)</td>
<td>9</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Unpaired(Alternate)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Kindergarten

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of Plateaus</th>
<th>Number of Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>22 13 0 0 0 0 0</td>
<td>55</td>
</tr>
<tr>
<td>B</td>
<td>9  6  0 0 0 0 0</td>
<td>15</td>
</tr>
<tr>
<td>Paired</td>
<td>11 4 1 0 0 0 0</td>
<td>16</td>
</tr>
<tr>
<td>Unpaired</td>
<td>2  0  0 0 0 0 0</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>8  4  0 0 0 0 0</td>
<td>12</td>
</tr>
<tr>
<td>Paired</td>
<td>9  5  0 0 0 0 0</td>
<td>14</td>
</tr>
<tr>
<td>D Paired</td>
<td>10 2  0 0 0 0 0</td>
<td>12</td>
</tr>
<tr>
<td>E Paired</td>
<td>6  0  0 0 0 0 0</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>113 53 10 4 1 1 1</td>
<td>182</td>
</tr>
</tbody>
</table>
five had from one to five plateaus. This is an interesting fact, that the percentage of children having no plateaus is the same for all forms of presentations considered collectively and for the standard form of presentation, the form by which the largest number of children learned the material. Another interesting point is the fact that the greater number of plateaus occurs among the curves of the younger children. Of the 150 children of the junior primary and kindergarten groups, 104 (69.3 per cent) have no plateaus, three only have as many as two plateaus, and no child has more than two. Among the preschool children, however, the situation is very different; of the thirty-two, nine (28.1 per cent) have no plateaus, (71.9 per cent) and twenty-three have from one to five plateaus. A smaller number of preschool children have no plateaus than had one plateau, and this situation is not found in any other group of children used in this study. From these facts it may be concluded that plateaus are not a necessity in the association reaction type of learning and that whether or not they occur seems to be a matter of individual differences and of maturity. An interpretation of the plateau that seems applicable to the learning curves under discussion is that sometimes when new associative bonds are formed, particularly if
several new bonds are formed at almost the same time, they are not formed with sufficient security to be considered fixed and a basis for the upbuilding of further associations. The fact that a plateau or even a decrease in score almost always follows a very large increase seems to suggest a relation between the period of rapid progress and the period when apparently no progress is taking place. Progress, in one sense, probably is occurring, that is, new associative bonds that were formed at the time of the very rapid progress are becoming fixed and automatized. Until automatization of these bonds has taken place, there can be no further progress. The group of curves shown in Figures 16 and 17 show the plotted records of eight children who with one exception had a trial on the learning material according to the standard form of presentation and on successive days; Child 2, Figure 16, was given the material on alternate days. The curves of Child 1, 2, 3, and 4, Figure 16, and Child 1 and Child 3, Figure 17, represent a large increase in number of associations formed, followed by a plateau, and the curves of Child 2 and Child 4, Figure 17, show a decrease in score following upon a large increase. These are a few random samplings, but in almost every
Individual learning curves showing tendency for a large increase in score to be followed by a plateau or decrease. Standard form of presentation (-----) and interchange of associations (---).
Individual learning curves showing tendency for a large increase in score to be followed by a plateau or decrease. Standard form of presentation(---) and interchange of associations(---).
learning curve in which one or more plateaus occur, a large gain is to be found immediately before it.

Recently, there has come into usage in psychological literature the term "shock absorber" to denote a preliminary test similar to the test upon which the subject is to be scored for subjects who are not accustomed to psychological test conditions. The difference in response on the first trial between children accustomed to psychological tests and those unaccustomed to them is well demonstrated in the results obtained on the junior primary and kindergarten groups, in which the children are comparable in age and school status.

The Iowa Child Welfare Research Station Laboratories, as the name suggests, are laboratories where special problems are investigated rather than schools. Every child in the preschool and junior primary groups had had several psychological tests previous to being a subject for the learning experiment, and many of the children who had been in the preschool group the year or years previous had taken a large number of psychological tests. They were thoroughly habituated to psychological test conditions or to "playing a game" as the examiners always suggest
it when a child is asked to leave the play group to go into the examining room for a mental test.

The kindergarten children were unaccustomed to taking psychological tests. With a few exceptions, all of the kindergarten children had been given the Detroit Kindergarten Test seven months previously by their teachers, but some had never had a psychological test of any kind.

The majority of junior primary children begin with a score of 9 or above and several of them begin with a score of 15 or more. The majority of the kindergarten children, however, begin with a very low score. Several of the very bright kindergarten children made a score of 3 or 4 points on the first trial and a number, a score of 5 or 6 points. Those who begin so low invariably show a very rapid rise, after which the curve progresses very much the same as the curves of the junior primary children. In no case does a junior primary child make as large an initial gain as in many cases of initial gain found among the kindergarten children.

The children were not afraid of the examiner, their cooperation was excellent, and they seemed interested in the blocks and pictures. As far as could be observed, there were no extraneous factors that might detract from
the children's attention, or account for in any way the constant low score on the first trial found among all of the kindergarten children, unless it may be attributed to the fact that the child had to become accustomed to psychological test conditions. Since the kindergarten children are able to complete the learning within the same number of trials as the junior primary children with whom they are comparable and the number of the trial on which the child attains the third consecutive perfect score is the measure of learning for this experiment, the factor of a low score on the first trial is hidden in the results.

Figures 18 and 19, individual learning curves of kindergarten children, show this tendency to begin with a low score which is followed by a rapid initial rise.

**Records of Data**

**Tabulated Scores**

In addition to plotting a learning curve for each child who was a subject of any part of the experiment, a tabulated record was kept showing the score made by each child on each trial. This represents of course, the same thing as the learning curve but in a different way. For certain purposes of comparison, such as comparing the records of
Figure 18

Individual learning curves of kindergarten children, showing low beginning scores and rapid initial rises.
Figure 19

Individual learning curves on kindergarten children, showing low beginning scores and rapid initial rises.
several children, or comparing children whose scores are almost the same for several trials, the comparison is more readily seen by referring to the tabulated records of individual scores on each trial than by comparing the individual learning curves.

Several of the tables that have been referred to in other parts of this study show samples of some of the tabulated records of individual scores. Among the tables that show tabulated individual scores are tables 5, 7, 8, and 9.

**Analysis of Errors**

In order to analyse the data obtained from this experiment, it is necessary to know not only how many errors are made but exactly what these errors are. A child's correct response is indicated on the score sheet by putting a plus sign upon the corresponding figure. When a child responds with the incorrect block, instead of simply indicating an error by a minus sign, the examiner draws the incorrect block upon the score sheet beside the outline of the block. By means of distribution charts, successes and errors have been tabulated for the various groups of children according to each form of presentation and to each method of learning. In this way, it may be seen
how many times each one of the blocks has been given correctly and how many times each one of the block has been confused with each of the remaining nineteen blocks.

Figure 20 is a chart that shows a summary of the distribution chart of the analysis of successes and errors of the thirty-two preschool children who learned the material according to the standard form of presentation on successive days, and shows the frequency of correct responses and of errors. The chart represents the records of thirty-two children who had a total number of 434 trials. The drawings of the blocks in perpendicular position on the left hand side of the chart represent the order of sequence of the twenty forms and this is the correct order in which the child is to respond. The drawings of the blocks in horizontal position at the top of the chart are in the same order. The method of reading the chart is as follows: by selecting any block on the left hand side and continuing straight across the chart, it may be seen at a glance exactly how many times each block was given for each of the other blocks by reading the numbers at the point of intersection with the column below each drawing of one of the twenty blocks. The diagonal shows the number of times each block was given correctly since it is at these points that the drawing of each block on the perpendicular intersects with the drawing of the same block on the horizontal.
| 96 |

| Figure 20 |

Frequency of errors on associations with twenty blocks, presented according to standard form. Thirty-two preschool children.
A study of this chart will reveal certain interesting facts: The six-pointed star, block 20, was given forty times instead of the five-pointed star, block 10, and the five-pointed star, block 10, was given fifty times instead of the six-pointed star, block 20. The hexagon, block 15, was given thirty-three times instead of the pentagon, block 5, and the pentagon, block 5, was given fifty-eight times instead of the hexagon, block 15. In these instances, the large number of errors was due to confusion between two similar blocks. In other instances, the errors were due to confusion between two pictures of somewhat similar objects. For instance, block 17 was given twenty-three times instead of block 15, and block 13 was given thirty-three times instead of block 17. Block 13 goes with the picture of a flying bird and block 17 with the picture of a duck. Sometimes, the confusion was not between block and block, or picture and picture, but between block and picture. This was illustrated best by the confusion of the round block, block 1, and the picture of a six-spoked wheel, picture 15. The round block, block 1, was given sixty times incorrectly for the picture of a six-spoked wheel, picture 15. On
the other hand, block 15, was given six times only for picture 1. This shows definitely that the errors were due neither to a confusion of one block with another, nor to a confusion of picture with another, but to the confusion of one block with the wrong picture.

Figure 21 is a chart that shows a summary of the distribution chart of the analysis of successes and errors of the sixty-two kindergarten children who learned the material according to the standard form of presentation on successive days, and shows the frequency of correct responses and of errors. The chart represents the records of sixty-two children who had a total number of 435 trials. The method of reading this chart and the ones that follow is the same as the method that has been described for the reading of the chart representing the successes and errors of the thirty-two preschool children, figure 20.

A comparison of figures 20 and 21 brings out an interesting fact. Figure 20 represents the records of thirty-two preschool children who had a total number of 434 trials. Figure 21 represents the records of sixty-two kindergarten children who had a total number of 436 trials. The number of kindergarten children is almost exactly twice the number of
Figure 21

Frequency of errors on associations with twenty blocks, presented according to standard form. Sixty-two kindergarten children.
preschool children yet the total number of trials required by the kindergarten children is 435 and the total number of trials required by the preschool children is 434. This is a striking example of decrease in number of trials required with increase in age.

A comparison of the same confusions mentioned in the discussion of figure 20 brings out the following facts in regard to figure 21: The six pointed star, block 20, was given sixty-four times instead of the five-pointed star, block 10, and the five-pointed star, block 10, was given fifty times instead of the six-pointed star, block 20. The hexagon, block 15, was given thirty-one times instead of the pentagon, block 5, and the pentagon, block 5, was given thirty-five times instead of the hexagon, block 15. Block 18 was given eighteen times instead of block 13, and block 13 was given thirty-seven times instead of block 17. Block 1 was given twenty-two times for picture 15 but block 15 was not given once for picture 1.

Figure 22 is a chart that shows a summary of the distribution chart of the analysis of successes and errors of the twenty-two junior primary children who learned the material according to the standard form of presentation on successive days for eleven of
Figure 22

Comparison of frequency of errors on associations with twenty blocks, presented according to standard form on successive days (upper figure) and alternate days (lower figure) to children studied by pairs. Twenty-two junior primary children.
the children, and on alternate days for the remaining eleven children, and shows the frequency of correct responses and of errors for each group. The upper figures in each pair of figures at each intersection represent the records of the children who learned the material on successive days. The lower figures in each pair of figures at each intersection represent the records of the children who learned the material on alternate days. The chart represents the records of eleven children who learned the material on successive days who had a total number of ninety-five trials, and eleven children who learned the material on alternate days who had a total number of sixty-four trials. Since these children were so comparable on three variables, mental age, height, and weight, the reduction in number of trials required for learning the material according to the standard form on successive days when compared with the number of trials required for learning the material according to the standard form on alternate days is probably, the most significant fact represented by this chart.

A comparison of the most frequent confusions, or a comparison of confusions to reveal whether these are due to confusions of block and block, picture and picture, or picture and block, may be made as has been described in the discussions of figures 20 and 21.
In a similar manner a chart was made representing a summary of the distribution chart of the analysis of successes and errors of the twelve junior primary children who learned the material according to the standard form of presentation on successive days for five children, and on alternate days for the remaining seven children, and the frequency of correct responses and of errors for each group together with the number of successes and failures for each group when relearning the material one year later according to the standard form of presentation on successive or alternate days according to the method that was used in the learning of the material one year earlier. Charts showing the summary of the analysis of successes and errors on each of the two variant forms of presentation of material were made also. The three charts referred to above are not included because of their general similarity to figures 20, 21, and 22.

Order of Difficulty in Forming the Required Associations.

The diagonal through each of the charts representing a summary of correct and incorrect responses shows the number of times each block was given correctly since it is at these points that the drawing of each block on the perpendicular intersects with the drawing
of the same block on the horizontal. In order to ascertain the order of difficulty in forming the required associations, the figures on each chart that are found on the diagonal were arranged in order from highest to lowest. This represents the order of difficulty from least difficult to most difficult in forming the required associations. Figure 23 represents the order of difficulty from least difficult to most difficult in forming the required associations of twenty blocks and twenty pictures as found from the records of thirty-two preschool children, twenty-six junior primary children, and sixty-two kindergarten children each of whom learned the material according to the standard form of presentation on successive days.

There is a very close similarity between the order of difficulty for the children in the three groups. As would be supposed, the order of difficulty is more similar between the junior primary and the kindergarten children than between the preschool and the junior primary children or between the preschool and kindergarten children. Coefficients of correlation were computed by Pearson's rank difference method for each combination of two of the groups of children. The results were as follows:
Order of difficulty on associations with twenty blocks for thirty-two preschool, twenty-six junior primary, and sixty-two kindergartan children.
Groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>r</th>
<th>P.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preschool and junior primary.....</td>
<td>.842</td>
<td>.044</td>
</tr>
<tr>
<td>Preschool and kindergarten........</td>
<td>.861</td>
<td>.039</td>
</tr>
<tr>
<td>Junior primary and kindergarten..</td>
<td>.945</td>
<td>.175</td>
</tr>
</tbody>
</table>

The coefficient of correlation in each case is a sufficient number of times larger than the probable error for the correlation to be regarded as significant.

Comments of the Children During the Experiment

The pictures used in this experiment were designed purposely to resemble in some way the blocks with which they are to be associated. Although similar, an attempt was made to have the pictures not too similar to the blocks, in order to avoid the possibility of the situation resolving itself into merely a matching of block and picture. Even the youngest child, age two years and two months, observed and commented upon certain of the resemblances. The materials elicited a great deal of comment from almost every child to whom it was presented. In addition to remarks that stated the resemblance between either certain parts of the picture and certain parts of the block or the block as a whole; or between the block as a whole and the picture as a whole or certain parts of the picture, many of the children gave to certain blocks the name of the object represented in the picture with which
the block corresponds. Frequently, a child when looking for a block would ask, "Where is the train?" "Where is the drum?" "Where is the flower?" meaning where is the block that goes with the picture of the train or the picture of the drum or the picture of the flower; or after having found the required block, the child would exclaim, "Here's the train", "I found the drum", or "This is the flower" in each case identifying the block by the name of the object represented in the picture that corresponds with the block. The blocks seemed to be the actual objects to the children. This may be due in part to the fact that few of the children knew the names of the various shaped blocks. Some of the children referred to the round block as "the round one", some referred to the five or six-pointed star as "stars", only a very few of the children referred to the square block as "a square" and none of the other blocks were referred to by name except to call the block by the name of the picture with which the block corresponds. A large majority of the children tried to fit the blocks upon the pictures. Some of them responded in this way from the first trial; others, following the directions a little more exactly, responded at first by handing each block to the examiner but later, as resemblances stood out more clearly in their minds probably, began to fit cer-
tain blocks, or each block, upon its corresponding picture. Some of the children, when trying to fit a certain block on a certain picture, between which there was an obvious resemblance, seemed annoyed or disappointed when either the block or the picture was too large or too small for the picture and block to fit together exactly. Many of the children commented upon this, particularly in regard to block 8 and picture 8. Many of them said, "This block is too fat" or asked in reference to the block, "Why doesn't that go farther in?", referring to the concave sides of block 8. The fact that there was no stem attached to block 18, which corresponds with picture of a flower on a stem, picture 18, annoyed some children who commented, "It (the block) is just like it (the picture) but it hasn't got this" (pointing to the stem on the picture of the flower.) More frequently the children asked a question in regard to the dissimilarity between picture and block instead of stating the dissimilarity. Generally it was in the form, "Why doesn't this (the block) have this (referring to some part of the picture that is not a part of the block) on it?" The pentagon, block 5, seemed incomplete to many of the children because it had nothing attached to it that resembled the tail of the kite in the picture that is to be
associated with the pentagon, picture 5, although in other respects the block and picture are identical in shape. This occurred in several other associations besides in connection with those mentioned. It seemed that the children after having found a similarity between block and picture then looked for identity between the two.

One outstanding fact of the learning situation as a whole was the general optimism of the subjects as expressed in their comments. It was a most usual occurrence for a child to say, "I got them all right today", as soon as one of the trials had been finished. Frequently, this was after one of the trials near the beginning of the child's learning of the material when his score was far from perfect. Sometimes the child would not seem as positive of his absolute correctness and after stating, "I got them all right today" would add, "Didn't I?", and lookquestioningly at the examiner. Sometimes before beginning a trial, the child would say, "I got them all right the last time and I'm going to get them all right today", although on neither the former performance nor on the present one had a perfect score been made. One preschool boy remarked, "I know them, don't I", at the end of the first trial. His score was 8.
One time as the examiner was taking a child back to the kindergarten room, she met another kindergarten child, Mildred, just outside the door of the examining room. The examiner had not intended having Mildred next but when she remarked, "I came next because I wanted to play the game. Can I play next?" the examiner let her have her turn then. This was Mildred's third trial and she made a score of 16. When/finished this trial, she remarked, "Maybe I'll get them all right tomorrow". Then an instant later she added, "Maybe I won't. We can't tell yet. Who do you want next? I'll go and get them". Mildred showed more self-criticism than most of the children and realized that she had not made a perfect score. The next day, as Mildred entered the examining room, she remarked, "I think I'll get them all right today".

Many of the children remarked upon the ease in knowing which was the correct block that went with a certain picture; fewer of the children remarked upon the difficulty in knowing which was the correct block that went with a certain picture. Comments such as, "That's an easy, easy one", usually referred to block 1 and picture 1, the picture of the face of a clock, and to block 18 and picture 18, the picture of a flower. Although many of the children were unable to recognize the picture of the old-fashioned desk, picture 12, the block
that goes with it, block 12, is so similar that the response for this association too, brought out the comment, "That's easy".

A great many of the children said that they liked the game or said, "This is a nice game" or made some similar remark. There was only one child among the 206 with whom the experiment was tried who seemed to become tired of the game. This was a boy in the preschool who was the dullest child in the group at the time when he was being a subject of the association reaction learning experiment. After about fifteen trials he seemed somewhat reluctant to come to "play the game". With this one exception, all of the children were interested in "the game" and the materials used appealed to them and held their attention. They did not tire of the repetition. Perhaps the same thing in a child's make-up that causes him to want to be told the same story again and again, or to be shown the same pictures over and over, or to be sung the same songs repeatedly, makes the child like to "play the block game" for many trials without tiring.

More of the individual comments of the children will be given in Chapter IV where a special study is made of twelve interesting subjects of the experiment.
Statistical Analysis

It has been stated that the number of children at each age, or on each form of presentation of the material is too small to yield reliable statistical results except for the five and one-half year age group of children who learned the material according to the standard form of presentation on successive days. Almost all of the statistical results given below are based therefore, upon this one age group and according to this one form of presentation and one method of learning. The correlations have been worked separately for junior primary and kindergarten children.

Reliability of the Experiment

The reliability of the experiment was found by correlating the scores on one half of the material (Series I) with the scores on the other half of the material (Series II) on all records of children five and one-half years of age who had learned the material according to the standard form of presentation on successive days. The reliability coefficient of one-half of the material correlated with the other half is .828 P.E. .02 for the junior primary children and .829 P.E. .01 for the kindergarten children. The reliability of the experiment was found in another way, by correlating the scores on the "odd" and "even"
items of the material on all records of children five and one-half years of age who had learned the material according to the standard form of presentation on successive days. The reliability coefficient of "odd" and "even" items of the material is .869 P.E. .01 for the junior primary children and .846 P.E. .01 for the kindergarten children.

When the Spearman-Brown prophecy formula,

\[ x_1 = \frac{N \rho_1}{1 + (N-1) \rho_1} \]

was applied for the two halves of the material, the result was .907 for both the junior primary and kindergarten children. When the Spearman-Brown prophecy formula was applied for the "odd" and "even" items of the material, the result was .950 for the junior primary children and .918 for the kindergarten children.

The correlation of Series I and Series II referred to above is based upon the records of the children who learned all of the material of both series together as one series. A correlation of the scores on Series I and Series II of paired kindergarten children, one of each pair having learned Series I only and the other of the pair having learned Series II only, gives a reliability coefficient of .981 P.E. .054. Table 12 shows the reliability coefficients on the learning material used in this experiment.
Table 12

Reliability Coefficients on Learning Material Used in This Experiment

<table>
<thead>
<tr>
<th>Scores on Series I and Scores on Series II</th>
<th>Brown Spearman Prophecy Formula</th>
<th>Brown Spearman Prophecy Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same child Paired children</td>
<td>Brown Spearman Prophecy Formula</td>
<td>Brown Spearman Prophecy Formula</td>
</tr>
<tr>
<td>Junior .83</td>
<td>.91</td>
<td>.87 .93</td>
</tr>
<tr>
<td>Primary ±.02</td>
<td></td>
<td>±.01</td>
</tr>
<tr>
<td>Kindergarten .83</td>
<td>.91</td>
<td>.85 .92</td>
</tr>
<tr>
<td>±.01</td>
<td></td>
<td>±.01</td>
</tr>
</tbody>
</table>
Correlations of Number of Trials Necessary for Complete Learning on the Standard Form with Results of Stanford-Binet Tests

The number of trials necessary for complete learning is the basis of scoring the results of this experiment. The number of trials necessary for complete learning was correlated with Stanford-Binet mental ages for various age groups, boys and girls combined, and for age five and one-half years, boys and girls separate.

Of the 132 children who completely learned the material according to the standard form of presentation, 113 were given an individual Stanford-Binet examination by the same examiner who carried on the learning experiment. Nineteen of the children were given the Stanford-Binet examination by one of three other examiners of the Iowa Child Welfare Research Station. One of these examiners gave the Stanford-Binet examination to four of the preschool children, another examiner gave it to one preschool child and five junior primary children, and the third examiner gave it to nine junior primary children. Each of the sixty-two kindergarten children included in the total of 132 children was given the Stanford-Binet mental examination by the same examiner who carried on the learning experiment. The factor of
the personal equation of the examiner is therefore reduced considerably since six times as many of the Stanford-Binet examinations were given by the same examiner who carried on the learning experiment as were given by other examiners. All of the sixty-two Stanford-Binet examinations of the kindergarten children were given during the same time interval while the learning experiment was being carried on. In some cases, the preschool or junior primary children were subjects of the learning experiment a few months after having been given a Stanford-Binet mental examination. The mental age was corrected up to the time of the learning experiment in all cases where there was a difference of one month or more in chronological age between the time of the Stanford-Binet and the time when the child was a subject of the learning experiment.

Mental Age (Stanford-Binet) by Groups. - Of the thirty-two preschool children who completed the learning of the material according to the standard form of presentation, one was in the two year age group, three were in the three year age group, seventeen in the four year age group, and eleven in the five year age group. Twenty-six junior primary and sixty-two kindergarten children were in the five and one-half year age group. The one child in the two year age group and the three children in the three year age group were disregarded, and a correlation
was found between the number of trials necessary for complete learning on the standard form and the Stanford-Binet mental ages of the four, five and five and a half year-old children of the preschool laboratories, including both preschool and junior primary. The total number of children when the three ages were combined was fifty-four.

By the method of partial correlation for eliminating the influence of mental age, the correlation between chronological age and number of trials required for complete learning for fifty-four children of the three ages, four, five, and five and one-half was -.27 P.E. .08; by the method of partial correlation for eliminating the influence of chronological age, the correlation between mental age and number of trials required for complete learning was -.47 P.E. .07. These correlations show that the number of trials necessary for complete learning correlates better with mental age than with chronological age. The negative correlations must be interpreted as follows: on the Stanford-Binet, the higher the mental age in relation to the chronological age, the better is the child's performance; whereas, for the learning material, the fewer the number of trials required for complete learning, the better is the child's performance. Thus, instead of having an increase in score to denote superior performance on the learning material as is the usual method of scoring psychological tests, a superior performance on the learning material is denoted by a decrease in number of trials required for complete
learning as compared with the number of trials required for complete learning when the performance is either average or below average. The correlation -.47 P.E. .07, when the influence of chronological age is eliminated through the method of partial correlation, shows that there is a relation to that extent between the two variables, mental age and number of trials, and that the higher the mental age, the fewer the number of trials required for complete learning of the association reaction learning material.

In addition to the correlation between number of trials required for complete learning of the association reaction learning material, and mental age of the children in the three age groups combined, the correlation was found between number of trials and mental age for the two groups of children of the chronological age five and one-half years. For twenty-six junior primary children of the five and one-half year age group the correlation between number of trials required for complete learning and mental age is -.48 P.E. .10; for sixty-two kindergarten children of the five and one-half year age group, the correlation between number of trials required for complete learning and mental age is -.52 P.E. .06. The correlations therefore, are very similar to each other, and are similar also to the correlation -.47 P.E..07 found between number of trials and preschool and junior primary children of the three age groups combined.
Mental Age (Stanford-Binet) by Sexes. - The correlation for twenty-six junior primary and sixty-two kindergarten children of the five and one-half year age group that has been discussed in the above paragraph includes every child in each of the two groups and both sexes together. Correlations were computed also for five and one-half year old children keeping the records of boys and girls separate but combining the records of the boys in the junior primary with the records of the boys in the kindergartens, and combining the records of the girls in the junior primary with the records of the girls in the kindergartens. It was not known how nearly evenly the sexes were divided until the records were being separated for computing the correlation for each sex separately. The sex distribution of the eighty-eight children in the five and one-half year age group is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior Primary</td>
<td>8</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td>Kindergartens</td>
<td>35</td>
<td>27</td>
<td>62</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>46</td>
<td>88</td>
</tr>
</tbody>
</table>

The correlation between number of trials required for complete learning and mental age of forty-three boys of the five and one-half year age group is -.58 \( p < .07 \).

The correlation between number of trials required for complete learning and mental age of forty-five girls of
the five and one-half year age group is -.40 P.E. .08. The difference in the correlations between number of trials and mental age for boys and girls of the five and one-half year age group is greater than the difference in the correlations between the two five and one-half year age groups, junior primary and kindergarten children, when sexes are not considered separately and the correlation for boys is higher than for girls.

All of the correlations based upon number of trials required for complete learning of the association reaction learning material and mental age are found to be negative and must be interpreted as has been explained. The correlations are not very high but in each case, the correlation is a sufficient number of times larger than the probable error for the correlation to be regarded as significant. Table 15 shows the correlations of number of trials necessary for complete learning on the standard form of presentation of the association reaction learning material and Stanford-Binet mental ages of the various groupings of children.

Correlations of Number of Trials Necessary for Complete Learning on the Standard Form with Various Psychological Tests on Boys and Girls of the Five and One-Half Year Age Group

Of the twenty-six junior primary children of the five and one-half year age group, records were available
Table 13

Correlations of Number of Trials Necessary for Complete Learning on Standard Form with Results of Stanford-Binet Tests

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number</th>
<th>Age, Years</th>
<th>r</th>
<th>P.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sexes Combined</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preschool Laboratories, M.A. constant</td>
<td>54</td>
<td>4, 5, 5½</td>
<td>.27</td>
<td>.08</td>
</tr>
<tr>
<td>Preschool Laboratories, C.A. constant</td>
<td>54</td>
<td>4, 5, 5½</td>
<td>.47</td>
<td>.07</td>
</tr>
<tr>
<td>Junior Primary, M.A.</td>
<td>26</td>
<td>5½</td>
<td>-.48</td>
<td>.10</td>
</tr>
<tr>
<td>Kindergartens, M.A.</td>
<td>62</td>
<td>5½</td>
<td>-.52</td>
<td>.06</td>
</tr>
<tr>
<td><strong>Sexes Separate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior Primary and Kindergartens, Boys, M.A.</td>
<td>43</td>
<td>5½</td>
<td>-.58</td>
<td>.07</td>
</tr>
<tr>
<td>Junior Primary and Kindergartens, Girls, M.A.</td>
<td>45</td>
<td>5½</td>
<td>-.40</td>
<td>.08</td>
</tr>
</tbody>
</table>
on the Detroit Kindergarten Test, and two of the Pintner-Paterson performance tests—the Goddard-Seguin form board and the manikin test—for twenty-two of the children, and for nineteen of the children, a record on the Montessori cylinders test was to be had. Each of these eighty-five individual tests had been given to the junior primary children by the same examiner who carried on the learning experiment. Here again, the factor of the personal equation of the examiner may be regarded as of negligible influence when correlating the scores on these various psychological tests with the number of trials required for complete learning of the material of the association reaction learning experiment.

Of the sixty-two kindergarten children of the five and one-half year age group, a record was available on the Detroit Kindergarten Test for fifty-four children. These children were from three kindergartens so three different persons administered the Detroit kindergarten tests to the children in this group, as each kindergarten teacher gave this test to her own pupils. The personal equation of the examiner is not therefore, a constant factor in these records.

Table 14 shows the correlations of number of trials required for complete learning according to the standard form of presenting the learning material with
Table 14

Correlations of the Number of Trials Necessary for Complete Learning on Standard Form with Various Psychological Tests on Boys and Girls of Five and One-Half Year Age Group

<table>
<thead>
<tr>
<th>Test</th>
<th>Number of Children</th>
<th>r</th>
<th>P.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergartens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detroit Kindergarten</td>
<td>54</td>
<td>-.33</td>
<td>.08</td>
</tr>
<tr>
<td>Junior Primary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detroit Kindergarten</td>
<td>22</td>
<td>-.26</td>
<td>.13</td>
</tr>
<tr>
<td>Goddard Seguin Form Board</td>
<td>22</td>
<td>.12</td>
<td>.14</td>
</tr>
<tr>
<td>Manikin</td>
<td>22</td>
<td>-.05</td>
<td>.14</td>
</tr>
<tr>
<td>Montessori Cylinders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Board 1</td>
<td>19</td>
<td>.21</td>
<td>.15</td>
</tr>
<tr>
<td>Board 2</td>
<td>19</td>
<td>.32</td>
<td>.14</td>
</tr>
<tr>
<td>Board 3</td>
<td>19</td>
<td>.26</td>
<td>.14</td>
</tr>
</tbody>
</table>
scores on the Detroit Kindergarten test for both junior primary and kindergarten boys and girls of the five and one-half year age group, and for the junior primary boys and girls of the same age group, on Goddard Seguin form board, manikin test, and Montessori cylinders test.

**Detroit Kindergarten Test.** - As shown on table 14, the correlation between number of trials required for complete learning and scores on the Detroit Kindergarten test for the fifty-four kindergarten children is -.33 P.E. .08. This correlation indicates that those children who are above average in mental age require fewer than average number of trials for completing the learning. The correlation is a little more than four times the probable error so that the correlation may be regarded as significant.

A different situation is found when the number of trials required for complete learning is correlated with the scores on Detroit Kindergarten test for the twenty-two junior primary children. The correlation in this case is -.26 P.E. .13. The correlation is only twice the probable error and therefore, the correlation may not be regarded as significant.

**Two Performance Tests (Pintner and Paterson).** - The Goddard-Seguin form board was given to twenty-two of the twenty-six junior primary children. The number of
trials required for complete learning was correlated with the shortest time required for one of three trials on the Goddard-Seguin form board test. For this test, the shorter the time, the better is the performance, just as in the case of the learning material, the fewer the number of trials, the better is the performance. The correlation in this case is plus but it is too small to be of any significance. The correlation between number of trials required for complete learning and shortest time required on one trial of the Goddard Seguin form board test is .12 P.E. .14.

The manikin test was given to the same twenty-two junior primary children to whom the Goddard-Seguin form board had been given. The number of trials for complete learning was correlated with the score on the manikin test. In the case of the manikin test, the higher the score, the better is the performance, whereas, in the learning experiment, the fewer the number of trials, the better is the performance. The correlation is negative again. It is, however, too small to be of any significance since it is -.05 P.E. .14.

Montessori Cylinders. - Nineteen of the same twenty-two junior primary children were given the three parts of the Montessori cylinders test. The number of
trials required for complete learning was correlated with the score on each of the three parts of the Montessori cylinders test. On this test, a high score denotes a better performance. The correlations, however, were positive. In no case is the correlation of any significance. For board 1, the correlation is .21 P.E.=.15, for board 2, it is .32 P.E.=.14, and for board 3, the correlation is .26 P.E.=.14.

The correlations between number of trials required for complete learning according to the standard form of presenting the association reaction material and the results of the various psychological tests included here are of no significance with the exception, perhaps, of the correlation between number of trials and scores on the Detroit Kindergarten test in the case of fifty-four kindergarten children when the correlation is -.35 P.E. .08.
CHAPTER IV

STUDY OF SPECIAL CASES

In the statistical analysis of data, interesting features of individual records are hidden. In order to bring out some of these interesting points, a selection has been made of the records of twelve children who learned the material according to the standard form of presentation. In one case the learning was on alternate days; in all other cases, on successive days. The records include those of four children who failed to learn the material within twenty trials and of eight children who completed the learning. The cases of failure demonstrate the part played in the learning process by factors such as immaturity, emotional instability, and memory defects. The records of successful learning demonstrate the ability of the youngest child to complete the learning because of her superior mental development; unusual rapidity of some children in forming associations; consistent alternation of gains and plateaus, in one case; persistency for six trials in confusion of two blocks after two successive perfect scores of 20, in one case; and marked resemblance in learning the standard form and learning when associations are interchanged, in a number of cases.
Analysis of Four Cases of Failure

Eleven children who were given the material for learning in this experiment failed to make a perfect score within the limit of twenty trials. Although the records of these eleven children had to be discarded when making an analysis of the results of the experiment since only records of completed learning were included, these cases of failure are very interesting from the standpoint of analysis of individual reactions to the material, and for the light which they throw upon the learning process in cases in which a certain amount of learning is achieved but not completed within the requirements of the experimental situation.

It will be noted from Table 1 that of the total of eleven cases of failure, nine occurred in the preschool group, that is, among the very youngest of the subjects of the experiment. The material is undoubtedly too difficult for two-year-old children, as a group, although one exceptionally bright child of this age completed the learning within the number of trials set as the limit. It is interesting to note that of the eighty-eight children of kindergarten age, the total number of junior primary and kindergarten children
combined, there were two cases of failure only and these may be accounted for by special defects in each case.

The records of four of the children, two boys and two girls, who failed to complete the learning within twenty trials, have been selected for the purpose of individual analysis. Figure 24 shows the learning curves of these four children.

**Child 1**

Sara, who belonged to the preschool group, was chronologically two years and eight months old at the time of the experiment. Her mental age then was three years and three months and her intelligence quotient 123. Failure in this case was due, undoubtedly, to immaturity. The task of learning twenty associations within twenty trials was beyond the stage of development of her ability at that time. The learning curve for this child shows, however, several interesting features. For trials 1 through 7, scores include three scores of 1, two scores of 0, one score of 2, and one of 3. No doubt, during these trials at the beginning of the experiment, the whole situation was too large and too complex for the child to grasp, with the result that there was probably a buzzing confusion in
Learning curves in four cases of failure.

Figure 24
her mind as to just what was expected of her. Successes during trials 1 to 7 may be regarded as due to chance with the possible exceptions of the association of block 1 and the picture of the clock and block 18 and the picture of a flower, since from the early trials these occurred correctly more times than any other association. After the seventh trial, the situation evidently began to become clearer in Sara's mind, and from the seventh through the thirteenth trials there was a steady increase of score that shows a daily increase of 2 points during four of the six intervals between these trials and an increase of 1 point between each of the trials for the two other intervals.

In plotting Sara's learning curves (Figure 24) it was found that up to the thirteenth trial, when one occurs that extends over two trials, this is followed by an increase of one point after which there is another plateau extending over two trials, then another increase of 1 point followed by a plateau lasting for three trials. On the succeeding trial, the score increases by 2 points, reaching a total of 15. This is on the twentieth trial, however, when the experiment was discontinued. Although this curve represents
failure as judged by the criteria used here for complete learning, it shows learning quite plainly and definitely. From the continued period of increase in amount learned and from the fact that the shape of the curve from the seventh trial through the twentieth is very similar to many of the curves of completed learning, one seems justified in assuming that this child would have completed the learning within perhaps five more trials if it had been allowable to continue the experiment.

Sara seemed interested in the material and paid close attention while the examiner showed it to her. Almost every time a picture and its corresponding block were presented to her, she nodded her head as if she understood the directions, but evidently she either did not understand them or, because of immaturity, was unable to form the necessary associations. The latter seems the more plausible reason. During the early trials, her responses consisted mainly in picking up blocks at random, especially the blocks directly in front of her, and frequently she picked up the blocks in the order that they had been placed upon the table. Sometimes, beginning with the seventh trial, when Sara began to know some of the associations, she responded with an incorrect block, put it down quickly,
and reached for the correct one. From this trial on, she really looked for the correct forms and showed less of the tendency to pick up one block after another as placed before her. She showed perseverance in her responses, particularly with blocks 1 and 3. In the beginning, she was more interested in the pictures than in connecting them with the blocks. On the second trial she named several of the pictures as "trees", "star", "little birdie" (for flying bird), "round wheel", "house" (for windmill) and during almost every trial thereafter she named these and others of the pictures. After a few trials she responded by placing the blocks upon the pictures as if trying to fit them together. On the twelfth trial, Sara made a comment that showed she was definitely comparing blocks and pictures; when the examiner showed her the picture of the maple leaf and block 10 (the five pointed star), Sara pointed to the star and said, "Too small". On the next trial she made a similar comment by saying in regard to block 14 and the picture of the sailboat, "That's too little". After this she commented, "Just like it" for several pictures and their corresponding blocks.
Child 2

John, in the preschool group, was chronologically three years and seven months at the time of the experiment. His mental age then was three years and nine months and his intelligence quotient 104.

John's learning curve (Figure 34) is the most eccentric of the total number of 203 curves plotted. When the examiner showed it to one of the other workers in the Laboratory and to the child's teacher, each of whom had known, worked with, and observed the child over a much longer period of time than the examiner who used the learning material with the children, one of the immediate remarks was, "Well, isn't that just typical of John! He's such an erratic child." Their further remarks and personal observations made by the examiner seem to justify the statement that the learning curve of this child may be regarded as typical of his reactions to many other situations and may be looked upon as a profile of the child without overestimating and overinterpreting what the curve represents.

One day John tries to hit every other child in the room; the next day, he plays so quietly at the sand table, or with some other equipment in the laboratory, that one acquainted with the group assumes at
first that he is absent. Not infrequently he incurs the displeasure of every child in the group because of his striking them and because of his bullying attitude and later he goes around the room and asks each child, one at a time, to play with him, only to be refused by every child. At times he is extremely noisy, shouting aloud and banging toys or furniture or anything that happens to be near at hand; at other times he is very quiet. His emotional instability is quite pronounced and seems to be traceable directly to his mother. This child and two or three others came to school daily in a taxi. It was a usual occurrence for this little boy to hit a certain little girl who came in the taxi. The driver finally had John ride on the front seat with him for a while, but he was allowed again to ride with the other children, he began hitting the little girl who previously had been the object of his blows. There were days intermittently when he would ride with the other children without creating any disturbance.

John's learning curve begins with a plateau on a score of 2 points. This is followed by two rapid rises, so that by the fourth trial, he has scored 11 points. The record of the next trial drops, however,
to 3 points, a greater decrease than in any other of
the total of 203 learning curves plotted for this study.
The score of 11 obtained on trial 4 is not reached or
surpassed until trials 18 and 19, each of which has a
score of 12 points. Between trials 4 and 18, there is
a continual fluctuation in score. On the twentieth
and last trial, there is a very unusual drop in score
from 12 to 5. John did not seem bored with the material
now nor was he ever reluctant to come to "play the game" with
the examiner. In fact, he is rather the type of child
who enjoys adult attention and came very willingly to
the examining room each day. During every one of the
twenty trials, he was very talkative and usually kept
up a running conversation during the entire experiment.
Several times, on the first trial and on a few succes-
sive trials, after John had made a response, he picked
up another block and asked, "Where's the picture that
goes with this one?" Beginning with the second trial,
when he named "the star" and other blocks and called
the picture of the bell "a dinner bell", he very of-
ten named either the pictures or the blocks. He seemed
to observe resemblances carefully while the examiner
showed him the blocks and pictures. On the fourth trial
when the examiner showed John the picture of the six-
spoked wheel and held up block 15 he said, "This one
(picking up block 1) should go with that". In reality block 15 is more similar in shape to the picture of the wheel than the block that is to be associated with it. In responding, however, John gave the correct block. The next day, when the examiner showed the picture of the six-spoked wheel and held up block 15, John again picked up block 1 and asked, "Why wouldn't this be the right one?" and this time responded with block 1. Frequently, he fitted the block upon its corresponding picture, particularly if it were an association that had been definitely formed. Sometimes he asked, as he placed a block upon its corresponding picture, "Does this fit with this one?" or "Will it fit on that picture?" "Will it fit on there?" Sometimes he tried to fit the wrong block on a picture as, for example, when he responded with block 3 instead of block 16, but turned block 3 in a perpendicular position instead of horizontal, the way in which it is used. In this turned position it more nearly resembles block 16 and could be made almost to fit over picture 16.

This child seemed at all times interested in the "game" and responded quickly. During the first trial he said that he liked the blocks and volunteered the information that he had some blocks at home. The next day
when the examiner asked him to come out with her to play a game, he asked, "Going to play with the blocks?" and seemed interested in the prospect. Throughout his twenty trials this child seemed interested and paid close attention to all of the directions, co-operated well, and responded without urging, but continued to make poor records.

**Child 3**

One of the two kindergarten children who failed to learn completely the material used in this experiment is George. At the time of experiment, he was chronologically five years and eleven months, mentally five years and eight months, and had an intelligence quotient of 96. He is a dull appearing child.

During the learning experiment, George nodded his head each time the examiner showed him a block and the corresponding picture. While he was responding with the blocks, he worked quietly, looked carefully for each block, and evidently was trying very hard to make correct responses. His learning curve (Figure 24) is a rather unusual one. It shows three plateaus, each of which extends over a period of three trials and another plateau that extends over two trials. At five points on the curve there is a decrease in score and at two of these points the de-
of course comes immediately after a plateau that extends over three trials. Fluctuations of this type in George's learning made the examiner suspect a memory defect. The examiner asked his teacher for information concerning him and was told at once that the child's memory seemed to be defective. When carrying on a project that could not be completed in one day most of the children in the group would start in the next day and continue the work where it was left off. George seemed never to remember from one day to the next, however, so that it was necessary each day to give again to him all of the directions that had been given the previous day. This and similar instances of inability to retain material had made the kindergarten teacher feel doubtful of promoting him to the first grade. It would be interesting to follow this child for a few years to note whether or not his learning on school work follows the form of the curve that represents his record on the association reaction learning.

Child 4

The only other kindergarten child who failed to learn completely the material of this experiment was Gladys, who was, at the time of the learning experiment, five years and four months chronologically and mentally
five years and six months. Her intelligence quotient was 103.

Gladys seems to be of the emotionally unstable type. She showed a marked tendency toward indecision; in almost every trial there occurred several instances when she made a response and then changed it. Frequently she changed a response two or three times. When Gladys was mentioned to the teacher, she at once began to comment upon the child's defective memory and told of several situations in which the quantity and quality of the child's work fluctuated markedly from day to day.

At the time the examiner was collecting data on the learning experiment, the kindergarten teacher was having the children learn the names of various birds by means of large colored pictures of each bird. The names of seventeen different birds had been taught to the class and many of the children could identify the entire series. The teacher said that on one day Gladys would be able to recognize as many as fourteen of the bird pictures and on the following day only three, or perhaps four.

Gladys's learning curve (Figure 24) shows the same number of points at which there is a decrease in score as is found in George's learning curve. In the
case of Gladys's record, however, the amount of each decrease is larger generally and at one time there is a drop of 5 points. Each time the examiner presented the material to her she nodded, but seldom made comments. Almost all of the children of Gladys's age learn the material in less than nine trials. After the twelfth trial, the examiner asked Gladys if she were tired of playing the game. She smiled, shook her head vigorously, and said, "No, I like this game". Gladys did not show at any time a disinclination to come "to play the game".

In this case, as in the preceding, the child's teacher mentioned his or her noticeably memory defect and a tendency for both children to show marked fluctuations between good work on one day and very poor work on the following day. Undoubtedly, memory defect is the most important factor in determining the failure of these two children to learn the required associations. Learning is directly dependent upon memory; upon the fact that past experiences are preserved within the psychophysical organism in the form of bonds ready to act when a given stimulus is presented. Unless the bonds have not been formed sufficiently strong, a repeated presentation of the stimulus will not call forth the correct response.
Eight Cases of Successful Learning

In addition to the curves discussed in Chapter III that follow the typical curve for the learning of the material used in this experiment, there are certain individual curves of successful learnings that are especially interesting. The curves of eight children who completed the learning of the association reaction material according to the standard form of presentation have been selected for an analysis. With the exception of Child 3, Figure 25, who learned the material by presentation on alternate days, all of these children learned the material by presentation on successive days.

Child 1

Ruth is perhaps the most outstanding child in the group. She is the only two-year old child who completed the learning within twenty trials. This little girl was chronologically two years and two months at the time of learning. Her mental age (Stanford-Binet) was then three years and eight months and her intelligence quotient 168.

When Ruth was one year, six months, and twenty-one days of age, her mother brought her to the Baby Examining Laboratory of the Iowa Child Welfare Research Station. Two of the psychologists who give mental ex-
Figure 25
Learning curves in four cases of success.
aminations to babies were present and the examiner who was observing said recently in regard to this child's first test, "I remember/her performance was simply astounding. She just seemed to eat up the tests. It almost seemed uncanny to see that young child responding as she did to some of the tests". The psychologist who made the mental examination wrote the following note upon this child's record sheet, "Speaks fluently - not at all embarrassed - very co-operative". The baby psychological tests upon which this examination was based have not yet been standardized, but this child's record is equal to the average of children several months older. As Gesell points out, mental development of a few months at the early ages is the equivalent of mental development of many more months at a later age. The child did so remarkably well on the mental tests that the psychologist who made the examination asked her mother to enter her in the Preschool Laboratory at the opening of the new term in the fall. The child entered in September when she was one year and eleven months of age. Previous to this time, no child had been admitted under the age of two years, and the youngest children in the group had been two or three months past their second birthdays.
Thirteen days after Ruth was two years old she was given the psychological baby tests again as a demonstration before a seminar group at the Iowa Child Welfare Research Station. At least twenty adults were present. The child was very much at ease, went through the series of test with remarkably good performance, and the only time she seemed conscious of anyone around her was when she looked through the doorway into an adjoining room at a six-months old baby whose mother was holding her and waiting for a demonstration test to be given to her child. The two-year old seemed interested in the baby, but the various toys and other things that compose the baby test material interested her more so that her attention was diverted from the tests for only a brief time. She made an unusually high score for one of her age and it was considerably higher than the score on the baby tests six months previously. The examiner who made the baby demonstration test made a note on the child's record as follows: "Demonstration test, but Ruth was much at ease. After first test she paid practically no attention to spectators. Stuck to tasks well". One of the most interesting observations during her examination occurred near the end of the series of tests, when the tasks near the upper end of the scale
were becoming too difficult for her. At these times, she worked and worked at the task persistently for some time, then, with an air of finality, pushed the materials of that test over to one side of the table and was ready to try some new materials. As soon as a new test was given to her or she had reached for it, as she did frequently, she began to work with it and worked persistently for some time. If the new task were too difficult it too would be pushed aside later on and she was ready for something else. She never gave up, however, until she had tried the task persistently for some time.

For a third time the baby mental tests were given to Ruth when she was two years, three months, and thirteen days of age. Each examination showed a rapidly increasing score over the previous one. When given a Stanford-Binet examination Ruth responded very readily to each test. Her remarkably good vocabulary and method of expressing herself were noted by the examiner as being unusual for a child of her age. Her cooperation at all times is excellent. She is a child of unusually sunny disposition and enters into any new projects very willingly.

Ruth's performance as compared with that of other two-year old children is phenomenal. The begin-
ning of the learning curve (Figure 25) is quite similar to those of children of this same chronological age; the one or two successes that occur are due to chance probably. The score of 2 in the first trial is followed by 0, another 2, and three successive scores of 1 point each. From the seventh trial on, the curve shows definite learning until complete learning has been attained. By the eleventh trial a score of 13 points has been reached and this same score is maintained for the next trial also. The score goes to 17 on the twelfth trial, and remains stationary for the succeeding trial. The next score is 19, then 20, and this perfect score is maintained for the successive trials.

The learning curve of this child, whose chronological age is two years and two months and mental age three years and eight months, is remarkably similar to those of three other children, each of whom has a mental age of three years and ten months and another child of four years and no months. It is evident that Ruth's high mental age enables her to perform in a manner far superior to that of the other two-year-old children and to accomplish learning in a similar manner and with a similar number of trials of others of her same mental age.
During trials 1 to 4, Ruth asked "what's that?" almost every time a picture was shown to her. Beginning with trial 5, she named some of the pictures herself, saying, "That's a tick-tack", "That's a too-too train", "Christmas tree", "House", "Glass", "Big flying bird", "Big bell", but continued to ask the examiner what certain other of the pictures were. The first association that Ruth formed definitely was between the picture of the cross and block 9. Beginning with trial 8, while the examiner was showing the pictures and their corresponding blocks, she would reach for block 9 before the examiner had reached for it. During trial 8, she commented eight times that the block she gave the examiner was like the picture. "Like that, that goes with the picture". "Like that choo-choo train", "That like the kite", "That's like that", "That's like the leaf" were some of her comments as she responded with a block, thus showing that even the youngest child was able to see similarity in shape between the pictures and blocks. On the same trial, Ruth said six times, "That's the right one", or "That's the right block" while handing a block to the examiner. Ruth continued to make such comments for the remaining two trials. When the eighth trial was finished, Ruth
picked up block 18 and remarked, "That's the 'flower' (flower)." It was a frequent occurrence for the children to give to a block the name of the thing represented in the picture with which the block corresponds. On trial 10 Ruth made a response that seemed quite remarkable for a child of two years and two months. While she was being shown the pictures and responding with the blocks, she picked up blocks 8 and 17, which somewhat resemble each other in shape, and said, "See. Two." She held the blocks side by side and handed block 8 to the examiner and said, "That's the right block." When the trial was finished, she again picked up blocks 8 and 17, looked at them for a while as if comparing the two, made no comments, replaced the blocks upon the table and left the examining room. During this trial she had begun placing the blocks upon the pictures and continued to respond in this way until learning had been completed. Beginning with trial 13, after placing each block upon the picture, she removed the block and replaced it upon the table showing that she had observed that this was what the examiner did each time a block was handed to her.

Ruth was a most co-operative child and did not seem to tire of the "game," although she had it for eighteen consecutive trials followed by the check upon learn-
ing. She seemed to enjoy the latter form of presentation very much. She walked up and down while looking for the correct pictures and exclaimed "That!" for each one as she hit it very decisively with her fingers.

**Child 2**

Hazel, a child in the Junior Primary Group, has a record that is of particular interest because of the unusual rapidity with which she formed the required associations. Her learning curve (Figure 25) is the shortest in the entire group. While the examiner was showing Hazel the pictures and blocks for the first trial she remarked, after seeing only a few, "They look mostly like the pictures." On her first trial, she gave seventeen correct responses. The second, third, and fourth trials each yielded perfect scores. Before the examiner began on the third trial, Hazel remarked, "I know them without you showing them to me. You don't have to show them today." She responded very quickly for each association, and remarked several times, "That's easy", as she handed a block to the examiner. When she was given the check on learning, Hazel responded quickly and accurately, but apparently did not recognize that the pictures were placed in the same order as the blocks with which they correspond, since she remarked,
"They're all mixed around." Hazel has been an outstanding pupil in her class from the time when she entered the Junior Primary Group. The learning curve shown here seems to represent more accurately her capacity to learn and the rapidity with which she grasps material presented to the class than one would expect from her record on the Stanford-Binet. According to it, at the time of the learning experiment, her mental age was seven years and two months and her intelligence quotient 118. Her chronological age was then six years and one month. From her records on a number of psychological tests and her reaction to the group situation, one would be inclined to believe that certain outside factors must have been operating at the time the Stanford-Binet was given and that Hazel did not respond as accurately as she is capable of doing. Hazel's learning curve is shorter than that of any in the entire number of curves. The year after Hazel was given the learning material it was given to her younger brother, and his curve was shorter than that of any child then in the preschool group.

Child 3

Another child who formed very rapidly the associations of pictures and blocks is Harold, of the junior primary group, who was five years and eleven
months old chronologically, and seven years and three months mentally, and had an intelligence quotient of 122 at the time of the learning experiment. This child's record is the only one of the selected group of cases of successful learning in which the learning took place on alternate days. His learning curve (Figure 25) starts very low and makes rapid progress without the occurrence of one plateau. On the first trial his score is 8, but on the second trial it jumps to 15, and on the third trial, to 19. This is followed by three successive scores of 20. Harold paid close attention to directions and seemed very much interested in the "game". During the first and second trials he responded somewhat slowly, but very carefully. On the second trial he remarked, "The blocks look just like the pictures, don't they?" On the fourth trial he started to respond with block 3, the rectangle, instead of block 2, the square, but corrected his error at once.

Child 4

About two weeks after Billy's fifth birthday he was a subject for the learning experiment. His mental age at that time was six years and three months and his intelligence quotient 125. Billy was a preschool
child. His learning curve (Figure 25) is one of the most unusual learning curves of the entire number of children to whom the learning material was given. His record begins with a score of 14. There are no decreases in score in the whole length of the curve, but each time that there is an increase, a plateau follows. There is not another curve of this type among the 203 curves that have been plotted. The most probable explanation of the numerous plateaus seems to be that the new associations formed, represented by increases in score, had not become well established, and time is required for the automatization of such associations. The loose, unautomatized associations must become automatic before further progress can be made.

On the first trial, Billy kept up a running conversation. Very frequently before responding with a block, he named the picture and then searched for the block. When shown the picture of the five-pointed leaf, he said before looking for block 10, the five-pointed star, "The leaf. Where is that right one? Where did it go?" Next came the picture of the owl. As soon as he saw it, he said, "Big old owl takes this one" and picked up the correct block, block 11. When shown the picture of the bell, he said, "Big bell. This one goes."
Child 5

The record card of Alice, a preschool child, shows that at the time of learning the association of blocks and pictures she was three years and eleven months of age, had a mental age of four years and six months, and an intelligence quotient of 117. Her learning curve (Figure 26) is a very interesting one. It begins with a score of 2, reaches 11 on the second day, and rises to 15 on the third day. At this point, the large increase between trials ceases; there is an increase of 2 points for two successive trials, followed by an increase of 1 point that brings the score to 20. After having attained one perfect trial, the score falls back 3 points. These are regained on the next trial, however, and this score of 20 is maintained for two more successive trials and thus the learning is completed. The curve has risen from score 2 to the first perfect score of 20 in six trials, and undoubtedly the instability of certain of the associative bonds is due to the rapidity with which they were formed. This accounts for their breaking down, as shown in the decrease of 3 points in score after one perfect performance.
Figure 26
Learning curves in four cases of success.
Child 6

The learning curve of Elizabeth (Figure 26), a preschool child, who had had her fifth birthday a few days before beginning the learning experiment, shows some unusual and very interesting features. At the time, her mental age was five years and six months, and her intelligence quotient 108. Her record begins with a score of 3. It increases to 5 points on the second trial, and then has a rapid rise to 12 on the third trial. The next score is 15 points. A plateau occurs at this point, followed by a decrease in score. An increase of 4 points occurs on the next trial, but this is followed by a decrease of 2 points. The score then increases 4 points, which brings it to 20, where it remains for two successive trials. Then it drops down 2 points and remains at 18 for six consecutive trials before rising to 19, then 20, and remaining there for three consecutive perfect scores. This child completed the learning on the twentieth trial, the maximum number of trials allowed for learning, although trials 9 and 10 yielded a score of 20 points also. The plateaus and the several decreases after large increases in score seem to uphold the theory that both the plateaus and the decreases in score are due to the
instability of certain of the associations that have been formed so rapidly and that time is needed for the automatization of the bonds. The outstanding feature of this learning curve is the plateau of six trials on score 18 that follows two successful perfect trials. The plateau is due to a persistence of confusion between blocks 5 and 15, the pentagon and the hexagon. The associations between these two blocks and their corresponding forms had been very difficult for Elizabeth to form so that it is not surprising to see in the curve the place where these two associations are broken down, after having been correctly built up. During each trial Elizabeth was shown the correct block that corresponds with each picture, but it was very difficult for her to form and retain the correct association for blocks 5 and 15. An incorrect association for these two blocks, that consisted in a confusion between the two, had been formed early in the experiment and it was difficult for the newer, correct association to eliminate the earlier formed incorrect associations.

After Elizabeth had three successive perfect scores she was given the check on learning on which she made a perfect score. During the check, she responded very quickly and without even one hesitation. She held her hands behind her and each time brought her right
hand forward to touch the pictures. Just before completing the learning, it seemed that she had localized the position on the table of certain of the blocks and this seemed to carry over to the situation in which the material was presented as a check on learning. She walked up and down as she made her responses and seemed to know whether to go toward the left or toward the right when a picture was needed. The material was presented to Elizabeth for learning with the learned associations. The learning of the interchanged associations was accomplished in less than one-half of the number of trials required for the original learning. The learning curve for the learning of reversed associations is shorter, but resembles in general the learning curve for original learning. Both show decreases in score following upon large increases. Although the curve for learning the interchanged associations shows decreases it does not show plateaus.

Observational notes on Elizabeth's records state that she always paid close attention and showed much interest while the examiner presented the material to her. Beginning with the second trial, she looked carefully back and forth between picture and block as the examiner held them side by side before her. When it was Elizabeth's turn to respond, she searched care-
fully for each block. At the end of the second trial, she remarked that she liked the game and when the examiner said that she would "play the game again", Elizabeth seemed pleased and inquired, "Tomorrow?" At the beginning of the fourth trial, she remarked again that she liked the game, and added, "These blocks aren't so hard, are they?" She looked over the blocks carefully before picking up each one. By the fifth trial, she had formed fifteen correct associations. Several of the incorrect associations are interesting. They demonstrate the child's ability to observe resemblances, although at times the wrong cue is followed and the wrong response follows. For example, blocks 5 and 15, blocks 8 and 17, and blocks 10 and 20 were confused. Almost all of Elizabeth's errors were due to a close but incorrect resemblance of blocks. Beginning with the fifth trial, she responded quickly and seemed to be very sure of her responses. She picked up each block and firmly laid it down directly in front of the examiner. Sometimes while the examiner was going through the series of blocks and pictures, Elizabeth named each picture, as "That's a clock", "That's a train", and later when she responded with the blocks she called the block by the name of the picture, as "kite", "drum", "bell", "wheel". This was done by a number of the children.
When learning had been completed and the material was presented to Elizabeth for interchange of learned association, she responded with ten correct blocks on the first trial. She was very thoughtful in her responses. Several times during this first trial she was somewhat slow in responding, but after these hesitations she usually gave correct responses and appeared to be thinking very attentively during her silences. On this first trial of interchanged associations, she showed only one persistence of a former association. This was in the case of the picture of a flower and block 6. She worked quietly, but asked a few times, "Is this the one that goes with that now?" or "Is this the right one?". When she came to the examining room for the fifth trial, she said, "I got them all right yesterday, didn't I?" The score on the day before had been 16, but she scored 20 that day. When she had almost finished this trial she remarked, "I'm doing it quicker. Aren't I doing it quicker?" Just as on the original learning, so on the learning of interchanged associations, Elizabeth responded each time by reaching over both rows of blocks, and by placing the block before the examiner.
On the sixth trial, as soon as she sat down before the blocks, she picked up blocks 11, 12, and 13, and said, "These are the ones" evidently referring to the ones that come at the beginning of the material when it is presented for learning of interchanged associations. "Does this go with the train?" and she held up block 13. "Does the tree go next?" and she reached over and picked up block 14. She responded quickly and accurately, and completed the learning of interchanged associations in nine trials. Twenty trials had been necessary for her learning the material completely by the original form of presentation.

Child 7

Paul's learning curve (Figure 26) shows that he learned the twenty associations quickly for a child of his age. He was a preschool child chronologically four years and eight months at the time of the experiment. His mental age was five years and four months, and his intelligence quotient 114. After Paul had completed the learning by the standard form he was given the material to learn by the method of interchanged associations. He learned the required associations by this method even more quickly than he had learned them according to the standard form. Paul's scores for
learning by each of the two methods are remarkably similar. Nine trials were required to complete the learning when the material was presented according to the standard form of learning, and eight trials when the associations already learned were interchanged. There are no crossings of these two curves, as is generally observed. Seven of the nine scores on learning according to the standard form are parallel-ed by the scores on learning the interchange of associations. Since learning on interchange of associations is accomplished in one less than the number of trials required for the original learning, there is really one point only at which the learning curve for the original learning according to standard form of presentation is not paralleled by the learning curve for the interchange of learned associations. The latter curve is above the former at all points until the two curves coincide when complete learning has been attained.

Paul saw resemblances between pictures and blocks on the first trial and tried to fit several of the blocks upon their corresponding pictures. In the meantime he made remarks such as "That's the drum" and "That just fits", as he responded by placing block 6 upon the picture of the drum. Once when he started to make an in-
correct response he said, "No, that doesn't fit it". He remarked, when responding with block 13 to the picture of the flying bird, "That's the wing", indicating that he had observed the similarity between the points on the picture of the bird's wings and the points on the corresponding block. The next day when Paul came into the examining room for the second trial and saw the blocks, he said at once, "Here are those blocks that I played with before. I remember the game". Then he added thoughtfully, "But I don't remember what is the picture that goes with each block", and began picking up blocks and naming them. Paul paid very close attention while the examiner showed him the series of blocks and pictures. He nodded his head and said, "Yes" almost every time the examiner showed him a picture and the block that corresponded with it. He responded by placing nearly every block upon a picture, and said, "I put that one on". "That doesn't cover it all up", or "That just covers the picture up". When the examiner showed him the picture of the Christmas tree, he said, as he picked up the triangular block, block 3, "'Cause that's a Christmas tree, and that's way that (triangular block) goes with that 'cause it's this way" and he ran his finger up and down the two sides of the tri-
angle and on the corresponding part of the picture of a tree. He made remarks about certain of the blocks such as block 12 and 18, about each of which he said, "That's an easy one" as he handed the block to the examiner.

On the first trial with the interchanged blocks, Paul said several times, "This used to be the one", and then gave the correct response according to the method of interchange of associations. When the first trial was over by this new method, he smiled and said, "I just like this funny game", and seemed amused by the fact that a certain block that formerly was paired with a certain picture was now paired with a different one. On the third trial, as soon as he entered the examining room, he picked up block II and said, "This is the one and this (picking up block 1) used to be the one that went with the clock". He responded very quickly and accurately. His score was 18, although it was only his third trial on the interchange of associations.

Paul is an alert, talkative child who seemed very much interested in "the game" at all times. He responded by looking carefully for the blocks and from the first trial did not pick up the blocks at random.
He showed a great deal of interest in his own success and frequently asked the examiner, "Have I got most of them?" or "Have I got them all yet?" Sometimes he said to the examiner, as when he was half finished with trial 2, "I'm getting them all right today". His score on this trial was 11.

Child 8

Fred had the highest intelligence quotient of any little boy in the preschool group. At the time of giving him the learning material, he was two years and eleven months of age, and had a mental age of four years and six months. His intelligence quotient was 153. Fred is very talkative and has a remarkable vocabulary for a child of his age.

Fred's learning curve starts at 1, jumps to 5, and after this rise falls back. Next comes a slight increase, followed by a large increase, 6 points, but a decrease follows it again. Then the curve goes upward for four trials at which it reaches the score of 20, but falls back again. On the next trial the score of 20 is regained and maintained for three successive perfect trials. Each time that a decrease occurs, it is after a large increase. When the examiner came into the group play room the day after Fred's
second trial Fred came up, took the examiner by the hand, and said he wanted to go to "play the game". Fred picked up block 1, as soon as he saw the first picture and before the examiner had begun the directions and placed it upon the picture. Fred was very much interested and enthusiastic while the examiner showed the blocks and pictures, and while he was responding with the blocks. After he had responded correctly with block 10, Fred picked up blocks 13, 18, and 19, and asked for each, "We haven't come to this one yet, have we?" By the fourth trial, certain associations had been formed correctly, but at first when he did not know what block to pick up he responded with any block near at hand, without looking around. When Fred came to the examining room the day of the sixth trial, he picked up the triangular block, block 4, and said, "Let me see the Christmas tree" and then picked up the five pointed star, block 10, and said, "Let me see the pretty leaf". This was before the examiner began to show him the pictures and blocks. His interest in the material lasted until learning had been completed. On his fourteenth and last trial, he announced to the examiner, "All ready for the game", as soon as he came into the examining room. This may be considered
as typical of Fred's attitude; he is always ready to enter into any project. He is one of the youngest children in the preschool group, but is very mature for his age and talks like a child much older. He may be regarded as another example of a very young child completing the learning because of superior mental ability. Figure 26 shows his learning curve.

**Summary**

The cases selected for discussion in this chapter are only a few that have outstanding features that make them worthy of special attention. It would be interesting to know how far the curves of each child represented here will be typical of his learning reactions in other situations. Will Ruth, the very young child who successfully learned the association reaction type of learning continue to stand out as superior to all others in the group? Will John, because of his emotional instability, continue to show marked fluctuations from day to day in his ability to learn so that he will become the exasperation of the various teachers in whose classes he will be? In like manner, will those children who learned the material with unusual rapidity continue to be at the head of their classmates?
CHAPTER V

REATIONS OF A SELECTED GROUP OF ADULTS TO THE LEARNING MATERIAL

The comments of the children gave many clues as to how they formed the necessary associations of block and picture during the course of the experiment. The children, of course, could not be expected to purposely introspect, but many of their comments take on the nature of introspections. Shortly after beginning to use the learning material, the examiner asked a few of the junior primary children at the end of a trial on which the score was twenty or almost twenty, "How do you know which block goes with each picture?" or, held up a certain picture and its corresponding block and asked, "How do you know this is the right block that goes with the picture?" The children could not tell when asked the question directly. Several children who voluntarily pointed out resemblances of blocks and pictures could not explain when asked to tell how they knew the correct blocks when shown the pictures. After a few attempts only, the examiner decided not to ask the children these questions and to rely wholly upon the information volunteered by the children in regard to how they associated certain blocks with certain pictures.

It was thought that if the material were presented to a few adult subjects who were well qualified to
give introspections as to how they formed the associations, and to state what to them seemed to be the order of difficulty in forming the associations, an interesting comparison might be made between the comments of the children and the introspections of the adults. Seven adults trained in introspection agreed to act as subjects. Subjects A, D, E, and G are graduate students who hold appointments as research assistants in psychology; subjects B and C are graduate assistants in psychology, and subject F is a widely known professor of psychology. Two of the graduate students received the Ph.D. degree a few weeks later, and each of the others has had work beyond an M.A. degree. Subjects A, B, D and E are women; subjects C, F, and G, are men.

The material was presented once only to each adult according to the standard form of presentation. After the subject had responded to each of the twenty pictures, the examiner showed one at a time each block and its corresponding picture, and asked the subject to tell exactly how he formed the association between block and picture in each case, and to introspect on the formation of the association, as fully as possible. Although the scores of the adults are not taken into account in analyzing their introspective reports, it is interesting to note that of these seven highly selected adults, two
only scored twenty, one scored nineteen, one eighteen, one seventeen, one sixteen, and one fourteen. It seems therefore, that the material is such that even for these adults there is an opportunity for learning to take place since two only of the seven made a perfect score.

Reports of Introspection of Adults

A few general statements will be made before taking up responses to specific blocks and pictures. Both adults and children have certain factors in common in the process of forming the required associations, as shown from a comparison of comments of children and reports of introspections of adults.

The adults mentioned specifically certain similarities between blocks and their corresponding pictures, and those cases in which the similarity seemed most obvious to the adults were also the ones mentioned most frequently by the children. Almost every child at some time during the experiment responded by placing certain of the blocks upon their corresponding pictures and tried to fit the blocks to the pictures. As the directions say nothing about a resemblance between block and picture, the response of trying to fit the block to the picture is due obviously to the child's perception of the existing similarity. Some children tried to fit almost every block to its picture and showed quite plainly that they were pleased when the blocks and
pictures were very similar in outline and showed that they were annoyed when certain of the blocks did not correspond so well to their respective pictures. Each of the seven adults mentioned "a tendency to try to fit the block to the picture," or, a tendency to say inwardly "The same" or "The same. The block fits the picture." In the case of the adults, it was a mental fitting of block to picture, but in the case of the children, it was an actual placing of the block upon the picture. Each of the adults expressed a feeling of annoyance in the cases of most dissimilarity between block and picture. In the case of the children, annoyance over these dissimilarities was most generally shown by facial expressions. In certain instances, the child asked, "Why doesn't that fit?" "That's not exactly the same" or "That's larger," "That's smaller" or "That's too large" or "Too small" accordingly.

Many of the children named aloud all blocks that were of shapes with which they were familiar, such as "the star," "the round one," "the square one" or "the long one," as the rectangle was frequently referred to, or "the pointed one," as several children called the triangle. Undoubtedly, the names of the geometrical forms of many of the blocks were unknown to the children, since it would be difficult for an adult to call each of the twenty forms by its correct geometrical name. It would seem that the ability or inability to name the form of the block would have its influence upon rapidity
in forming the required association for the block.

Two of the adults mentioned specifically a tendency to name each block as presented and experienced a slight annoyance in each case when it was not easy to name the form of the block instantly. One of these two persons referred to mentioned also a tendency to name the pictures and thus, in part, her formation of associations was based on association between name of block and name of picture, as "triangle - Christmas trees," as well as on similarity between the shape of the block and outline of the picture.

Each of the seven adults mentioned that in certain cases the similarity of the block as a whole to the picture was noted, and in other cases, the association was between one small part of block and picture. The same holds true of the children in many instances, where comments such as, "This block is just like this picture" or, when one small element was selected as, for instance, the sloping side of block 12 over which one child daily ran his finger and then ran it over the corresponding slope in the picture of the old-fashioned desk and remarked that they were "just alike" or "just the same." By both children and adults, block 8 was associated with the picture of the goblet because of the curve on each side and not by the resemblance as a whole. This holds true for several other blocks and their corresponding pictures. Four of the adults mentioned that in certain instances the resemblance was
seen first as a whole and then as a resemblance between elements. Six of the adults mentioned that when a part was picked out and responded to, there was a tendency to ignore all other parts.

Two of the adult subjects mentioned localization as an aid to learning. The position of the middle blocks or end blocks was frequently thought of and noted as the experimenter picked up the block to show the subject with which picture it was to be associated and noted again as the experimenter replaced the block upon the table. It was found that a very few of the children, when all or nearly all of the correct associations had been built up, responded in part through localization of the blocks.

Six of the adults mentioned "subvocal verbalization" or "verbal inner speech" as an aid to learning; six mentioned kinaesthetic imagery in connection with certain of the associations, and four mentioned visual imagery. There is, of course, no data available as to these processes in the preschool subjects.

One adult subject mentioned that in the case of her responses it was "all or nothing." She either knew immediately or did not know at all which was the correct response. Her score was sixteen. Two other subjects stated that when they did not know which one was the right block they looked around for the block most like the picture and in some instances this
resulted in the arousal of the association that had been in mind when the examiner was demonstrating which block and picture were to be associated, and therefore the correct response was given.

Comments made by the children and introspections on certain associations made by the adults in regard to specific blocks and pictures should be of interest in addition to the summarized statements that have just been given.

The association with which there was the most affective tone was between the picture of the flower and the corresponding block, block 18. Subject E stated, "The block was just the same general shape as the picture of the flower. The curves of the block and of the picture had a sort of soothing, restful effect." Subject F said, "That was a real joy. A kind of feeling of relief and satisfaction. The center of the flower faded out and the outlines corresponded very nicely. There was a tendency to fit this block on the picture. The block sort of floated over on the picture and filled in the contour. It's the same size. The little lines in the center faded out and the effect was a feeling of satisfaction." Subject G's introspection on this association was as follows, "In several cases the general form of the block and picture are similar. This is true here. About the same size and same outline. It made me think of flowers in my grandmother's flower bed, her favorite flower. I had a visual image of my grandmother's
flower bed. The association was very pleasing." The children made less detailed comments on this association than was made by adults, but among the children it was this association more than any other that brought out comments indicative of affective tone. Their comments were very often a short statement, such as "That's a pretty flower," "I like that flower," "I'd like to have a pretty flower like that," "That's the prettiest picture," "I like that best of all."

The association that brought out the greatest kinaesthetic imagery was between block 13 and the picture of the flying bird. Subject C stated, "In that association, it was a feeling of motion, so I looked for the block that nearest suggested motion to me even before you picked up and showed it to me. The points didn't mean a thing to me, but now I see that one could associate the points on the block with the points on the wing of the bird and points on the bird's tail." Subject D combined both of these possible means of forming the required association but the feeling of motion predominated. She stated, "I thought of this point and this point here on the block (indicating points on bird's wings and points on block). There was a feeling of the instability of this (the block) and the flying bird. There was a motor feeling here - a certain tension of the muscles of the shoulder and I had a feeling of taking in my breath. It was a feeling of conscious expectation, a feeling of motion too."
It was the bird as a whole flying and the whole block more than the points, but it was the two criteria. It was the flying bird. If the bird had not been flying it wouldn't have done any good. I wouldn't have found the association so easy. I got the idea of motion from the block too." Almost all of the children referred to the bird as the flying bird, but whether or not they had kinaesthetic imagery is impossible to state.

The data from the adult reactions alone would form an interesting study which can not be gone into here. Enough material has been given to show that there is a decided similarity in the method of forming the associations by both adult and preschool subjects.

Order of Difficulty in Forming the Required Associations

The order of difficulty in forming the required associations among the preschool children was found by an actual analysis of all correct and incorrect responses. In order to obtain, at least roughly, the order of difficulty in forming the required associations by adults, each adult was asked, after having given his introspections, to arrange the blocks upon the table in what seemed to him the order of difficulty in forming the association. As it would be extremely difficult, if not impossible, for a person to arrange the twenty blocks in order of difficulty, the subjects that were told/they could group the blocks according to degree of difficulty. The subjects were not told any
certain number of groups into which the blocks were to be put. It was interesting to note that subjects B, D, E, F, and G placed the blocks in six groupings arranged from easiest to most difficult. Subject A placed them in five groupings. As subject A was the last of the adults to perform the experiment, after she had grouped the blocks into five groupings she was asked if it would be possible for her to make one more grouping. This was done so that the groupings could be compared, since all of the other subjects had without direction separated the blocks into six groups. Subject C was the first of the adults to perform the experiment and he was not asked to arrange the blocks in order of difficulty. It was a few days after subject C had been given this learning material that the experimenter decided to add the arranging of blocks in order of difficulty to the adult performance of this experiment. This explains why in Figure 27, which shows the order of difficulty on associations with twenty blocks for a selected group of adults, the column for the arrangement by subject C is blank.

In Figure 27, the letters A, B, C, D, E, F, and G represent the seven adults who were subjects of this part of the experiment. The columns on the left half of the figure represent the order of difficulty in forming the associations, as shown by the subjects' groupings of the blocks into six groups.
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**Figure 27**

Order of difficulty on associations with twenty blocks for a selected group of six adults.
In this figure, 1 represents the group of easiest associations, 2 those that are next in difficulty, 3 those that are still more difficult, and so on to 6 which represents those associations that the adults believe are the most difficult of all the associations to form. The right half of the table gives the frequency of each block in regard to the grouping into which it was placed.

A comparison of Figure 27, the order of difficulty in the formation of the associations by adults, with Figure 23, the order of difficulty in the formation of the same associations by preschool children, reveals some interesting facts. It must be kept in mind that Figure 23 represents actual order based upon correct and incorrect responses, and Figure 27 represents only approximate order as arranged by the adult subjects.

Each adult picked out block 1 as the easiest association of all. This agrees perfectly with responses given by the preschool children. Block 18, which is associated with the flower, is placed in the easiest group by four adults and in the next to the easiest group by the two remaining adults. Results show that it was just as easy as block 1 for the Junior Primary children and held third place in order of difficulty for both preschool and kindergarten children. Block 13, which was second in order for the preschool and kindergarten children and third for the Junior Primary group is classed in the easiest
group by five adults and in the second group by one adult.

Although there are a number of discrepancies in regard to the difficulty in forming certain of the associations by children and by adults, on the whole there is a high degree of correspondence in order of difficulty in forming the twenty associations involved in this association reaction learning material when adult and preschool subjects are compared. The methods of forming these associations are also similar to a large extent.
CHAPTER VI
SUMMARY, RESULTS, AND CONCLUSIONS

The purpose of this investigation was to study the psychology of the learning process of young children. The method of approach was through controlled association reaction. Twenty small blocks of geometrical design and twenty simple outline pictures that resemble the blocks in some way furnished the material for this learning experiment. The aim was to use as simple material as possible and to have the response of the child as simple as possible, and at the same time to use material that has an appeal for young children. The learning involved consisted in forming the correct association between each one of the pictures and one of the blocks. The plan of having a certain similarity between block and picture was decided upon in order that the learning would be not too difficult for preschool children. The twenty blocks were devised in such a way that the complete series of blocks may be regarded as consisting of two parallel series arranged in approximate order of complexity, from the simpler to the more complex. Each block of Series II, blocks 11 to 20, is a modification, or variant, of the block that parallels it in Series I, blocks 1 to 10. The material was designed in this way purposely so that it might be presented in several different forms, known as standard and variant
forms, and learned according to various methods in order to investigate some of the important problems involved in the study of the learning process. The criterion of learning in this experiment was three successive perfect trials. Complete learning was checked by reversing the learning situation.

The subjects of the investigation were 205 children from the Preschool Laboratories of the Iowa Child Welfare Research Station and from kindergartens in another city. The chronological age range of these children was from two years and two months to six years and five months; and the Stanford-Binet mental age range was from three years and eight months to eight years and eight months. The majority of the children had one trial daily. Groups of children were paired carefully on the basis of close similarity in Stanford-Binet mental age, height, and weight, and the learning of the children in one group who had one trial daily was compared with that of another group who had one trial every other day. The learning of children in one group who were given only the first half of the material was compared with the learning of those to whom only the second half of the material was presented. Some of the children who had completely learned the material according to one form of presentation were given it to learn according to one of the other forms in order to study whether there
was transfer or interference in the learning. To a small group of children the material was given for relearning exactly one year after the date of the original learning of the material.

From a quantitative and qualitative analysis of the data from this experiment the following results and conclusions have been obtained:

1. One of the criteria of learning used in the experiment is the attainment of three consecutive perfect scores. The results of the present investigation show that one perfect performance is inadequate as a criterion of learning, but that when a child has given three successive perfect responses the material may be regarded as having been completely learned.

2. Since the effect of absence on the child's record on learning would be a factor that cannot be measured, and since in any learning situation the distribution of work periods and rest periods is of great importance, it was arbitrarily decided before beginning the investigation to discontinue work with any subject who was absent for more than three consecutive days. Among the total number of subjects under discussion, there are almost two and a half times as many children who had not a single day's absence as the total number of children who had from one to five days' absence; no child was absent exactly six times, and one child was absent seven times, which was the maximum. The
influence of absence on progress in learning has, therefore, been reduced to a minimum.

3. Almost every child made some comment upon the similarity of certain of the pictures and their corresponding blocks. The resemblance between pictures and blocks was evident enough for even the youngest of the children to observe and comment upon certain of the resemblances. Frequently a child pointed out a resemblance and then added a comment that no doubt helped to fix the association in his mind.

4. The results of this experiment are scored on the basis of the number of trials required for complete learning. When the learning material was presented daily to the child, the average number of trials for the preschool children was 13.56; for the junior primary children 7.42, and for the kindergarten children 7.08. It is interesting to note that the average number of trials required for learning by the preschool children is reduced almost 50 per cent by the junior primary and kindergarten children.

5. For this type of learning, presentation of material on alternate days resulted in greater economy of learning than presentation of material on successive days. The results of the junior primary children who were paired for this part of the experiment show that the group composed of the first child
of each pair to whom the learning material was presented daily required an average of 8.73 trials for complete learning, and the group composed of the second child of each pair to whom the material was presented on alternate days required an average of 5.75 trials. The average curve that represents learning on successive days shows more fluctuation than the average curve that represents learning on alternate days.

6. Relearning of the material after an interval of one year is accomplished in fewer trials for all children used in this part of the investigation than were required for the original learning.

7. A correlation of .33 was found between the number of trials required to learn the material according to the standard form and the number of trials required to learn it immediately after when the learned associations were interchanged. This correlation is sufficiently high to be interpreted that the learning of the associations according to the standard form assists in the learning of the interchanged associations rather than interferes with their learning.

8. Results show a marked similarity between the number of trials required by one child of a pair to learn the ten associations of the first half of the complete series, and the number of trials required by the other child of the pair to learn the ten associations
of the second half of the complete series. The correlation between the number of trials required for learning Series I and Series II was \( r = 0.98 \). The average number of trials required for learning Series I was 5.61 and for learning Series II was 5.79. The average number of trials required for learning Series I and Series II was found to be 5.75. It is an interesting point to note that the average number of trials for learning the complete material according to the standard form of presentation and on alternate days was 5.75, and the average number of trials required for learning only one half of the material on successive days was 5.75. These results seem to have significance from the standpoint of effect of distribution of practice periods upon learning.

9. Three successive perfect scores were followed by one trial of a different nature that served as a check on learning. For various reasons, some children were not given this check. Of 171 children who had attained three successive perfect scores and were given the check on learning, 166 attained a perfect score on the trial of the check and five children only attained less than a perfect score on the check.

10. Of the 182 children who completed the learning of the material, 113 (62.1 per cent) have no plateaus in their learning curves and sixty-nine have from one to five plateaus. Of the 120 children who
learned the material according to the standard form of presentation on successive days, the largest number of children who can be grouped together on the basis of a common factor, seventy-five (62.5 per cent) have no plateaus and forty-five have from one to five plateaus. It is an interesting fact that the percentage of children having no plateaus is the same for all forms of presentation considered collectively and for the standard form of presentation, the form by which the largest number of children learned the material. The greatest number of plateaus occurs among the curves of the younger children. From these facts it may be concluded that plateaus are not a necessity and that whether or not they occur seems to be a matter of individual differences and maturity. The majority of the plateaus may be regarded therefore, as epiphenomena, i.e., chance fluctuations without statistical significance.

11. The difference in response on the first trial between children accustomed to psychological tests and those unaccustomed to them is well demonstrated in the results obtained on the junior primary and kindergarten groups, in which the children are comparable in age and school status. The children from the Preschool Laboratories of the Iowa Child Welfare Research Station are thoroughly accustomed to psychological test conditions. The kindergarten children are totally unfamiliar
with psychological tests. The kindergarten children unaccustomed to test conditions begin with lower scores, but complete the learning in the same number of trials as children of the same mental age who are habituated to the taking of psychological tests.

12. An analysis was made of the correct and incorrect responses given during the experiment as a means of studying the order of difficulty in forming the required associations. There is a very close similarity between the order of difficulty for the children in the three groups. As would be supposed, the order of difficulty is more similar between the junior primary and the kindergarten children than between the preschool and the junior primary children or between the preschool and the kindergarten children. Correlations for each combination of two of the groups of children based on the similarity in order of difficulty in forming the required associations were (1) preschool .84 ± .04; (2) preschool and kindergarten and junior primary/.86 ± .04; (3) junior primary and kindergarten .95 ± .17.

13. The reliability of the experiment was found by correlating the scores on one half of the material (Series I) with the scores on the other half of the material (Series II) and was found to be .83 ± .01 for both the Iowa City and kindergarten children. When the reliability coefficient of the experiment was found by correlating the scores on "odd" and "even" items of the material it was found to be .87 ± .01 for the Iowa City children and .85 ± .01 for the kindergarten children.
When the Spearman-Brown prophecy formula was applied for the two halves of the material, the result was .91 for both groups. When the Spearman-Brown prophecy formula was applied for the "odd" and "even" items of the material, the result was .93 for the Iowa City children and .92 for the kindergarten children. The correlation of Series I and Series II referred to above is based upon the records of the children who learned all of the material of both series together as one series.

A correlation of the scores on Series I and Series II of paired kindergarten children, one of each pair having learned Series I only and the other of the pair having learned Series II only, gives a reliability coefficient of .98 ± .05.

The correlations between number of trials necessary for complete learning of the material and Stanford-Binet mental age were -.40 ± .06, -.47 ± .07, -.48 ± .10, -.52 ± .06, -.58 ± .07 for the various groups. The negative correlations must be interpreted as follows: on the Stanford-Binet, the higher the mental age in relation to the chronological age, the better is the child's performance; whereas, for the learning material, the fewer the number of trials required for complete learning, the better is the child's performance. Thus, instead of having an increase in score to denote superior performance on the learning material, as is the usual method of scoring psychological tests, a superior performance on the learning material is denoted by a decrease in number of trials required for complete learning as compared with
the number of trials required for complete learning when the performance is either average or below average. The correlations are sufficiently high to be interpreted that the higher the mental age, the fewer the number of trials required for complete learning of the association reaction learning material. The number of trials necessary for complete learning correlates better with mental age than with chronological age.

15. The correlation between number of trials required for complete learning of the association reaction material and scores on the Detroit Kindergarten test was \(-0.33 \pm 0.08\) for the kindergarten children, indicating that those children who are above average in mental age require fewer than average number of trials for completing the learning. On a small group of the Iowa City children, about one-third as many as were included in the kindergarten group, the correlation between number of trials and score on Detroit kindergarten test was found to be \(-0.26 \pm 0.15\), and therefore not significant.

16. The correlations between number of trials required for complete learning of the association reaction material and scores on the Goddard-Seguin form board test, manikin test, and Montessori cylinders test were computed, but in no case were found to be significant.
REFERENCES

Learning in Preschool Children

